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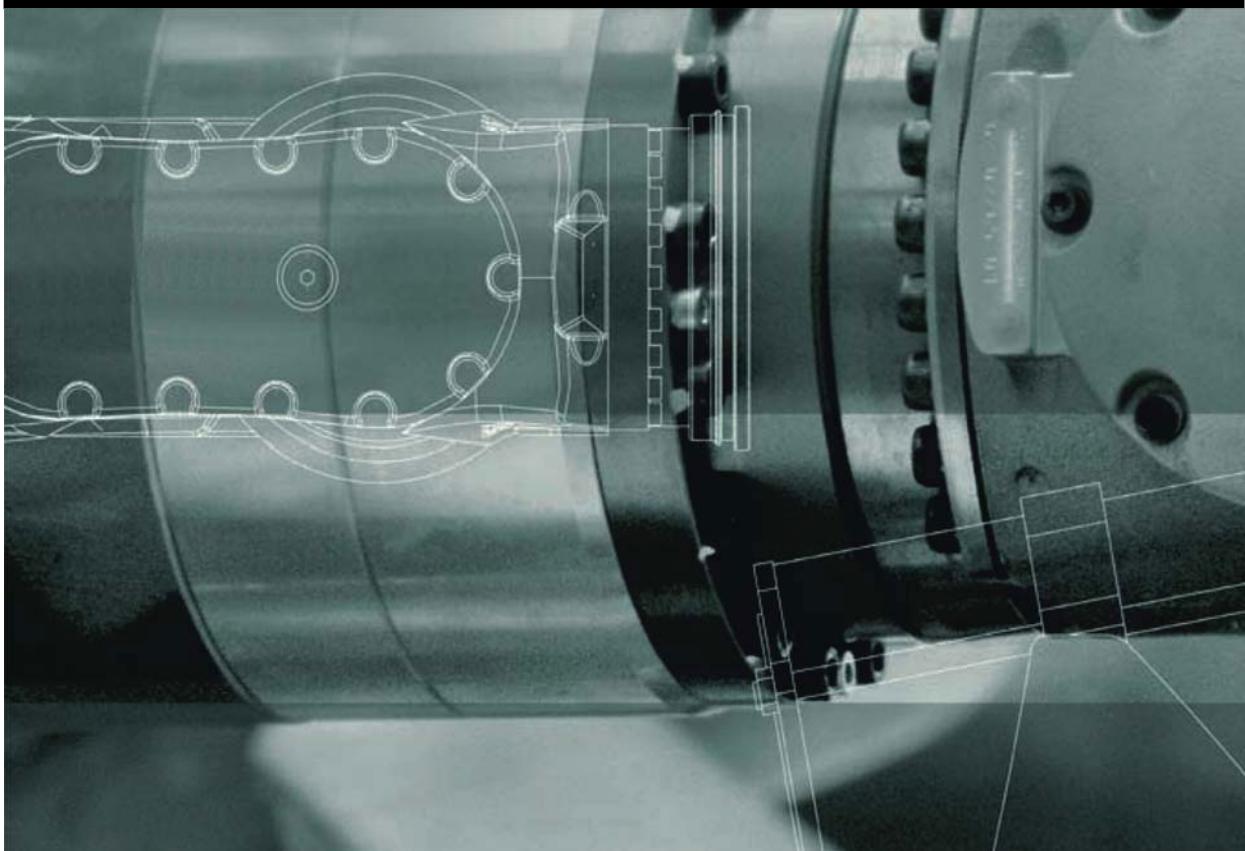
Robots

KUKA Deutschland GmbH

KR QUANTEC prime

With F, C and CR Variants

Operating Instructions



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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.

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1 Introduction

1.1 Industrial robot documentation

The industrial robot documentation consists of the following parts:

- Documentation for the manipulator
- Documentation for the robot controller
- Operating and programming instructions for the System Software
- Instructions for 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

These warnings are relevant to safety and **must** be observed.



DANGER These warnings mean that it is certain or highly probable that death or severe injuries **will** occur, if no precautions are taken.



WARNING These warnings mean that death or severe injuries **may** occur, if no precautions are taken.



CAUTION These warnings mean that minor injuries **may** occur, if no precautions are taken.



NOTICE These warnings mean that damage to property **may** occur, if no precautions are taken.



These warnings contain references to safety-relevant information or general safety measures.

These warnings do not refer to individual hazards or individual precautionary measures.

This warning draws attention to procedures which serve to prevent or remedy emergencies or malfunctions:



SAFETY INSTRUCTIONS The following procedure must be followed exactly!

Procedures marked with this warning **must** be followed exactly.

Notices

These notices serve to make your work easier or contain references to further information.



Tip to make your work easier or reference 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 industrial robot is intended for handling tools and fixtures or for processing and transferring components or products. Use is only permitted under the specified environmental conditions.

Misuse

Any use or application deviating from the intended use is deemed to be misuse and is not allowed. This includes e.g.:

- Use as a climbing aid
- Operation outside the specified operating parameters
- Operation without the required safety equipment

NOTICE

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

NOTICE

Deviations from the operating conditions specified in the technical data or the use of special functions or applications can lead to premature wear. KUKA Deutschland GmbH must be consulted.



The robot system is an integral part of a complete system and may only be operated in a CE-compliant system.

3 Product description

3.1 Overview of the robot system

A robot system ([>>> Fig. 3-1](#)) comprises all the assemblies of an industrial robot, including the manipulator (mechanical system and electrical installations), control cabinet, connecting cables, end effector (tool) and other equipment. The KR QUANTEC prime product family comprises the types:

- KR 240 R2500 prime
- KR 240 R2700 prime
- KR 210 R2700 prime
- KR 180 R2900 prime
- KR 150 R3100 prime

The robots of type KR 210 R2700 prime are available as F variants (foundry), C variants (ceiling-mounted) and CR variants (cleanroom, floor-mounted). F and CR robots have additional corrosion prevention measures in the form of stainless steel components and screws.

An industrial robot of this type comprises the following components:

- Manipulator
- Robot controller
- Connecting cables
- KCP teach pendant (KUKA smartPAD)
- Software
- Options, accessories

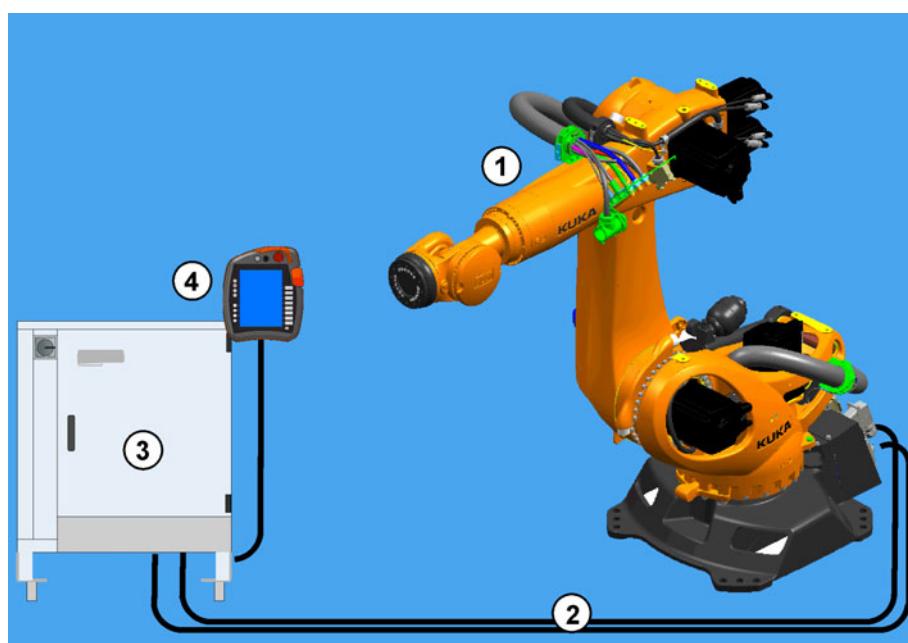


Fig. 3-1: Example of a robot system

- | | |
|---------------------|--------------------|
| 1 Manipulator | 3 Robot controller |
| 2 Connecting cables | 4 Control panel |

3.2 Description of the manipulator

Overview

The manipulators (robot = robot arm and electrical installations) ([>>> Fig. 3-2](#)) of the “prime” variants are designed as 6-axis jointed-arm kinematic systems. They consist of the following principal components:

- In-line wrist
- Arm
- Link arm
- Rotating column
- Base frame
- Counterbalancing system
- Electrical installations

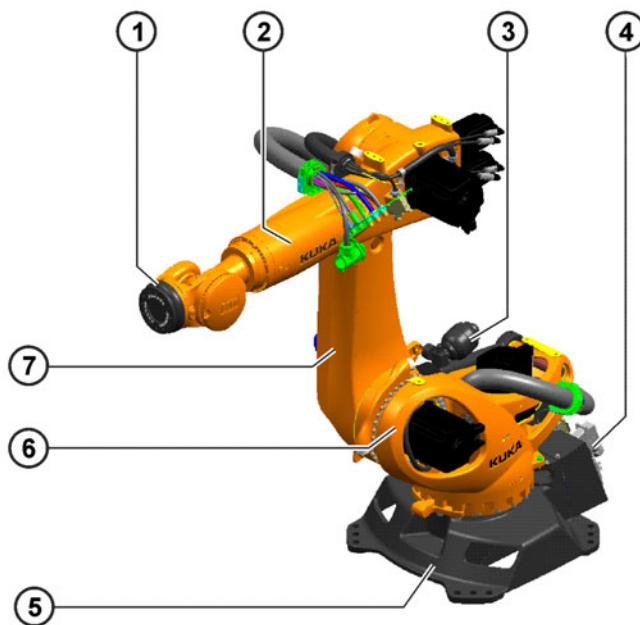


Fig. 3-2: Main assemblies of the manipulator

1	In-line wrist	5	Base frame
2	Arm	6	Rotating column
3	Counterbalancing system	7	Link arm
4	Electrical installations		

In-line wrist

The robot is fitted with a 3-axis in-line wrist. The in-line wrist contains axes 4, 5 and 6. The motor of axis 6 is located directly on the wrist, inside the arm. It drives the wrist directly, while for axes 4 and 5 the drive comes from the rear of the arm via connecting shafts. For attaching end effectors (tools), the in-line wrist has a mounting flange. For the payload categories 240 kg and 210 kg, a mounting flange with a 160 mm hole circle is used, and for the payload categories 150 kg, 180 kg and 210 kg, a mounting flange with a 125 mm hole circle is used. Both mounting flanges conform, with minimal deviations, to DIN/ISO 9409-1-A.

Additional measures have been taken to enable in-line wrists of the F variants to meet higher specifications in terms of resistance to temperature, dust and corrosion. F variant in-line wrists meet the requirements of IP67.

Arm

The arm is the link between the in-line wrist and the link arm. It houses the motors of wrist axes 4 and 5. The arm is driven by the motor of axis 3. The maximum permissible swivel angle is mechanically limited by a stop for each

direction, plus and minus. The associated buffers are attached to the arm. There is an interface on the arm with 4 holes for fastening supplementary loads. In combination with the link arm, there are three arm variants available to obtain the specified reach.

The arms of the F variants are pressurized to prevent penetration of moisture and dust. The required compressed air is supplied via a hose in the cable harness. The pressure regulator for this is installed in the push-in module for the electrical installations.

Link arm

The link arm is the assembly located between the arm and the rotating column. It consists of the link arm body with the buffers for axis 2. In combination with the arm, there are two link arm variants available to obtain the specified reach. There is an interface on the link arm with 4 holes for fastening supplementary loads.

Rotating column

The rotating column houses the motors of axes 1 and 2. The rotational motion of axis 1 is performed by the rotating column. This is screwed to the base frame via the gear unit of axis 1 and is driven by a motor in the rotating column. The link arm is also mounted in the rotating column.

CR-variant robots are equipped with a cover on A1 to ensure higher protection from the emission of particles.

Base frame

The base frame is the base of the robot. It is screwed to the mounting base. The flexible tube for the electrical installations is fastened in the base frame. Also located on the base frame is the interface for the motor and control cable and the energy supply system.

Counterbalancing system

The counterbalancing system is installed between the rotating column and the link arm and serves to minimize the moments generated about axis 2 when the robot is in motion and at rest. A closed, hydropneumatic system is used. The system consists of two accumulators, a hydraulic cylinder with associated hoses, a pressure gauge and a bursting disc as a safety element to protect against overload. The accumulators are classified below category I, fluid group 2, of the Pressure Equipment Directive.

Different variants of the counterbalancing system are used for floor and ceiling-mounted robots and for the F variants. For the CR variant, the specially protected counterbalancing system of the F variant is used.

The mode of operation is reversed for ceiling-mounted robots, i.e. the piston rod pushes against the link arm.

Electrical installations

The electrical installations include all the motor and control cables for the motors of axes 1 to 6. All connections are implemented as connectors in order to enable the motors to be exchanged quickly and reliably. The electrical installations also include the RDC box and the multi-function housing (MFH). The RDC box is located in the rotating column. The MFH and the connector for the control cables are mounted on the robot base frame. The connecting cables from the robot controller are connected here by means of connectors. The electrical installations also include a protective circuit.

Options

The robot can be fitted and operated with various options, such as energy supply systems for axes 1 to 3, energy supply systems for axes 3 to 6, range limitation systems for A1 and A3, a mounting flange (adapter) or a control cable for single axis ([>>> 13 "Options" Page 233](#)). The options are described in separate documentation.

4 Technical data

4.1 Technical data, overview

The technical data for the individual robot types can be found in the following sections:

Robot	Technical data
KR 240 R2700 prime	<ul style="list-style-type: none"> ■ Technical data (>>> 4.2 "Technical data, KR 240 R2700 prime" Page 19) ■ Supplementary loads (>>> 4.11 "Supplementary load" Page 82) ■ Plates and labels (>>> 4.12 "Plates and labels" Page 83) ■ Stopping distances and times (>>> 4.14.4 "Stopping distances and times, KR 240 R2700 prime" Page 94)
KR 240 R2500 prime	<ul style="list-style-type: none"> ■ Technical data (>>> 4.3 "Technical data, KR 240 R2500 prime" Page 26) ■ Supplementary loads (>>> 4.11 "Supplementary load" Page 82) ■ Plates and labels (>>> 4.12 "Plates and labels" Page 83) ■ Stopping distances and times (>>> 4.14.3 "Stopping distances and stopping times for KR 240 R2500 prime" Page 89)
KR 210 R2700 prime	<ul style="list-style-type: none"> ■ Technical data (>>> 4.4 "Technical data, KR 210 R2700 prime" Page 33) ■ Supplementary loads (>>> 4.11 "Supplementary load" Page 82) ■ Plates and labels (>>> 4.12 "Plates and labels" Page 83) ■ Stopping distances and times (>>> 4.14.5 "Stopping distances and stopping times for KR 210 R2700 prime" Page 99)
KR 210 R2700 prime F	<ul style="list-style-type: none"> ■ Technical data (>>> 4.5 "Technical data, KR 210 R2700 prime F" Page 40) ■ Supplementary loads (>>> 4.11 "Supplementary load" Page 82) ■ Plates and labels (>>> 4.12 "Plates and labels" Page 83) ■ Stopping distances and times (>>> 4.14.5 "Stopping distances and stopping times for KR 210 R2700 prime" Page 99)

Robot	Technical data
KR 210 R2700 prime CR	<ul style="list-style-type: none"> ■ Technical data (>>> 4.6 "Technical data, KR 210 R2700 prime CR" Page 47) ■ Supplementary loads (>>> 4.11 "Supplementary load" Page 82) ■ Plates and labels (>>> 4.12 "Plates and labels" Page 83) ■ Stopping distances and times (>>> 4.14.5 "Stopping distances and stopping times for KR 210 R2700 prime" Page 99)
KR 210 R2700 prime C	<ul style="list-style-type: none"> ■ Technical data (>>> 4.7 "Technical data, KR 210 R2700 prime C" Page 54) ■ Supplementary loads (>>> 4.11 "Supplementary load" Page 82) ■ Plates and labels (>>> 4.12 "Plates and labels" Page 83) ■ Stopping distances and times (>>> 4.14.6 "Stopping distances and times, KR 210 R2700 prime C" Page 104)
KR 210 R2700 prime C-F	<ul style="list-style-type: none"> ■ Technical data (>>> 4.8 "Technical data, KR 210 R2700 prime C-F" Page 61) ■ Supplementary loads (>>> 4.11 "Supplementary load" Page 82) ■ Plates and labels (>>> 4.12 "Plates and labels" Page 83) ■ Stopping distances and times (>>> 4.14.6 "Stopping distances and times, KR 210 R2700 prime C" Page 104)
KR 180 R2900 prime	<ul style="list-style-type: none"> ■ Technical data (>>> 4.9 "Technical data, KR 180 R2900 prime" Page 68) ■ Supplementary loads (>>> 4.11 "Supplementary load" Page 82) ■ Plates and labels (>>> 4.12 "Plates and labels" Page 83) ■ Stopping distances and times (>>> 4.14.7 "Stopping distances and stopping times for KR 180 R2900 prime" Page 109)
KR 150 R3100 prime	<ul style="list-style-type: none"> ■ Technical data (>>> 4.10 "Technical data, KR 150 R3100 prime" Page 75) ■ Supplementary loads (>>> 4.11 "Supplementary load" Page 82) ■ Plates and labels (>>> 4.12 "Plates and labels" Page 83) ■ Stopping distances and times (>>> 4.14.8 "Stopping distances and stopping times for KR 150 R3100 prime" Page 114)

4.2 Technical data, KR 240 R2700 prime

4.2.1 Basic data, KR 240 R2700 prime

Basic data

		KR 240 R2700 prime
Number of axes		6
Number of controlled axes		6
Volume of working envelope		55 m ³
Pose repeatability (ISO 9283)		± 0.06 mm
Weight		approx. 1111 kg
Rated payload		240 kg
Maximum reach		2696 mm
Protection rating (IEC 60529)		IP65
Protection rating, in-line wrist (IEC 60529)		IP65
Sound level		< 75 dB (A)
Mounting position		Floor
Footprint		830 mm x 830 mm
Hole pattern: mounting surface for kinematic system		S934
Permissible angle of inclination		≤ 5 °
Default color		Base frame: black (RAL 9005); Moving parts: KUKA orange 2567
Controller		KR C4
Transformation name		KR C4: KR240R2700 PRIME C4 FLR

Hollow shaft diameter	
A1	139 mm (partially occupied by motor cables)

Ambient conditions

Humidity class (EN 60204)	-
Classification of environmental conditions (EN 60721-3-3)	3K3
Ambient temperature	
During operation	10 °C to 55 °C (283 K to 328 K)
During storage/transportation	-40 °C to 60 °C (233 K to 333 K)



For operation at low temperatures, it may be necessary to warm up the robot.

Connecting cables

Cable designation	Connector designation robot controller - ro- bot	Interface with robot
Motor cable	X20 - X30	Harting connectors at both ends

Cable designation	Connector designation robot controller - robot	Interface with robot
Data cable	X21 - X31	Rectangular connector at both ends
Ground conductor / equipotential bonding 16 mm ² (can be ordered as an option)		M8 ring cable lug at both ends
Cable lengths		
Standard		7 m, 15 m, 25 m, 35 m, 50 m
Minimum bending radius		5x D

For detailed specifications of the connecting cables, see "Description of the connecting cables".

4.2.2 Axis data, KR 240 R2700 prime

Axis data

Motion range	
A1	±185 °
A2	-140 ° / -5 °
A3	-120 ° / 155 °
A4	±350 °
A5	±122.5 °
A6	±350 °
Speed with rated payload	
A1	105 °/s
A2	107 °/s
A3	107 °/s
A4	136 °/s
A5	129 °/s
A6	206 °/s

The direction of motion and the arrangement of the individual axes may be noted from the diagram ([>>>](#) Fig. 4-1).

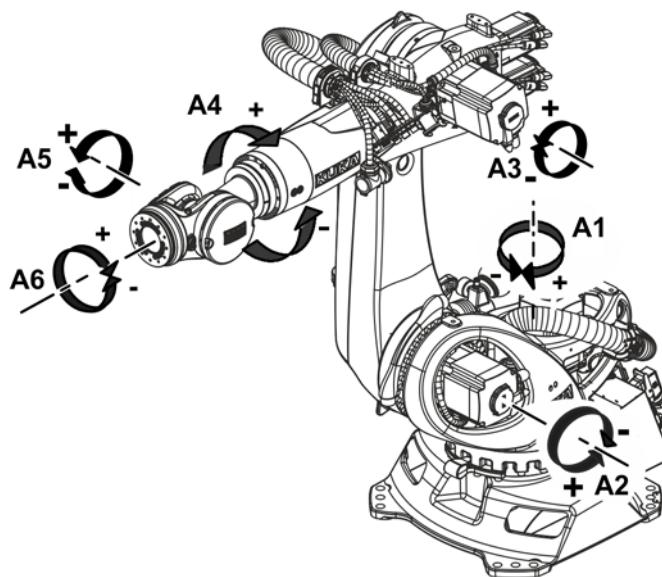


Fig. 4-1: Direction of rotation of the axes

Mastering position

Mastering position	
A1	-20 °
A2	-120 °
A3	110 °
A4	0 °
A5	0 °
A6	0 °

Working envelope

The following diagrams ([Fig. 4-2](#)) and ([Fig. 4-3](#)) show the load center of gravity, shape and size of the working envelope.

The reference point for the working envelope is the intersection of axis 4 with axis 5.

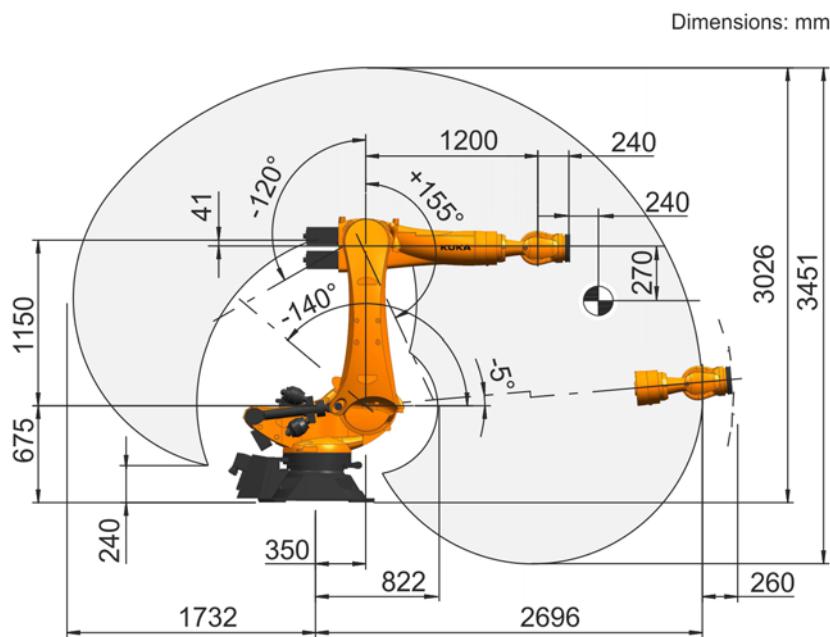


Fig. 4-2: KR 240 R2700 prime, working envelope, side view

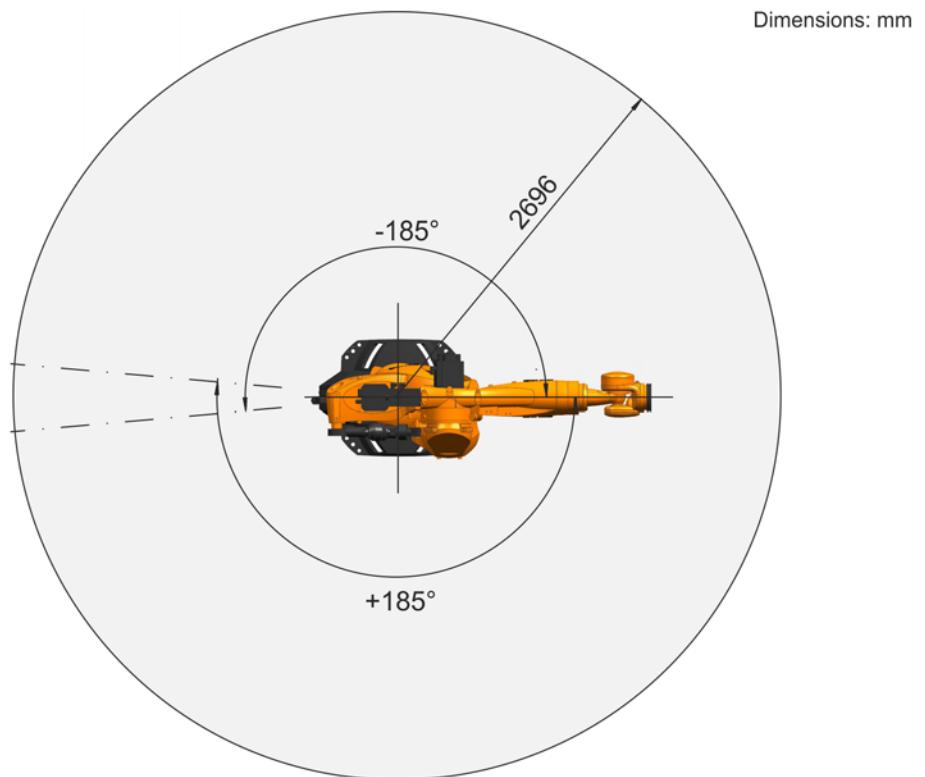


Fig. 4-3: KR 240 R2700 prime, working envelope, top view

4.2.3 Payloads, KR 240 R2700 prime

Payloads

Rated payload	240 kg
Rated mass moment of inertia	120 kgm ²
Rated total load	290 kg
Rated supplementary load, base frame	0 kg
Maximum supplementary load, base frame	-
Rated supplementary load, rotating column	0 kg
Maximum supplementary load, rotating column	300 kg
Rated supplementary load, link arm	0 kg
Maximum supplementary load, link arm	130 kg
Rated supplementary load, arm	50 kg
Maximum supplementary load, arm	150 kg
Nominal distance to load center of gravity	
L _{xy}	270 mm
L _z	240 mm

NOTICE

Exceeding the payloads and supplementary loads will reduce the service life of the robot and overload the motors and the gears. We recommend always testing the specific application with KUKA.Load. In cases where individual values are exceeded, KUKA Deutschland GmbH must be consulted.

Load center of gravity

For all payloads, the load center of gravity refers to the distance from the face of the mounting flange on axis 6. Refer to the payload diagram for the nominal distance.

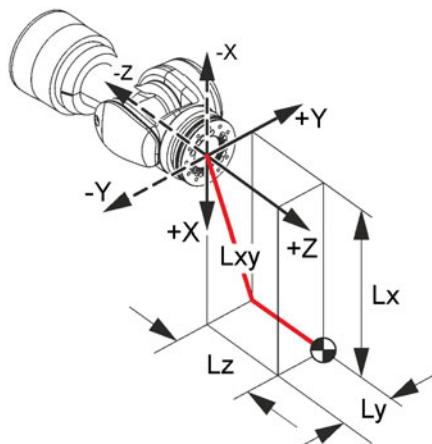


Fig. 4-4: Load center of gravity

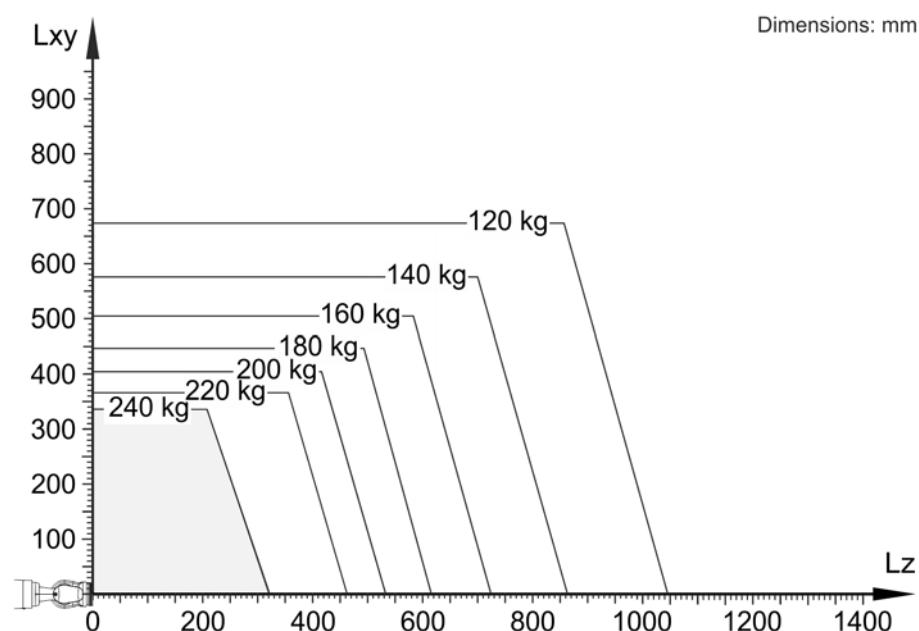
Payload diagram

Fig. 4-5: KR QUANTEC prime payload diagram, payload 240 kg

NOTICE

This loading curve corresponds to the maximum load capacity. Both values (payload and mass moment of inertia) must be checked in all cases. Exceeding this capacity will reduce the service life of the robot and overload the motors and the gears; in any such case KUKA Deutschland GmbH must be consulted beforehand. The values determined here are necessary for planning the robot application. For commissioning the robot, additional input data are required in accordance with the operating and programming instructions of the KUKA System Software. The mass inertia must be verified using KUKA.Load. It is imperative for the load data to be entered in the robot controller!

In-line wrist

In-line wrist type	ZH 210/240
Mounting flange	see drawing

Mounting flange

Screw grade	10.9
Screw size	M10
Number of fastening screws	11
Clamping length	1.5 x nominal diameter
Depth of engagement	min. 12 mm, max. 16 mm
Locating element	10 H7

The mounting flange is depicted with axis 6 in the zero position ([>>> Fig. 4-6](#)) The symbol X_m indicates the position of the locating element (bushing) in the zero position.

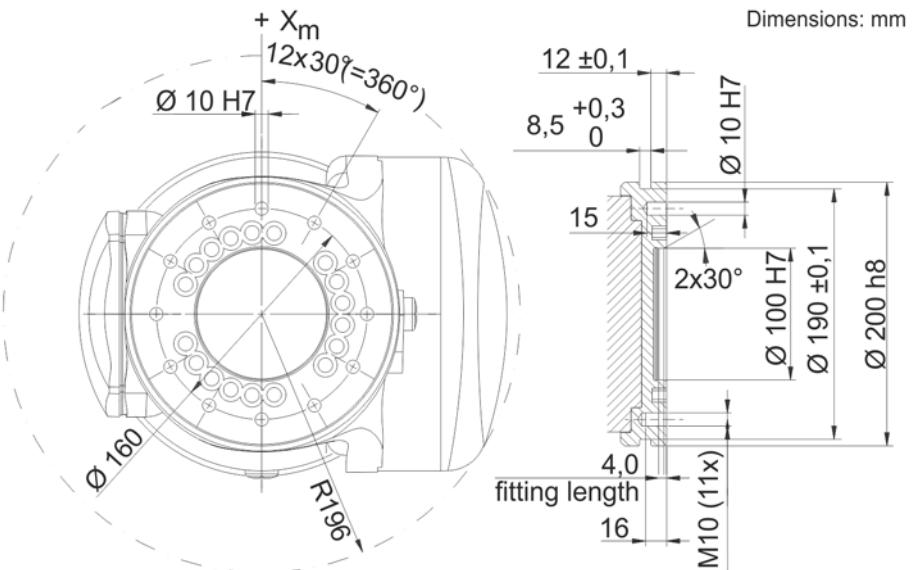


Fig. 4-6: Mounting flange D=160

4.2.4 Loads acting on the foundation, KR 240 R2700 prime

Foundation loads

The specified forces and moments already include the payload and the inertia force (weight) of the robot.

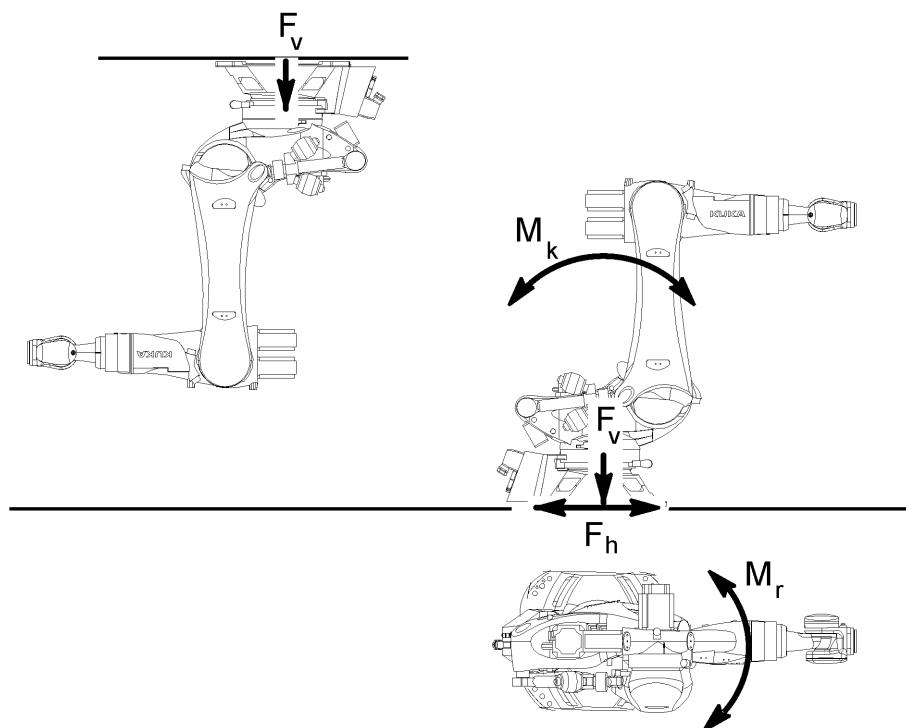


Fig. 4-7: Loads acting on the mounting base

Vertical force $F(v)$	
$F(v \text{ normal})$	19100 N
$F(v \text{ max})$	24000 N
Horizontal force $F(h)$	
$F(h \text{ normal})$	9200 N
$F(h \text{ max})$	16000 N
Tilting moment $M(k)$	
$M(k \text{ normal})$	24000 Nm
$M(k \text{ max})$	49000 Nm
Torque about axis 1 $M(r)$	
$M(r \text{ normal})$	10200 Nm
$M(r \text{ max})$	35000 Nm

Vertical force $F(v)$, horizontal force $F(h)$, tilting torque $M(k)$, torque about axis 1 $M(r)$

⚠ WARNING

Normal loads and maximum loads for the foundations are specified in the table.

The maximum loads must be referred to when dimensioning the foundations and must be adhered to for safety reasons. Failure to observe this can result in personal injury and damage to property.

The normal loads are average expected foundation loads. The actual loads are dependent on the program and on the robot loads and may therefore be greater or less than the normal loads.

The supplementary loads (A1, A2 and A3) are not taken into consideration in the calculation of the foundation load. These supplementary loads must be taken into consideration for F_v .

4.3 Technical data, KR 240 R2500 prime

4.3.1 Basic data, KR 240 R2500 prime

Basic data

	KR 240 R2500 prime
Number of axes	6
Number of controlled axes	6
Volume of working envelope	41 m ³
Pose repeatability (ISO 9283)	± 0.06 mm
Weight	approx. 1102 kg
Rated payload	240 kg
Maximum reach	2496 mm
Protection rating (IEC 60529)	IP65
Protection rating, in-line wrist (IEC 60529)	IP65
Sound level	< 75 dB (A)
Mounting position	Floor
Footprint	830 mm x 830 mm
Hole pattern: mounting surface for kinematic system	S934
Permissible angle of inclination	≤ 5 °
Default color	Base frame: black (RAL 9005); Moving parts: KUKA orange 2567
Controller	KR C4
Transformation name	KR C4: KR240R2500 PRIME C4 FLR

Hollow shaft diameter	
A1	139 mm (partially occupied by motor cables)

Ambient conditions

Humidity class (EN 60204)	-
Classification of environmental conditions (EN 60721-3-3)	3K3
Ambient temperature	
During operation	10 °C to 55 °C (283 K to 328 K)
During storage/transportation	-40 °C to 60 °C (233 K to 333 K)



For operation at low temperatures, it may be necessary to warm up the robot.

Connecting cables

Cable designation	Connector designation robot controller - robot	Interface with robot
Motor cable	X20 - X30	Harting connectors at both ends

Cable designation	Connector designation robot controller - robot	Interface with robot
Data cable	X21 - X31	Rectangular connector at both ends
Ground conductor / equipotential bonding 16 mm ² (can be ordered as an option)		M8 ring cable lug at both ends
Cable lengths		
Standard		7 m, 15 m, 25 m, 35 m, 50 m
Minimum bending radius		5x D

For detailed specifications of the connecting cables, see "Description of the connecting cables".

4.3.2 Axis data, KR 240 R2500 prime

Axis data

Motion range	
A1	±185 °
A2	-140 ° / -5 °
A3	-120 ° / 155 °
A4	±350 °
A5	±122.5 °
A6	±350 °
Speed with rated payload	
A1	105 °/s
A2	107 °/s
A3	114 °/s
A4	136 °/s
A5	129 °/s
A6	206 °/s

The direction of motion and the arrangement of the individual axes may be noted from the diagram ([>>>](#) Fig. 4-8).

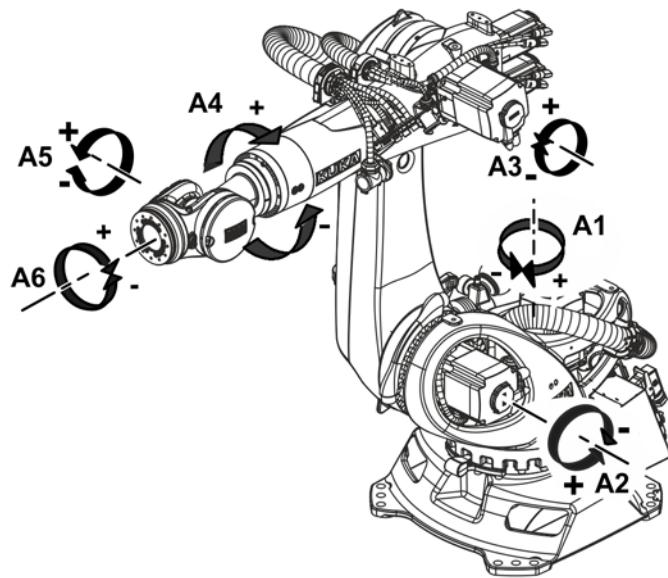


Fig. 4-8: Direction of rotation of the axes

Mastering position

Mastering position	
A1	-20 °
A2	-120 °
A3	110 °
A4	0 °
A5	0 °
A6	0 °

Working envelope

The following diagrams ([>>> Fig. 4-9](#)) and ([>>> Fig. 4-10](#)) show the load center of gravity, shape and size of the working envelope.

The reference point for the working envelope is the intersection of axis 4 with axis 5.

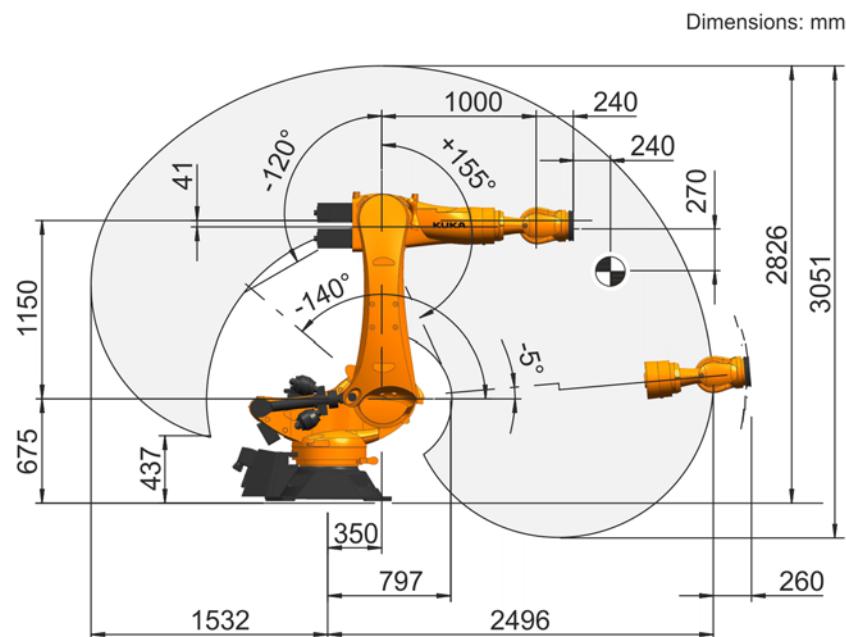


Fig. 4-9: KR 240 R2500 prime, working envelope, side view

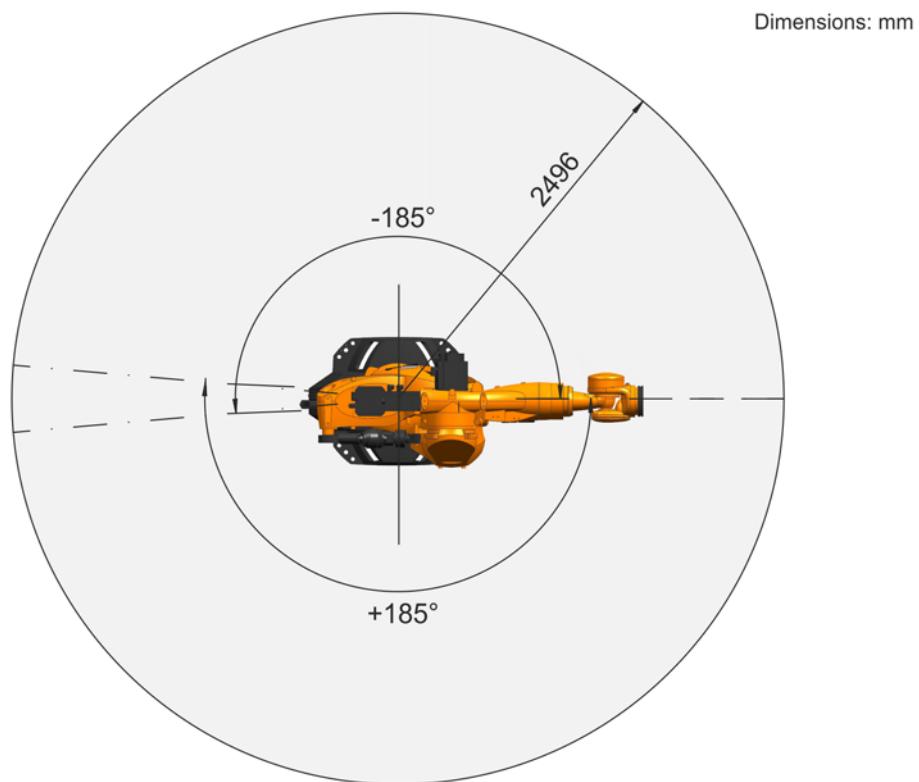


Fig. 4-10: KR 240 R2500 prime, working envelope, top view

4.3.3 Payloads, KR 240 R2500 prime

Payloads

Rated payload	240 kg
Rated mass moment of inertia	120 kgm ²
Rated total load	290 kg
Rated supplementary load, base frame	0 kg
Maximum supplementary load, base frame	-
Rated supplementary load, rotating column	0 kg
Maximum supplementary load, rotating column	300 kg
Rated supplementary load, link arm	0 kg
Maximum supplementary load, link arm	130 kg
Rated supplementary load, arm	50 kg
Maximum supplementary load, arm	150 kg
Nominal distance to load center of gravity	
L _{xy}	270 mm
L _z	240 mm

NOTICE

Exceeding the payloads and supplementary loads will reduce the service life of the robot and overload the motors and the gears. We recommend always testing the specific application with KUKA.Load. In cases where individual values are exceeded, KUKA Deutschland GmbH must be consulted.

Load center of gravity

For all payloads, the load center of gravity refers to the distance from the face of the mounting flange on axis 6. Refer to the payload diagram for the nominal distance.

