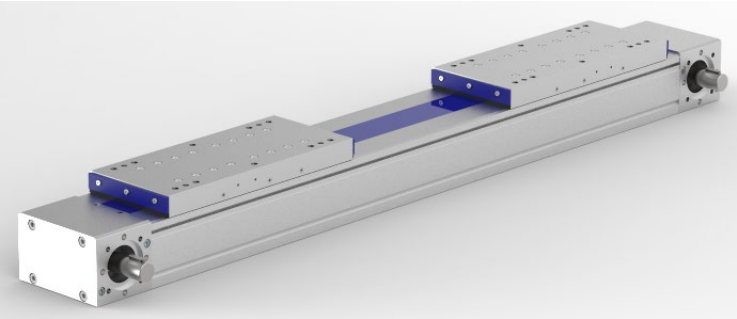
Assembly and Maintenance Instructions

Linear unit



Type
Beta 140-ZRSD

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1 Safety

These assembly and maintenance instructions are part of the unit and must be kept readily available at all times for reference.
The instructions must be passed on together with the unit to any third party.

It is important that you contact the manufacturer should there be any part of these operating instructions that you do not clearly understand.

1.1 Symbols used

In these operating instructions, the following warning symbols and other symbols are used:

DANGER

Indicates immediate danger.
Failure to comply with this instruction risks death or serious injury.

WARNING

Indicates a hazard involving a medium to high risk.
Failure to comply with this instruction may result in death or serious injury.

CAUTION

Indicates a hazard involving low risk.
Failure to comply with this instruction may result in minor or moderate injury or material damage.

☛ Note
Indicates tips for handling and optimum use of the unit.

1.2 Intended use

The mechanical linear unit is designed for installation in machinery and is solely intended for manipulating, positioning, transporting, palletising, loading, unloading, clamping, synchronising, tensioning, testing, measuring, handling and pressing of component parts or tools.

Please take note of the principal application areas of the linear unit (see Section 4 and Section 3).

In order to guarantee compliance with the law concerning the electromagnetic compatibility of devices (EMC directive), the mechanical linear unit may only be used for industrial applications.

Utilisation of the product for any other purpose would constitute inappropriate use. The manufacturer accepts no liability for any damage resulting from such use. The risk is borne solely by the user.

1.3 General safety

Date of commissioning

The linear unit may only be operated when the machine or installation in which it has been installed is found to comply with the following guidelines, laws, regulations and standards:

- EC/EU directives
- standards regarding electromagnetic compatibility of equipment

Safe operation

To ensure safe operation, please observe the following documentation:

- These operating instructions for the linear unit, in particular the technical data
- The operating instructions for the entire installation

Decommissioning

Dispose of the product in accordance with the applicable national requirements. Observe the safety data sheets.

1.4 Use in clean rooms (ISO 14644)

When using the linear units in clean rooms, they are equipped with a vent hole (normally G1/2") in the basic profile.

The following specifications must be adhered to:

- A partial vacuum of 0.2 bar must be applied to the linear unit.
- The linear unit must be lubricated with grease approved for clean room use (initial lubrication with Klübersynth BEM 32-34).

1.5 Use in potentially explosive areas

The linear units are suitable for use in explosive atmospheres in zones according to their ATEX marking. In addition to these assembly and maintenance instructions, the document **" FM_319_Use-in-Atex-zones-MuW "** must also be observed.

1.6 Technical condition of the linear unit

State of the art technology

The unit conforms to the current state of the art and applicable rules and regulations. The device complies with the EC Machinery Directive and the relevant Harmonised Standards (European standards). Furthermore, the EC Declaration of Incorporation applies.

1.7 Modifications to the linear unit

Rebuilding and modifications

No modifications, either to the construction or relating to safety, are to be made to the linear unit without the prior written agreement of HSB. We accept no liability for any unauthorised modifications carried out to the unit.

The operator may only carry out the maintenance and repair work specified in these operating instructions. Any further work involving the replacement of wearing or substitute parts may only be carried out following consultation with our service technicians and by the service technicians themselves or by HSB.

Never remove or decommission any safety or protection devices.

Follow the assembly instructions supplied by the manufacturer when using special attachment parts.

1.8 Requirements for personnel

Any work involving live parts may only be carried out by trained electricians. This work includes:

- Installation of safety limit switches
- Attachment of a drive
- Checking the drive rotation direction

1.9 Responsibilities of the operator

Preservation of labels	The operator must ensure that any lettering, information signs or labels are fully legible (in particular the serial number) and always observed. Any damaged or illegible information signs and labels must be replaced.
Accident Prevention and Environmental Protection	The applicable regulations for accident prevention and environmental protection must be observed.
Disposal	Dispose of the product according to the relevant national regulations. Refer to the safety data sheets.

2 Warranty

The warranty conditions are specified in the sales documents (delivery and payment conditions). Any warranty claim is voided if:

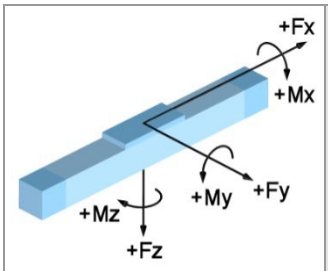
- the unit has not been used in accordance with its intended use
- these operating instructions have not been adhered to
- the unit has been modified without prior authorisation from the manufacturer
- screws sealed using locking paint have been opened

The manufacturer is liable only if genuine substitute parts have been used during any maintenance or repair work carried out on the unit.

