KUKA

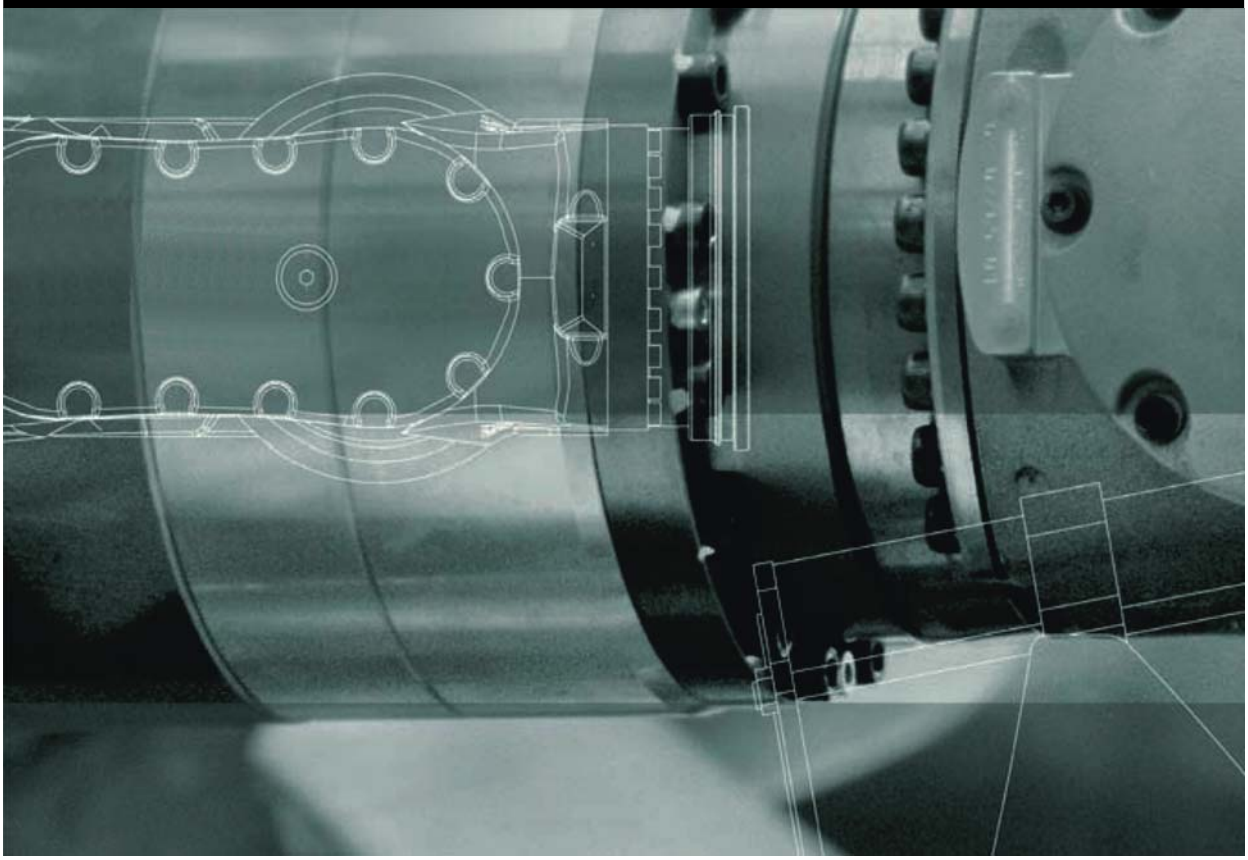
Linear Units

KUKA Roboter GmbH

KL 1500-3; KL 1500-3 T; KL 1500-3 S

Assembly and Operating Instructions

Serial Number 141215



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Other functions not described in this documentation may be operable in the controller. The user has no claims to these functions, however, in the case of a replacement or service work.

We have checked the content of this documentation for conformity with the hardware and software described. Nevertheless, discrepancies cannot be precluded, for which reason we are not able to guarantee total conformity. The information in this documentation is checked on a regular basis, however, and necessary corrections will be incorporated in the subsequent edition.

Subject to technical alterations without an effect on the function.

Translation of the original documentation

KIM-PS5-DOC

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Label: MA KL 1500-3 T S 141215 V1

Contents

1 Introduction

1.1 Documentation for the linear unit

The linear unit documentation consists of the following parts:

- Operating instructions for the linear unit
- Operating and programming instructions for the KUKA System Software
- Documentation relating to options and accessories
- Parts catalog on storage medium

Each of these sets of instructions is a separate document.

1.2 Representation of warnings and notes

Safety

Warnings marked with this pictogram are relevant to safety and **must** be observed.

Danger!
This warning means that death, severe physical injury or substantial material damage **will** occur, if no precautions are taken.

Warning!
This warning means that death, severe physical injury or substantial material damage **may** occur, if no precautions are taken.

Caution!
This warning means that minor physical injuries or minor material damage **may** occur, if no precautions are taken.

Notes

Notes marked with this pictogram contain tips to make your work easier or references to further information.

Tips to make your work easier or references to further information.

2 Purpose

2.1 Target group

This documentation is aimed at users with the following knowledge and skills:

- Advanced knowledge of mechanical engineering
- Advanced knowledge of electrical and electronic systems
- Knowledge of the robot controller system

For optimal use of our products, we recommend that our customers take part in a course of training at KUKA College. Information about the training program can be found at www.kuka.com or can be obtained directly from our subsidiaries.

2.2 Intended use

Use

The linear unit is used for linear traversing of a robot or of other equipment. Use is only permitted under the specified environmental conditions.

Misuse

Any use or application deviating from the designated use is deemed to be impermissible misuse. This includes e.g.:

- Transportation of persons and animals
- Use as a climbing aid
- Operation outside the permissible operating parameters
- Use in potentially explosive environments

Caution!
Changing the structure of the linear unit, e.g. by drilling holes, etc., can result in damage to the components. This is considered improper use and leads to loss of guarantee and liability entitlements.

The linear unit is an integral part of an overall system and may only be operated in a CE-compliant system.

3 Product description

3.1 Description of the linear unit

The linear unit is a single-axis unit for horizontal installation. It is used for linear traversing of the robot or of other equipment. The linear unit is controlled by the robot controller as an external axis. The rated travel of the carriage is defined specifically for each individual unit. The interval is 500 mm. The linear unit is available in the variants: standard, T and S.

Variants	Use
KL 1500-3 (standard)	KR 30 to KR 125, KR 150, KR 200, KR 360, KR 500; without pedestal KR 150 to KR 270 (Series 2000); without pedestal
KL 1500-3 T	KR 30 to KR 125, KR 150, KR 200, KR 360, KR 500; without pedestal KR 30 to KR 125, KR 150, KR 200; with pedestal KR 150 to KR 270 (Series 2000); with pedestal
KL 1500-3 S	KR 30 to KR 125, KR 150, KR 200, KR 360, KR 500; without pedestal KR 30 to KR 125, KR 150, KR 200; with pedestal KR 150 to KR 270 (Series 2000); with pedestal

The linear unit consists of the following components (>>> Fig. 3-1):

- Beam
- Carriage
- Drive assembly
- Energy supply system

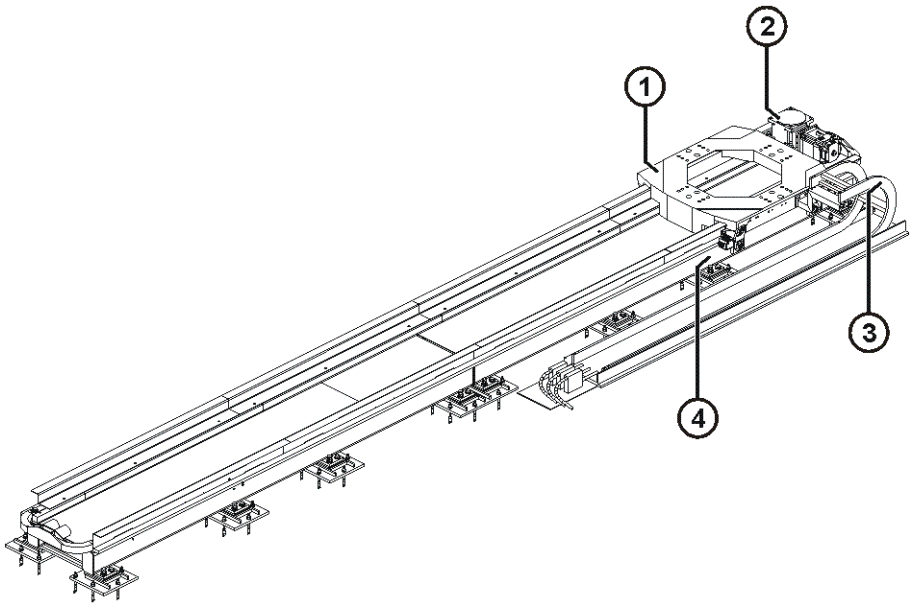


Fig. 3-1: Structure of the linear unit

1	Carriage	3	Energy supply system
2	Drive assembly	4	Beam

A linear unit can be equipped with up to four independently controlled carriages. Variants with mirrored design and a tender carriage are also possible. The carriage is designed to be suitable for every design of linear unit. The tender carriage does not have a drive of its own. It is moved by being coupled to the carriage.

The carriage is driven by the drive unit (drive assembly), an AC servomotor with gearing and a pinion, which engages with a rack. The movement range of the carriage is limited by programmable software limit switches. It is additionally safeguarded by means of mechanical stops (crash elements).

The carriage is equipped with a horizontal mounting face for mounting the robot.

The linear unit may optionally be fitted with working range monitoring.

3.1.1 Description of the beam

The beam (>>> Fig. 3-2) serves to fasten the linear unit to the floor. Beyond a beam length of 10 m, several beams are lined up and screwed together using a connecting assembly. This ensures that the arrangement of the beams remains the same.
The beam is fastened to the floor through a mounting base. If a number of beams are fastened together, a special mounting base is used at the joints. The tracks and racks are screwed onto the beam.

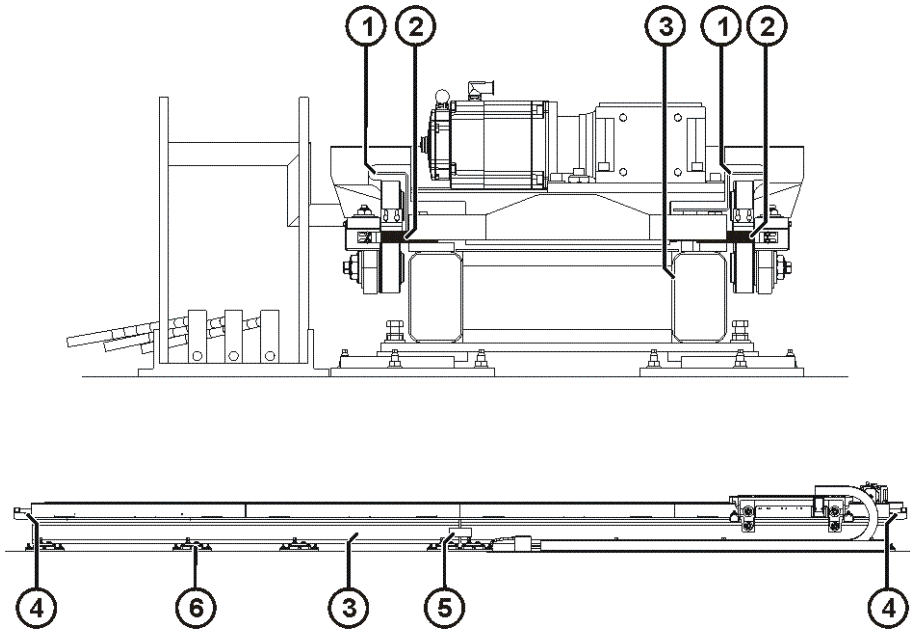


Fig. 3-2: Beam

1	Cover	4	Buffer
2	Track	5	Connecting assembly
3	Beam	6	Mounting base

3.1.2 Description of the carriage

The carriage (>>> Fig. 3-3) serves as a mount for the robot. It features a mounting face which is equipped with two centering pins. The hole pattern on the mounting face depends on the robot type. The drive unit, and the driver for the energy supply system, are also fastened to the carriage. The carriage is guided by means of four roller guides on the tracks of the beam.

The range of motion of the carriage is restricted by programmable software limit switches. If the permitted movement range is exceeded, the buffers on the beam bring the carriage to a stop.
The carriage can be mastered with a KTL mastering set. A mount with a gauge cartridge is provided for this purpose.

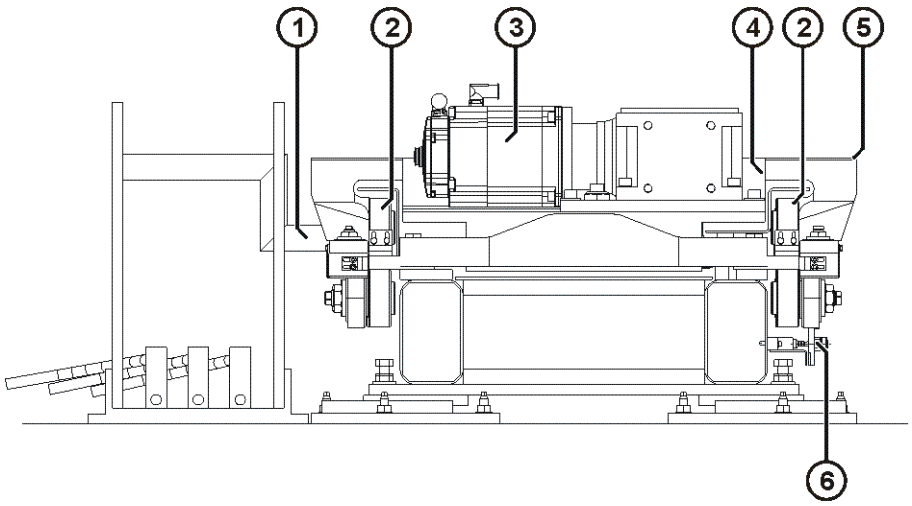


Fig. 3-3: Carriage

1	Driver for energy supply system	4	Carriage
2	Roller guide	5	Mounting surface
3	Drive assembly	6	Mount for gauge cartridge

3.1.3 Description of the drive assembly

The drive assembly (>>> Fig. 3-4) of the carriage consists of a servomotor, a gear unit, an intermediate plate and fasteners. The pinion of the drive engages with the rack on the beam, thereby moving the carriage. The drive assembly is designed to be suitable for use with both the standard design and the mirrored design of linear unit. The drive assembly is fastened to the carriage via the intermediate plate.

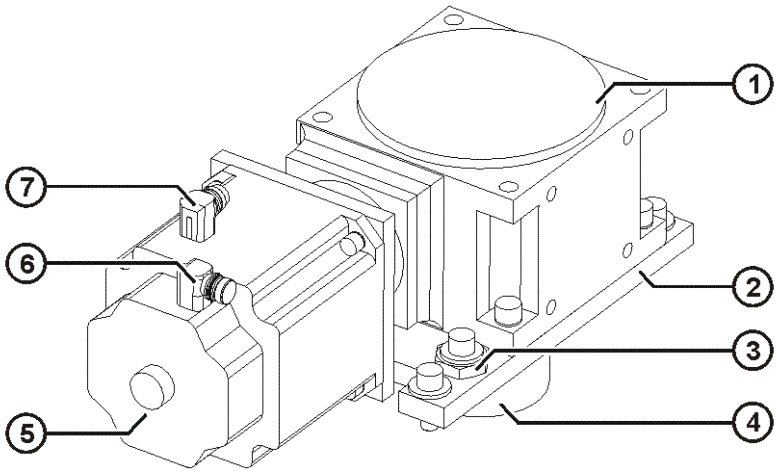


Fig. 3-4: Drive assembly

1	Gear unit	5	Servomotor
2	Intermediate plate	6	Connector XP7, control cable
3	Eccentric	7	Connector XM7, motor cable
4	Pinion		

Servomotor

The servomotor essentially comprises the motor with an integrated solenoid brake and a position sensing system. The solenoid brake prevents motion of the carriage at standstill.
The solenoid brake is closed when deenergized, i.e. the armature is pulled against the solenoid brake by a permanent magnetic field. When current flows through the solenoid brake, the permanent magnetic field decays and the armature is released.
The servomotor is fastened on the side of the gear unit. The motor and control cables are connected by means of the connectors.

Gear unit

The motor speed is reduced by the gear unit and transferred by the pinion to the rack. The gear unit is fastened to the carriage via an intermediate plate. The backlash is adjusted by means of the eccentric on the intermediate plate. The gear unit is lifetime-lubricated. The rack and pinion are greased.

3.1.4 Description of the energy supply system

The energy supply system consists of the energy supply chain, the connector plate and a driver. The energy supply chain contains the supply lines for the robot and the energy and fluid supply. These supply lines are required for operating the linear unit and the robot and for any connected tools (e.g. spot weld gun). The energy supply system is supported in guides. It is fastened to the floor via the connector plate and to the carriage via the driver. The attachment on the carriage is dependent on the length of the energy supply chain. The length of the energy supply chain depends on the travel of the carriage.

Figure (>>> Fig. 3-5) below shows the two variants for attaching the energy supply system. These depend on the travel (H) of the carriage and on the chain width (BK).

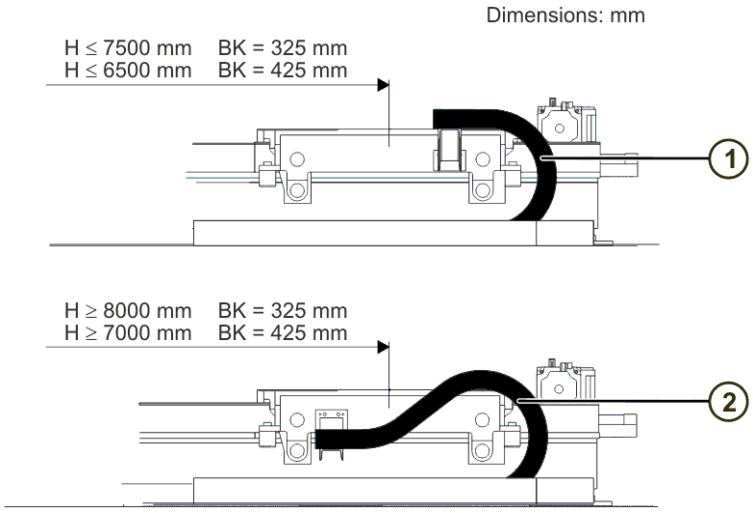


Fig. 3-5: Attaching the energy supply system

1	Energy supply system for rated travels of up to 7,500 mm (6,500 mm)
2	Energy supply system for rated travels greater than 8,000 mm (7,000 mm)

Trough system

The energy supply chain lies in a trough system (>>> Fig. 3-6) manufactured by IGUS.

See the assembly instructions from IGUS.

The trough system consists essentially of two troughs and C-profiles. The C-profiles are positioned at right angles to the troughs. The length of the troughs and the number of C-profiles depend on the travel of the linear unit and thus on the length of the energy supply chain. The trough system is fastened via the C-profiles to the floor using chemical anchors.

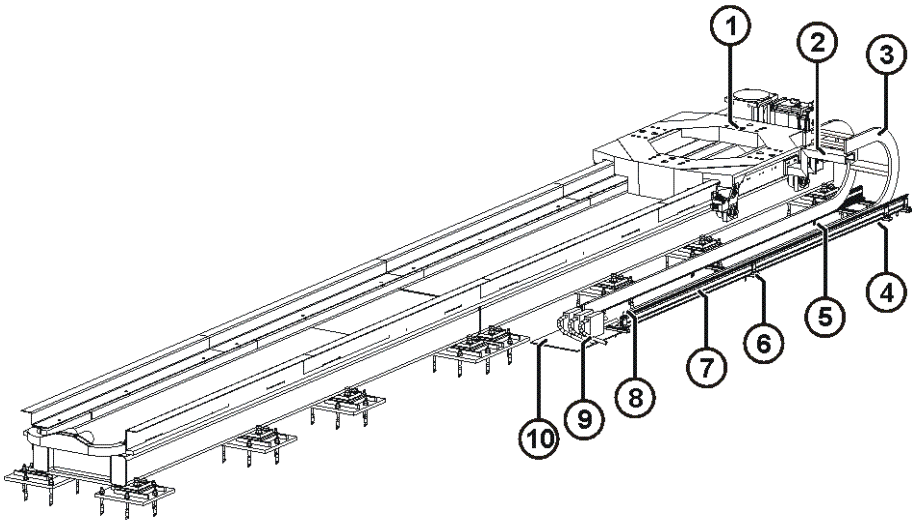


Fig. 3-6: Trough system (example)

1	Carriage	6	C-profiles
2	Driver	7	Trough

3	Energy supply chain	8	Fixed point module
4	Screw anchor	9	Connecting cables
5	Trough system	10	Connector plate

3.1.5 Design of the linear unit

Description

The possible variants of the linear unit are shown in the illustration (>>> Fig. 3-7).

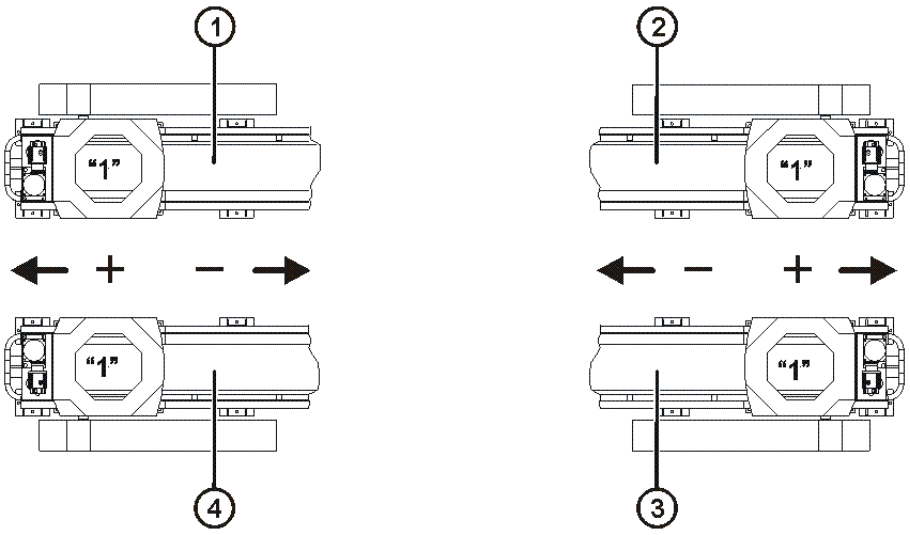


Fig. 3-7: Design and direction of travel of the linear unit

1	Linear unit, standard design, rotated
2	Linear unit, mirrored design
3	Linear unit, standard design
4	Linear unit, mirrored design, rotated

Direction of travel

Direction of travel of the linear unit is always determined by the first carriage. In the illustration (>>> Fig. 3-7), the first carriage is indicated with **"1"**. By default, the carriage moves in the minus direction when moving away from the starting point. The travel of the carriage in the plus direction is motion towards the starting point. If more than one carriage is used on a single linear unit, the direction of travel of the other carriages corresponds to that of the first carriage.

3.2 Options

3.2.1 Working range monitoring

The linear unit may optionally be fitted with working range monitoring.

4 Technical data

4.1 Basic data

Type	KL 1500-3, T, S
Number of axes	1
Rated travel	Min. rated travel = 1,000 mm Max. rated travel = 30,000 mm (longer rated travels available on request)
Gradation of rated travel	500 mm
Velocity	v_{max} = 1.45 m/s, KL 1500-3 v_{max} = 1.89 m/s, KL 1500-3 T v_{max} = 2.35 m/s, KL 1500-3 S
Repeatability (ISO 9283)	±0.02 mm
Mass of carriage	m = 440 kg
Mass of beam assy	m = 345 kg/m
Payload	Robot with supplementary loads, see robot
Max. permissible payload	2,000 kg, KL 1500-3 3,800 kg, KL 1500-3 T 3,800 kg, KL 1500-3 S
Number of chemical anchors per mounting base	6x M16, with Dynamic Set 10x M16, with Dynamic Set 4x M20, without Dynamic Set (optional) 8x M20, without Dynamic Set (optional)
Loads acting on the foundation	see (>>> 6.2.1 "Loads acting on the foundation" page 42)
Mounting base dimensions	see (>>> 6.2 "Foundation data" page 42)
Color	Carriage: KUKA orange 2567 Beam: RAL 7022
Protection classification	Motor and gear unit connected (according to EN 60729) IP 64. Linear unit ready for operation, with connecting cables plugged in (according to EN 60729) IP 64.
Sound level	< 75 dB (A) outside the working envelope (moving KL with moving robot) < 69 dB (A) outside the working envelope (moving KL without robot)
Permissible angle of inclination	0°
Mounting position	Floor
Number of carriages	max. 4 carriages
Valid for robots	KR 30 to KR 125, KR 150, KR 200, KR 360, KR 500 KR 150 to KR 270 (Series 2000)

Pedestals (for robots)	min. 200 mm high max. 800 mm high gradation 100 mm
Order-specific technical data	The “Order-specific technical data” can be found in the section (>>> 4.4 "Order-specific technical data" page 24).

Ambient temperature

Operation	283 K to 328 K (+10 °C to +55 °C) 283 K to 288 K (+10 °C to +15 °C) At these temperatures the robot may have to be warmed up before normal operation. Other temperature limits available on request.
Operation with Safe RDC	283 K to 323 K (+10 °C to +50 °C)
Storage and transportation	233 K to 333 K (-40 °C to +60 °C)
Humidity rating	Humidity class EN 60204/4.4.4 F

4.2 Principal dimensions

Linear unit

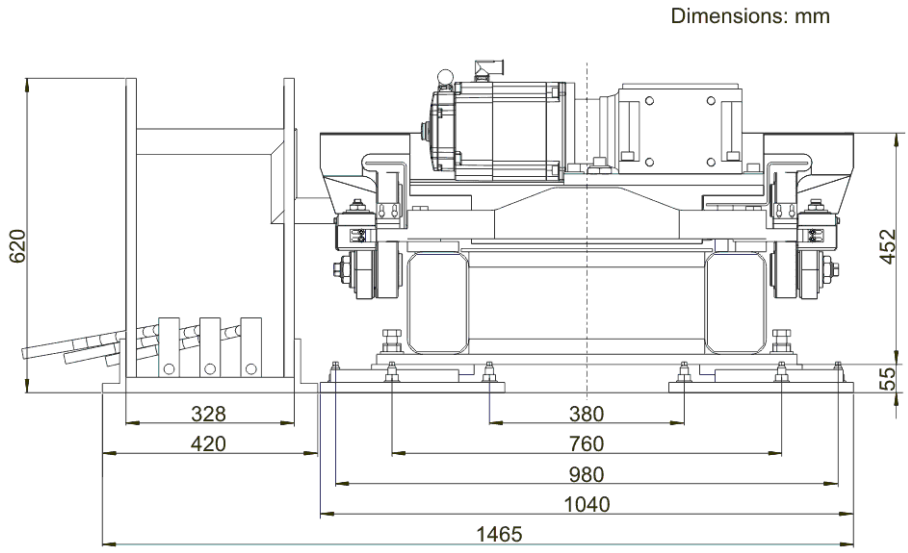


Fig. 4-1: Principal dimensions, cross-section

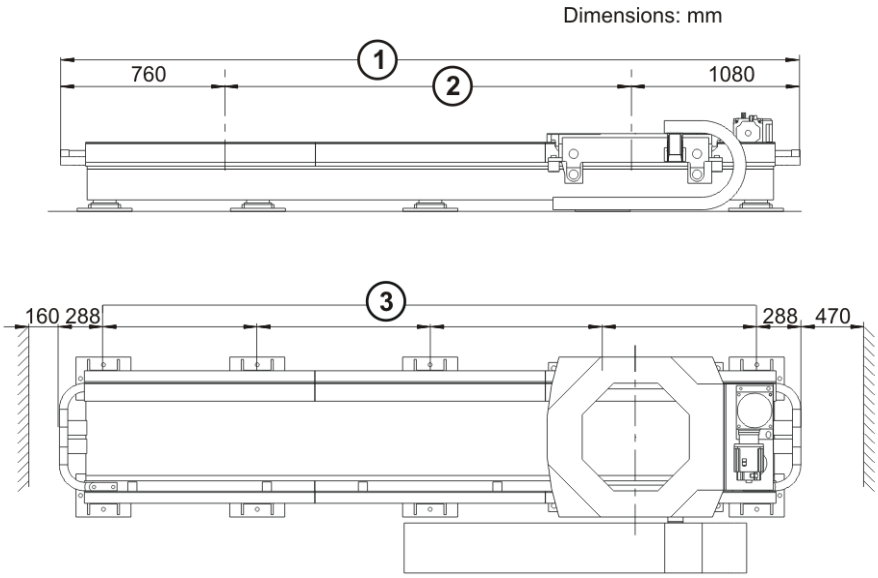


Fig. 4-2: Principal dimensions

1 Rated travel + 1840 mm
2 Effective travel
3 Spacing of the mounting bases, dependent on the travel

Carriage

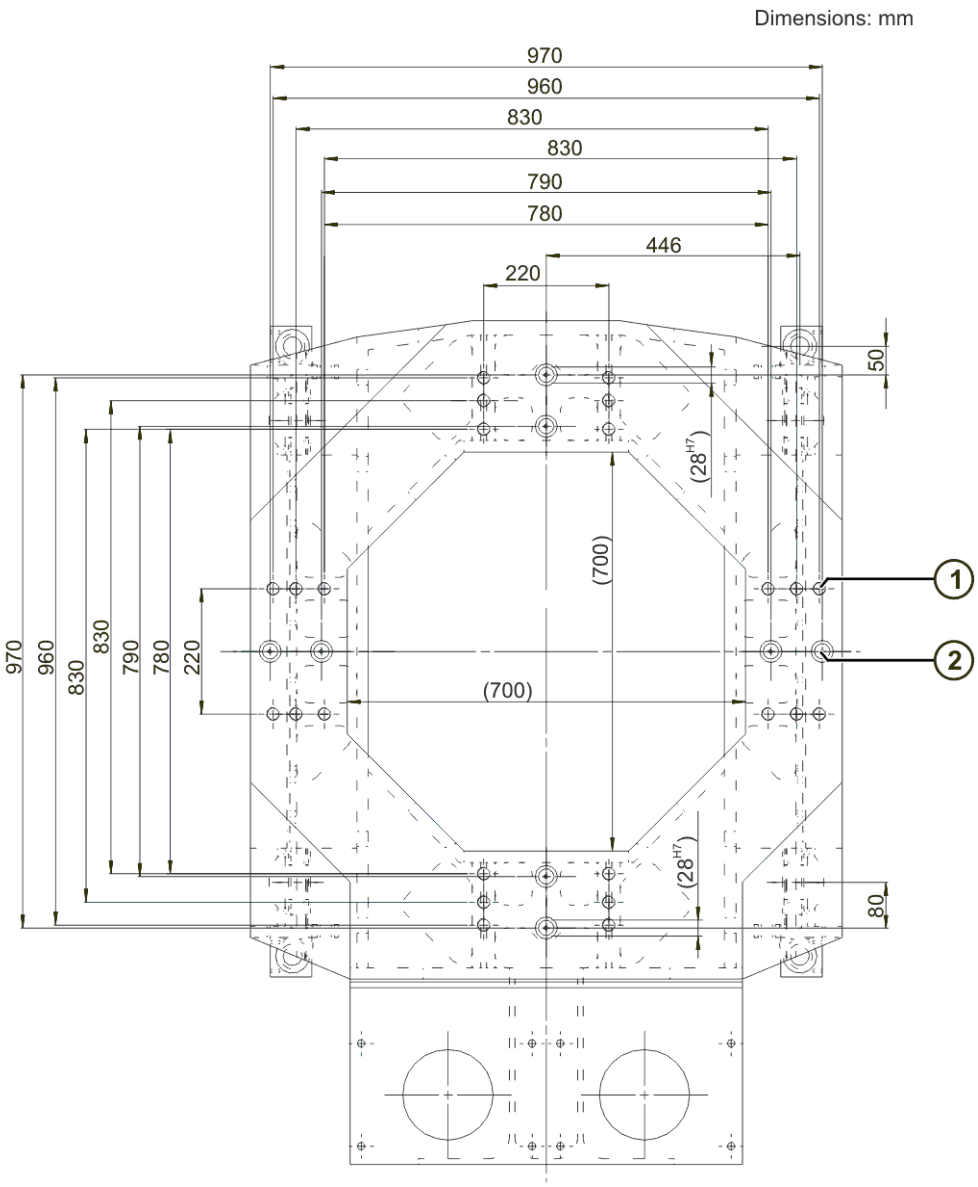


Fig. 4-3: Mounting face for KR 30 to KR 500

1 M24 tapped hole, 24x
2 M8 tapped hole, 8x

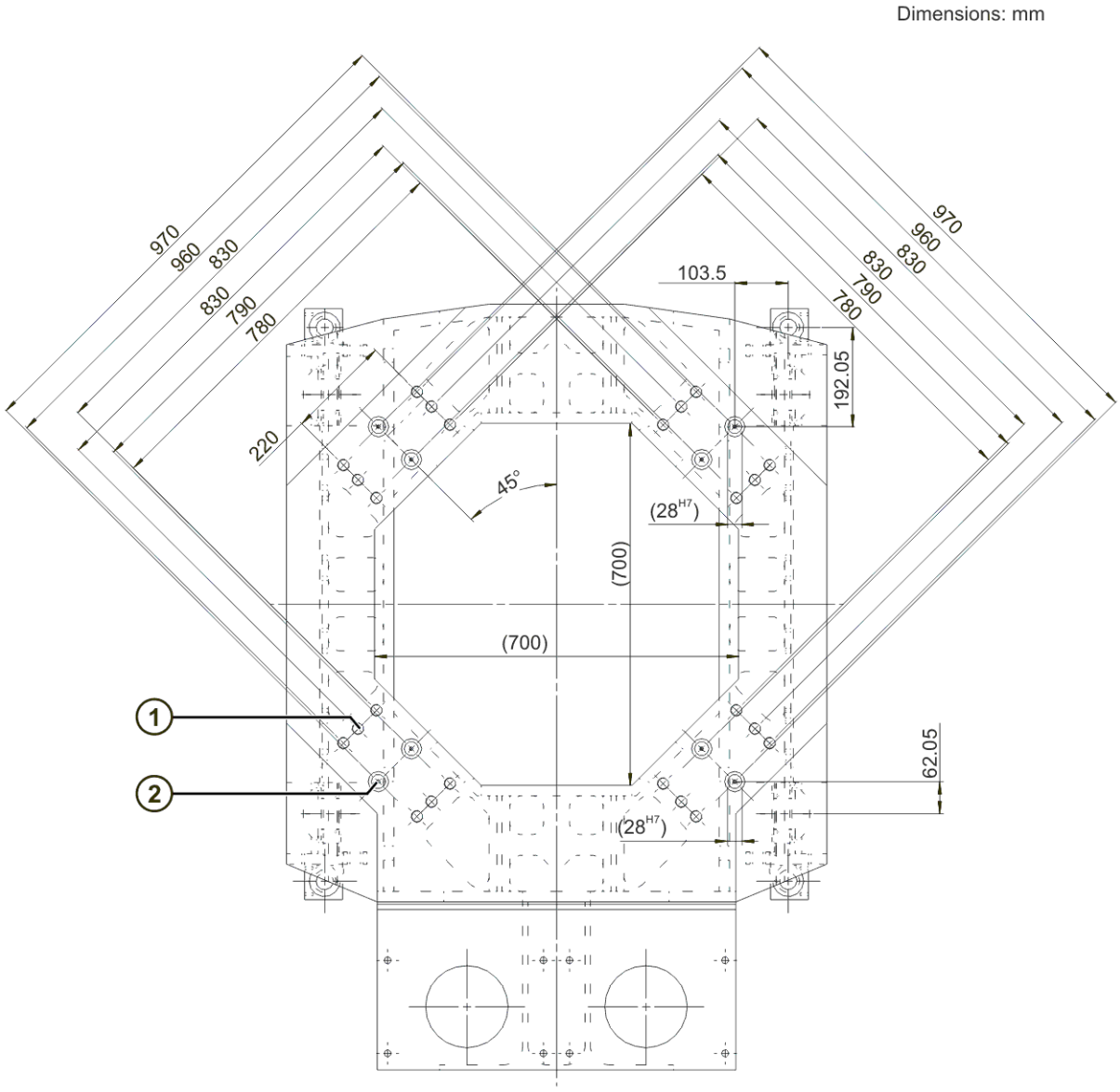


Fig. 4-4: Mounting face for KR 30 to KR 500, robot mounted at 45°

1 M24 tapped hole, 24x
2 M8 tapped hole, 8x

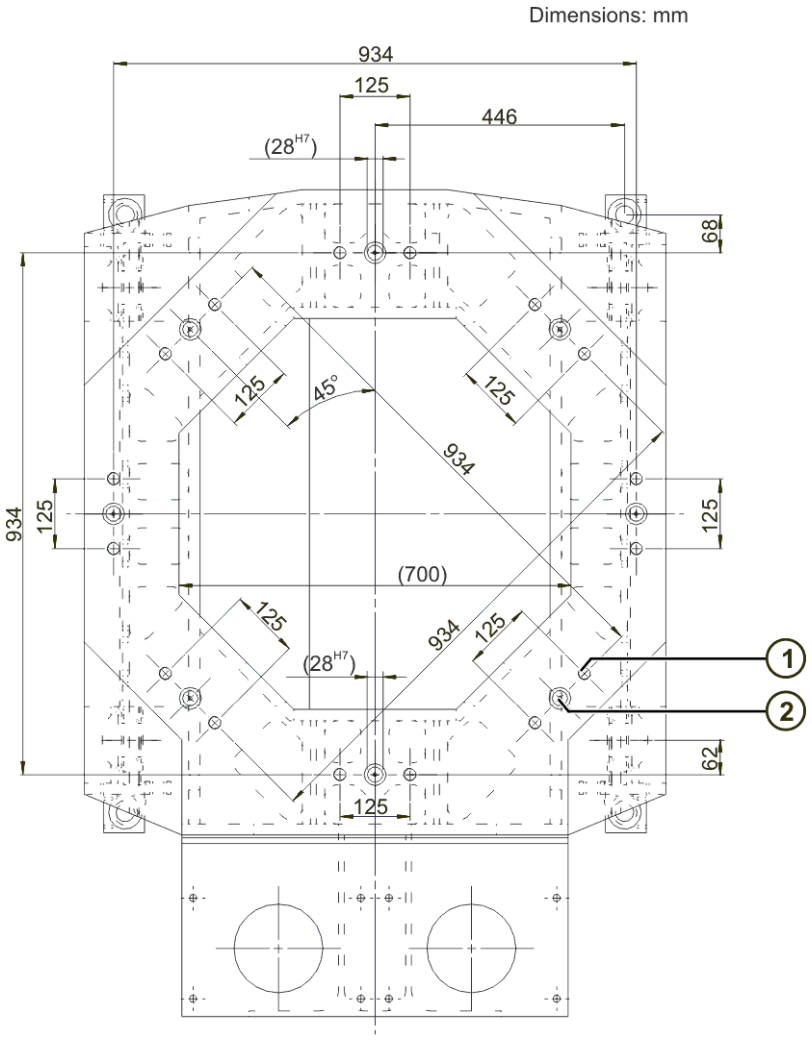


Fig. 4-5: Mounting face for KR 150 to KR 270 (KR 2000 series)

1 M24 tapped hole, 16x
2 M8 tapped hole, 8x

4.3 Plates and labels

Plates and labels

The following plates and labels (>>> Fig. 4-6) are attached to the linear unit. They must not be removed or rendered illegible. Illegible plates and labels must be replaced.