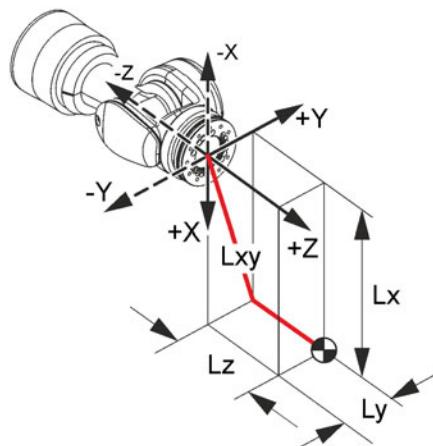


Fig. 4-11: Load center of gravity

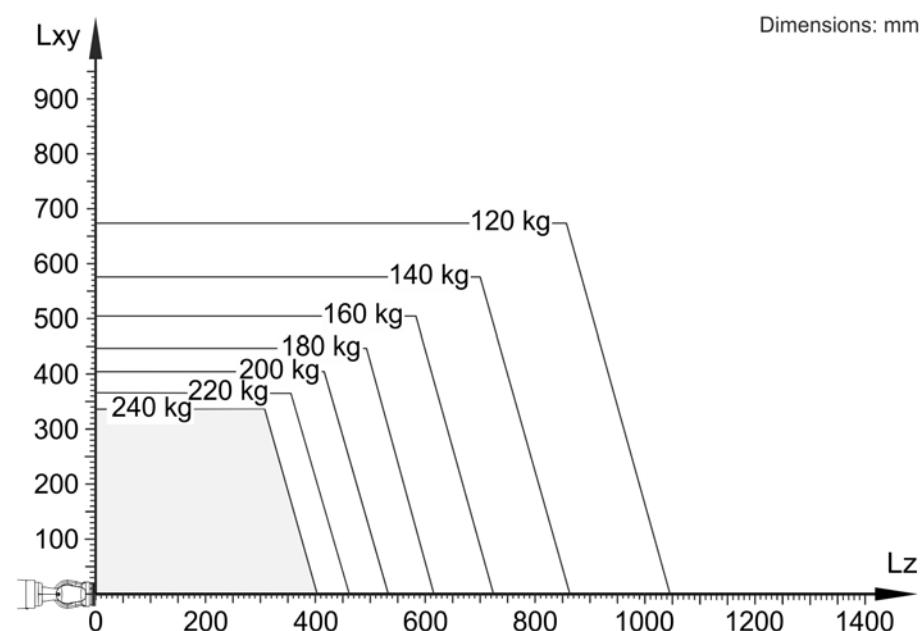
Payload diagram


Fig. 4-12: KR QUANTEC prime payload diagram, payload 240 kg

NOTICE

This loading curve corresponds to the maximum load capacity. Both values (payload and mass moment of inertia) must be checked in all cases. Exceeding this capacity will reduce the service life of the robot and overload the motors and the gears; in any such case KUKA Deutschland GmbH must be consulted beforehand. The values determined here are necessary for planning the robot application. For commissioning the robot, additional input data are required in accordance with the operating and programming instructions of the KUKA System Software. The mass inertia must be verified using KUKA.Load. It is imperative for the load data to be entered in the robot controller!

In-line wrist

In-line wrist type	ZH 210/240
Mounting flange	see drawing

Mounting flange

Screw grade	10.9
Screw size	M10
Number of fastening screws	11
Clamping length	1.5 x nominal diameter
Depth of engagement	min. 12 mm, max. 16 mm
Locating element	10 H7

The mounting flange is depicted with axis 6 in the zero position ([>>> Fig. 4-13](#)) The symbol X_m indicates the position of the locating element (bushing) in the zero position.

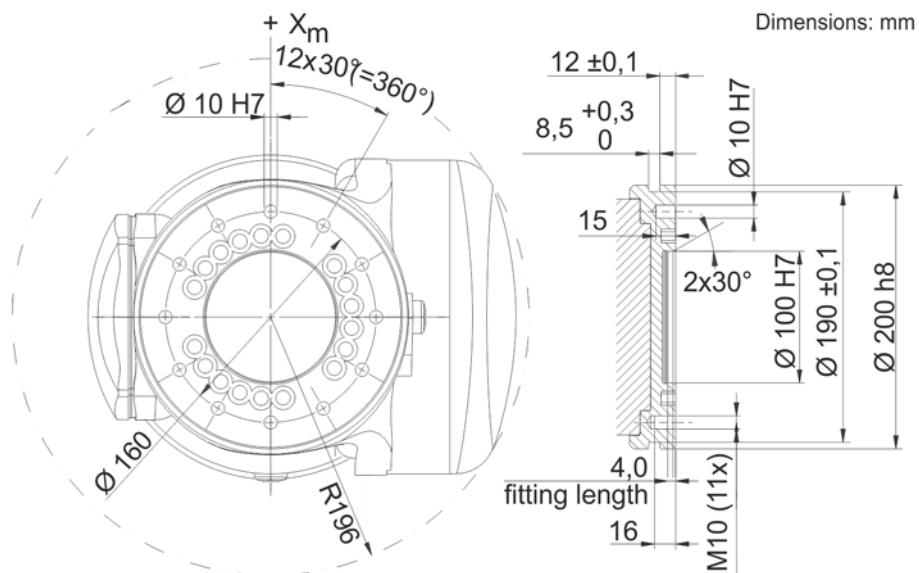


Fig. 4-13: Mounting flange D=160

4.3.4 Loads acting on the foundation, KR 240 R2500 prime

Foundation loads The specified forces and moments already include the payload and the inertia force (weight) of the robot.

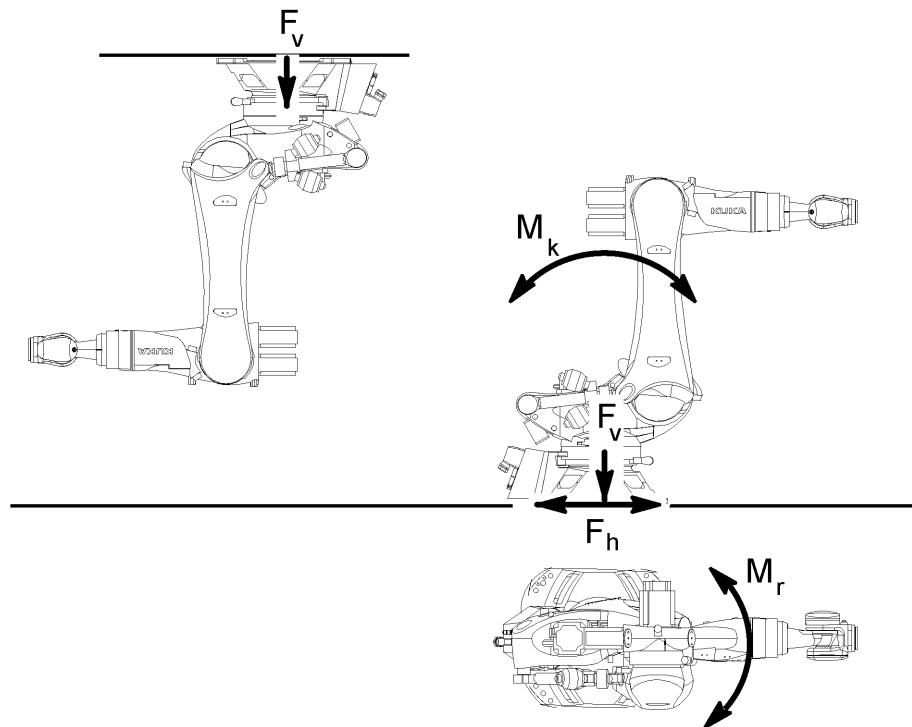


Fig. 4-14: Loads acting on the mounting base

Vertical force $F(v)$	
$F(v \text{ normal})$	19100 N
$F(v \text{ max})$	24000 N
Horizontal force $F(h)$	
$F(h \text{ normal})$	9200 N
$F(h \text{ max})$	16000 N
Tilting moment $M(k)$	
$M(k \text{ normal})$	24000 Nm
$M(k \text{ max})$	49000 Nm
Torque about axis 1 $M(r)$	
$M(r \text{ normal})$	10200 Nm
$M(r \text{ max})$	35000 Nm

Vertical force $F(v)$, horizontal force $F(h)$, tilting torque $M(k)$, torque about axis 1 $M(r)$

⚠ WARNING

Normal loads and maximum loads for the foundations are specified in the table.

The maximum loads must be referred to when dimensioning the foundations and must be adhered to for safety reasons. Failure to observe this can result in personal injury and damage to property.

The normal loads are average expected foundation loads. The actual loads are dependent on the program and on the robot loads and may therefore be greater or less than the normal loads.

The supplementary loads (A1, A2 and A3) are not taken into consideration in the calculation of the foundation load. These supplementary loads must be taken into consideration for F_v .

4.4 Technical data, KR 210 R2700 prime

4.4.1 Basic data, KR 210 R2700 prime

Basic data

		KR 210 R2700 prime
Number of axes	6	
Number of controlled axes	6	
Volume of working envelope	55 m ³	
Pose repeatability (ISO 9283)	± 0.06 mm	
Weight	approx. 1111 kg	
Rated payload	210 kg	
Maximum reach	2696 mm	
Protection rating (IEC 60529)	IP65	
Protection rating, in-line wrist (IEC 60529)	IP65	
Sound level	< 75 dB (A)	
Mounting position	Floor	
Footprint	830 mm x 830 mm	
Hole pattern: mounting surface for kinematic system	S934	
Permissible angle of inclination	≤ 5 °	
Default color	Base frame: black (RAL 9005); Moving parts: KUKA orange 2567	
Controller	KR C4	
Transformation name	KR C4: KR210R2700 PRIME C4 FLR	

Hollow shaft diameter	
A1	139 mm (partially occupied by motor cables)

Ambient conditions

Humidity class (EN 60204)	-
Classification of environmental conditions (EN 60721-3-3)	3K3
Ambient temperature	
During operation	10 °C to 55 °C (283 K to 328 K)
During storage/transportation	-40 °C to 60 °C (233 K to 333 K)



For operation at low temperatures, it may be necessary to warm up the robot.

Connecting cables

Cable designation	Connector designation robot controller - ro- bot	Interface with robot
Motor cable	X20 - X30	Harting connectors at both ends

Cable designation	Connector designation robot controller - robot	Interface with robot
Data cable	X21 - X31	Rectangular connector at both ends
Ground conductor / equipotential bonding 16 mm ² (can be ordered as an option)		M8 ring cable lug at both ends
Cable lengths		
Standard		7 m, 15 m, 25 m, 35 m, 50 m
Minimum bending radius		5x D

For detailed specifications of the connecting cables, see "Description of the connecting cables".

4.4.2 Axis data, KR 210 R2700 prime

Axis data

Motion range	
A1	±185 °
A2	-140 ° / -5 °
A3	-120 ° / 155 °
A4	±350 °
A5	±122.5 °
A6	±350 °
Speed with rated payload	
A1	105 °/s
A2	107 °/s
A3	114 °/s
A4	136 °/s
A5	129 °/s
A6	206 °/s

The direction of motion and the arrangement of the individual axes may be noted from the diagram ([>>> Fig. 4-15](#)).

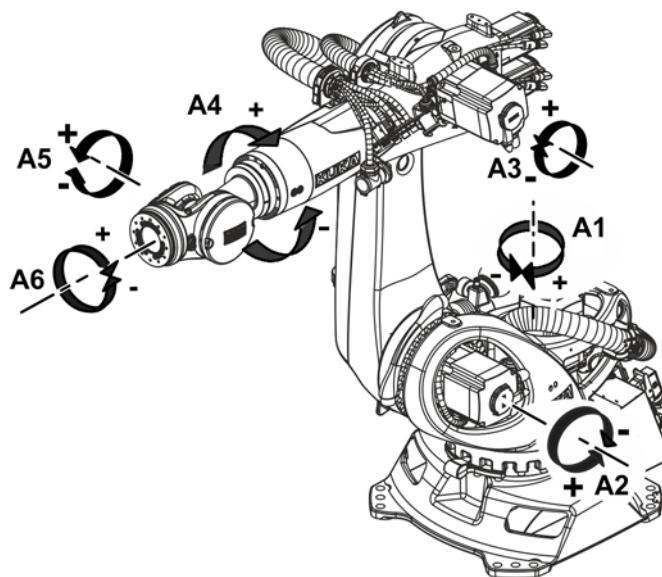


Fig. 4-15: Direction of rotation of the axes

Mastering position

Mastering position	
A1	-20 °
A2	-120 °
A3	110 °
A4	0 °
A5	0 °
A6	0 °

Working envelope

The following diagrams ([>>> Fig. 4-16](#)) and ([>>> Fig. 4-17](#)) show the load center of gravity, shape and size of the working envelope.

The reference point for the working envelope is the intersection of axis 4 with axis 5.

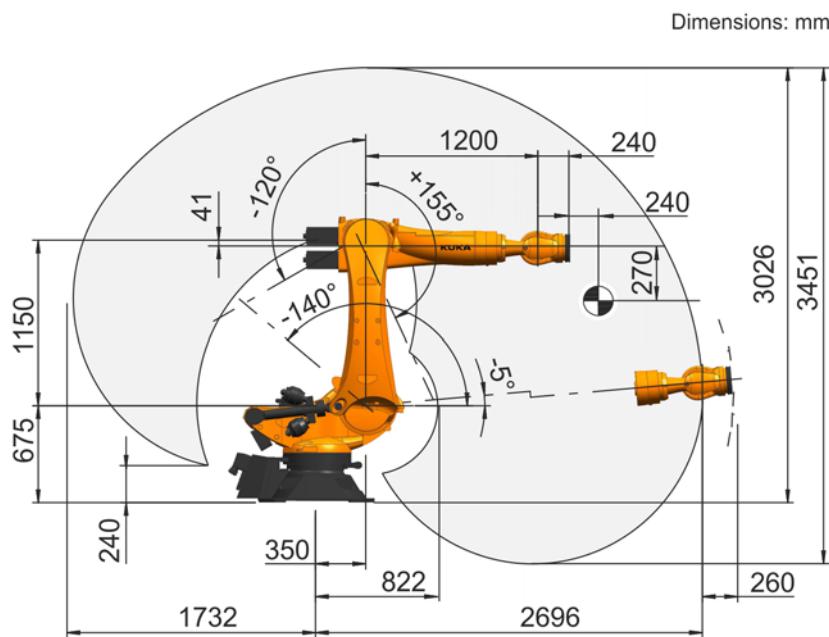


Fig. 4-16: KR 210 R2700 prime, working envelope, side view

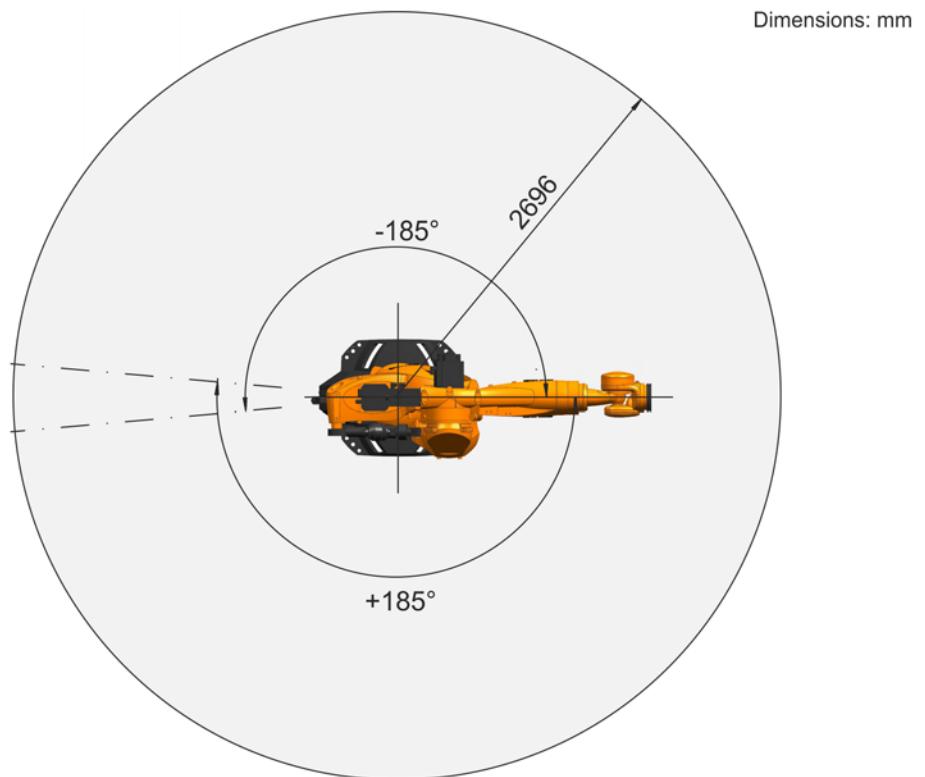


Fig. 4-17: KR 210 R2700 prime, working envelope, top view

4.4.3 Payloads, KR 210 R2700 prime

Payloads

Rated payload	210 kg
Rated mass moment of inertia	105 kgm ²
Rated total load	260 kg
Rated supplementary load, base frame	0 kg
Maximum supplementary load, base frame	-
Rated supplementary load, rotating column	0 kg
Maximum supplementary load, rotating column	300 kg
Rated supplementary load, link arm	0 kg
Maximum supplementary load, link arm	130 kg
Rated supplementary load, arm	50 kg
Maximum supplementary load, arm	150 kg
Nominal distance to load center of gravity	
L _{xy}	270 mm
L _z	240 mm

NOTICE

Exceeding the payloads and supplementary loads will reduce the service life of the robot and overload the motors and the gears. We recommend always testing the specific application with KUKA.Load. In cases where individual values are exceeded, KUKA Deutschland GmbH must be consulted.

Load center of gravity

For all payloads, the load center of gravity refers to the distance from the face of the mounting flange on axis 6. Refer to the payload diagram for the nominal distance.

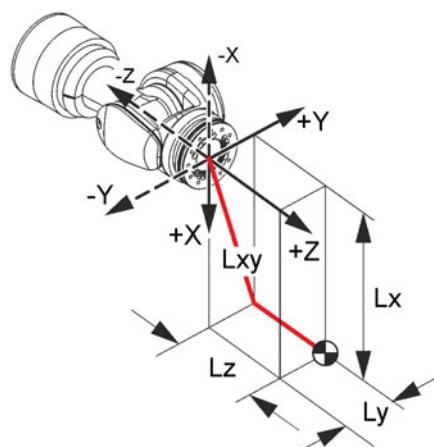


Fig. 4-18: Load center of gravity

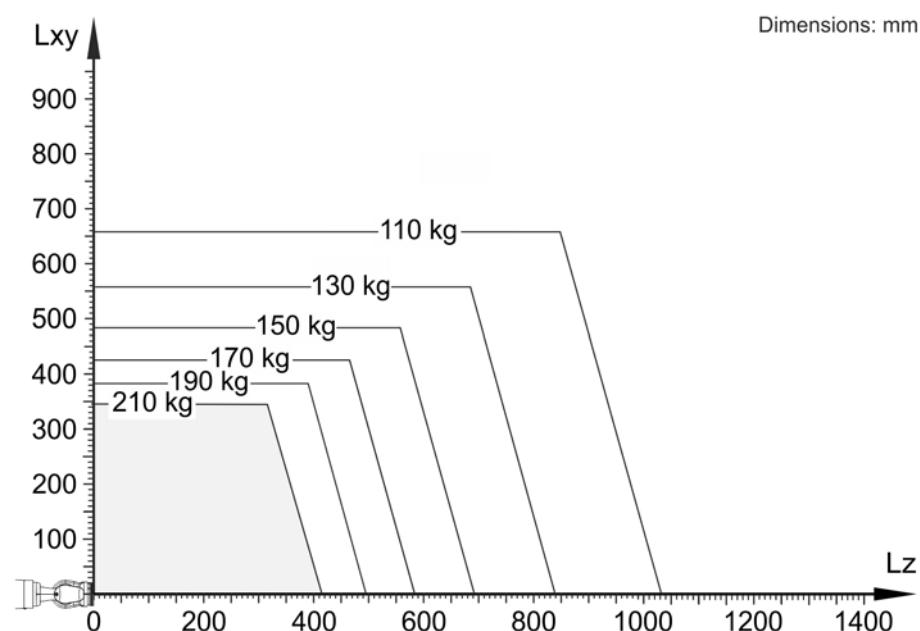
Payload diagram

Fig. 4-19: KR QUANTEC prime payload diagram, payload 210 kg

NOTICE

This loading curve corresponds to the maximum load capacity. Both values (payload and mass moment of inertia) must be checked in all cases. Exceeding this capacity will reduce the service life of the robot and overload the motors and the gears; in any such case KUKA Deutschland GmbH must be consulted beforehand. The values determined here are necessary for planning the robot application. For commissioning the robot, additional input data are required in accordance with the operating and programming instructions of the KUKA System Software. The mass inertia must be verified using KUKA.Load. It is imperative for the load data to be entered in the robot controller!

In-line wrist

In-line wrist type	ZH 210/240
Mounting flange	see drawing

Mounting flange

Screw grade	10.9
Screw size	M10
Number of fastening screws	11
Clamping length	1.5 x nominal diameter
Depth of engagement	min. 12 mm, max. 16 mm
Locating element	10 H7

The mounting flange is depicted with axis 6 in the zero position ([>>> Fig. 4-20](#)) The symbol X_m indicates the position of the locating element (bushing) in the zero position.

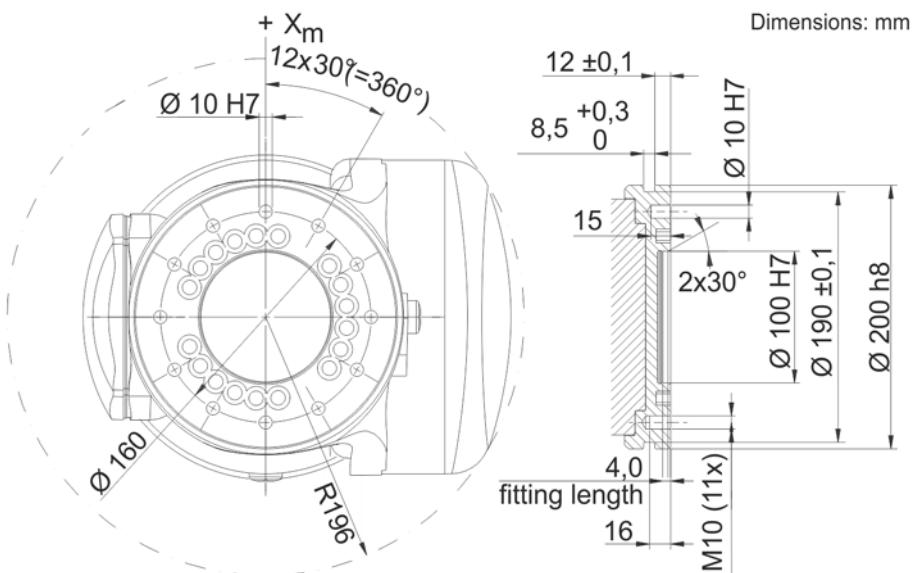


Fig. 4-20: Mounting flange D=160

4.4.4 Loads acting on the foundation, KR 210 R2700 prime

Foundation loads The specified forces and moments already include the payload and the inertia force (weight) of the robot.

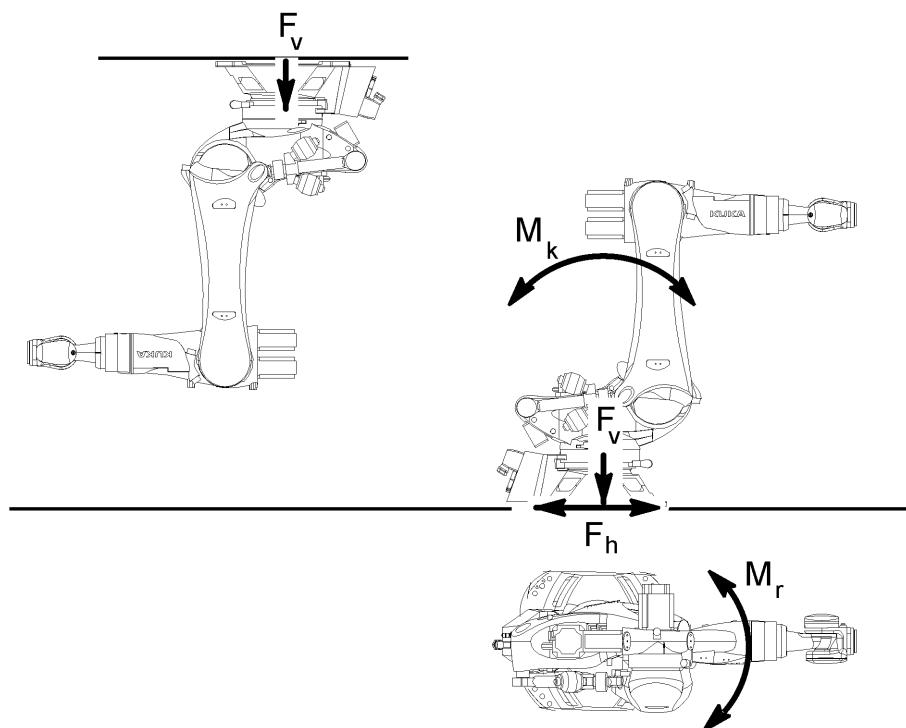


Fig. 4-21: Loads acting on the mounting base

Vertical force $F(v)$	
$F(v \text{ normal})$	19100 N
$F(v \text{ max})$	24000 N
Horizontal force $F(h)$	
$F(h \text{ normal})$	9200 N
$F(h \text{ max})$	16000 N
Tilting moment $M(k)$	
$M(k \text{ normal})$	24000 Nm
$M(k \text{ max})$	49000 Nm
Torque about axis 1 $M(r)$	
$M(r \text{ normal})$	10200 Nm
$M(r \text{ max})$	35000 Nm

Vertical force $F(v)$, horizontal force $F(h)$, tilting torque $M(k)$, torque about axis 1 $M(r)$

⚠ WARNING

Normal loads and maximum loads for the foundations are specified in the table.

The maximum loads must be referred to when dimensioning the foundations and must be adhered to for safety reasons. Failure to observe this can result in personal injury and damage to property.

The normal loads are average expected foundation loads. The actual loads are dependent on the program and on the robot loads and may therefore be greater or less than the normal loads.

The supplementary loads (A1, A2 and A3) are not taken into consideration in the calculation of the foundation load. These supplementary loads must be taken into consideration for F_v .

4.5 Technical data, KR 210 R2700 prime F

4.5.1 Basic data, KR 210 R2700 prime F

Basic data

	KR 210 R2700 prime F
Number of axes	6
Number of controlled axes	6
Volume of working envelope	55 m ³
Pose repeatability (ISO 9283)	± 0.06 mm
Weight	approx. 1111 kg
Rated payload	210 kg
Maximum reach	2696 mm
Protection rating (IEC 60529)	IP65
Protection rating, in-line wrist (IEC 60529)	IP67
Sound level	< 75 dB (A)
Mounting position	Floor
Footprint	830 mm x 830 mm
Hole pattern: mounting surface for kinematic system	S934
Permissible angle of inclination	≤ 5 °
Default color	Base frame: black (RAL 9005); Moving parts: KUKA orange 2567
Controller	KR C4
Transformation name	KR C4: KR210R2700 PRIME C4 FLR

Hollow shaft diameter	
A1	139 mm (partially occupied by motor cables)

Foundry robots

Overpressure in the arm	0.01 MPa (0.1 bar) ±10%
Compressed air	Free of oil and water Class 4 in accordance with ISO 8573-1
Compressed air supply line	Air line in the cable set
Air consumption	0.1 m ³ /h
Air line connection	Push-in fitting for hose, 6 mm
Input pressure	0.1 - 1.2 MPa (1 - 12 bar)
Pressure regulator	0.005 - 0.07 MPa (0.05 - 0.7 bar)
Manometer range	0.0 - 0.1 MPa (0.0 - 1.0 bar)
Thermal loading	10 s/min at 353 K (180 °C)
Resistance	Increased resistance to dust, lubricants, coolants and water vapor.
Special paint finish on wrist	Heat-resistant and heat-reflecting silver paint finish on the in-line wrist.

Special paint finish on the robot	Special paint finish on the entire robot, and an additional protective clear coat.
Other ambient conditions	KUKA Deutschland GmbH must be consulted if the robot is to be used under other ambient conditions.

Ambient conditions

Humidity class (EN 60204)	-
Classification of environmental conditions (EN 60721-3-3)	3K3
Ambient temperature	
During operation	10 °C to 55 °C (283 K to 328 K)
During storage/transportation	-40 °C to 60 °C (233 K to 333 K)



For operation at low temperatures, it may be necessary to warm up the robot.

Connecting cables

Cable designation	Connector designation robot controller - robot	Interface with robot
Motor cable	X20 - X30	Harting connectors at both ends
Data cable	X21 - X31	Rectangular connector at both ends
Ground conductor / equipotential bonding 16 mm ² (can be ordered as an option)		M8 ring cable lug at both ends

Cable lengths	
Standard	7 m, 15 m, 25 m, 35 m, 50 m
Minimum bending radius	5x D

For detailed specifications of the connecting cables, see "Description of the connecting cables".

4.5.2 Axis data, KR 210 R2700 prime F**Axis data**

Motion range	
A1	±185 °
A2	-140 ° / -5 °
A3	-120 ° / 155 °
A4	±350 °
A5	±122.5 °
A6	±350 °
Speed with rated payload	
A1	105 °/s
A2	107 °/s
A3	114 °/s

A4	136 °/s
A5	129 °/s
A6	206 °/s

The direction of motion and the arrangement of the individual axes may be noted from the diagram ([>>> Fig. 4-22](#)).

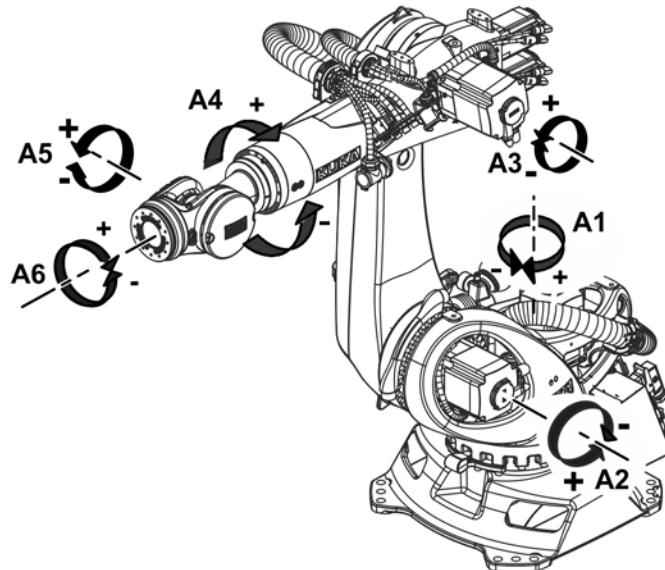


Fig. 4-22: Direction of rotation of the axes

Mastering position

Mastering position	
A1	-20 °
A2	-120 °
A3	110 °
A4	0 °
A5	0 °
A6	0 °

Working envelope

The following diagrams ([>>> Fig. 4-23](#)) and ([>>> Fig. 4-24](#)) show the load center of gravity, shape and size of the working envelope.

The reference point for the working envelope is the intersection of axis 4 with axis 5.

Dimensions: mm

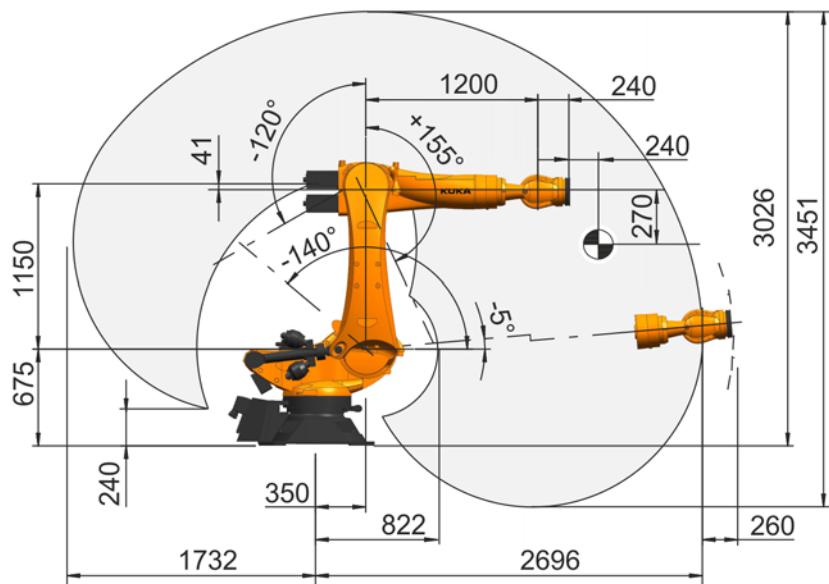


Fig. 4-23: KR 210 R2700 prime, working envelope, side view

Dimensions: mm

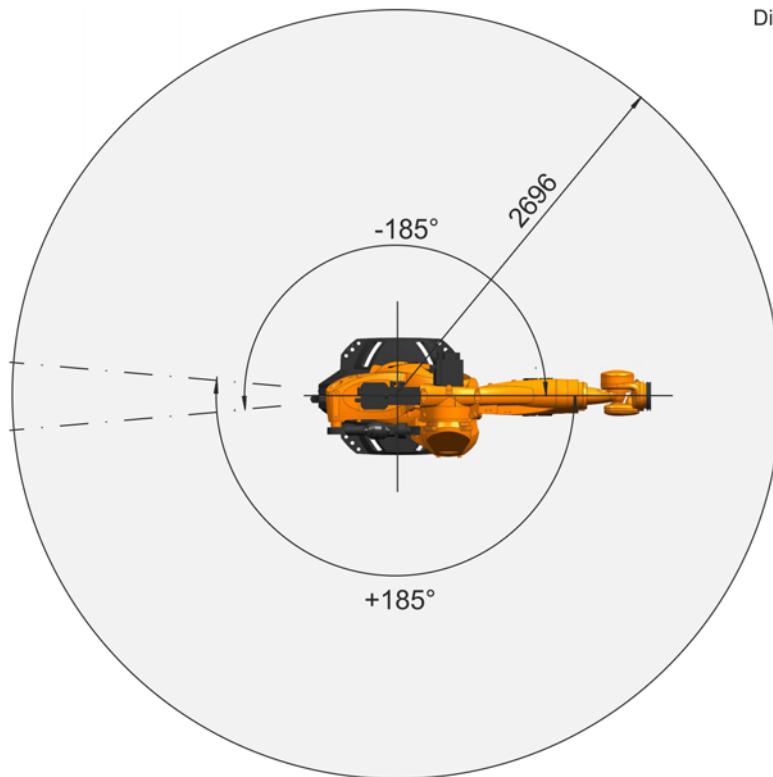


Fig. 4-24: KR 210 R2700 prime, working envelope, top view

4.5.3 Payloads, KR 210 R2700 prime F

Payloads

Rated payload	210 kg
Rated mass moment of inertia	105 kgm ²
Rated total load	260 kg
Rated supplementary load, base frame	0 kg

Maximum supplementary load, base frame	-
Rated supplementary load, rotating column	0 kg
Maximum supplementary load, rotating column	300 kg
Rated supplementary load, link arm	0 kg
Maximum supplementary load, link arm	130 kg
Rated supplementary load, arm	50 kg
Maximum supplementary load, arm	150 kg
Nominal distance to load center of gravity	
L _{xy}	270 mm
L _z	240 mm

NOTICE

Exceeding the payloads and supplementary loads will reduce the service life of the robot and overload the motors and the gears. We recommend always testing the specific application with KUKA.Load. In cases where individual values are exceeded, KUKA Deutschland GmbH must be consulted.

Load center of gravity

For all payloads, the load center of gravity refers to the distance from the face of the mounting flange on axis 6. Refer to the payload diagram for the nominal distance.

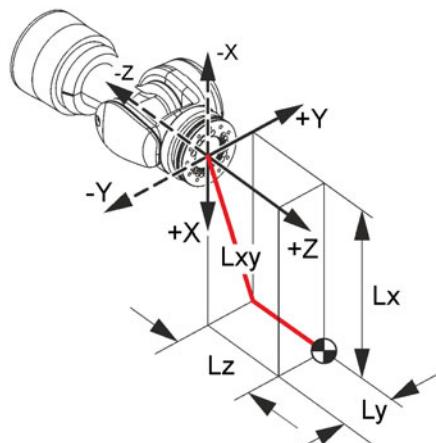
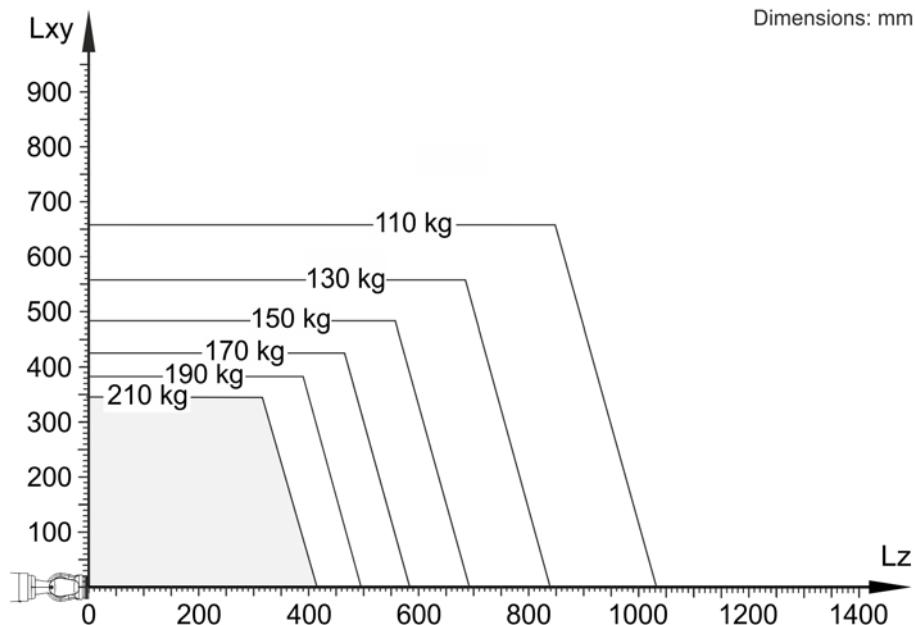


Fig. 4-25: Load center of gravity

Payload diagram**Fig. 4-26: KR QUANTEC prime payload diagram, payload 210 kg****NOTICE**

This loading curve corresponds to the maximum load capacity. Both values (payload and mass moment of inertia) must be checked in all cases. Exceeding this capacity will reduce the service life of the robot and overload the motors and the gears; in any such case KUKA Deutschland GmbH must be consulted beforehand. The values determined here are necessary for planning the robot application. For commissioning the robot, additional input data are required in accordance with the operating and programming instructions of the KUKA System Software. The mass inertia must be verified using KUKA.Load. It is imperative for the load data to be entered in the robot controller!

In-line wrist

In-line wrist type	ZH 210/240 F
Mounting flange	see drawing

Mounting flange

Screw grade	10.9
Screw size	M10
Number of fastening screws	11
Clamping length	1.5 x nominal diameter
Depth of engagement	min. 12 mm, max. 16 mm
Locating element	10 H7

The mounting flange is depicted with axis 6 in the zero position ([>>>](#) Fig. 4-27) The symbol X_m indicates the position of the locating element (bushing) in the zero position.

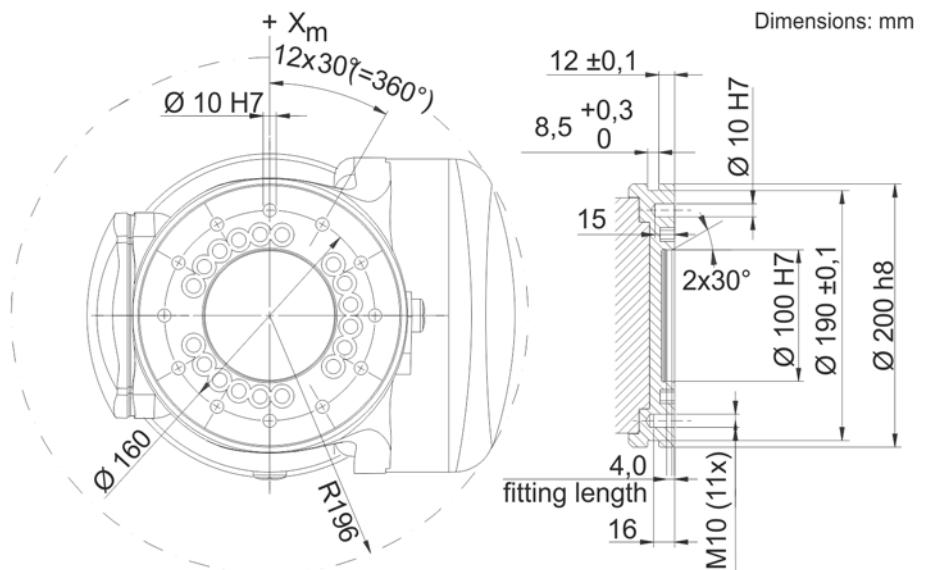


Fig. 4-27: Mounting flange D=160

4.5.4 Loads acting on the foundation, KR 210 R2700 prime F

Foundation loads

The specified forces and moments already include the payload and the inertia force (weight) of the robot.

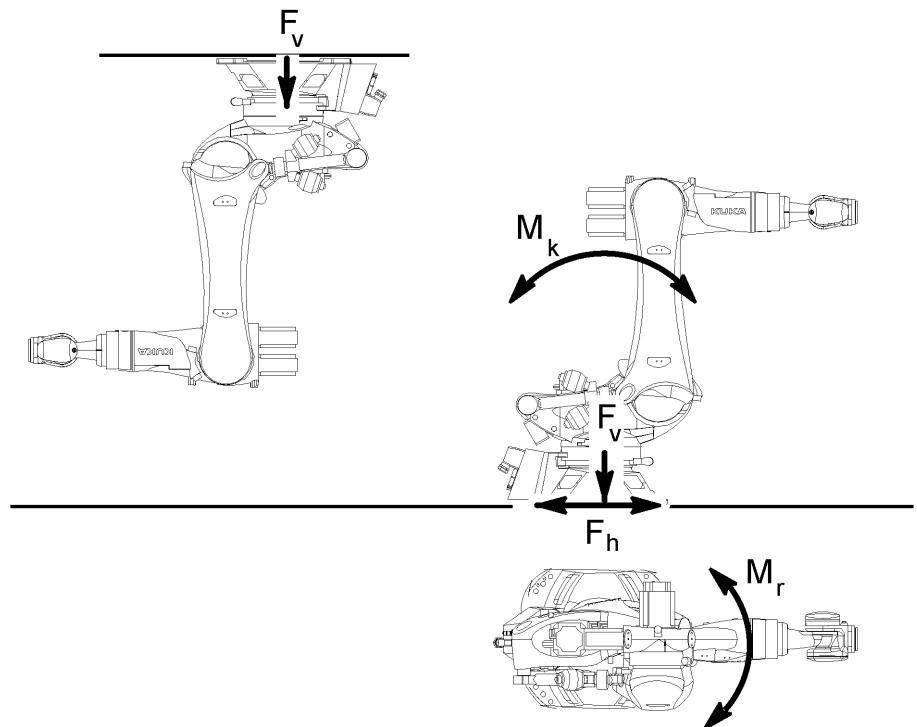


Fig. 4-28: Loads acting on the mounting base

Vertical force F(v)	
F(v normal)	19100 N
F(v max)	24000 N
Horizontal force F(h)	
F(h normal)	9200 N
F(h max)	16000 N

Tilting moment M(k)	
M(k normal)	24000 Nm
M(k max)	49000 Nm
Torque about axis 1 M(r)	
M(r normal)	10200 Nm
M(r max)	35000 Nm

Vertical force $F(v)$, horizontal force $F(h)$, tilting torque $M(k)$, torque about axis 1 $M(r)$



Normal loads and maximum loads for the foundations are specified in the table.

The maximum loads must be referred to when dimensioning the foundations and must be adhered to for safety reasons. Failure to observe this can result in personal injury and damage to property.

The normal loads are average expected foundation loads. The actual loads are dependent on the program and on the robot loads and may therefore be greater or less than the normal loads.

The supplementary loads (A1, A2 and A3) are not taken into consideration in the calculation of the foundation load. These supplementary loads must be taken into consideration for F_v .

4.6 Technical data, KR 210 R2700 prime CR

4.6.1 Basic data, KR 210 R2700 prime CR

Basic data

	KR 210 R2700 prime CR
Number of axes	6
Number of controlled axes	6
Volume of working envelope	51 m ³
Pose repeatability (ISO 9283)	± 0.06 mm
Weight	approx. 1116 kg
Rated payload	210 kg
Maximum reach	2696 mm
Protection rating (IEC 60529)	IP65
Protection rating, in-line wrist (IEC 60529)	IP65
Sound level	< 75 dB (A)
Mounting position	Floor
Footprint	830 mm x 830 mm
Hole pattern: mounting surface for kinematic system	S934
Permissible angle of inclination	≤ 5 °
Default color	Base frame: traffic white (RAL 9016); Moving parts: traffic white (RAL 9016); Protective cover: traffic white (RAL 9016)
Controller	KR C4
Transformation name	KR C4: KR210R2700 PRIME CR C4 FLR

Hollow shaft diameter	
A1	139 mm (partially occupied by motor cables)

Cleanroom robots	Classification	Class 4 at 40% override Class 4 at 80% override
	Standard	DIN EN ISO 14644-1, approximately corresponding to US Fed. Std. 209E, class 10

Ambient conditions	Humidity class (EN 60204)	-
	Classification of environmental conditions (EN 60721-3-3)	3K3
	Cleanroom class (ISO 14644-1)	Class 4 at 40% override; Class 5 at 80% override
	Ambient temperature	
	During operation	10 °C to 55 °C (283 K to 328 K)
	During storage/transportation	-40 °C to 60 °C (233 K to 333 K)



For operation at low temperatures, it may be necessary to warm up the robot.