3 Technical data – standard design

Linear unit technical data **Beta type with toothed belt drive**	**Unit size** **Beta 140** **ZRSD**
Drive element	Toothed belt
Stroke per revolution [mm]	180
Max. speed [m/s]	8.00
Max. acceleration [m/s^2]	60
Idle torque [Nm]	2.85
Maximum stroke (standard) [mm]	3100
Repeat accuracy [mm]	±0.08
Operating temperature [°C] (continuous operation)	0...80
Geometrical moment of inertia I_Y [mm^4]	3137166
Geometrical moment of inertia I_Z [mm^4]	9107732
Length of standard carriage [mm]	320
Weight (without stroke) [kg]	19.20
Weight (per 100 mm stroke) [kg]	1.30
Weight of standard carriage [kg]	6.30
Max. noise emission [dB A] [1)]	80

[1)] The value changes when assembled with other parts of the installation.



Forces and moments for Beta linear unit with toothed belt drive

Type designation	Dynamic forces [N]				Dynamic moments [Nm]			
	F_X	F_Y	F_Z	$-F_Z$	M_X	M_Y	M_Z	M_{idle}
Beta 140-ZRSD	1000	2500	5000	3000	350	700	500	2.85

M_{idle} = Idle torque ±30 %
The specified forces and moments are maximum values for the relevant single load. The individual values must be reduced for a mixed load or for simultaneous occurrence of several torques or moments. If in doubt, please contact technical support.

Static and dynamic load ratings for roller guides in Beta linear unit

Unit size	Size (∅) [mm]	Number of bearing rollers for Fz	Number of bearing rollers for Fy	Load rating per roller C_{stat} [N]	Load rating per roller C_{dyn} [N]	Guiding distance* in x direction [mm]		Guiding distance in y direction [mm]
						lx1	lx2	ly
Beta 140	35	4	2	3,000	6,800	202	202	98

The pretensioning per roller is approx. 5%.

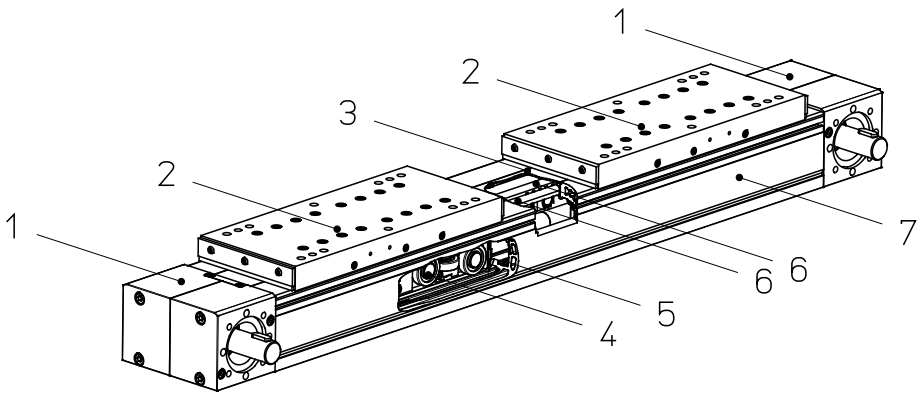
Tightening torques [Nm] for fastening screws							
Fastening screws	**M4**	**M5**	**M6**	**M8**	**M10**	**M12**	The values specified are standard values. The values must be adapted accordingly for shorter screw-in depths.
DIN912/ISO4762-8.8	2.7	5.4	9.0	22.0	43.0	74.0	
DIN912/ISO4762-10.9	3.0	5.7	9.0	22.0	43.0	74.0	
DIN912/ISO4762-12.9	3.0	5.7	9.0	22.0	43.0	74.0	

Tightening torques [Nm] for coupling with clamping hub					
Size	**14**	**19**	**24**	**28**	**38**
Coupling diameter [mm]	30	40	55	65	80
Screw size	M3	M6	M6	M8	M8
Tightening torque [Nm]	1.34	10.50	10.50	25.00	25.00

Tightening torques [Nm] for coupling with clamping ring					
Size	**14**	**19**	**24**	**28**	**38**
Coupling diameter [mm]	30	40	55	65	80
Screw size	M3	M4	M5	M5	M6
Tightening torque [Nm]	1.34	2.90	6.00	6.00	10.00

4 Product description

Linear unit with toothed belt drive



Key				
	1	Bearing housing	5	Guide band
	2	Carriage	6	Toothed belt
	3	Cover band	7	Basic profile
	4	Roller		

Figure 1: Sub-assemblies of Beta 140-ZRSD linear unit with toothed belt drive

A mechanical linear unit converts rotation into linear motion and thus facilitates fast, safe and accurate movement of loads from one position to another. It consists of a basic aluminium profile, (at least) two moveable carriages that are supported by a guide element (track roller guide), and a drive element (toothed belt drive).