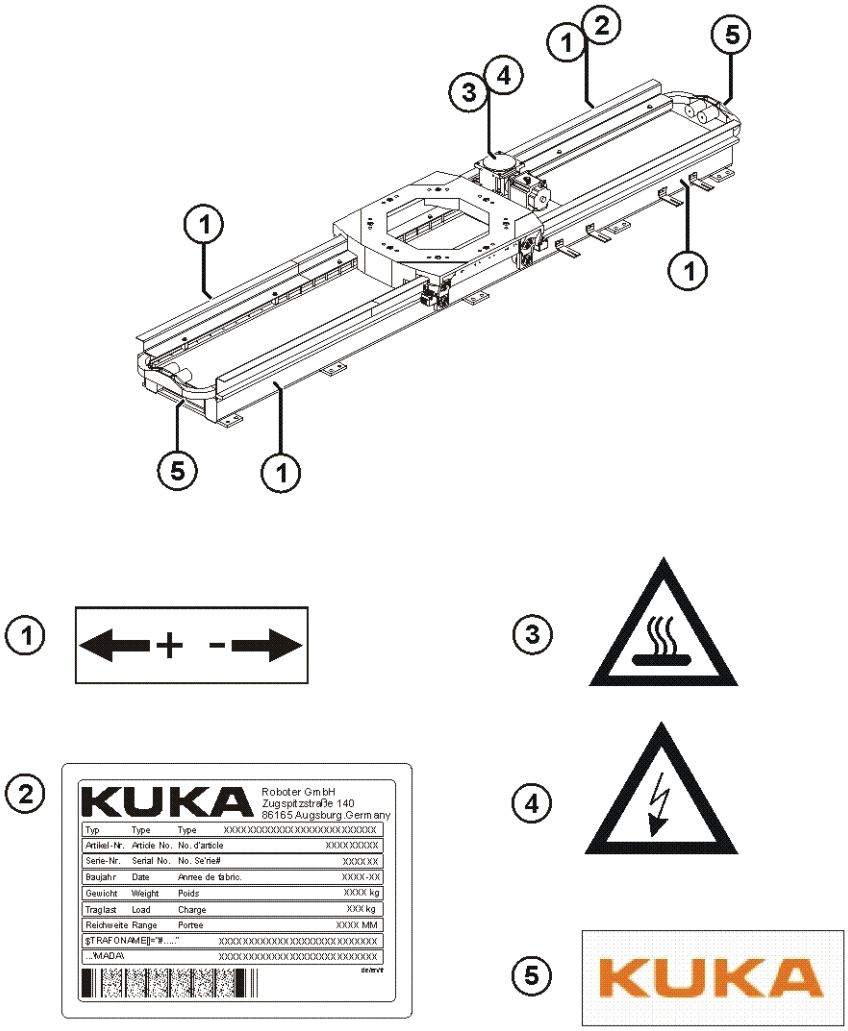


Fig. 4-6: Plates and labels

4.4 Order-specific technical data

4.4.1 Principal dimensions

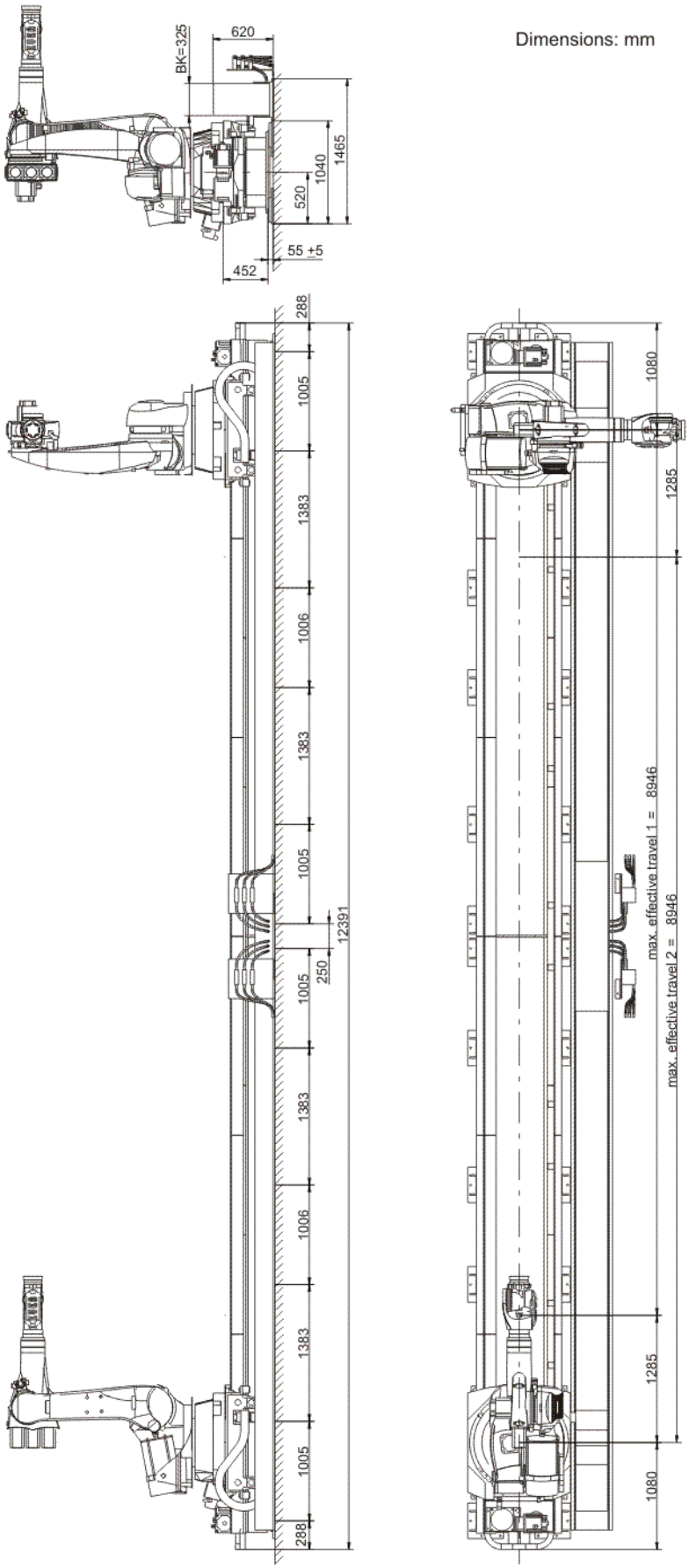


Fig. 4-7: Principal dimensions, serial no. 141215

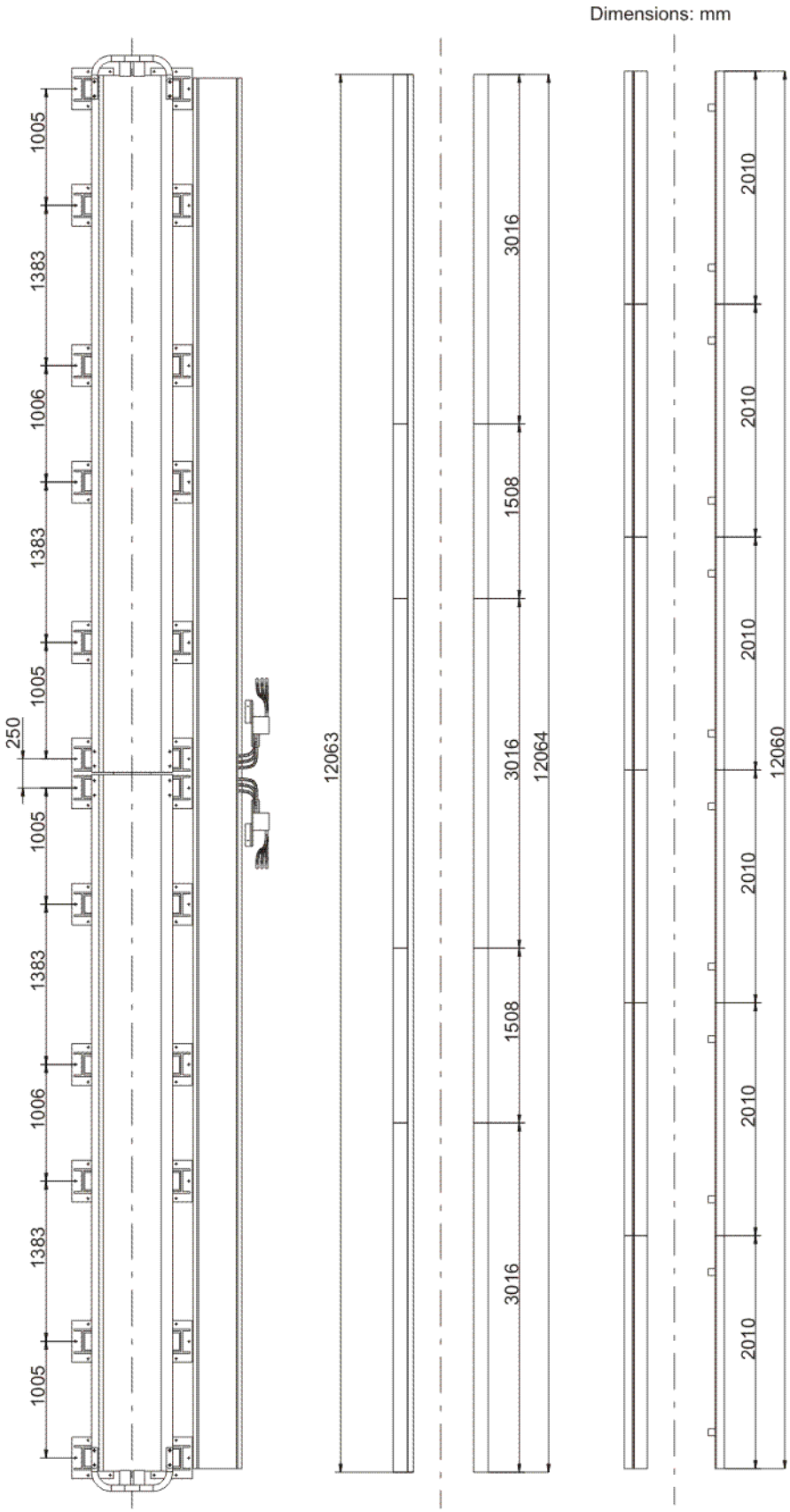


Fig. 4-8: Mounting bases, racks, covers; serial no. 141215

5 Safety

5.1 General

- This “Safety” chapter refers to a mechanical component of an industrial robot.
- If the mechanical component is used together with a KUKA robot controller, the “Safety” chapter of the operating instructions or assembly instructions of the robot controller must be used!

  This contains all the information provided in this “Safety” chapter. It also contains additional safety information relating to the robot controller which must be observed.
- Where this “Safety” chapter uses the term “industrial robot”, this also refers to the individual mechanical component if applicable.

5.1.1 Liability

The device described in this document is either an industrial robot or a component thereof.

Components of the industrial robot:

- Manipulator
- Robot controller
- Teach pendant
- Connecting cables
- External axes (optional)

  e.g. linear unit, turn-tilt table, positioner
- Software
- Options, accessories

The industrial robot is built using state-of-the-art technology and in accordance with the recognized safety rules. Nevertheless, misuse of the industrial robot may constitute a risk to life and limb or cause damage to the industrial robot and to other material property.

The industrial robot may only be used in perfect technical condition in accordance with its intended use and only by safety-conscious persons who are fully aware of the risks involved in its operation. Use of the industrial robot is subject to compliance with this document and with the declaration of incorporation supplied together with the industrial robot. Any functional disorders affecting the safety of the industrial robot must be rectified immediately.

Safety information

Safety information cannot be held against KUKA Roboter GmbH. Even if all safety instructions are followed, this is not a guarantee that the industrial robot will not cause personal injuries or material damage.

No modifications may be carried out to the industrial robot without the authorization of KUKA Roboter GmbH. Additional components (tools, software, etc.), not supplied by KUKA Roboter GmbH, may be integrated into the industrial robot. The user is liable for any damage these components may cause to the industrial robot or to other material property.

In addition to the Safety chapter, this document contains further safety instructions. These must also be observed.

5.1.2 Intended use of the industrial robot

The industrial robot is intended exclusively for the use designated in the “Purpose” chapter of the operating instructions or assembly instructions.

Further information is contained in the “Purpose” chapter of the operating instructions or assembly instructions of the component.

Using the industrial robot for any other or additional purpose is considered impermissible misuse. The manufacturer cannot be held liable for any damage resulting from such use. The risk lies entirely with the user.

Operating the industrial robot and its options within the limits of its intended use also involves observance of the operating and assembly instructions for the individual components, with particular reference to the maintenance specifications.

Misuse

Any use or application deviating from the intended use is deemed to be impermissible misuse. This includes e.g.:

- Transportation of persons and animals
- Use as a climbing aid
- Operation outside the permissible operating parameters
- Use in potentially explosive environments
- Operation without additional safeguards
- Outdoor operation

5.1.3 EC declaration of conformity and declaration of incorporation

This industrial robot constitutes partly completed machinery as defined by the EC Machinery Directive. The industrial robot may only be put into operation if the following preconditions are met:

- The industrial robot is integrated into a complete system.

  Or: The industrial robot, together with other machinery, constitutes a complete system.

  Or: All safety functions and safeguards required for operation in the complete machine as defined by the EC Machinery Directive have been added to the industrial robot.
- The complete system complies with the EC Machinery Directive. This has been confirmed by means of an assessment of conformity.

Declaration of conformity

The system integrator must issue a declaration of conformity for the complete system in accordance with the Machinery Directive. The declaration of conformity forms the basis for the CE mark for the system. The industrial robot must be operated in accordance with the applicable national laws, regulations and standards.

The robot controller is CE certified under the EMC Directive and the Low Voltage Directive.

Declaration of incorporation

The industrial robot as partly completed machinery is supplied with a declaration of incorporation in accordance with Annex II B of the EC Machinery Directive 2006/42/EC. The assembly instructions and a list of essential requirements complied with in accordance with Annex I are integral parts of this declaration of incorporation.

The declaration of incorporation declares that the start-up of the partly completed machinery remains impermissible until the partly completed machinery has been incorporated into machinery, or has been assembled with other parts

to form machinery, and this machinery complies with the terms of the EC Machinery Directive, and the EC declaration of conformity is present in accordance with Annex II A.

The declaration of incorporation, together with its annexes, remains with the system integrator as an integral part of the technical documentation of the complete machinery.

5.1.4 Terms used

Term	Description
Axis range	Range of each axis, in degrees or millimeters, within which it may move. The axis range must be defined for each axis.
Stopping distance	Stopping distance = reaction distance + braking distance The stopping distance is part of the danger zone.
Workspace	The manipulator is allowed to move within its workspace. The workspace is derived from the individual axis ranges.
Operator (User)	The user of the industrial robot can be the management, employer or delegated person responsible for use of the industrial robot.
Danger zone	The danger zone consists of the workspace and the stopping distances.
KCP	The KCP (KUKA Control Panel) teach pendant has all the operator control and display functions required for operating and programming the industrial robot.
Manipulator	The robot arm and the associated electrical installations
Safety zone	The safety zone is situated outside the danger zone.
Stop category 0	The drives are deactivated immediately and the brakes are applied. The manipulator and any external axes (optional) perform path-oriented braking. **Note:** This stop category is called STOP 0 in this document.
Stop category 1	The manipulator and any external axes (optional) perform path-maintaining braking. The drives are deactivated after 1 s and the brakes are applied. **Note:** This stop category is called STOP 1 in this document.
Stop category 2	The drives are not deactivated and the brakes are not applied. The manipulator and any external axes (optional) are braked with a normal braking ramp. **Note:** This stop category is called STOP 2 in this document.
System integrator (plant integrator)	System integrators are people who safely integrate the industrial robot into a complete system and commission it.
T1	Test mode, Manual Reduced Velocity (<= 250 mm/s)
T2	Test mode, Manual High Velocity (> 250 mm/s permissible)
External axis	Motion axis which is not part of the manipulator but which is controlled using the robot controller, e.g. KUKA linear unit, turn-tilt table, Posiflex.

5.2 Personnel

The following persons or groups of persons are defined for the industrial robot:

- User
- Personnel

All persons working with the industrial robot must have read and understood the industrial robot documentation, including the safety chapter.

User

The user must observe the labor laws and regulations. This includes e.g.:

- The user must comply with his monitoring obligations.
- The user must carry out instruction at defined intervals.

Personnel

Personnel must be instructed, before any work is commenced, in the type of work involved and what exactly it entails as well as any hazards which may exist. Instruction must be carried out regularly. Instruction is also required after particular incidents or technical modifications.

Personnel includes:

- System integrator
- Operators, subdivided into:
  - Start-up, maintenance and service personnel
  - Operating personnel
  - Cleaning personnel

Installation, exchange, adjustment, operation, maintenance and repair must be performed only as specified in the operating or assembly instructions for the relevant component of the industrial robot and only by personnel specially trained for this purpose.

System integrator

The industrial robot is safely integrated into a complete system by the system integrator.

The system integrator is responsible for the following tasks:

- Installing the industrial robot
- Connecting the industrial robot
- Performing risk assessment
- Implementing the required safety functions and safeguards
- Issuing the declaration of conformity
- Attaching the CE mark
- Creating the operating instructions for the complete system

Operator

The operator must meet the following preconditions:

- The operator must be trained for the work to be carried out.
- Work on the industrial robot must only be carried out by qualified personnel. These are people who, due to their specialist training, knowledge and experience, and their familiarization with the relevant standards, are able to assess the work to be carried out and detect any potential hazards.

Example

The tasks can be distributed as shown in the following table.

Tasks	Operator	Programmer	System integrator
Switch robot controller on/off	x	x	x
Start program	x	x	x
Select program	x	x	x
Select operating mode	x	x	x
Calibration (tool, base)		x	x
Master the manipulator		x	x
Configuration		x	x

Tasks	Operator	Programmer	System integrator
Programming		x	x
Start-up			x
Maintenance			x
Repair			x
Decommissioning			x
Transportation			x

Work on the electrical and mechanical equipment of the industrial robot may only be carried out by specially trained personnel.

5.3 Workspace, safety zone and danger zone

Workspaces are to be restricted to the necessary minimum size. A workspace must be safeguarded using appropriate safeguards.

The safeguards (e.g. safety gate) must be situated inside the safety zone. In the case of a stop, the manipulator and external axes (optional) are braked and come to a stop within the danger zone.

The danger zone consists of the workspace and the stopping distances of the manipulator and external axes (optional). It must be safeguarded by means of physical safeguards to prevent danger to persons or the risk of material damage.

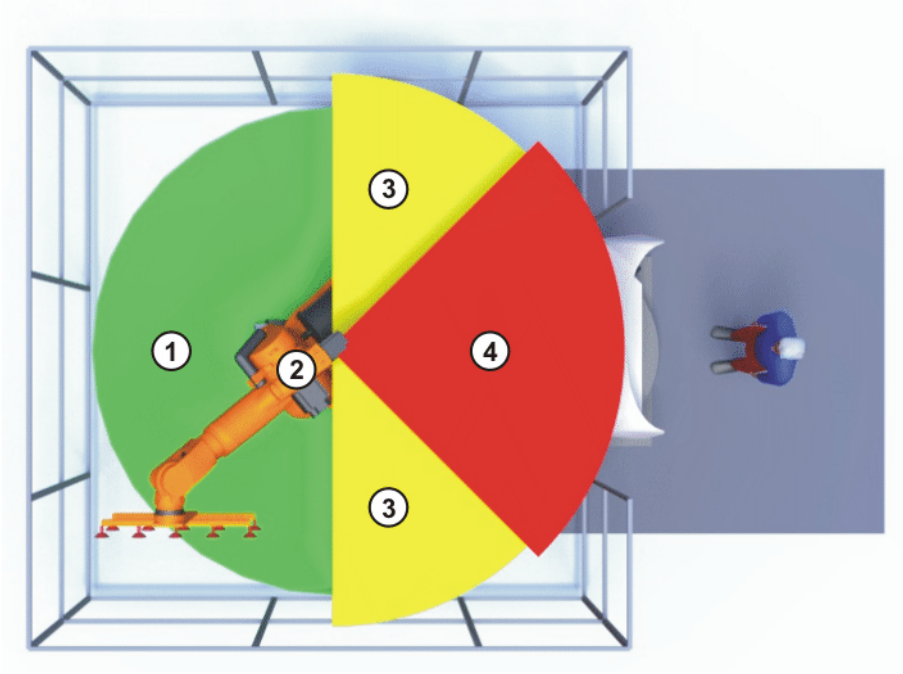


Fig. 5-1: Example of axis range A1

1	Workspace	3	Stopping distance
2	Manipulator	4	Safety zone

5.4 Overview of protective equipment

The protective equipment of the mechanical component may include:

- Mechanical end stops
- Mechanical axis range limitation (optional)
- Axis range monitoring (optional)
- Release device (optional)
- Labeling of danger areas

Not all equipment is relevant for every mechanical component.

5.4.1 Mechanical end stops

The axis ranges of main axes A1 to A3 and wrist axis A5 of the manipulator are limited by means of mechanical end stops with buffers.

Additional mechanical end stops can be installed on the external axes.

Warning!
If the manipulator or an external axis hits an obstruction or a buffer on the mechanical end stop or axis range limitation, this can result in material damage to the industrial robot. KUKA Roboter GmbH must be consulted before the industrial robot is put back into operation (>>> 16 "KUKA Service" page 139). The affected buffer must be replaced with a new one before operation of the industrial robot is resumed. If a manipulator (or external axis) collides with a buffer at more than 250 mm/s, the manipulator (or external axis) must be exchanged or recommissioning must be carried out by KUKA Roboter GmbH.

5.4.2 Mechanical axis range limitation (optional)

Some manipulators can be fitted with mechanical axis range limitation in axes A 1 to A 3. The adjustable axis range limitation systems restrict the working range to the required minimum. This increases personal safety and protection of the system.

In the case of manipulators that are not designed to be fitted with mechanical axis range limitation, the workspace must be laid out in such a way that there is no danger to persons or material property, even in the absence of mechanical axis range limitation.

If this is not possible, the workspace must be limited by means of photoelectric barriers, photoelectric curtains or obstacles on the system side. There must be no shearing or crushing hazards at the loading and transfer areas.

This option is not available for all robot models. Information on specific robot models can be obtained from KUKA Roboter GmbH.

5.4.3 Axis range monitoring (optional)

Some manipulators can be fitted with dual-channel axis range monitoring systems in main axes A1 to A3. The positioner axes may be fitted with additional axis range monitoring systems. The safety zone for an axis can be adjusted and monitored using an axis range monitoring system. This increases personal safety and protection of the system.

This option is not available for all robot models. Information on specific robot models can be obtained from KUKA Roboter GmbH.

5.4.4 Release device (optional)

Description

The release device can be used to move the manipulator manually after an accident or malfunction. The release device can be used for the main axis drive motors and, depending on the robot variant, also for the wrist axis drive motors. It is only for use in exceptional circumstances and emergencies (e.g. for freeing people).

Warning!
The motors reach temperatures during operation which can cause burns to the skin. Contact should be avoided. Appropriate safety precautions must be taken, e.g. protective gloves must be worn.

Procedure

1. Switch off the robot controller and secure it (e.g. with a padlock) to prevent unauthorized persons from switching it on again.
2. Remove the protective cap from the motor.
3. Push the release device onto the corresponding motor and move the axis in the desired direction.

   The directions are indicated with arrows on the motors. It is necessary to overcome the resistance of the mechanical motor brake and any other loads acting on the axis.

Warning!
Moving an axis with the release device can damage the motor brake. This can result in personal injury and material damage. After using the release device, the affected motor must be exchanged.

5.4.5 Labeling on the industrial robot

All plates, labels, symbols and marks constitute safety-relevant parts of the industrial robot. They must not be modified or removed.

Labeling on the industrial robot consists of:

- Rating plates
- Warning labels
- Safety symbols
- Designation labels
- Cable markings
- Identification plates

Further information is contained in the technical data of the operating instructions or assembly instructions of the components of the industrial robot.

5.5 Safety measures

5.5.1 General safety measures

The industrial robot may only be used in perfect technical condition in accordance with its intended use and only by safety-conscious persons. Operator errors can result in personal injury and damage to property.

It is important to be prepared for possible movements of the industrial robot even after the robot controller has been switched off and locked. Incorrect installation (e.g. overload) or mechanical defects (e.g. brake defect) can cause the manipulator or external axes to sag. If work is to be carried out on a switched-off industrial robot, the manipulator and external axes must first be

moved into a position in which they are unable to move on their own, whether the payload is mounted or not. If this is not possible, the manipulator and external axes must be secured by appropriate means.

Danger!
In the absence of operational safety functions and safeguards, the industrial robot can cause personal injury or material damage. If safety functions or safeguards are dismantled or deactivated, the industrial robot may not be operated.

Warning!
Standing underneath the robot arm can cause death or serious physical injuries. For this reason, standing underneath the robot arm is prohibited!

Warning!
The motors reach temperatures during operation which can cause burns to the skin. Contact should be avoided. Appropriate safety precautions must be taken, e.g. protective gloves must be worn.

KCP

The user must ensure that the industrial robot is only operated with the KCP by authorized persons.

If more than one KCP is used in the overall system, it must be ensured that each KCP is unambiguously assigned to the corresponding industrial robot. They must not be interchanged.

Warning!
The operator must ensure that decoupled KCPs are immediately removed from the system and stored out of sight and reach of personnel working on the industrial robot. This serves to prevent operational and non-operational EMERGENCY STOP facilities from becoming interchanged.
Failure to observe this precaution may result in death, severe physical injuries or considerable damage to property.

External keyboard, external mouse

An external keyboard and/or external mouse may only be used if the following conditions are met:

- Start-up or maintenance work is being carried out.
- The drives are switched off.
- There are no persons in the danger zone.

The KCP must not be used as long as an external keyboard and/or external mouse are connected.

The external keyboard and/or external mouse must be removed as soon as the start-up or maintenance work is completed or the KCP is connected.

Faults

The following tasks must be carried out in the case of faults in the industrial robot:

- Switch off the robot controller and secure it (e.g. with a padlock) to prevent unauthorized persons from switching it on again.
- Indicate the fault by means of a label with a corresponding warning (tag-out).
- Keep a record of the faults.
- Eliminate the fault and carry out a function test.

Modifications

After modifications to the industrial robot, checks must be carried out to ensure the required safety level. The valid national or regional work safety regulations must be observed for this check. The correct functioning of all safety circuits must also be tested.

New or modified programs must always be tested first in Manual Reduced Velocity mode (T1).

After modifications to the industrial robot, existing programs must always be tested first in Manual Reduced Velocity mode (T1). This applies to all components of the industrial robot and includes modifications to the software and configuration settings.

5.5.2 Transportation

Manipulator

The prescribed transport position of the manipulator must be observed. Transportation must be carried out in accordance with the operating instructions or assembly instructions of the manipulator.

Robot controller

The robot controller must be transported and installed in an upright position. Avoid vibrations and impacts during transportation in order to prevent damage to the robot controller.

Transportation must be carried out in accordance with the operating instructions or assembly instructions of the robot controller.

External axis (optional)

The prescribed transport position of the external axis (e.g. KUKA linear unit, turn-tilt table, etc.) must be observed. Transportation must be carried out in accordance with the operating instructions or assembly instructions of the external axis.

5.5.3 Start-up and recommissioning

Before starting up systems and devices for the first time, a check must be carried out to ensure that the systems and devices are complete and operational, that they can be operated safely and that any damage is detected.

The valid national or regional work safety regulations must be observed for this check. The correct functioning of all safety circuits must also be tested.

The passwords for logging onto the KUKA System Software as “Expert” and “Administrator” must be changed before start-up and must only be communicated to authorized personnel.

Danger!
The robot controller is preconfigured for the specific industrial robot. If cables are interchanged, the manipulator and the external axes (optional) may receive incorrect data and can thus cause personal injury or material damage. If a system consists of more than one manipulator, always connect the connecting cables to the manipulators and their corresponding robot controllers.

Warning!
If additional components (e.g. cables), that are not part of the scope of supply of KUKA Roboter GmbH, are integrated into the industrial robot, the user is responsible for ensuring that these components do not adversely affect or disable safety functions.

Caution!
If the internal cabinet temperature of the robot controller differs greatly from the ambient temperature, condensation can form, which may cause damage to the electrical components. Do not put the robot controller into operation until the internal temperature of the cabinet has adjusted to the ambient temperature.

Function test

The following tests must be carried out before start-up and recommissioning:

It must be ensured that:

- The industrial robot is correctly installed and fastened in accordance with the specifications in the documentation.
- There are no foreign bodies or loose parts on the industrial robot.
- All required safety equipment is correctly installed and operational.
- The power supply ratings of the industrial robot correspond to the local supply voltage and mains type.
- The ground conductor and the equipotential bonding cable are sufficiently rated and correctly connected.
- The connecting cables are correctly connected and the connectors are locked.

Machine data

It must be ensured that the rating plate on the robot controller has the same machine data as those entered in the declaration of incorporation. The machine data on the rating plate of the manipulator and the external axes (optional) must be entered during start-up.

Warning!
The robot must not be moved if incorrect machine data are loaded. Death, severe physical injuries or considerable damage to property may otherwise result. The correct machine data must be loaded.

5.5.4 Manual mode

Manual mode is the mode for setup work. Setup work is all the tasks that have to be carried out on the industrial robot to enable automatic operation. Setup work includes:

- Jog mode
- Teaching
- Programming
- Program verification

The following must be taken into consideration in manual mode:

- If the drives are not required, they must be switched off to prevent the manipulator or the external axes (optional) from being moved unintentionally.

  New or modified programs must always be tested first in Manual Reduced Velocity mode (T1).
- The manipulator, tooling or external axes (optional) must never touch or project beyond the safety fence.
- Components, tooling and other objects must not become jammed as a result of the industrial robot motion, nor must they lead to short-circuits or be liable to fall off.
- All setup work must be carried out, where possible, from outside the safeguarded area.

If the setup work has to be carried out inside the safeguarded area, the following must be taken into consideration:

In **Manual Reduced Velocity mode (T1)**:

- If it can be avoided, there must be no other persons inside the safeguarded area.

  If it is necessary for there to be several persons inside the safeguarded area, the following must be observed:
  - Each person must have an enabling device.
  - All persons must have an unimpeded view of the industrial robot.

- Eye-contact between all persons must be possible at all times.
- The operator must be so positioned that he can see into the danger area and get out of harm's way.

In **Manual High Velocity mode (T2)**:

- This mode may only be used if the application requires a test at a velocity higher than Manual Reduced Velocity.
- Teaching and programming are not permissible in this operating mode.
- Before commencing the test, the operator must ensure that the enabling devices are operational.
- The operator must be positioned outside the danger zone.
- There must be no other persons inside the safeguarded area. it is the responsibility of the operator to ensure this.

5.5.5 Automatic mode

Automatic mode is only permissible in compliance with the following safety measures:

- All safety equipment and safeguards are present and operational.
- There are no persons in the system.
- The defined working procedures are adhered to.

If the manipulator or an external axis (optional) comes to a standstill for no apparent reason, the danger zone must not be entered until an EMERGENCY STOP has been triggered.

5.5.6 Maintenance and repair

After maintenance and repair work, checks must be carried out to ensure the required safety level. The valid national or regional work safety regulations must be observed for this check. The correct functioning of all safety circuits must also be tested.

The purpose of maintenance and repair work is to ensure that the system is kept operational or, in the event of a fault, to return the system to an operational state. Repair work includes troubleshooting in addition to the actual repair itself.

The following safety measures must be carried out when working on the industrial robot:

- Carry out work outside the danger zone. If work inside the danger zone is necessary, the user must define additional safety measures to ensure the safe protection of personnel.
- Switch off the industrial robot and secure it (e.g. with a padlock) to prevent unauthorized persons from switching it on again. If it is necessary to carry out work with the robot controller switched on, the user must define additional safety measures to ensure the safe protection of personnel.
- If it is necessary to carry out work with the robot controller switched on, this may only be done in operating mode T1.
- Label the system with a sign indicating that work is in progress. This sign must remain in place, even during temporary interruptions to the work.
- The EMERGENCY STOP systems must remain active. If safety functions or safeguards are deactivated during maintenance or repair work, they must be reactivated immediately after the work is completed.

Faulty components must be replaced using new components with the same article numbers or equivalent components approved by KUKA Roboter GmbH for this purpose.

Cleaning and preventive maintenance work is to be carried out in accordance with the operating instructions.

Robot controller

Even when the robot controller is switched off, parts connected to peripheral devices may still carry voltage. The external power sources must therefore be switched off if work is to be carried out on the robot controller.

The ESD regulations must be adhered to when working on components in the robot controller.

Voltages in excess of 50 V (up to 600 V) can be present in various components for several minutes after the robot controller has been switched off! To prevent life-threatening injuries, no work may be carried out on the industrial robot in this time.

Water and dust must be prevented from entering the robot controller.

Counterbalancing system

Some robot variants are equipped with a hydropneumatic, spring or gas cylinder counterbalancing system.

The hydropneumatic and gas cylinder counterbalancing systems are pressure equipment and, as such, are subject to obligatory equipment monitoring. Depending on the robot variant, the counterbalancing systems correspond to category II or III, fluid group 2, of the Pressure Equipment Directive.

The user must comply with the applicable national laws, regulations and standards pertaining to pressure equipment.

Inspection intervals in Germany in accordance with Industrial Safety Order, Sections 14 and 15. Inspection by the user before commissioning at the installation site.

The following safety measures must be carried out when working on the counterbalancing system:

- The manipulator assemblies supported by the counterbalancing systems must be secured.
- Work on the counterbalancing systems must only be carried out by qualified personnel.

Hazardous substances

The following safety measures must be carried out when handling hazardous substances:

- Avoid prolonged and repeated intensive contact with the skin.
- Avoid breathing in oil spray or vapors.
- Clean skin and apply skin cream.

To ensure safe use of our products, we recommend that our customers regularly request up-to-date safety data sheets from the manufacturers of hazardous substances.

5.5.7 Decommissioning, storage and disposal

The industrial robot must be decommissioned, stored and disposed of in accordance with the applicable national laws, regulations and standards.

5.6 Applied norms and regulations

Name	Definition	Edition
2006/42/EC	Machinery Directive: Directive 2006/42/EC of the European Parliament and of the Council of 17 May 2006 on machinery, and amending Directive 95/16/EC (recast)	2006
2004/108/EC	EMC Directive: Directive 2004/108/EC of the European Parliament and of the Council of 15 December 2004 on the approximation of the laws of the Member States relating to electromagnetic compatibility and repealing Directive 89/336/EEC.	2004
97/23/EC	Pressure Equipment Directive: Directive 97/23/EC of the European Parliament and of the Council of 29 May 1997 on the approximation of the laws of the Member States concerning pressure equipment	1997
EN ISO 13850	Safety of machinery: Emergency stop - Principles for design	2008
EN ISO 13849-1	Safety of machinery: Safety-related parts of control systems - Part 1: General principles for design	2008
EN ISO 13849-2	Safety of machinery: Safety-related parts of control systems - Part 2: Validation	2008
EN ISO 12100-1	Safety of machinery: Basic concepts, general principles for design - Part 1: Basic terminology, methodology	2003
EN ISO 12100-2	Safety of machinery: Basic concepts, general principles for design - Part 2: Technical principles	2003
EN ISO 10218-1	Industrial robots: Safety	2008
EN 614-1	Safety of machinery: Ergonomic design principles - Part 1: Terminology and general principles	2006
EN 61000-6-2	Electromagnetic compatibility (EMC): Part 6-2: Generic standards; Immunity for industrial environments	2005
EN 61000-6-4	Electromagnetic compatibility (EMC): Part 6-4: Generic standards; Emission standard for industrial environments	2007
EN 60204-1	Safety of machinery: Electrical equipment of machines - Part 1: General requirements	2006

6 Planning

6.1 Mounting base

Description

The linear unit is fastened to the floor with M16 (standard) or M20 (alternative) chemical anchors (resin-bonded anchors). M16 chemical anchors are installed with a Dynamic Set in the floor.