Connecting cables	Cable designation	Connector designation robot controller - robot	Interface with robot
	Motor cable	X20 - X30	Harting connectors at both ends
	Data cable	X21 - X31	Rectangular connector at both ends
	Ground conductor / equipotential bonding 16 mm ² (can be ordered as an option)		M8 ring cable lug at both ends

Cable lengths	
Standard	7 m, 15 m, 25 m, 35 m, 50 m

Minimum bending radius	5x D
-------------------------------	------

For detailed specifications of the connecting cables, see "Description of the connecting cables".

4.6.2 Axis data, KR 210 R2700 prime CR

Axis data	Motion range
A1	±165 °
A2	-140 ° / -5 °
A3	-120 ° / 155 °
A4	±350 °

A5	$\pm 122.5^\circ$
A6	$\pm 350^\circ$
Speed with rated payload	
A1	105 °/s
A2	107 °/s
A3	114 °/s
A4	136 °/s
A5	129 °/s
A6	206 °/s

The direction of motion and the arrangement of the individual axes may be noted from the diagram ([>>> Fig. 4-29](#)).

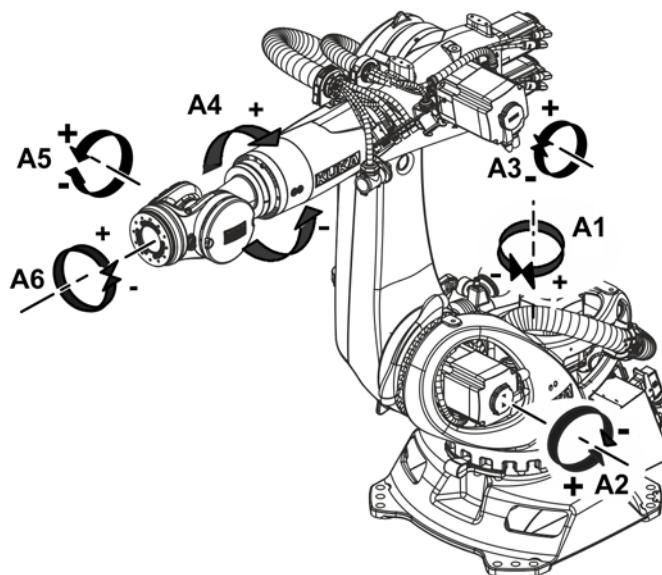


Fig. 4-29: Direction of rotation of the axes

Mastering position

Mastering position	
A1	-20 °
A2	-120 °
A3	110 °
A4	0 °
A5	0 °
A6	0 °

Working envelope

The following diagrams ([>>> Fig. 4-30](#)) and ([>>> Fig. 4-31](#)) show the load center of gravity, shape and size of the working envelope.

The reference point for the working envelope is the intersection of axis 4 with axis 5.

Dimensions: mm

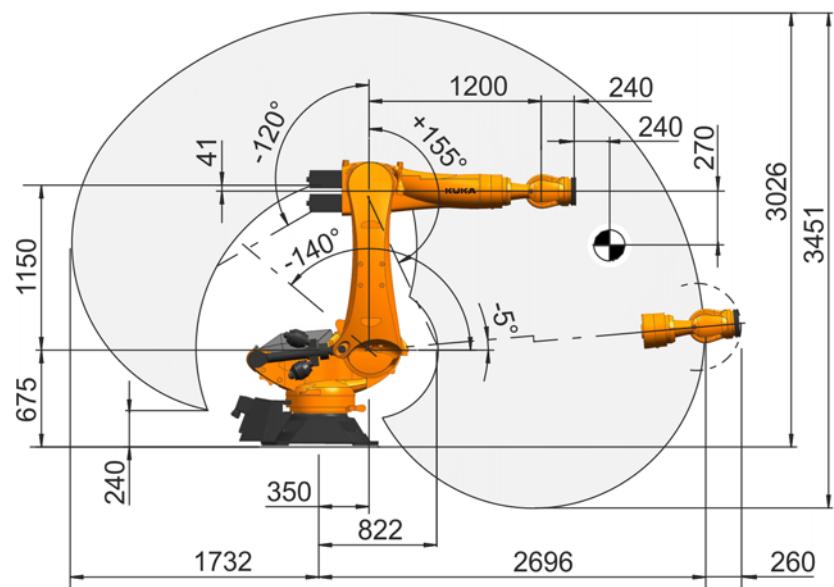


Fig. 4-30: KR 210 R2700 prime CR, working envelope, side view

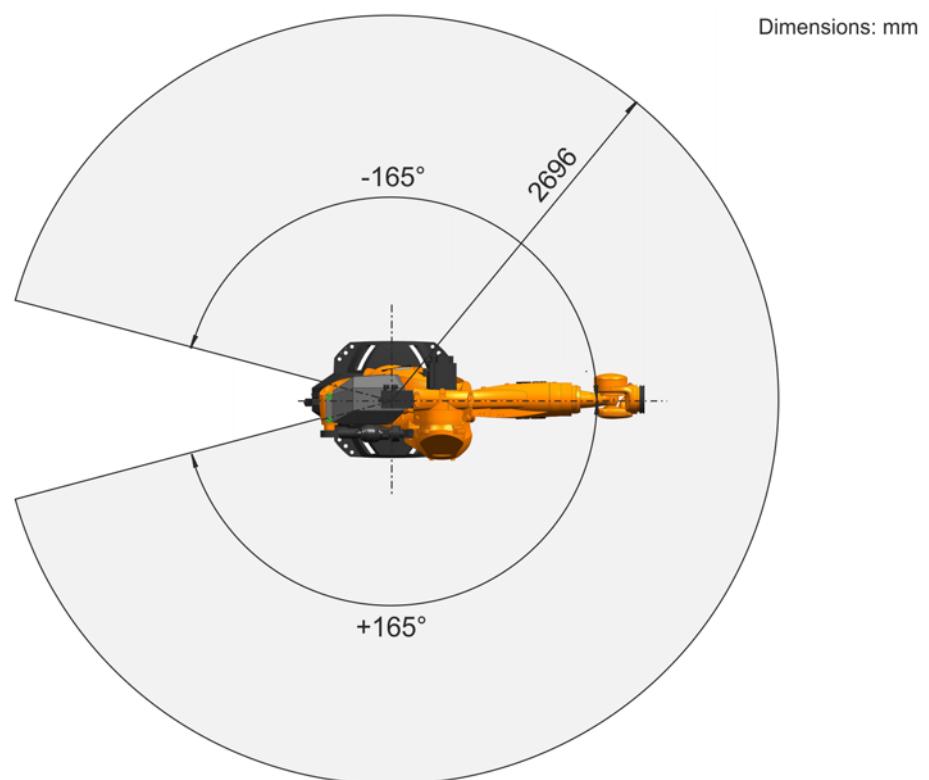


Fig. 4-31: KR 210 R2700 prime CR, working envelope, top view

4.6.3 Payloads, KR 210 R2700 prime CR

Payloads

Rated payload	210 kg
Rated mass moment of inertia	105 kgm ²
Rated total load	260 kg
Rated supplementary load, base frame	0 kg

Maximum supplementary load, base frame	-
Rated supplementary load, rotating column	0 kg
Maximum supplementary load, rotating column	-
Rated supplementary load, link arm	0 kg
Maximum supplementary load, link arm	-
Rated supplementary load, arm	50 kg
Maximum supplementary load, arm	-
Nominal distance to load center of gravity	
L _{xy}	270 mm
L _z	240 mm

NOTICE

Exceeding the payloads and supplementary loads will reduce the service life of the robot and overload the motors and the gears. We recommend always testing the specific application with KUKA.Load. In cases where individual values are exceeded, KUKA Deutschland GmbH must be consulted.

Load center of gravity

For all payloads, the load center of gravity refers to the distance from the face of the mounting flange on axis 6. Refer to the payload diagram for the nominal distance.

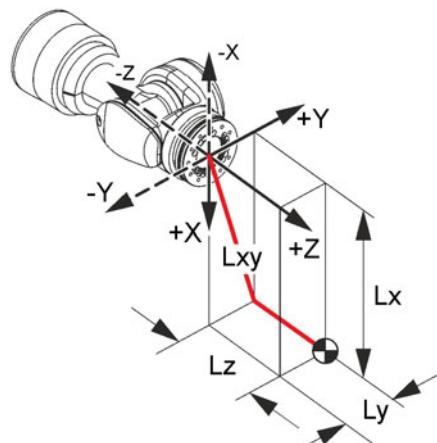
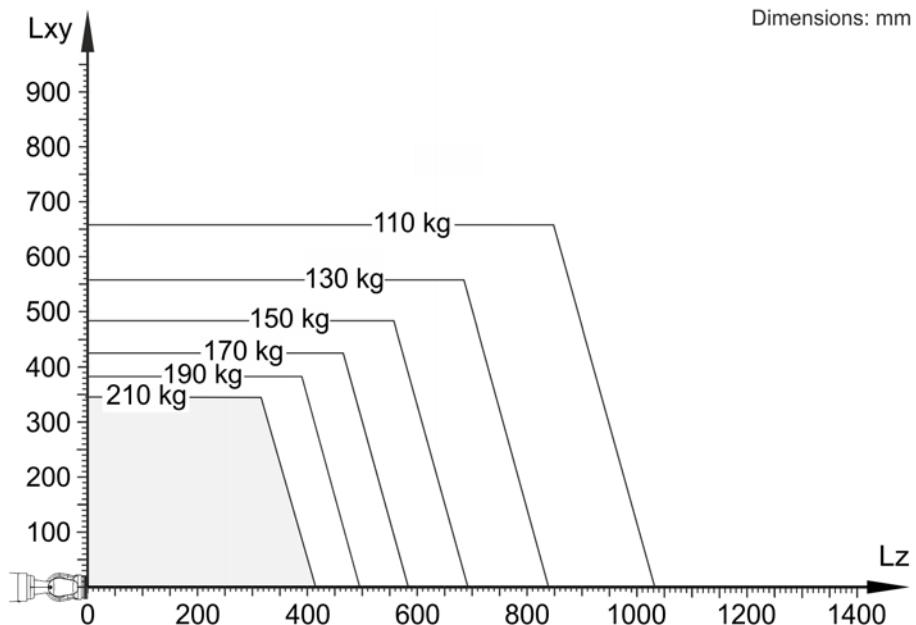


Fig. 4-32: Load center of gravity

Payload diagram**Fig. 4-33: KR QUANTEC prime payload diagram, payload 210 kg****NOTICE**

This loading curve corresponds to the maximum load capacity. Both values (payload and mass moment of inertia) must be checked in all cases. Exceeding this capacity will reduce the service life of the robot and overload the motors and the gears; in any such case KUKA Deutschland GmbH must be consulted beforehand. The values determined here are necessary for planning the robot application. For commissioning the robot, additional input data are required in accordance with the operating and programming instructions of the KUKA System Software. The mass inertia must be verified using KUKA.Load. It is imperative for the load data to be entered in the robot controller!

In-line wrist

In-line wrist type	ZH 210/240 CR
Mounting flange	see drawing

Mounting flange

Screw grade	10.9
Screw size	M10
Number of fastening screws	11
Clamping length	1.5 x nominal diameter
Depth of engagement	min. 12 mm, max. 16 mm
Locating element	10 H7

The mounting flange is depicted with axis 6 in the zero position ([>>>](#) Fig. 4-34) The symbol X_m indicates the position of the locating element (bushing) in the zero position.

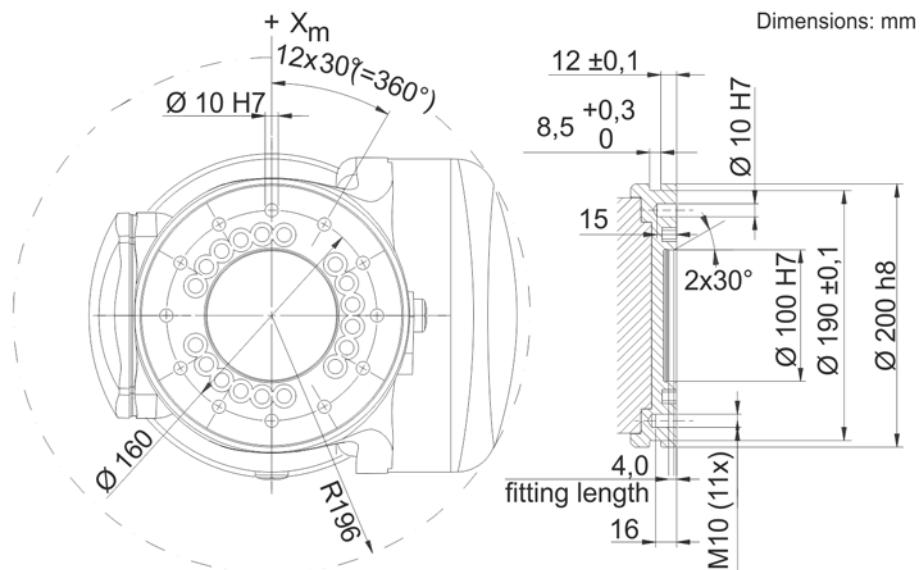


Fig. 4-34: Mounting flange D=160

4.6.4 Loads acting on the foundation, KR 210 R2700 prime CR

Mounting base loads

The specified forces and moments already include the payload and the inertia force (weight) of the robot.

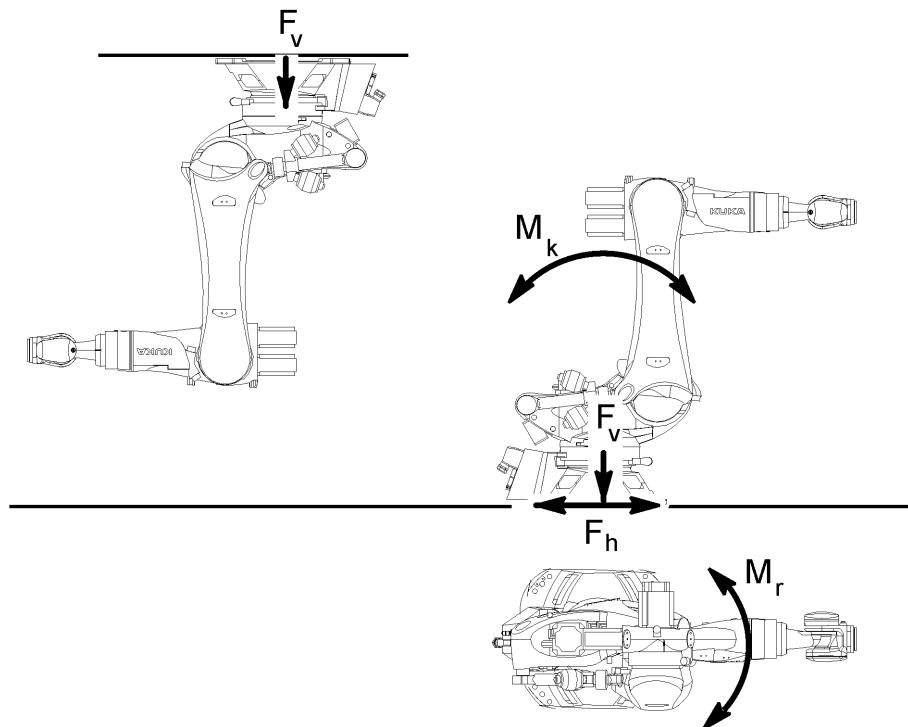


Fig. 4-35: Loads acting on the mounting base

Vertical force F(v)	
F(v normal)	19100 N
F(v max)	24000 N
Horizontal force F(h)	
F(h normal)	9200 N
F(h max)	16000 N

Tilting moment M(k)	
M(k normal)	24000 Nm
M(k max)	49000 Nm
Torque about axis 1 M(r)	
M(r normal)	10200 Nm
M(r max)	35000 Nm

Vertical force F(v), horizontal force F(h), tilting torque M(k), torque about axis 1 M(r)



Normal loads and maximum loads for the foundations are specified in the table.

The maximum loads must be referred to when dimensioning the foundations and must be adhered to for safety reasons. Failure to observe this can result in personal injury and damage to property.

The normal loads are average expected foundation loads. The actual loads are dependent on the program and on the robot loads and may therefore be greater or less than the normal loads.

The supplementary loads (A1 and A2) are not taken into consideration in the calculation of the mounting base load. These supplementary loads must be taken into consideration for F_v .

4.7 Technical data, KR 210 R2700 prime C

4.7.1 Basic data, KR 210 R2700 prime C

Basic data

	KR 210 R2700 prime C
Number of axes	6
Number of controlled axes	6
Volume of working envelope	42.33 m ³
Pose repeatability (ISO 9283)	± 0.06 mm
Weight	approx. 1111 kg
Rated payload	210 kg
Maximum reach	2556 mm
Protection rating (IEC 60529)	IP65
Protection rating, in-line wrist (IEC 60529)	IP65
Sound level	< 75 dB (A)
Mounting position	Ceiling
Footprint	830 mm x 830 mm
Hole pattern: mounting surface for kinematic system	S934
Permissible angle of inclination	≤ 0 °
Default color	Base frame: black (RAL 9005); Moving parts: KUKA orange 2567
Controller	KR C4
Transformation name	KR C4: KR210R2700 PRIME C4 CLG

Hollow shaft diameter

A1	139 mm (partially occupied by motor cables)
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Ambient conditions

Humidity class (EN 60204)	-
Classification of environmental conditions (EN 60721-3-3)	3K3
Ambient temperature	
During operation	10 °C to 55 °C (283 K to 328 K)
During storage/transportation	-40 °C to 60 °C (233 K to 333 K)



For operation at low temperatures, it may be necessary to warm up the robot.

Connecting cables

Cable designation	Connector designation robot controller - ro- bot	Interface with robot
Motor cable	X20 - X30	Harting connectors at both ends
Data cable	X21 - X31	Rectangular connector at both ends
Ground conductor / equipotential bonding 16 mm ² (can be ordered as an option)		M8 ring cable lug at both ends

Cable lengths	
Standard	7 m, 15 m, 25 m, 35 m, 50 m

Minimum bending radius	5x D
------------------------	------

For detailed specifications of the connecting cables, see "Description of the connecting cables".

4.7.2 Axis data, KR 210 R2700 prime C**Axis data**

Motion range	
A1	±185 °
A2	-140 ° / -29 °
A3	-120 ° / 155 °
A4	±350 °
A5	±122.5 °
A6	±350 °
Speed with rated payload	
A1	105 °/s
A2	107 °/s
A3	114 °/s
A4	136 °/s
A5	129 °/s
A6	206 °/s

The direction of motion and the arrangement of the individual axes may be noted from the diagram ([>>>](#) Fig. 4-36).

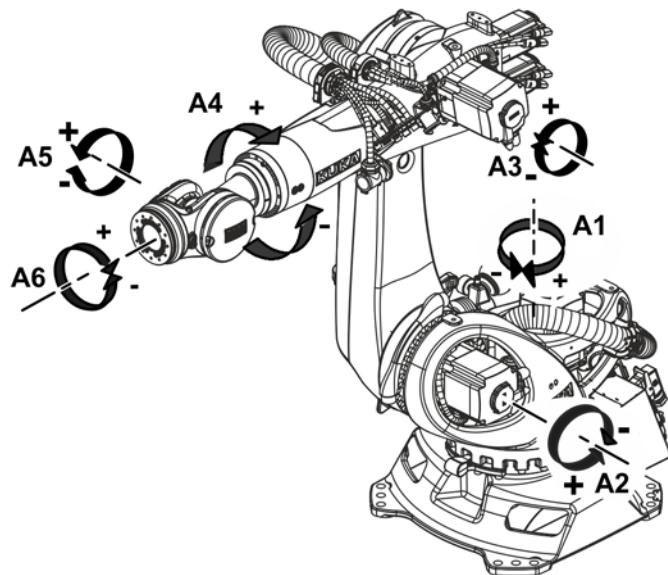


Fig. 4-36: Direction of rotation of the axes

Mastering position

Mastering position	
A1	-20 °
A2	-120 °
A3	110 °
A4	0 °
A5	0 °
A6	0 °

Working envelope

The following diagrams ([>>> Fig. 4-37](#)) and ([>>> Fig. 4-38](#)) show the load center of gravity, shape and size of the working envelope.

The reference point for the working envelope is the intersection of axis 4 with axis 5.

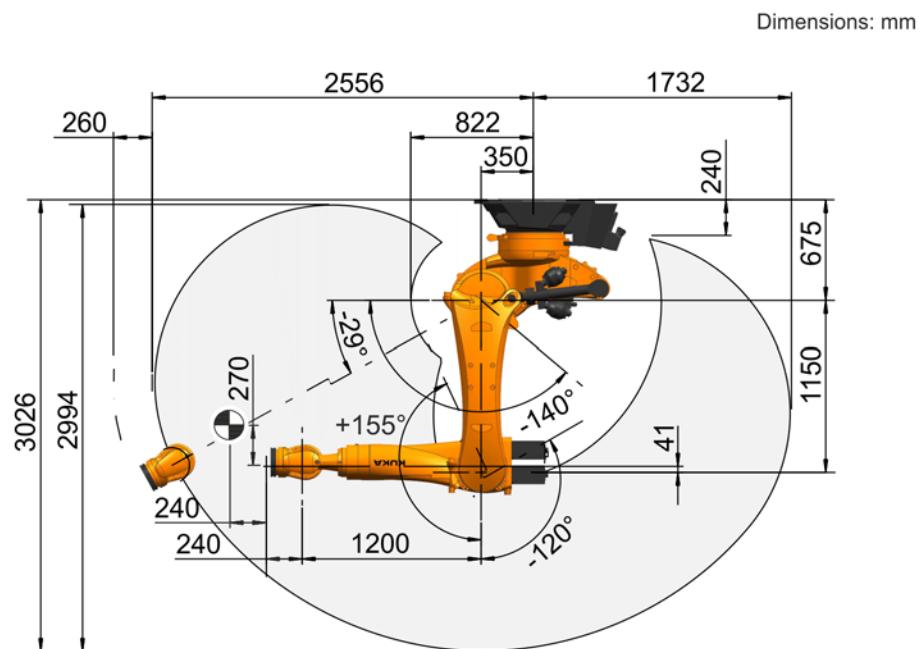


Fig. 4-37: KR 210 R2700 prime C, working envelope, side view

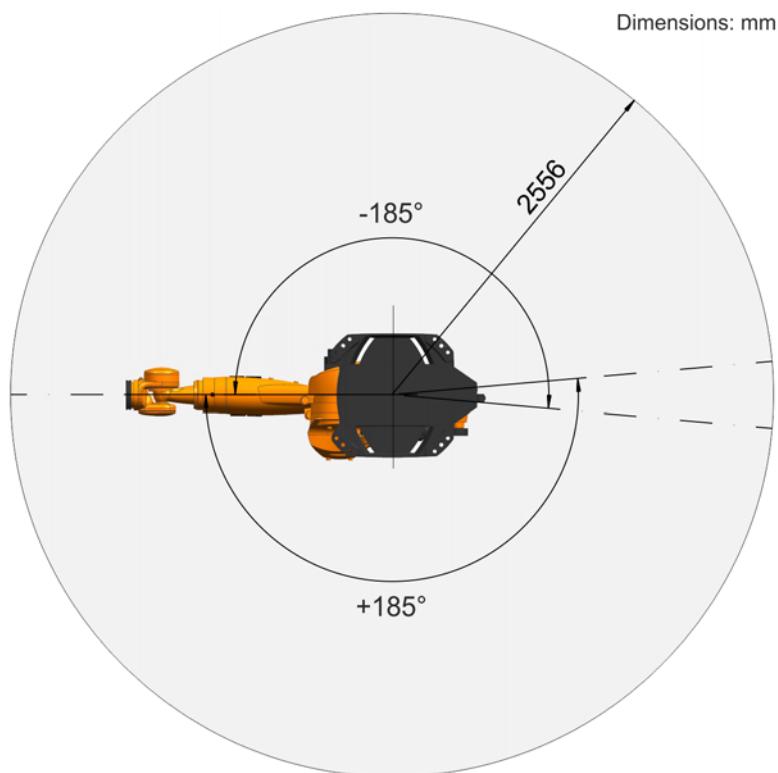


Fig. 4-38: KR 210 R2700 prime C, working envelope, top view

4.7.3 Payloads, KR 210 R2700 prime C

Payloads

Rated payload	210 kg
Reduced payload	-
Rated mass moment of inertia	105 kgm ²
Rated total load	260 kg
Rated supplementary load, base frame	0 kg
Maximum supplementary load, base frame	-
Rated supplementary load, rotating column	0 kg
Maximum supplementary load, rotating column	300 kg
Rated supplementary load, link arm	0 kg
Maximum supplementary load, link arm	130 kg
Rated supplementary load, arm	50 kg
Maximum supplementary load, arm	150 kg
Nominal distance to load center of gravity	
L _{xy}	270 mm
L _z	240 mm

NOTICE

Exceeding the payloads and supplementary loads will reduce the service life of the robot and overload the motors and the gears. We recommend always testing the specific application with KUKA.Load. In cases where individual values are exceeded, KUKA Deutschland GmbH must be consulted.

Load center of gravity

For all payloads, the load center of gravity refers to the distance from the face of the mounting flange on axis 6. Refer to the payload diagram for the nominal distance.

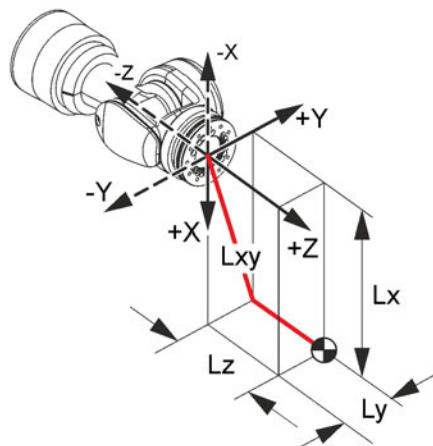
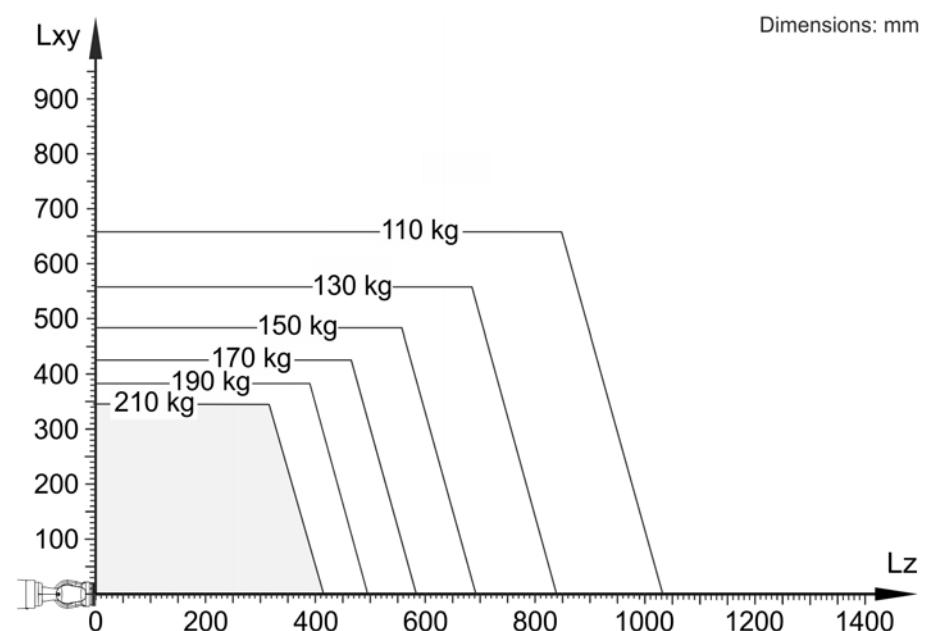


Fig. 4-39: Load center of gravity

Payload diagram


Dimensions: mm

Fig. 4-40: KR QUANTEC prime payload diagram, payload 210 kg

NOTICE

This loading curve corresponds to the maximum load capacity. Both values (payload and mass moment of inertia) must be checked in all cases. Exceeding this capacity will reduce the service life of the robot and overload the motors and the gears; in any such case KUKA Deutschland GmbH must be consulted beforehand. The values determined here are necessary for planning the robot application. For commissioning the robot, additional input data are required in accordance with the operating and programming instructions of the KUKA System Software. The mass inertia must be verified using KUKA.Load. It is imperative for the load data to be entered in the robot controller!

In-line wrist

In-line wrist type	ZH 210/240
Mounting flange	see drawing

Mounting flange

Screw grade	10.9
Screw size	M10
Number of fastening screws	11
Clamping length	1.5 x nominal diameter
Depth of engagement	min. 12 mm, max. 16 mm
Locating element	10 H7

The mounting flange is depicted with axis 6 in the zero position ([>>> Fig. 4-41](#)) The symbol X_m indicates the position of the locating element (bushing) in the zero position.

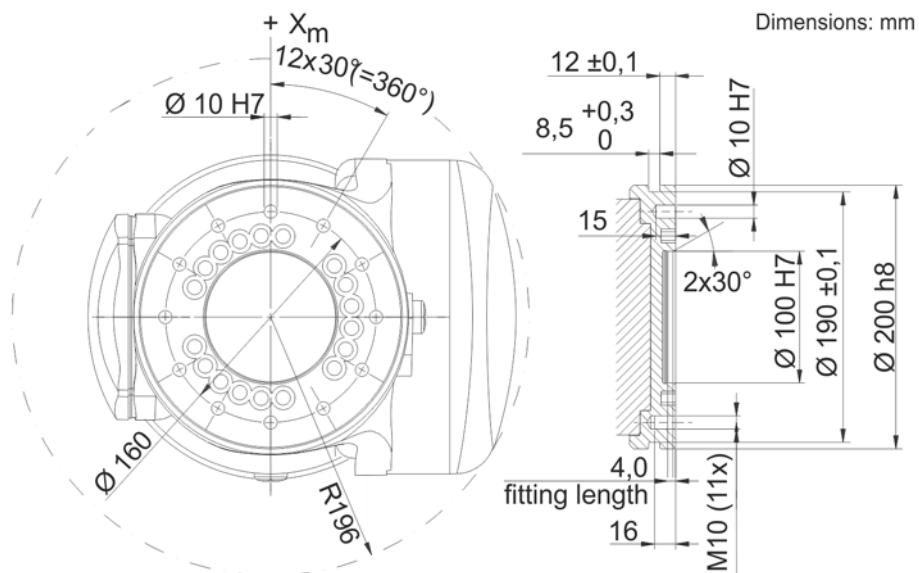


Fig. 4-41: Mounting flange D=160

4.7.4 Loads acting on the foundation, KR 210 R2700 prime C

Foundation loads The specified forces and moments already include the payload and the inertia force (weight) of the robot.

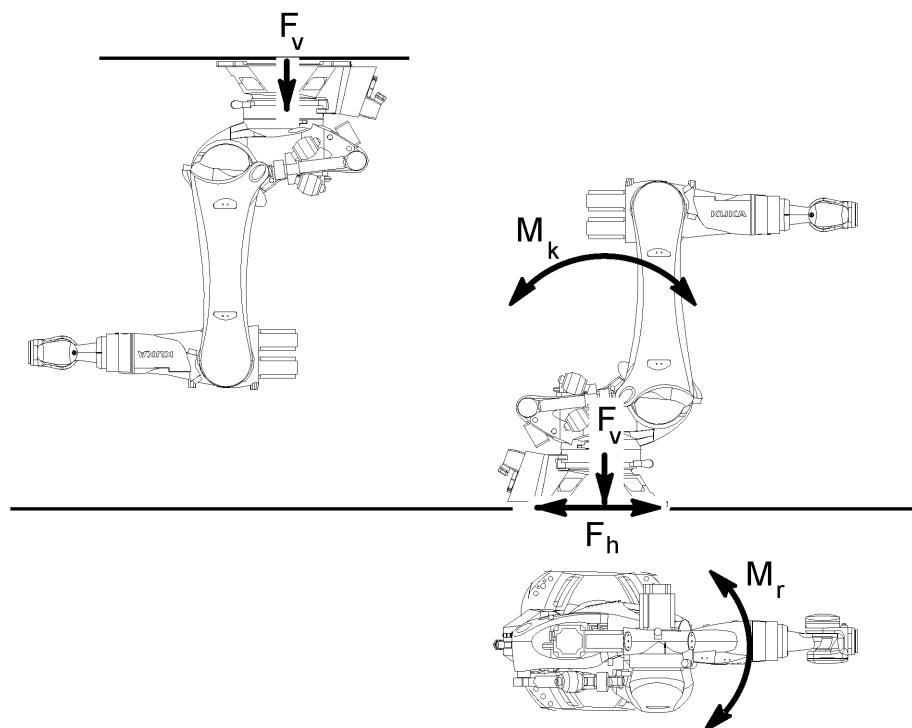


Fig. 4-42: Loads acting on the mounting base

Vertical force $F(v)$	
$F(v \text{ normal})$	19100 N
$F(v \text{ max})$	24000 N
Horizontal force $F(h)$	
$F(h \text{ normal})$	9200 N
$F(h \text{ max})$	16000 N
Tilting moment $M(k)$	
$M(k \text{ normal})$	24000 Nm
$M(k \text{ max})$	49000 Nm
Torque about axis 1 $M(r)$	
$M(r \text{ normal})$	10200 Nm
$M(r \text{ max})$	35000 Nm

Vertical force $F(v)$, horizontal force $F(h)$, tilting torque $M(k)$, torque about axis 1 $M(r)$

⚠ WARNING

Normal loads and maximum loads for the foundations are specified in the table.

The maximum loads must be referred to when dimensioning the foundations and must be adhered to for safety reasons. Failure to observe this can result in personal injury and damage to property.

The normal loads are average expected foundation loads. The actual loads are dependent on the program and on the robot loads and may therefore be greater or less than the normal loads.

The supplementary loads (A1, A2 and A3) are not taken into consideration in the calculation of the foundation load. These supplementary loads must be taken into consideration for F_v .

4.8 Technical data, KR 210 R2700 prime C-F

4.8.1 Basic data, KR 210 R2700 prime C-F

Basic data

		KR 210 R2700 prime C-F
Number of axes	6	
Number of controlled axes	6	
Volume of working envelope	42.33 m ³	
Pose repeatability (ISO 9283)	± 0.06 mm	
Weight	approx. 1111 kg	
Rated payload	210 kg	
Maximum reach	2556 mm	
Protection rating (IEC 60529)	IP65	
Protection rating, in-line wrist (IEC 60529)	IP67	
Sound level	< 75 dB (A)	
Mounting position	Ceiling	
Footprint	830 mm x 830 mm	
Hole pattern: mounting surface for kinematic system	S934	
Permissible angle of inclination	≤ 0 °	
Default color	Base frame: black (RAL 9005); Moving parts: KUKA orange 2567	
Controller	KR C4	
Transformation name	KR C4: KR210R2700 PRIME C4 CLG	

Hollow shaft diameter	
A1	139 mm (partially occupied by motor cables)

Foundry robots

Overpressure in the arm	0.01 MPa (0.1 bar) ±10%
Compressed air	Free of oil and water Class 4 in accordance with ISO 8573-1
Compressed air supply line	Air line in the cable set
Air consumption	0.1 m ³ /h
Air line connection	Push-in fitting for hose, 6 mm
Input pressure	0.1 - 1.2 MPa (1 - 12 bar)
Pressure regulator	0.005 - 0.07 MPa (0.05 - 0.7 bar)
Manometer range	0.0 - 0.1 MPa (0.0 - 1.0 bar)
Thermal loading	10 s/min at 353 K (180 °C)
Resistance	Increased resistance to dust, lubricants, coolants and water vapor.
Special paint finish on wrist	Heat-resistant and heat-reflecting silver paint finish on the in-line wrist.

Special paint finish on the robot	Special paint finish on the entire robot, and an additional protective clear coat.
Other ambient conditions	KUKA Deutschland GmbH must be consulted if the robot is to be used under other ambient conditions.

Ambient conditions

Humidity class (EN 60204)	-
Classification of environmental conditions (EN 60721-3-3)	3K3
Ambient temperature	
During operation	10 °C to 55 °C (283 K to 328 K)
During storage/transportation	-40 °C to 60 °C (233 K to 333 K)



For operation at low temperatures, it may be necessary to warm up the robot.

Connecting cables

Cable designation	Connector designation robot controller - robot	Interface with robot
Motor cable	X20 - X30	Harting connectors at both ends
Data cable	X21 - X31	Rectangular connector at both ends
Ground conductor / equipotential bonding 16 mm ² (can be ordered as an option)		M8 ring cable lug at both ends

Cable lengths	
Standard	7 m, 15 m, 25 m, 35 m, 50 m
Minimum bending radius	5x D

For detailed specifications of the connecting cables, see "Description of the connecting cables".

4.8.2 Axis data, KR 210 R2700 prime C-F**Axis data**

Motion range	
A1	±185 °
A2	-140 ° / -29 °
A3	-120 ° / 155 °
A4	±350 °
A5	±122.5 °
A6	±350 °
Speed with rated payload	
A1	105 °/s
A2	107 °/s
A3	114 °/s

A4	136 °/s
A5	129 °/s
A6	206 °/s

The direction of motion and the arrangement of the individual axes may be noted from the diagram ([>>> Fig. 4-43](#)).

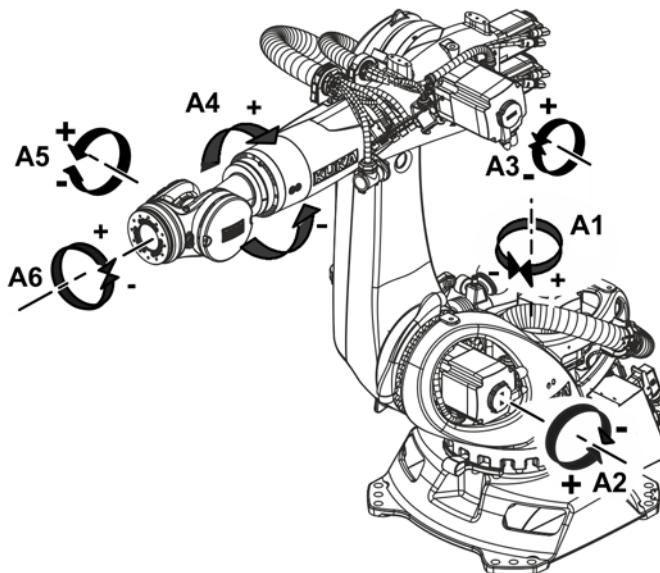


Fig. 4-43: Direction of rotation of the axes

Mastering position

Mastering position	
A1	-20 °
A2	-120 °
A3	110 °
A4	0 °
A5	0 °
A6	0 °

Working envelope

The following diagrams ([>>> Fig. 4-44](#)) and ([>>> Fig. 4-45](#)) show the load center of gravity, shape and size of the working envelope.

The reference point for the working envelope is the intersection of axis 4 with axis 5.

Dimensions: mm

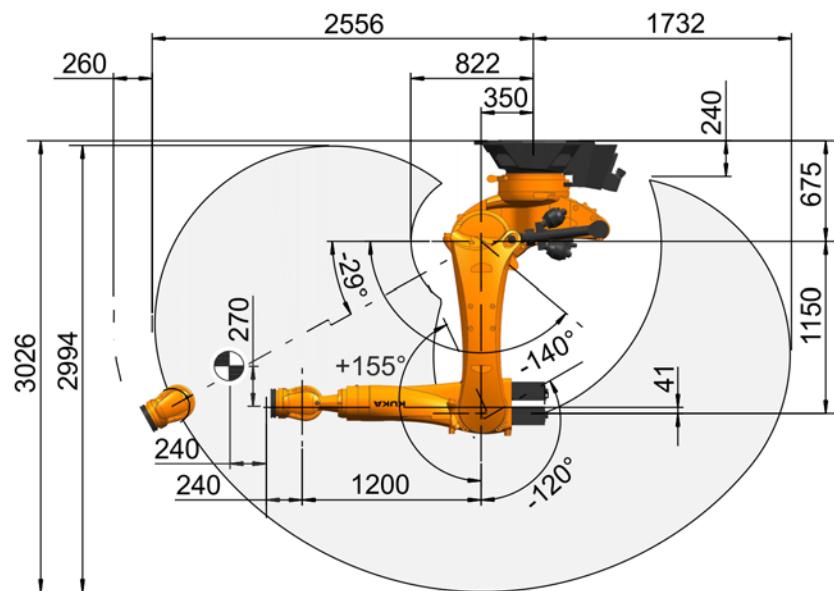


Fig. 4-44: KR 210 R2700 prime C, working envelope, side view

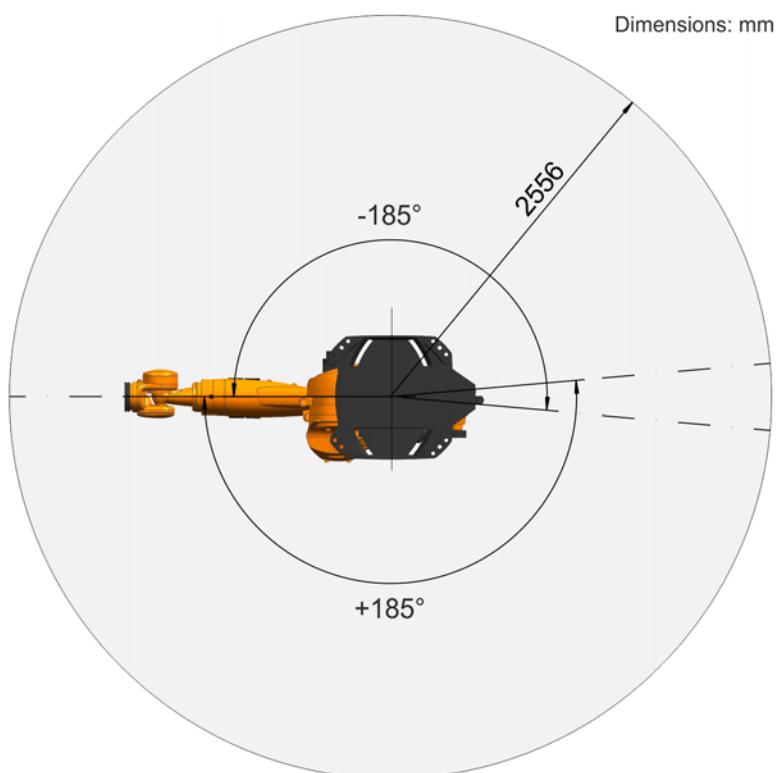


Fig. 4-45: KR 210 R2700 prime C, working envelope, top view

4.8.3 Payloads, KR 210 R2700 prime C-F

Payloads

Rated payload	210 kg
Reduced payload	-
Rated mass moment of inertia	105 kgm ²
Rated total load	260 kg

Rated supplementary load, base frame	0 kg
Maximum supplementary load, base frame	-
Rated supplementary load, rotating column	0 kg
Maximum supplementary load, rotating column	300 kg
Rated supplementary load, link arm	0 kg
Maximum supplementary load, link arm	130 kg
Rated supplementary load, arm	50 kg
Maximum supplementary load, arm	150 kg
Nominal distance to load center of gravity	
Lxy	270 mm
Lz	240 mm

NOTICE

Exceeding the payloads and supplementary loads will reduce the service life of the robot and overload the motors and the gears. We recommend always testing the specific application with KUKA.Load. In cases where individual values are exceeded, KUKA Deutschland GmbH must be consulted.

Load center of gravity

For all payloads, the load center of gravity refers to the distance from the face of the mounting flange on axis 6. Refer to the payload diagram for the nominal distance.