Depending on the design, the carriage can absorb forces and moments in all directions and is non-positively connected to the guide and drive element via the carriage plate.

The basic profile is self-supporting up to a certain length and fitted with grooves to keep it in place.

Optionally the linear unit can be fitted with accessories such as a cover, inductive or mechanical limit switches and other add-on parts (see Section **6.3**).

The operating area can be flexibly arranged. Several linear units of Alpha, Beta or Delta types can be configured to cover a large area (2 axes) or a spatial arrangement (3 axes).
A plate can be used to connect driven linear units to non-driven linear units of the same type, for example in order to be able to take on large loads.

5 Transport and storage

The mechanical linear unit is a precision instrument. Any heavy impact to this instrument may damage the mechanics and impair its functionality.

CAUTION

Risk of damage due to heavy impact or bending.
Only transport an assembled linear unit using transport locks.

In order to avoid any damage to the linear unit when storing or transporting it, the following measures must be taken in order to protect it from jolting or slipping:

- Transport the unit in a sufficiently large container
- Use cushioned packaging

The weight values for the units are listed in Section 3.

The units must be protected against:

- Dirt
- Corrosion
- Water
- Aggressive atmosphere

6 Assembly and alignment

The linear unit can be mounted as follows:

- With mounting brackets
- With screws in the sliding blocks
- With screws in the factory-fitted threaded rails (optional)

☛ Mount the linear unit on flat surfaces only. Standard parallelism <0.2 mm/1000 mm.

☛ Mounting the linear unit using the threaded rails is recommended for the following situations:
for highly dynamic applications
where the linear unit is attached at only 2 attachment points

6.1 Assembling the linear unit with mounting brackets

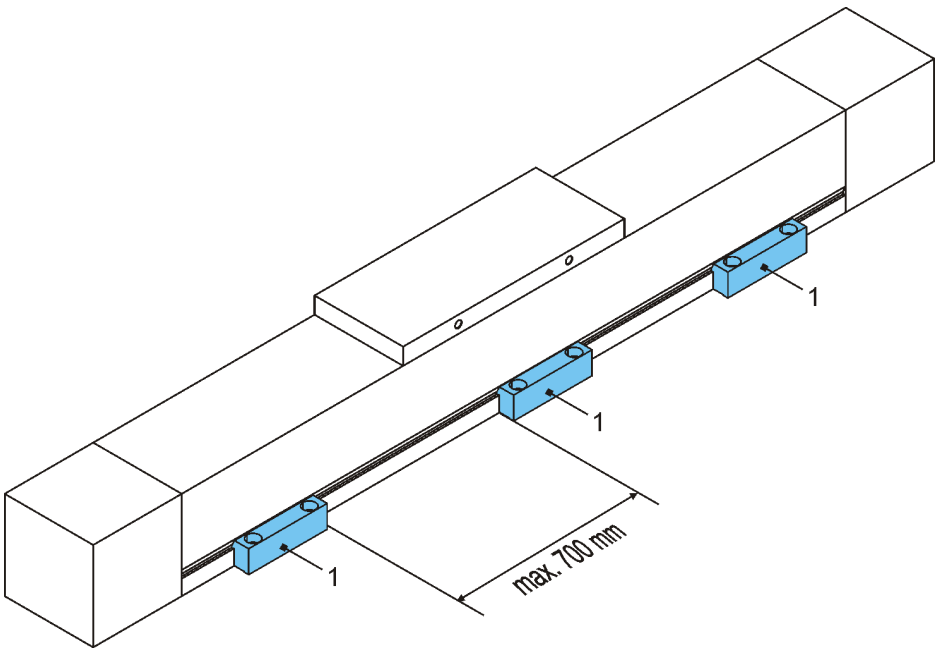


Figure 2: Mounting brackets (1)

☛ The recommended maximum distance between the mounting brackets is 700 mm.

Method

1. Loosely fit the mounting brackets (1) in position (Figure 2).
2. Align the linear unit axially.
3. Screw the mounting brackets (1) into place
(for tightening torques see Section 3).

6.2 Screw linear unit into place from underneath

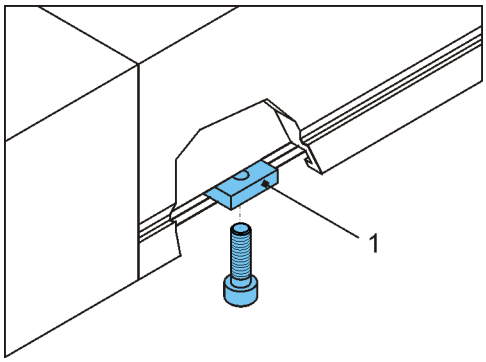


Figure 3: Sliding blocks (1) in the slot on the underside of the basic profile

Secure the linear unit in the basic aluminium profile from below with fastening screws using the sliding blocks or the threaded rails (Figure 3).

Method

1. Align the linear unit.
2. Align the sliding blocks (1) / threaded rails.
3. Screw the linear unit into place
   (for tightening torques see Section 3).