The mounting base (>>> Fig. 6-1) consists of:

- Plate
- Chemical anchors (resin-bonded anchors) with Dynamic Set (optionally without Dynamic Set)
- Fasteners

This mounting variant requires a level and smooth surface on a concrete foundation with adequate load bearing capacity. The concrete foundation must be able to accommodate the forces occurring during operation. The minimum dimensions must be observed.

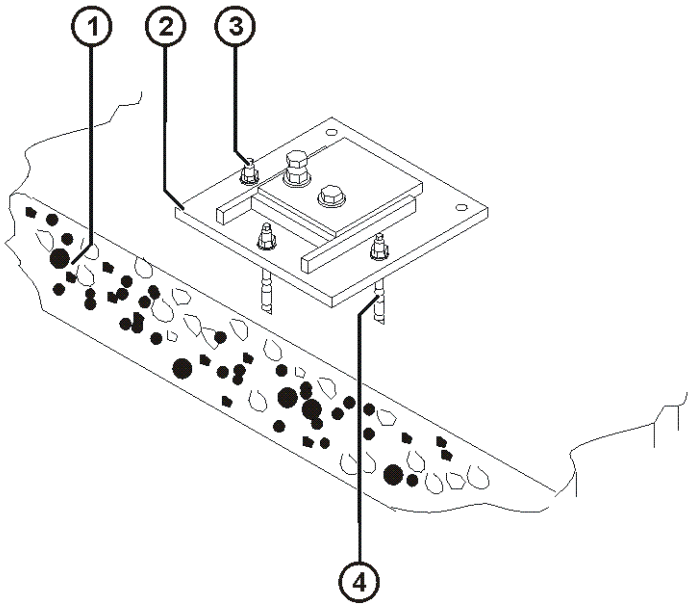


Fig. 6-1: Mounting base

1	Concrete foundation, free from cracks	3	Fasteners
2	Plate	4	Chemical anchors

Grade of concrete for foundations

When producing foundations from concrete, observe the load-bearing capacity of the ground and the country-specific construction regulations. The concrete must have no cracks and fulfill the following norms for quality:

- B25 according to DIN 1045:1988
- C20/25 according to DIN EN 206-1:2001/DIN 1045-2:2001

6.2 Foundation data

6.2.1 Loads acting on the foundation

The loads acting on the foundation depend on the robot variant and the number of carriages and pedestals. The individual maximum values can be taken from the tables “Foundation loads 1” and “Foundation loads 2”. These are the maximum values acting on one plate.

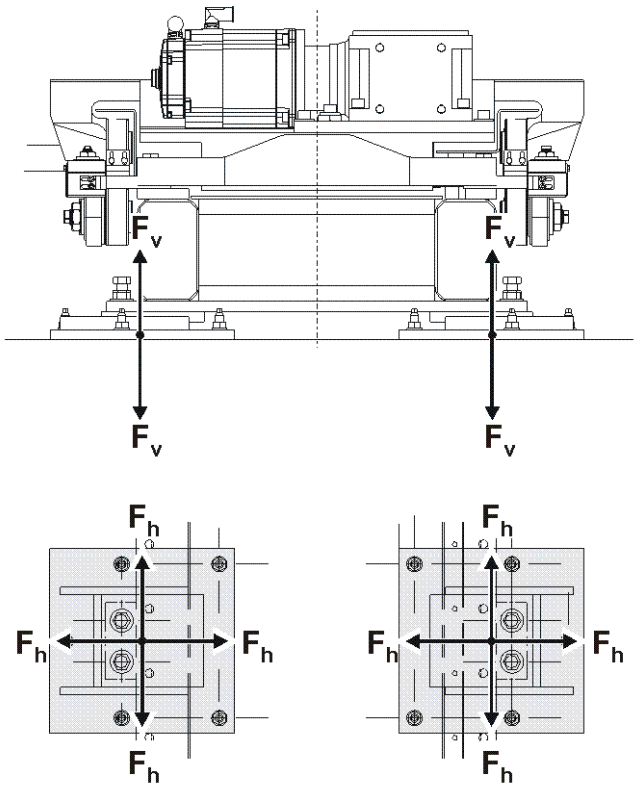


Fig. 6-2: Loads acting on the foundation

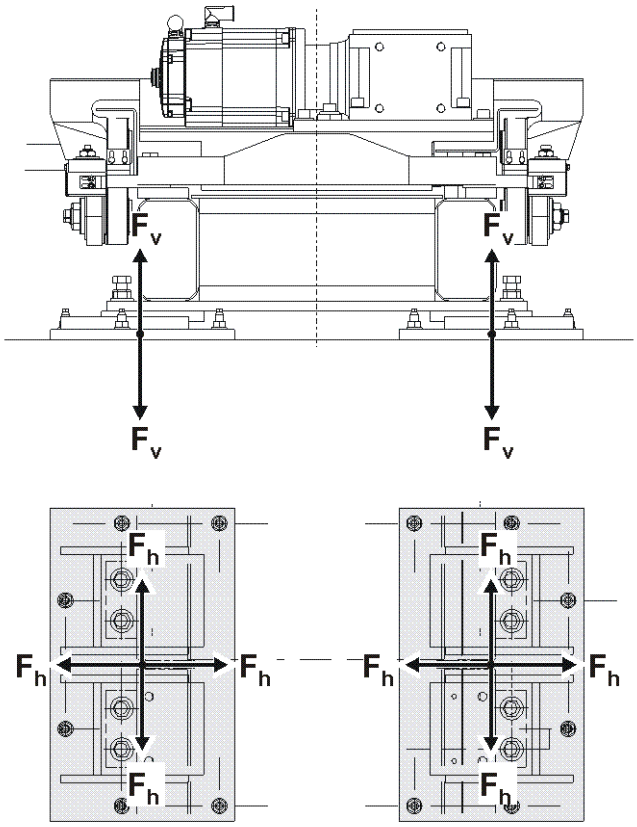


Fig. 6-3: Loads acting on the foundation, beam joint

Foundation loads 1

Robot type	KR 30 - KR 125, KR 150, KR 200	KR 30 - KR 125, KR 150, KR 200 with two to four carriages, with pedestal up to 800 mm	KR 150 - KR 270 (Series 2000)
Vertical force F_v dynamic (pull on anchors)	6,100 N	11,100 N	17,440 N
Vertical force F_v dynamic (pressure on concrete)	17,900 N	23,100 N	36,800 N
Vertical force F_v dynamic (pressure on concrete during E-STOP)	35,600 N	60,390 N	60,390 N

Robot type	KR 30 - KR 125, KR 150, KR 200	KR 30 - KR 125, KR 150, KR 200 with two to four carriages, with pedestal up to 800 mm	KR 150 - KR 270 (Series 2000)
Lateral force F_h dynamic	5,800 N	5,900 N	7,400 N
Lateral force F_v dynamic (max. load during E-STOP)	11,700 N	15,755 N	15,755 N

Foundation loads 2

Robot type	KR 150 - KR 270 (Series 2000) with two to four carriages, with pedestal up to 800 mm	KR 360 and KR 500	KR 360 and KR 500 with two to four carriages
Vertical force F_v dynamic (pull on anchors)	23,600 N	38,200 N	40,000 N
Vertical force F_v dynamic (pressure on concrete)	43,300 N	74,000 N	77,500 N
Vertical force F_v dynamic (pressure on concrete during E-STOP)	84,410 N	84,410 N	107,420 N
Lateral force F_h dynamic	7,600 N	12,500 N	13,000 N
Lateral force F_v dynamic (max. load during E-STOP)	32,690 N	32,690 N	40,610 N

6.2.2 Mounting base variants

The number of chemical anchors for each individual mounting base are dependent on the loads acting on the foundation. These depend on the robot type. The number of chemical anchors required per mounting base are specified in the following table.

Robot type	KR 30 - KR 125, KR 150, KR 200	KR 30 - KR 125, KR 150, KR 200 with two to four carriages, with pedestal up to 800 mm	KR 150 - KR 270 (Series 2000)
Number of chemical anchors per mounting base	6x M16, with Dynamic Set or 4x M20, without Dynamic Set (optional)		
Number of chemical anchors per mounting base at the beam joint	8x M16, with Dynamic Set or 8x M20, without Dynamic Set (optional)		

Robot type	KR 150 - KR 270 (Series 2000) with two to four carriages, with pedestal up to 800 mm	KR 360 and KR 500	KR 360 and KR 500 with two to four carriages
Number of chemical anchors per mounting base	10x M16, with Dynamic Set or 8x M20, without Dynamic Set (optional)		
Number of chemical anchors per mounting base at the beam joint	12x M16, with Dynamic Set or 8x M20, without Dynamic Set (optional)		

Mounting base,
6x M16

Dimensions: mm

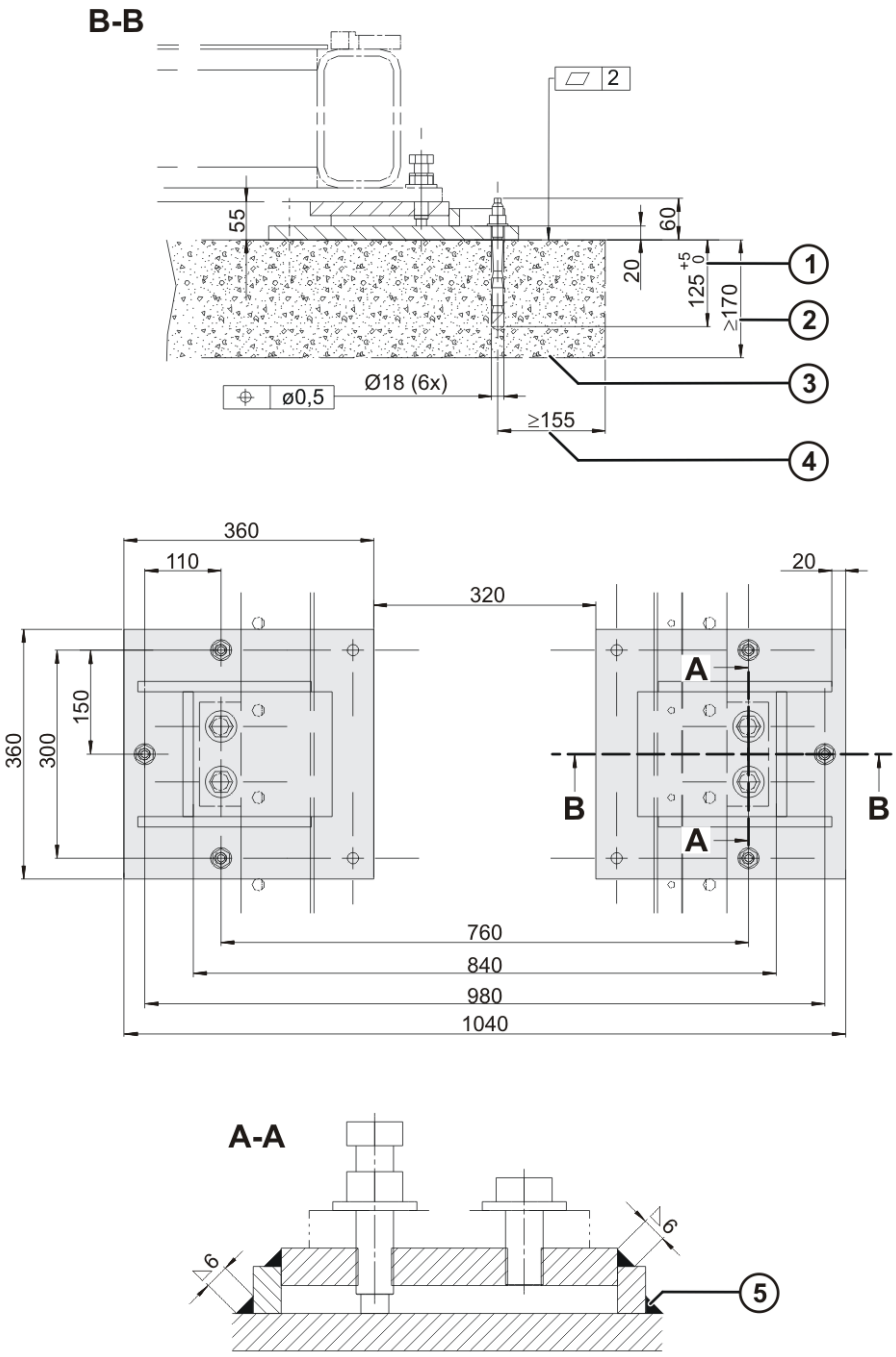


Fig. 6-4: Mounting base, 6x M16

1	Borehole depth	4	Distance to edge of foundation
2	Thickness of concrete, without screed	5	Weld seams
3	Concrete foundation, free from cracks		

Mounting base, 10x M16

Dimensions: mm

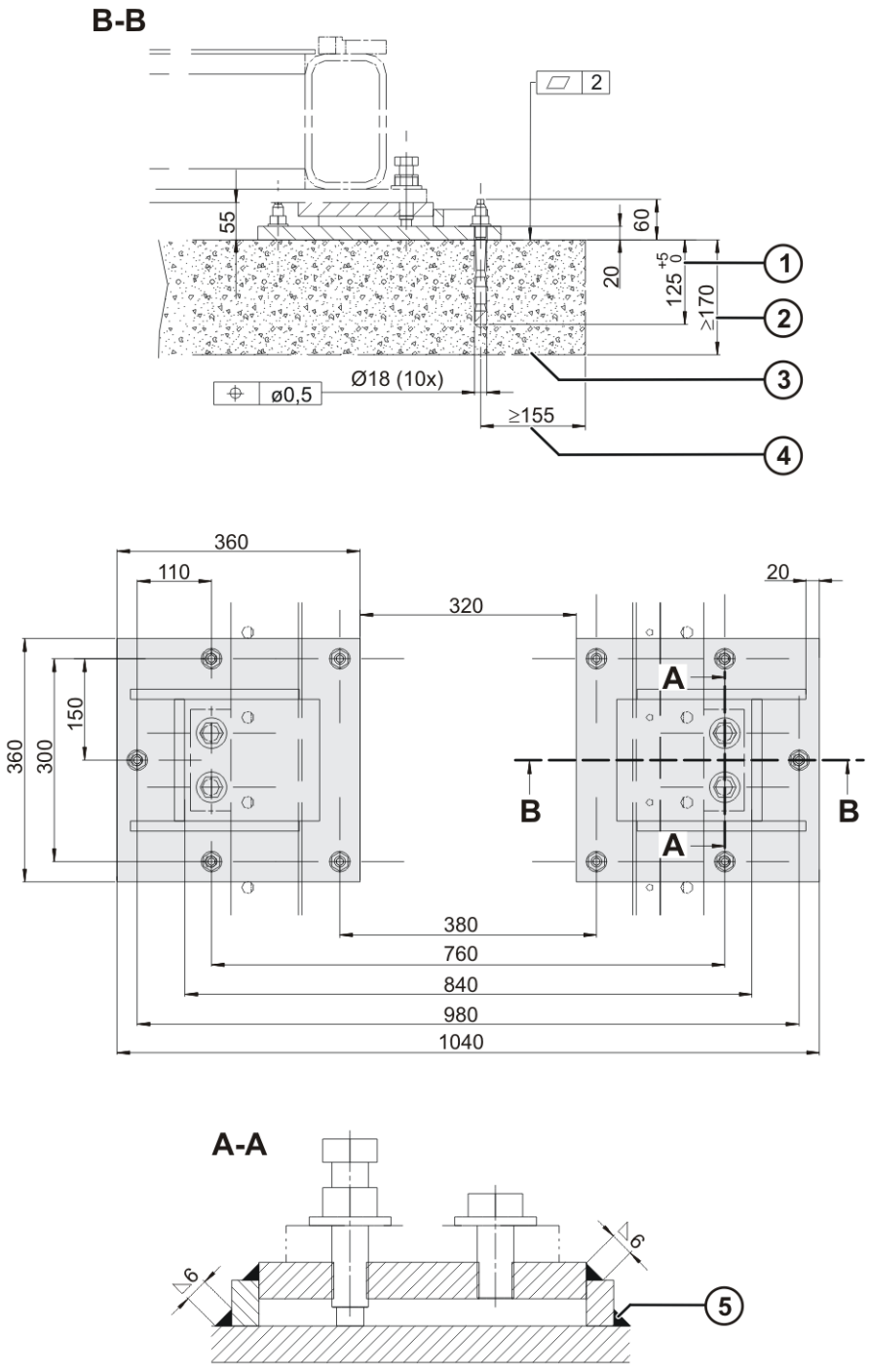


Fig. 6-5: Mounting base, 10x M16

1	Borehole depth	4	Distance to edge of foundation
2	Thickness of concrete, without screed	5	Weld seams
3	Concrete foundation, free from cracks		

Mounting base, beam joint, 8x M16

The beam joint is the point at which two beams are joined end to end. Special mounting bases are used at this position.

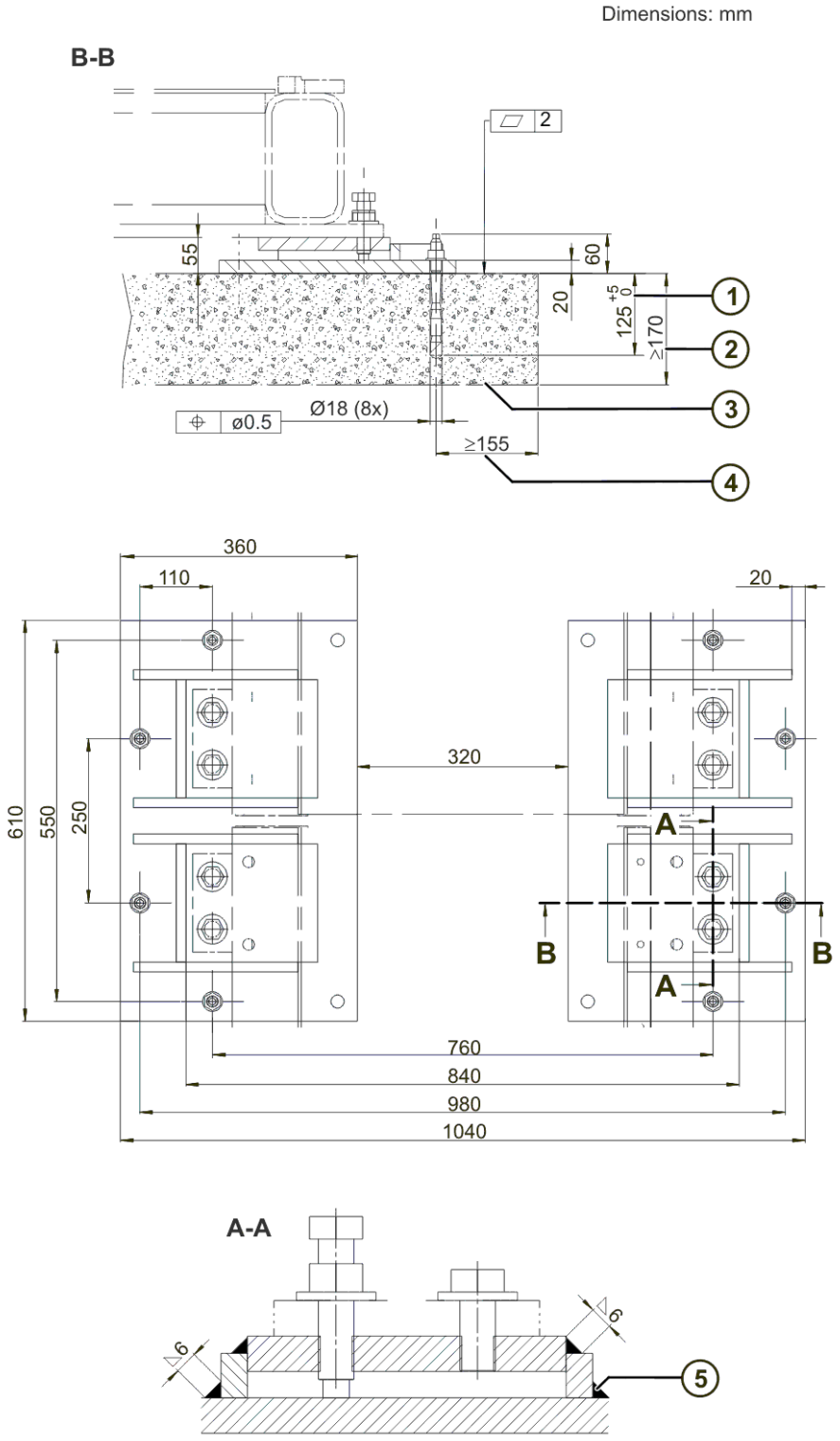


Fig. 6-6: Mounting base, beam joint, 8x M16

1	Borehole depth	4	Distance to edge of foundation
2	Thickness of concrete, without screed	5	Weld seams
3	Concrete foundation, free from cracks		

Mounting base, beam joint, 12x M16

The beam joint is the point at which two beams are joined end to end. Special mounting bases are used at this position.

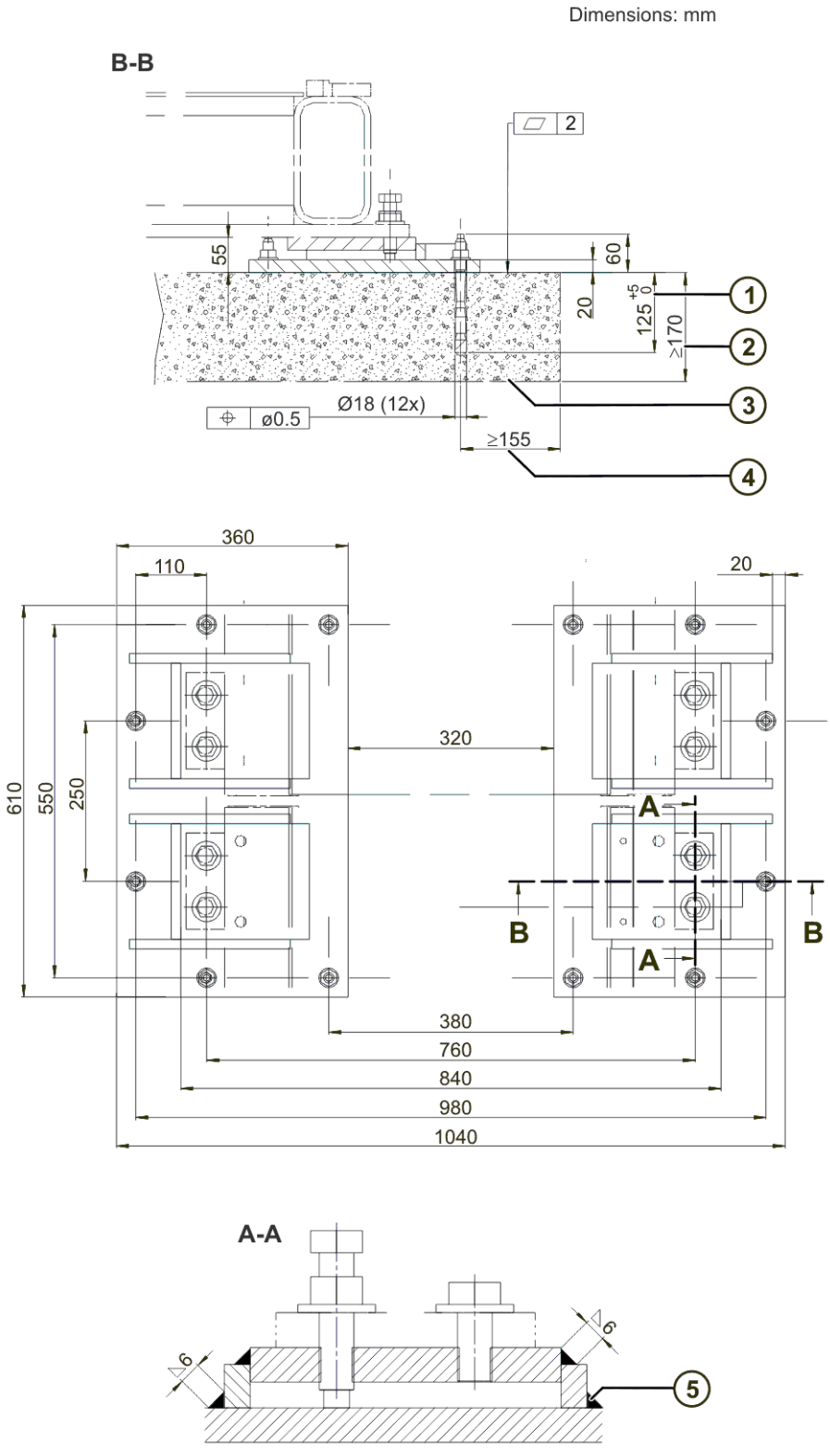


Fig. 6-7: Mounting base, beam joint, 12x M16

1	Borehole depth	4	Distance to edge of foundation

2	Thickness of concrete, without screed	5	Weld seams
3	Concrete foundation, free from cracks		

6.3 Connecting cables and interfaces

Connecting cables

The connecting cables comprise all the cables for transferring energy and signals between the robot, the robot controller and the linear unit. The set of connecting cables comprises:

- Motor cable XM7
- Control cable XP7
- Ground conductor, only for connecting cables > 25 m

The motor cable A 1 - A 6 and data cable are described in the robot operating manual.

A connector plate serving as an interface is located on the linear unit. The connector plate serves as a common interface for all the cables.

The motor cable and control cable, as well as the ground conductor of axis 7, are connected to the robot controller via the connector plate and the connecting cable (robot). A connection panel is provided on the robot controller for the external axis A 7. For motor cables, control cables and ground conductors, standard lengths are available in 7 m, 15 m, 25 m and 35 m.

For connecting cables of length > 25 m an additional ground conductor is required to provide a low-resistance connection between the linear unit and the control cabinet in accordance with DIN EN 60204. The ground conductors are connected via ring cable lugs. These ground conductors and the threaded bolts are included in the scope of supply for connecting cable sets > 25 m.

Wiring diagrams, connector pin allocations and connector designations for the energy supply chain can be found in the section “Electrical installations” (>>> 12 "Electrical installations" page 95).

The following points must be observed when planning and routing the connecting cables:

- The bending radius for fixed routing – 150 mm for motor cables and 60 mm for control cables – must not be exceeded.
- Protect cables against exposure to mechanical stress
- Route the cables without mechanical stress – no tensile forces on the connectors
- Cables are only to be installed indoors
- Observe permissible temperature range (fixed installation) of 263 K (-10 °C) to 343 K (+70 °C).
- Route the motor cables and the control cables separately in metal ducts; if necessary, additional measures must be taken to ensure electromagnetic compatibility (EMC).

Caution!
Permissible cable lengths:
The length of the connecting cables between the robot controller and the robot must not exceed 50 m.
If Safe robots are used, the cable length must not exceed 35 m.

Interface for energy supply systems

The linear unit can be fitted with an energy supply system. The energy supply chain forms the moving (translational) connection between the connector plate and the driver on the carriage. The interfaces are equipped with connections for cables and hoses depending on the application. Detailed information on the connector pin allocation, threaded unions, etc. is given in separate documentation.

7 Transportation

7.1 Transportation of assemblies and components

The following measures are to be taken before assemblies and individual components are transported:

- Protect components against corrosion (>>> 13.2 "Storage" page 104)
- Pack motors and gear units in wooden cases with protection against moisture and transport damage.
- Wrap components in PVC foil or waxed paper, with desiccant if necessary.
- Provide electrical components with shock-resistant and break-proof packing.

Mark transport cases and packing according to the sensitivity of their contents (e.g. TOP, FRAGILE, DO NOT BEND) and attach labels to ensure correct transportation (e.g. indication of center of gravity). In addition to these measures, the regulations and conditions of the company entrusted with the transportation are to be observed.

7.2 Transportation of beams

Prior to transportation the beam of the linear unit must be separated from all its individual assemblies and components that are to be transported separately. If a carriage is installed on the beam, it must be ensured that it is in the middle of the beam and that it cannot move.

Description The beam can be transported by fork lift truck or using a crane.

Caution!
Risk of injury and damage to property resulting from unsuitable handling equipment. Only use handling equipment with a sufficient load-bearing capacity. The beam must always be picked up over the center of gravity.

7.2.1 Transportation by fork lift truck

Description For transportation by fork lift truck (>>> Fig. 7-1), the beam must be picked up at its center of gravity in order to prevent it from toppling.

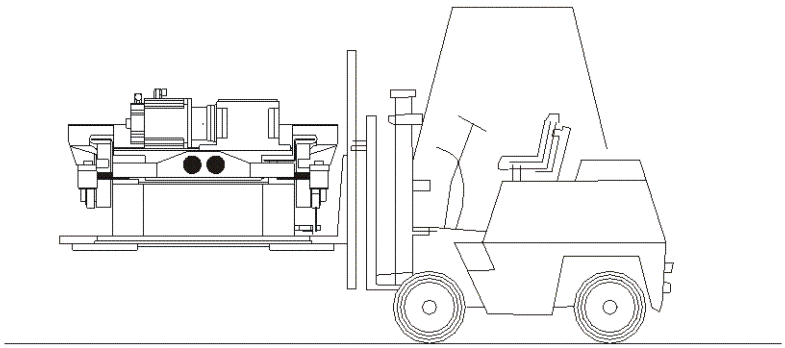


Fig. 7-1: Transportation by fork lift truck

7.2.2 Transportation by crane

Description

The beam can be transported using a crane (>>> Fig. 7-2). All ropes must be long enough and must be routed in such a way that the beam is not damaged.

When attaching the lifting tackle, care must be taken not to damage any components (e.g. covers).

Caution!
The beam may tip during transportation. Risk of injury and damage to property.
If the beam is being transported using lifting tackle, special care must be exercised to prevent it from tipping. Additional safeguarding measures must be taken. It is forbidden to pick up the beam in any other way using a crane!

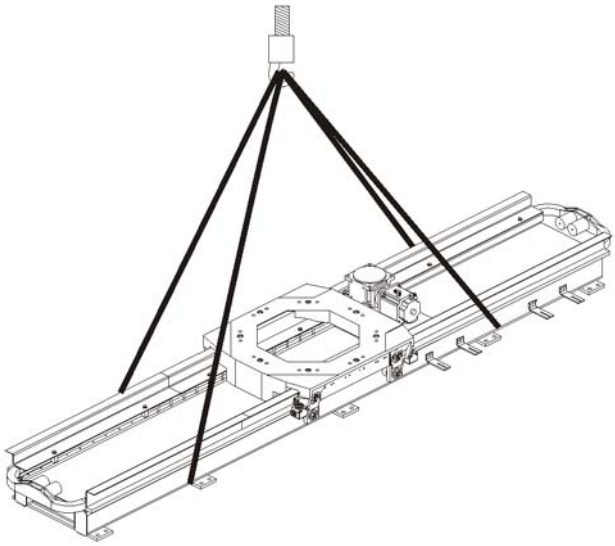


Fig. 7-2: Transportation by crane

8 Start-up and recommissioning

8.1 Installing the mounting base

Description

The linear unit is fastened to an suitable concrete foundation using bedplates and chemical anchors (resin-bonded anchors).

If the surface of the concrete foundation is not sufficiently smooth and even, even out the differences with a suitable leveling compound.

When using chemical anchors (resin-bonded anchors), use only resin capsules and anchors (threaded rods) from the same manufacturer. No diamond tools or core drills may be used for drilling the anchor holes; for preference, drilling tools supplied by the anchor manufacturer are to be used. Observe also the manufacturer's instructions for the use of resin-bonded anchors.

Preconditions

- The concrete foundation must have the required dimensions and cross-section.
- The surface of the foundation must be smooth and even.
- The mounting base assembly must be complete.
- Have the leveling compound readily at hand.

Special tools

The following special tools are required:

- Drill with a ø 18 mm bit (optionally ø 25 mm)
- Setting tool approved by the anchor manufacturer.

Procedure

1. Position the plates on the foundation (>>> 4.4 "Order-specific technical data" page 24). Maximum difference in level between any two plates: 5 mm.

If the plates are not fully seated on the concrete foundation, fill the gap with leveling compound. To do this, lift the plates again and apply sufficient leveling compound. Then set the plates down again and align them, removing any excess leveling compound. No leveling compound must be allowed to penetrate into the tapped holes for fastening the linear unit.

2. Allow the leveling compound to cure for about three hours. The curing time is longer at temperatures below 293 K (20 °C).
3. Drill anchor holes (>>> Fig. 8-1) through the holes of the plates into the foundation.
4. Remove the plates and clean the anchor holes with a vacuum cleaner.

The boreholes must be free of dust and loose pieces of concrete. No fluids or dust bonding agents may be used for cleaning.

5. Replace the plates on the foundation and realign them.
6. Insert the resin capsules one after the other.
7. Clamp the setting tool with the chemical anchor rod in the drill and insert it into the anchor hole at max. 750 rpm. The chemical anchor rod is set correctly if the resin is completely mixed and the anchor hole in the concrete is completely filled to the upper edge.
8. Allow the resin to cure. See table, or as specified by manufacturer. These values are guide values.

Temperature	Time
≥293 K (+20 °C)	20 minutes
≥283 K (+10 °C)	30 minutes

Temperature	Time
≥273 K (0 °C)	1 hour
268 K (-5 °C)	5 hours

9. Screw on the M20 hexagon nuts and lock washers and tighten them one after the other with a torque wrench. Gradually increase the tightening torque to a value of 120 Nm.

   For M16 chemical anchors with Dynamic Set:
   mount filling disc, spherical washer, nut and lock washer and tighten with torque wrench. Gradually increase the tightening torque to a value of 90 Nm. Inject hybrid resin into hole in filling disc. Allow the hybrid resin to cure.
10. Retighten the hexagon nuts after 100 hours of operation.

The mounting base is now ready for the linear unit to be installed.

Dimensions: mm

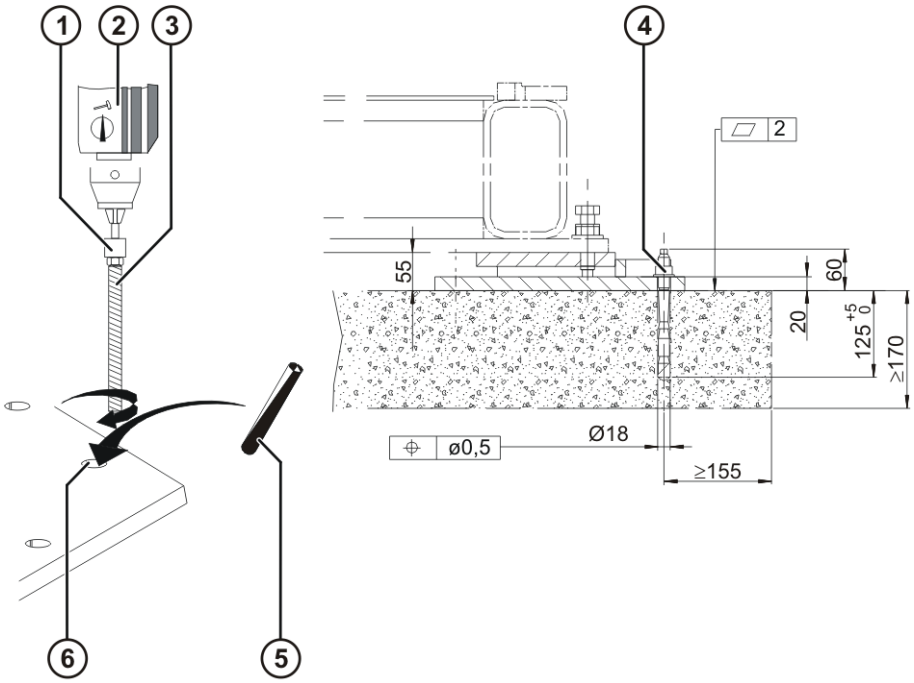


Fig. 8-1: Installing the chemical anchors

1	Setting tool	4	Hexagon nut
2	Drill	5	Resin capsule
3	Chemical anchor rod	6	Hole in the plate

8.2 Installing a linear unit with a one-piece beam

Preconditions

- The bedplates are anchored to the floor as described in Section (>>> 8.1 "Installing the mounting base" page 55).
- The connecting cables and energy supply system cables are installed on the system side.
- The site of installation must be accessible with a fork lift truck or with a crane. Observe the minimum payload capacity.

Procedure

1. Lower the linear unit with bolted-on strips (>>> Fig. 8-2) (4) onto the plates.

2. Level the linear unit.
   Align the beam by means of hexagon bolts (7) and spirit level.
   The reference surface is the tracks.
   Tolerance: ± 0.1 mm/m track
3. Weld the linear unit to the plate (6) and the strip (4) using the side strips (3).
4. Clean and repaint welds.
5. Tighten the hexagon nut (8) with a torque of M_A = 370 Nm.
6. Remove protective coatings from the tracks and re-oil them.
7. Remove protective coatings from the racks and re-grease them.
8. Install the energy supply system; see Section (>>> 8.6 "Installing the energy supply system" page 62).
9. Connect the equipotential bonding (ground conductor) on the carriage.
10. Install the robot in accordance with the operating instructions.
11. Put the linear unit into operation in accordance with the “Start-up” chapter of the operating and programming instructions for the KUKA System Software (KSS) and the “Start-up” chapter of the operating instructions for the robot controller.