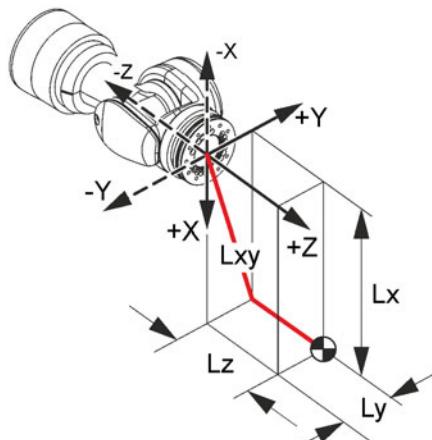
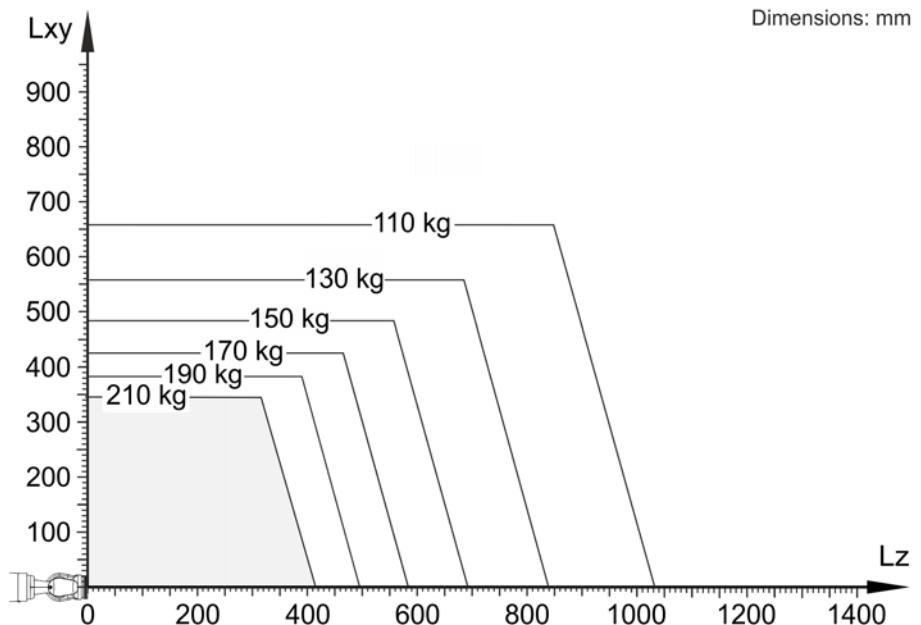


Fig. 4-46: Load center of gravity

Payload diagram

Dimensions: mm

Fig. 4-47: KR QUANTEC prime payload diagram, payload 210 kg**NOTICE**

This loading curve corresponds to the maximum load capacity. Both values (payload and mass moment of inertia) must be checked in all cases. Exceeding this capacity will reduce the service life of the robot and overload the motors and the gears; in any such case KUKA Deutschland GmbH must be consulted beforehand. The values determined here are necessary for planning the robot application. For commissioning the robot, additional input data are required in accordance with the operating and programming instructions of the KUKA System Software. The mass inertia must be verified using KUKA.Load. It is imperative for the load data to be entered in the robot controller!

In-line wrist

In-line wrist type	ZH 210/240 F
Mounting flange	see drawing

Mounting flange

Screw grade	10.9
Screw size	M10
Number of fastening screws	11
Clamping length	1.5 x nominal diameter
Depth of engagement	min. 12 mm, max. 16 mm
Locating element	10 H7

The mounting flange is depicted with axis 6 in the zero position ([>>>](#) Fig. 4-48) The symbol X_m indicates the position of the locating element (bushing) in the zero position.

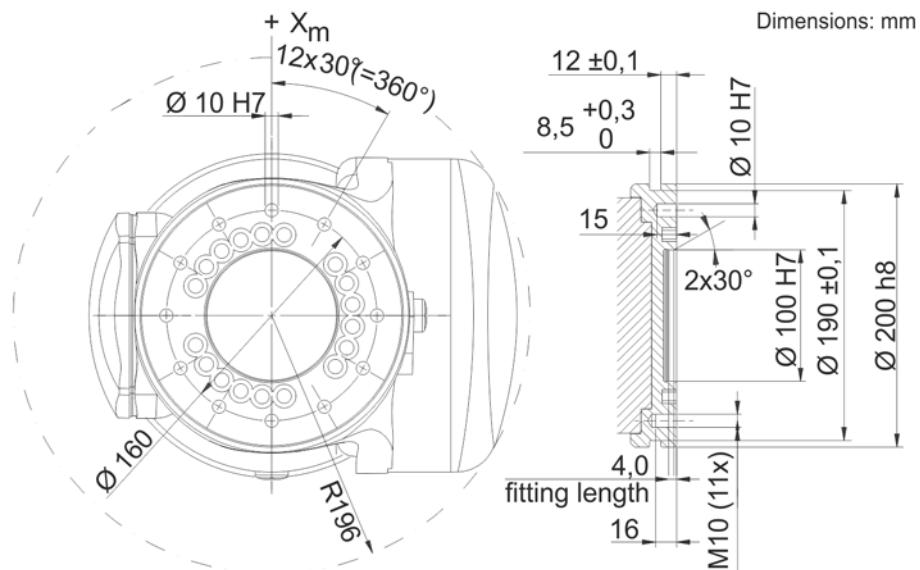


Fig. 4-48: Mounting flange D=160

4.8.4 Loads acting on the foundation, KR 210 R2700 prime C-F

Foundation loads The specified forces and moments already include the payload and the inertia force (weight) of the robot.

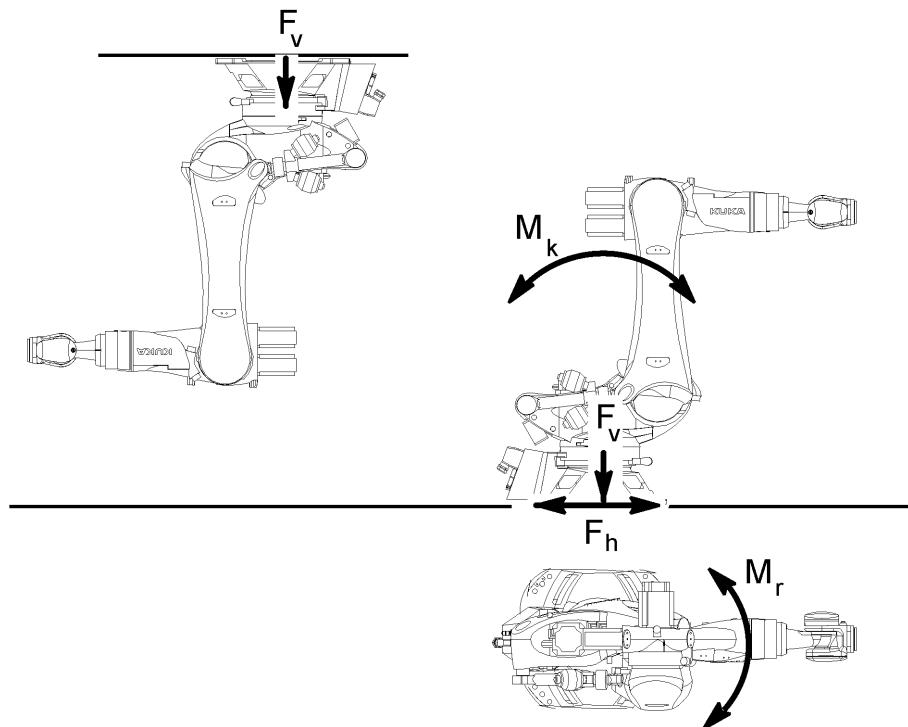


Fig. 4-49: Loads acting on the mounting base

Vertical force F(v)	
F(v normal)	19100 N
F(v max)	24000 N
Horizontal force F(h)	
F(h normal)	9200 N
F(h max)	16000 N

Tilting moment M(k)	
M(k normal)	24000 Nm
M(k max)	49000 Nm
Torque about axis 1 M(r)	
M(r normal)	10200 Nm
M(r max)	35000 Nm

Vertical force $F(v)$, horizontal force $F(h)$, tilting torque $M(k)$, torque about axis 1 $M(r)$



Normal loads and maximum loads for the foundations are specified in the table.

The maximum loads must be referred to when dimensioning the foundations and must be adhered to for safety reasons. Failure to observe this can result in personal injury and damage to property.

The normal loads are average expected foundation loads. The actual loads are dependent on the program and on the robot loads and may therefore be greater or less than the normal loads.

The supplementary loads (A1, A2 and A3) are not taken into consideration in the calculation of the foundation load. These supplementary loads must be taken into consideration for F_v .

4.9 Technical data, KR 180 R2900 prime

4.9.1 Basic data, KR 180 R2900 prime

Basic data

	KR 180 R2900 prime
Number of axes	6
Number of controlled axes	6
Volume of working envelope	66 m ³
Pose repeatability (ISO 9283)	± 0.06 mm
Weight	approx. 1106 kg
Rated payload	180 kg
Maximum reach	2896 mm
Protection rating (IEC 60529)	IP65
Protection rating, in-line wrist (IEC 60529)	IP65
Sound level	< 75 dB (A)
Mounting position	Floor
Footprint	830 mm x 830 mm
Hole pattern: mounting surface for kinematic system	S934
Permissible angle of inclination	≤ 5 °
Default color	Base frame: black (RAL 9005); Moving parts: KUKA orange 2567
Controller	KR C4
Transformation name	KR C4: KR180R2900 PRIME C4 FLR

Hollow shaft diameter

A1	139 mm (partially occupied by motor cables)
----	---

Ambient conditions

Humidity class (EN 60204)	-
Classification of environmental conditions (EN 60721-3-3)	3K3
Ambient temperature	
During operation	10 °C to 55 °C (283 K to 328 K)
During storage/transportation	-40 °C to 60 °C (233 K to 333 K)



For operation at low temperatures, it may be necessary to warm up the robot.

Connecting cables

Cable designation	Connector designation robot controller - ro- bot	Interface with robot
Motor cable	X20 - X30	Harting connectors at both ends
Data cable	X21 - X31	Rectangular connector at both ends
Ground conductor / equipotential bonding 16 mm ² (can be ordered as an option)		M8 ring cable lug at both ends

Cable lengths	
Standard	7 m, 15 m, 25 m, 35 m, 50 m

Minimum bending radius	5x D
------------------------	------

For detailed specifications of the connecting cables, see "Description of the connecting cables".

4.9.2 Axis data, KR 180 R2900 prime**Axis data**

Motion range	
A1	±185 °
A2	-140 ° / -5 °
A3	-120 ° / 155 °
A4	±350 °
A5	±125 °
A6	±350 °
Speed with rated payload	
A1	105 °/s
A2	107 °/s
A3	114 °/s
A4	179 °/s
A5	172 °/s
A6	219 °/s

The direction of motion and the arrangement of the individual axes may be noted from the diagram ([>>>](#) Fig. 4-50).

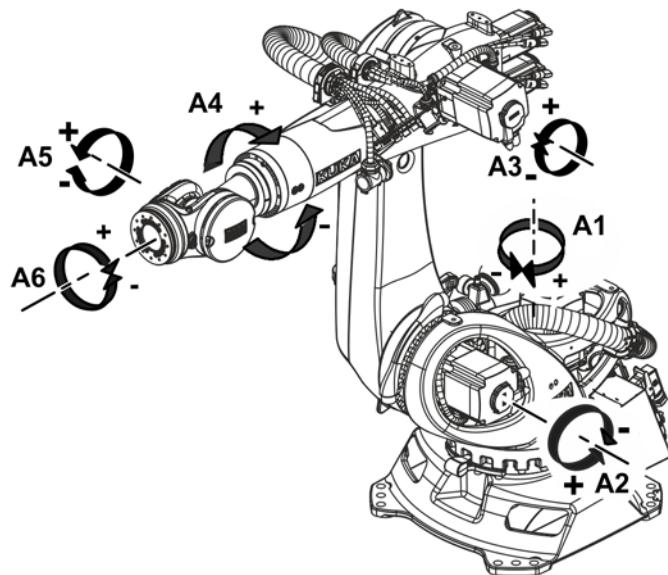


Fig. 4-50: Direction of rotation of the axes

Mastering position

Mastering position	
A1	-20 °
A2	-120 °
A3	110 °
A4	0 °
A5	0 °
A6	0 °

Working envelope

The following diagrams ([>>> Fig. 4-51](#)) and ([>>> Fig. 4-52](#)) show the load center of gravity, shape and size of the working envelope.

The reference point for the working envelope is the intersection of axis 4 with axis 5.

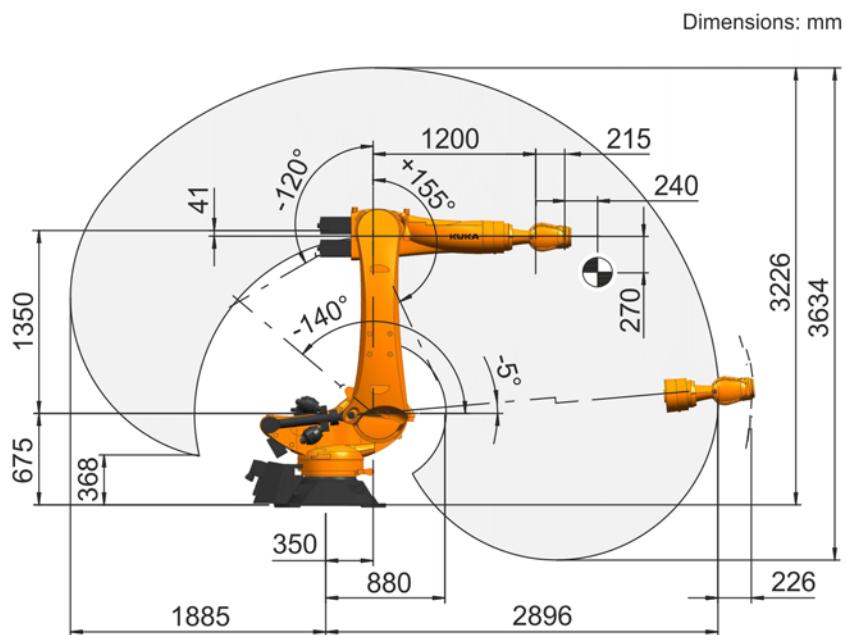


Fig. 4-51: KR 180 R2900 prime, working envelope, side view

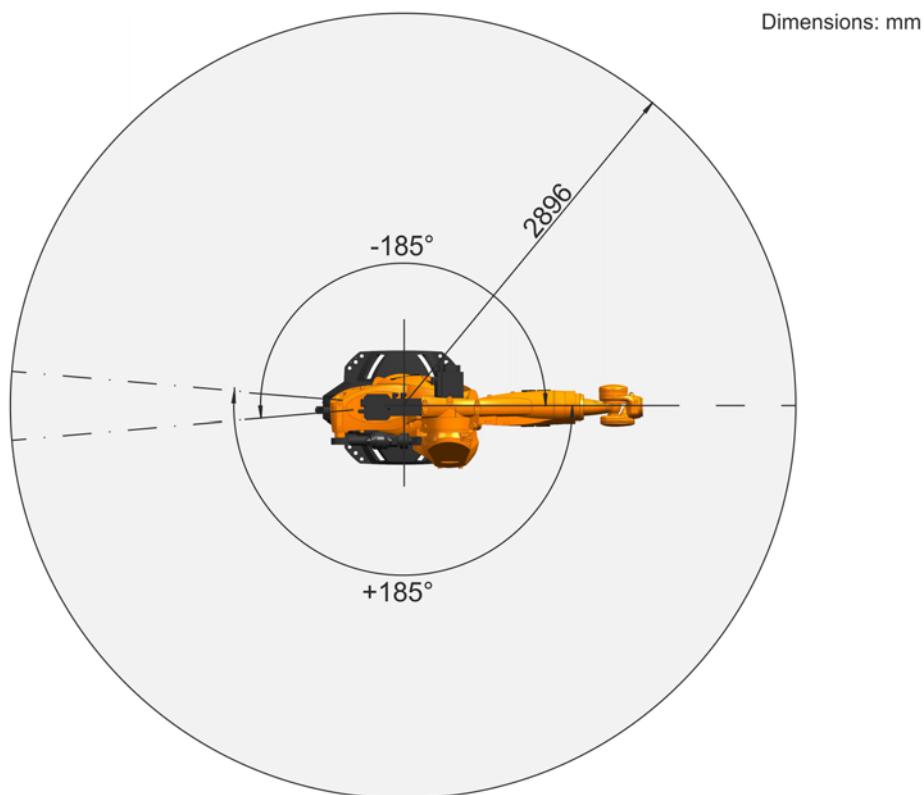


Fig. 4-52: KR 180 R2900 prime, working envelope, top view

4.9.3 Payloads, KR 180 R2900 prime

Payloads

Rated payload	180 kg
Rated mass moment of inertia	90 kgm ²
Rated total load	230 kg
Rated supplementary load, base frame	0 kg
Maximum supplementary load, base frame	-
Rated supplementary load, rotating column	0 kg
Maximum supplementary load, rotating column	300 kg
Rated supplementary load, link arm	0 kg
Maximum supplementary load, link arm	130 kg
Rated supplementary load, arm	50 kg
Maximum supplementary load, arm	150 kg
Nominal distance to load center of gravity	
L _{xy}	270 mm
L _z	240 mm

NOTICE

Exceeding the payloads and supplementary loads will reduce the service life of the robot and overload the motors and the gears. We recommend always testing the specific application with KUKA.Load. In cases where individual values are exceeded, KUKA Deutschland GmbH must be consulted.

Load center of gravity

For all payloads, the load center of gravity refers to the distance from the face of the mounting flange on axis 6. Refer to the payload diagram for the nominal distance.

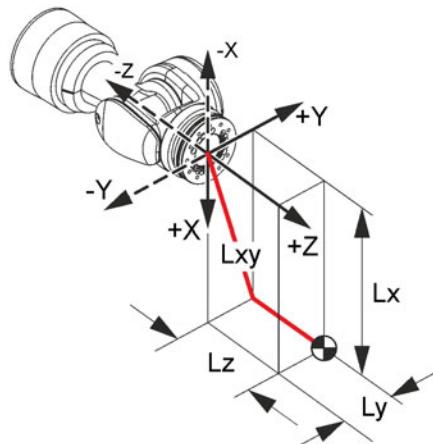


Fig. 4-53: Load center of gravity

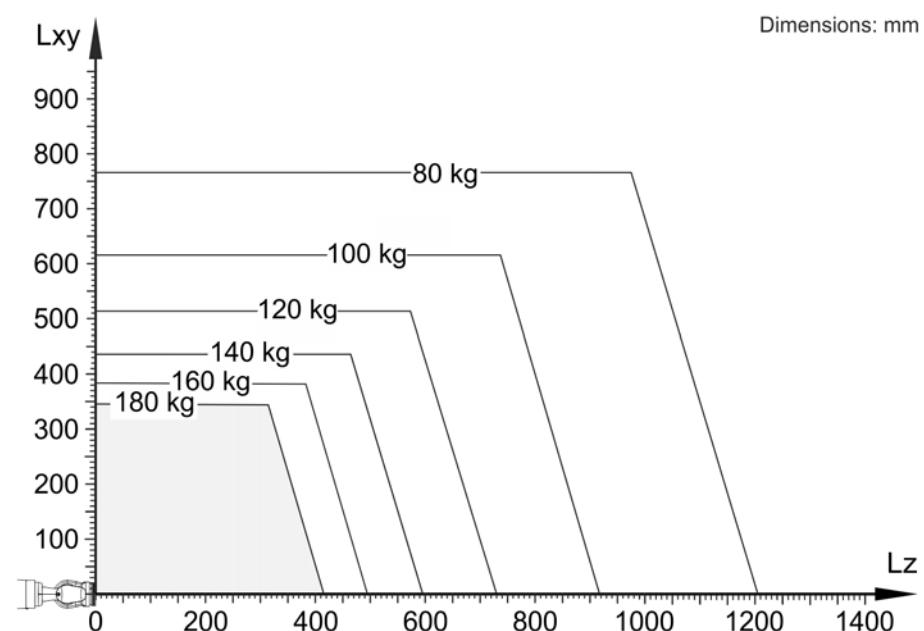
Payload diagram

Fig. 4-54: KR QUANTEC prime payload diagram, payload 180 kg

NOTICE

This loading curve corresponds to the maximum load capacity. Both values (payload and mass moment of inertia) must be checked in all cases. Exceeding this capacity will reduce the service life of the robot and overload the motors and the gears; in any such case KUKA Deutschland GmbH must be consulted beforehand. The values determined here are necessary for planning the robot application. For commissioning the robot, additional input data are required in accordance with the operating and programming instructions of the KUKA System Software. The mass inertia must be verified using KUKA.Load. It is imperative for the load data to be entered in the robot controller!

In-line wrist

In-line wrist type	ZH 150/180/210
Mounting flange	see drawing

Mounting flange

Screw grade	10.9
Screw size	M10
Number of fastening screws	11
Clamping length	1.5 x nominal diameter
Depth of engagement	min. 12 mm, max. 16 mm
Locating element	10 H7

The mounting flange is depicted with axis 6 in the zero position ([>>> Fig. 4-55](#)) The symbol X_m indicates the position of the locating element (bushing) in the zero position.

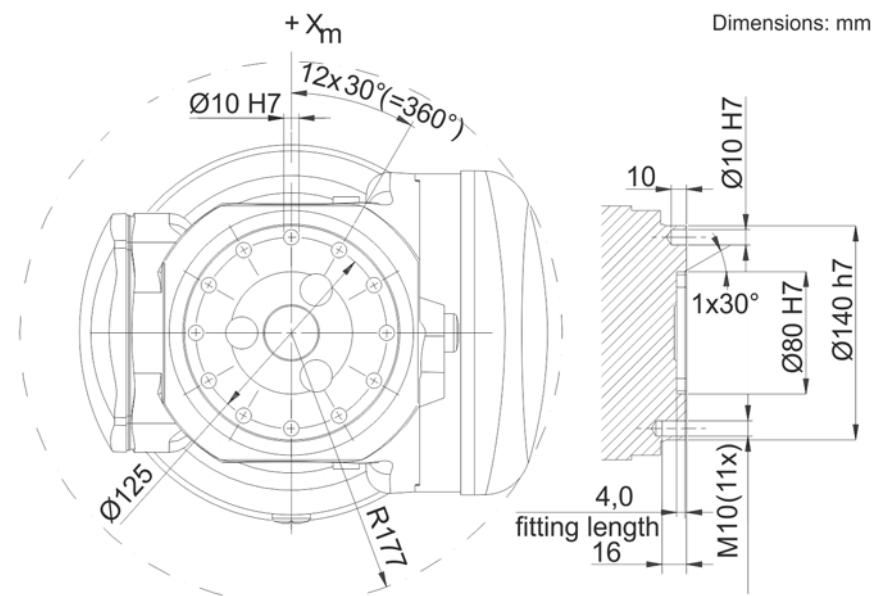


Fig. 4-55: Mounting flange D=125

NOTICE

An optional adapter is available for the mounting flange. Further information about this option may be found in the chapter "Options" ([>>> 13 "Options" Page 233](#)).

4.9.4 Loads acting on the foundation, KR 180 R2900 prime

Foundation loads

The specified forces and moments already include the payload and the inertia force (weight) of the robot.

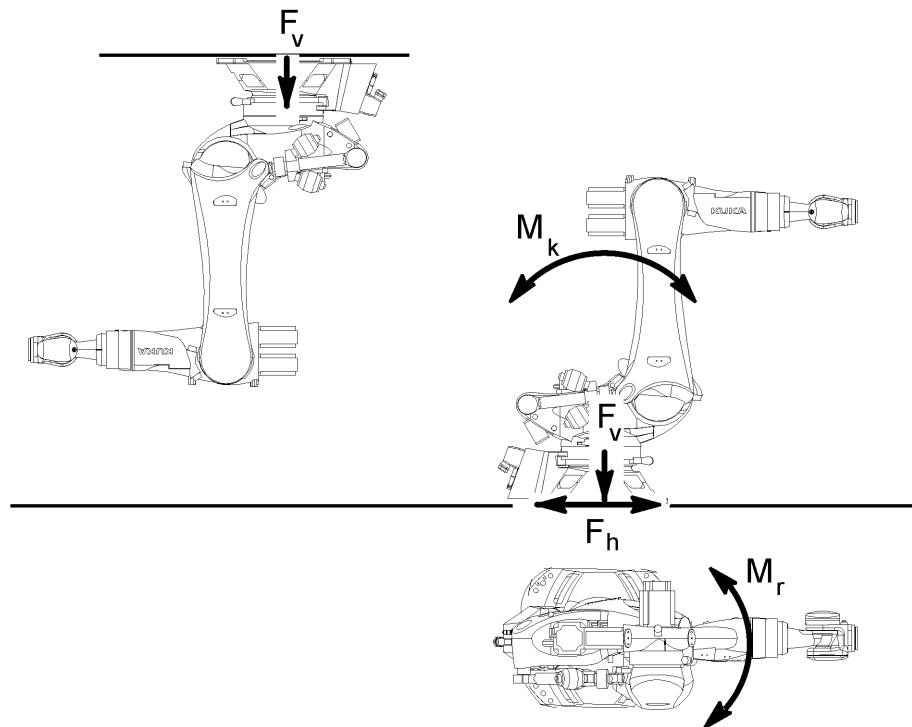


Fig. 4-56: Loads acting on the mounting base

Vertical force $F(v)$	
$F(v \text{ normal})$	19100 N
$F(v \text{ max})$	24000 N
Horizontal force $F(h)$	
$F(h \text{ normal})$	9200 N
$F(h \text{ max})$	16000 N
Tilting moment $M(k)$	
$M(k \text{ normal})$	24000 Nm
$M(k \text{ max})$	49000 Nm
Torque about axis 1 $M(r)$	
$M(r \text{ normal})$	10200 Nm
$M(r \text{ max})$	35000 Nm

Vertical force $F(v)$, horizontal force $F(h)$, tilting torque $M(k)$, torque about axis 1 $M(r)$

⚠ WARNING

Normal loads and maximum loads for the foundations are specified in the table.

The maximum loads must be referred to when dimensioning the foundations and must be adhered to for safety reasons. Failure to observe this can result in personal injury and damage to property.

The normal loads are average expected foundation loads. The actual loads are dependent on the program and on the robot loads and may therefore be greater or less than the normal loads.

The supplementary loads (A1, A2 and A3) are not taken into consideration in the calculation of the foundation load. These supplementary loads must be taken into consideration for F_v .

4.10 Technical data, KR 150 R3100 prime

4.10.1 Basic data, KR 150 R3100 prime

Basic data

	KR 150 R3100 prime
Number of axes	6
Number of controlled axes	6
Volume of working envelope	84 m ³
Pose repeatability (ISO 9283)	± 0.06 mm
Weight	approx. 1114 kg
Rated payload	150 kg
Maximum reach	3095 mm
Protection rating (IEC 60529)	IP65
Protection rating, in-line wrist (IEC 60529)	IP65
Sound level	< 75 dB (A)
Mounting position	Floor
Footprint	830 mm x 830 mm
Hole pattern: mounting surface for kinematic system	S934
Permissible angle of inclination	≤ 5 °
Default color	Base frame: black (RAL 9005); Moving parts: KUKA orange 2567
Controller	KR C4
Transformation name	KR C4: KR150R3100 PRIME C4 FLR

Hollow shaft diameter	
A1	139 mm (partially occupied by motor cables)

Ambient conditions

Humidity class (EN 60204)	-
Classification of environmental conditions (EN 60721-3-3)	3K3
Ambient temperature	
During operation	10 °C to 55 °C (283 K to 328 K)
During storage/transportation	-40 °C to 60 °C (233 K to 333 K)



For operation at low temperatures, it may be necessary to warm up the robot.

Connecting cables

Cable designation	Connector designation robot controller - robot	Interface with robot
Motor cable	X20 - X30	Harting connectors at both ends

Cable designation	Connector designation robot controller - robot	Interface with robot
Data cable	X21 - X31	Rectangular connector at both ends
Ground conductor / equipotential bonding 16 mm ² (can be ordered as an option)		M8 ring cable lug at both ends
Cable lengths		
Standard		7 m, 15 m, 25 m, 35 m, 50 m
Minimum bending radius		5x D

For detailed specifications of the connecting cables, see "Description of the connecting cables".

4.10.2 Axis data, KR 150 R3100 prime

Axis data

Motion range	
A1	±185 °
A2	-140 ° / -5 °
A3	-120 ° / 155 °
A4	±350 °
A5	±125 °
A6	±350 °
Speed with rated payload	
A1	105 °/s
A2	107 °/s
A3	114 °/s
A4	179 °/s
A5	172 °/s
A6	219 °/s

The direction of motion and the arrangement of the individual axes may be noted from the diagram ([>>> Fig. 4-57](#)).

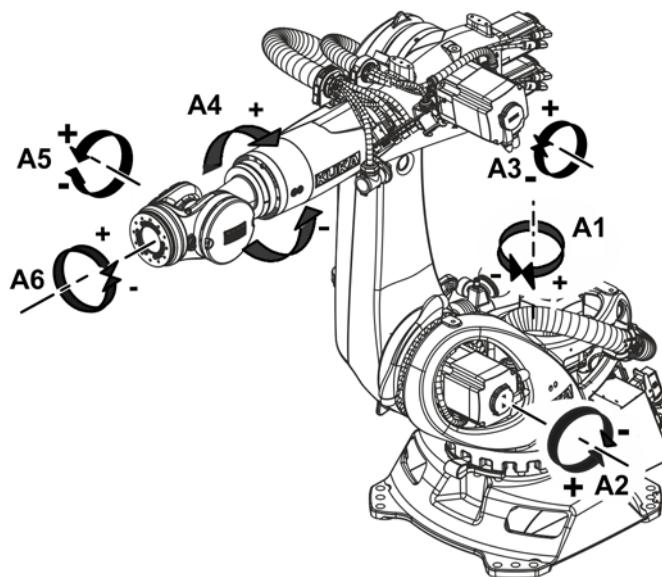


Fig. 4-57: Direction of rotation of the axes

Mastering position

Mastering position	
A1	-20 °
A2	-120 °
A3	110 °
A4	0 °
A5	0 °
A6	0 °

Working envelope

The following diagrams ([>>> Fig. 4-58](#)) and Working envelope, top view show the load center of gravity and the shape and size of the working envelope.

The reference point for the working envelope is the intersection of axis 4 with axis 5.

Dimensions: mm

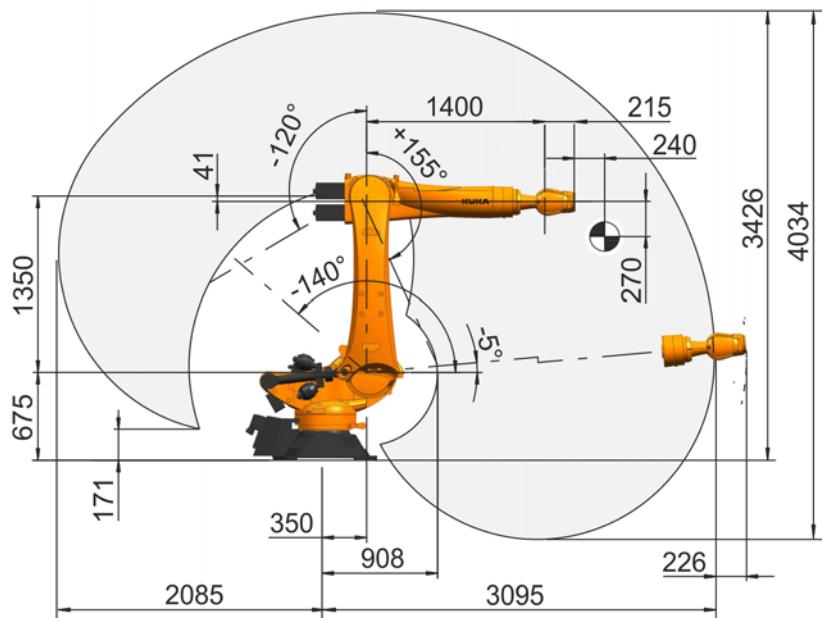


Fig. 4-58: KR 150 R3100 prime, working envelope, side view

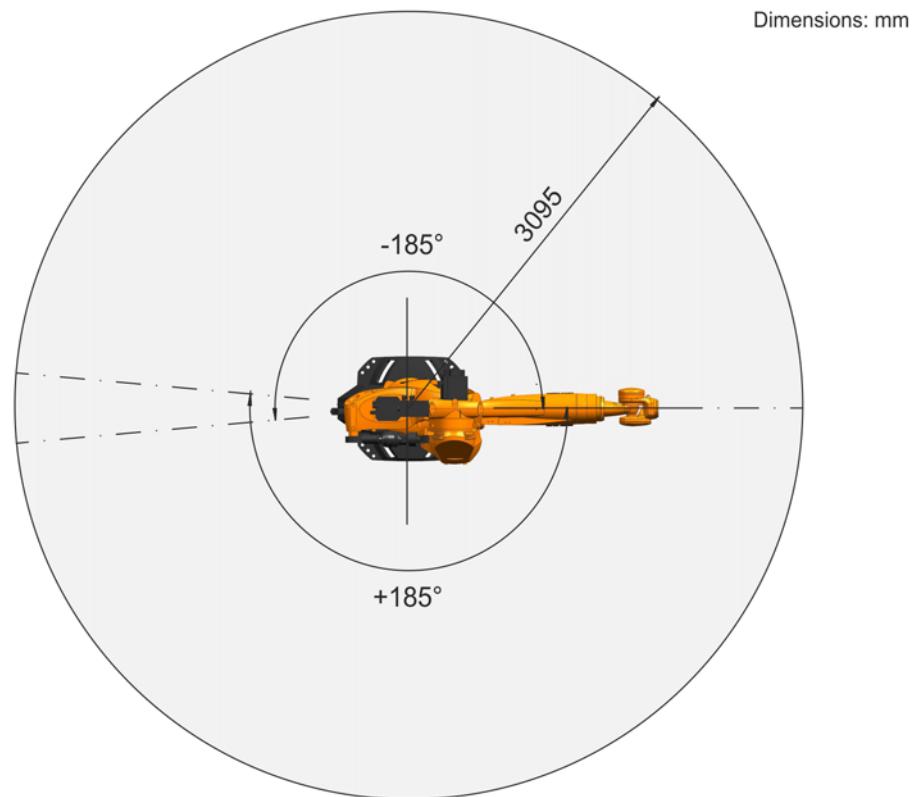


Fig. 4-59: KR 150 R3100 prime, working envelope, top view

4.10.3 Payloads, KR 150 R3100 prime

Payloads

Rated payload	150 kg
Rated mass moment of inertia	75 kgm ²
Rated total load	200 kg

Rated supplementary load, base frame	0 kg
Maximum supplementary load, base frame	-
Rated supplementary load, rotating column	0 kg
Maximum supplementary load, rotating column	300 kg
Rated supplementary load, link arm	0 kg
Maximum supplementary load, link arm	130 kg
Rated supplementary load, arm	50 kg
Maximum supplementary load, arm	150 kg
Nominal distance to load center of gravity	
Lxy	270 mm
Lz	240 mm

NOTICE

Exceeding the payloads and supplementary loads will reduce the service life of the robot and overload the motors and the gears. We recommend always testing the specific application with KUKA.Load. In cases where individual values are exceeded, KUKA Deutschland GmbH must be consulted.

Load center of gravity

For all payloads, the load center of gravity refers to the distance from the face of the mounting flange on axis 6. Refer to the payload diagram for the nominal distance.

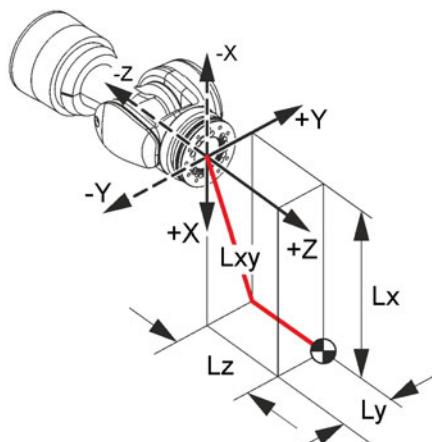
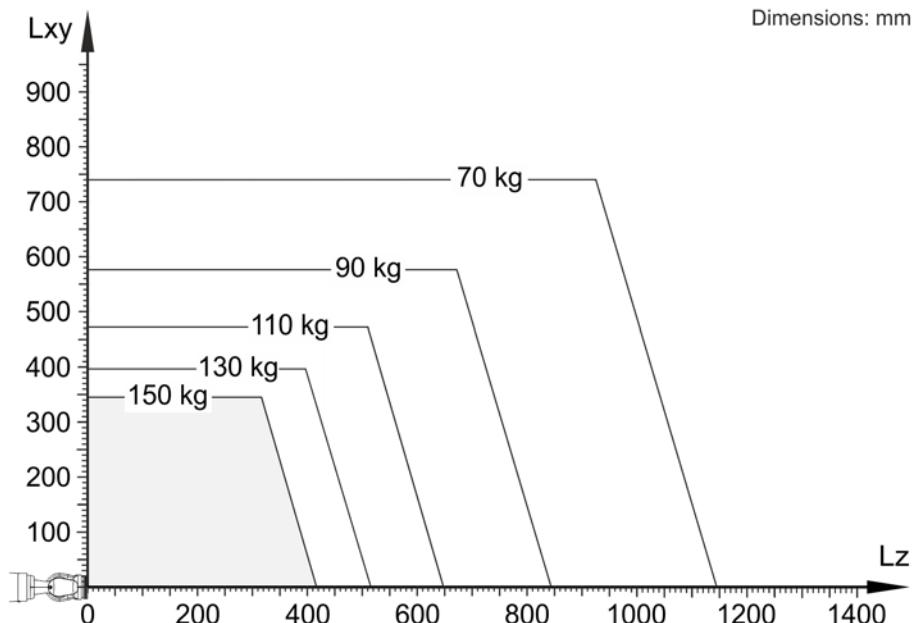


Fig. 4-60: Load center of gravity

Payload diagram**Fig. 4-61: KR QUANTEC prime payload diagram, payload 150 kg****NOTICE**

This loading curve corresponds to the maximum load capacity. Both values (payload and mass moment of inertia) must be checked in all cases. Exceeding this capacity will reduce the service life of the robot and overload the motors and the gears; in any such case KUKA Deutschland GmbH must be consulted beforehand. The values determined here are necessary for planning the robot application. For commissioning the robot, additional input data are required in accordance with the operating and programming instructions of the KUKA System Software. The mass inertia must be verified using KUKA.Load. It is imperative for the load data to be entered in the robot controller!

In-line wrist

In-line wrist type	ZH 150/180/210
Mounting flange	see drawing

Mounting flange

Screw grade	10.9
Screw size	M10
Number of fastening screws	11
Clamping length	1.5 x nominal diameter
Depth of engagement	min. 12 mm, max. 16 mm
Locating element	10 H7

The mounting flange is depicted with axis 6 in the zero position ([>>>](#) Fig. 4-62) The symbol X_m indicates the position of the locating element (bushing) in the zero position.

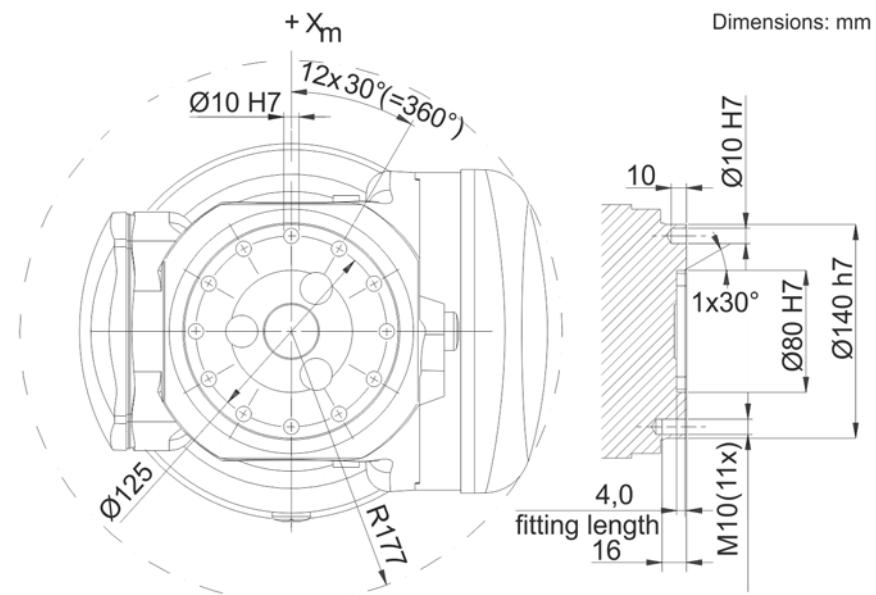


Fig. 4-62: Mounting flange D=125

NOTICE

An optional adapter is available for the mounting flange. Further information about this option may be found in the chapter "Options" (>>> 13 "Options" Page 233).

4.10.4 Loads acting on the foundation, KR 150 R3100 prime

Foundation loads The specified forces and moments already include the payload and the inertia force (weight) of the robot.

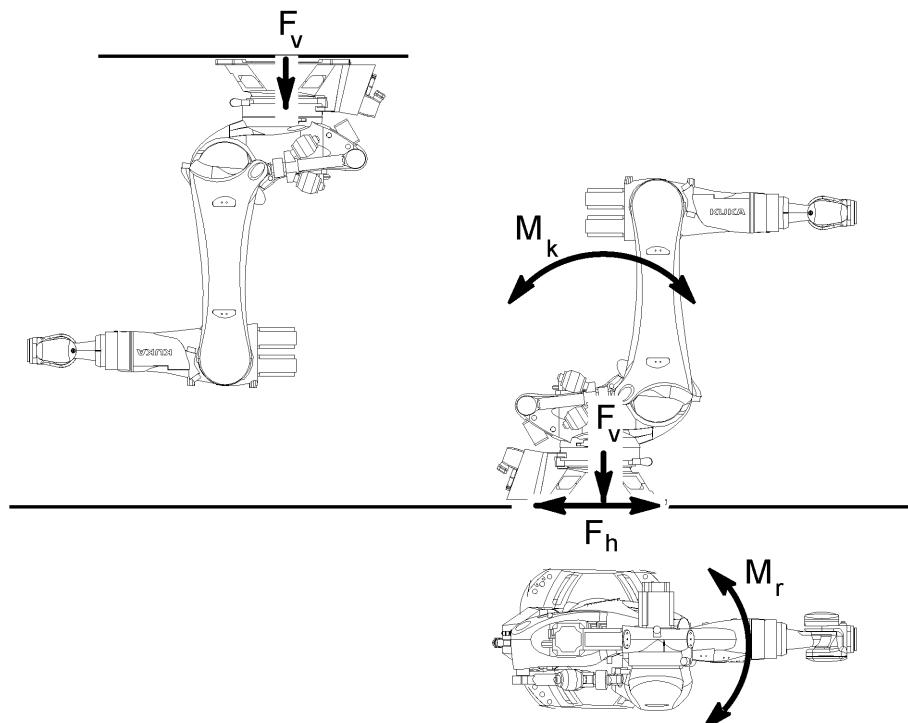


Fig. 4-63: Loads acting on the mounting base

Vertical force F(v)	
F(v normal)	19100 N

F(v max)	24000 N
Horizontal force F(h)	
F(h normal)	9200 N
F(h max)	16000 N
Tilting moment M(k)	
M(k normal)	24000 Nm
M(k max)	49000 Nm
Torque about axis 1 M(r)	
M(r normal)	10200 Nm
M(r max)	35000 Nm

Vertical force F(v), horizontal force F(h), tilting torque M(k), torque about axis 1 M(r)

⚠ WARNING

Normal loads and maximum loads for the foundations are specified in the table.

The maximum loads must be referred to when dimensioning the foundations and must be adhered to for safety reasons. Failure to observe this can result in personal injury and damage to property.

The normal loads are average expected foundation loads. The actual loads are dependent on the program and on the robot loads and may therefore be greater or less than the normal loads.

The supplementary loads (A1, A2 and A3) are not taken into consideration in the calculation of the foundation load. These supplementary loads must be taken into consideration for F_v.

4.11 Supplementary load

Description

The robot can carry supplementary loads on the rotating column, link arm and arm. When mounting the supplementary loads, be careful to observe the maximum permissible total load. The dimensions and positions of the installation options can be seen in the following diagram.