6.3 Setting the maximum stroke

DANGER

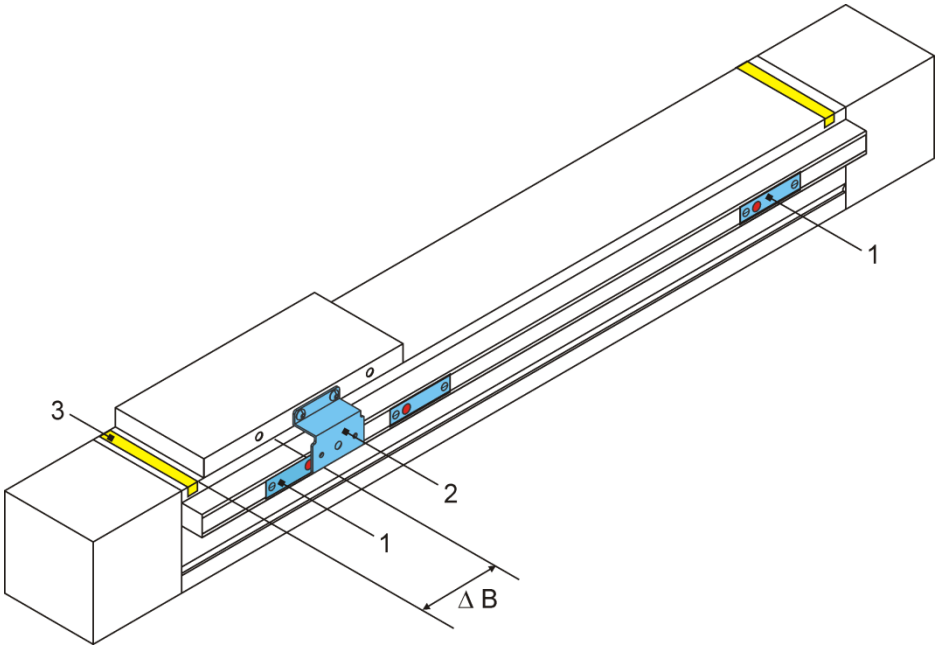
Risk of serious injury from overturning transport devices.
Should the carriage come to a stop beyond the safety area, the transport device mounted on this may break off or overturn. The linear unit can be damaged beyond repair.
Please take note of the specified safety area when setting up the unit and set the limit switches accordingly.
Electric switches may only be connected by a qualified electrician.

☛ Allow for a sufficient braking distance to ensure that there is enough time to slow down the carriage in the case of an emergency stop.

6.3.1 Adjusting the position of the inductive limit switches

The task of the inductive limit switches is to shut down the electric drive before the mechanical limit of travel is reached.

The necessary braking distance (Δ B) depends on the speed and deceleration. This braking distance must be less than the distance between the trip point of the limit switch and the actual mechanical limit of travel.



Key		
	1	Inductive limit switch
	2	Switching cam
	3	Band marking the safety area

Figure 4: Inductive limit switches

CAUTION

The limit switches must trip so that the carriage comes to a stop immediately short of the safety area. On delivery, the safety area is marked with a band (3).

Method

1. Switch on the power supply for the limit switches.
2. Loosen the fastening screws for the limit switch.
3. Move the carriage to the braking position.
4. Move the limit switch (NC) far enough under the switching cam for it to trip and the LED on the sensor to go out.
5. Move the carriage away.
6. Tighten the limit switch fastening screws.
7. Check the correct position of the limit switch: Move the carriage along by hand and check the switch tripping point.
8. Fit the limit switch bar cover.

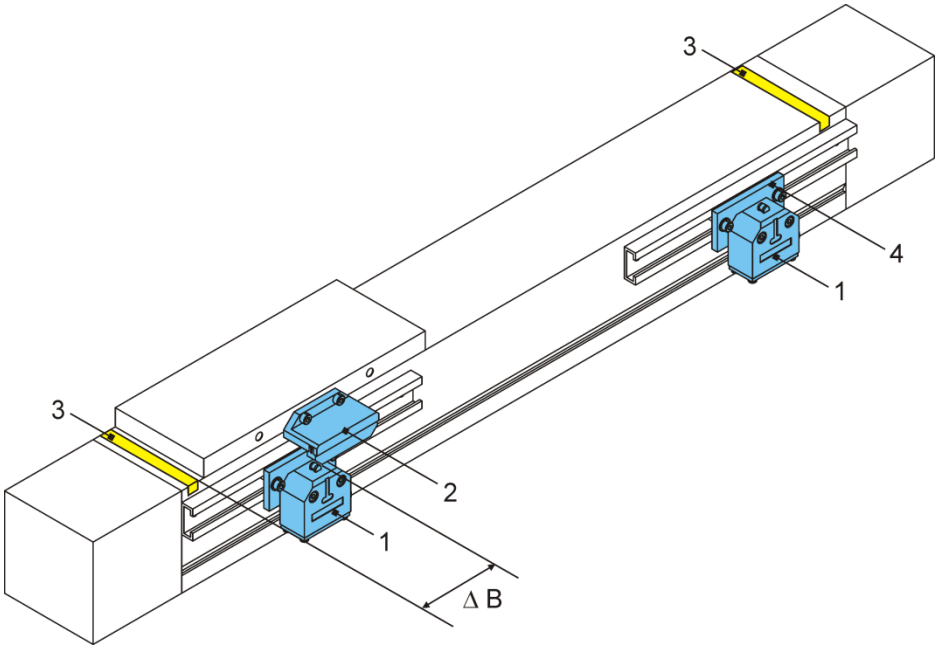
6.3.2 Adjusting the position of the mechanical limit switches

Mechanical safety limit switches (NC) must be used if there is a risk that persons may be endangered unless the electric drive shuts down immediately.