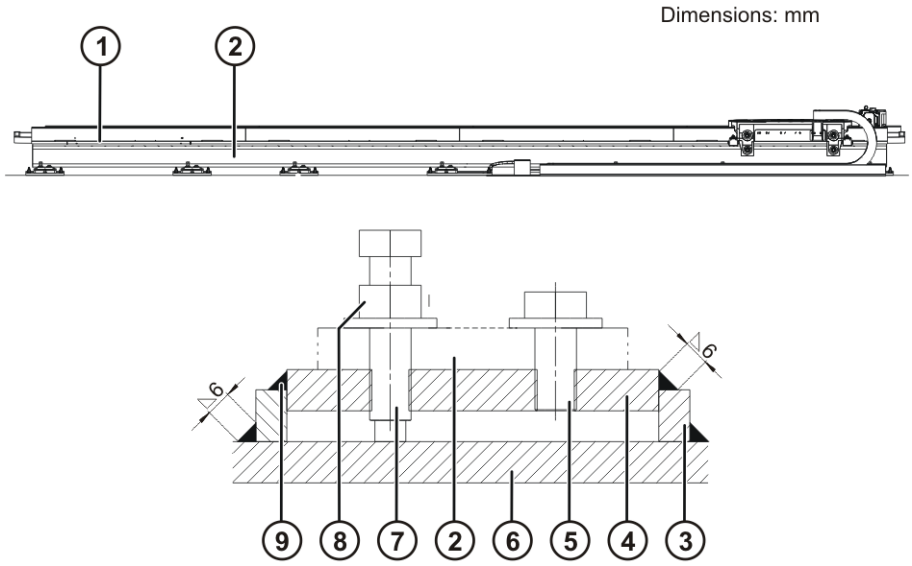


Fig. 8-2: Installation

1	Track	6	Plate
2	Beam	7	Hexagon bolt
3	Side strip	8	Hexagon nut
4	Strip	9	Weld seam
5	Hexagon bolt		

8.3 Removing linear unit with one-piece beam

Preconditions

- The removal site is accessible with a fork lift truck or with a crane. Observe the minimum payload capacity.

Warning!
Unintentional motions of the linear unit, the robot and affected system components can cause injuries and damage to property. If work is carried out on an operational linear unit, the linear unit, the robot and affected system components must be secured by activating the EMERGENCY STOP button. Warn all persons concerned before putting it back into operation.

Procedure

1. Remove the robot in accordance with the operating instructions.
2. Release and unplug the equipotential bonding (ground conductor) on the carriage.
3. Remove the energy supply system; see Section (>>> 8.7 "Removing the energy supply system" page 64).
4. Clean the tracks and racks and protect them against corrosion.
5. Remove the hexagon bolts (>>> Fig. 8-3) (5, 7) and lock washers.
6. Lift up and remove the linear unit using a crane or a fork lift truck.
7. If the linear unit is not to be reinstalled, it must be protected against corrosion in accordance with (>>> 13 "Decommissioning, storage and disposal" page 103) before being put into storage.

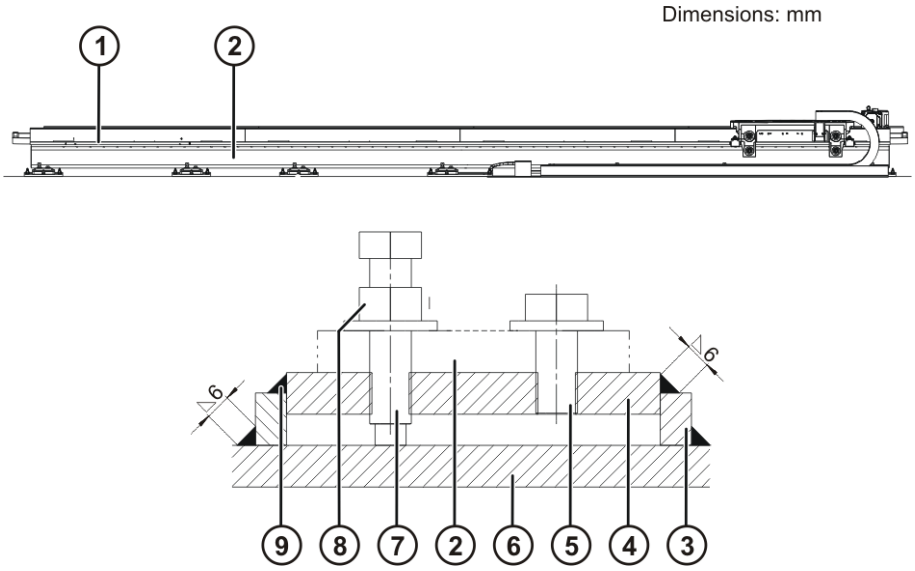


Fig. 8-3: Installation

1	Track	6	Plate
2	Beam	7	Hexagon bolt
3	Side strip	8	Hexagon nut
4	Strip	9	Weld seam
5	Hexagon bolt		

8.4 Installing a linear unit with a beam made up of several parts

Preconditions

- Beam of the linear unit consists of several parts.
- Beam of the linear unit is dismantled ready for transportation.
- The bedplates are anchored to the floor as described in Section (>>> 8.1 "Installing the mounting base" page 55).
- The connecting cables and energy supply system cables are installed on the system side.
- The site of installation must be accessible with a fork lift truck or with a crane. Observe the minimum payload capacity.

Procedure

1. Lower the beam sections of the linear unit with bolted-on strips (>>> Fig. 8-4) (6) onto the plates.
2. Assemble the beam sections.
3. Insert an M16x150-8.8 hexagon bolt (4) with nut and lock washers into the connecting assembly and tighten with a torque of M_A = 195 Nm.
4. Level the linear unit.
   Align the beam by means of hexagon bolts (9) and spirit level.
   The reference surface is the tracks.
   Tolerance: ± 0.1 mm/m track
5. Mount the removed track on the fixed bearing side of the beam.
6. Align the track and attach it using M20x55-8.8 hexagon screws together with lock washers. Tighten the hexagon bolts with a torque of M_A = 370 Nm.

The track must be in full contact with the mounting surface of the beam. There must be a gap of < 0.02 mm between the tracks. Check height offset with a hairline gauge or flat needle.

7. Mount the removed track on the floating bearing side, together with covers, on the beam.
8. Align the track and attach it using M20x55-8.8 hexagon screws together with lock washers. Tighten the hexagon bolts with a torque of M_A = 370 Nm.
9. Fit the removed rack, together with the track cover, and fasten it with M12x80-8.8 hexagon bolts and lock washers.
10. Lightly tighten the M12x80-8.8 hexagon bolts.

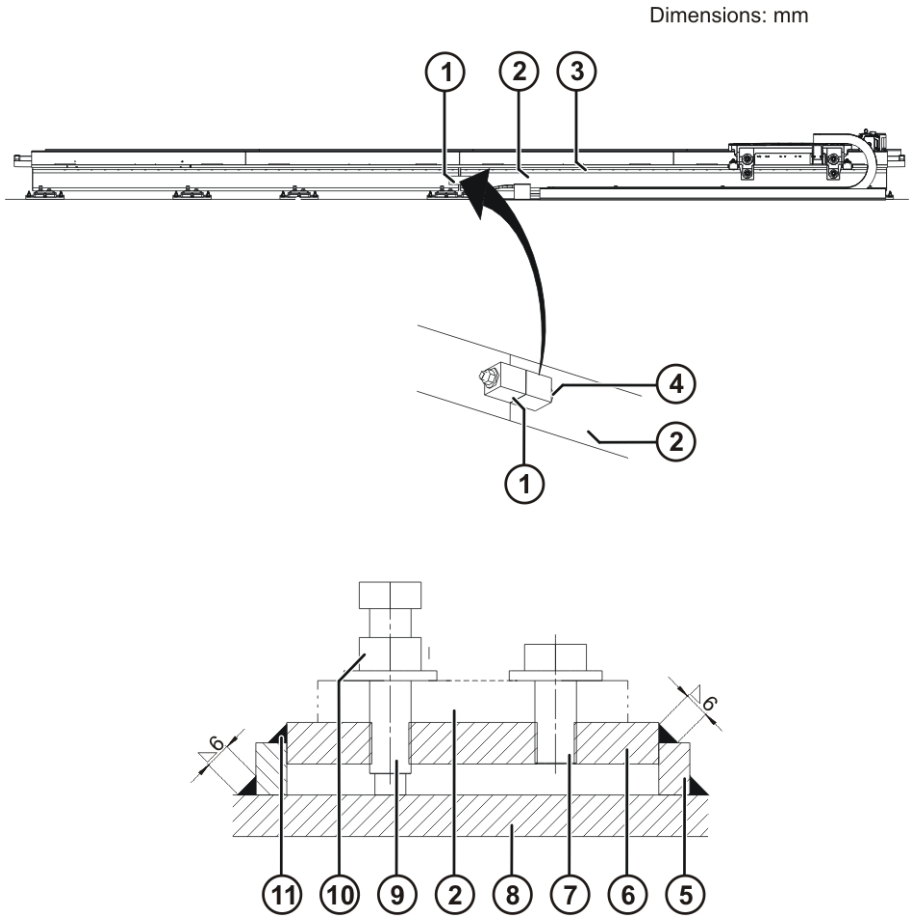


Fig. 8-4: Installation

1	Connecting assembly	7	Hexagon bolt
2	Beam	8	Plate
3	Track	9	Hexagon bolt
4	Hexagon bolt	10	Hexagon nut
5	Side strip	11	Weld seam
6	Strip		

11. Align the racks.
    The flank spacing can be determined by measuring the distance across any two teeth, as shown in (>>> Fig. 8-5). For this purpose, lay two Ø 10 mm parallel pins into the tooth spaces and determine dimension X using calipers. This dimension X must then be obtained across the joint between the racks. The alignment of the racks at the joint between them can also be carried out by placing a mating piece onto them.
12. Measure the distance between two teeth across the joint between the racks. If dimension X at the joint between the racks has been set, tighten the M12x80-8.8 hexagon screws with a torque of M_A = 78 Nm.
13. Measure the distance between the two teeth across the joint again and align them again if necessary.

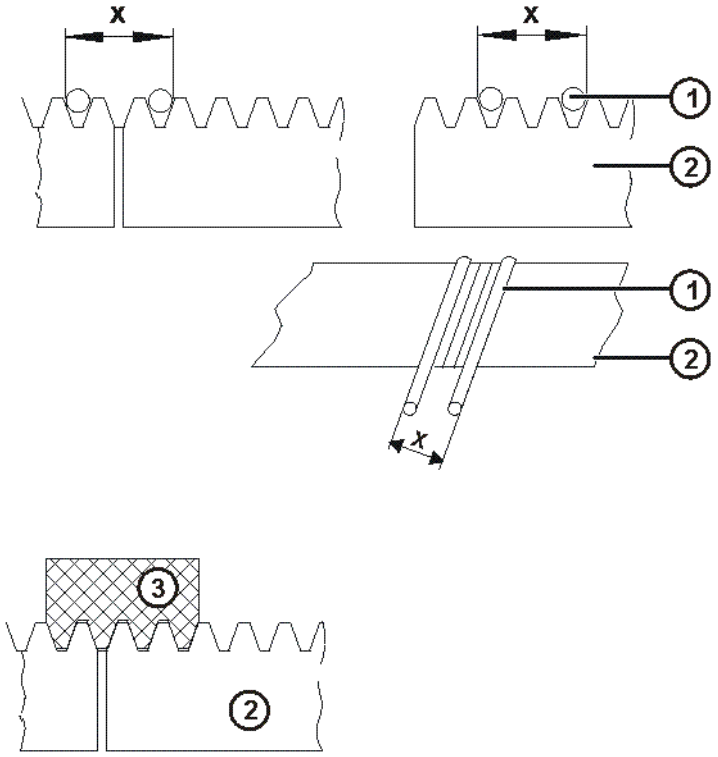


Fig. 8-5: Determining the distance between racks

1	Dowel pin
2	Rack
3	Mating piece

14. Weld the linear unit to the plate (8) and the strip (6) using the side strips (>>> Fig. 8-4) (5).
15. Clean and repaint welds.
16. Tighten the hexagon nut (10) with a torque of M_A = 370 Nm.
17. Remove protective coatings from the tracks and re-oil them.
18. Remove protective coatings from the racks and re-grease them.

19. Install the energy supply system; see Section (>>> 8.6 "Installing the energy supply system" page 62).
20. Connect the equipotential bonding (ground conductor) on the carriage.
21. Install the robot in accordance with the operating instructions.
22. Put the linear unit into operation in accordance with the “Start-up” chapter of the operating and programming instructions for the KUKA System Software (KSS) and the “Start-up” chapter of the operating instructions for the robot controller.

8.5 Removing a linear unit with a beam made up of several parts

Preconditions

- The removal site is accessible with a fork lift truck or with a crane. Observe the minimum payload capacity.
- If a working range monitoring system is fitted, the cams must be removed at the beam joint.

Warning!
Unintentional motions of the linear unit, the robot and affected system components can cause injuries and damage to property. If work is carried out on an operational linear unit, the linear unit, the robot and affected system components must be secured by activating the EMERGENCY STOP button. Warn all persons concerned before putting it back into operation.

Procedure

1. Remove the robot in accordance with the operating instructions.
2. Release and unplug the equipotential bonding (ground conductor) on the carriage.
3. Remove the energy supply system; see Section (>>> 8.7 "Removing the energy supply system" page 64).
4. Remove the track covers, tracks and racks at the beam joint.
5. Slacken and remove the nut, and pull the hexagon bolt (>>> Fig. 8-6) (4) out of the connecting assembly.
6. Remove the hexagon bolts (7, 9) and lock washers.
7. Separate the beam sections.
8. Clean the tracks and racks and protect them against corrosion.
9. Lift up and remove the beam sections using a crane or a fork lift truck.
10. If the linear unit is not to be reinstalled, it must be protected against corrosion in accordance with (>>> 13 "Decommissioning, storage and disposal" page 103) before being put into storage.

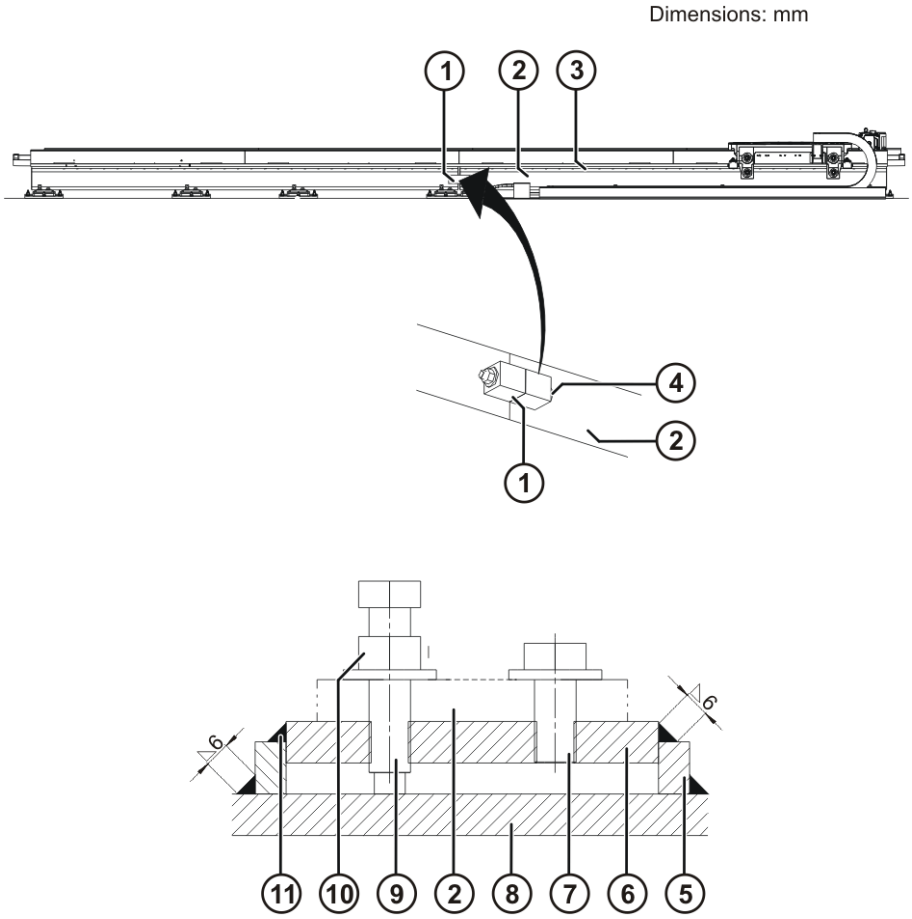


Fig. 8-6: Installation

1	Connecting assembly	7	Hexagon bolt
2	Beam	8	Plate
3	Track	9	Hexagon bolt
4	Hexagon bolt	10	Hexagon nut
5	Side strip	11	Weld seam
6	Strip		

8.6 Installing the energy supply system

Description

The energy supply system is implemented in accordance with the length of travel of the linear unit. This section describes the energy supply system for the shorter travel. With the longer travel, the driver for the energy supply chain is mounted in a different position on the carriage.

Preconditions

- Energy supply system completely assembled together with the supply chain

Caution!
Permissible cable lengths:
The length of the connecting cables between the robot controller and the robot must not exceed 50 m.
If Safe robots are used, the cable length must not exceed 35 m.

Procedure

1. Assemble the trough system (>>> Fig. 8-7).

See the assembly instructions from IGUS.

2. Fasten the driver to the carriage with M12x30-8.8 Allen screws and lock washers. Tighten the Allen screws with a torque of M_A = 78 Nm.
3. Insert ISO8752-8x24 roll pins.
4. Align the trough system with the linear unit in accordance with Section (>>> 4.4 "Order-specific technical data" page 24)
5. Drill two 6x50 mm holes in the floor for each C-profile.
6. Fasten the C-profiles to the floor with two HUS-H 7.5x45 screw anchors each.
7. Screw the energy supply chain to the fixed point module.

See the assembly instructions from IGUS.

8. Screw the other end of the energy supply chain to the driver using M8x25-8.8 Allen screws and lock washers.
9. Fasten the connector plate to the floor with HUS-H 7.5x45 screw anchors.
10. Connect the connecting cables.
11. Connect the equipotential bonding (ground conductor) on the connector plate and on the beam of the linear unit.
12. Connect the equipotential bonding (ground conductor) in the energy supply chain (KR C4 only) on the connector plate and on the robot.
13. If required, connect the energy supply lines.
14. Put the robot and linear unit into operation and move the robot over the entire length of the travel. The energy supply chain must roll properly in the trough system.
15. Shut down the linear unit and the robot and lock them.

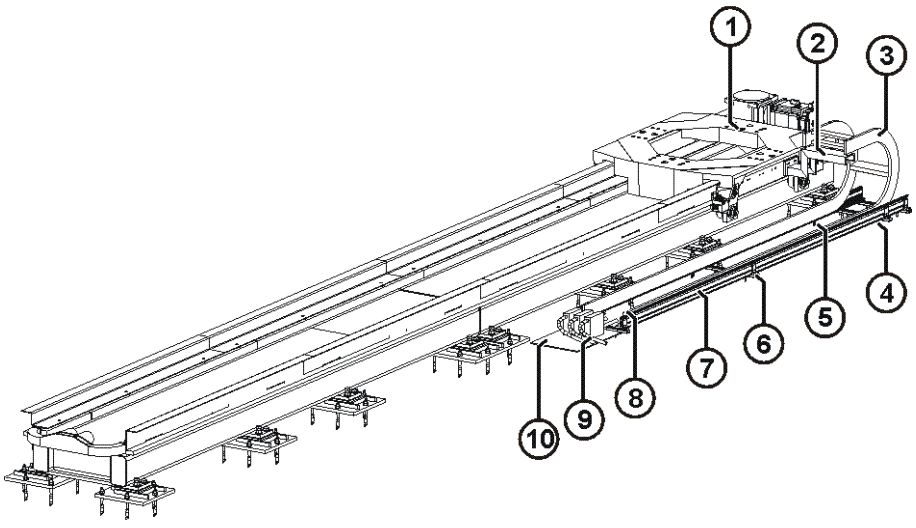


Fig. 8-7: Energy supply system, short travel

1	Carriage	6	C-profiles
2	Driver	7	Trough
3	Energy supply chain	8	Fixed point module
4	Screw anchor	9	Connecting cables
5	Trough system	10	Connector plate

8.7 Removing the energy supply system

Description

The energy supply system is implemented in accordance with the length of travel of the linear unit. This section describes the energy supply system for the shorter travel. With the longer travel, the driver for the energy supply chain is mounted in a different position on the carriage.

Preconditions

Warning!
Unintentional motions of the linear unit, the robot and affected system components can cause injuries and damage to property. If work is carried out on an operational linear unit, the linear unit, the robot and affected system components must be secured by activating the EMERGENCY STOP button. Warn all persons concerned before putting it back into operation.

Procedure

1. Release and unplug all connectors (>>> Fig. 8-8) and unions.
2. Unscrew the screw anchors of the connector plate from the floor, and remove the connector plate.
3. Unscrew the energy supply chain from the fixed point module.
4. Remove the Allen screws and lock washers of the energy supply chain from the driver and set down the energy supply chain.
5. Take the energy supply chain out of the trough system and put it into storage.
6. Remove the Allen screws and take off the driver.
7. Unscrew the screw anchors from the C-profiles, and remove the trough system.
8. If necessary, dismantle the trough system.

See the assembly instructions from IGUS.

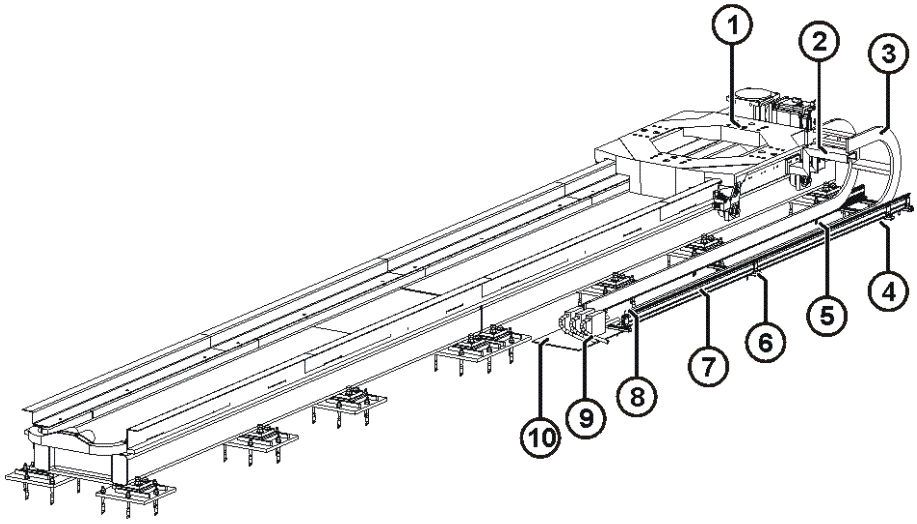


Fig. 8-8: Energy supply system, short travel

1	Carriage	6	C-profiles
2	Driver	7	Trough
3	Energy supply chain	8	Fixed point module
4	Screw anchor	9	Connecting cables
5	Trough system	10	Connector plate

9 Maintenance

9.1 Maintenance table

Preconditions

- The maintenance points must be freely accessible.
- The carriage is secured against unintended motion.
- Remove the tools and any additional items of equipment if they impede maintenance work.

Warning!
If work is carried out immediately after the linear unit has stopped operating, there is liable to be an elevated surface temperature at the motors. The appropriate safety measures must be taken.

Description

Lubrication is performed either at the specified maintenance intervals or every 5 years after commissioning by the customer. With maintenance intervals of 10,000 hours, for example, the first maintenance (oil change) is performed either after 10,000 operating hours or 5 years after commissioning by the customer, whichever is reached first.

The maintenance intervals given in the tables are valid for the operating conditions specified in the technical data (>>> 4 "Technical data" page 17). In case of variations from normal conditions (e.g. increased dust or water content in the environment), KUKA must be consulted.

Caution!
Only lubricants approved by KUKA Roboter GmbH may be used.

Maintenance symbols


Lubricate with brush


Tighten screw/nut


Check component, visual inspection

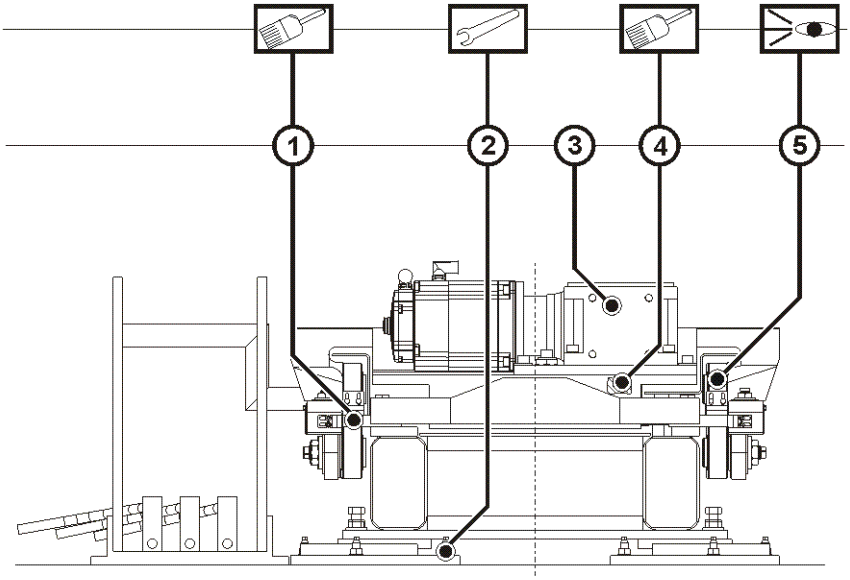


Fig. 9-1: Maintenance work

Interval	Item	Activity	Lubricant
-	3	Gear unit, lifetime lubrication	-
100 h after start-up	2	Mounting bases, chemical anchors: Check tightening torques for bolts and nuts. See Section (>>> 8 "Start-up and recommissioning" page 55).	-
2,000 h	4	Apply grease to the entire length of the racks with a brush. See safety data sheet in Section (>>> 15.1 "Safety data sheets" page 123).	Aralub LFZ 1 Art. no. 83-087-830
4,000 h	4	Clean and re-grease the racks. See safety data sheet in Section (>>> 15.1 "Safety data sheets" page 123).	Aralub LFZ 1 Art. no. 83-087-830
4,000 h	1	Clean and re-oil the tracks. See safety data sheet in Section (>>> 15.1 "Safety data sheets" page 123).	Ferrocote 5856-HF Art. no. 83-236-750
4,000 h	5	Check preload. Check roller seals for lubricant leakage and adjust cleaning brushes.	-

9.2 Cleaning the linear unit

Description

The linear unit must be cleaned in compliance with the instructions given here in order to prevent damage. System components, tools and the robot controller must be cleaned in accordance with the cleaning instructions relevant to them.

The following must be taken into consideration when using cleaning agents and carrying out cleaning work:

- Only use solvent-free, water-soluble cleaning agents.
- Do not use flammable cleaning agents.
- Do not use aggressive cleaning equipment.
- Do not use steam or refrigerants for cleaning.
- Do not use pressure equipment or compressed fluids for cleaning.
- It must be ensured that no cleaning agent enters electrical or mechanical system components.
- Personnel protection measures must be taken.

Warning!
Unintentional motions of the linear unit, the robot and affected system components can cause injuries and damage to property. If work is carried out on an operational linear unit, the linear unit, the robot and affected system components must be secured by activating the EMERGENCY STOP button. Warn all persons concerned before putting it back into operation.

Procedure

1. Shut down the linear unit and the robot and lock them.
2. Stop adjacent system components and lock them.

3. Remove enclosures if this is necessary in order to carry out the cleaning work.
4. Clean the linear unit.
5. Completely remove all traces of cleaning agents from the linear unit.
6. Clean any areas of corrosion and reapply corrosion protection.
7. Remove cleaning agents and equipment from the workspace of the linear unit.
8. Dispose of cleaning agents properly.
9. Install any safety equipment that has been removed and check that it is functioning correctly.
10. Replace any damaged or illegible plates and covers.
11. Put back in place any enclosures that have been removed.
12. Put only fully functional linear units and systems back into operation.

10 Adjustment

10.1 Adjusting the backlash

Description

Backlash (>>> Fig. 10-1) occurs between the tooth flanks of the drive pinion and rack. It has to be readjusted in the case of wear and after the drive assembly, the rack or the drive pinion has been replaced.

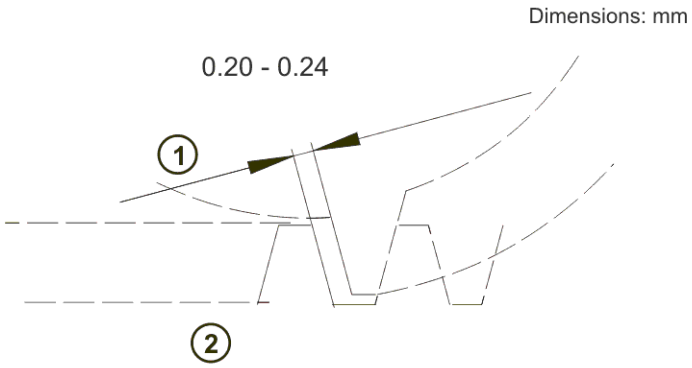


Fig. 10-1: Backlash

1 Pinion
2 Rack

The backlash can be adjusted by shifting the intermediate plate (>>> Fig. 10-2) on the carriage. The intermediate plate is shifted by turning the eccentric.

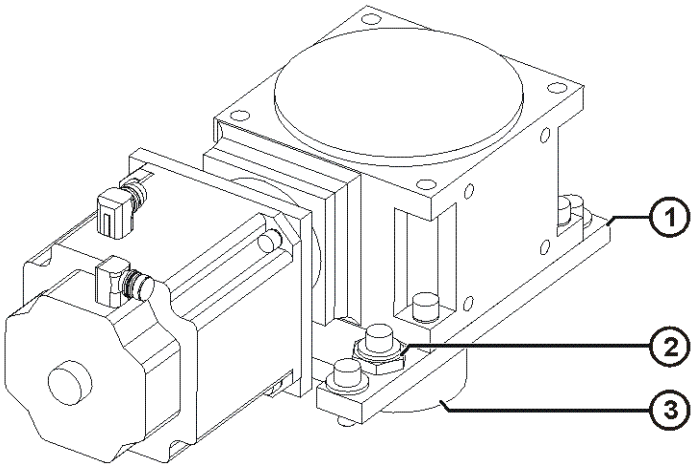


Fig. 10-2: Backlash

1 Intermediate plate
2 Eccentric
3 Pinion

Warning!
If work is carried out immediately after the linear unit has stopped operating, there is liable to be an elevated surface temperature at the motors. The appropriate safety measures must be taken.

Warning!
Unintentional motions of the linear unit, the robot and affected system components can cause injuries and damage to property. If work is carried out on an operational linear unit, the linear unit, the robot and affected system components must be secured by activating the EMERGENCY STOP button. Warn all persons concerned before putting it back into operation.

Tooling and additional equipment must be removed before the adjustment process is started if they are likely to impede the adjustment work.

10.1.1 Measuring the backlash

Preconditions

- The drive assembly must be freely accessible, and it must be possible to fasten the dial gauge to the beam.

The following aids are required:

- Dial gauge with magnetic stand.
- Spring balance with measurement range ≥ 400 N.

Procedure

1. Fasten the dial gauge (>>> Fig. 10-3) to the beam so that the probe is in contact with the carriage.
2. Attach a spring balance at a suitable point on the carriage.
3. Pull the carriage with a force of 400 N (spring balance) in the plus direction.
4. Set the dial gauge to zero while maintaining the force.
5. Pull the carriage with a force of 400 N (spring balance) in the minus direction.
6. Read the measured value.
7. If the measured value is outside the range from 0.2 mm to 0.24 mm, the backlash must be adjusted as shown in (>>> 10.1.2 "Adjusting the backlash" page 71).
8. If the measured value is within the range from 0.2 mm to 0.24 mm, the backlash is correct.
9. Remove the measuring set-up.

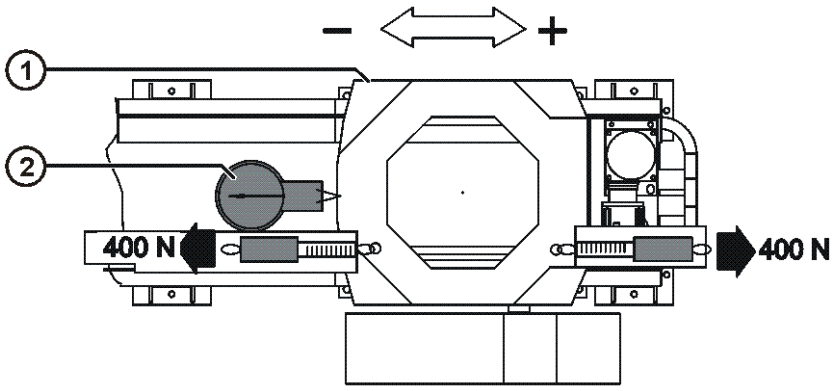


Fig. 10-3: Measuring device (schematic)

1 Carriage
2 Dial gauge

10.1.2 Adjusting the backlash

Procedure

1. Slacken the three M16x45-10.9 Allen screws (>>> Fig. 10-4) (1) and the M16x55-10.9 Allen screw (3).
2. Shift the intermediate plate on the carriage by turning the eccentric slightly.
3. Turn the eccentric counterclockwise until the tooth flanks of the pinion are in full contact with both flanks of the rack without play.
4. Turn the eccentric clockwise. The tooth flanks of the pinion now only make contact on one side. On the other side there is a backlash, which must be within the permissible range between 0.2 mm and 0.24 mm. Measure the backlash with a feeler gauge.
5. Tighten the M16x45-10.9 Allen screws (1) and the M16x55-10.9 Allen screw (3) with a tightening torque of M_A = 250 Nm.
6. Measure the backlash again, in accordance with Section (>>> 10.1.1 "Measuring the backlash" page 70). Re-adjust the backlash if required.
   - Turning the eccentric counterclockwise reduces the size of the backlash.
   - Turning the eccentric clockwise increases the size of the backlash.

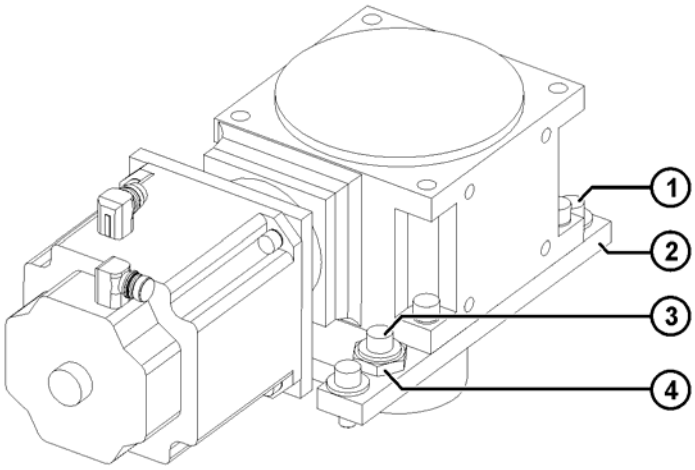


Fig. 10-4: Intermediate plate

1	Allen screw	3	Allen screw
2	Intermediate plate	4	Eccentric

10.2 Adjusting the rollers

Description

The carriage is guided by six centric and six eccentric rollers on two tracks. The centric rollers are indicated by a “Z” and eccentric ones are indicated by an “E”. The centric side rollers are always located on the fixed bearing side.

The type of wheel bearing is indicated on the end face of the square of each roller.

All carriage rollers must be in contact with the tracks. An eccentric is located in the square of the eccentric rollers (E) (>>> Fig. 10-5). By turning the eccentric with a torque wrench it is possible to position the eccentric roller (E) on the track in a defined manner.

Warning!
If work is carried out immediately after the linear unit has stopped operating, there is liable to be an elevated surface temperature at the motors. The appropriate safety measures must be taken.

Warning!
Unintentional motions of the linear unit, the robot and affected system components can cause injuries and damage to property. If work is carried out on an operational linear unit, the linear unit, the robot and affected system components must be secured by activating the EMERGENCY STOP button. Warn all persons concerned before putting it back into operation.

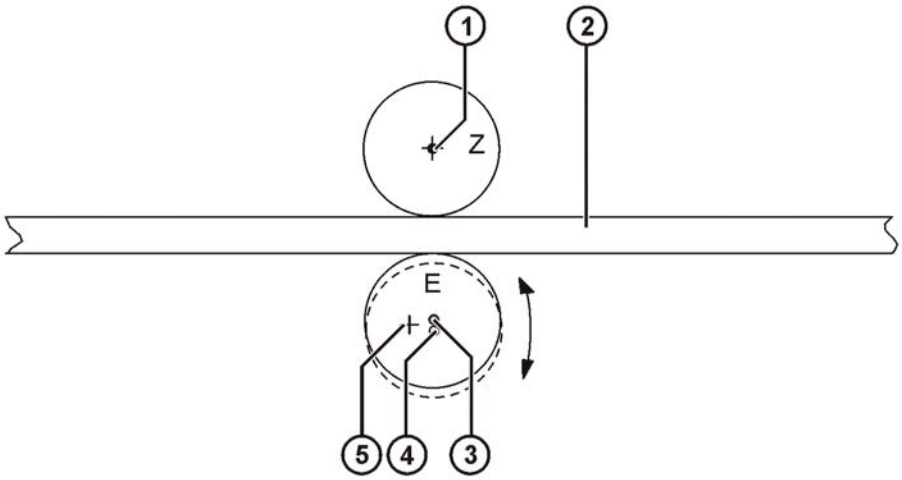


Fig. 10-5: Upper rollers, lower rollers

1 Center of rotation of centric roller (Z)
2 Track
3 Center of rotation of eccentric roller (E), engaged
4 Center of rotation of eccentric roller (E), disengaged
5 Center of rotation of eccentric

Procedure

First adjust the side eccentric rollers (E).

1. Successively turn in a counterclockwise direction the eccentric on the square of all six eccentric rollers (E) using a torque wrench. This positions the rollers on the track.
2. Tighten the hexagon nut with a torque wrench. Apply counterforce using an open-end wrench on the square of the roller.
   For tightening torques, see the following table.

Roller	Eccentric M_A	Hexagon nut M_A
Ø72	22 Nm	150 Nm
Ø110	55 Nm	380 Nm

11 Repair

11.1 Exchanging the drive assembly

Description

The “drive assembly” (>>> 3.1.3 "Description of the drive assembly" page 13) consists of a servomotor, gear unit, intermediate plate and various attachments.

Warning!
Unintentional motion of the robot and the linear unit can result in danger to persons and materials. If the robot and the linear unit have reached their disassembly position, shut down the system and take measures to prevent it from being switched on again unintentionally. If several robots or linear units are in a system, these must also be switched off and secured against being switched on again unintentionally.