Dimensions: mm

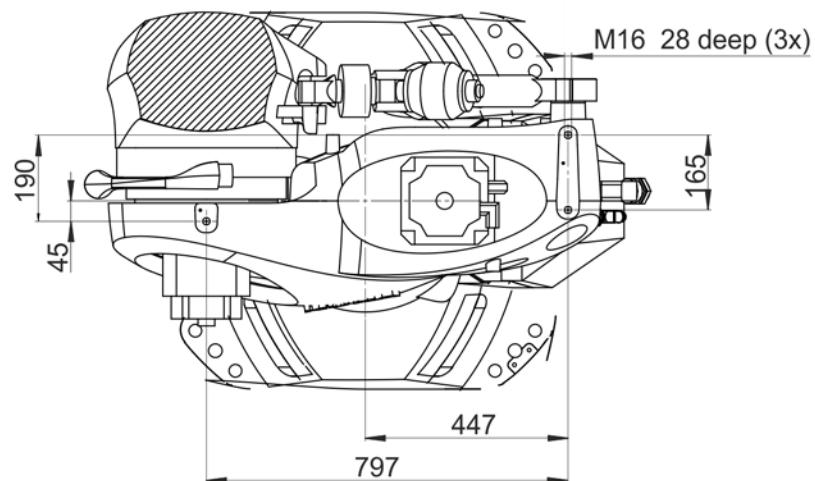


Fig. 4-64: Supplementary load, rotating column

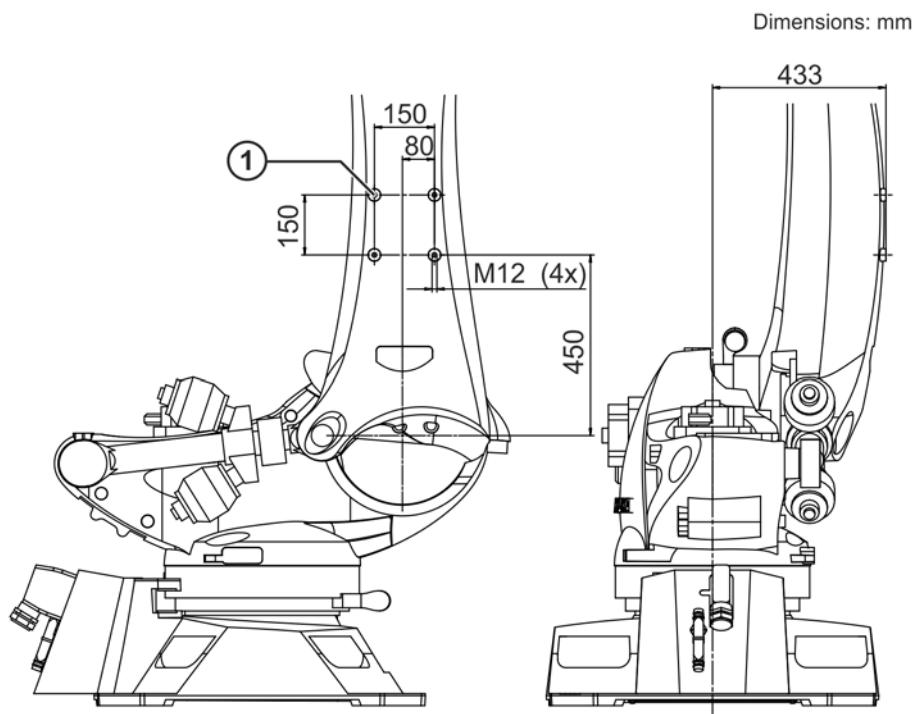


Fig. 4-65: Supplementary load, link arm

1 Mounting surface

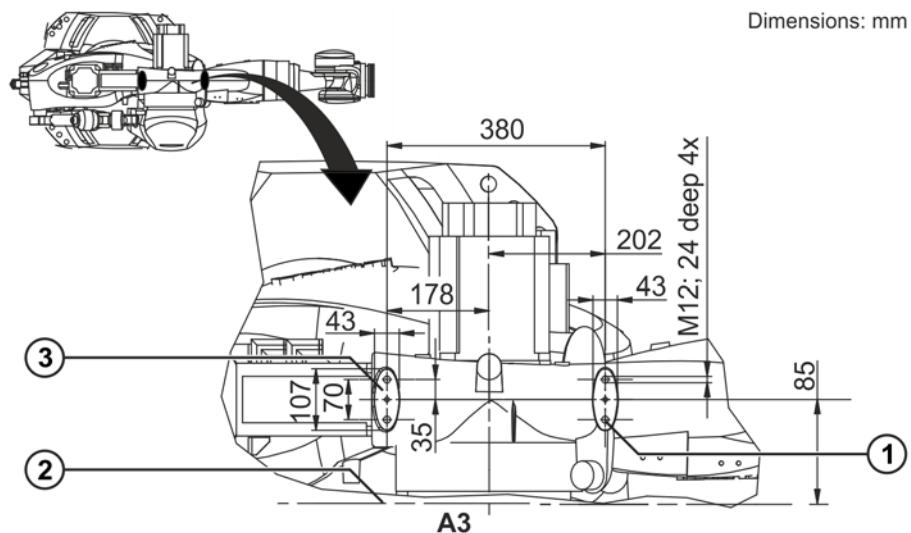


Fig. 4-66: Supplementary load, arm

1 Fastening thread

2 Interference contour, arm

3 Mounting surface

4.12 Plates and labels

Plates and labels

The following plates and labels (>>> Fig. 4-67)are attached to the robot. They must not be removed or rendered illegible. Illegible plates and labels must be replaced.

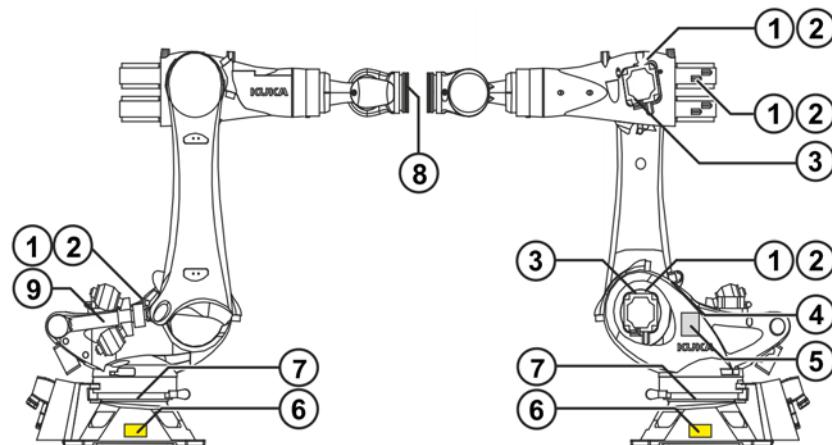
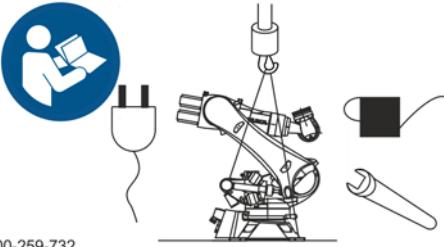
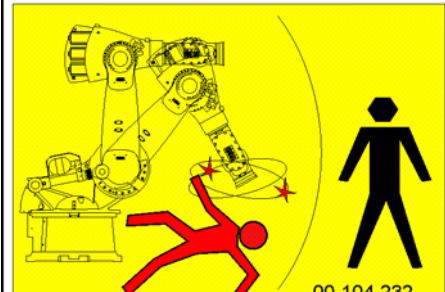
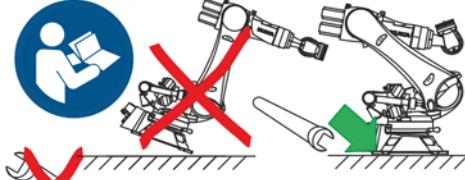
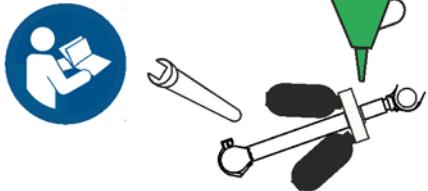


Fig. 4-67: Location of plates and labels

Item	Description		
1	High voltage Any improper handling can lead to contact with current-carrying components. Electric shock hazard!		
2	Hot surface During operation of the robot, surface temperatures may be reached that could result in burn injuries. Protective gloves must be worn!		
3	 00-259-732	CAUTION ATTENTION VORSICHT	Before removing the motor, secure robot axis to prevent it from turning! Avant de retirer le moteur, protéger l'axe du robot contre le basculement! Vor Entfernen des Motors, Roboterachse gegen Bewegungen sichern!
	Secure the axes Before exchanging any motor, secure the corresponding axis through safeguarding by suitable means/devices to protect against possible movement. The axis can move. Risk of crushing!		

Item	Description						
4	  00-259-732 <table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="padding: 5px; background-color: #ffff00;">⚠ CAUTION</td><td style="padding: 5px;">Secure the system before beginning work on the robot. Read and observe the safety instructions!</td></tr> <tr> <td style="padding: 5px; background-color: #ffff00;">⚠ ATTENTION</td><td style="padding: 5px;">Bloquer le système avant d'effectuer des travaux sur le robot. Lire et respecter les remarques relatives à la sécurité!</td></tr> <tr> <td style="padding: 5px; background-color: #ffff00;">⚠ VORSICHT</td><td style="padding: 5px;">Vor Arbeiten am Roboter, System sichern. Sicherheitshinweise lesen und beachten!</td></tr> </table> <p>Work on the robot Before start-up, transportation or maintenance, read and follow the assembly and operating instructions.</p>	⚠ CAUTION	Secure the system before beginning work on the robot. Read and observe the safety instructions!	⚠ ATTENTION	Bloquer le système avant d'effectuer des travaux sur le robot. Lire et respecter les remarques relatives à la sécurité!	⚠ VORSICHT	Vor Arbeiten am Roboter, System sichern. Sicherheitshinweise lesen und beachten!
⚠ CAUTION	Secure the system before beginning work on the robot. Read and observe the safety instructions!						
⚠ ATTENTION	Bloquer le système avant d'effectuer des travaux sur le robot. Lire et respecter les remarques relatives à la sécurité!						
⚠ VORSICHT	Vor Arbeiten am Roboter, System sichern. Sicherheitshinweise lesen und beachten!						
5	 <p>Identification plate Content according to Machinery Directive.</p>						
6	 00-104-232 <p>Danger zone Entering the danger zone of the robot is prohibited if the robot is in operation or ready for operation. Risk of injury!</p>						

Item	Description												
7	  <table border="1" data-bbox="969 417 1414 473"> <tr> <td>A1</td> <td>A2</td> <td>A3</td> <td>A4</td> <td>A5</td> <td>A6</td> </tr> <tr> <td>0°</td> <td>-140°</td> <td>+150°</td> <td>0°</td> <td>-120°</td> <td>0°</td> </tr> </table> <p>00-259-732</p> <p>⚠ CAUTION Move the robot into its transport position before removing the mounting base!</p> <p>⚠ ATTENTION Amener le robot en position de transport avant de défaire la fixation aux fondations!</p> <p>⚠ VORSICHT Roboter vor Lösen der Fundamentbefestigung in Transportstellung bringen!</p> <p>Transport position Before loosening the bolts of the mounting base, the robot must be in the transport position as indicated in the table. Risk of toppling!</p>	A1	A2	A3	A4	A5	A6	0°	-140°	+150°	0°	-120°	0°
A1	A2	A3	A4	A5	A6								
0°	-140°	+150°	0°	-120°	0°								
8	<table border="1" data-bbox="639 792 1096 1096"> <tr> <td>Schrauben Einschraubtiefe Klemmlänge</td> <td>M10 Qualitat 10.9 min. 12 max. 16mm min. 12mm</td> </tr> <tr> <td>Fastening screws Engagement length Screw grip</td> <td>M10 quality 10.9 min. 12 max. 16mm min. 12mm</td> </tr> <tr> <td>Vis Longueur vissée Longueur de serrage</td> <td>M10 qualite 10.9 min. 12 max. 16mm min. 12mm</td> </tr> <tr> <td colspan="2">Art.Nr. 00-139-033</td> </tr> </table> <p>Mounting flange on in-line wrist The values specified on this plate apply for the installation of tools on the mounting flange of the wrist and must be observed.</p>	Schrauben Einschraubtiefe Klemmlänge	M10 Qualitat 10.9 min. 12 max. 16mm min. 12mm	Fastening screws Engagement length Screw grip	M10 quality 10.9 min. 12 max. 16mm min. 12mm	Vis Longueur vissée Longueur de serrage	M10 qualite 10.9 min. 12 max. 16mm min. 12mm	Art.Nr. 00-139-033					
Schrauben Einschraubtiefe Klemmlänge	M10 Qualitat 10.9 min. 12 max. 16mm min. 12mm												
Fastening screws Engagement length Screw grip	M10 quality 10.9 min. 12 max. 16mm min. 12mm												
Vis Longueur vissée Longueur de serrage	M10 qualite 10.9 min. 12 max. 16mm min. 12mm												
Art.Nr. 00-139-033													

Item	Description									
9	 <div style="display: flex; justify-content: space-around;"> <div style="text-align: center;">  <p>p > 10 MPa (100 bar)</p> <p>00-259-732</p> </div> <div style="text-align: center;">  </div> </div> <table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="padding: 5px; background-color: yellow;">CAUTION</td><td style="padding: 5px;">Counterbalancing system pressurized – read and observe safety instructions before beginning work!</td></tr> <tr> <td style="padding: 5px; background-color: yellow;">ATTENTION</td><td style="padding: 5px;">Le système d'équilibrage est sous pression, lire et respecter les remarques relatives à la sécurité avant d'effectuer des travaux !</td></tr> <tr> <td style="padding: 5px; background-color: yellow;">VORSICHT</td><td style="padding: 5px;">Gewichtsausgleich unter Druck, vor Arbeiten Sicherheitshinweise lesen und beachten!</td></tr> </table> <p>Counterbalancing system</p> <p>The system is pressurized with oil and nitrogen. Read and follow the assembly and operating instructions before commencing work on the counterbalancing system. Risk of injury!</p>				CAUTION	Counterbalancing system pressurized – read and observe safety instructions before beginning work!	ATTENTION	Le système d'équilibrage est sous pression, lire et respecter les remarques relatives à la sécurité avant d'effectuer des travaux !	VORSICHT	Gewichtsausgleich unter Druck, vor Arbeiten Sicherheitshinweise lesen und beachten!
CAUTION	Counterbalancing system pressurized – read and observe safety instructions before beginning work!									
ATTENTION	Le système d'équilibrage est sous pression, lire et respecter les remarques relatives à la sécurité avant d'effectuer des travaux !									
VORSICHT	Gewichtsausgleich unter Druck, vor Arbeiten Sicherheitshinweise lesen und beachten!									
10	Only for CR robot on each oil filler plug  <p>FoodProof</p> <p>Applying on gear unit. Unlike the standard gear unit, this gear unit must be filled with "FoodProof 1800" oil. Please observe the particularities!</p>									

4.13 REACH duty to communicate information acc. to Art. 33 of Regulation (EC) 1907/2006

On the basis of the information provided by our suppliers, this product and its components contain no substances included on the "Candidate List" of Substances of Very High Concern (SVHCs) in a concentration exceeding 0.1 percent by mass.

4.14 Stopping distances and times

4.14.1 General information

Information concerning the data:

- The stopping distance is the angle traveled by the robot from the moment the stop signal is triggered until the robot comes to a complete standstill.
- The stopping time is the time that elapses from the moment the stop signal is triggered until the robot comes to a complete standstill.
- The data are given for the main axes A1, A2 and A3. The main axes are the axes with the greatest deflection.
- Superposed axis motions can result in longer stopping distances.

- Stopping distances and stopping times in accordance with DIN EN ISO 10218-1, Annex B.
- Stop categories:
 - Stop category 0 » STOP 0
 - Stop category 1 » STOP 1
 according to IEC 60204-1
- The values specified for Stop 0 are guide values determined by means of tests and simulation. They are average values which conform to the requirements of DIN EN ISO 10218-1. The actual stopping distances and stopping times may differ due to internal and external influences on the braking torque. It is therefore advisable to determine the exact stopping distances and stopping times where necessary under the real conditions of the actual robot application.
- Measuring technique
The stopping distances were measured using the robot-internal measuring technique.
- The wear on the brakes varies depending on the operating mode, robot application and the number of STOP 0 stops triggered. It is therefore advisable to check the stopping distance at least once a year.

4.14.2 Terms used

Term	Description
m	Mass of the rated load and the supplementary load on the arm.
Phi	Angle of rotation (°) about the corresponding axis. This value can be entered in the controller via the KCP/smartPAD and can be displayed on the KCP/smartPAD.
POV	Program override (%) = velocity of the robot motion. This value can be entered in the controller via the KCP/smartPAD and can be displayed on the KCP/smartPAD.
Extension	Distance (l in %) (>>> Fig. 4-68) between axis 1 and the intersection of axes 4 and 5. With parallelogram robots, the distance between axis 1 and the intersection of axis 6 and the mounting flange.
KCP	KUKA Control Panel Teach pendant for the KR C2/KR C2 edition2005 The KCP has all the operator control and display functions required for operating and programming the industrial robot.
smartPAD	Teach pendant for the KR C4 The smartPAD has all the operator control and display functions required for operating and programming the industrial robot.

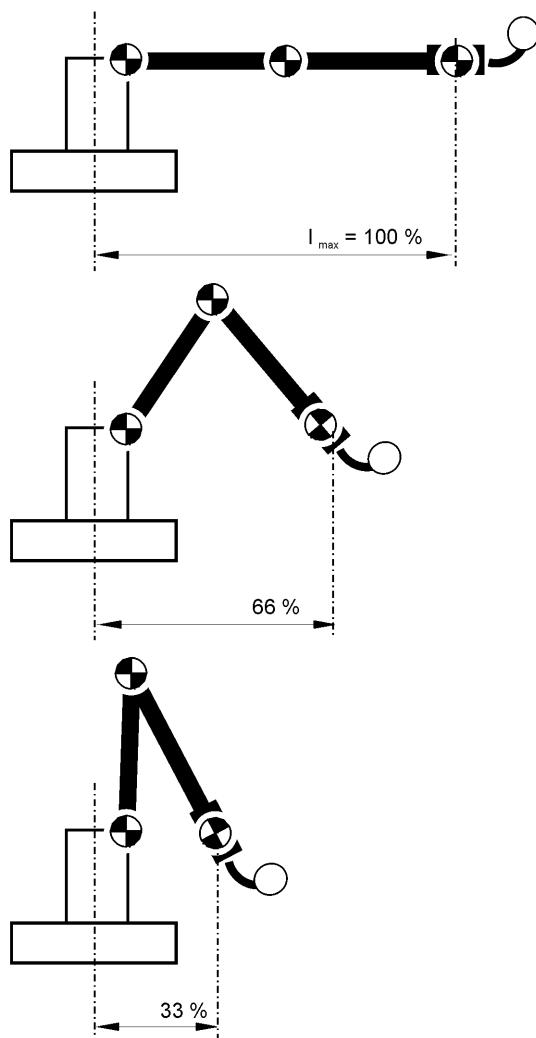


Fig. 4-68: Extension

4.14.3 Stopping distances and stopping times for KR 240 R2500 prime

4.14.3.1 Stopping distances and stopping times for STOP 0, axis 1 to axis 3

The table shows the stopping distances and stopping times after a STOP 0 (category 0 stop) is triggered. The values refer to the following configuration:

- Extension I = 100%
- Program override POV = 100%
- Mass m = maximum load (rated load + supplementary load on arm)

	Stopping distance (°)	Stopping time (s)
Axis 1	30.1	0.61
Axis 2	28.3	0.54
Axis 3	25.4	0.47

4.14.3.2 Stopping distances and stopping times for STOP 1, axis 1

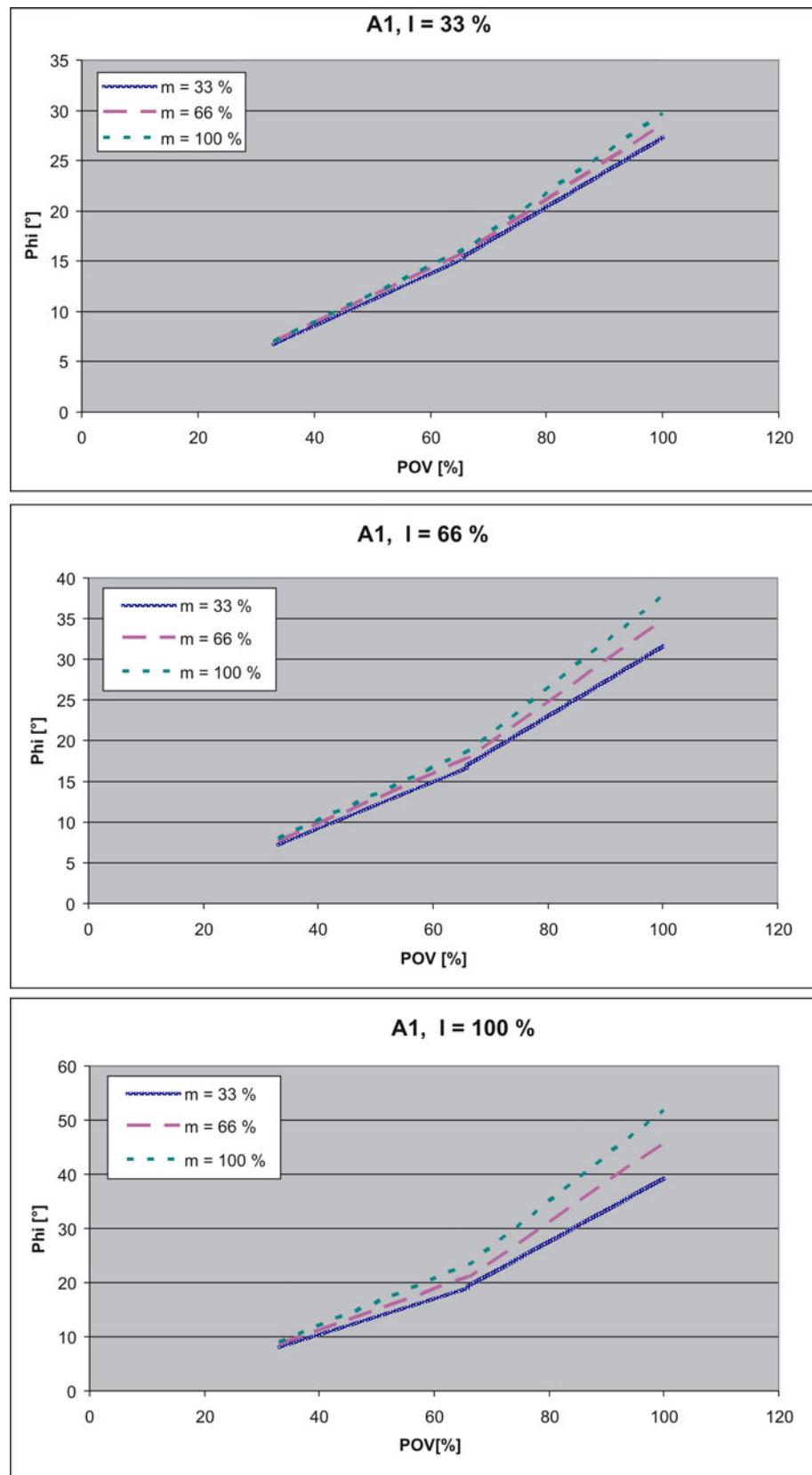


Fig. 4-69: Stopping distances for STOP 1, axis 1

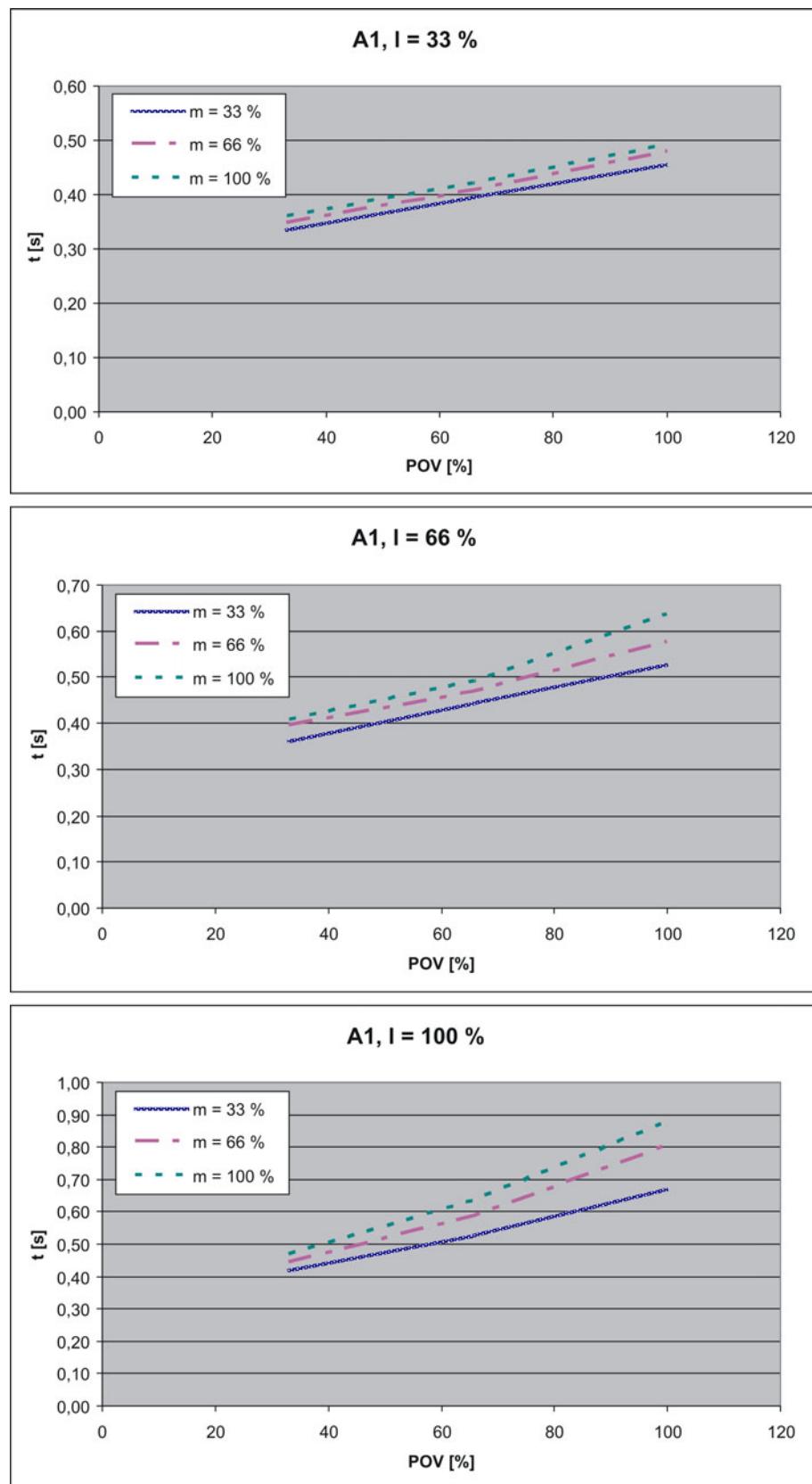


Fig. 4-70: Stopping times for STOP 1, axis 1

4.14.3.3 Stopping distances and stopping times for STOP 1, axis 2

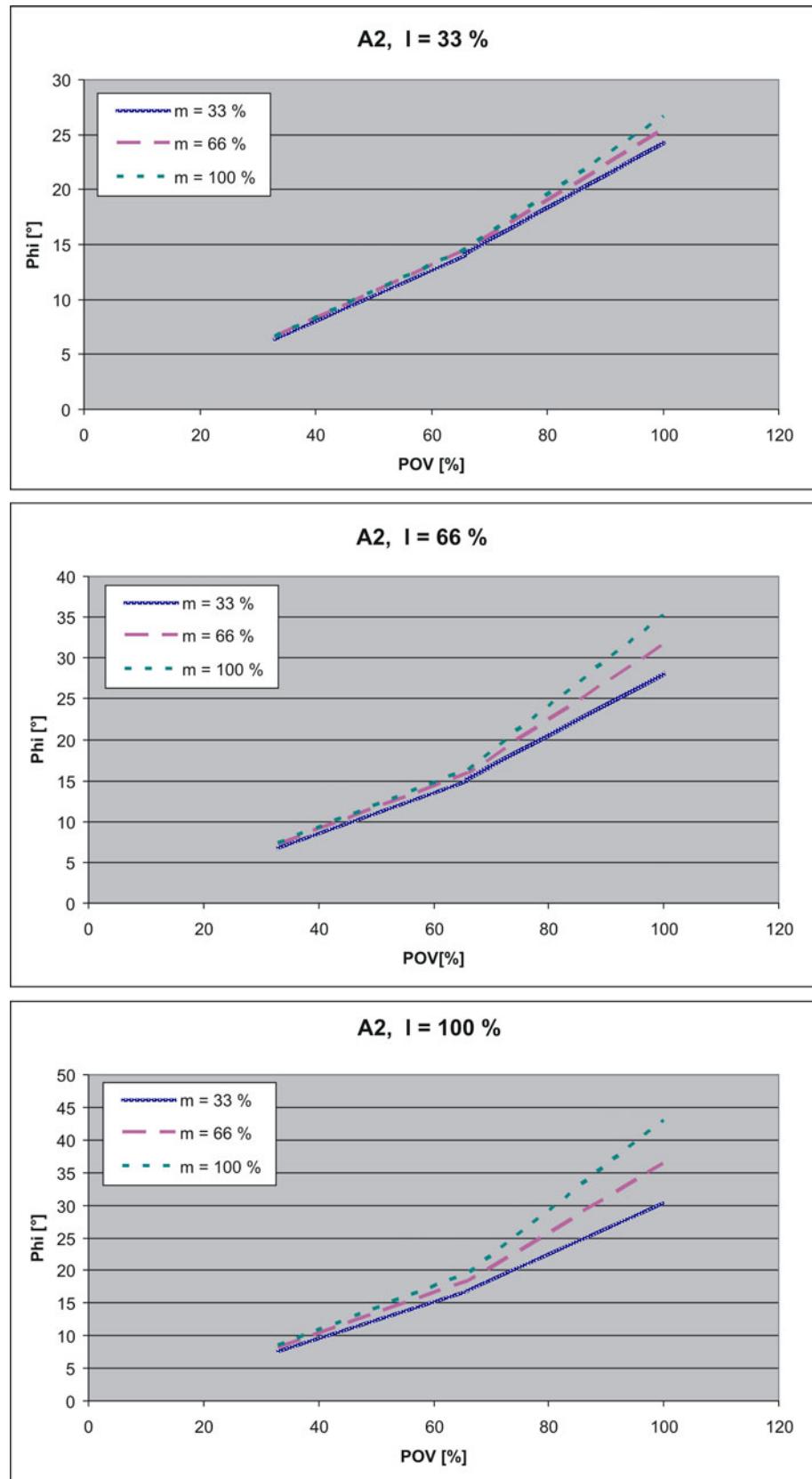


Fig. 4-71: Stopping distances for STOP 1, axis 2

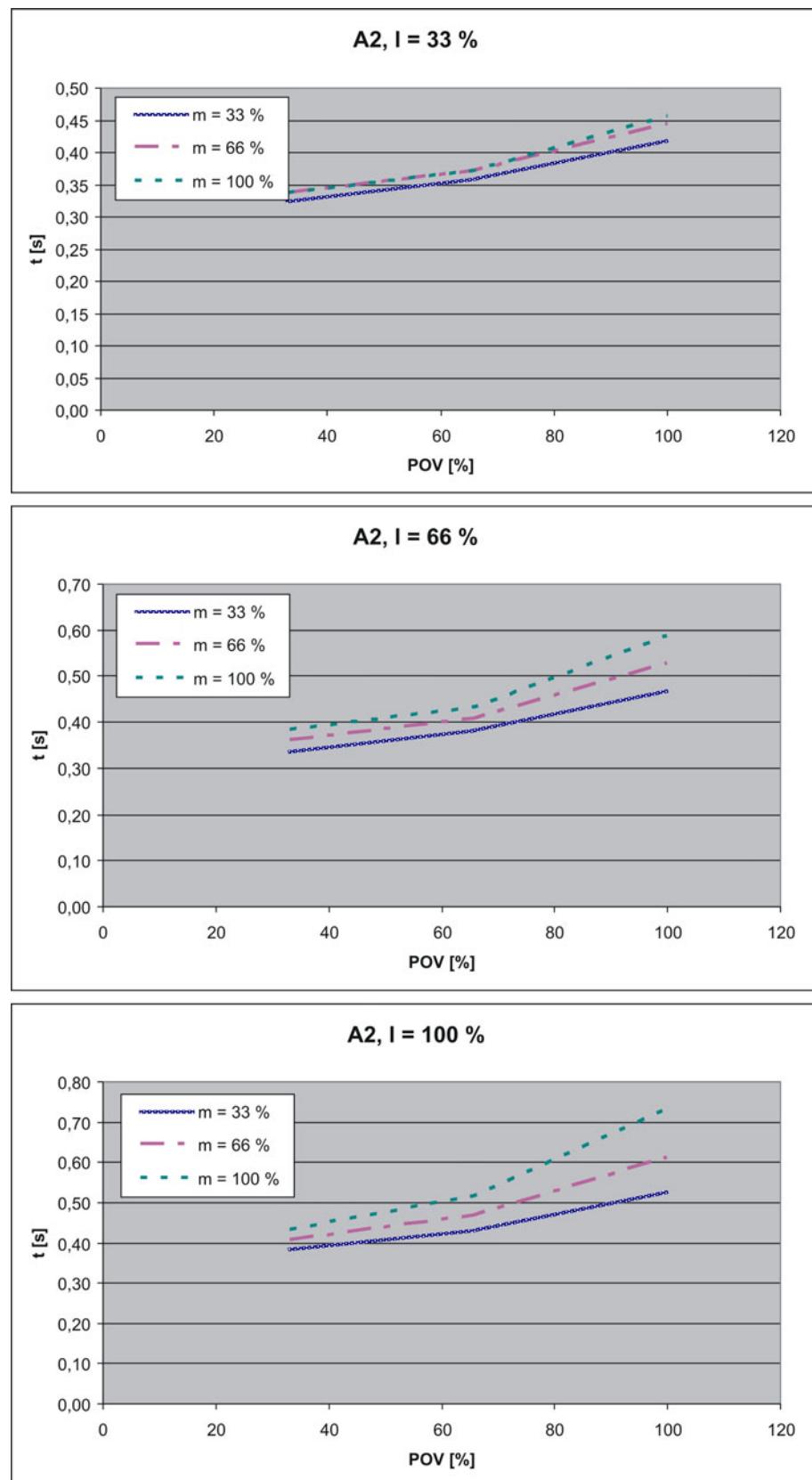


Fig. 4-72: Stopping times for STOP 1, axis 2

4.14.3.4 Stopping distances and stopping times for STOP 1, axis 3

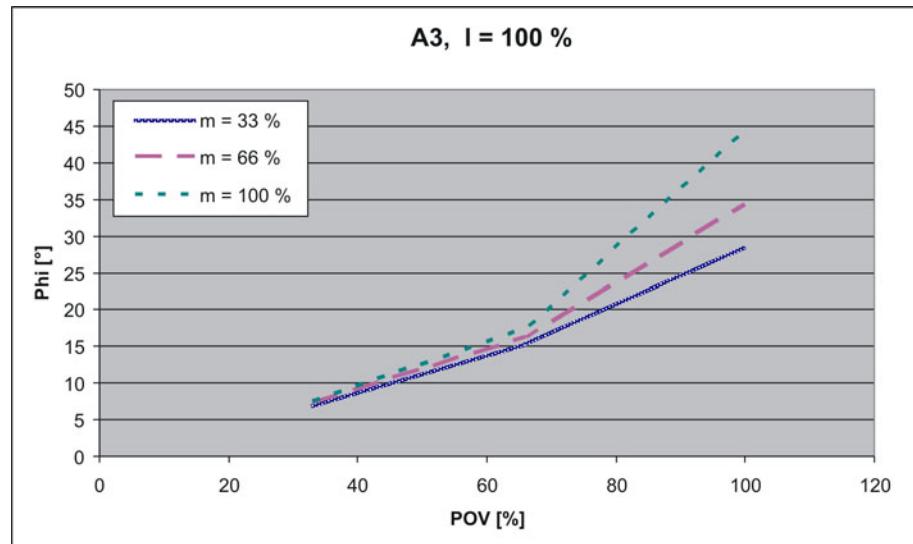


Fig. 4-73: Stopping distances for STOP 1, axis 3

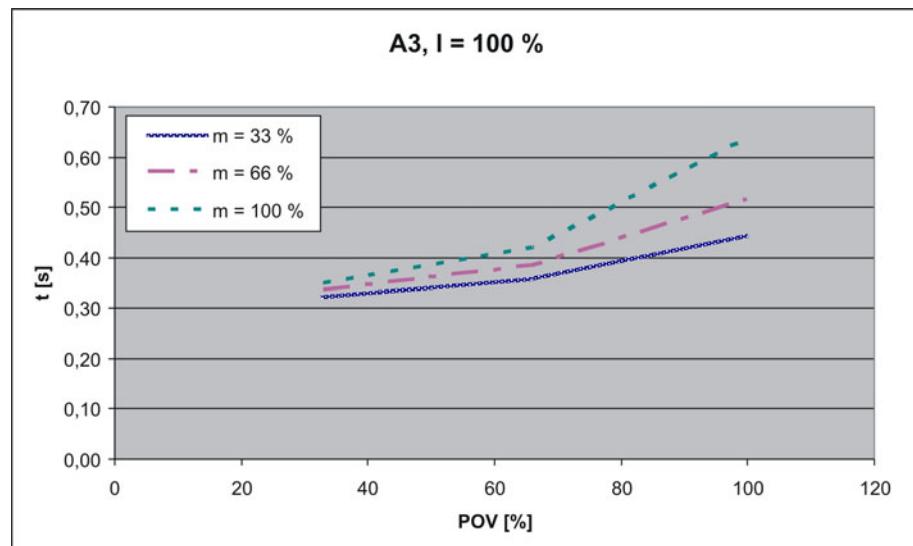


Fig. 4-74: Stopping times for STOP 1, axis 3

4.14.4 Stopping distances and times, KR 240 R2700 prime

4.14.4.1 Stopping distances and stopping times for STOP 0, axis 1 to axis 3

The table shows the stopping distances and stopping times after a STOP 0 (category 0 stop) is triggered. The values refer to the following configuration:

- Extension I = 100%
- Program override POV = 100%
- Mass m = maximum load (rated load + supplementary load on arm)

	Stopping distance (°)	Stopping time (s)
Axis 1	30.1	0.61
Axis 2	28.3	0.54
Axis 3	25.4	0.47