The drive may only be started up once all limit switches are correctly set and are closed.

Mechanical safety limit switches may be combined with inductive limit switches.

External dampers must be fitted as protection against mechanical damage.
The necessary braking distance (Δ B) depends on the speed and deceleration. This braking distance must be less than the distance between the trip point of the limit switch and the actual mechanical limit of travel (Figure 5).



Key	1	Mechanical limit switches
	2	Switching cam
	3	Band marking the safety area
	4	Retaining plate
	B	Braking distance

Figure 5: Mechanical limit switches

CAUTION

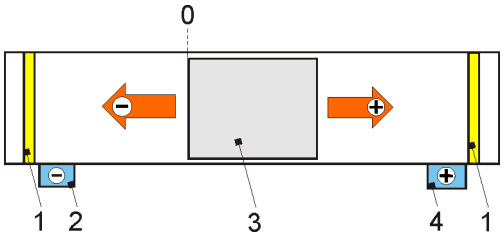
The limit switches must trip so that the carriage comes to a stop immediately short of the safety area. On delivery, the safety area is marked with a band (3).

Method

1. Switch on the power supply for the limit switches.
2. Loosen the clamping screw for the retaining plate (Figure 5).
3. Move the carriage to the safety area.
4. Push the limit switch along until it trips.
5. Tighten the clamping screw on the retaining plate.
6. Check the correct position of the limit switch: Move the carriage along by hand and check the switch tripping point.
   If this leaves insufficient braking distance, repeat the adjustment process.

6.4 Installing the drive

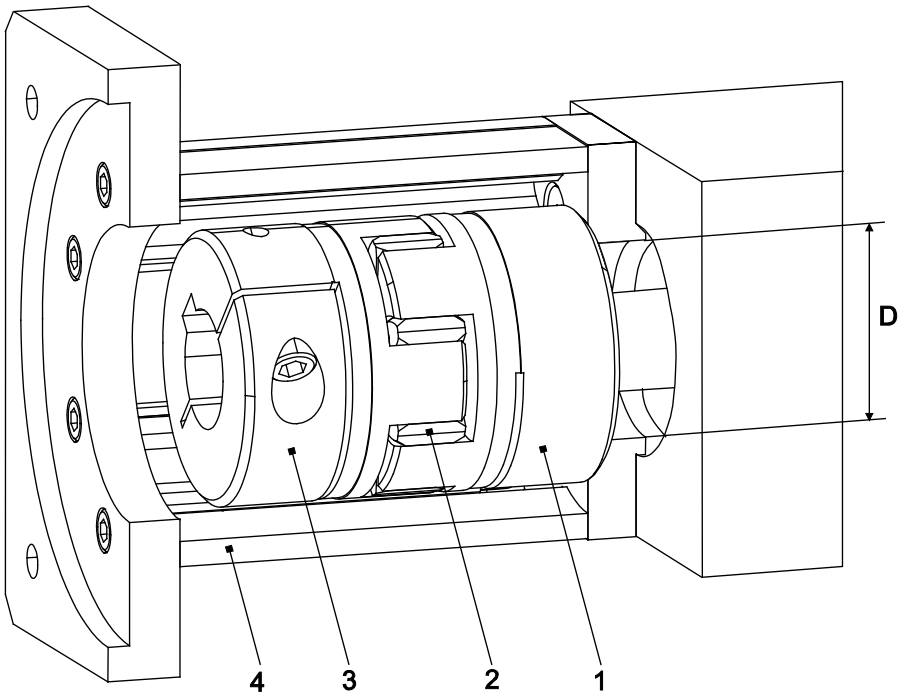
Make sure that the direction of rotation of the external drive corresponds to the direction of rotation of the spindle or the toothed belt, so that the limit switches operate correctly.



Key				
	1	Safety area	3	Carriage with plus and minus direction of travel from reference point 0
	2	Minus direction limit switch	4	Plus direction limit switch

Figure 6: Example of direction of travel and limit switch wiring

6.4.1 Installing the motor



Key				
	1	Coupling half 1	4	Motor mounting
	2	Coupling collar	D	Diameter at motor mounting
	3	Coupling half 2		

Figure 7 Motor mounting with motor coupling at drive journal

Method

1. Place the motor and the coupling elements in the mounting position alongside the linear unit.
2. Check the direction of rotation of the motor. It must take into account the safety limit switches (Figure 6). Change the direction of rotation of the motor if required.
3. If the coupling diameter is smaller than dimension D at the motor mounting (4), first fit coupling half 1 (1) (bore flush with the drive shaft) and then the motor mounting (4) (Figure 7).