Caution!
When exchanging the drive assembly, attention must be paid to the specifications on the rating plate of the gear unit. The designation and transmission ratio of the old and new gear units must be the same.

Warning!
If work is carried out immediately after the linear unit has stopped operating, there is liable to be an elevated surface temperature at the motors. The appropriate safety measures must be taken.

11.1.1 Removing the drive assembly

Preconditions

- Remove the tool and any additional items of equipment if these impede repair work.
- The carriage is secured against unintended motion.

Warning!
The drive assembly weighs approx. 100 kg. When removing or installing the drive assembly, care must be taken to avoid injury by crushing. Protective gloves must be worn.

Procedure

1. Release and unplug connectors XM7 and XP7 (>>> Fig. 11-1) from the sockets.
2. Remove Allen screw (5) and lock washer and take off eccentric.
3. Remove three Allen screws (3) together with lock washers.
4. Attach lifting tackle to the drive assembly and lift it out of the carriage.

Caution!
When moving out the drive assembly, take care not to damage the toothing of the pinion and racks.

5. Remove four Allen screws (4) and lock washers, and separate the gear unit from the intermediate plate.
6. If the drive assembly is not to be reinstalled, it must be protected against corrosion before being put into storage.

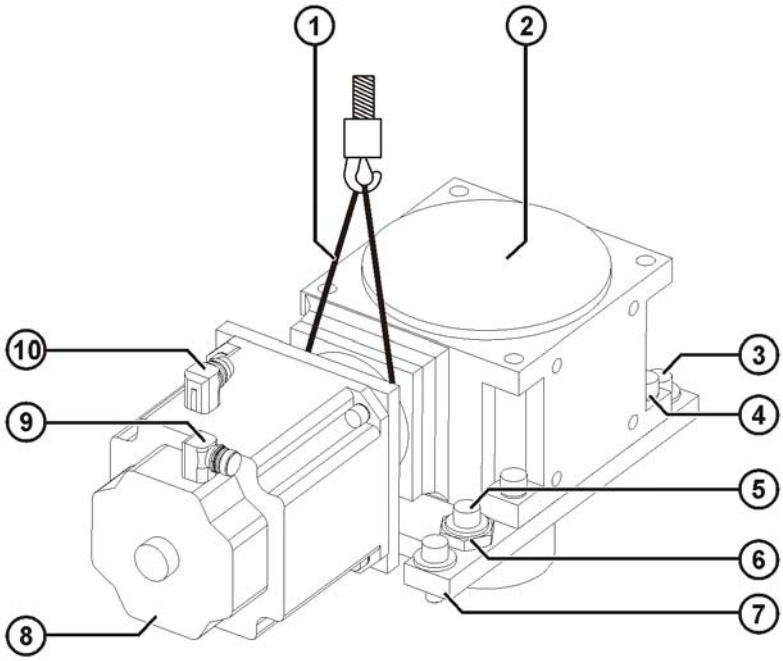


Fig. 11-1: Removing the drive assembly

1	Crane with rope sling	6	Eccentric
2	Gear unit	7	Intermediate plate
3	Allen screw	8	Servomotor
4	Allen screw	9	Connector XP7, control cable
5	Allen screw	10	Connector XM7, motor cable

11.1.2 Installing the drive assembly

Preconditions

- The carriage is secured against unintended motion.
- The protective coatings and oil have been removed from the new drive.

Warning!
The drive assembly weighs approx. 100 kg. When removing or installing the drive assembly, care must be taken to avoid injury by crushing. Protective gloves must be worn.

Procedure

If it is not possible to insert the pinion into the rack, release the motor brake and turn the pinion until the drive can be engaged.

1. Screw gear unit (>>> Fig. 11-2) to the intermediate plate using four M16x40-8.8 Allen screws (4) and lock washers. Tighten the Allen screws with a torque of M_A = 195 Nm.
2. Attach lifting tackle to the drive assembly and insert it into the carriage.
3. Insert three M16x45-10.9 Allen screws (3) and lock washers and tighten until the drive assembly can still just be shifted.
4. Insert the eccentric and the M16x55-10.9 Allen screw (5) together with lock washer and lightly tighten.
5. Remove the lifting tackle.
6. Adjust the backlash (>>> 10.1.2 "Adjusting the backlash" page 71).

7. Tighten the three M16x45-10.9 Allen screws (3) and the M16x55-10.9 Allen screw (5) with a tightening torque of M_A = 250 Nm.
8. Plug connectors XM7 and XP7 into the sockets.
9. Remove elements securing the carriage.
10. Carry out mastering of the linear unit.

Further information about mastering is contained in the operating and programming instructions for the KUKA System Software.

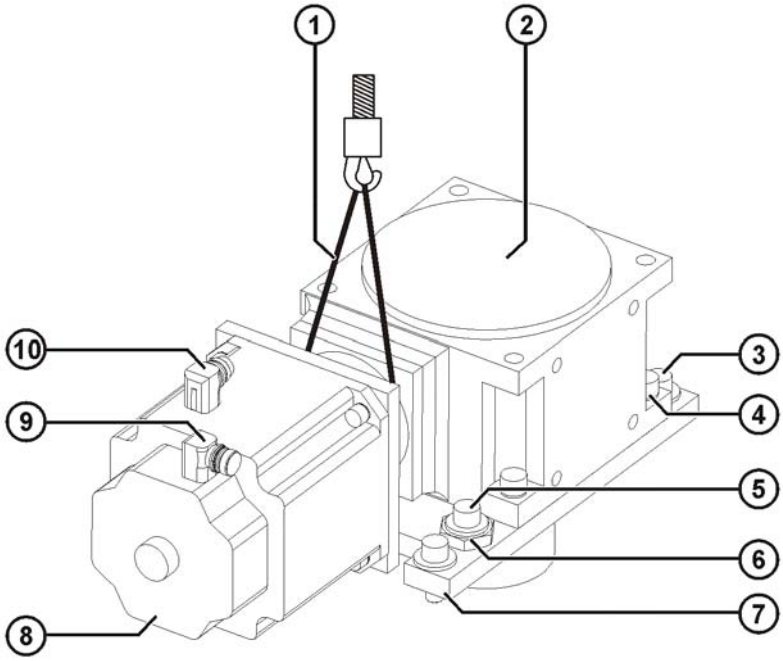


Fig. 11-2: Installing the drive assembly

1	Crane with rope sling	6	Eccentric
2	Gear unit	7	Intermediate plate
3	Allen screw	8	Servomotor
4	Allen screw	9	Connector XP7, control cable
5	Allen screw	10	Connector XM7, motor cable

11.2 Exchanging the servomotor

Description

The servomotor is a component of the drive assembly and is fastened to the side of the gear unit. The servomotor can be separated from the gear unit only when the drive assembly has been removed from the linear unit.

Warning!
If work is carried out immediately after the linear unit has stopped operating, there is liable to be an elevated surface temperature at the motors. The appropriate safety measures must be taken.

Caution!
The servomotor must not be tilted. The orientation of the servomotor is identified from the position of the sockets. When the motor unit is installed, these sockets must be positioned in the same way as before removal.

11.2.1 Removing the servomotor

Preconditions

- Drive assembly removed as described in Section (>>> 11.1.1 "Removing the drive assembly" page 73).

Warning!
The servomotor weighs approx. 30 kg. When removing or installing the servomotor, care must be taken to avoid injury by crushing. Protective gloves must be worn.

Procedure

1. Slacken four Allen screws (>>> Fig. 11-3) (3) but do not remove them.
2. Attach lifting tackle to servomotor.
3. Remove the four Allen screws (3) together with lock washers.
4. Remove the servomotor.

Caution!
The servomotor must not be tilted. The orientation of the servomotor is identified from the position of the sockets. When the motor unit is installed, these sockets must be positioned in the same way as before removal.

5. Remove the lifting tackle.
6. If the servomotor is not to be reinstalled, it must be protected against corrosion before being put into storage.
7. Cover the gear unit and protect it against fouling.

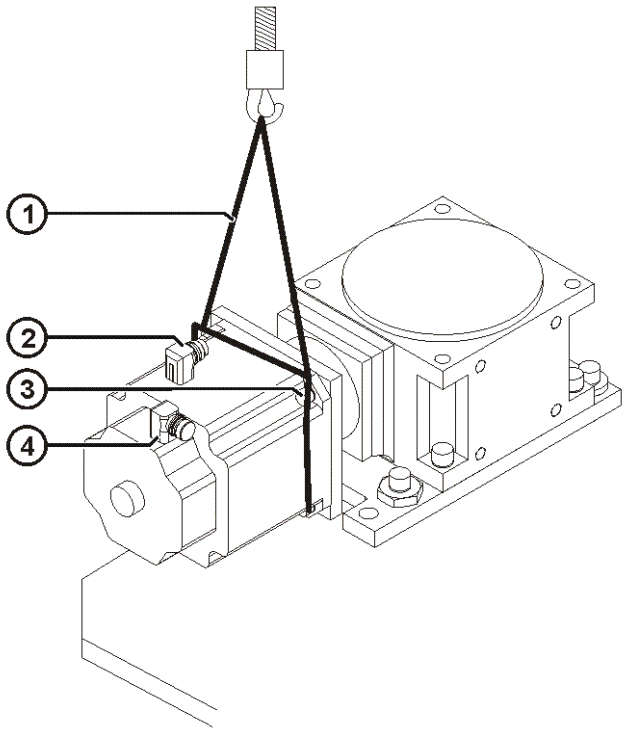


Fig. 11-3: Removing the servomotor

1	Crane with rope sling	3	Allen screw
2	Connector XM7, motor cable	4	Connector XP7, control cable

11.2.2 Installing the servomotor

Preconditions

- The protective coatings and oil have been removed from the new servomotor.

Caution!
When installing the motor, it must be ensured that the toothing of the motor and gear unit are not damaged.

Warning!
The servomotor weighs approx. 30 kg. When removing or installing the servomotor, care must be taken to avoid injury by crushing. Protective gloves must be worn.

Procedure

1. Clean the toothing of the motor and the gear unit before installation and apply a thin but continuous coat of Microlube GL 261 grease. See safety data sheet in Section (>>> 15.1 "Safety data sheets" page 123).
2. Clean the mounting surface for the servomotor on the gear unit.
3. Attach lifting tackle to servomotor.
4. Insert the servomotor.

   The motor shaft must not be subjected to any axial loads during installation.

   When inserting the servomotor, it must be ensured that the spline shaft connection of the servomotor and gear unit meshes properly. This can be facilitated by gently turning the servomotor during insertion.

Caution!
The servomotor must not be tilted. The orientation of the servomotor is identified from the position of the sockets. When the motor unit is installed, these sockets must be positioned in the same way as before removal.

5. Fasten the servomotor with four M12x30-8.8 Allen screws (>>> Fig. 11-4) (3) and lock washers.
6. Tighten the four M12x30-8.8 Allen screws (3) with a torque of M_A = 78 Nm.
7. Remove the lifting tackle.
8. Install the drive assembly as described in Section (>>> 11.1.2 "Installing the drive assembly" page 74).

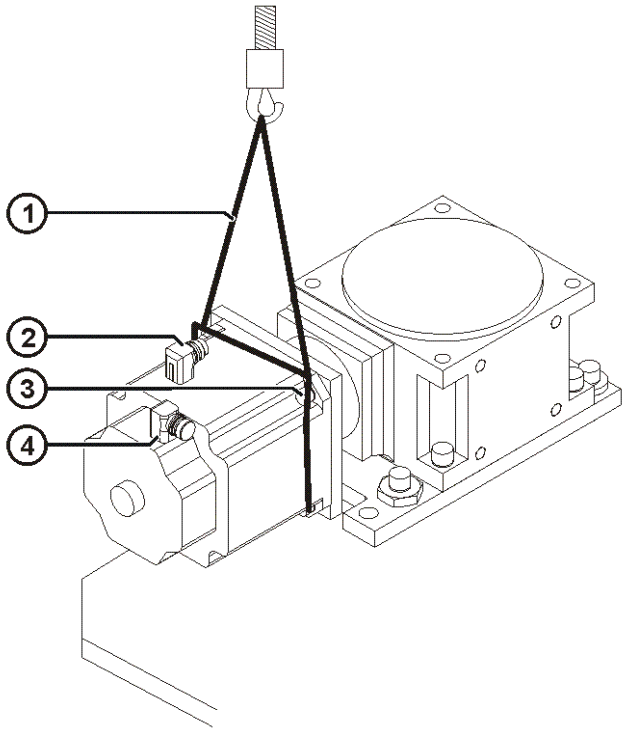


Fig. 11-4: Installing the servomotor

1	Crane with rope sling	3	Allen screw
2	Connector XM7, motor cable	4	Connector XP7, control cable

11.3 Exchanging the upper/lower rollers using the auxiliary device

Description

The carriage (>>> Fig. 11-5) is guided by six centric and six eccentric rollers on two tracks. The centric rollers are indicated by a “Z” and eccentric ones are indicated by an “E”. The centric side rollers are always located on the fixed bearing side. The fixed bearing side is the side on which the drive engages with the rack.

The type of wheel bearing is indicated on the end face of the square of each roller.

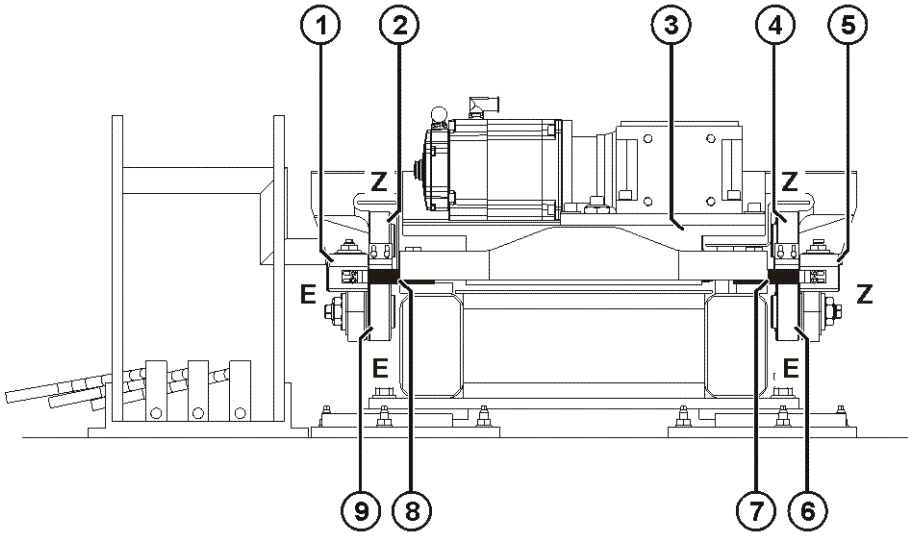


Fig. 11-5: Arrangement and number of the rollers

1	Lateral eccentric roller (E), floating bearing side	6	Lower eccentric roller (E), fixed bearing side
2	Upper centric roller (Z), floating bearing side	7	Track, fixed bearing side
3	Carriage	8	Track, floating bearing side
4	Upper centric roller (Z), fixed bearing side	9	Lower eccentric roller (E), floating bearing side
5	Lateral centric roller (Z), fixed bearing side		

The lateral rollers (side rollers) are easy to access and can be exchanged without removing the carriage. The upper and lower rollers can only be exchanged after the carriage has been partially or fully removed, depending on the installation position of the linear unit.

The auxiliary device (>>> Fig. 11-6) is used to extend the track to the side. It is fastened to the track. For the opposite track, the auxiliary device can be converted to a mirror-image part. To exchange the rollers, the carriage concerned is moved onto the auxiliary device so that the rollers destined for removal are free.

If the carriage is on the auxiliary device, it is held by nine rollers on the tracks and the auxiliary device.

Warning!
No exchange work may be carried out on the rollers on the auxiliary device. The carriage and robot can tip over!
Risk of severe injury and damage to property!

If the carriage is on the auxiliary device, the remaining three rollers are not guided by a track. These three rollers are freely accessible for exchange work.

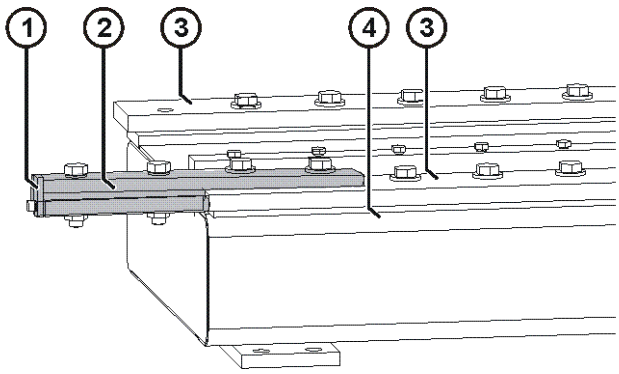


Fig. 11-6: Auxiliary device, installed

1	Stop for carriage	3	Track
2	Auxiliary device	4	Beam

11.3.1 Installing the auxiliary device

Preconditions

- The linear unit has been prepared for exchanging the rollers.
- The space available makes a partial removal of the carriage from the linear unit possible, by moving the carriage to the side.
- Auxiliary device available, article no. 00-122-061
- The auxiliary device is not assembled.

Procedure

1. Screw the rail (>>> Fig. 11-7) to the strip using two M20x80-8.8 hexagon bolts (5) together with lock washers and hexagon nuts. Tighten the hexagon bolts with a torque of M_A = 370 Nm.
2. Screw the carriage stop to the rail using an M10x25-8.8 Allen screw (6) and lock washer. Tighten the Allen screw with a torque of M_A = 45 Nm. The stop must be attached so that the lower edge of the stop is flush with the lower edge of the rail.
3. Remove the track cover on the fixed bearing side at the assembly position of the auxiliary device. Remove the hexagon bolts and lock washers from the cover and remove the cover.
4. Remove the bar with crash elements at the assembly position of the auxiliary device.
5. Remove the hexagon bolts and lock washers from the track cover and remove the cover, only if the auxiliary device is being installed on the floating bearing side.
6. Mount the auxiliary device on the track and fasten it using two M20x80-8.8 hexagon bolts (11) and lock washers. Tighten the hexagon bolts with a torque of M_A = 370 Nm.
7. Exchange the rollers.

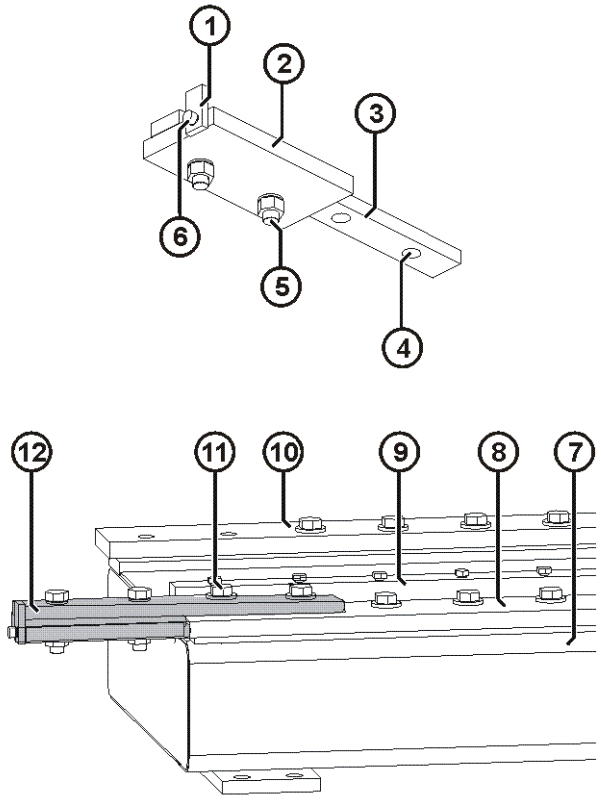


Fig. 11-7: Installing the auxiliary device

1	Carriage stop	7	Beam
2	Rail	8	Track, fixed bearing side
3	Strip	9	Rack
4	Hole for hexagon bolt	10	Track, floating bearing side
5	Hexagon bolt	11	Hexagon bolt
6	Allen screw	12	Auxiliary device, installed

11.3.2 Removing the auxiliary device

Preconditions

- The rollers have been exchanged and the carriage moved back onto the linear unit.

Procedure

1. Remove the two hexagon bolts (>>> Fig. 11-8) (11) and lock washers from the auxiliary device and remove the auxiliary device.
2. Mount the cover on the track on the floating bearing side and insert the M20x55-8.8 hexagon bolts and lock washers, only if the auxiliary device is being removed on the floating bearing side. Tighten the hexagon bolts with a torque of M_A = 370 Nm.
3. Install the bar with crash elements. If the rollers are also to be exchanged on the opposite track, then the bar with the crash elements should be installed after that.
4. Mount the track cover on the rack on the fixed bearing side and insert the M12x80-8.8 hexagon bolts and lock washers. Tighten the hexagon bolts with a torque of M_A = 78 Nm.

The track cover on the fixed bearing side can only be installed once all work is completed and the bar with the crash elements has been installed.

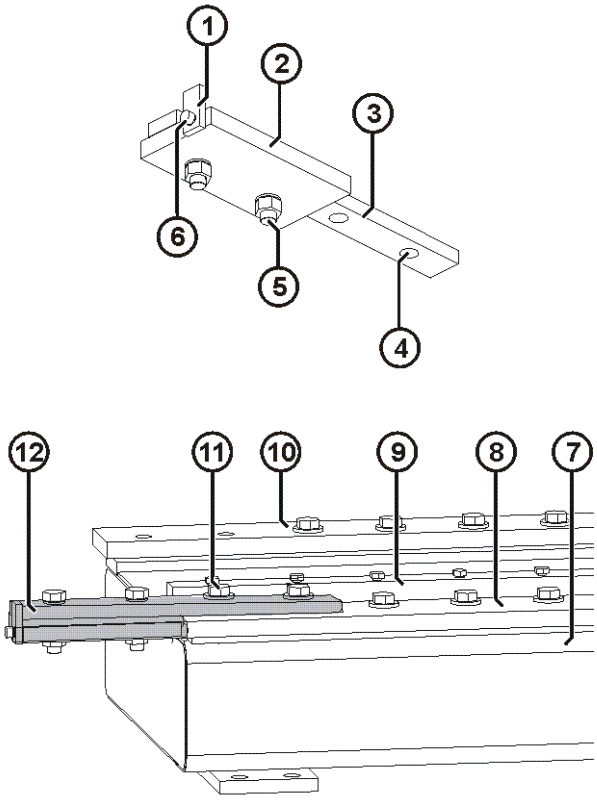


Fig. 11-8: Removing the auxiliary device

1	Carriage stop	7	Beam
2	Rail	8	Track, fixed bearing side
3	Strip	9	Rack
4	Hole for hexagon bolt	10	Track, floating bearing side
5	Hexagon bolt	11	Hexagon bolt
6	Allen screw	12	Auxiliary device, installed

11.3.3 Converting the auxiliary device

Preconditions

- The rollers have been exchanged on one side and the carriage moved back onto the linear unit.

Procedure

1. Remove the two hexagon bolts (>>> Fig. 11-9) (11) and lock washers from the auxiliary device and remove the auxiliary device.
2. Remove the two M20x80-8.8 hexagon bolts (5) and lock washers from the strip. Turn the rail through 180° and fasten it to the strip again. Tighten the hexagon bolts with a torque of M_A = 370 Nm.
3. Remove the M10x25-8.8 Allen screw (6) and lock washer and turn the carriage stop through 180°. Fasten the carriage stop to the track again. Tighten the Allen screw with a torque of M_A = 45 Nm. The stop must be attached so that the lower edge of the stop is flush with the lower edge of the rail.
4. Remove the hexagon bolts and lock washers from the track cover and remove the cover, only if the auxiliary device is being installed on the floating bearing side.
5. Mount the auxiliary device on the track and fasten it using two M20x80-8.8 hexagon bolts (11) and lock washers. Tighten the hexagon bolts with a torque of M_A = 370 Nm.

6. Exchange the rollers.
7. Remove the auxiliary device as described in Section (>>> 11.3.2 "Removing the auxiliary device" page 81).

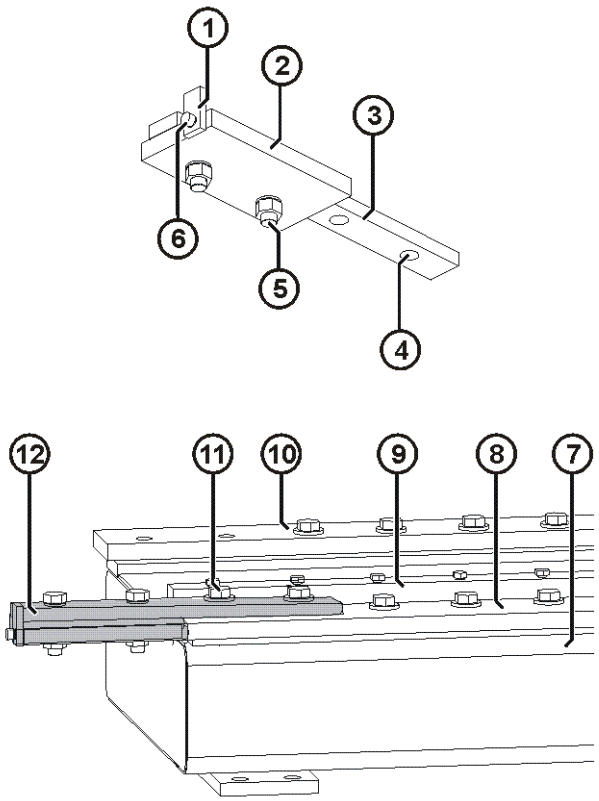


Fig. 11-9: Converting the auxiliary device

1	Carriage stop	7	Beam
2	Rail	8	Track, fixed bearing side
3	Strip	9	Rack
4	Hole for hexagon bolt	10	Track, floating bearing side
5	Hexagon bolt	11	Hexagon bolt
6	Allen screw	12	Auxiliary device, installed

11.3.4 Removing the upper/lower rollers

Preconditions

- Removal of the upper and lower rollers, which are accessed by partially moving the carriage out of the linear unit.
- The space available makes a partial removal of the carriage from the linear unit possible, by moving the carriage to the side.
- The carriage is secured against unintended motion.

Warning!
Unintentional motion of the robot and the linear unit can result in danger to persons and materials. If the robot and the linear unit have reached their disassembly position, shut down the system and take measures to prevent it from being switched on again unintentionally. If several robots or linear units are in a system, these must also be switched off and secured against being switched on again unintentionally.

Procedure

1. Remove the drive assembly as described in Section (>>> 11.1.1 "Removing the drive assembly" page 73).

2. Install the auxiliary device as described in Section (>>> 11.3.1 "Installing the auxiliary device" page 80).
3. Carefully release the motion safeguards on the carriage.
4. Move the carriage onto the auxiliary device.
5. Secure the carriage again so that it cannot be moved unintentionally.
6. Remove the roller (upper or lower) intended for removal. To do so, slacken the hexagon nut of the free upper roller. Remove the nut together with lock washers.
7. Pull the roller (upper or lower) intended for removal inwards and out of the carriage.

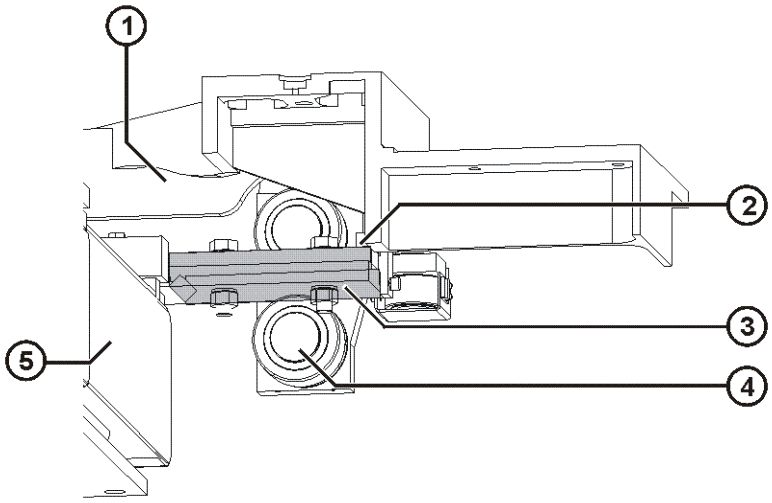


Fig. 11-10: Rollers on auxiliary device (diagram)

1	Carriage	4	Roller
2	Stop for carriage	5	Beam
3	Auxiliary device	6	Rack

11.3.5 Installing the upper/lower rollers

Preconditions

- The carriage is secured against unintended motion.

Warning!
Unintentional motion of the robot and the linear unit can result in danger to persons and materials. If the robot and the linear unit have reached their disassembly position, shut down the system and take measures to prevent it from being switched on again unintentionally. If several robots or linear units are in a system, these must also be switched off and secured against being switched on again unintentionally.

Procedure

1. Insert the roller to be installed (upper or lower) from the inside through the hole in the carriage.
2. Fit the lock washer and tighten the hexagon nut by hand.
3. Tighten the hexagon bolts with a torque of M_A = 380 Nm. Apply counterforce using an open-end wrench on the square of the roller.
4. Carefully release the motion safeguards on the carriage.
5. Move the carriage away from the assembly position.
6. Secure the carriage again so that it cannot be moved unintentionally.
7. Remove the auxiliary device as described in Section (>>> 11.3.2 "Removing the auxiliary device" page 81).

8. Adjust the rollers (>>> 10.2 "Adjusting the rollers" page 71).
   To do so, turn in a counterclockwise direction the eccentric on the square of all six eccentric rollers (E) using a torque wrench. This positions the rollers on the track. Tighten the hexagon nut with a torque wrench. Apply counterforce using an open-end wrench on the square of the roller.
   For tightening torques, see the following table.

Roller	Eccentric	Hexagon nut
Ø72	22 Nm	150 Nm
Ø110	55 Nm	380 Nm

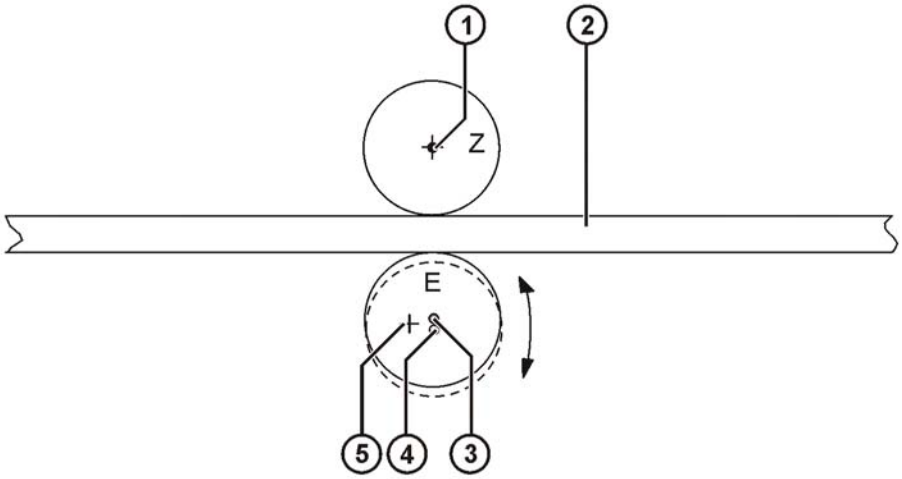


Fig. 11-11: Upper rollers, lower rollers

1	Center of rotation of centric roller (Z)
2	Track
3	Center of rotation of eccentric roller (E), engaged
4	Center of rotation of eccentric roller (E), disengaged
5	Center of rotation of eccentric

9. Install the drive assembly as described in Section (>>> 11.1.2 "Installing the drive assembly" page 74).
10. Carry out mastering of the linear unit.

Further information about mastering is contained in the operating and programming instructions for the KUKA System Software.

11.4 Exchanging the upper/lower rollers without using the auxiliary device

Description

The carriage is guided by six centric and six eccentric rollers on two tracks. The centric rollers are indicated by a “Z” and eccentric ones are indicated by an “E”. The centric side rollers are always located on the fixed bearing side. The fixed bearing side is the side on which the drive engages with the rack.

The type of wheel bearing is indicated on the end face of the square of each roller.

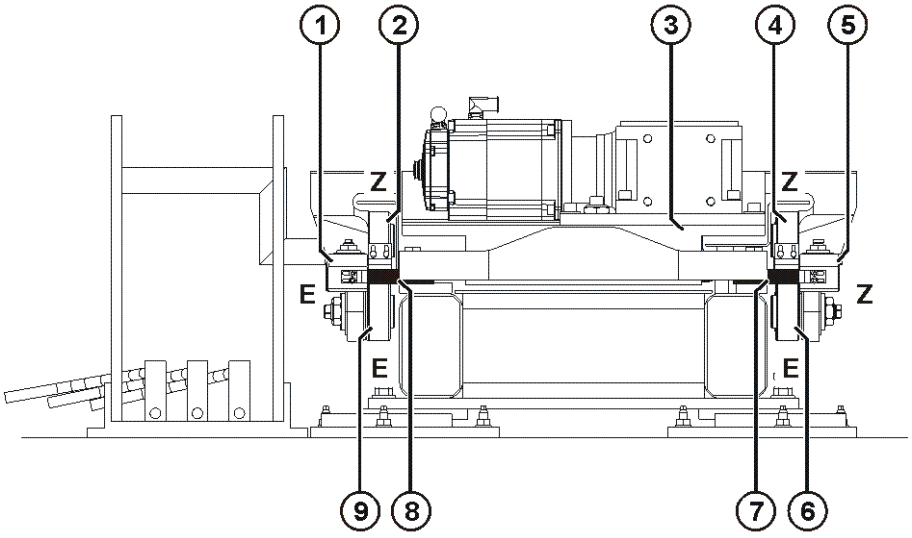


Fig. 11-12: Arrangement and number of the rollers

1	Lateral eccentric roller (E), floating bearing side	6	Lower eccentric roller (E), fixed bearing side
2	Upper centric roller (Z), floating bearing side	7	Track, fixed bearing side
3	Carriage	8	Track, floating bearing side
4	Upper centric roller (Z), fixed bearing side	9	Lower eccentric roller (E), floating bearing side
5	Lateral centric roller (Z), fixed bearing side		

The lateral rollers (side rollers) are easy to access and can be exchanged without removing the carriage. The upper and lower rollers can only be exchanged after the carriage has been partially or fully removed, depending on the installation position of the linear unit. See Section (>>> 11.6 "Exchanging the carriage" page 89).

11.4.1 Removing the upper/lower rollers

Preconditions

- The upper/lower rollers can only be exchanged after the carriage has been removed in its entirety.

Warning!
Unintentional motion of the robot and the linear unit can result in danger to persons and materials. If the robot and the linear unit have reached their disassembly position, shut down the system and take measures to prevent it from being switched on again unintentionally. If several robots or linear units are in a system, these must also be switched off and secured against being switched on again unintentionally.

Procedure

1. Remove the carriage in accordance with (>>> 11.6 "Exchanging the carriage" page 89).
2. Loosen the hexagon nut of the roller (upper or lower) to be removed, and remove the nut and lock washers.
3. Pull the roller (upper or lower) intended for removal inwards and out of the carriage.

11.4.2 Installing the upper/lower rollers

Preconditions

Warning!
Unintentional motion of the robot and the linear unit can result in danger to persons and materials. If the robot and the linear unit have reached their disassembly position, shut down the system and take measures to prevent it from being switched on again unintentionally. If several robots or linear units are in a system, these must also be switched off and secured against being switched on again unintentionally.

Procedure

1. Insert the roller to be installed (upper or lower) from the inside through the hole in the carriage.
2. Fit the lock washer and tighten the hexagon nut by hand.
3. Tighten the hexagon nut with a torque wrench (tightening torque M_A = 380 Nm). Apply counterforce using an open-end wrench on the square of the roller.
4. Install the carriage in accordance with (>>> 11.6 "Exchanging the carriage" page 89).

11.5 Exchanging the side rollers

Description

The carriage is guided by six centric and six eccentric rollers on two tracks. The centric rollers are indicated by a “Z” and eccentric ones are indicated by an “E”. The centric side rollers are always located on the fixed bearing side. The fixed bearing side is the side on which the drive engages with the rack.

The type of wheel bearing is indicated on the end face of the square of each roller.

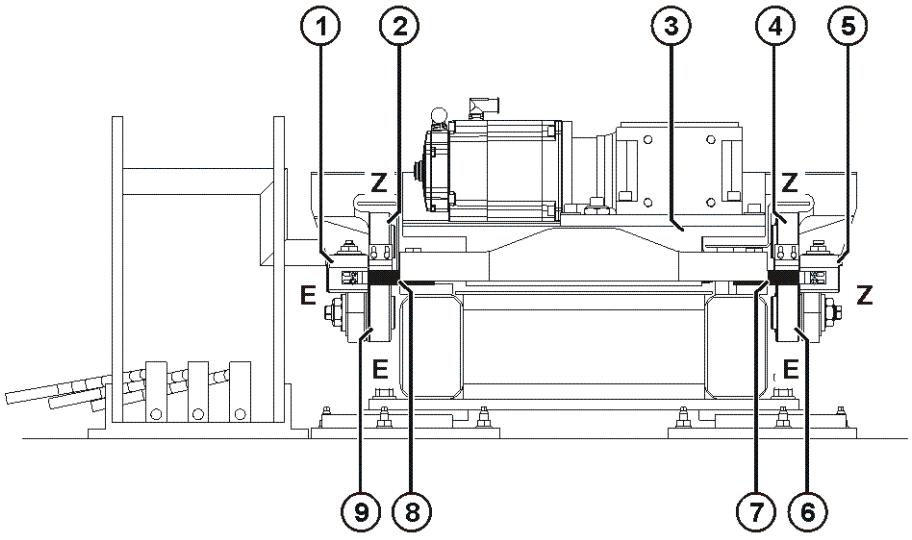


Fig. 11-13: Arrangement and number of the rollers

1	Lateral eccentric roller (E), floating bearing side	6	Lower eccentric roller (E), fixed bearing side
2	Upper centric roller (Z), floating bearing side	7	Track, fixed bearing side
3	Carriage	8	Track, floating bearing side

4 Upper centric roller (Z), fixed bearing side
5 Lateral centric roller (Z), fixed bearing side
9 Lower eccentric roller (E), floating bearing side

The lateral rollers (side rollers) are easy to access and can be exchanged without removing the carriage.