4.14.4.2 Stopping distances and stopping times for STOP 1, axis 1

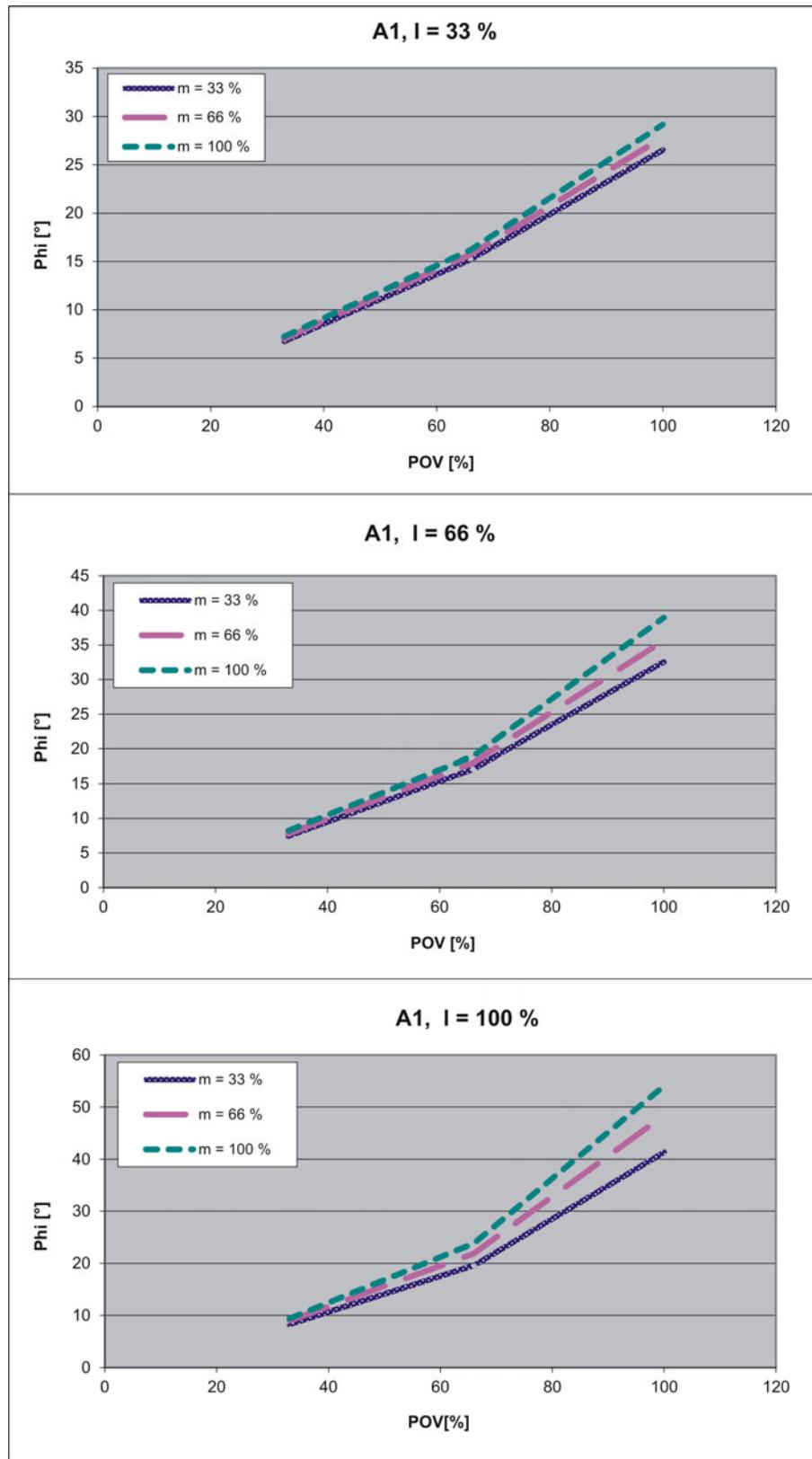


Fig. 4-75: Stopping distances for STOP 1, axis 1

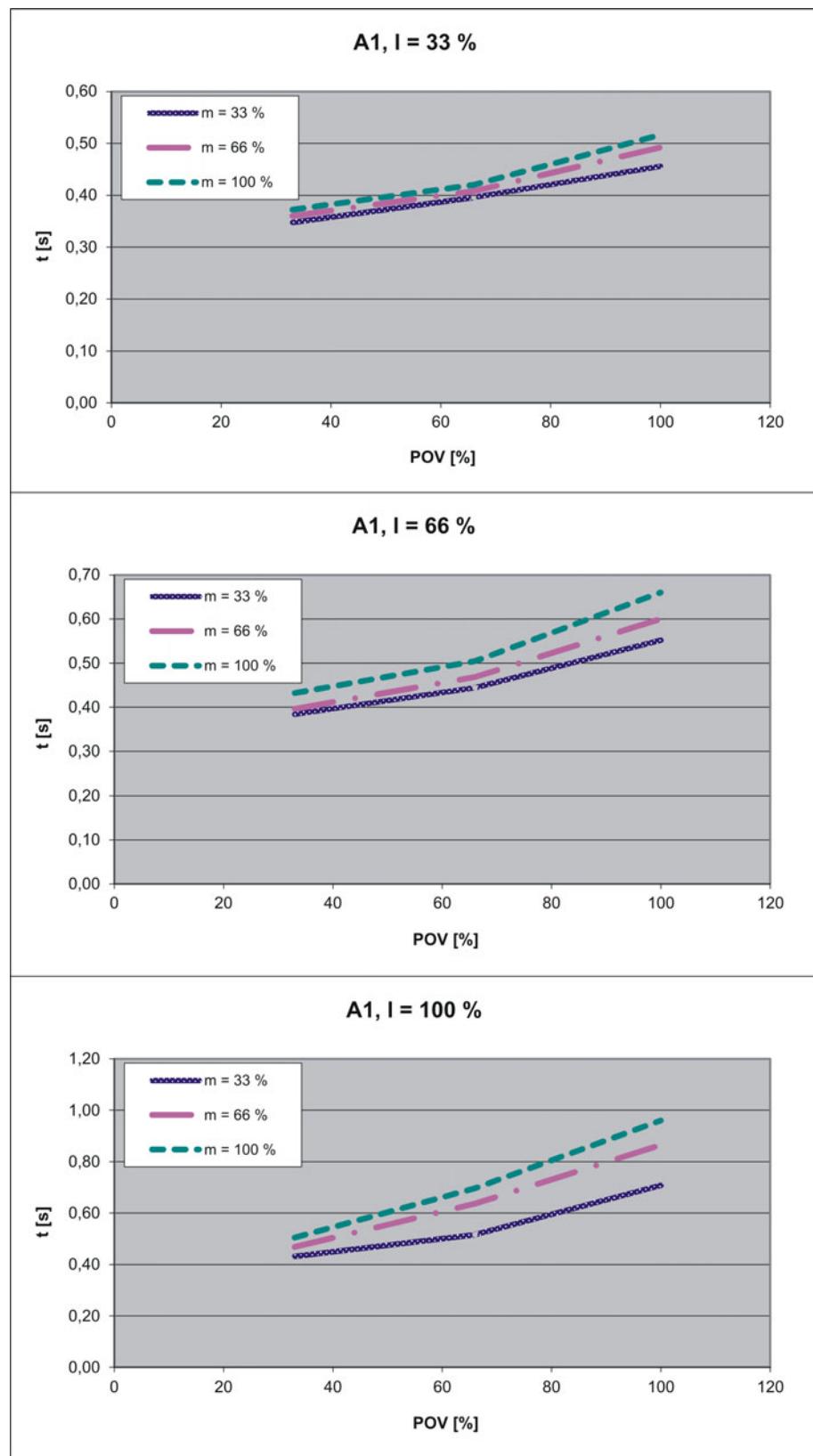


Fig. 4-76: Stopping times for STOP 1, axis 1

4.14.4.3 Stopping distances and stopping times for STOP 1, axis 2

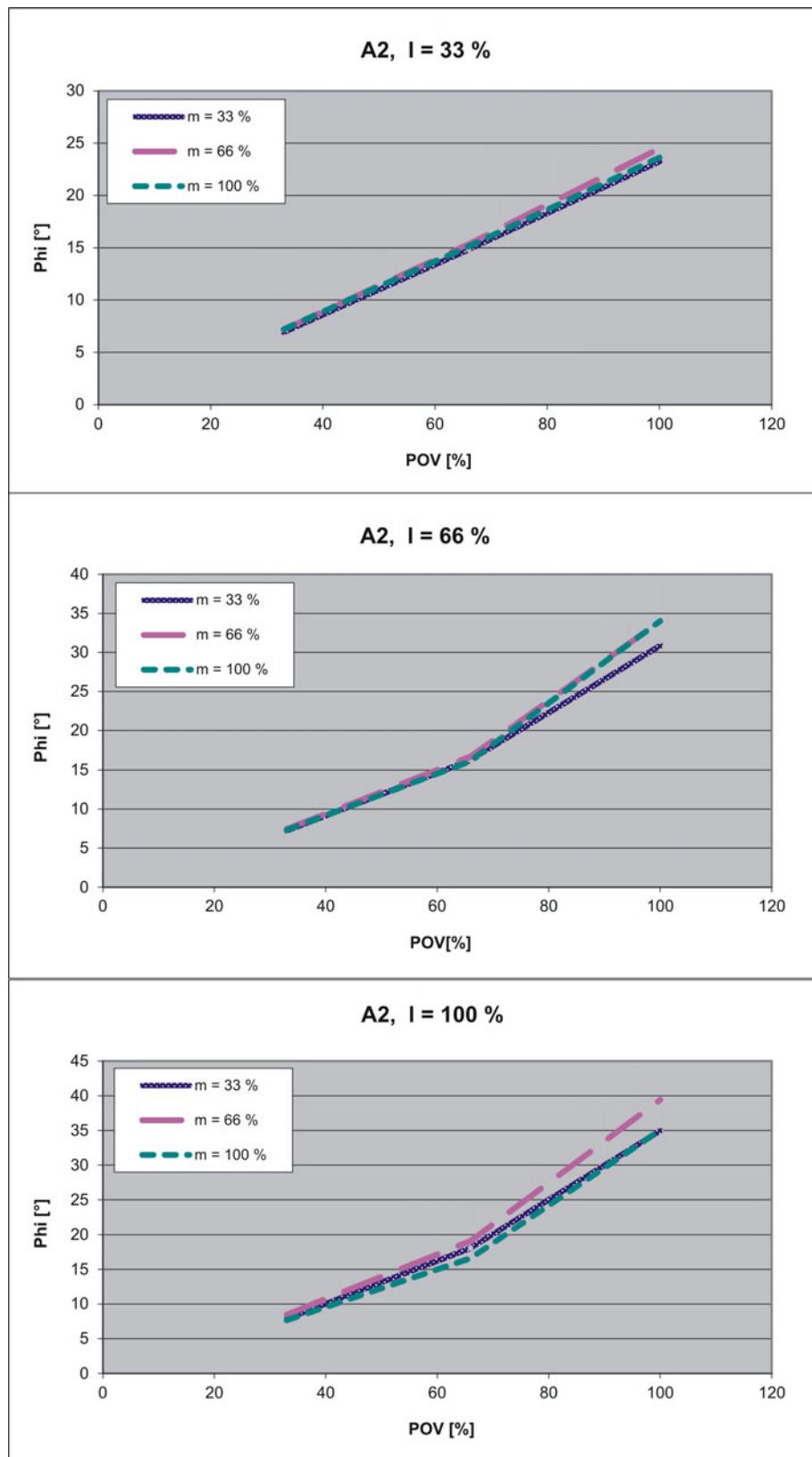


Fig. 4-77: Stopping distances for STOP 1, axis 2

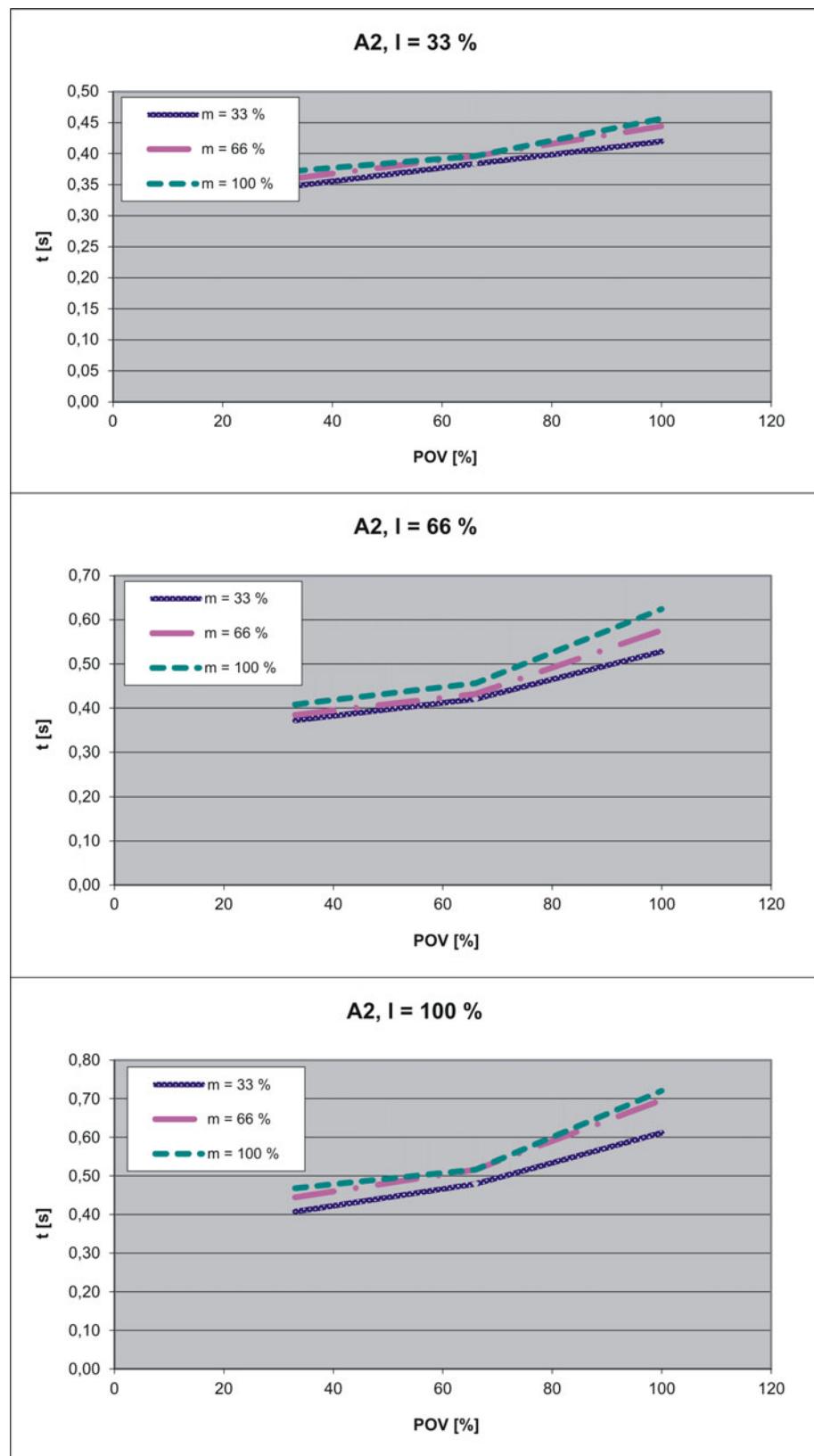


Fig. 4-78: Stopping times for STOP 1, axis 2

4.14.4.4 Stopping distances and stopping times for STOP 1, axis 3

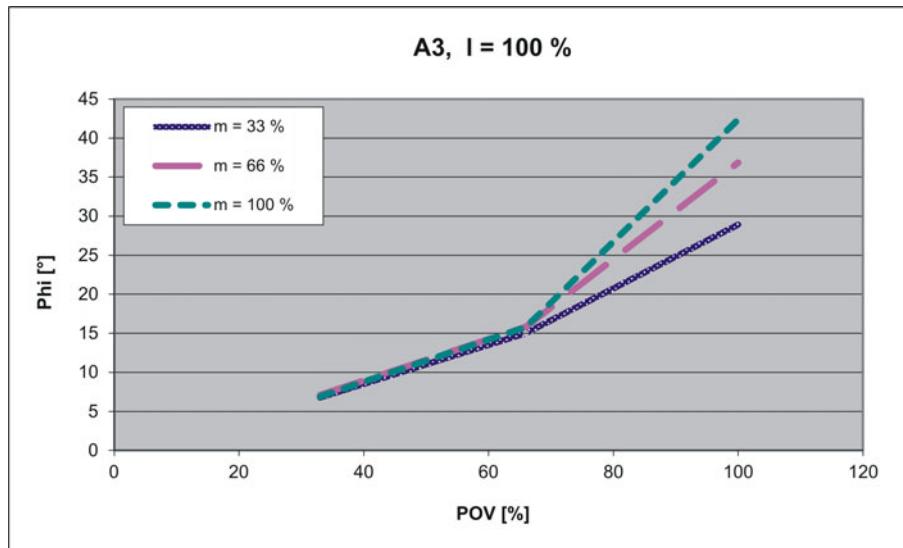


Fig. 4-79: Stopping distances for STOP 1, axis 3

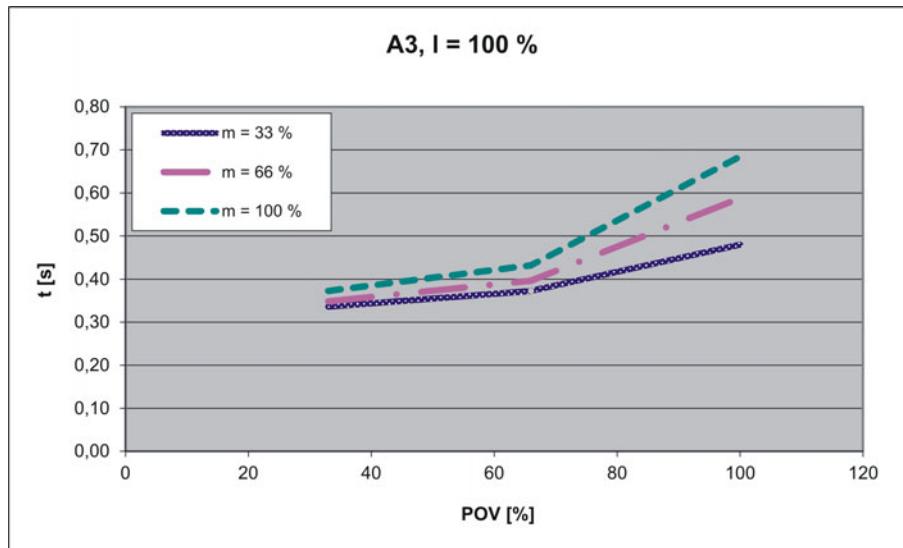


Fig. 4-80: Stopping times for STOP 1, axis 3

4.14.5 Stopping distances and stopping times for KR 210 R2700 prime

4.14.5.1 Stopping distances and stopping times for STOP 0, axis 1 to axis 3

The table shows the stopping distances and stopping times after a STOP 0 (category 0 stop) is triggered. The values refer to the following configuration:

- Extension I = 100%
- Program override POV = 100%
- Mass m = maximum load (rated load + supplementary load on arm)

	Stopping distance (°)	Stopping time (s)
Axis 1	30.1	0.61
Axis 2	28.3	0.54
Axis 3	25.4	0.47

4.14.5.2 Stopping distances and stopping times for STOP 1, axis 1

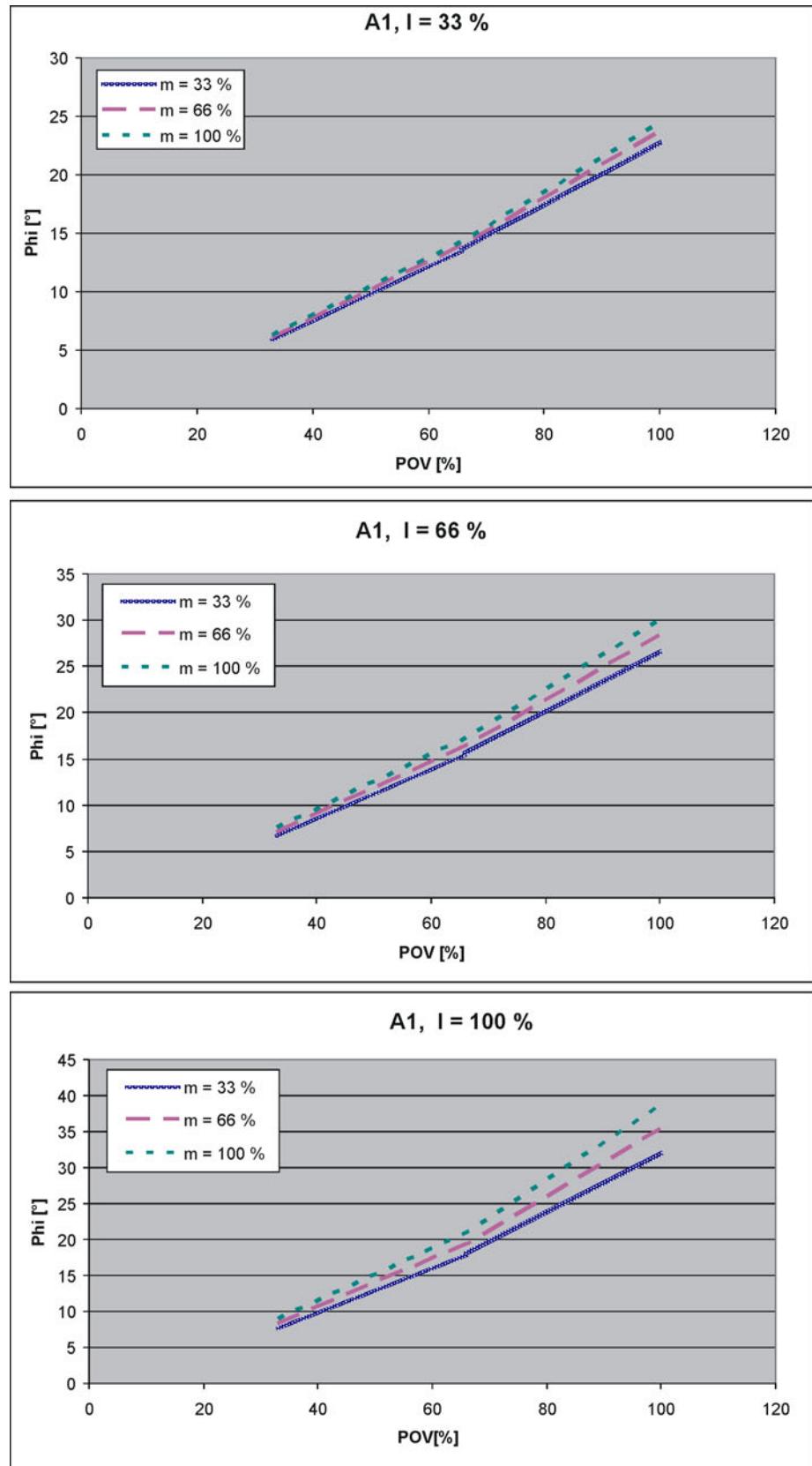


Fig. 4-81: Stopping distances for STOP 1, axis 1

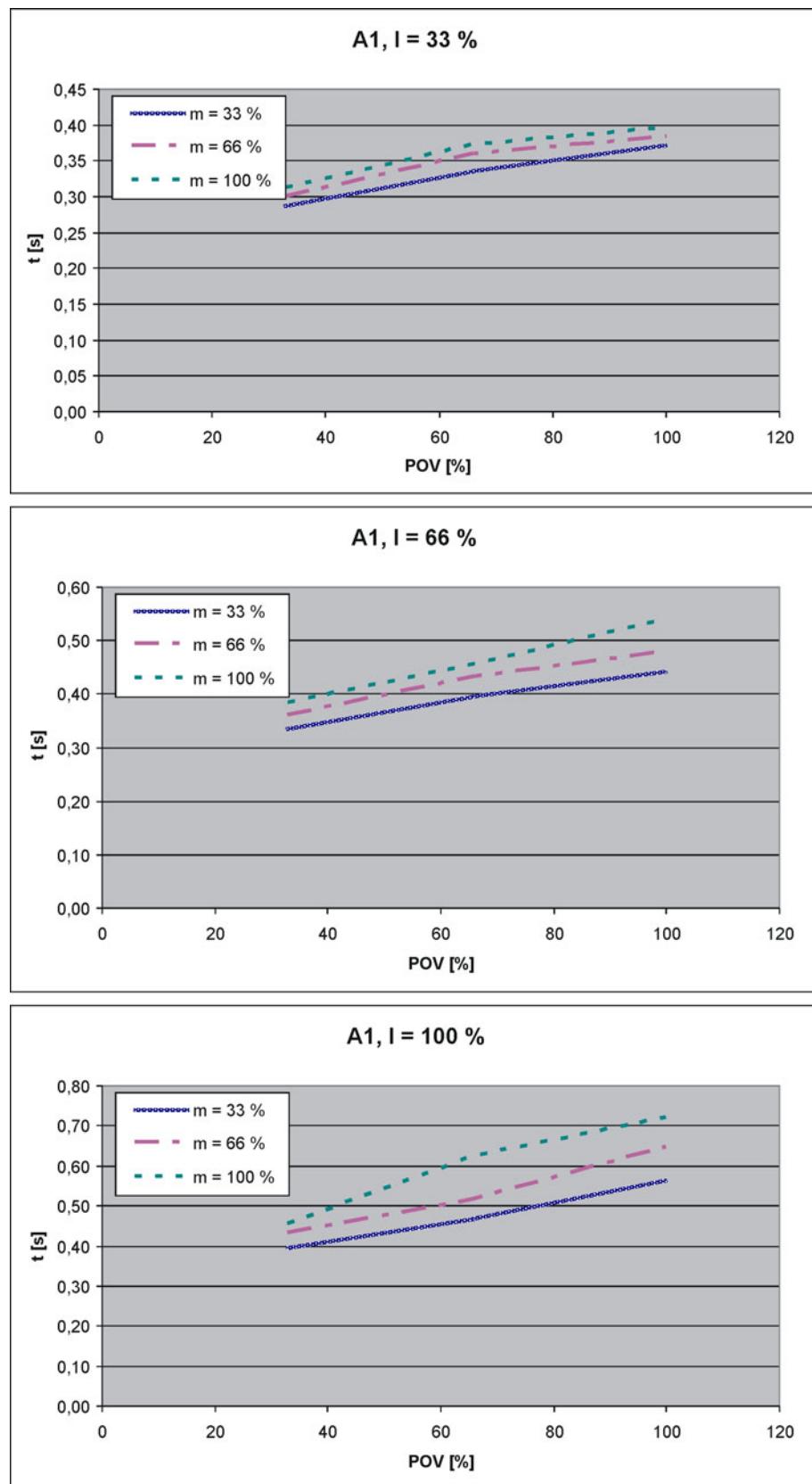


Fig. 4-82: Stopping times for STOP 1, axis 1

4.14.5.3 Stopping distances and stopping times for STOP 1, axis 2

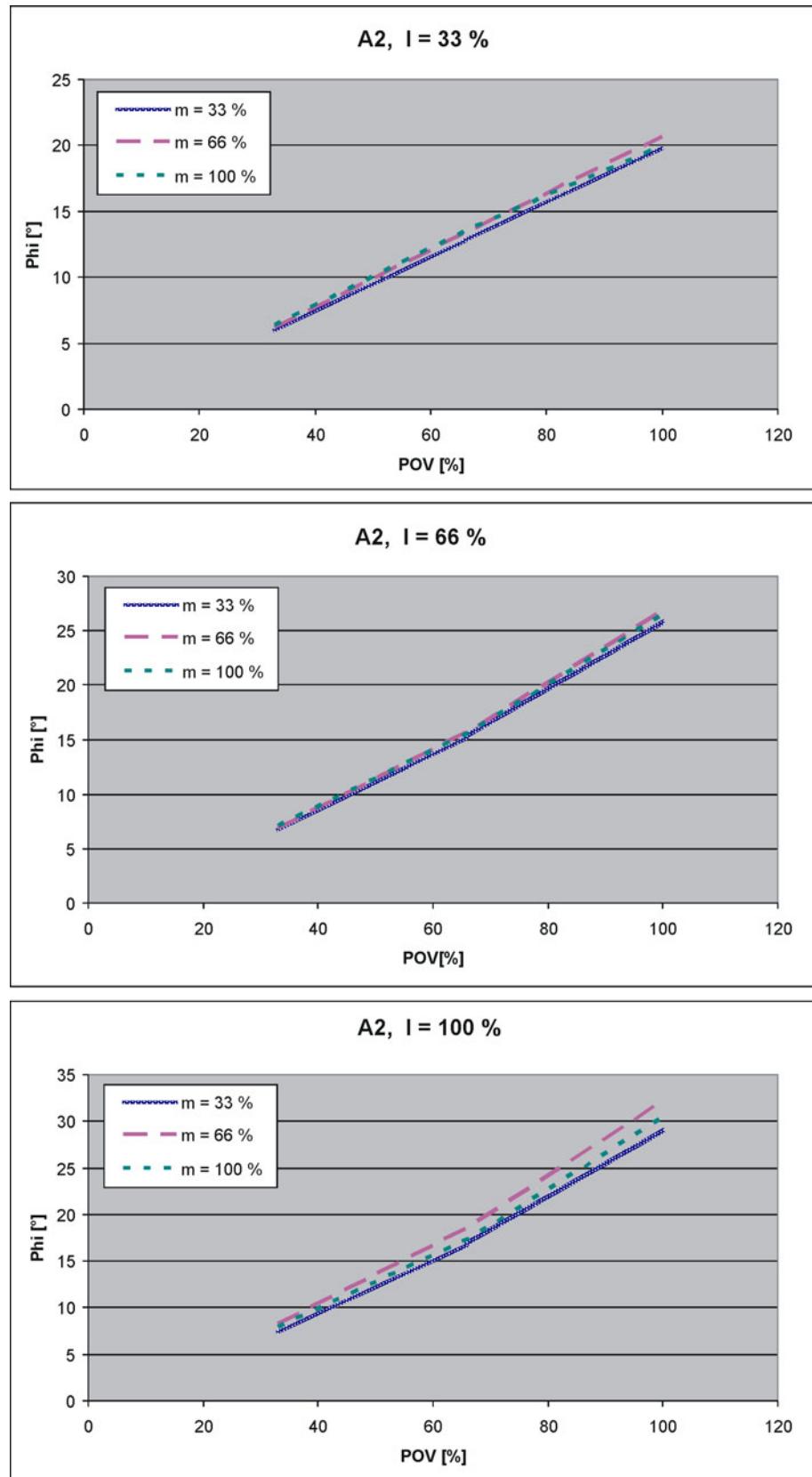


Fig. 4-83: Stopping distances for STOP 1, axis 2

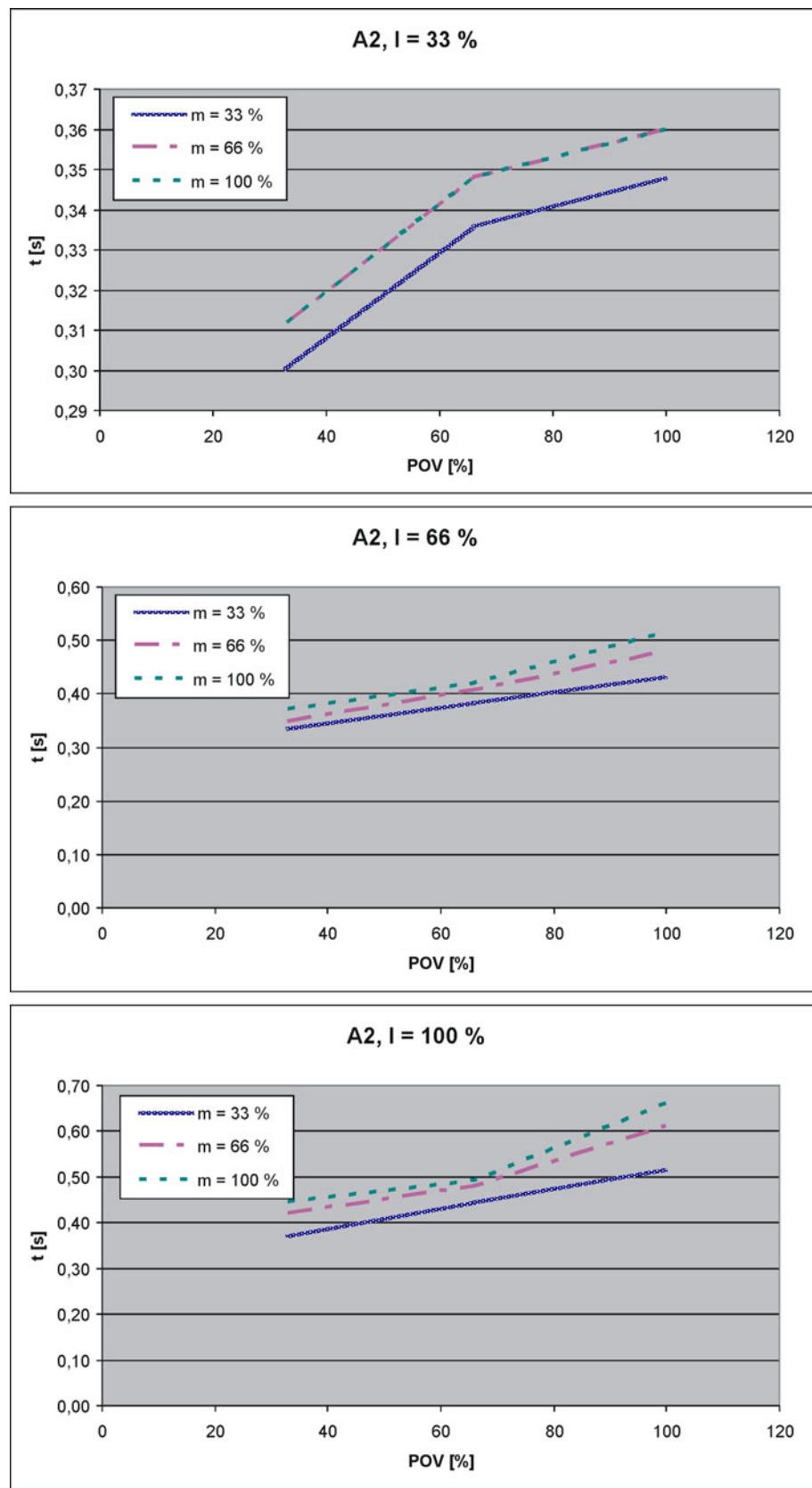


Fig. 4-84: Stopping times for STOP 1, axis 2

4.14.5.4 Stopping distances and stopping times for STOP 1, axis 3

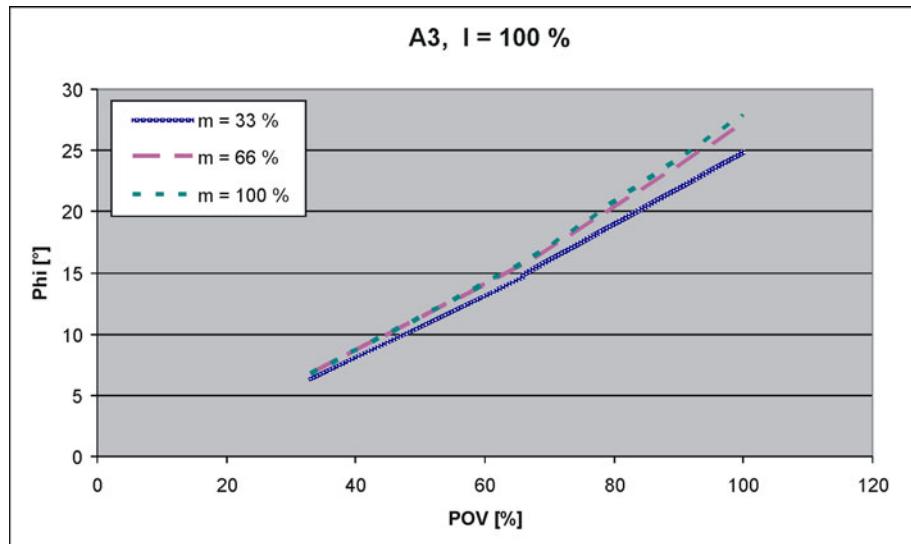


Fig. 4-85: Stopping distances for STOP 1, axis 3

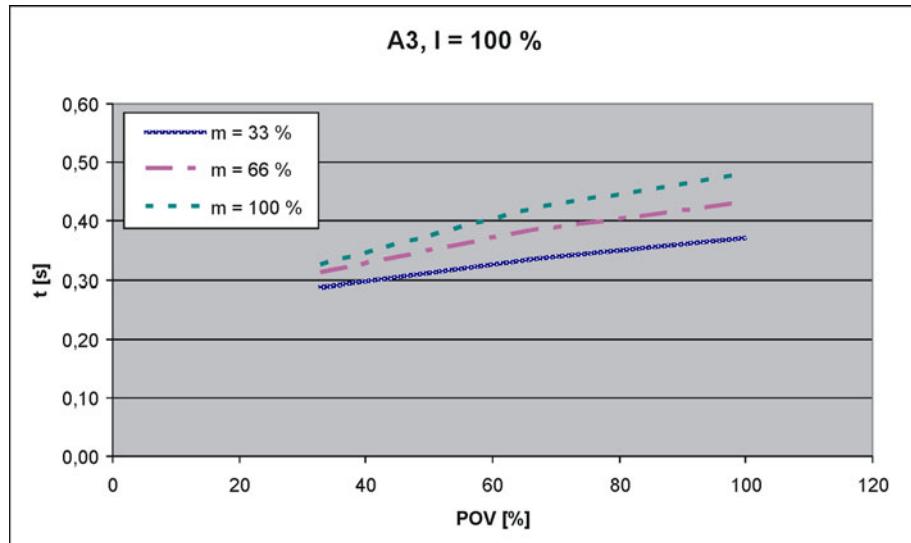


Fig. 4-86: Stopping times for STOP 1, axis 3

4.14.6 Stopping distances and times, KR 210 R2700 prime C

4.14.6.1 Stopping distances and stopping times for STOP 0, axis 1 to axis 3

The table shows the stopping distances and stopping times after a STOP 0 (category 0 stop) is triggered. The values refer to the following configuration:

- Extension I = 100%
- Program override POV = 100%
- Mass m = maximum load (rated load + supplementary load on arm)

	Stopping distance (°)	Stopping time (s)
Axis 1	30.1	0.61
Axis 2	28.3	0.54
Axis 3	25.4	0.47

4.14.6.2 Stopping distances and stopping times for STOP 1, axis 1

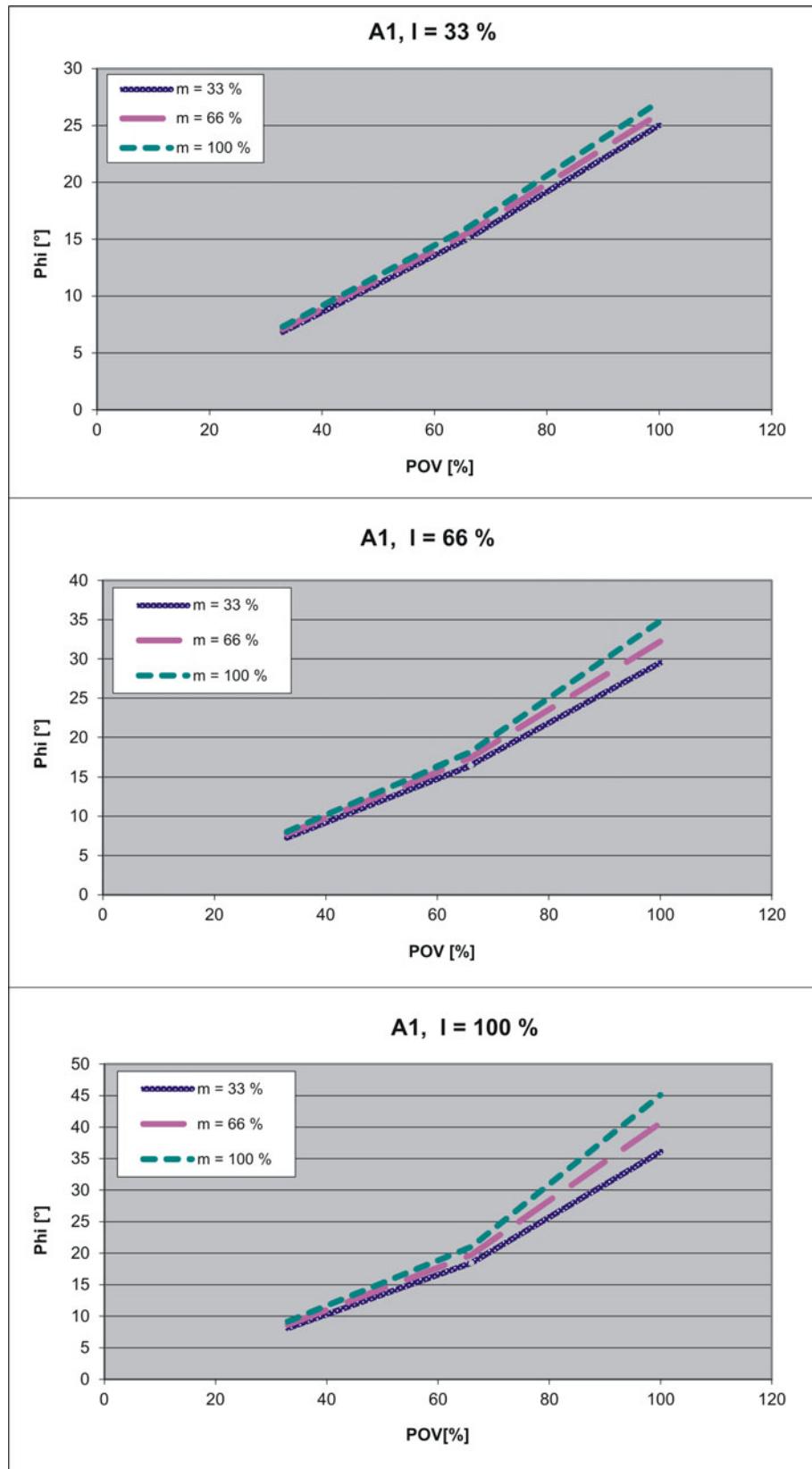


Fig. 4-87: Stopping distances for STOP 1, axis 1

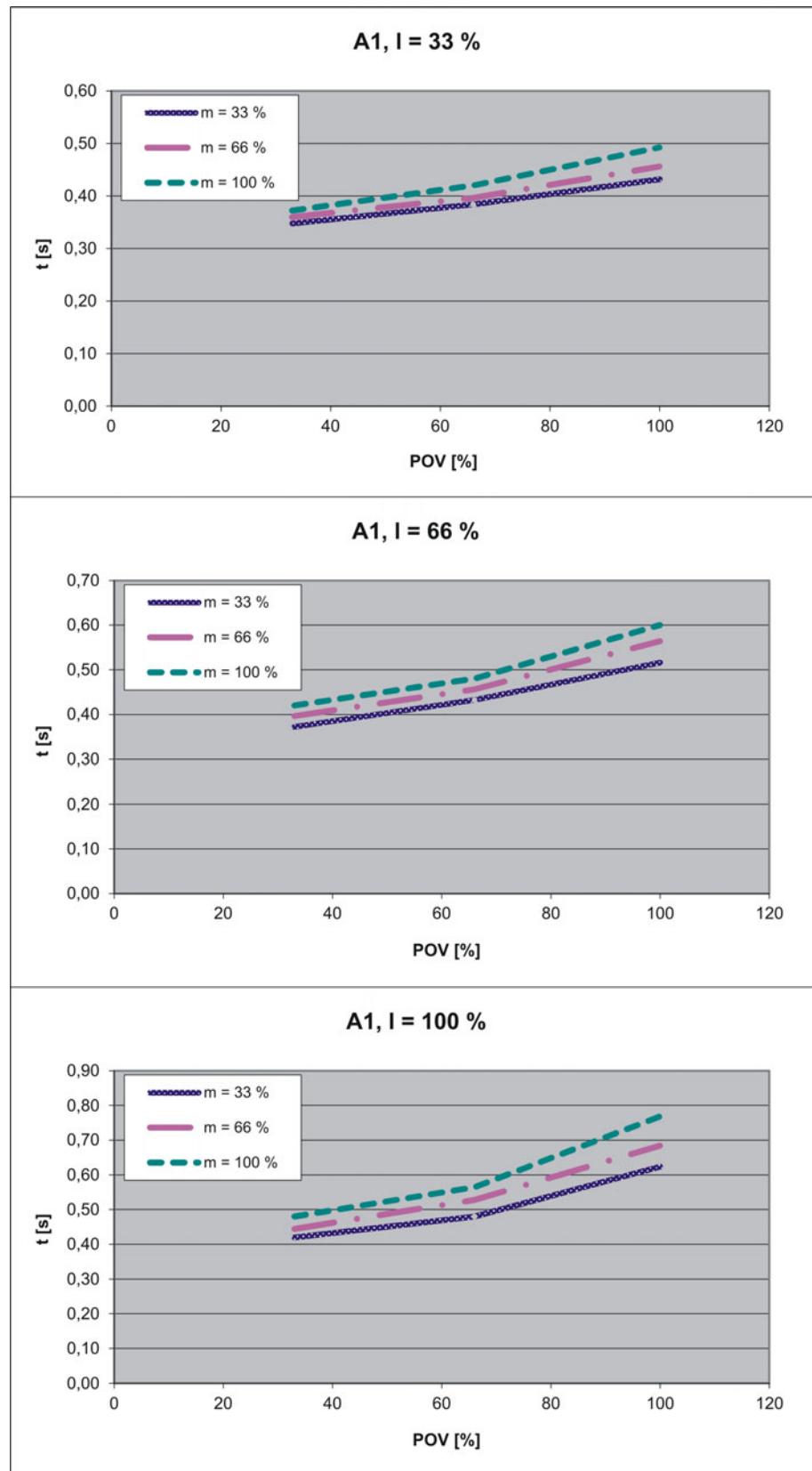


Fig. 4-88: Stopping times for STOP 1, axis 1

4.14.6.3 Stopping distances and stopping times for STOP 1, axis 2

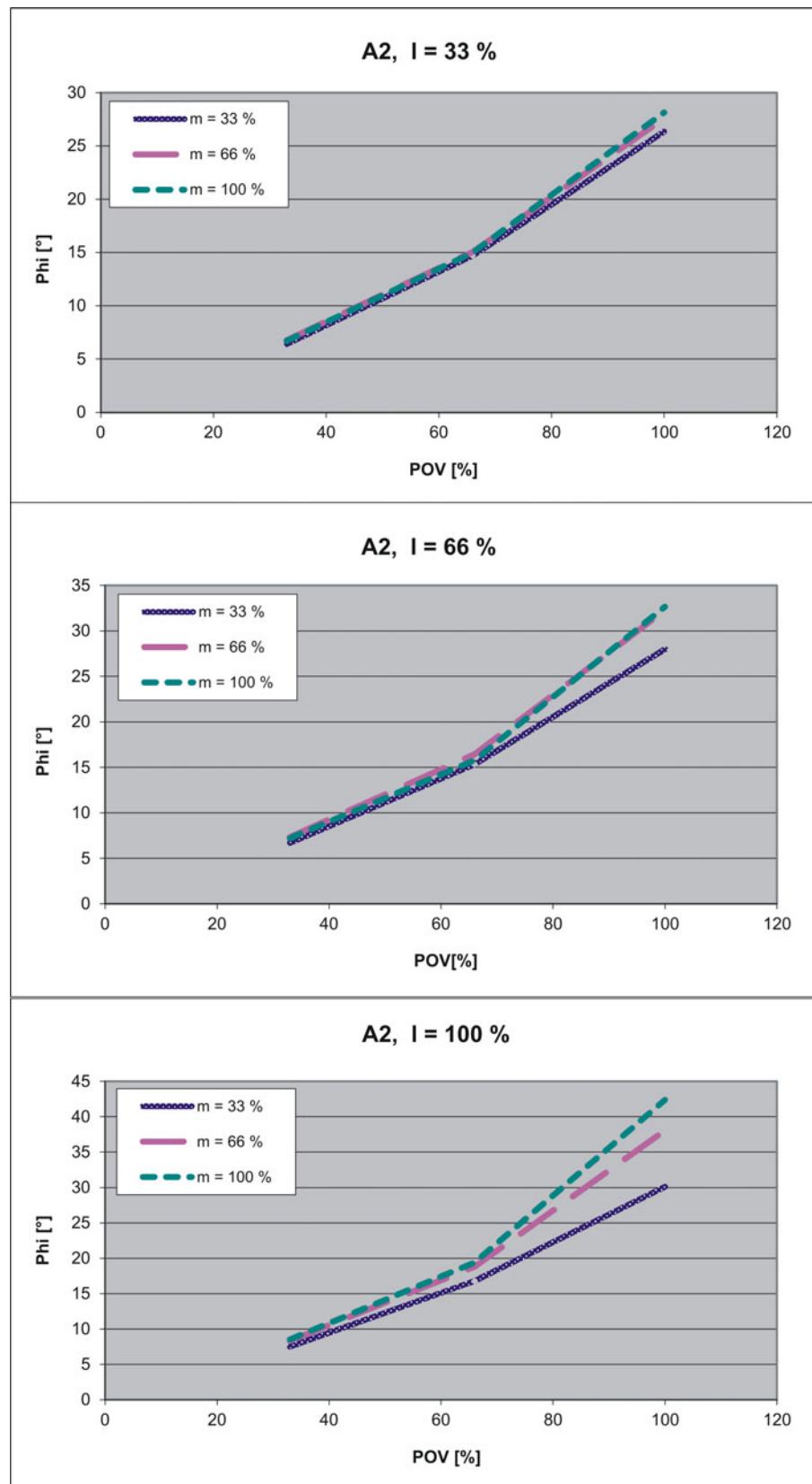


Fig. 4-89: Stopping distances for STOP 1, axis 2

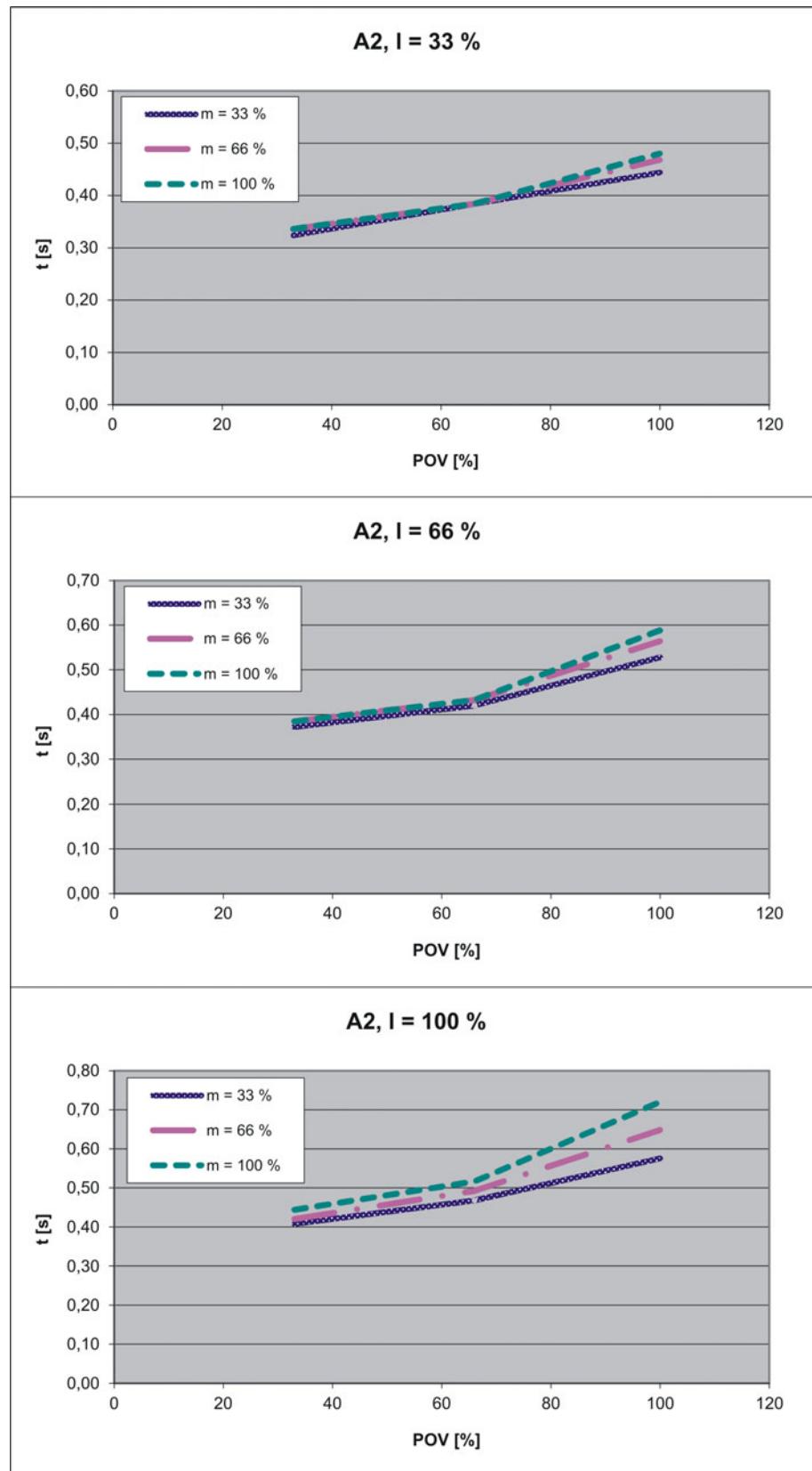


Fig. 4-90: Stopping times for STOP 1, axis 2

4.14.6.4 Stopping distances and stopping times for STOP 1, axis 3

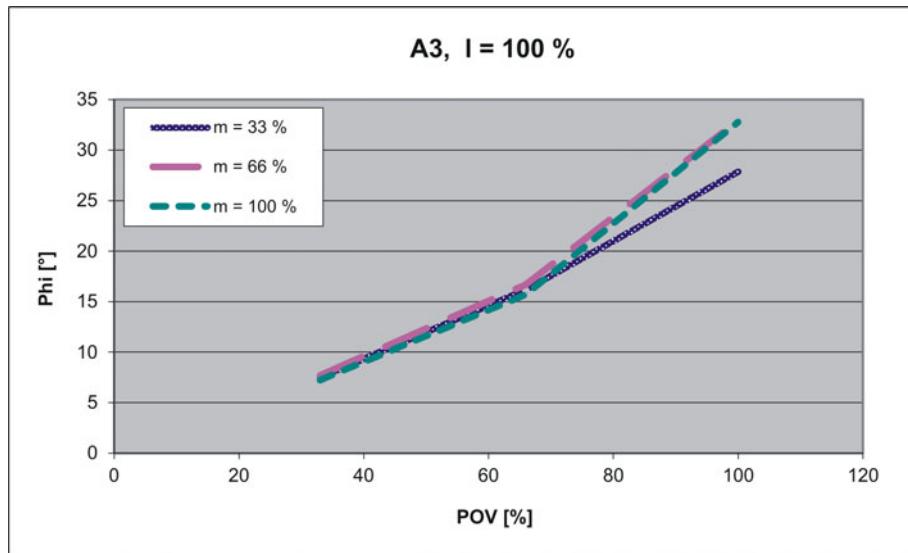


Fig. 4-91: Stopping distances for STOP 1, axis 3

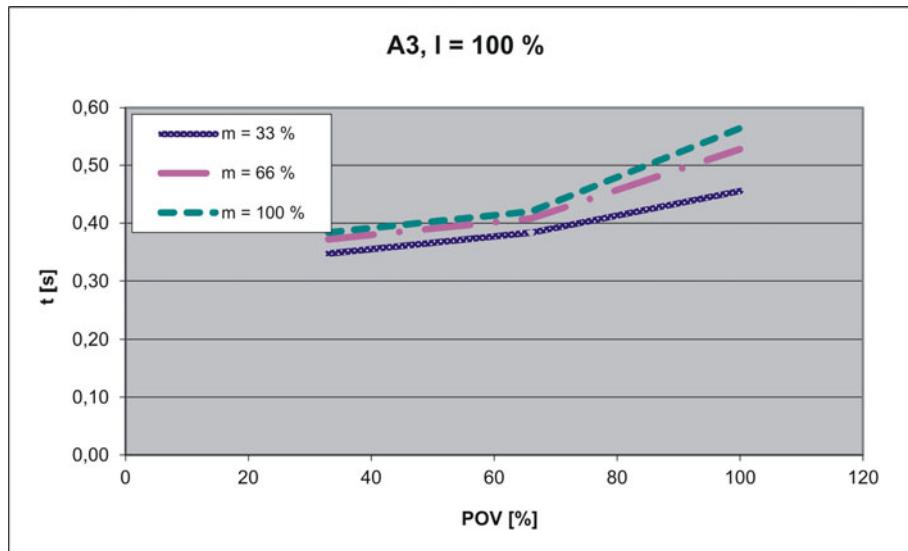


Fig. 4-92: Stopping times for STOP 1, axis 3

4.14.7 Stopping distances and stopping times for KR 180 R2900 prime

4.14.7.1 Stopping distances and stopping times for STOP 0, axis 1 to axis 3

The table shows the stopping distances and stopping times after a STOP 0 (category 0 stop) is triggered. The values refer to the following configuration:

- Extension I = 100%
- Program override POV = 100%
- Mass m = maximum load (rated load + supplementary load on arm)

	Stopping distance (°)	Stopping time (s)
Axis 1	30.1	0.61
Axis 2	28.3	0.54
Axis 3	25.4	0.47

4.14.7.2 Stopping distances and stopping times for STOP 1, axis 1

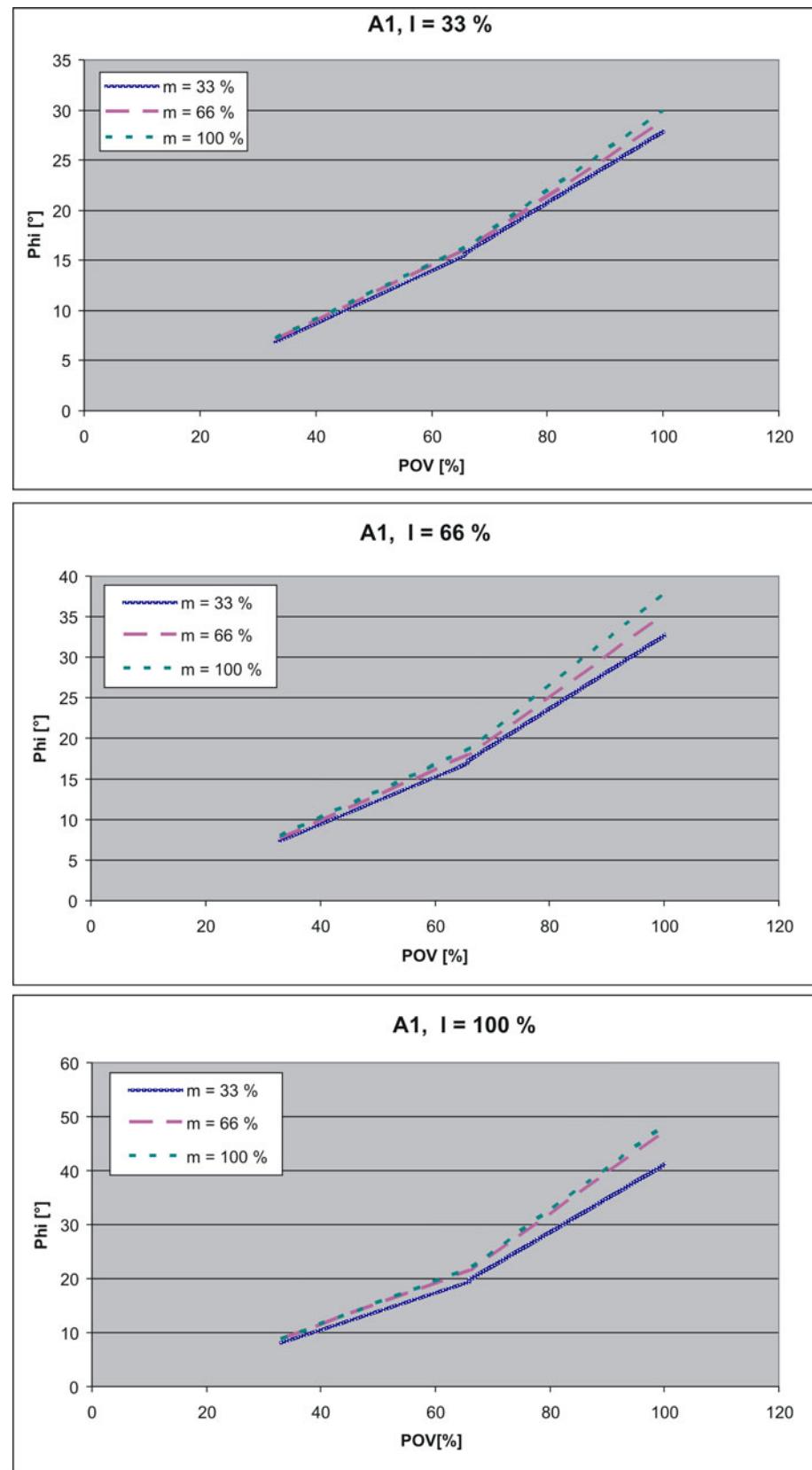


Fig. 4-93: Stopping distances for STOP 1, axis 1

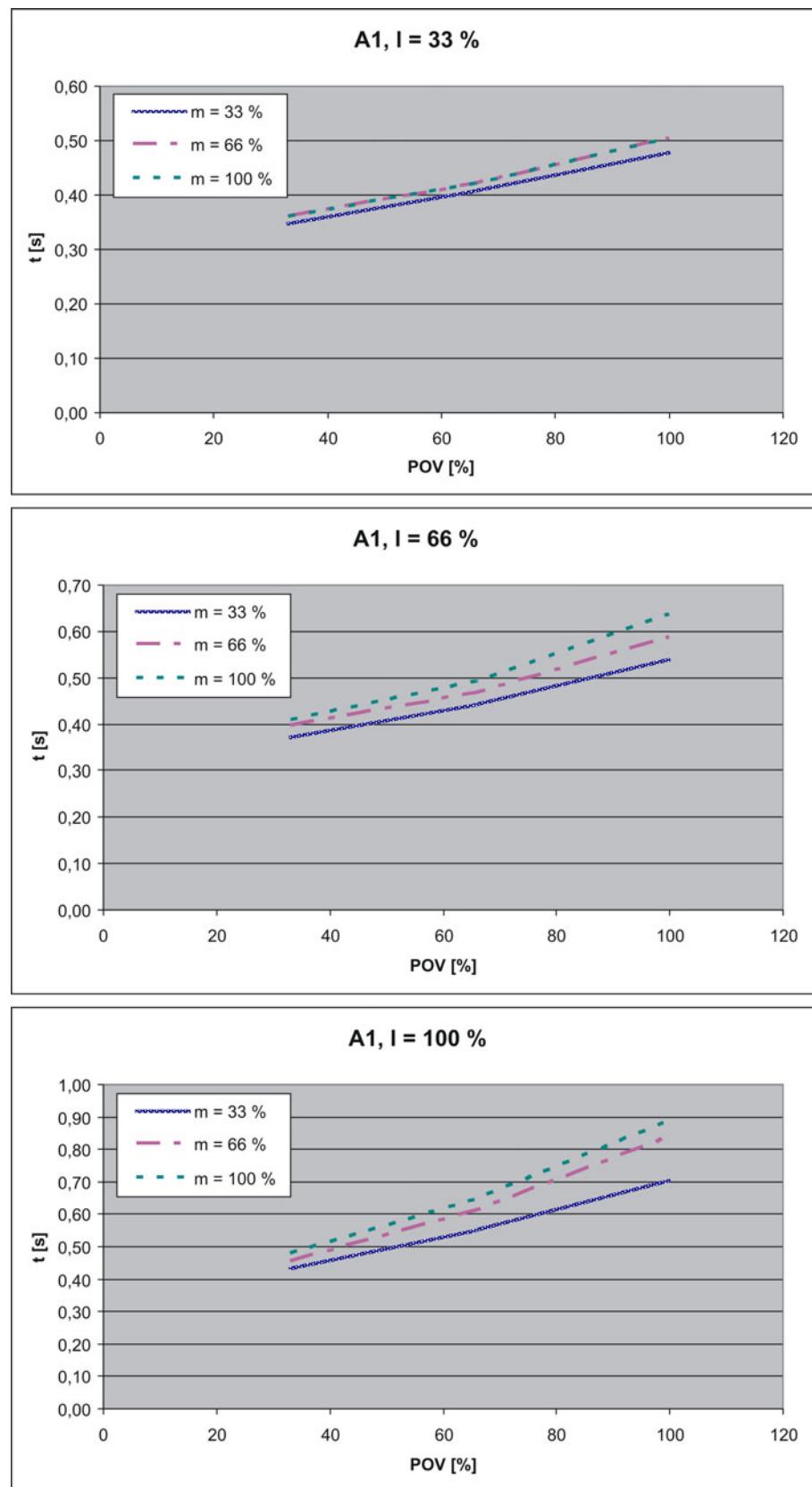


Fig. 4-94: Stopping times for STOP 1, axis 1

4.14.7.3 Stopping distances and stopping times for STOP 1, axis 2

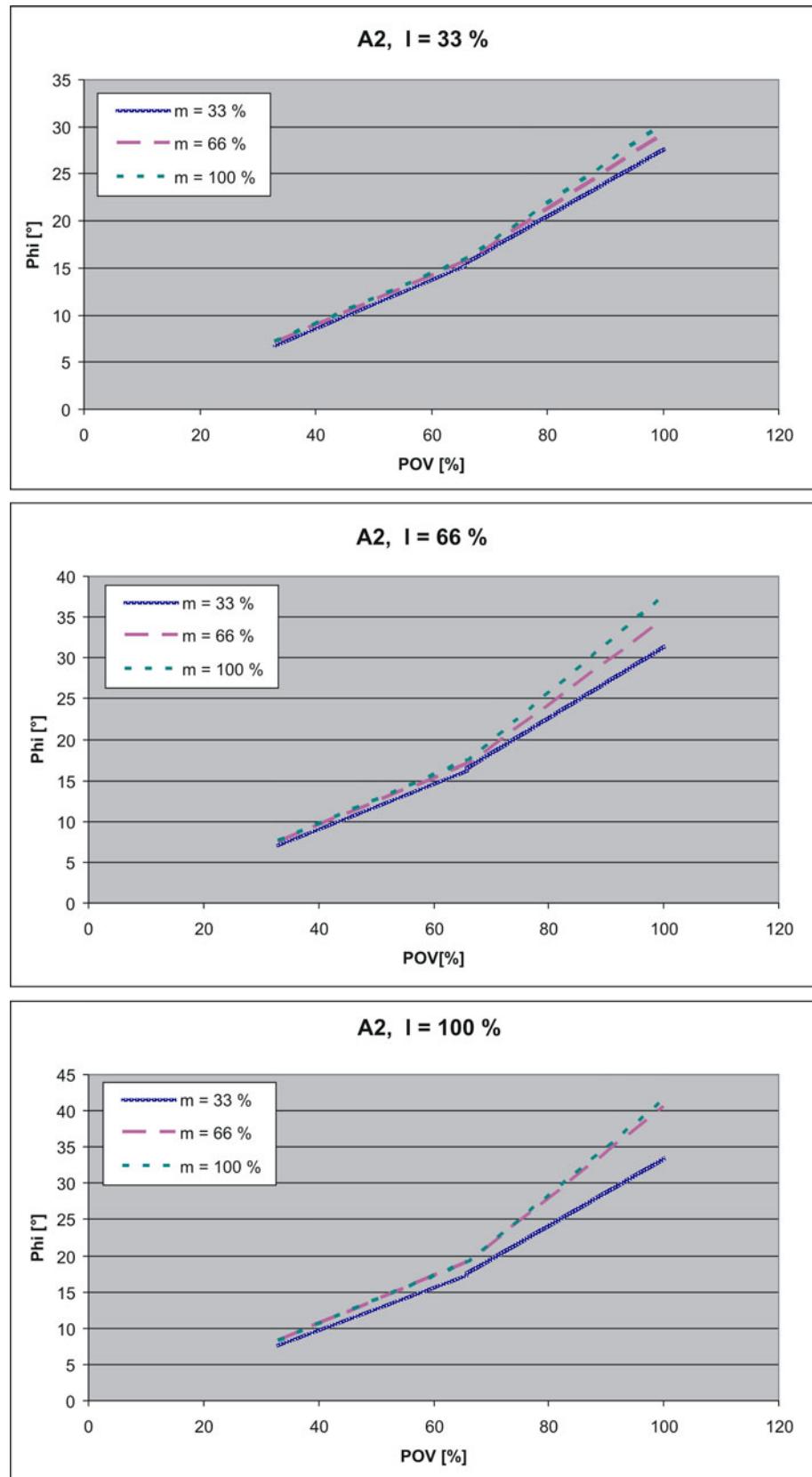


Fig. 4-95: Stopping distances for STOP 1, axis 2

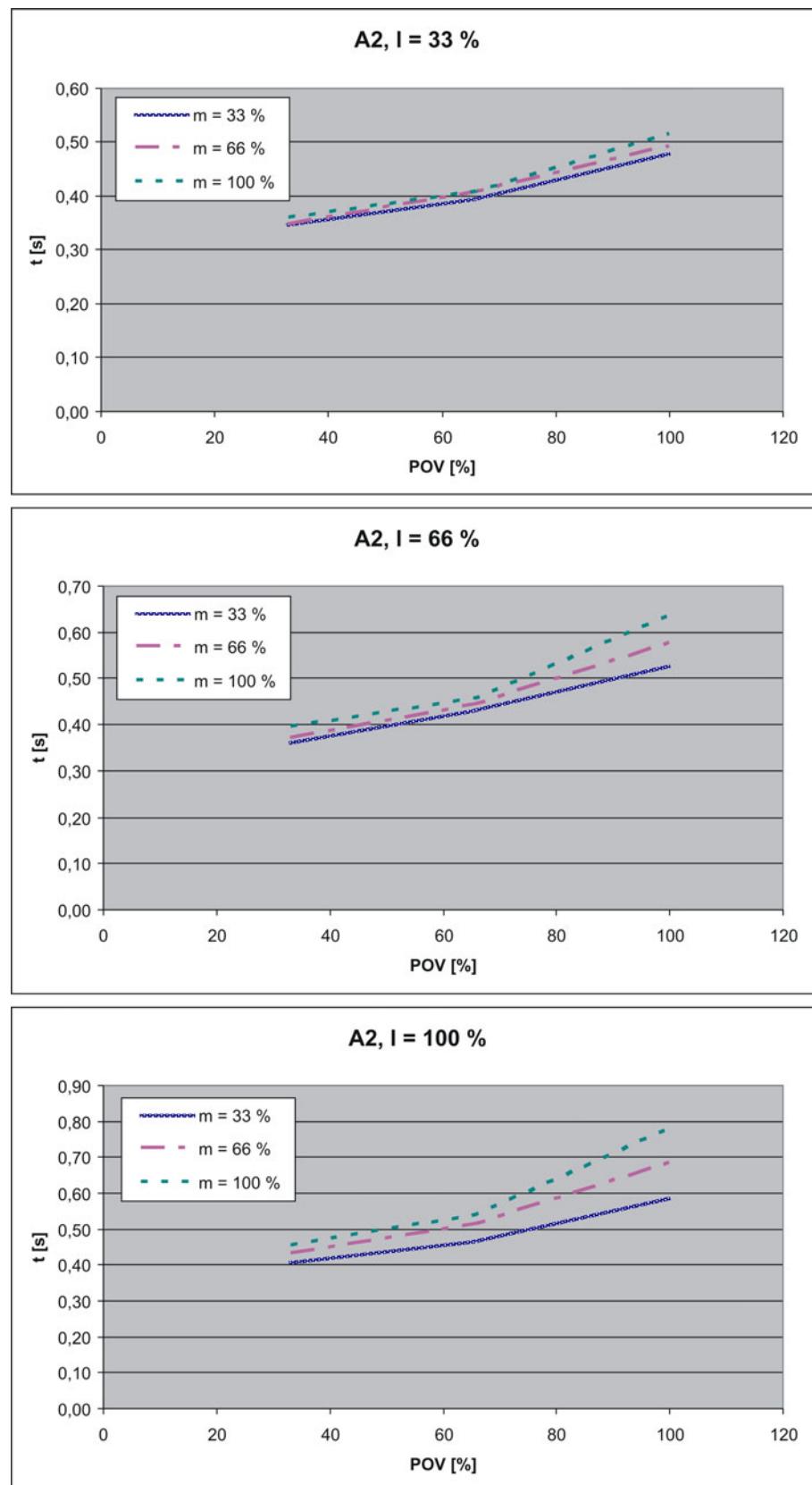


Fig. 4-96: Stopping times for STOP 1, axis 2

4.14.7.4 Stopping distances and stopping times for STOP 1, axis 3

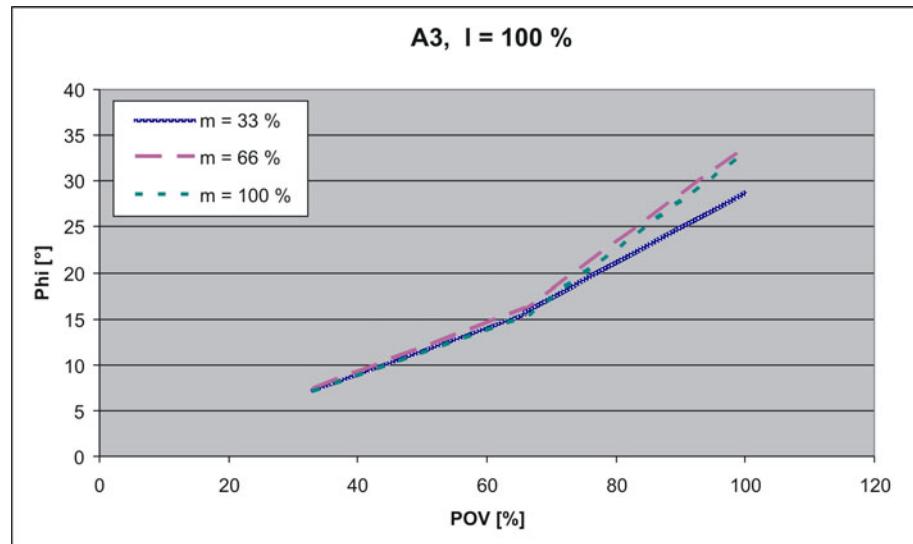


Fig. 4-97: Stopping distances for STOP 1, axis 3

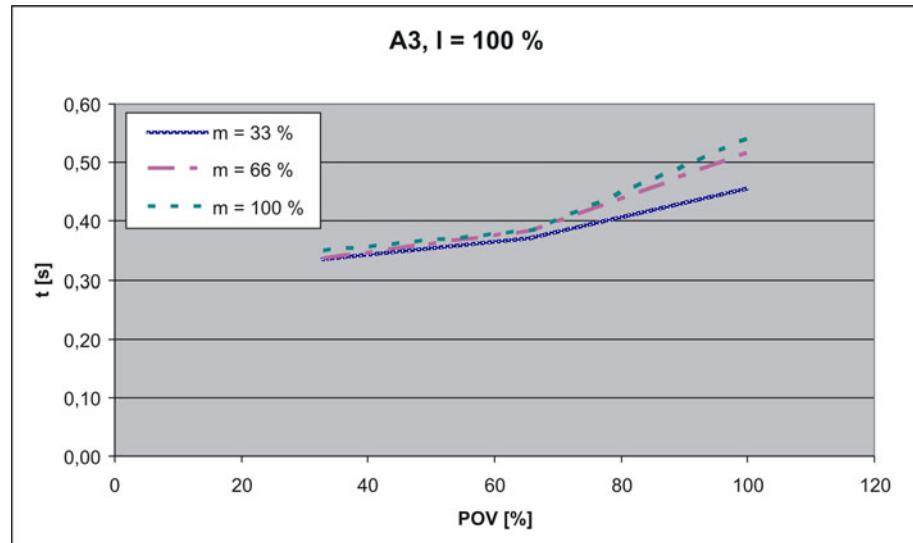


Fig. 4-98: Stopping times for STOP 1, axis 3

4.14.8 Stopping distances and stopping times for KR 150 R3100 prime

4.14.8.1 Stopping distances and stopping times for STOP 0, axis 1 to axis 3

The table shows the stopping distances and stopping times after a STOP 0 (category 0 stop) is triggered. The values refer to the following configuration:

- Extension I = 100%
- Program override POV = 100%
- Mass m = maximum load (rated load + supplementary load on arm)

	Stopping distance (°)	Stopping time (s)
Axis 1	30.1	0.61
Axis 2	28.3	0.54
Axis 3	25.4	0.47

4.14.8.2 Stopping distances and stopping times for STOP 1, axis 1

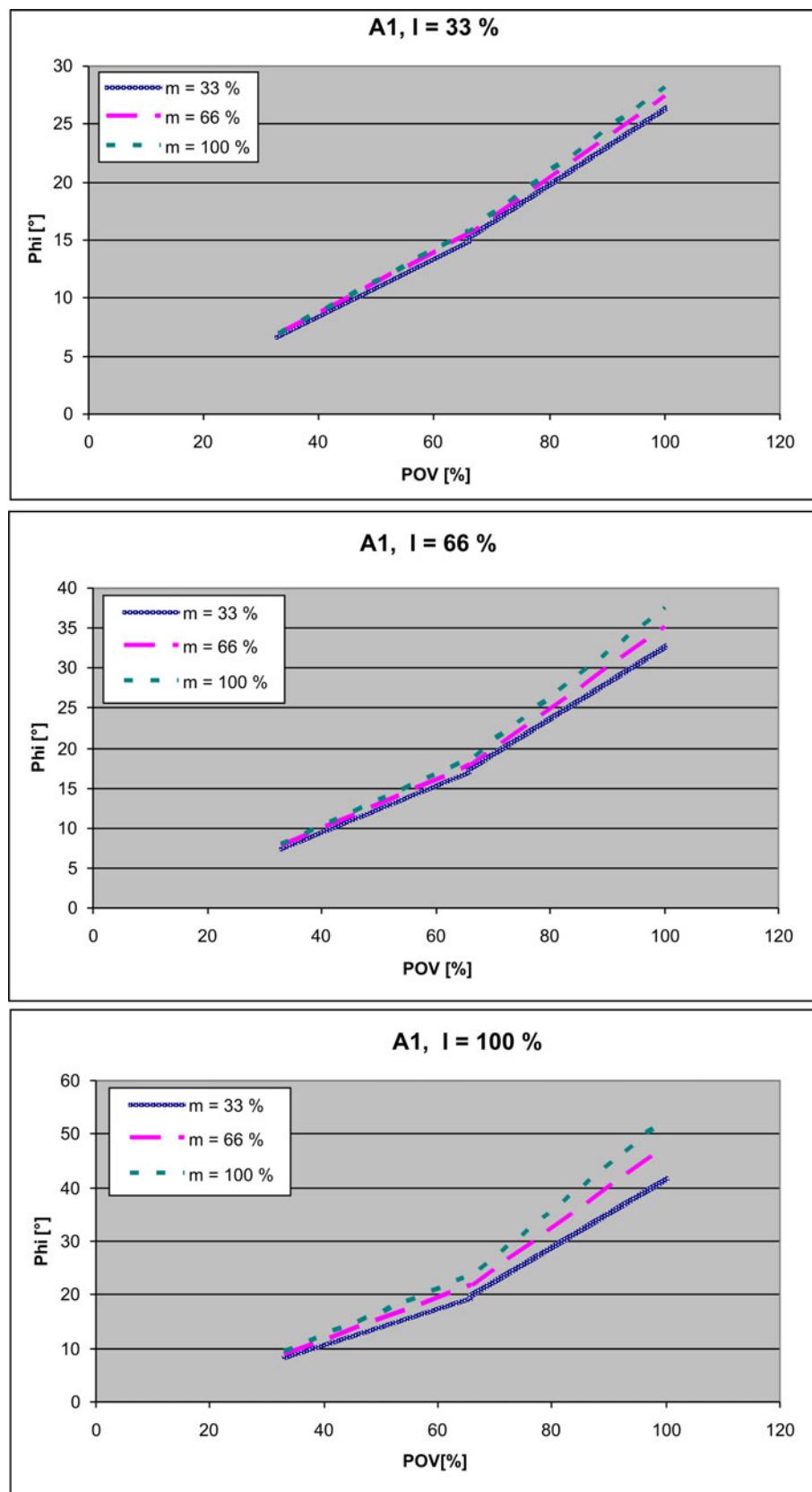


Fig. 4-99: Stopping distances for STOP 1, axis 1

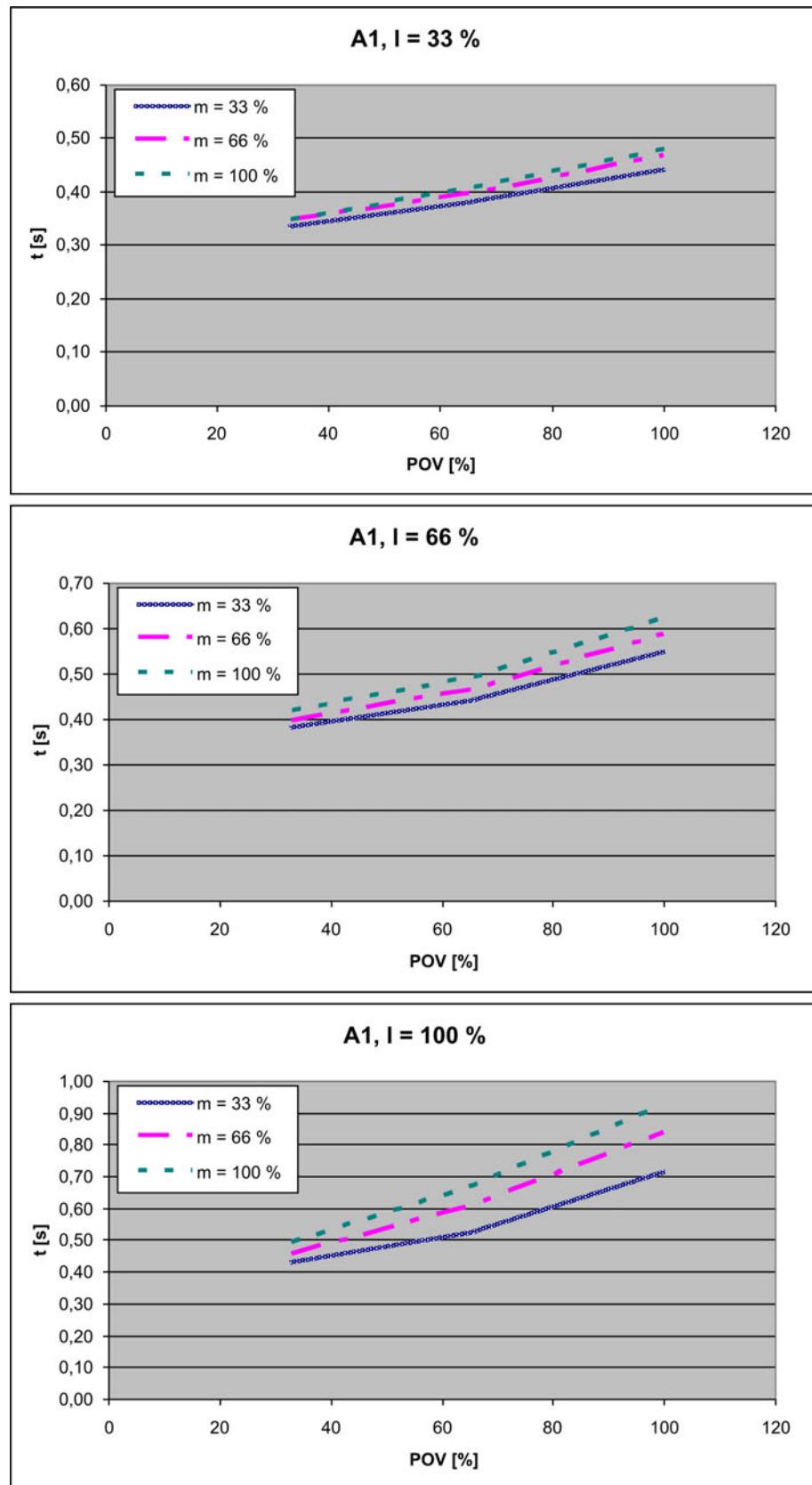


Fig. 4-100: Stopping times for STOP 1, axis 1

4.14.8.3 Stopping distances and stopping times for STOP 1, axis 2

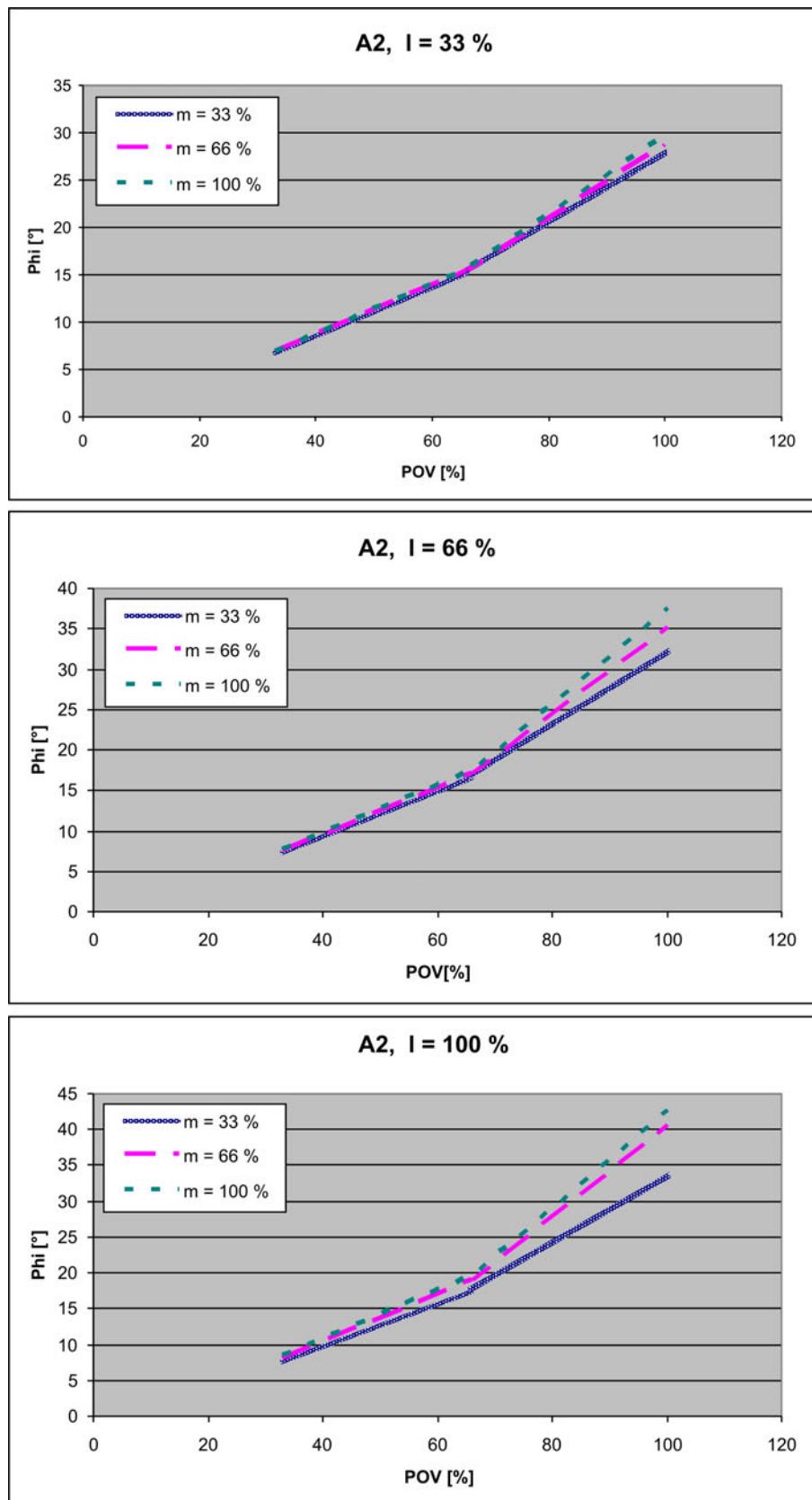


Fig. 4-101: Stopping distances for STOP 1, axis 2

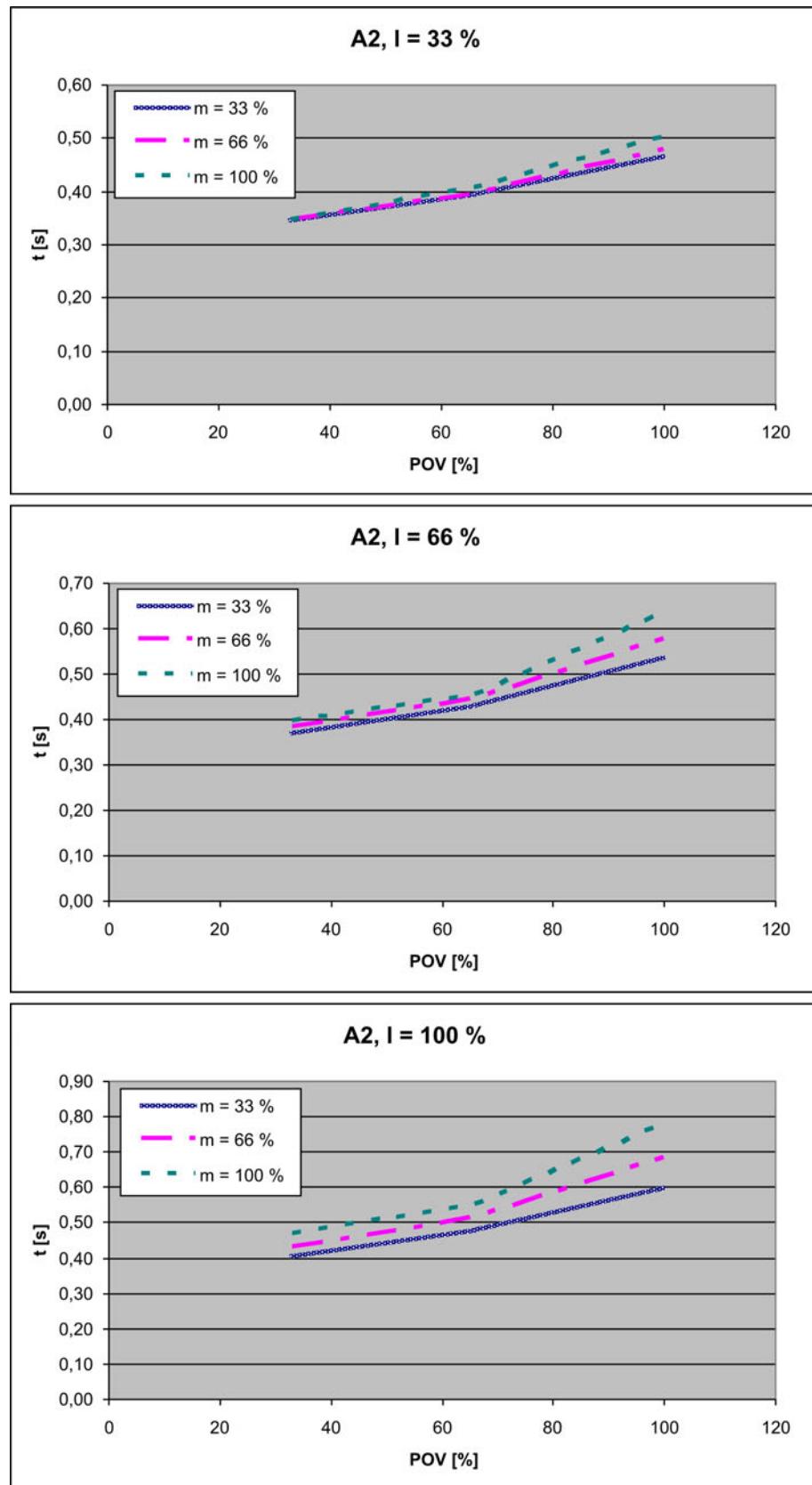
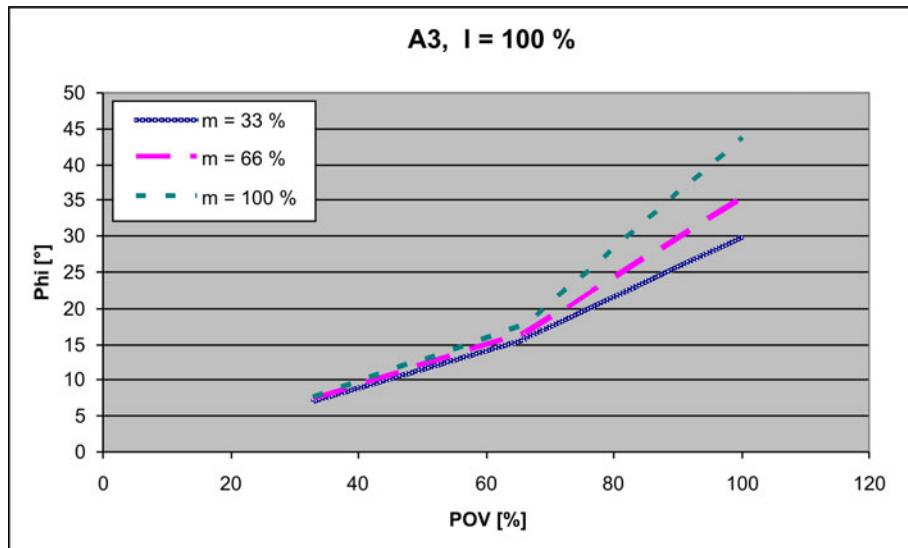
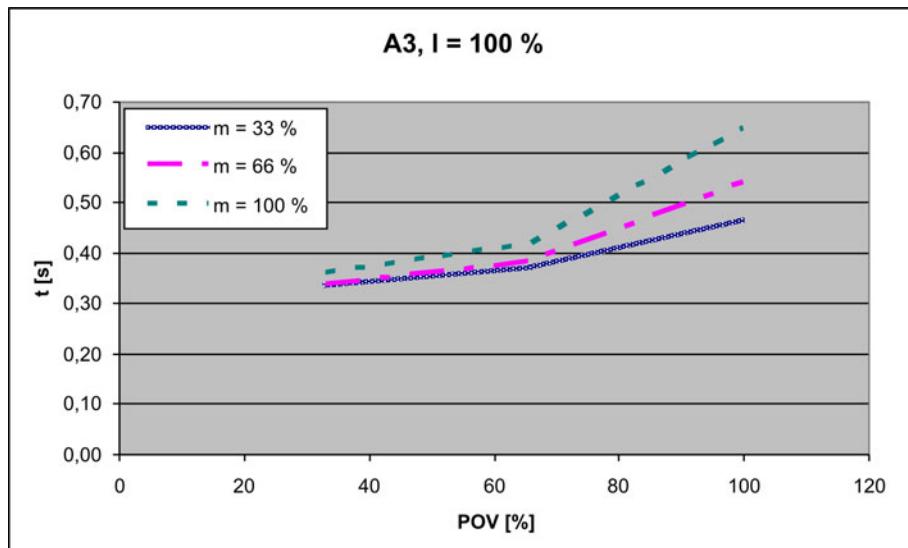


Fig. 4-102: Stopping times for STOP 1, axis 2

4.14.8.4 Stopping distances and stopping times for STOP 1, axis 3**Fig. 4-103: Stopping distances for STOP 1, axis 3****Fig. 4-104: Stopping times for STOP 1, axis 3**

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 designated 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 safety must be rectified immediately.