   If the coupling diameter is larger than dimension D at the motor mounting (4), first fit the motor mounting (4) and then coupling half 1 (1) (bore flush with the drive shaft). Tighten the coupling clamping screw using the mounting bore at the motor mounting (4).
4. If necessary, push the coupling collar (2) onto the coupling.
5. Attach coupling half 2 (3) to the motor journal.
6. Attach the motor to the motor mounting.

Tightening torques [Nm] for clamping screws

Screw	Size	Torque
M6	5	14
M8	6	35
M10	8	65
M12	10	74

7 Commissioning

WARNING

Injury or damage to other parts of the installation
due to fast linear motion of the transport devices
due to centrifugal load.
Only authorised personnel are permitted to commission the linear unit.

DANGER

Risk of crushing due to incorrect direction of movement of the transport device.
Should the direction of rotation of the drive (motor or gearbox) and the carriage drive (spindle or toothed belt) not correspond, the transport device mounted on it may travel in the wrong direction. In the vicinity of all rotating parts, e.g. GX shaft and in the area of the toothed belt (when used without cover band), there is a risk of being pulled in, and of clothing or body parts becoming entangled and trapped. There is also a risk of crushing around the moving carriage. These hazards can be countered by installing effective safety mechanisms that comply with the current standards and are state-of-the-art. These are not supplied with the linear unit and must be installed by the manufacturer of the overall installation.
Use of the deflection belt drive without the protective hood supplied is not permitted.
Only qualified electricians are permitted to carry out any work on the electrical installation or check the direction of rotation.

Checking the unit before commissioning

Before commissioning, the following must be checked:

- whether the holding devices used are consistent with the mass and acceleration information provided by the manufacturer
- whether the machine or installation in which the linear unit is installed complies with the provisions set out in the machinery directive, the harmonised standards, the European standards or the national standards
- whether the linear unit is correctly mounted
- whether the inductive and/or mechanical limit switches are correctly connected and functioning properly
- whether the direction of rotation of the motor shaft and, if applicable, the intermediate gearbox corresponds to the direction of rotation of the spindle or the toothed belt

If faults are detected during this inspection, commissioning is not permitted.

Test run

To prevent accidents, collisions and possible errors in the programming, move the linear unit along the stroke several times at such a low speed that it can be stopped in good time in case of an emergency.

The installation can be started up once it has been ensured that there is no risk of a collision when exceeding the maximum stroke.

8 Operation

DANGER

The drive motor can heat up considerably during operation.
In this case, refer to the operating instructions supplied for the drive motor.

CAUTION

Risk of damage due to harmful environmental influences.
The linear unit may only be operated under ambient conditions which are permitted by the manufacturer.

Ambient conditions

The linear unit may only be operated within the permitted temperature range of 0 - 80 °C.

Operating the unit in damp, abrasive conditions may result in foreign objects entering components in the linear unit. To prevent this, as part of the integration of the linear unit into the entire plant, measures may need to be taken to prevent foreign bodies from penetrating, e.g. using folding plates, baffle plates, sealing air.

Required inspection

The linear unit must be occasionally checked during operation to see that it is functioning correctly.

The personnel responsible must check the linear unit and the machinery for any visible signs of damage or defects at least once during each shift.

Should any changes be observed which may compromise safety, it must be switched off immediately.

Emergency stop

The maximum permissible load values must not be exceeded even in an emergency stop situation.

As a rule, the category 1 emergency stop strategy (targeted braking to standstill, then de-energise) is chosen for automation equipment with moving masses. A simple emergency stop strategy is not usually effective, as the masses are still moving and can cause damage.

End position damping

The end stops and stop buffers installed in our linear modules protect the unit at low speed (commissioning). They are definitely not intended to completely protect the unit against damage at high speed and/or with a large mass.

9 Decommissioning

WARNING

Risk of injury or damage to other parts of the installation due to falling parts.
Only authorised personnel are permitted to disassemble the linear unit.

1. Disconnect the machine/installation from the mains supply.
2. Detach the drive from the linear unit.
3. Unscrew the linear unit from the machine/installation.

10 Maintenance

DANGER

Around all rotating parts, e.g. GX shaft and around the toothed belt (when used without cover band), there is a risk of being pulled in, and of clothing or body parts becoming entangled and trapped. There is also a risk of crushing around the moving carriage.
For this reason, lubrication of the linear unit may only be carried out while it is moving slowly (max. 0.025 m/s), and for any cleaning work the linear unit drive must be shut down and secured against being restarted.

- All installed ball bearings are sealed and maintenance-free.
- Remove excessive dust and dirt from the cover band and other parts of the linear unit regularly.
- The toothed belt is maintenance-free. Replace the toothed belt should there be any breakage or strain beyond the elastic zone.

10.1 Lubrication

Initial lubrication

☛ Basic lubrication has already been carried out by the manufacturer.