11.5.1 Removing the side rollers

Preconditions

- The carriage is secured against unintended motion.

Warning!
Unintentional motion of the robot and the linear unit can result in danger to persons and materials. If the robot and the linear unit have reached their disassembly position, shut down the system and take measures to prevent it from being switched on again unintentionally. If several robots or linear units are in a system, these must also be switched off and secured against being switched on again unintentionally.

Procedure

1. Remove the cover over the side rollers.
2. Slacken hexagon nut on the eccentric roller (E) situated opposite.
3. Turn the eccentric on the square of the eccentric roller (E) clockwise. The roller is thus disengaged.
4. Fully remove hexagon nut of the roller to be removed (centric or eccentric).
5. Pull the roller (centric or eccentric) intended for removal downwards and out of the carriage.

11.5.2 Installing the side rollers

Preconditions

Warning!
Unintentional motion of the robot and the linear unit can result in danger to persons and materials. If the robot and the linear unit have reached their disassembly position, shut down the system and take measures to prevent it from being switched on again unintentionally. If several robots or linear units are in a system, these must also be switched off and secured against being switched on again unintentionally.

Procedure

1. Insert the roller to be installed (centric or eccentric) from below through the hole in the carriage.
2. A centric roller (Z) is installed as follows:
   Install the centric roller (Z). Fit the lock washer, tighten the hexagon nut by hand and then with a tightening torque of M_A= 150 Nm. Apply counterforce using an open-end wrench on the square of the roller.

Caution!
No gap should be visible between the centric roller and the track.

An eccentric roller (E) is installed as follows:
Insert the eccentric roller (E). Fit the lock washer and tighten the hexagon nut by hand.

3. Adjust the rollers. To do so, use a torque wrench (MA = 22 Nm) to turn in a counterclockwise direction the eccentric on the square of the eccentric roller (E) situated opposite. The roller is engaged with the track.
4. Tighten the hexagon nut of the eccentric roller situated opposite with a tightening torque of M_A= 150 Nm. Apply counterforce using an open-end wrench on the square of the roller.

Caution!
It must not be possible to turn the roller by hand.

5. Install the cover over the side rollers.

11.6 Exchanging the carriage

Description

For the removal and installation of a carriage, there are two methods depending on the installation situation of the linear unit and the number of carriages installed. The carriage can be removed and installed from the side or from above.

Removal/installation of the carriage from the side

This method is used if the carriage concerned is on the left or right edge of an arrangement of carriages on the track and sufficient space is available at the side.

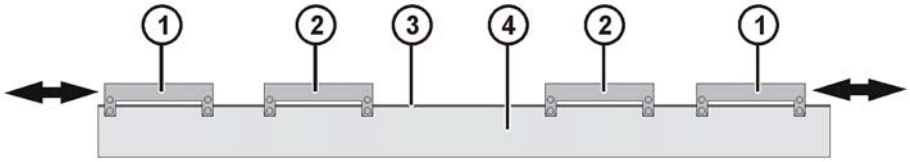


Fig. 11-14: Lateral removal/installation

1	Carriage on the edge of the arrangement
2	Carriages within the arrangement
3	Track
4	Beam

Removal/installation of carriage from above

This method is used when lateral carriage removal and installation is not possible due to the unfavorable installation situation of the linear unit.

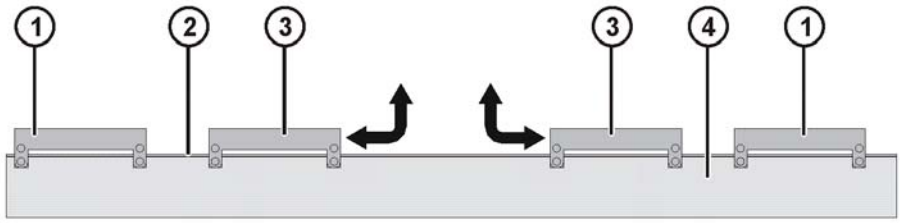


Fig. 11-15: Upward removal/installation

1	Carriage on the edge of the arrangement
2	Track
3	Carriages within the arrangement
4	Beam

11.6.1 Lateral removal of carriage

Preconditions

- If the carriage concerned is rigidly connected to a second carriage (tender arrangement), they must be disconnected prior to the removal of the carriage.
- All connecting cables must be disconnected at the robot. The energy supply chain must be removed from the carriage.

Warning!
Unintentional motion of the robot and the linear unit can result in danger to persons and materials. If the robot and the linear unit have reached their disassembly position, shut down the system and take measures to prevent it from being switched on again unintentionally. If several robots or linear units are in a system, these must also be switched off and secured against being switched on again unintentionally.

Procedure

1. Remove the robot in accordance with the operating instructions.
2. Release and unplug the equipotential bonding (ground conductor) on the carriage.
3. Unscrew the energy supply chain from the driver and set it down.
4. Remove the drive assembly as described in Section (>>> 11.1.1 "Removing the drive assembly" page 73).
5. Move the carriage away from the proposed disassembly position.
6. Secure the carriage to be removed so that it cannot be moved unintentionally.
7. Remove the bar with crash elements at the disassembly position.
8. Retract the cleaning brushes at the upper rollers.
9. Loosen the nuts on all eccentric rollers (E).
10. Disengage all eccentric rollers (E) by rotating counterclockwise or clockwise at the eccentric bolt.
11. Fasten the carriage to the lifting tackle using four M28 DIN580 eyebolts.
12. Slightly raise the carriage.
13. Remove the motion safeguards from the carriage.
14. Move the carriage sideways onto the tracks.

Warning!
When moving the carriage out of the tracks, sudden changes in the position of the carriage and the load can occur.
Risk of injury and damage to property!

15. Set the carriage down onto a wooden support.

11.6.2 Lateral installation of carriage

Preconditions

- All six eccentric rollers must be slackened.

Warning!
Unintentional motion of the robot and the linear unit can result in danger to persons and materials. If the robot and the linear unit have reached their disassembly position, shut down the system and take measures to prevent it from being switched on again unintentionally. If several robots or linear units are in a system, these must also be switched off and secured against being switched on again unintentionally.

Procedure

1. Fasten the carriage to the lifting tackle using four M28 DIN580 eyebolts.
2. Move the carriage onto the tracks from the side.

3. Secure the carriage so that it cannot be moved unintentionally.
4. Lower the carriage fully, and remove the lifting tackle.
5. Bring all eccentric rollers into position: using a torque wrench, turn in a counterclockwise direction the eccentric on the square of the eccentric roller (E). The roller is engaged with the track. Tighten the hexagon nut with a torque wrench.
   For tightening torques, see the following table.

Roller	Eccentric	Hexagon nut
Ø72	22 Nm	150 Nm
Ø110	55 Nm	380 Nm

6. Install the drive assembly as described in Section (>>> 11.1.2 "Installing the drive assembly" page 74).
7. Push the cleaning brushes at the upper rollers onto the track and fasten them.
8. In the case of a tender carriage, reinstall the connecting bolts on the driven carriage.
9. Install the bar with crash elements.
10. Fasten the energy supply chain to the driver.
11. Connect the equipotential bonding (ground conductor) on the carriage.
12. Install the robot in accordance with the operating instructions.
13. Carry out mastering of the linear unit.

Further information about mastering is contained in the operating and programming instructions for the KUKA System Software.

11.6.3 Removing the carriage from above

Preconditions

- If the carriage to be removed is rigidly connected to a second carriage (tender arrangement), they must be disconnected prior to the removal.
- All connecting cables must be disconnected at the robot. The energy supply chain must be removed from the carriage.
- Any optional components of the linear unit that would hinder the removal work must be dismounted.

Warning!
Unintentional motion of the robot and the linear unit can result in danger to persons and materials. If the robot and the linear unit have reached their disassembly position, shut down the system and take measures to prevent it from being switched on again unintentionally. If several robots or linear units are in a system, these must also be switched off and secured against being switched on again unintentionally.

Procedure

1. Remove the robot in accordance with the operating instructions.
2. Release and unplug the equipotential bonding (ground conductor) on the carriage.
3. Unscrew the energy supply chain from the driver and set it down.
4. Remove the drive assembly as described in Section (>>> 11.1.1 "Removing the drive assembly" page 73).
5. Determine a suitable track for removal.
6. Move all carriages (>>> Fig. 11-16) away from this track. The carriage to be removed must be situated to the side of the track to be removed.

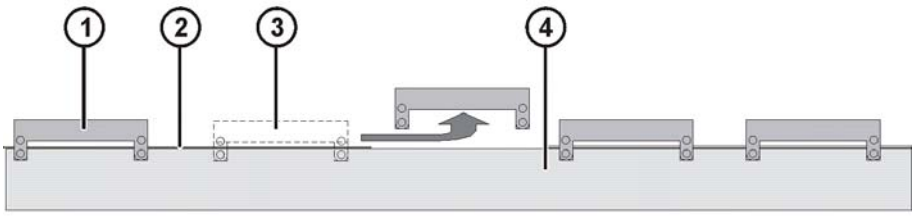


Fig. 11-16: Removal of a carriage (schematic)

1	Carriage on tracks
2	Installed track segments
3	Carriage to be removed
4	Beam

7. Secure the carriage to be removed so that it cannot be moved unintentionally.
8. Remove the hexagon bolts and lock washers from the covers of the track segments that are to be removed, and remove the covers. Mark the installation position.
9. Remove the hexagon bolts and lock washers – except for the two outermost hexagon bolts – from the track segment to be removed.
10. Pick up the track segment with a lifting magnet and lifting tackle.
    Remove the two remaining hexagon bolts and lock washers.
11. Raise the track segment and remove it. Mark the installation position.
12. Remove the hexagon bolts and lock washers – except for the two outermost hexagon bolts – from the track segment on the opposite side.
13. Pick up the track segment with a lifting magnet and lifting tackle.
    Remove the two remaining hexagon bolts and lock washers.
14. Raise the track segment and remove it. Mark the installation position.

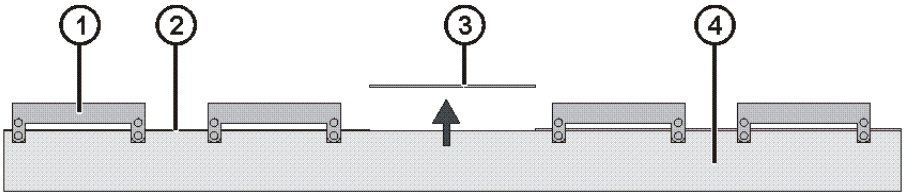


Fig. 11-17: Removing a track segment

1	Carriage
2	Installed track segments
3	Removed track segment
4	Beam

15. Retract the cleaning brushes at the upper rollers.
16. Loosen the nuts on all eccentric rollers (E).
17. Disengage all eccentric rollers (E) by rotating counterclockwise or clockwise at the eccentric bolt.
18. Fasten the carriage to the lifting tackle using four M28 DIN 580 eyebolts.
19. Slightly raise the carriage.
20. Remove the motion safeguards from the carriage.
21. Move the carriage into the area of the removed track segments.

22. Move the carriage sideways out of the tracks using the lifting tackle.

Warning!
When moving the carriage out of the tracks, sudden changes in the position of the carriage and the load can occur.
Risk of injury and damage to property!

23. Set the carriage down onto a wooden support.

11.6.4 Installing the carriage from above

Preconditions

- All six eccentric rollers must be slackened.

Warning!
Unintentional motion of the robot and the linear unit can result in danger to persons and materials. If the robot and the linear unit have reached their disassembly position, shut down the system and take measures to prevent it from being switched on again unintentionally. If several robots or linear units are in a system, these must also be switched off and secured against being switched on again unintentionally.

Procedure

1. Fasten the carriage to the lifting tackle using four M28 DIN 580 eyebolts.
2. Move the carriage into the area of the removed track segments.
3. Lower the carriage until the rollers can be inserted sideways onto the end of the tracks in the gap.
4. Move the carriage onto the tracks.
5. Secure the carriage so that it cannot be moved unintentionally.
6. Lower the carriage fully, and remove lifting gear.
7. Bring all eccentric rollers into position: using a torque wrench, turn in a counterclockwise direction the eccentric on the square of the eccentric roller (E). The roller is engaged with the track. Tighten the hexagon nut with a torque wrench. For tightening torques, see the following table.

Roller	Eccentric	Hexagon nut
Ø72	22 Nm	150 Nm
Ø110	55 Nm	380 Nm

8. Install the drive assembly as described in Section (>>> 11.1.2 "Installing the drive assembly" page 74).
9. Push the cleaning brushes at the eccentric rollers onto the track and fasten them.
10. In the case of a tender carriage, reinstall the connecting bolts on the driven carriage.
11. Using lifting tackle, insert the track segment (fixed bearing side) into the correct installation position on the beam.
12. Insert the two outermost M20x55-8.8 hexagon bolts and lock washers by hand.
13. Remove lifting magnet and lifting tackle.
14. Press the track segment inwards against the beam section.
15. Insert the remaining M20x55-8.8 hexagon bolts and lock washers by hand. Do not insert the hexagon bolts for the covers.
16. Tighten all the M20x55-8.8 hexagon bolts with a torque of M_A = 370 Nm.
17. Using lifting tackle and lifting magnet, insert the track segment situated opposite (Floating bearing side) into the correct installation position on the beam.
18. Insert the two outermost M20x55-8.8 hexagon bolts and lock washers by hand.

19. Remove lifting magnet and lifting tackle.
20. Insert the remaining M20x55-8.8 hexagon bolts and lock washers by hand. Do not insert the hexagon bolts for the covers.
21. Align the track with the neighboring tracks.
22. Tighten all the M20x55-8.8 hexagon bolts with a torque of M_A = 370 Nm.
23. Clean and grease the installed track segments as described in Section (>>> 9.1 "Maintenance table" page 65).
24. Mount the covers and fasten them using M20x55-8.8 or M12x80-8.8 hexagon screws together with lock washers. Tighten the M20x55-8.8 hexagon bolts with a torque of M_A = 370 Nm. Tighten the M12x80-8.8 hexagon bolts with a torque of M_A = 78 Nm.
25. Fasten the energy supply chain to the driver.
26. Connect the equipotential bonding (ground conductor) on the carriage.
27. Install the robot in accordance with the operating instructions.
28. Carry out zero adjustment.

Further information about mastering is contained in the operating and programming instructions for the KUKA System Software.

12 Electrical installations

12.1 Electrical installations of the linear unit, KR 2000 Series

Caution!
Permissible cable lengths:
The length of the connecting cables between the robot controller and the robot must not exceed 50 m.
If Safe robots are used, the cable length must not exceed 35 m.

12.1.1 Description

Most of the cables have plug-and-socket connections, which enables them to be quickly and reliably exchanged. The plugs and sockets are provided with identification labels.
Only ground conductors (PE conductors) are fastened with cable lugs to threaded bolts.

If the length of the connecting cables is greater than 25 m, a separate ground conductor must be connected between the linear unit and the control cabinet.

The energy supply chain forms the moving (translational) connection between the connector plate and the driver on the carriage.

The energy supply chain installations comprise:

- one motor cable, A1 to A6, X30
- one data cable with coding pin, X31
- one motor cable A7, XM7
- peripheral cables (optional)
- ground conductor, energy supply chain (optional)

The carriage installations comprise:

- one control cable A7, XP7
- ground conductors (carriage - robot, beam - connector plate)

Installation overview

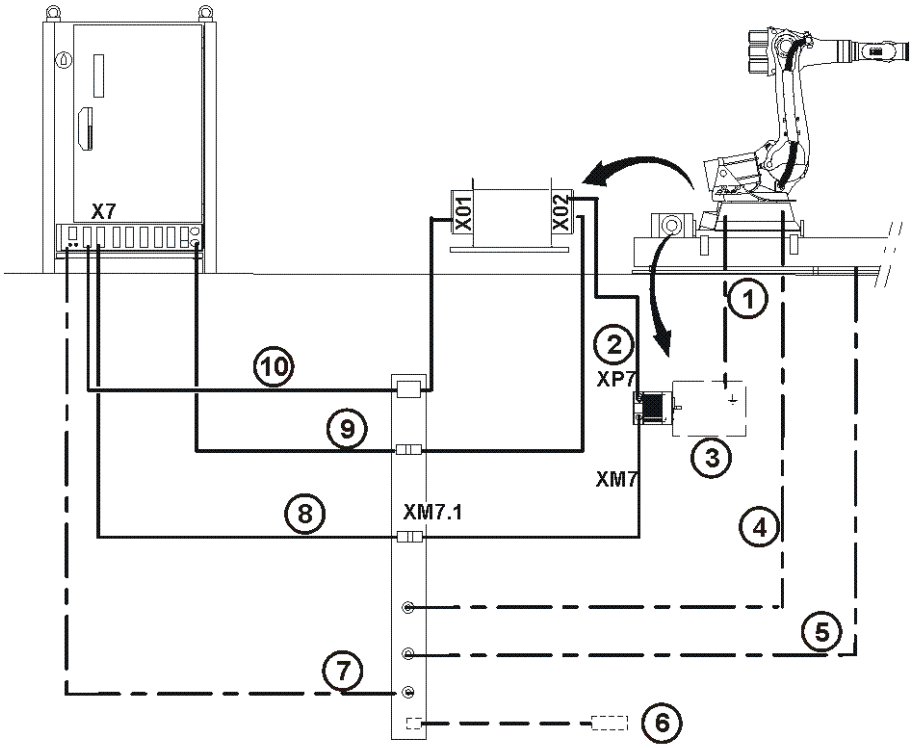


Fig. 12-1: Connection diagram for external axes

1	Ground conductor, carriage	6	Peripheral cables (optional)
2	Control cable A7, XP7	7	Ground conductor, controller
3	Motor A7	8	Motor cable A7, XM7
4	Ground conductor, energy supply chain (optional)	9	Data cable, X31
5	Ground conductor, beam	10	Motor cable A1 - A6, X30

For motor cables, control cables and ground conductors, standard lengths are available in 7 m, 15 m and 25 m.

Caution!
Permissible cable lengths:
The length of the connecting cables between the robot controller and the robot must not exceed 50 m.
If Safe robots are used, the cable length must not exceed 35 m.

The connecting cables for A1 to A6 are described in the robot operating instructions.

Cable designation	from	to
Motor cable, A1 to A6	Connector X30.1	Connector X30 Motor, brake and PE for axes 1 to 6
Data cable with coding pin	Connector X31.1	Connector X31 Resolver and temperature monitoring for axes 1 to 8
Motor cable A7	Connector XM7.1	Connector XM7 Motor, brake and PE for axis 7

Cable designation	from	to
Control cable A7	Connector X7	Connector XP7 Resolver and temperature monitoring for axis 7
Ground conductor	PE bolt on robot	PE bolt on carriage
Ground conductor	PE bolt on beam	PE bolt on connector plate
Ground conductor	PE bolt on connector plate	PE bolt on controller
Ground conductor, energy supply chain (optional)	PE bolt on connector plate	PE bolt on robot for energy supply system

12.1.2 Cabling diagrams

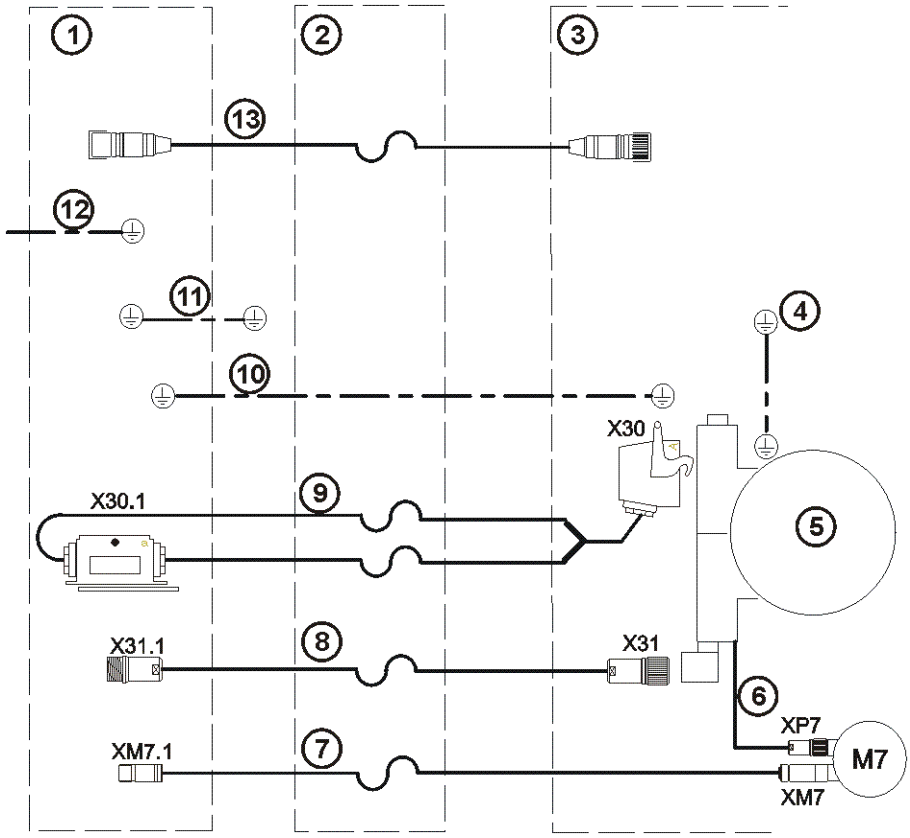
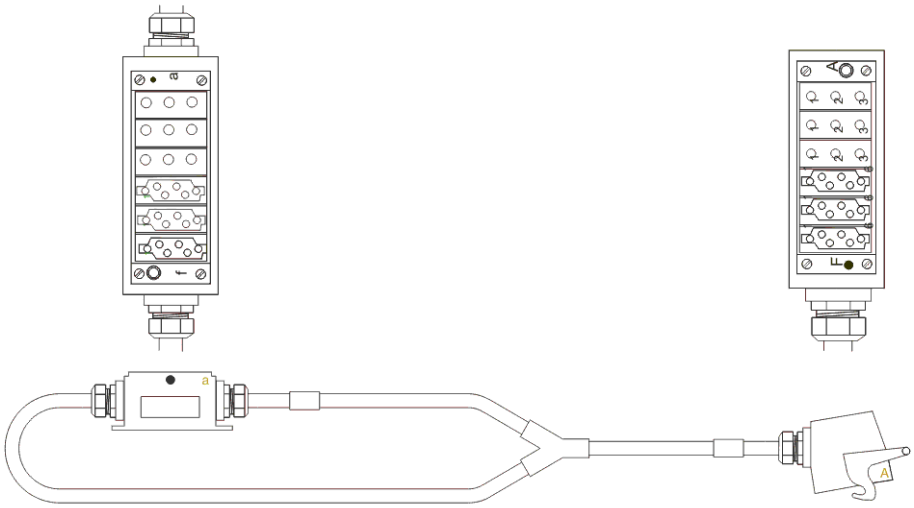


Fig. 12-2: Cabling plan and pin allocation diagram

1	Connector plate	8	Data cable with coding pin, X31
2	Energy supply chain	9	Motor cable A1 to A6, X30
3	Carriage	10	Ground conductor, energy supply chain (optional)
4	Ground conductor, carriage	11	Ground conductor, beam
5	Robot A1 to A6	12	Ground conductor, controller
6	Control cable A7, XP7	13	Peripheral cables (optional)
7	Motor cable A7, XM7		



Wiring diagram

Connec. Nr.	Pin No.	Cable No.	Wire No.	Strip No.	Terminal No.	Cable No.	Wire No.	Device or Connector No.	Pin Nr.	Comments
X30.1	A 1	2.5 mm²	1					X30	A 1	Motor M1 U
	1	2.5 mm²	4						1	Motor M1 U
	2	2.5 mm²	2						2	Motor M1 V
	2	2.5 mm²	5						2	Motor M1 V
	3	2.5 mm²	3						3	Motor M1 W
	3	2.5 mm²	6						3	Motor M1 W
	b 1	2.5 mm²	10						B 1	Motor M2 U
	1	2.5 mm²	13						1	Motor M2 U
	2	2.5 mm²	11						2	Motor M2 V
	2	2.5 mm²	14						2	Motor M2 V
	3	2.5 mm²	12			CABLE 1			3	Motor M2 W
	3	2.5 mm²	15						3	Motor M2 W
	f 1	2.5 mm²	16						F 1	Motor M6 U
	3	2.5 mm²	7						3	Brake +
	4	2.5 mm²	17			CABLE 2			4	Motor M6 V
	5	2.5 mm²	16						5	Brake -
	6	2.5 mm²	18						6	Motor M6 W
2.5 mm²	PE		GN/YE		2.5 mm²			2.5 mm²	PE	Pin-type cable lug
			GN/YE		2.5 mm²					
Cable gland										Cable gland
6 mm²	PE		GN/YE		2.5 mm²			6 mm²	PE	Wire end ferrule
			GN/YE		2.5 mm²					
	c 1	2.5 mm²	1						C 1	Motor M3 U
	1	2.5 mm²	4						1	Motor M3 U
	2	2.5 mm²	2						2	Motor M3 V
	2	2.5 mm²	5						2	Motor M3 V
	3	2.5 mm²	3						3	Motor M3 W
	3	2.5 mm²	6						3	Motor M3 W
	d 1	2.5 mm²	10			CABLE 2			D 1	Motor M4 U
	3	2.5 mm²	8						3	Brake +
	4	2.5 mm²	11						4	Motor M4 V
	5	2.5 mm²	17						5	Brake -
	6	2.5 mm²	12						6	Motor M4 W
	e 1	2.5 mm²	13						E 1	Motor M5 U
	3	2.5 mm²	9						3	Brake +
	4	2.5 mm²	14						4	Motor M5 V
	5	2.5 mm²	18						5	Brake -
	6	2.5 mm²	15						6	Motor M5 W

Fig. 12-3: Connecting cable, motor cable X30.1 - X30

X31.1 X31

Wiring diagram

Plug	Pin	Wire			Plug	Pin	
X31.1	1				X31	1	
	2	WH				2	
	3	BN	Twisted		Twisted	3	
	4	GN				4	
	5	YE	Twisted		Twisted	5	
	6	GY				6	
	7	PK	Twisted		Twisted	7	
	8	BU				8	
	9	RD	Twisted		Twisted	9	
	10	BK				10	
	11	VT	Twisted		Twisted	11	
	12	RD/BU				12	
	13	GY/PK	Twisted		Twisted	13	
	14	WH/GN				14	
	15	BN/GN	Twisted		Twisted	15	
Housing							Housing

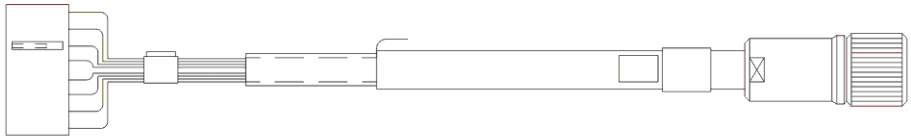
Fig. 12-4: Connecting cable, data cable X31.1 - X31

X... XM..

Wiring diagram

Plug	Pin	Wire	Wire	Wire	Plug	Pin	Signal designation
X...	1		1		XM...	1	U
	2		2			2	V
	6		3			6	W
	4		RD			4	Brake +
	5		BU			5	Brake -
	⏚		ye/gn			⏚	Grd. conductor
Housing							Shield housing-connector

Fig. 12-5: Connecting cable, motor cable XM7.1 - XM7



Wiring diagram

Plug	Pin	Wire	Strip	Wire	Plug	Pin	Signal designation
X..	1		0.25 mm²	BN	XP..	9	Temp.
	2		0.25 mm²	WH		8	Temp.
						4	Shield
	4		0.25 mm²	YE		7	R2
	5		0.25 mm²	GN		10	R1
	6		0.25 mm²	PK		2	S4
	7		0.25 mm²	GY		1	S2
	8		0.25 mm²	RD		12	S3
	9		0.25 mm²	BU		11	S1
Housing						5	Shield
						3	Shield
						6	Shield

Fig. 12-6: Connecting cable, control cable X7 - XP7

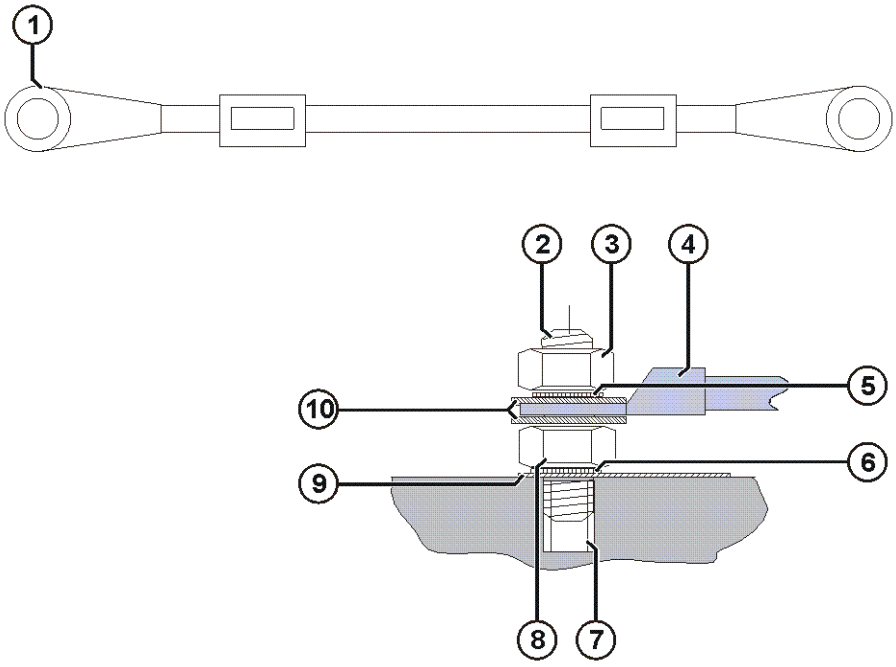


Fig. 12-7: Ground conductor, energy supply chain (optional)

1	M8 ring cable lug	6	Conical spring washer
2	PE bolt	7	M8 tapped hole
3	M8 nut	8	M8 nut
4	Cable lug	9	Ground plate
5	Conical spring washer	10	8.4 washer

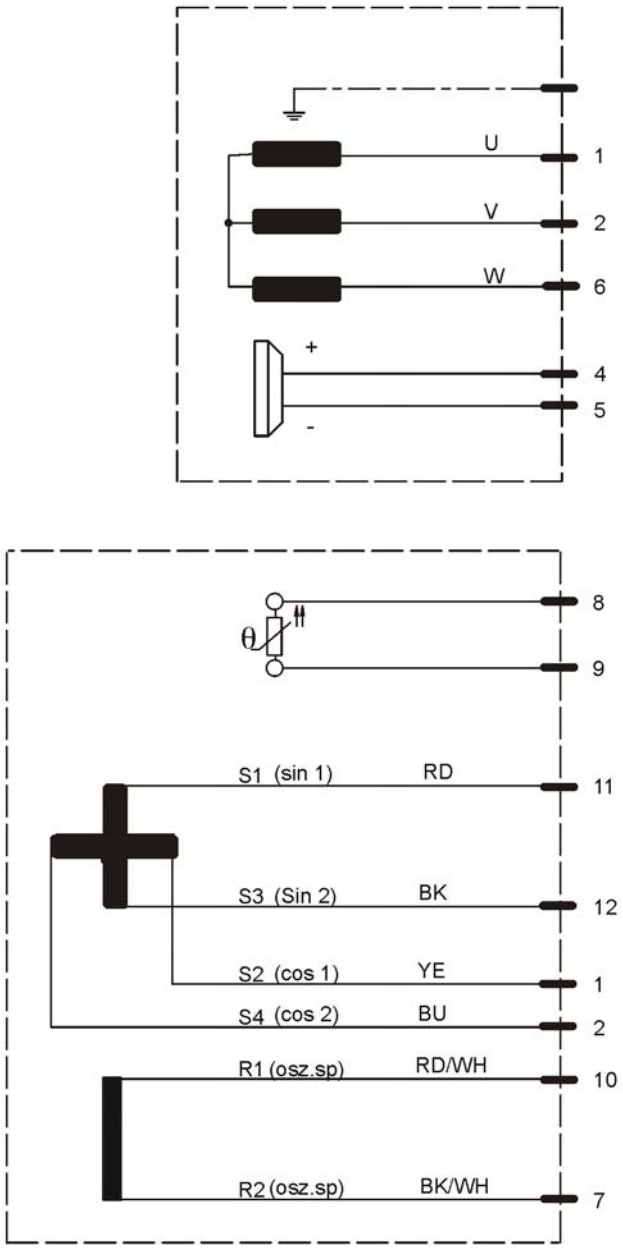


Fig. 12-8: Circuit schematic, motor wiring

12.2 Electrical installations, options

12.2.1 Connecting cable, Multibus cable X71 (optional)

Description

The Multibus cable is routed in the energy supply chain from the carriage to the connector plate.

The Multibus cable has plug-and-socket connections, which enables it to be quickly and reliably exchanged. The plugs and sockets are provided with identification labels.

Caution!
Permissible cable lengths:
The length of the connecting cables between the robot controller and the robot must not exceed 50 m.
If Safe robots are used, the cable length must not exceed 35 m.

Overview

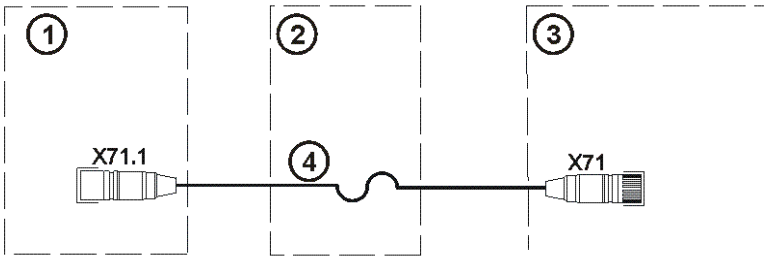
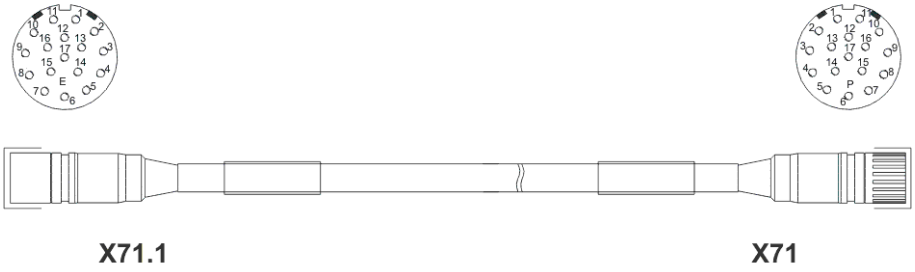


Fig. 12-9: Cabling plan and pin allocation diagram

1	Connector plate	3	Carriage
2	Energy supply chain	4	Multibus cable

Wiring diagram



Wiring diagram

Connector	PIN	Wire	Strip	Wire	Connector	PIN	Signal name
X71.1					X71		
	7	0.25 mm²		YE		7	IBS D0
	8	0.25 mm²		GN		8	IBS $\overline{D0}$
	9	0.25 mm²		GY		9	IBS D1
	10	0.25 mm²		PK		10	IBS $\overline{D1}$
	11	0.34 mm²		GN		11	Profi A
	6	0.34 mm²		RD		6	Profi B
	17	0.34 mm²		RD		17	CAN
	12	0.34 mm²		BU		12	CAN
	13	0.34 mm²		WH		13	CAN high
	14	0.34 mm²		BU		14	CAN low
	2	1 mm²		BU		2	US2 0V
	3	1 mm²		BN		3	US2 24V
	1	1 mm²		BK		1	US1 OV
	4	1 mm²		RD		4	US1 24V
	5	1 mm²		YE/GN		5	PE
	15					15	n.c.
	16					16	n.c.
	Housing		Shields			Housing	

Fig. 12-10: Connecting cable, Multibus X71.1 - X71 (optional)

13 Decommissioning, storage and disposal

13.1 Decommissioning

Description

This section describes all the work required for decommissioning the linear unit if the linear unit is to be removed from the system. After decommissioning, it is prepared for storage or for transportation to a different location.

Following its removal, the linear unit can be transported by means of transport tackle and crane or by fork lift truck. For transportation, the beam must be picked up over its center of gravity in order to prevent tilting.

Preconditions

- The removal site must be accessible with a crane or with a fork lift truck for transportation.
- There is no hazard posed by system components.

Procedure

1. Secure the linear unit.

Warning!
Unintentional motion of the robot and the linear unit can result in danger to persons and materials. If the robot and the linear unit have reached their disassembly position, shut down the system and take measures to prevent it from being switched on again unintentionally. If several robots or linear units are in a system, these must also be switched off and secured against being switched on again unintentionally.

2. Move the carriage (>>> Fig. 13-1) to the middle of the beam and secure it so that it cannot be moved unintentionally.
3. Remove the robot in accordance with the operating instructions.
4. Release and unplug the equipotential bonding (ground conductor) on the carriage.
5. Remove the energy supply system; see Section (>>> 8.7 "Removing the energy supply system" page 64).
6. Release and unplug connectors XM7 and XP7.
7. Fully remove the screwed connections from the mounting bases.
8. Attach the lifting tackle at four places, or pick up the beams with a fork lift truck.
9. Lift off the beam and transport it away. In the case of a multi-piece beam, the beam sections must be transported individually.
10. Prepare the beam for storage.

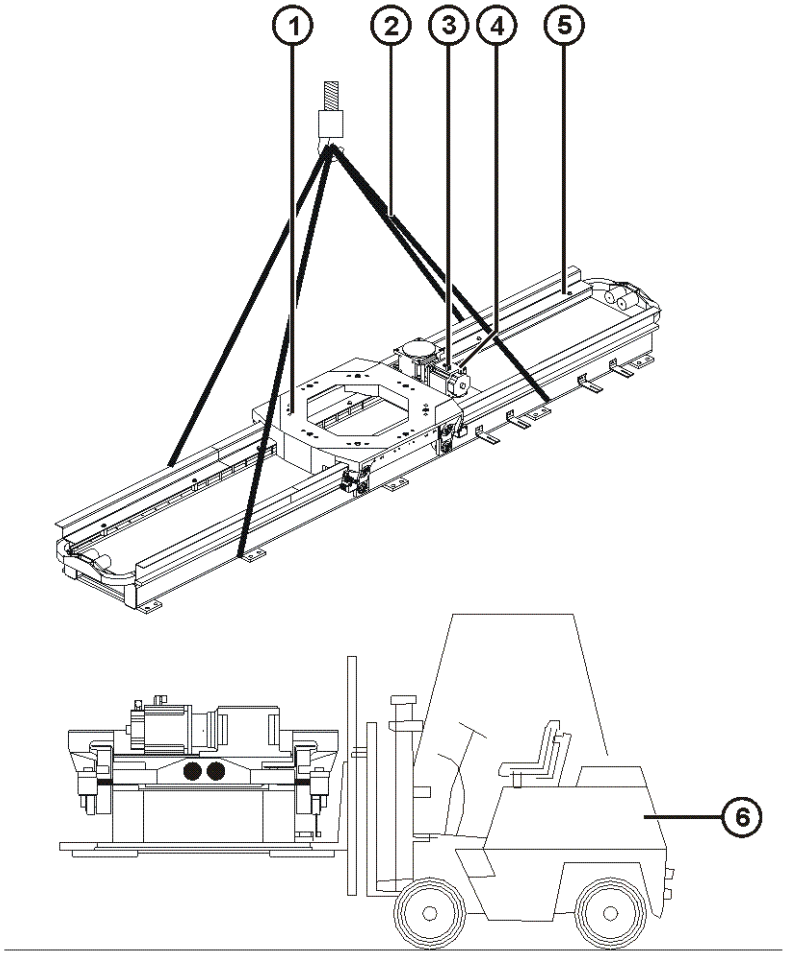


Fig. 13-1: Removing the linear unit

1	Carriage	4	Connector XP7
2	Lifting tackle	5	Beam
3	Connector XM7	6	Fork lift truck

13.2 Storage

Description

If the linear unit is to be put into long-term storage, the following points must be observed:

- The place of storage must be as dry and dust-free as possible.
- Avoid temperature fluctuations.
- Avoid wind and drafts.
- Avoid condensation.
- Use appropriate coverings that cannot detach themselves and which can withstand the expected environmental conditions.
- Do not leave any loose parts on the linear unit, especially ones that might knock against other parts.
- Do not leave the linear unit exposed to direct sunlight while in storage.
- Observe and comply with the permissible temperature ranges for storage. See Section (>>> 4 "Technical data" page 17).
- Select a storage location in which the covers cannot be damaged.

Procedure

1. Remove tools and equipment.

2. Remove the linear unit.
3. Clean and dry the linear unit. No dirt or cleaning agents may remain on or in the linear unit.
4. Inspect the linear unit, both internally and externally.
5. Remove any foreign bodies.
6. Remove any corrosion.
7. Clean the tracks and racks and protect them against corrosion.
8. Seal off electrical connections with suitable covers.
9. Seal hose connections by suitable means.
10. Cover the linear unit with plastic film and seal it against dust.
    If necessary, add a desiccant beneath the sheeting.

13.3 Disposal

When the linear unit reaches the end of its useful life, it can be removed from the system and dismantled, and the materials can be disposed of properly by type.

The following table provides an overview of the materials used in the linear unit. All plastic components are marked with a material designation and must be disposed of accordingly.

Material, designation	Subassembly, component	Remark
Steel	Gear units, screws and washers, beams, covers	
	Motors	Dispose of motors without dismantling them.
PUR	Cable sheaths	
Copper	Cables, wires	
PU	Hoses, energy supply chain	
Oil	Gear units	See safety data sheet, consumables (>>> 15.1 "Safety data sheets" page 123)
Lubricating grease	Gear teeth	See safety data sheet, consumables (>>> 15.1 "Safety data sheets" page 123)
PA	Hinged clamps	
NBR	O-rings	
FKM (fluorocarbon rubber)	Shaft sealing rings	

14 Options

14.1 Working range monitoring, welded

Description

The working range monitoring for axis 7 makes it possible to continuously monitor the position of axis 7. It consists of cams (>>> Fig. 14-1), which are attached by means of brackets to the beam of the linear unit, and position switches, which are mounted on a holder fastened to the carriage. The working range monitoring system A7 allows up to six motion ranges to be monitored on the linear unit.

A range is monitored by means of one position switch – or in the case of personnel protection, two position switches installed one behind the other – each of which is actuated by one cam. Each position switch has a make contact and a positively driven break contact.

Caution!
Only the position switch type specified in (>>> 14.1.1 "Technical data" page 108) may be used.

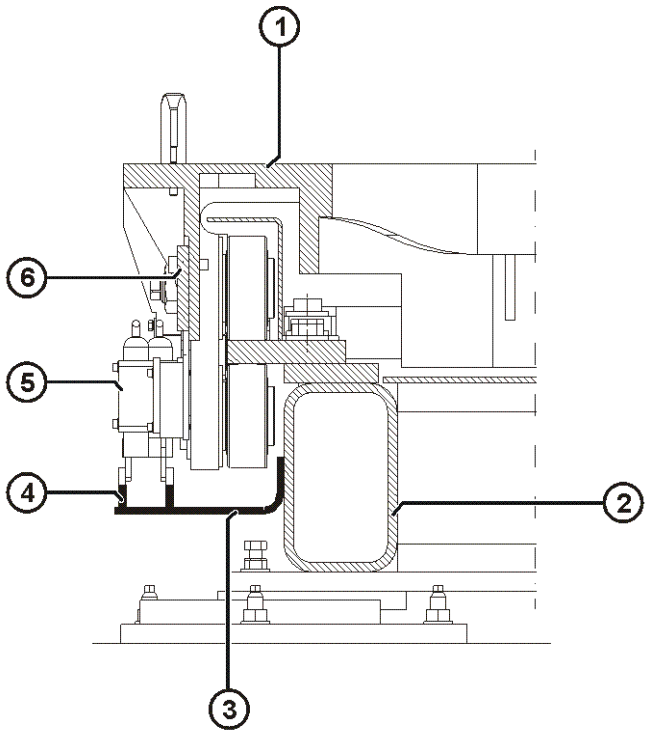


Fig. 14-1: Working range monitoring

1	Carriage	4	Cam
2	Beam	5	Position switch
3	Bracket	6	Holder

The position switches are wired to connector X39 in accordance with the number of monitoring ranges required by the user.

Connector X39 is the interface to the machine or system in which the linear unit is integrated. It is located on the carriage. This interface is freely available to the user of the machine or system. For working range monitoring with a personnel protection function, the wiring beyond the interface must be of failsafe design, and is the sole responsibility of the user.

If more than three ranges are monitored, the electric cabling must be wired using an additional connector.

Caution!
The user is responsible for this wiring in case of retrofits.

14.1.1 Technical data

Mechanical data

Max. monitoring range	Full range of motion of A 7
Number of monitoring ranges	max. 6
Length of one individual cam*	max. 2500 mm

* The overall length of a cam (consisting of one or more sections) corresponds to the size of the respective monitoring range. The monitoring range can be reduced or increased by shortening the cam or assembling several individual sections.

Electrical data

Contact elements	1 make contact, 1 break contact
Switching voltage	250 V AC
Switching current	10 A
Position switch type	3SE5112-0CH01
Protection classification (according to IEC 529)	IP 67

14.1.2 Installing the working range monitoring

Warning!
The relevant safety regulations are to be observed when carrying out welding. This applies especially to sparks and hot components.

Procedure

1. Determine the installation position of the brackets (>>> Fig. 14-2) on the beam.

The installation situation of the brackets and the location of the cams is shown in the drawing supplied with the retrofit kit. It is much easier to align the brackets and cams if a suitable installation aid is used.

2. Mount the brackets, align them and tack-weld them in place. Observe the specified distance from the track. See (>>> Fig. 14-3) for installation dimensions.
3. Mount the cams, align them and tack-weld them in place. Observe the correct installation dimensions.

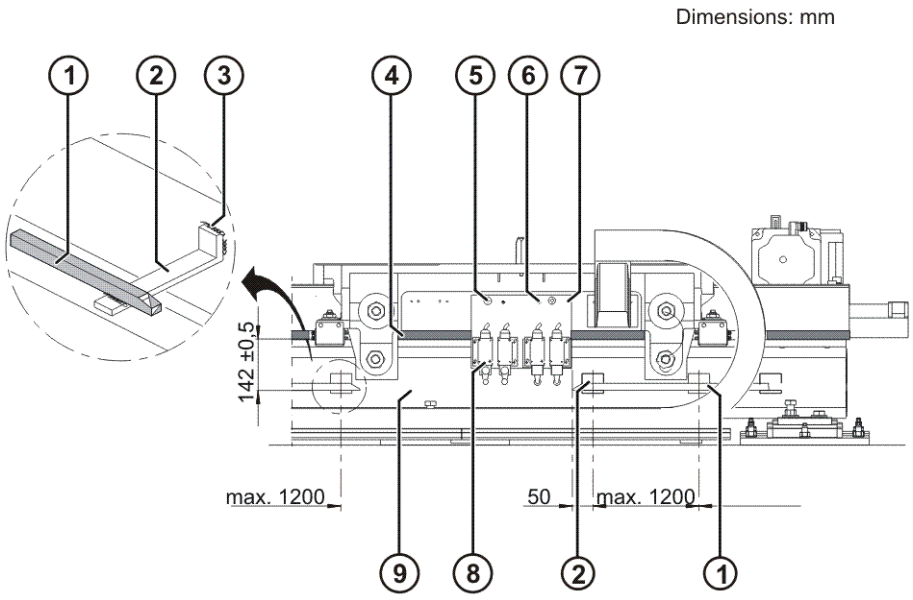


Fig. 14-2: Brackets and cams

1	Cam	6	Roll pin
2	Bracket	7	Holder
3	Weld seam	8	Position switch
4	Track	9	Beam
5	Allen screw		

4. Mount the holder (>>> Fig. 14-2) and fasten it with M12x30 Allen screws.
5. Insert 8x24 roll pins.
6. Mount the position switches on the holder, and check the installation position of the actuating levers.

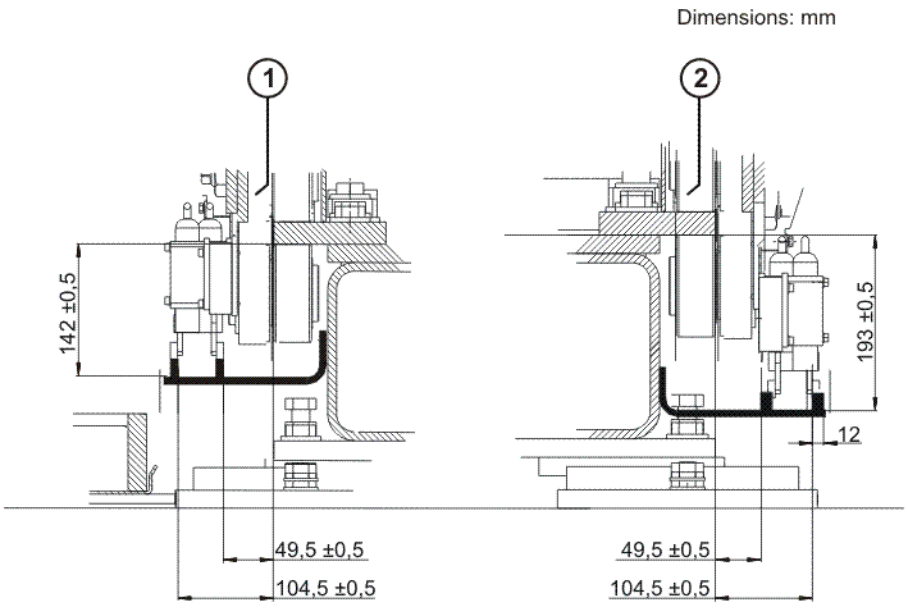


Fig. 14-3: Installation dimensions

1	Energy supply chain side
2	Drive side

If three monitoring ranges are required on one side, the actuating levers of the position switches for one monitoring range must be turned through 180°. To do this, remove two screws, take off the actuating lever, turn it through 180° and fasten it again.

7. Drill M4 holes for the surface-mounted housing X39 and fasten the surface-mounted housing with four M4x12 Allen screws and lock washers.

The installation position of surface-mounted housing X39 on the carriage may be freely determined by the user. When routing the control cables, it must be ensured that this does not adversely affect other parts of the system.

8. Route, fasten and connect the control cables.
9. Connect the position switches in accordance with the connection diagram (>>> 14.1.5 "Electrical installations" page 114).
10. Check the electrical installations:
    Test the individual wires for continuity and contacting,
    test the wires against each other for incorrect connection,
    test each wire against the surface-mounted housing.
11. Adjust the position switches in accordance with Section (>>> 14.1.3 "Adjusting the working range monitoring" page 110).
12. When all the position switches have been installed and adjusted, check the proper functioning of the cams and position switches.

Warning!
Before performing the next step, it must be ensured that it is not possible for anyone to be injured within the range of the slowly moving carriage. The carriage may only be moved at jog speed, with all applicable safety rules and regulations being observed.

13. Put the linear unit into operation and slowly move the carriage through the motion range to be monitored. Check also the switching function of the position switch.

Warning!
Shut down the linear unit and provide a safeguard to prevent it from being switched on again by unauthorized personnel.

14. Carry out the remaining welds on the cams and brackets.

When welding on the cams and brackets, it must be ensured that the weld distortion does not impair the function of the components. If this should happen, the welds must be separated and the cam positions adjusted once again.

14.1.3 Adjusting the working range monitoring

Preconditions

- Before beginning adjustment work, ensure that the working range monitoring system has been installed in accordance with Section (>>> 14.1.2 "Installing the working range monitoring" page 108) and is functional. For each monitoring range, one separate cam with one or two position switches must be mounted and adjusted, even if several (up to four) ranges are in use. The adjustment work can only be carried out when the carriage is positioned within the monitoring range.

Warning!
Shut down the linear unit and provide a safeguard to prevent it from being switched on again by unauthorized personnel.

Caution!
If not otherwise specified, all screws must be inserted with Drei Bond 1342 locking agent.

Procedure

1. Slacken two Allen screws (>>> Fig. 14-4) (3).

Caution!
It must be ensured that the position switch is securely screwed to the plate.

Slacken the Allen screws until the position switch can only just be shifted.

2. Slide the position switch towards the cam until there is a distance of 52 mm (>>> Fig. 14-5) between the cam and the fastening screw (5).

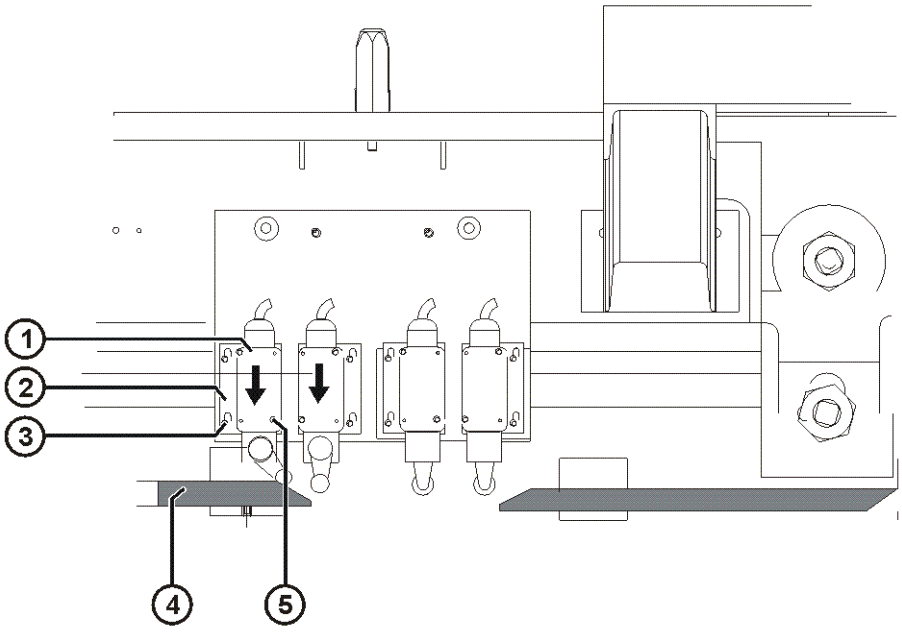


Fig. 14-4: Adjusting the position switch

1	Position switch	4	Cam
2	Plate	5	Fastening screw
3	Allen screw		

3. Tighten the two Allen screws (>>> Fig. 14-4) (3). To guarantee positive opening operation, an actuating angle of at least 50° (>>> Fig. 14-5) must be maintained.

Caution!
The distance between the center of the fastening screws on the switch housing and the upper edge of the cam must not be less than 52 mm.

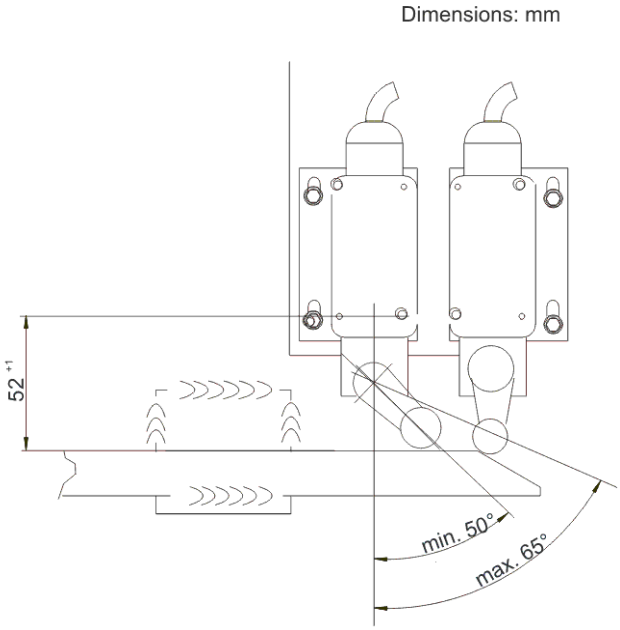


Fig. 14-5: Adjustment dimensions

4. Check the setting again.

Warning!
Before performing the next step, it must be ensured that it is not possible for anyone to be injured within the range of the slowly moving carriage. The carriage may only be moved at jog speed, with all applicable safety rules and regulations being observed.

5. Put the linear unit into operation and slowly move the carriage through the motion range to be monitored, checking the position of the actuating lever and the switching function of the position switches.

Warning!
The actuating angle between the cam and the actuating lever of the position switch must be at least 50° over the entire length of the cam.

6. Check the height offset (>>> Fig. 14-6) between the position switch and cam.

Warning!
The height offset must not exceed ± 2 mm. Otherwise there is a risk of incorrect actuation.

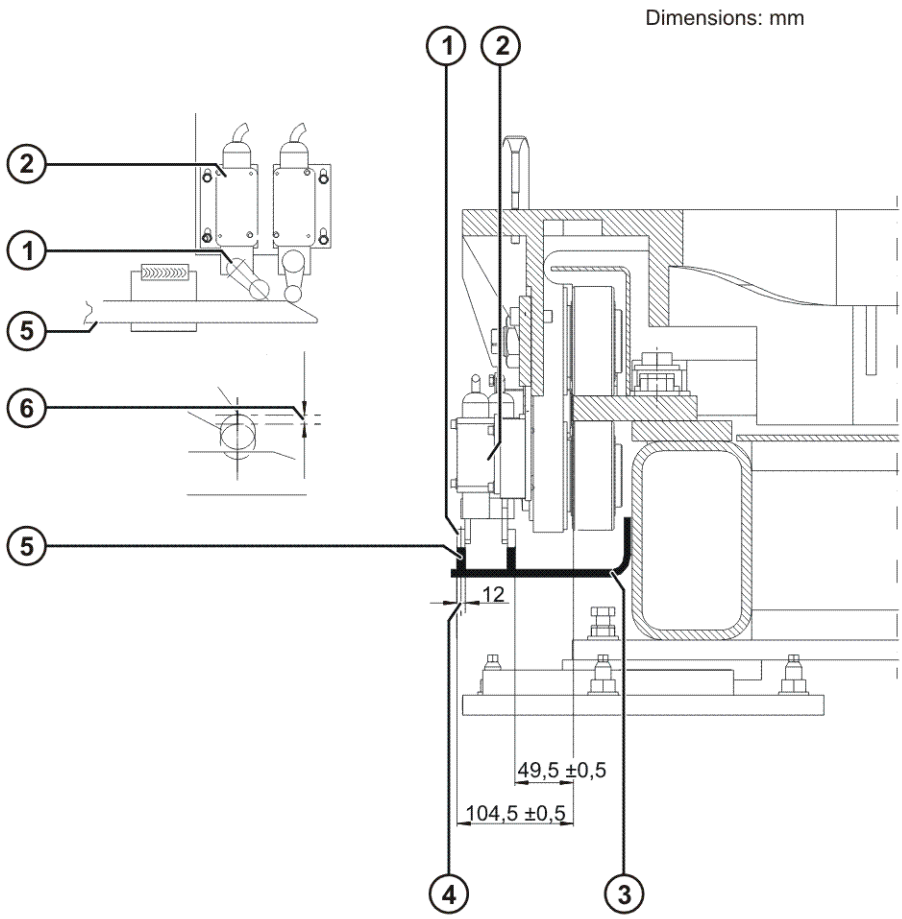


Fig. 14-6: Permissible height offset and lateral offset

1	Actuating lever	4	Width of cam
2	Position switch	5	Cam
3	Bracket	6	Height offset

7. Check the lateral offset of the actuating lever in relation to the width of the cam.

Warning!
The lateral offset between the middle of the roller on the actuating lever and the middle of the cam must not exceed ± 3 mm. Otherwise there is a risk of incorrect actuation.

Warning!
Shut down the linear unit and provide a safeguard to prevent it from being switched on again by unauthorized personnel.

8. Correct the height offset if it is outside of the tolerance. To correct the height offset, the bracket or the cam must be moved.
9. Check all the fastening elements of the working range monitoring system for a secure fit.
10. If necessary, weld the cam to the bracket.

14.1.4 Maintenance instructions

Preconditions Under normal ambient conditions, maintenance should be carried out on the working range monitoring with position switches every three months. In partic-

ularly dirty conditions, the maintenance intervals must be shortened accordingly.

Warning!
When work is carried out on the robot system, turn the main switch on the robot controller to “OFF” and secure it with a padlock to prevent unauthorized persons from switching it on again.

Maintenance table

Activity	Comments
Free position switches from dirt.	Do not damage position switches.
Check cams for wear, and exchange if necessary.	If the cams are worn or the position switches damaged, exchange the affected parts.
Check that the cams are fitted securely.	-
Check that the cams are not deformed.	Ensure that switching takes place correctly.
Check that position switches and holders are fitted securely.	-
Check mechanical function of the position switches.	Replace damaged or deformed position switches.
Check cables for wear.	Replace damaged cables; if necessary, change routing of cables.

14.1.5 Electrical installations

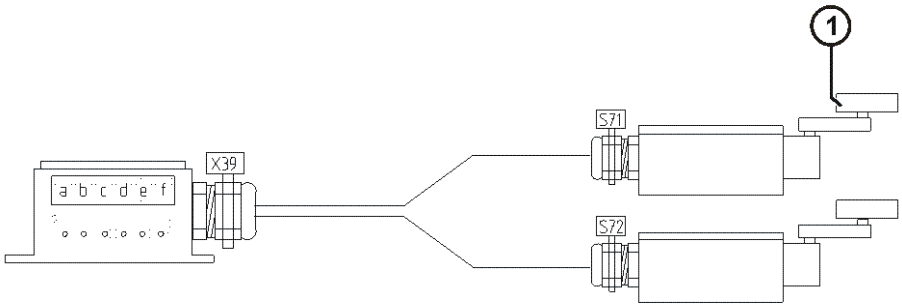


Fig. 14-7: One monitoring range, personnel protection

1 Actuating lever

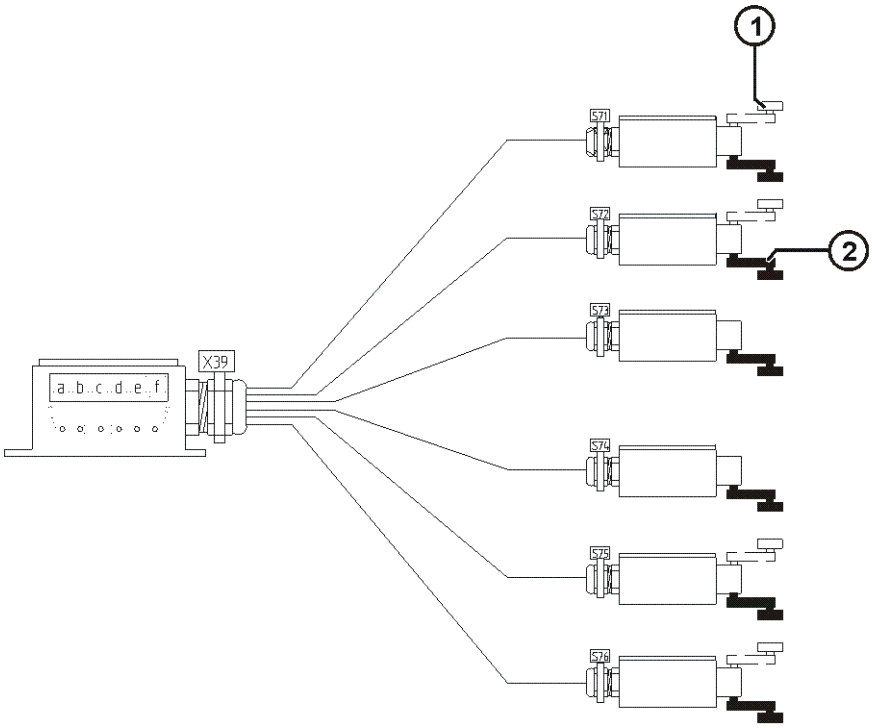


Fig. 14-8: Three monitoring ranges, personnel protection

1 Actuating lever, rotated
2 Actuating lever, standard

With three monitoring ranges, rotate actuating lever by 180°.

The position switch cables of axis 7 are connected to surface-mounted housing X39 as shown in (>>> Fig. 14-9). The cables enter the surface-mounted housing through a Pg gland.

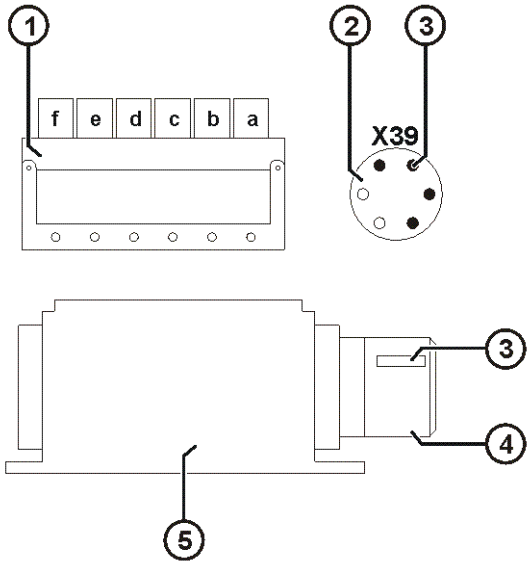


Fig. 14-9: Connection of the position switch cables to the surface-mounted housing

1	Ground conductor connection bracket	4	Pg gland
2	Sealing insert	5	Surface-mounted housing
3	Dummy post		

Caution!
Openings in the sealing insert that are not required must be sealed with dummy posts.

The individual cables and the dummy posts must have a diameter of approx. 7 mm to ensure that the sealing inserts provide a proper seal.

The ground conductors are connected to the respective ground conductor connection bracket.

Connection diagram

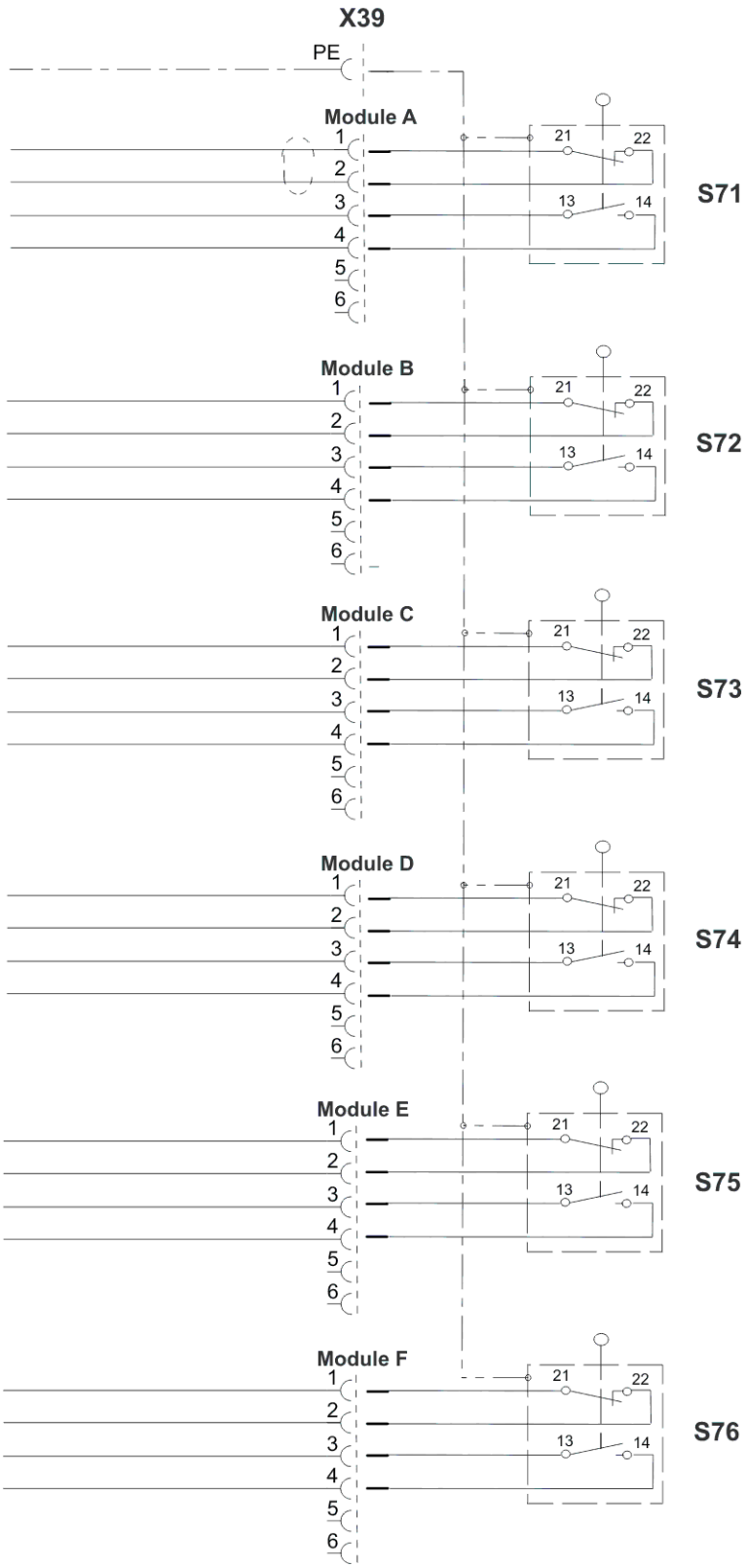


Fig. 14-10: Wiring diagram for carriage

14.2 Connecting cables for working range monitoring

Caution!
Permissible cable lengths:
The length of the connecting cables between the robot controller and the robot must not exceed 50 m.
If Safe robots are used, the cable length must not exceed 35 m.

14.2.1 Description

Most of the cables have plug-and-socket connections, which enables them to be quickly and reliably exchanged. The plugs and sockets are provided with identification labels.
Only ground conductors (PE conductors) are fastened with cable lugs to threaded bolts.

If the length of the connecting cables is greater than 25 m, a separate ground conductor must be connected between the linear unit and the control cabinet.

The energy supply chain forms the moving (translational) connection between the connector plate and the driver on the carriage.