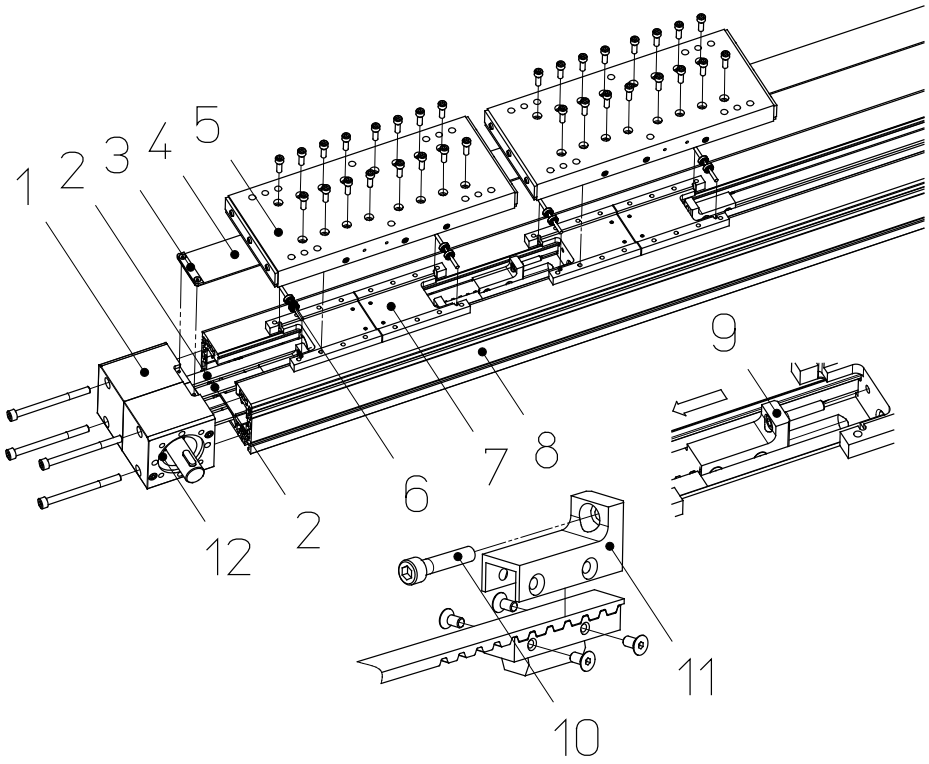
Note

Under normal operating conditions (dry environment, no dust etc.), the roller guide is lifetime lubricated by integrated lubricating felts.

10.2 Replacing the toothed belt

☛ To ensure optimum functioning of the linear unit and to prevent damage during operation, it must be ensured during installation that no foreign bodies enter the basic profile or other parts of the linear unit.

☛ Do not damage the standard parts (bolts, pins etc.) and the cover band with its elements as they are reused.



Key				
	1	Bearing housing	7	Attachment
	2	Toothed belt	8	Basic profile
	3	Clamping plate	9	Toothed belt holder
	4	Cover band	10	Tensioning screws
	5	Carriage plate	11	Toothed belt holder clamping plate
	6	Lifting roller		

Figure 8: Exposing and replacing the toothed belt

Method

1. Remove the drive (motor, gearbox).
2. Move the carriage to the centre of the linear unit.
   Then unscrew the carriage plate (5) and lift it off. Caution! Do not rotate the carriage plate. It must be refitted in the same position.

3. Unscrew the clamping plates (3) for the cover band.
4. Carefully lift the cover band (4) out of its guide and remove it from the toothed belt (2).
5. Detach the lifting rollers (6) upwards out of the attachment (7).
6. Loosen the tensioning screws (10) and pull the two toothed belt holders (9) out of the attachment.
7. Unscrew the two bearing housings (1).
8. Unscrew the countersunk screws on the toothed belt holders (9) and detach the clamping plate (11) upwards.
9. Pull the defective toothed belt out of the two bearing housings and remove.
10. Push the end of the new toothed belt into the lower slot in the left-hand bearing housing with the teeth upwards until the belt pulley engages.
11. Turn the drive shaft by hand and push the toothed belt out through the upper slot in the bearing housing.
12. Push the other end of the new toothed belt through the channel in the basic profile with the teeth upwards.
13. Push the end of the toothed belt into the lower slot in the right-hand bearing housing until the belt pulley engages.
14. Turn the drive shaft by hand and push the toothed belt out through the upper slot in the bearing housing.
15. Fit the toothed belt holders on both ends of the new toothed belt.
16. Re-attach the toothed belt holders to the attachment in the opposite order using the tensioning screws but do not tension the toothed belt. (Note: Secure the tensioning screws with Loctite 243.)
17. Screw the two bearing housings correctly to the basic profile. Secure the screws with Loctite 243.
18. Now tension the toothed belt.
19. Set the required tension precisely using a belt tensioning measurement device (see operating instructions for the measurement device).

☛ Only correctly setting the specified tension will guarantee optimum operation.

20. The measuring position and the Hz figure applicable for the toothed belt are supplied with the replacement toothed belt. Tension the toothed belt so that the specified Hz figure is indicated.
21. Fit the new cover band over the toothed belt with the broad side (the cut edge is oblique) facing downwards, and secure it at one end with the clamping plate.