The following cables and cable designations are used:

Cable designation	from	to
Control cable for working range monitoring A1 (optional)	Connector X37.1	Connector X37
Control cable for working range monitoring A7 (optional)	Connector X39.1	Connector X39
Control cable for working range monitoring A7 (optional)	Connector X40.1	Connector X40

14.2.2 Cabling diagrams

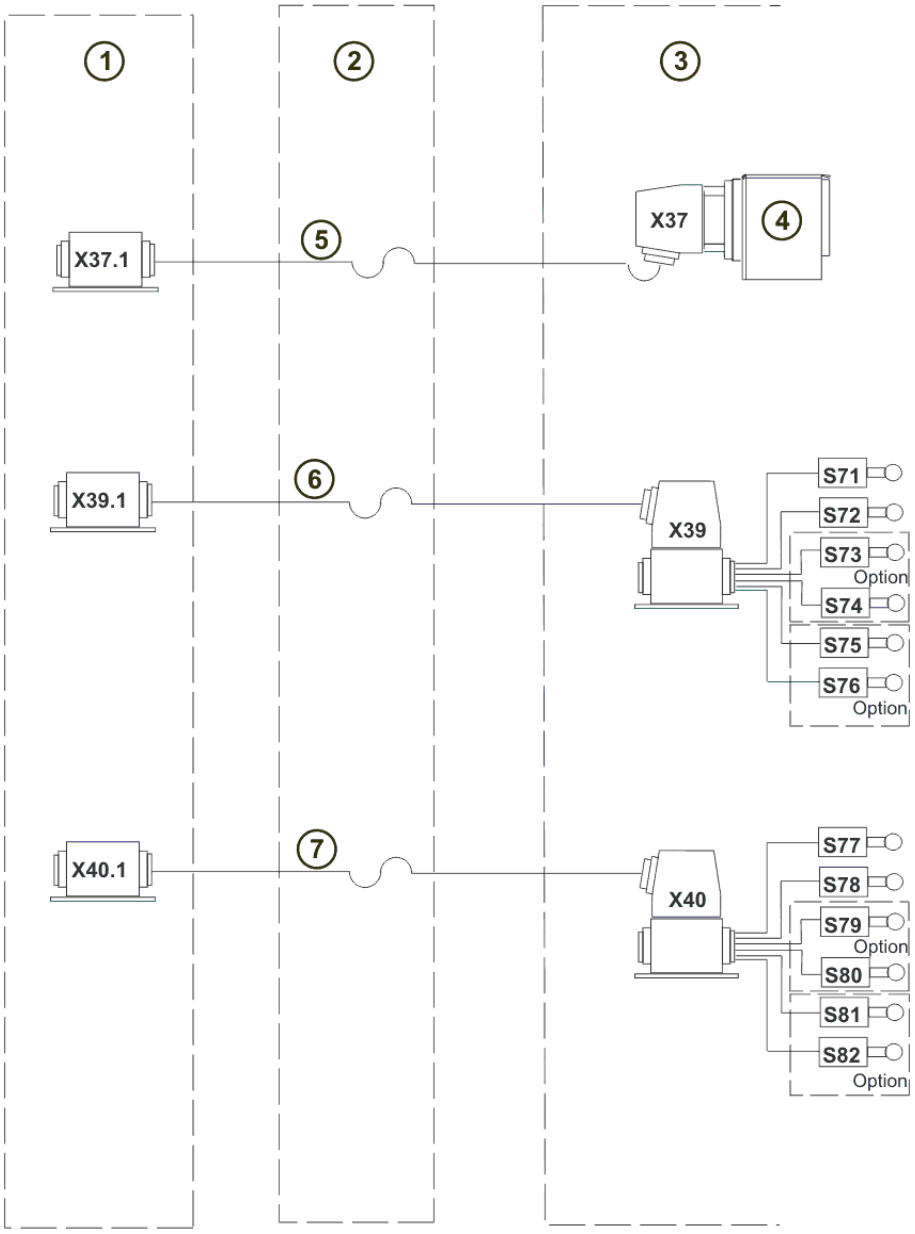


Fig. 14-11: Cabling plan and pin allocation diagram

1 Connector plate
2 Energy supply chain
3 Carriage
4 Multi-position proximity switch
5 Control cable, range monitoring A1, X37 (optional)
6 Control cable, range monitoring A7, X39 (optional)
7 Control cable, range monitoring A7, X40 (optional)

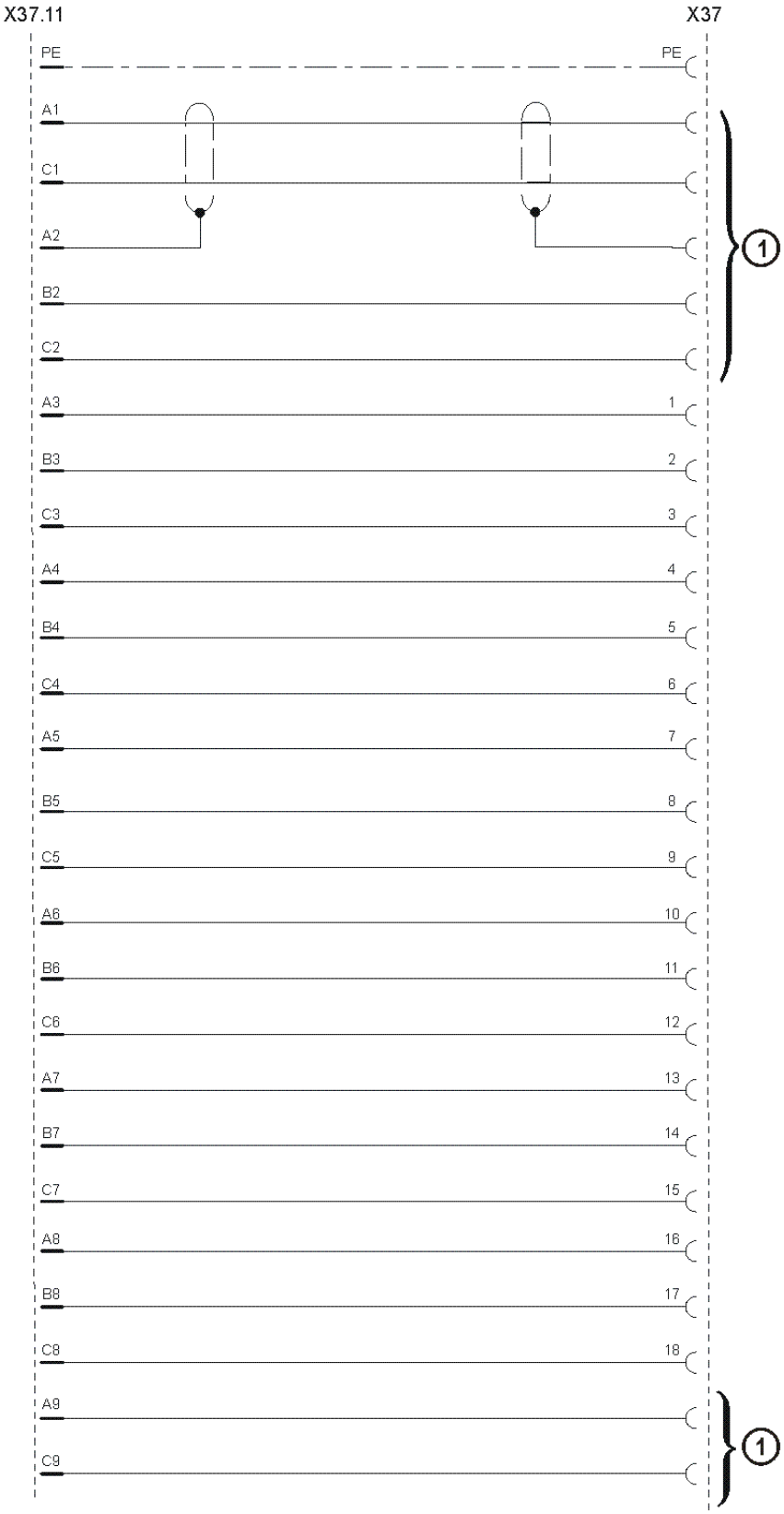


Fig. 14-12: Cabling plan for control cable, working range monitoring A1, X37 (optional)

1 Not assigned

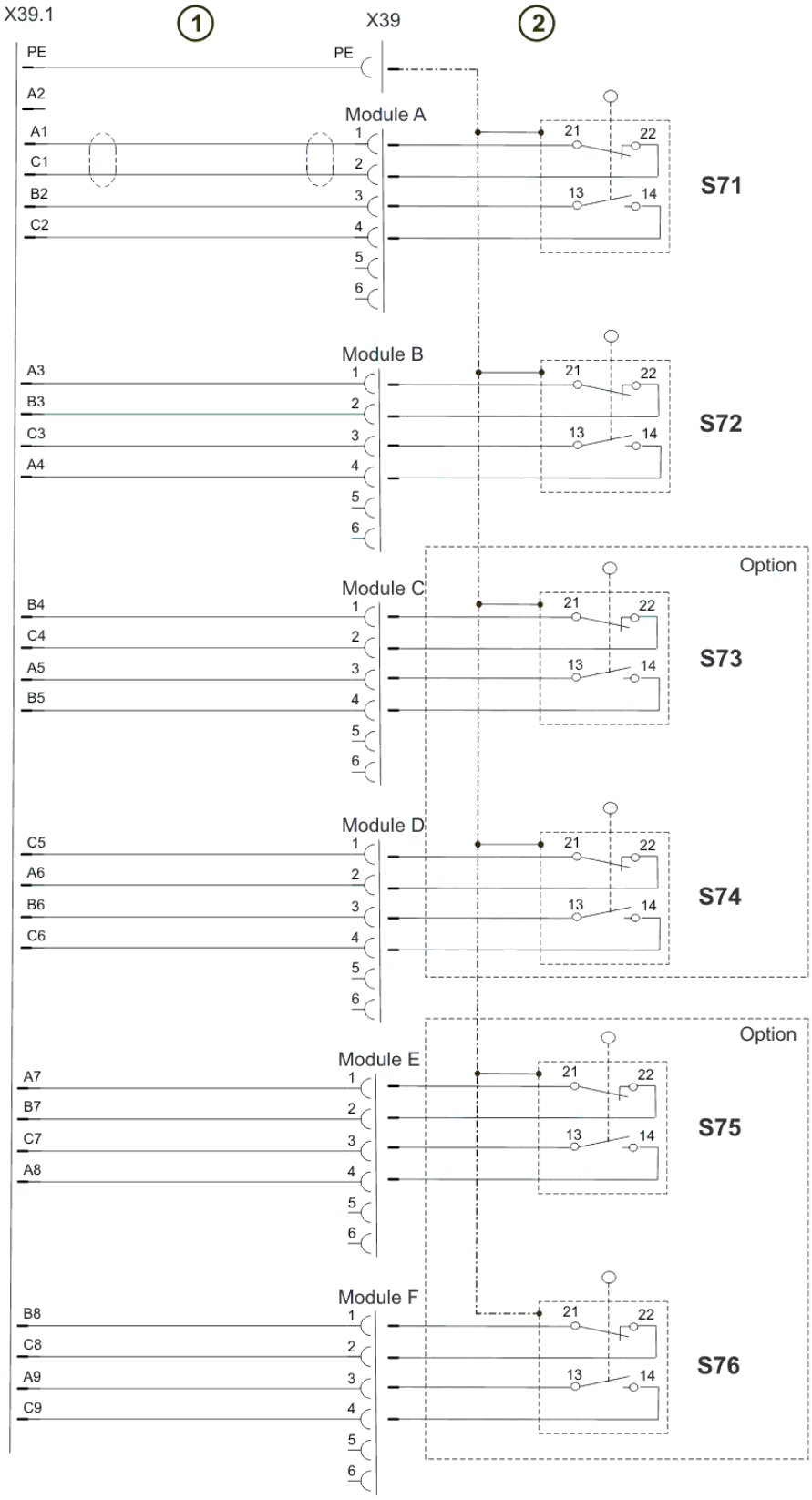


Fig. 14-13: Cabling plan for control cable, working range monitoring A7, X39 (optional)

1 Energy supply chain
2 Carriage

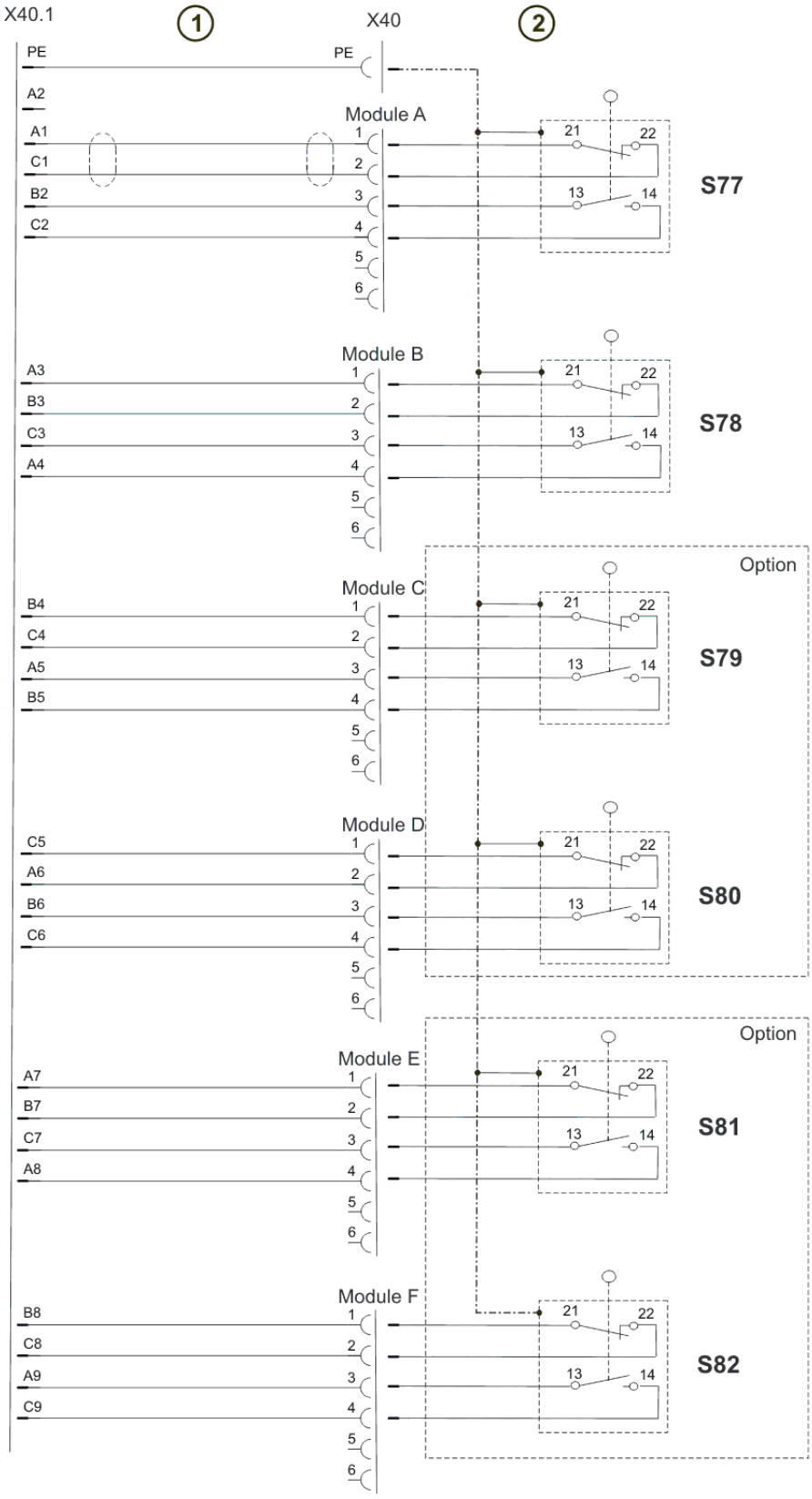


Fig. 14-14: Cabling plan for control cable, working range monitoring A7, X40 (optional)

1 Energy supply chain
2 Carriage

15 Appendix

15.1 Safety data sheets

15.1.1 Safety data sheet for Aralub LFZ 1 lubricating grease

The following extract from the safety data sheet according to 91/155/EEC must be observed.

15.1.1.1 Designation of substance/formulation and manufacturer

Name of substance/preparation	
Trade name:	**Aralub LFZ 1**
SDS no.:	456145
Use:	Lubricating grease

Manufacturer designation	
Company:	**Deutsche BP Aktiengesellschaft, Industrial Lubricants & Services**
Address:	Erkelenzer Strasse 20, D-41179 Mönchengladbach
Country:	Germany
Telephone:	+49 (0)2161 909 319
Fax:	+49 (0)2161 909 392
Emergency hotline:	Carechem: +44 (0)208 762 8322
e-mail address:	MSDSadvice@bp.com

15.1.1.2 Composition / Information about the components

Chemical characterization:	Highly refined base oil, soap, additives.

Hazardous components:	This product contains no dangerous components above the legally defined limit values.

15.1.1.3 Possible hazards

The preparation is **NOT** classified as hazardous in accordance with Directive 1999/45/EC in its altered and adapted version.

Physical / chemical hazards:	Not classified as dangerous.
Human health hazards:	May irritate eyes and skin.
Environmental hazards:	Unlikely to be harmful to aquatic organisms.

Effects and symptoms	
Eyes:	May cause mild eye irritation.
Skin:	Can dry out the skin and lead to irritation and/or dermatitis. Allergic reactions are possible in the worst case.

Effects and symptoms	
Inhalation:	Inhalation of oil mist or vapors at elevated temperatures may cause respiratory irritation.
Ingestion:	Ingestion may cause gastrointestinal irritation (e.g. diarrhea).

15.1.1.4 First aid measures

Contact with eyes:	Rinse eyes immediately with plenty of water for several minutes. If irritation occurs, consult a doctor.
Skin contact:	Wash affected areas of skin with soap and water, or use suitable cleaning agent. Change clothing and shoes if they become contaminated with product. Wash clothing before reuse. Clean shoes thoroughly before reuse. If irritation occurs consult a doctor.
Inhalation:	Take affected person into fresh air. Consult a doctor if symptoms persist.
Ingestion:	Do **not** induce vomiting. If the person is unconscious, do not give anything by mouth. Consult a physician immediately.
Notes to physician:	Treatment should in general be symptomic and directed at relieving any effects. Note regarding high-pressure applications Injection into the skin due to contact with a product under high pressure constitutes a major medical emergency. Within a few hours the tissue swells up and becomes discolored and extremely painful, with severe subcutaneous necrosis. Surgical treatment is absolutely imperative. Comprehensive opening of the wound and the tissue beneath it is necessary in order to reduce tissue loss and to prevent or limit lasting damage. The high pressure can cause the product to penetrate extensive areas of tissue layers.

15.1.1.5 Fire-fighting measures

Suitable extinguishing agents:	In the event of a fire, use foam or universal powder.
Unsuitable extinguishing agents:	**Do not** use water jets.
Special instructions for extinguishing work:	Contaminated extinguishing water must be collected separately and prevented from entering the drainage system.
Hazardous decomposition products:	Decomposition products include various oxides (e.g. carbon oxides).
Unusual fire/explosion hazards:	-
Special fire-fighting measures:	-
Protection of fire-fighters:	Fire-fighters must wear self-contained positive pressure breathing apparatus (SCBA) and full protective gear.

15.1.1.6 Measures after unintended release

Personal safety precautions:	Contact emergency personnel immediately. In case of spillage, isolate the hazard area. Avoid contact with the hazardous substance and avoid inhaling vapors. Ensure adequate ventilation. Where there is insufficient ventilation, wear suitable respiratory equipment. Use suitable protective equipment.
Environmental precautions and clean-up methods:	If no emergency personnel are available, contain spilled material. Remove solid or absorbed material using a tool and place in a suitable, labeled waste container. Prevent the product from entering the drainage system, surface waters and soil. Notify the competent authorities, if required.
Personal protection in the event of a large spill:	Before handling this product, consult a specialist regarding protective equipment. Wear splash goggles, full suit, boots and gloves.

15.1.1.7 Handling and storage

Handling:	Prevent contact with skin or clothing. Spilled and leaked product must be prevented from coming into contact with soil and surface waters. Wash thoroughly after handling.
Storage:	Keep containers tightly sealed. Keep containers in a cool, well-ventilated area.
Unsuitable:	Avoid prolonged exposure to increased temperatures.

15.1.1.8 Exposure limits and personal protective equipment

Ingredient name:	**Threshold limit values (TLV) acc. to ACGIH (USA)**
Base oil – unspecified	STEL: 10 mg/m^3 15 minute(s). Form: mineral oil mist TWA: 5 mg/m^3 8 hour(s). Form: mineral oil mist Further information can be obtained from the supplier.

Protective measures	
Limitation and monitoring of exposure in the workplace:	Provide exhaust ventilation or other engineering controls.
Hygiene measures:	Wash hands, forearms and face thoroughly after handling chemical products.
Respiratory protection:	Sufficient ventilation is recommended in industry. If ventilation is insufficient, respiratory protection is useful.
Hand protection:	Wear chemical-resistant gloves (recommended: nitrile gloves) if prolonged or repeated contact is likely.
Eye protection:	Protective goggles with side shields to guard against splashing.
Skin and body:	Wear appropriate clothing to avoid prolonged skin contact.

15.1.1.9 Physical and chemical properties

Physical state:	Grease
Color:	Black
Odor:	Oily
Density:	<1000 kg/m^3 (<1 g/cm^3) at 20 °C

Solubility:	Insoluble in water
LogK_{OW}:	The product is much more soluble in octanol; log(octanol/water) >3

15.1.1.10 Stability and reactivity

Incompatible with various substances:	Reactive or incompatible with oxidizing materials.
Hazardous polymerization:	The product is stable. No hazardous polymerization occurs under normal conditions.
Hazardous decomposition products:	Decomposition products may include various oxides (e.g. carbon oxides). No hazardous decomposition products should be formed under normal conditions of storage and use.

15.1.1.11 Toxicological information

Chronic effects:	No particular effects or risks known.
Effects on eyes:	May cause mild eye irritation.
Effects on skin:	Prolonged or repeated contact can dry out the skin and lead to irritation and/or dermatitis. Allergic reactions are possible in the worst case.
Effect if inhaled:	Vapors and aerosols may cause irritation of the mucous membranes of the nose and throat.
Effect if ingested:	May cause nausea, vomiting and diarrhea.
Carcinogenic effect:	No component of this product at levels greater than 0.1% is identified as a carcinogen by ACGIH, the International Agency for Research on Cancer (IARC) or the European Commission (EC).

15.1.1.12 Ecological information

Mobility:	The product is unlikely to penetrate the soil if spilled.
Bioaccumulative potential:	It is assumed that no bioaccumulation through the food chain will take place in the environment.
Environmental hazards:	Unlikely to be harmful to aquatic organisms.
Other ecological information:	This product is unlikely to partition in water.

15.1.1.13 Disposal information

Disposal information	
Disposal information / waste specifications:	Spilled and leaked product must be prevented from coming into contact with soil and surface waters. Observe local, regional and national regulations. Use only approved transporters, recyclers, treatment, storage or disposal facilities. If necessary, disposal should be entrusted to a recognized waste disposal company.

Unused product	
European Waste Catalog (EWC):	Waste code 12 01 12*: Used waxes and greases

Used/contaminated product	
European Waste Catalog (EWC):	Waste code 12 01 12*: Used waxes and greases

Use of the product for purposes other than those specified and/or impurities can necessitate the use of a different waste code number for the waste producer.

Hazardous waste
This product is listed as a hazardous substance by the EU Directive on hazardous waste. Dispose of in accordance with all national and local regulations and statutory provisions in force.

15.1.1.14 Transport information

Classification:	Not hazardous as defined by the transport regulations (ADR/RID, ADNR, IMDG, ICAO/IATA).

15.1.1.15 Regulations

EU regulations:	EC Directives 1999/45/EC and 67/548/EEC

Labeling requirements	
Risk (R) phrases:	This product is not classified according to the Dangerous Substances Order / EU regulations.

Miscellaneous provisions	
Inventories:	**European inventory:** In compliance **US inventory (TSCA 8b):** In compliance **Australian inventory (AICS):** In compliance **Canadian inventory:** In compliance **Inventory of Existing Chemical Substances in China (IECSC):** Not determined. **Japanese inventory of Existing and New Chemical Substances (ENCS):** Not determined. **Korean Existing Chemicals Inventory (KECI):** In compliance **Philippine Inventory of Chemicals and Chemical Substances (PICCS):** In compliance
Technical Guideline on Air:	Technical Guideline on Air, no. 5.2.1: 100%
Classification acc. to the German Administrative Regulation on the Classification of Substances Hazardous to Water into Water Hazard Classes (VwVwS):	1, Annex no. 3

15.1.1.16 Other information

Notes for the reader
All information is based on our current state of knowledge and is intended only to describe our product with regard to the safety data. It is not intended to provide assurance of particular properties. The product may only be used for the scope of work specified above; any other use requires prior consultation with KUKA. Using the product for any purpose other than for its designated use could lead to risks which are not described in this document. Further information on the use of the product may be found in the relevant technical specifications.

15.1.2 Safety data sheet for Microlube GL 261 lubricating grease

The following extract from the safety data sheet according to 91/155/EEC must be observed.

15.1.2.1 Designation of substance/formulation and manufacturer

Name of substance/preparation	
Trade name:	**Microlube GL 261**
Article no.:	020195
Use:	Lubricating grease

Manufacturer designation	
Company:	**Klüber Lubrication München AG**
Address:	Geisenhausenerstr. 7
Postal code:	D-81379 München
Country:	Germany
Telephone:	+49 (0)89 7876 0
Fax:	+49 (0)89 7876 333
Information center:	Material Compliance Management
Emergency hotline:	+49 (0)89 7876-700

15.1.2.2 Composition / Information about the components

Chemical characterization:	Mineral oil, lithium special soap, UV indicator

Hazardous components:	This product contains no dangerous components above the legally defined limit values.

15.1.2.3 Possible hazards

The preparation is **NOT** classified as hazardous in accordance with Directive 1999/45/EC in its altered and adapted version.

Physical / chemical hazards:	Not classified as dangerous.

Human health hazards:	May irritate eyes and skin.
Environmental hazards:	Unlikely to be harmful to aquatic organisms.

Effects and symptoms	
Eyes:	May cause mild eye irritation.
Skin:	Can dry out the skin and lead to irritation and/or dermatitis. Allergic reactions are possible in the worst case.
Inhalation:	Inhalation of oil mist or vapors at elevated temperatures may cause respiratory irritation.
Ingestion:	Ingestion may cause gastrointestinal irritation (e.g. diarrhea).

15.1.2.4 First aid measures

Contact with eyes:	Rinse eyes immediately with plenty of water for several minutes. If irritation occurs, consult a doctor.
Skin contact:	Wash affected areas of skin with soap and water, or use suitable cleaning agent. Change clothing and shoes if they become contaminated with product. Wash clothing before reuse. Clean shoes thoroughly before reuse. If irritation occurs consult a doctor.
Inhalation:	Take affected person into fresh air. Consult a doctor if symptoms persist.
Ingestion:	Do **not** induce vomiting. If the person is unconscious, do not give anything by mouth. Consult a physician immediately.
Notes to physician:	Treatment should in general be symptomic and directed at relieving any effects. Note regarding high-pressure applications Injection into the skin due to contact with a product under high pressure constitutes a major medical emergency. Within a few hours the tissue swells up and becomes discolored and extremely painful, with severe subcutaneous necrosis. Surgical treatment is absolutely imperative. Comprehensive opening of the wound and the tissue beneath it is necessary in order to reduce tissue loss and to prevent or limit lasting damage. The high pressure can cause the product to penetrate extensive areas of tissue layers.

15.1.2.5 Fire-fighting measures

Suitable extinguishing agents:	In the event of a fire: use water spray (mist), foam, dry chemicals or CO2.
Unsuitable extinguishing agents:	**Do not** use water jets.
Special instructions for extinguishing work:	Contaminated extinguishing water must be collected separately and prevented from entering the drainage system.
Hazardous decomposition products:	Decomposition products include various oxides (e.g. carbon oxides).
Unusual fire/explosion hazards:	This product is not inherently explosive in accordance with the applicable rules.

Special fire-fighting measures:	-
Protection of fire-fighters:	Fire-fighters must wear self-contained positive pressure breathing apparatus (SCBA) and full protective gear.

15.1.2.6 Measures after unintended release

Personal safety precautions:	In case of spillage, isolate the hazard area. Avoid contact with the hazardous substance and avoid inhaling vapors. Ensure adequate ventilation. Where there is insufficient ventilation, wear suitable respiratory equipment. Use suitable protective equipment.
Environmental protection measures:	Prevent the product from entering the drainage system, surface waters and soil. Notify the competent authorities, if required.
Large spills:	Stop the leak if you can do so without risk. Remove container from spill area. Flush spilled material into a wastewater treatment plant. Contain spilled material using a non-combustible absorbent (e.g. sand, soil, vermiculite, diatomaceous earth) and collect in the containers provided. Disposal should be entrusted to a recognized waste disposal company. Contaminated absorbents can be just as dangerous.
Small spills:	Stop the leak if you can do so without risk. Remove container from spill area. Dilute with water and mop up, or add absorbent material and place the substance in a suitable container for disposal. Disposal should be entrusted to a recognized waste disposal company.

15.1.2.7 Handling and storage

Handling:	Prevent contact with skin or clothing. Spilled and leaked product must be prevented from coming into contact with soil and surface waters. Wash thoroughly after handling.
Storage:	Keep containers tightly sealed. Keep containers in a cool, well-ventilated area.
Unsuitable:	Avoid prolonged exposure to increased temperatures.

VCI storage class:	11

15.1.2.8 Exposure limits and personal protective equipment

Threshold limit values (TLV):	No occupational exposure threshold limit values have been assigned for this product.

Protective measures	
Limitation and monitoring of exposure in the workplace:	Provide exhaust ventilation or other engineering controls.
Hygiene measures:	Wash hands, forearms and face thoroughly after handling chemical products.
Respiratory protection:	Sufficient ventilation is recommended in industry. If ventilation is insufficient, respiratory protection is useful.
Hand protection:	Wear chemical-resistant gloves (recommended: nitrile gloves) if prolonged or repeated contact is likely.

Protective measures	
Eye protection:	Protective goggles with side shields to guard against splashing.
Skin and body:	Wear appropriate clothing to avoid prolonged skin contact.

15.1.2.9 Physical and chemical properties

Physical state:	Paste
Color:	Tan
Odor:	Specific
Flash point:	-
Drop point:	>220 °C (DIN ISO 2176)
Density:	<1000 kg/m^3 (<1 g/cm^3) at 20 °C
Solubility:	Insoluble in water

15.1.2.10 Stability and reactivity

Incompatible with various substances:	Reactive or incompatible with oxidizing materials.
Hazardous polymerization:	The product is stable. No hazardous polymerization occurs under normal conditions.
Hazardous decomposition products:	Decomposition products may include various oxides (e.g. carbon oxides). No hazardous decomposition products should be formed under normal conditions of storage and use.

15.1.2.11 Toxicological information

Chronic effects:	No particular effects or risks known.
Effects on eyes:	May cause mild eye irritation.
Effects on skin:	Prolonged or repeated contact can dry out the skin and lead to irritation and/or dermatitis. Allergic reactions are possible in the worst case.
Effect if inhaled:	Vapors and aerosols may cause irritation of the mucous membranes of the nose and throat.
Effect if ingested:	May cause nausea, vomiting and diarrhea.

15.1.2.12 Ecological information

Persistence / degradability:	The product can be separated by mechanical means.
Mobility:	The product is insoluble in water.
Environmental hazards:	Prevent from entering wastewater and soil.

15.1.2.13 Disposal information

Disposal information	
Disposal information / waste specifications:	Spilled and leaked product must be prevented from coming into contact with soil and surface waters. Observe local, regional and national regulations. Use only approved transporters, recyclers, treatment, storage or disposal facilities. If necessary, disposal should be entrusted to a recognized waste disposal company.

Hazardous waste
On the basis of the supplier's current state of knowledge, this product is not considered as hazardous waste as defined by EU directive 91/689/EC.

15.1.2.14 Transport information

Classification:	Not hazardous as defined by the transport regulations (ADR/RID, ADNR, IMDG, ICAO/IATA).

15.1.2.15 Regulations

EU regulations:	EC Directives 1999/45/EC and 67/548/EEC

Classification acc. to the German Administrative Regulation on the Classification of Substances Hazardous to Water into Water Hazard Classes (VwVwS):	1, low hazard to waters, Annex 4

15.1.2.16 Other information

Notes for the reader
All information is based on our current state of knowledge and is intended only to describe our product with regard to the safety data. It is not intended to provide assurance of particular properties. The product may only be used for the scope of work specified above; any other use requires prior consultation with KUKA. Using the product for any purpose other than for its designated use could lead to risks which are not described in this document. Further information on the use of the product may be found in the relevant technical specifications.

15.1.3 Safety data sheet for Ferrocote 5856 HF

15.1.3.1 Designation of substance/formulation and manufacturer

Name of substance/preparation	
Trade name:	**Ferrocote 5856 HF**
Internal code:	006481-09 B
Use:	Anticorrosive agent

Manufacturer designation	
Company:	**Quaker Chemical Europe B.V.**
Address:	Industrieweg 1-13, NL-1422 Ah Uithoorn
Country:	Netherlands
Telephone:	+31 297 544644
Fax:	+31 297 544694
Emergency hotline:	+31 302748888, Nationaal Vergiftigingen Informatie Centrum (NL). This telephone number is only available to physicians in the event of accidental poisoning.
e-mail address:	www.quakerchem.com

15.1.3.2 Composition / Information about the components

Chemical characterization:	Mixture of mineral oil and additives.

Chemical description	CAS no.	Weight %	EC no.	Classification
Aliphatic/aromatic hydrocarbon	Secret	30 - 100	Listed	Xn; R65 Xn; R66
Barium sulfonate	Secret	5 - 10	Listed	Xn; R20/22
Hexadecylamine	143-27-1	1 - 5	205-596-8	C; R35 Xi; R41 Xn; R22

15.1.3.3 Possible hazards

The preparation is classified as **harmful** in accordance with Directive 1999/45/EC in its altered and adapted version.

Physical / chemical hazards:	Classified as harmful.
Human health hazards:	May irritate eyes and skin.
Environmental hazards:	May cause adverse effects in the aquatic environment.

Effects and symptoms	
Eyes:	May cause eye irritation.
Skin:	May cause skin dryness or cracking. Allergic reactions are possible in the worst case.
Inhalation:	Inhalation of oil spray or vapors may cause lung damage.
Ingestion:	Ingestion may cause gastrointestinal irritation (e.g. diarrhea). May cause lung damage.

15.1.3.4 First aid measures

Contact with eyes:	Rinse eyes immediately with plenty of water for several minutes. If irritation occurs, consult a doctor.
Skin contact:	Wash affected areas of skin with soap and water, or use suitable cleaning agent. Change clothing and shoes if they become contaminated with product. Wash clothing before reuse. Clean shoes thoroughly before reuse. If irritation occurs consult a doctor.

Inhalation:	Take affected person into fresh air. Consult a doctor if symptoms persist.
Ingestion:	Rinse out mouth with water and drink plenty of water afterwards. Consult a doctor immediately. Symptomatic treatment. After ingestion, the stomach must be pumped out under medical supervision using a stomach tube.
Notes to physician:	Treatment should in general be symptomic and directed at relieving any effects. Note regarding high-pressure applications Injection into the skin due to contact with a product under high pressure constitutes a major medical emergency. Within a few hours the tissue swells up and becomes discolored and extremely painful, with severe subcutaneous necrosis. Surgical treatment is absolutely imperative. Comprehensive opening of the wound and the tissue beneath it is necessary in order to reduce tissue loss and to prevent or limit lasting damage. The high pressure can cause the product to penetrate extensive areas of tissue layers.

15.1.3.5 Fire-fighting measures

Suitable extinguishing agents:	In the event of a fire: use water spray (mist), foam, dry chemicals or CO2.
Unsuitable extinguishing agents:	**Do not** use water jets.
Special instructions for extinguishing work:	Contaminated extinguishing water must be collected separately and prevented from entering the drainage system.
Hazardous decomposition products:	Decomposition products include various oxides (e.g. carbon oxides).
Unusual fire/explosion hazards:	-
Special fire-fighting measures:	Use self-contained breathing apparatus. Wear full protective equipment.
Protection of fire-fighters:	Fire-fighters must wear self-contained positive pressure breathing apparatus (SCBA) and full protective gear.

15.1.3.6 Measures after unintended release

Personal safety precautions:	In case of spillage, isolate the hazard area. Avoid contact with the hazardous substance and avoid inhaling vapors. Ensure adequate ventilation. Where there is insufficient ventilation, wear suitable respiratory equipment. Use suitable protective equipment.
Environmental protection measures:	Prevent the product from entering the drainage system, surface waters and soil. Notify the competent authorities, if required.

Large spills:	Stop the leak if you can do so without risk. Remove container from spill area. Flush spilled material into a wastewater treatment plant. Contain spilled material using a non-combustible absorbent (e.g. sand, soil, vermiculite, diatomaceous earth) and collect in the containers provided. Disposal should be entrusted to a recognized waste disposal company. Contaminated absorbents can be just as dangerous.
Small spills:	Stop the leak if you can do so without risk. Remove container from spill area. Dilute with water and mop up, or add absorbent material and place the substance in a suitable container for disposal. Disposal should be entrusted to a recognized waste disposal company.

15.1.3.7 Handling and storage

Handling:	Prevent contact with skin or clothing. Spilled and leaked product must be prevented from coming into contact with soil and surface waters. Wash thoroughly after handling.
Storage:	Keep containers tightly sealed. Keep containers in a cool, well-ventilated area.
Unsuitable:	Avoid prolonged exposure to increased temperatures.

15.1.3.8 Exposure limits and personal protective equipment

Ingredient name:	**Exposure limits**
Aliphatic/aromatic hydrocarbon	STEL: 580 mg/m^3 (Spain - OEL - STEL) TWA: 290 mg/m^3 (Spain - OEL - TWA) Further information can be obtained from the supplier.
Barium sulfonate	STEL: 2 mg/m^3 (AUSTRIA - OEL - STEL) TWA: 0.5 mg/m^3 (AUSTRIA - OEL - TWA (MAK)) Further information can be obtained from the supplier.

Protective measures	
Limitation and monitoring of exposure in the workplace:	Provide exhaust ventilation or other engineering controls.
Hygiene measures:	Wash hands, forearms and face thoroughly after handling chemical products.
Respiratory protection:	With short-term or low-level exposure, use respiratory filter device; with prolonged or intensive exposure, use self-contained breathing apparatus.
Hand protection:	Wear chemical-resistant gloves (recommended: nitrile gloves) if prolonged or repeated contact is likely.
Eye protection:	Protective goggles with side shields to guard against splashing.
Skin and body:	Wear appropriate clothing to avoid prolonged skin contact.

15.1.3.9 Physical and chemical properties

Physical state:	Liquid
Color:	Dark brown (amber)
Odor:	Specific

Flash point:	62 °C
Melting point/range:	<4 °C
Boiling point/range:	185 °C
Density:	<1000 kg/m^3 (<1 g/cm^3) at 24 °C
Solubility:	Insoluble in water
Viscosity:	Kinematic: 20.9 mm^2/s at 20 °C

15.1.3.10 Stability and reactivity

Incompatible with various substances:	Reactive or incompatible with oxidizing materials.
Hazardous polymerization:	The product is stable. No hazardous polymerization occurs under normal conditions.
Hazardous decomposition products:	Decomposition products may include various oxides (e.g. carbon oxides). No hazardous decomposition products should be formed under normal conditions of storage and use.

15.1.3.11 Toxicological information

Effects on eyes:	May cause eye irritation.
Effects on skin:	May cause irritation.
Effect if inhaled:	Mildly toxic effect.
Effect if ingested:	Mildly toxic effect.
Sensitization:	No sensitizing effect known.
LD50 (oral/rat):	200 - 2000 mg/kg (calculated)

15.1.3.12 Ecological information

Ecotoxicity	
Hexadecylamine Ecotoxicity - Fish Species Data:	EC50 0.13 mg/L daphnia 48 hr EC50 0.062 mg/L algae 72 hr report based on similar material
Inhibition of micro-organism activity:	None known.
Effects on wastewater treatment plants:	None known.

15.1.3.13 Disposal information

Disposal information	
Disposal information / waste specifications:	Spilled and leaked product must be prevented from coming into contact with soil and surface waters. Observe local, regional and national regulations. Use only approved transporters, recyclers, treatment, storage or disposal facilities. If necessary, disposal should be entrusted to a recognized waste disposal company.

Unused product	
European Waste Catalog (EWC):	Waste code 12 01 07*: Used machining oils, halogen-free (no emulsions)

Used/contaminated product	
European Waste Catalog (EWC):	Waste code 12 01 07*: Used machining oils, halogen-free (no emulsions)

Use of the product for purposes other than those specified and/or impurities can necessitate the use of a different waste code number for the waste producer.

Hazardous waste
This product is listed as a hazardous substance by the EU Directive on hazardous waste. Dispose of in accordance with all national and local regulations and statutory provisions in force.

15.1.3.14 Transport information

Classification:	Not hazardous as defined by the transport regulations (ADR/RID, ADNR, IMDG, ICAO/IATA).

15.1.3.15 Regulations

EU regulations:	EC Directives 1999/45/EC and 67/548/EEC

Labeling requirements	
Hazard designation:	Xn - Harmful
Risk (R) phrases:	R20/22 - Harmful by inhalation and if swallowed. R66 - Repeated exposure may cause skin dryness or cracking.
Safety (S) phrases:	S21 - When using do not smoke. S41 - In case of fire and/or explosion do not breathe fumes.

List of relevant R phrases
R20/22 - Harmful by inhalation and if swallowed.
R22 - Harmful if swallowed.
R35 - Causes severe burns.
R41 - Risk of serious damage to eyes.
R65 - Harmful: may cause lung damage if swallowed.
R66 - Repeated exposure may cause skin dryness or cracking.

Miscellaneous provisions	
Classification acc. to the German Administrative Regulation on the Classification of Substances Hazardous to Water into Water Hazard Classes (VwVwS):	2 (S)

15.1.3.16 Other information

Notes for the reader
All information is based on our current state of knowledge and is intended only to describe our product with regard to the safety data. It is not intended to provide assurance of particular properties. The product may only be used for the scope of work specified above; any other use requires prior consultation with KUKA. Using the product for any purpose other than for its designated use could lead to risks which are not described in this document. Further information on the use of the product may be found in the relevant technical specifications.

16 KUKA Service

16.1 Requesting support

Introduction

The KUKA Roboter GmbH documentation offers information on operation and provides assistance with troubleshooting. For further assistance, please contact your local KUKA subsidiary.

Faults leading to production downtime should be reported to the local KUKA subsidiary within one hour of their occurrence.

Information

The following information is required for processing a support request:

- Model and serial number of the robot
- Model and serial number of the controller
- Model and serial number of the linear unit (if applicable)
- Version of the KUKA System Software
- Optional software or modifications
- Archive of the software
- Application used
- Any external axes used
- Description of the problem, duration and frequency of the fault

16.2 KUKA Customer Support

Availability

KUKA Customer Support is available in many countries. Please do not hesitate to contact us if you have any questions.

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