22. Carefully push the cover band into its guide along its entire length so that it audibly clicks into place. Secure the loose end with the clamping plate.
23. The cover band must not protrude from its guide at any point, otherwise it will be damaged.
24. Place the carriage plate in its original position on the attachment(s) in such a way that the holes in the plate align exactly with the holes in the parts below.

☛ The correct alignment can be identified by the hole pattern.

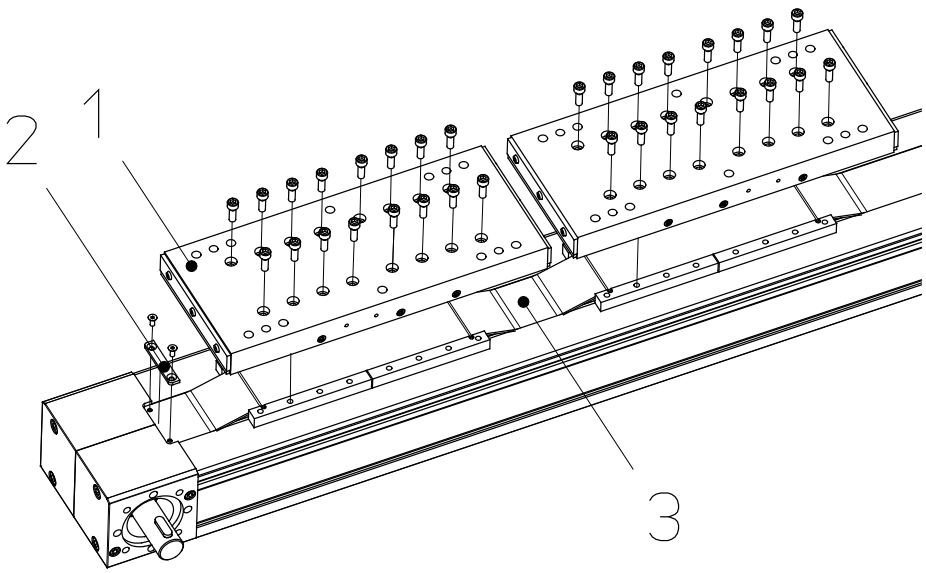
25. Screw the carriage plate to the attachments below it. Only use the original screws. The screws must be positioned in the centre of the holes.
26. If you do not use the original screws, make sure that the screws are not too long, otherwise they press against the basic profile or the cover band and damage it.
27. If necessary, replace the belts for the safety areas at the right and left end of the linear unit.
28. To ensure that the cover band engages securely in its guide, move the carriage slowly over the entire stroke by hand.

10.3 Replacing the cover band

☛ To ensure optimum functioning of the linear unit and to prevent damage during operation, it must be ensured during installation that no foreign bodies enter the basic profile or other parts of the linear unit.

☛ Do not damage the standard parts (screws, pins, etc.) or the parts that are removed, as they will be used again.

☛ Also replace the band guide elements if the cover bands are worn. If the cover bands are damaged, check the band guide elements for wear and replace them only if necessary.

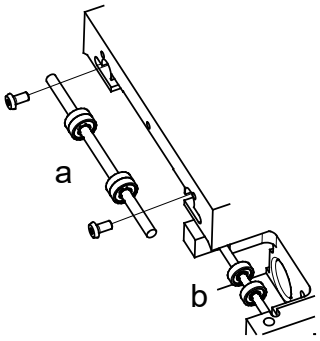


Key	1	Carriage plate
	2	Clamping plate
	3	Cover band

Figure 9: Exposing and replacing the cover band

Method

1. Move the carriage to the centre. Then unscrew the carriage plate (1) and lift it off.
   Caution! Do not rotate the carriage plate. It must be refitted in the same position.
2. Detach the clamping plates (2) from the ends of the cover band (3) and take off the cover band.
3. Check the belt guide elements, pressure rollers (a), lifting rollers (b) and guide pins for wear.
   - If the cover band is worn, it is essential the band guide elements are also replaced. Worn guide elements would damage the new cover band.
   - If the cover band is damaged, check that the belt guide elements are functioning correctly and replace if necessary.



4. Insert the new cover band with the broad side (the cut edge is oblique) facing downwards, and secure it at one end with the clamping plate.
5. Carefully push the cover band into its guide along its entire length so that it audibly clicks into place. It must not stick up at any point otherwise it will be damaged.
6. Tension the cover band and secure it at the other end with the clamping plate.
7. Place the carriage plate in its original position on the attachment(s) in such a way that the holes in the plate align exactly with the holes in the parts below.

☛ The correct alignment can be identified by the hole pattern.

8. Screw the carriage plate to the attachments below it. Only use the original screws. The screws must be positioned in the centre of the holes.
9. If you do not use the original screws, make sure that the screws are not too long, otherwise they press against the basic profile or the cover band and damage it.
10. If necessary, replace the belts for the safety areas at the right and left end of the linear unit.
11. To check that the installation is correct, move the carriage slowly from one end of the linear unit to the other, checking that the cover band remains in position at all times.