Safety information

Information about safety may not be construed against KUKA Deutschland 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 Deutschland GmbH. Additional components (tools, software, etc.), not supplied by KUKA Deutschland 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.

Any use or application deviating from the intended use is deemed to be misuse and is not allowed. The manufacturer is not liable for any damage resulting from such misuse. The risk lies entirely with the user.

Operation of the industrial robot in accordance with its intended use also requires compliance with 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 misuse and is not allowed. This includes e.g.:

- Use as a climbing aid
- Operation outside the specified operating parameters
- Operation without the required safety equipment

5.1.3 EC declaration of conformity and declaration of incorporation

The 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 a conformity assessment procedure.

EC declaration of conformity

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

The robot controller has a CE mark in accordance with the EMC Directive and the Low Voltage Directive.

Declaration of incorporation

The 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 is not allowed 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.

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.
Service life	The service life of a safety-relevant component begins at the time of delivery of the component to the customer. The service life is not affected by whether the component is used in a controller or elsewhere or not, as safety-relevant components are also subject to aging during storage
KCP	KUKA Control Panel Teach pendant for the KR C2/KR C2 edition2005 The KCP has all the operator control and display functions required for operating and programming the industrial robot.
KUKA smartPAD	see "smartPAD"
Manipulator	The robot arm and the associated electrical installations
Safety zone	The safety zone is situated outside the danger zone.
Safety options	Generic term for options which make it possible to configure additional safe monitoring functions in addition to the standard safety functions. Example: SafeOperation
smartPAD	Teach pendant for the KR C4 The smartPAD has all the operator control and display functions required for operating and programming the industrial robot.
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	Axis of motion that does not belong to the manipulator, yet is controlled with the same 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 briefing 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 EC declaration of conformity
- Attaching the CE mark
- Creating the operating instructions for the system

Operators

The operator must meet the following preconditions:

- The operator must be trained for the work to be carried out.
- Work on the system 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.



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.

5.4 Overview of protective equipment

The protective equipment of the mechanical component may include:

- Mechanical end stops
- Mechanical axis limitation (optional)
- Release device (optional)
- Brake release device (optional)
- Labeling of danger areas

Not all equipment is relevant for every mechanical component.

5.4.1 Mechanical end stops

Depending on the robot variant, the axis ranges of the main and wrist axes of the manipulator are partially limited by mechanical end stops.

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



If the manipulator or an external axis hits an obstruction or a mechanical end stop or mechanical axis limitation, the manipulator can no longer be operated safely. The manipulator must be taken out of operation and KUKA Deutschland GmbH must be consulted before it is put back into operation.

5.4.2 Mechanical axis limitation (optional)

Some manipulators can be fitted with mechanical axis limitation systems in axes A1 to A3. The axis 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 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 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 Deutschland GmbH.

5.4.3 Options for moving the manipulator without drive energy



The system user is responsible for ensuring that the training of personnel with regard to the response to emergencies or exceptional situations also includes how the manipulator can be moved without drive energy.

Description

The following options are available for moving the manipulator without drive energy after an accident or malfunction:

- Release device (optional)

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.

- Brake release device (option)

The brake release device is designed for robot variants whose motors are not freely accessible.

- Moving the wrist axes directly by hand

There is no release device available for the wrist axes of variants in the low payload category. This is not necessary because the wrist axes can be moved directly by hand.



Information about the options available for the various robot models and about how to use them can be found in the assembly and operating instructions for the robot or requested from KUKA Deutschland GmbH.

NOTICE

Moving the manipulator without drive energy can damage the motor brakes of the axes concerned. The motor must be replaced if the brake has been damaged. The manipulator may therefore be moved without drive energy only in emergencies, e.g. for rescuing persons.

5.4.4 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:

- Identification plates
- Warning signs
- Safety symbols
- Designation labels
- Cable markings
- Rating 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 out. 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.



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



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

KCP/smartPAD

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

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



WARNING The operator must ensure that decoupled KCPs/smart-PADs 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 devices from becoming interchanged. Failure to observe this precaution may result in death, severe 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/smartPAD must not be used as long as an external keyboard and/or external mouse are connected to the control cabinet.

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

Modifications	<p>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 functions must also be tested.</p> <p>New or modified programs must always be tested first in Manual Reduced Velocity mode (T1).</p> <p>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 e.g. modifications of the external axes or to the software and configuration settings.</p>
Faults	<p>The following tasks must be carried out in the case of faults in the industrial robot:</p> <ul style="list-style-type: none">■ 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.

5.5.2 Transportation

Manipulator	<p>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 robot.</p> <p>Avoid vibrations and impacts during transportation in order to prevent damage to the manipulator.</p>
Robot controller	<p>The prescribed transport position of the robot controller must be observed. Transportation must be carried out in accordance with the operating instructions or assembly instructions of the robot controller.</p> <p>Avoid vibrations and impacts during transportation in order to prevent damage to the robot controller.</p>
External axis (optional)	<p>The prescribed transport position of the external axis (e.g. KUKA linear unit, turn-tilt table, positioner) must be observed. Transportation must be carried out in accordance with the operating instructions or assembly instructions of the external axis.</p>

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.

WARNING

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.



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

NOTICE

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 is no damage to the robot that could be attributed to external forces. Example: Dents or abrasion that could be caused by an impact or collision.

WARNING

In the case of such damage, the affected components must be exchanged. In particular, the motor and counterbalancing system must be checked carefully.

External forces can cause non-visible damage. For example, it can lead to a gradual loss of drive power from the motor, resulting in unintended movements of the manipulator. Death, injuries or considerable damage to property may otherwise result.

- 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.

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.
- Workpieces, 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 possible in T1 mode.
- 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 functions 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 it from being switched 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 devices 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.



DANGER Before work is commenced on live parts of the robot system, the main switch must be turned off and secured against being switched on again. The system must then be checked to ensure that it is deenergized.
It is not sufficient, before commencing work on live parts, to execute an EMERGENCY STOP or a safety stop, or to switch off the drives, as this does not disconnect the robot system from the mains power supply. Parts remain energized. Death or severe injuries may result.

Faulty components must be replaced using new components with the same article numbers or equivalent components approved by KUKA Deutschland 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 and the provisions 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 regularly requesting up-to-date safety data sheets for 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/Edition	Definition
2006/42/EU:2006	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)
2014/68/EU:2014	Pressure Equipment Directive: Directive 2014/68/EU of the European Parliament and of the Council dated 15 May 2014 on the approximation of the laws of the Member States concerning pressure equipment (Only applicable for robots with hydropneumatic counterbalancing system.)
EN ISO 13850:2015	Safety of machinery: Emergency stop - Principles for design
EN ISO 13849-1:2015	Safety of machinery: Safety-related parts of control systems - Part 1: General principles of design
EN ISO 13849-2:2012	Safety of machinery: Safety-related parts of control systems - Part 2: Validation
EN ISO 12100:2010	Safety of machinery: General principles of design, risk assessment and risk reduction
EN ISO 10218-1:2011	Industrial robots – Safety requirements: Part 1: Robots Note: Content equivalent to ANSI/RIA R.15.06-2012, Part 1

EN 614-1:2006+A1:2009	Safety of machinery: Ergonomic design principles - Part 1: Terms and general principles
EN 61000-6-2:2005	Electromagnetic compatibility (EMC): Part 6-2: Generic standards; Immunity for industrial environments
EN 61000-6-4:2007 + A1:2011	Electromagnetic compatibility (EMC): Part 6-4: Generic standards; Emission standard for industrial environments
EN 60204-1:2006/A1:2009	Safety of machinery: Electrical equipment of machines - Part 1: General requirements

6 Planning

6.1 Information for planning

In the planning and design phase, care must be taken regarding the functions or applications to be executed by the kinematic system. The following conditions can lead to premature wear. They necessitate shorter maintenance intervals and/or earlier exchange of components. In addition, the permissible operating parameters specified in the technical data must be taken into account and observed during planning.

- Continuous operation near temperature limits or in abrasive environments
- Continuous operation close to the performance limits, e.g. high rpm of an axis
- High duty cycle of individual axes
- Monotonous motion profiles, e.g. short, frequently recurring axis motions
- Static axis positions, e.g. continuous vertical position of a wrist axis
- External forces (process forces) acting on the robot

If one or more of these conditions are to apply during operation of the kinematic system, KUKA Deutschland GmbH must be consulted.

If the robot reaches its corresponding operation limit or if it is operated near the limit for a period of time, the built-in monitoring functions come into effect and the robot is automatically switched off.

This protective function can limit the availability of the robot system.

In the case of high thermal, chemical and mechanical loads and to support maintenance work, the supplied pressure reducer and the associated manometer are to be installed away from the robot in a protected area, e.g. on the safety fence, system controller or control cabinet (max. distance 10 m from robot base; the greater the distance, the longer it takes before the overpressure in the robot has dissipated completely). Alternatively, or additionally, the pressure reducer and manometer can be protected by means of an enclosure.

6.2 Mounting base with centering

Description The mounting base with centering is used when the robot is fastened to the floor, i.e. directly on a concrete foundation.

The mounting base with centering consists of:

- Bedplates
- Resin-bonded anchors (chemical anchors)
- Fastening elements

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. There must be no layers of insulation or screed between the bedplates and the concrete foundation.

The minimum dimensions must be observed.

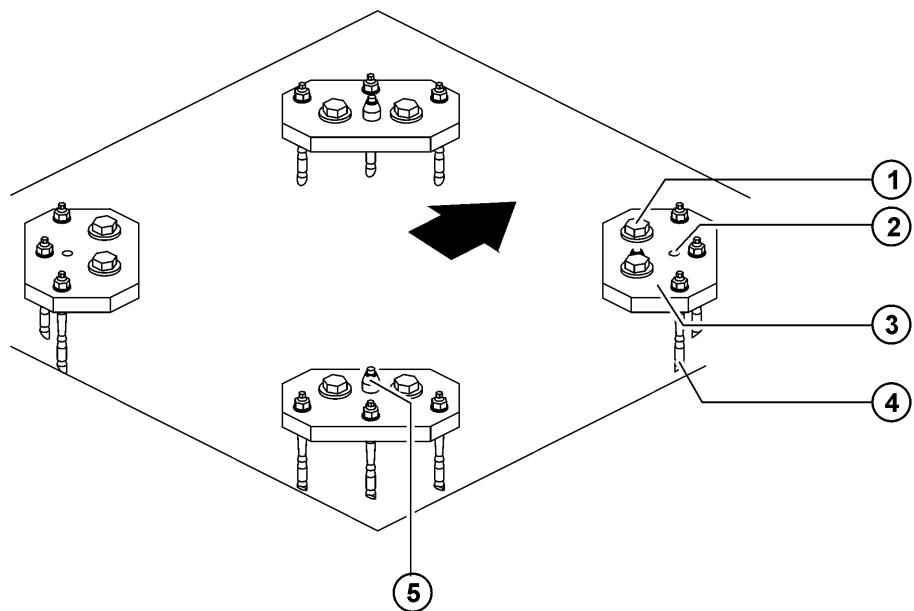


Fig. 6-1: Mounting base

- | | |
|----------------------------------|------------------------|
| 1 Hexagon bolt | 4 Resin-bonded anchor |
| 2 M20 thread for adjusting screw | 5 Pin with Allen screw |
| 3 Bedplate | |

**Grade of concrete
for foundations**

When producing foundations from concrete, observe the load-bearing capacity of the ground and the country-specific construction regulations. There must be no layers of insulation or screed between the bedplates and the concrete foundation. The quality of the concrete must meet the requirements of the following standard:

- C20/25 according to DIN EN 206-1:2001/DIN 1045-2:2008

**Dimensioned
drawing**

The following illustrations provide all the necessary information on the mounting base, together with the required foundation data. The specified foundation dimensions refer to the safe transmission of the foundation loads into the foundation and not to the stability of the foundation.

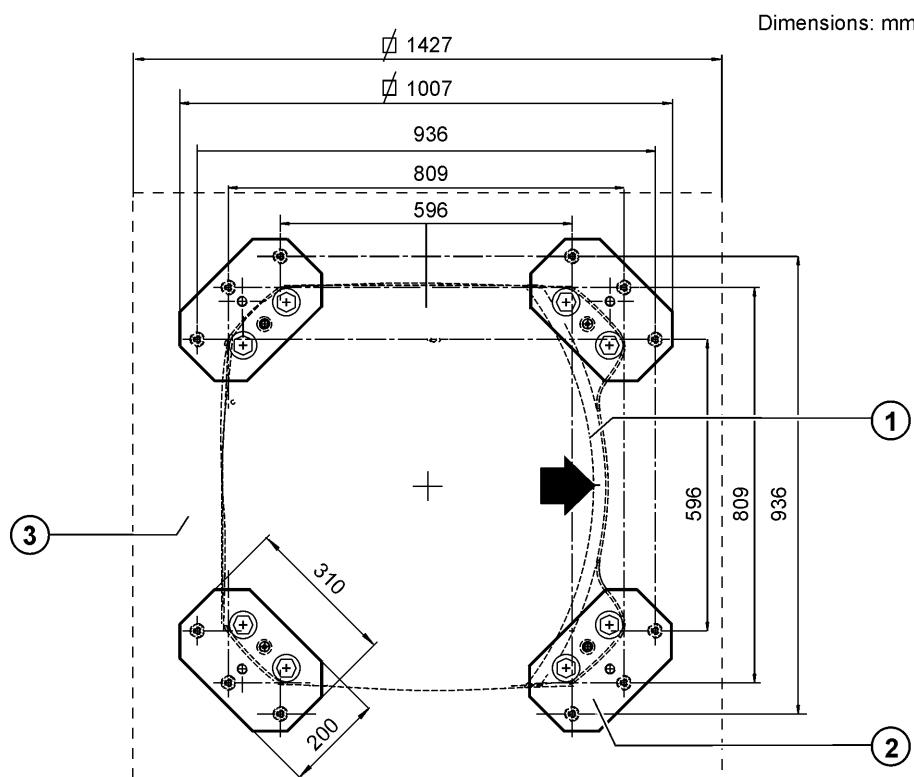


Fig. 6-2: Mounting base, dimensioned drawing

- 1 Robot
- 2 Bedplate
- 3 Concrete foundation

To ensure that the anchor forces are safely transmitted to the foundation, observe the dimensions for concrete foundations specified in the following illustration.

NOTICE The dimensions specified for the distance to the edge are valid for non-reinforced or normally reinforced concrete without verification of concrete edge failure. For safety against concrete edge failure in accordance with ETAG 001 Annex C, the concrete foundation must be provided with an appropriate edge reinforcement.

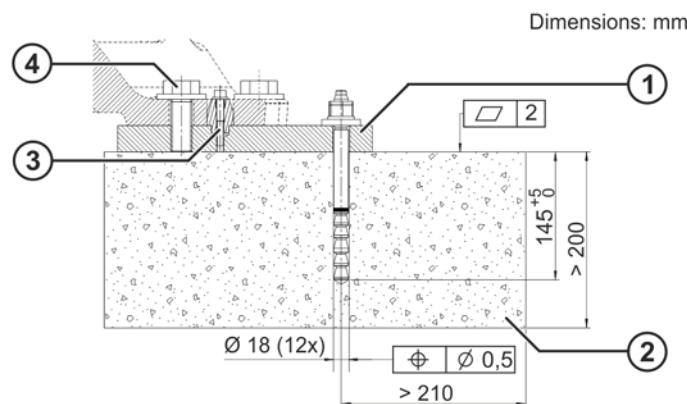


Fig. 6-3: Cross-section of foundations

- 1 Bedplate
- 2 Concrete foundation
- 3 Pin
- 4 Hexagon bolt

6.3 Machine frame mounting

Description

The "machine frame mounting" assembly with centering is used when the robot is fastened on a steel structure, a booster frame (pedestal) or a KUKA linear unit. This assembly is also used if the manipulator is installed in an inverted position, i.e. on the ceiling. It must be ensured that the substructure is able to withstand safely the forces occurring during operation (foundation loads). The following diagram contains all the necessary information that must be observed when preparing the mounting surface ([>>> Fig. 6-4](#)).

The machine frame mounting assembly consists of:

- Pins with fasteners
- Hexagon bolts with conical spring washers

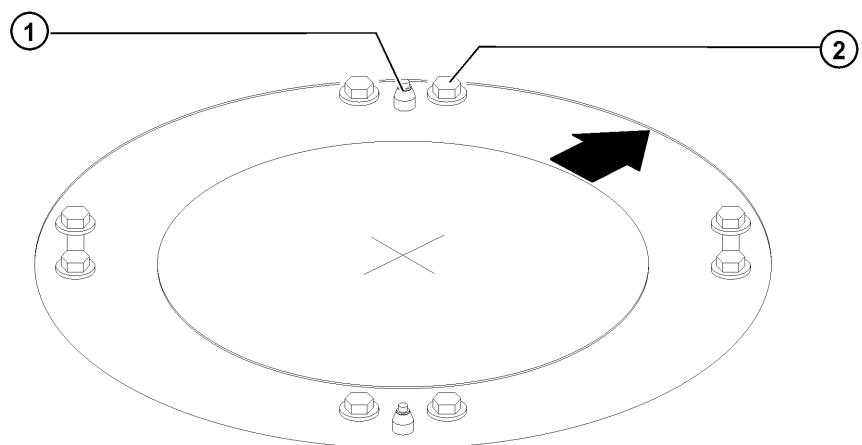


Fig. 6-4: Machine frame mounting

- 1 Pin
- 2 Hexagon bolt

Dimensioned drawing

The following illustration provides all the necessary information on machine frame mounting, together with the required foundation data.

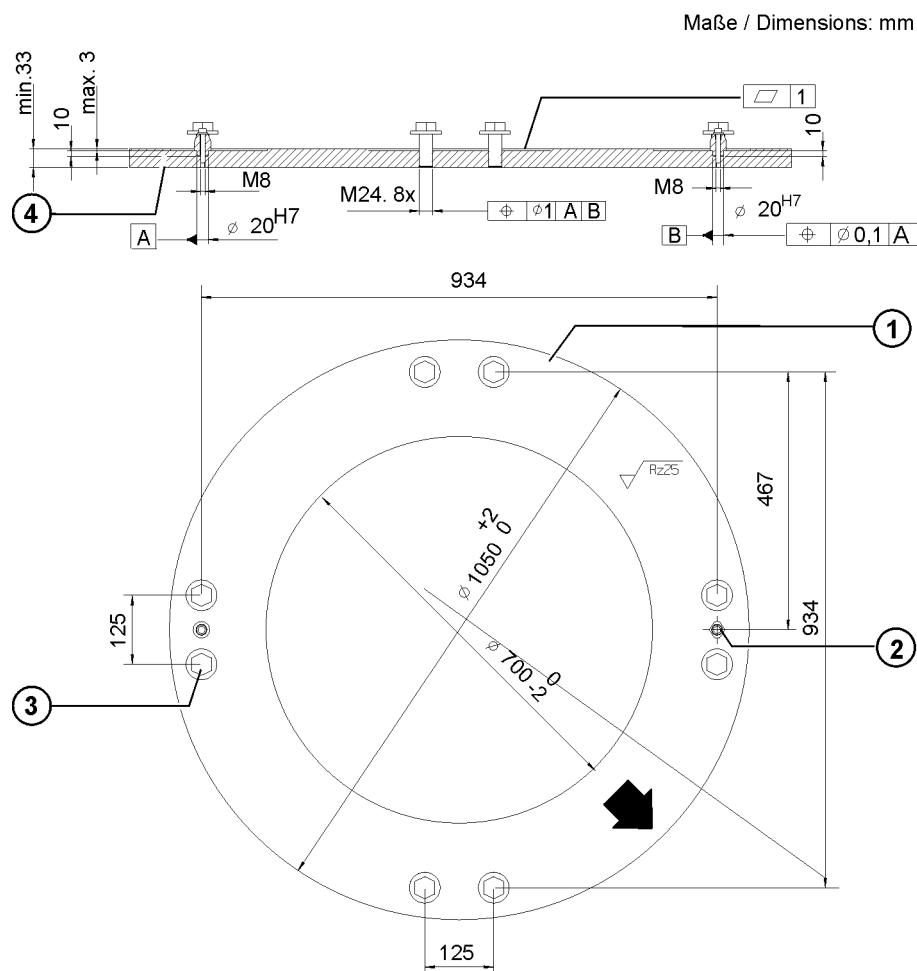


Fig. 6-5: Machine frame mounting, dimensioned drawing

- | | | | |
|---|------------------|---|-------------------|
| 1 | Mounting surface | 3 | Hexagon bolt (8x) |
| 2 | Pin | 4 | Steel structure |

6.4 Connecting cables and interfaces

Connecting cables

The connecting cables comprise all the cables for transferring energy and signals between the robot and the robot controller. They are connected to the robot junction boxes with connectors. The set of connecting cables comprises:

- Motor cable, X20 - X30
- Data cable X21 - X31
- Ground conductor (optional)

Depending on the specification of the robot, various connecting cables are used. Cable lengths of 7 m, 15 m, 25 m, 35 m and 50 m are available. The maximum length of the connecting cables must not exceed 50 m. Thus if the robot is operated on a linear unit which has its own energy supply chain these cables must also be taken into account.

For the connecting cables, an additional ground conductor is always required to provide a low-resistance connection between the robot and the control cabinet in accordance with DIN EN 60204. The ground conductors are connected via ring cable lugs. The threaded bolt for connecting the ground conductor is located on the base frame of the robot.

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

- The bending radius for fixed routing must not be less than 150 mm for motor cables and 60 mm for control cables.
- 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 the permissible temperature range (fixed installation) of 263 K (-10 °C) to 343 K (+70 °C).
- Route the motor cables and the data cables separately in metal ducts; if necessary, additional measures must be taken to ensure electromagnetic compatibility (EMC).

Interface for energy supply systems

The robot can be equipped with an energy supply system between axis 1 and axis 3 and a second energy supply system between axis 3 and axis 6. The A1 interface required for this is located on the rear of the base frame, the A3 interface is located on the side of the arm and the interface for axis 6 is located on the robot tool. Depending on the application, the interfaces differ in design and scope. They can be equipped e.g. with connections for cables and hoses. Detailed information on the connector pin allocation, threaded unions, etc. is given in separate documentation.

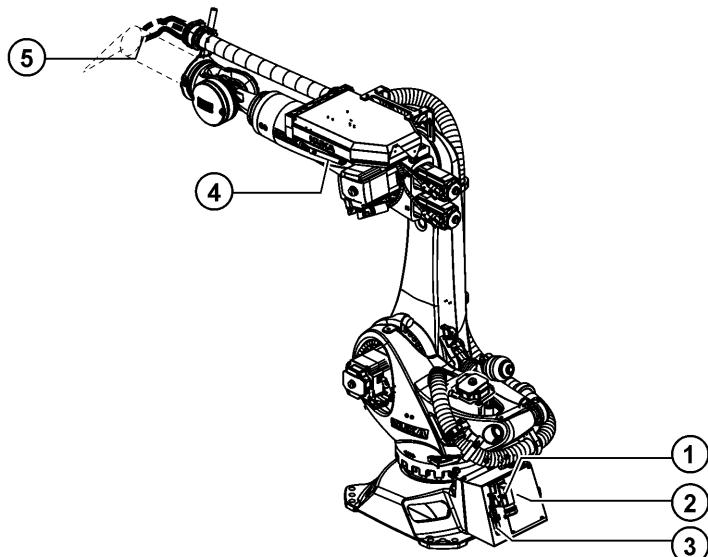


Fig. 6-6: Interfaces on the robot

- | | |
|---------------------------------|---------------------------|
| 1 Connection, motor cable X30 | 4 Interface, axis 3, arm |
| 2 Interface, axis 1, base frame | 5 Interface, axis 6, tool |
| 3 Connection, data cable, X31 | |

7 Transportation

7.1 Transporting the robot arm

Before transporting the robot, always move the robot into its transport position. It must be ensured that the robot is stable while it is being transported. The robot must remain in its transport position until it has been fastened in position. Before the robot is lifted, it must be ensured that it is free from obstructions. Remove all transport safeguards, such as nails and screws, in advance. First remove any rust or glue on contact surfaces.

Transport position

The robot must be in the transport position ([>>> Fig. 7-1](#)) before it can be transported. The robot is in the transport position when the axes are in the following positions:

Axis	A1	A2	A3	A4	A5	A6
Transport position	0°	-140°	+150°	0°	-120°	0°

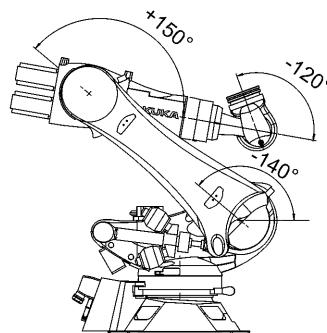


Fig. 7-1: Transport position

Transport dimensions

The transport dimensions ([>>> Fig. 7-2](#)) ([>>> Fig. 7-3](#)) for the robot may be noted from the following diagrams. The position of the center of gravity and the weight vary according to the specific configuration and the position of axes 2 and 3. The specified dimensions refer to the robot without equipment.

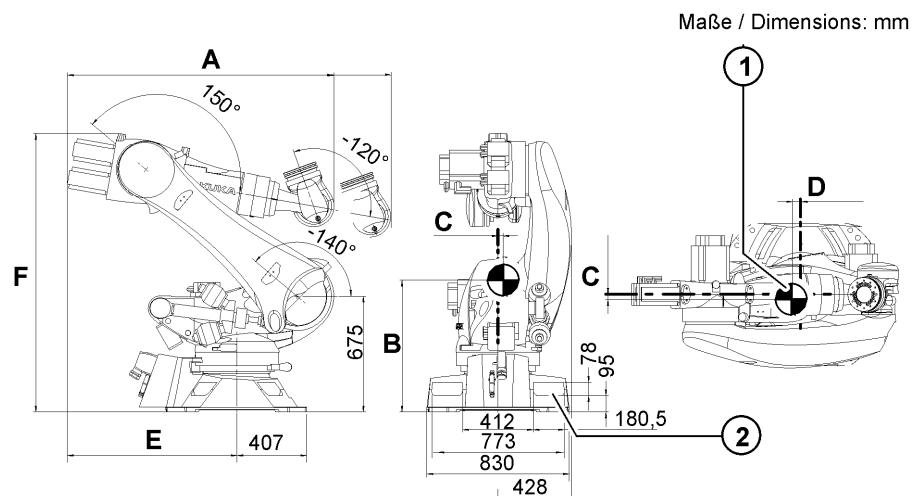


Fig. 7-2: Transport dimensions

- 1 Center of gravity
- 2 Fork slots

Transport dimensions and centers of gravity

Robot with reach	A	B	C	D	E	F
R2500	1582	765	33	50	997	1625
R2700	1761	753	44	21	997	1625
R2900	1747	803	38	87	1150	1754
R3100	1943	804	38	68	1150	1754

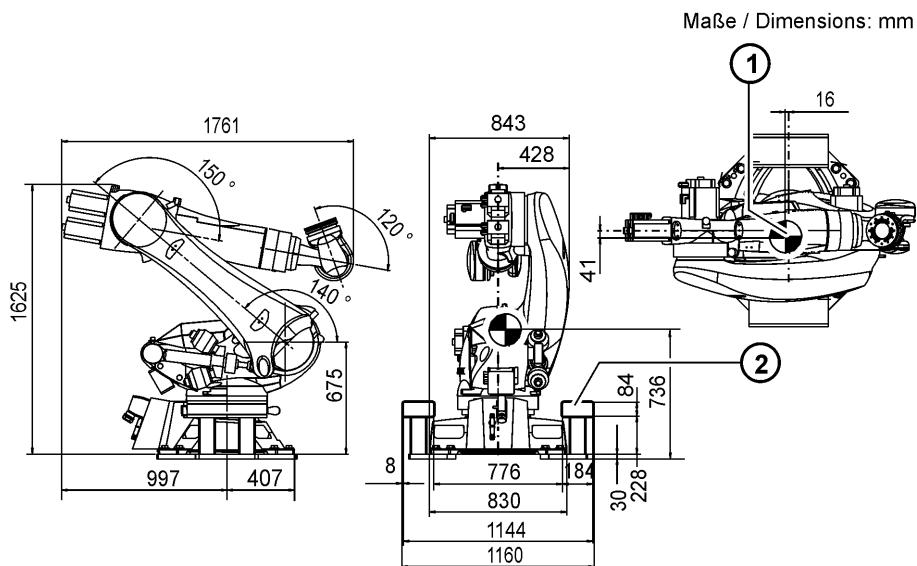


Fig. 7-3: Transport dimensions, CR robots

- 1 Center of gravity
- 2 Fork slots

Transport

The robot can be transported by fork lift truck or using lifting tackle.



WARNING Use of unsuitable handling equipment may result in damage to the robot or injury to persons. Only use authorized handling equipment with a sufficient load-bearing capacity. Only transport the robot in the manner specified here.

Transportation by fork lift truck

For transport by fork lift truck (>>> Fig. 7-4), two fork slots are provided in the base frame. The robot can be picked up by the fork lift truck from the front and rear. The base frame must not be damaged when inserting the forks into the fork slots. The forklift truck must have a minimum payload capacity of 2,000 kg and an adequate fork length.

Ceiling-mounted robots can only be transported by fork lift truck.

For installation situations in which the fork slots are not accessible, the "Recovery aid" accessory is available. With this device, the robot can also be transported using the fork lift truck.



NOTICE Avoid excessive loading of the fork slots through undue inward or outward movement of hydraulically adjustable forks of the fork lift truck. Failure to do so may result in material damage.

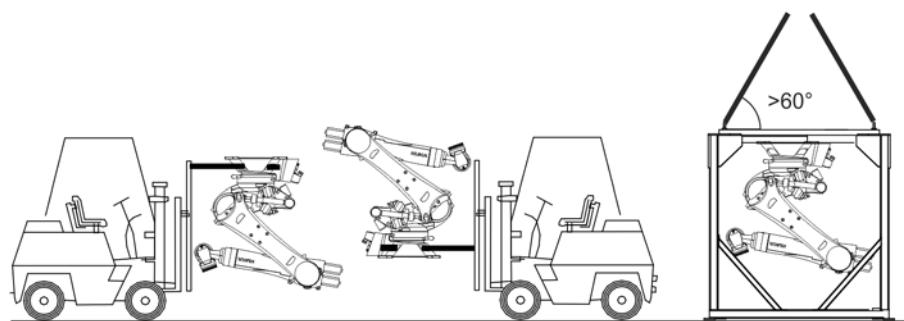


Fig. 7-4: Transportation by fork lift truck

Transportation by fork lift truck, CR robots

CR robots can be transported by fork lift truck (>>> Fig. 7-5) in two ways. For transport to the cleanroom, the robot is bolted to the fork slots according to the following diagram. The two fork slots provided in the base frame are used in the cleanroom. The forks must be inserted into the slots very carefully in order to prevent chipping of painted parts or damage to the base frame, which can lead to contamination of the cleanroom.

The robot can be picked up by the fork lift truck from the front and rear. The forklift truck must have a minimum payload capacity of 2,000 kg and an adequate fork length.

For installation situations in which the fork slots are not accessible, the “Recovery aid” accessory is available. With this device, the robot can also be transported using the fork lift truck. Appropriate care must be taken here as well to prevent contamination.

NOTICE

Avoid excessive loading of the fork slots through undue inward or outward movement of hydraulically adjustable forks of the fork lift truck. Failure to do so may result in material damage.

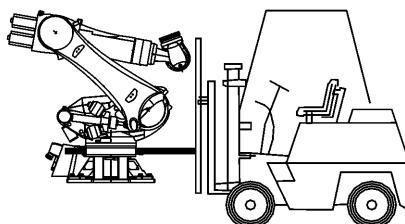


Fig. 7-5: Transportation of CR robots by fork lift truck

Transportation with lifting tackle

The robot can also be transported using lifting tackle (>>> Fig. 7-6). For this, it must be in the transport position. The lifting tackle is attached at 3 points to M16 DIN 580 eyebolts. All the legs must be routed as shown in the following illustration so that the robot is not damaged. Installed tools and items of equipment can cause undesirable shifts in the center of gravity. Items of equipment, especially energy supply systems, must be removed to the extent necessary to avoid them being damaged by the legs of the lifting tackle during transportation.

All the legs are labeled. Leg G3 is provided with an adjustable chain that must be adjusted so that the robot is suspended vertically from the crane. If necessary, the robot must be set down again and the chain readjusted.

If the robot is equipped with a cover on the rotating column, this must be removed before transporting the robot. It must be reinstalled before the robot is put back into operation.

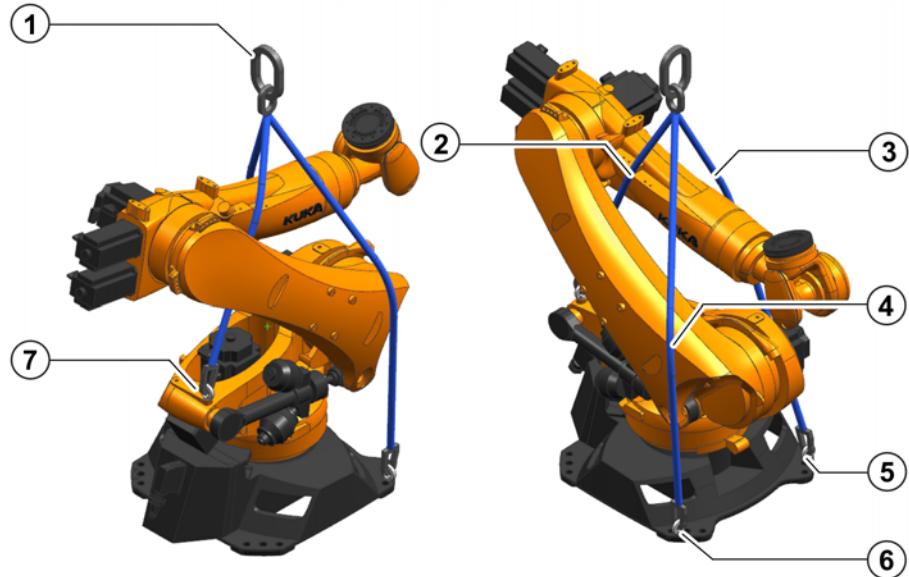
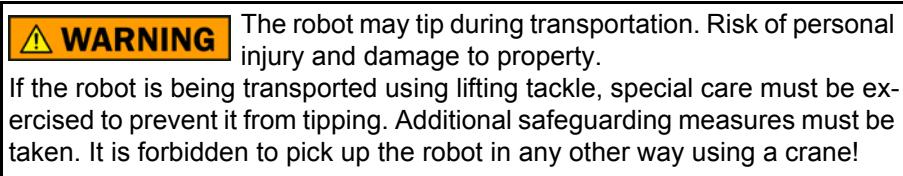


Fig. 7-6: Transportation using lifting tackle

- 1 Lifting tackle assembly
- 2 Leg G3
- 3 Leg G1
- 4 Leg G2
- 5 M16 eyebolt, base frame, left
- 6 M16 eyebolt, base frame, right
- 7 M16 eyebolt, rotating column, rear

8 Start-up and recommissioning

8.1 Installing the mounting base

Description	<p>These instructions apply to the variant "mounting base with centering (resin cartridge)". The robot is fastened to an appropriate concrete foundation using bedplates and resin-bonded anchors.</p> <p>If the surface of the concrete foundation is not sufficiently smooth and even, the differences must be evened out with a suitable leveling compound.</p> <p>When using resin-bonded anchors, use only resin cartridges and anchors 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. The manufacturer's instructions for the use of resin-bonded anchors must also be observed.</p>
Precondition	<ul style="list-style-type: none"> ■ 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	<p>The following special tools are required:</p> <ul style="list-style-type: none"> ■ Drill with a ø 18 mm bit ■ Setting tool approved by the anchor manufacturer
Procedure	<ol style="list-style-type: none"> 1. Lift the robot with fork lift truck or lifting tackle. 2. Fasten the 4 bedplates to the robot using 2 M24x65-8.8 Allen screws with conical spring washers for each one. <p>Increase the tightening torque to the specified value in several stages. 2 bedplates are fitted with locating pins for centering.</p> <ol style="list-style-type: none"> 3. Determine the position of the robot on the mounting base in relation to the working envelope. 4. Set the robot down on the mounting base in its installation position. 5. Align the robot horizontally. <div style="border: 1px solid black; padding: 10px; margin-top: 10px;"> <p>NOTICE If the bedplates are not fully seated on the concrete foundation, this can result in distortion or loosening of the mounting base. Fill the gap with leveling compound. To do this, lift the robot again and apply sufficient leveling compound to the underside of the bedplates (toothed spatula). Then set the robot down again and align it, removing any excess leveling compound. The maximum height of the leveling compound must not be exceeded. The area under the hexagon bolt for robot fastening must be kept free from leveling compound. Allow the leveling compound to set in accordance with the manufacturer's instructions.</p> </div> <ol style="list-style-type: none"> 6. Drill 12 anchor holes in accordance with the manufacturer's specifications and fit the anchors as specified in the instructions for use. The instructions for use are enclosed with the anchors and must be followed precisely. 7. Allow the resin to cure. See table provided by manufacturer. <p>The mounting base and robot are now ready for connection of the robot.</p>

8.2 Installing the machine frame mounting assembly

Description	The machine frame mounting assembly is used for installing robots on a steel structure prepared by the customer or on the carriage of a linear unit.
Preconditions	<ul style="list-style-type: none"> ■ The mounting surface has been prepared as shown in the diagram (>>> Fig. 6-5). ■ The substructure has been checked for sufficient safety. ■ The machine frame mounting assembly is complete.
Procedure	<ol style="list-style-type: none"> 1. Clean the mounting surface (>>> Fig. 8-1) of the robot. 2. Check the hole pattern. 3. Insert 2 pins and 2 M8x55-8.8 Allen screws with conical spring washers and tighten with a torque wrench; $M_A = 23.9 \text{ Nm}$. 4. Prepare 8 M24x65-8.8-A2K hexagon bolts and conical spring washers.

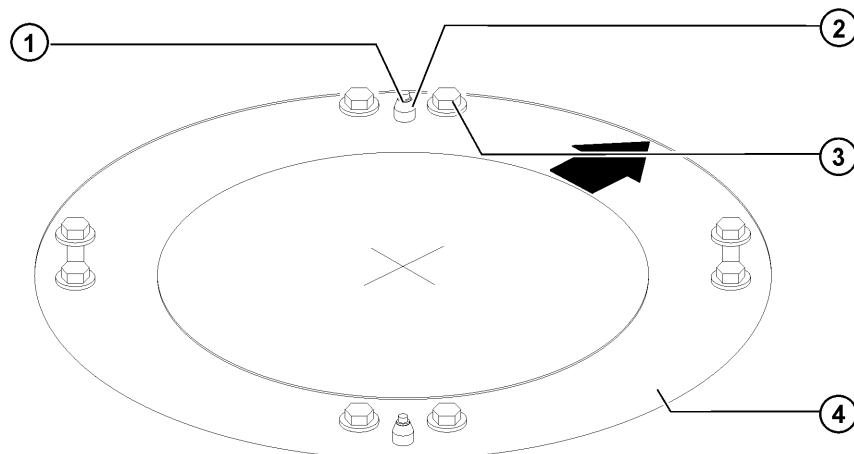


Fig. 8-1: Installing the machine frame mounting assembly

- | | |
|--|---|
| 1 Pin | 3 Hexagon bolt with conical spring washer, 8x |
| 2 Allen screw with conical spring washer, 2x | 4 Mounting surface |

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

8.3 Installing the robot

Description	This description is valid for the installation of robots on the floor, with the mounting variants: mounting base, machine frame mounting and adapter plates. The installation and start-up of the robot controller, the tools mounted and the applications are not described here.
Precondition	<ul style="list-style-type: none"> ■ The relevant mounting base is installed. ■ The installation site is accessible with a crane or fork lift truck. ■ Any tools or other system components which would hinder the work have been removed. ■ The robot is in the transport position. ■ The connecting cables and ground conductors are routed to the robot and installed. ■ Compressed air supply to the robot available; F variant only.

Procedure

1. Check that both pins (**>>> Fig. 8-2**) are undamaged and fitted securely.
2. Bring the robot to the installation site by crane or fork lift truck (**>>> 7 "Transportation" Page 141**).
The lifting tackle must not damage the robot.
3. Clean the mounting surface on the robot.
4. Lower the robot vertically onto the mounting base. Ensure that an entirely vertical position is maintained in order to prevent damage to the pins.
5. Insert 8 M24x65-8.8 hexagon bolts together with conical spring washers.
6. Tighten the hexagon bolts with a torque wrench. Gradually increase the tightening torque to 640 Nm.
7. Remove the lifting tackle and eyebolts or the fork slots.
8. Connect motor cable X30 and data cable X31.
9. Connect the ground conductor between the robot controller and the robot to the ground conductor connection.
10. Connect the ground conductor between the system component and the robot to the ground conductor connection.
11. Check the equipotential bonding in accordance with VDE 0100 and EN 60204-1.



Further information is contained in the assembly or operating instructions for the robot controller.

12. Connect compressed air supply to the pressure regulator and set the pressure regulator to zero; F variant only.
13. Open compressed air supply and set pressure regulator to 0.01 MPa (0.1 bar); F variant only.
14. Mount tooling, if required.
15. Retighten the 8 hexagon bolts with a torque wrench after 100 hours of operation.
16. Clean the robot; CR variant only.



During start-up and recommissioning, compliance with the cleanroom class requirements cannot be assured. Before the manipulator is put into operation, cleaning must be carried out in accordance with the requirements of the application.

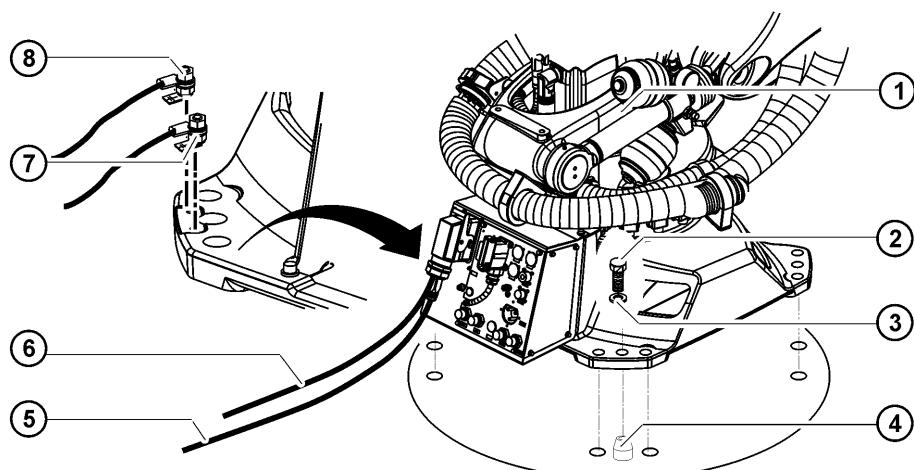


Fig. 8-2: Installing the robot

1 Rotating column

2 Hexagon bolts

5 Data cable

6 Motor cable

3	Conical spring washers	7	Ground conductor connection
4	Pin	8	Ground conductor connection, robot controller

Put the robot into operation in accordance with the "Start-up" chapter of the operating and programming instructions for the System Software and/or the assembly instructions or operating instructions for the robot controller.

NOTICE

Incorrectly adjusted pressure regulators or operation with no pressure regulator may result in damage to the robot. For this reason, the robot may only be operated with a correctly adjusted pressure regulator and with the compressed air supply connected.

8.4 Installing a ceiling-mounted robot

Description

This description is valid for the installation of ceiling-mounted robots with the mounting variants "Machine frame mounting" and "Adapter plates". For installation on the ceiling, the robot can be transported in a transport frame – already in the correct orientation. It is removed from this frame by fork lift truck and brought to the site of installation.

The installation and start-up of the robot controller, the tools mounted and the applications are not described here.

Precondition

- Machine frame mounting assembly is installed.
- The installation site is accessible with a fork lift truck.
- Any tools or other system components which would hinder the work have been removed.
- The robot is in the transport position and in the ceiling-mounting position.
- The connecting cables and ground conductors are routed to the robot and installed.
- Compressed air supply to the robot available; F variant only

Procedure

1. Check that both pins ([>>>](#) Fig. 8-3) (1) are undamaged and fitted securely.
2. Clean the mounting surface on the robot and the gantry.
3. Bring the robot to the installation site with the fork lift truck.
4. Raise the robot vertically with the fork lift truck and place it against the ceiling structure. Ensure that an entirely vertical position is maintained in order to prevent damage to the pins.
5. Insert 4 M24x65-8.8 hexagon bolts with conical spring washers. Continue pressing the robot against the ceiling structure until all of the hexagon bolts have been inserted and tightened with a torque wrench.
4 of the 8 fastening screws are inaccessible due to the fork lift truck.
6. Tighten the hexagon bolts with a torque wrench. Gradually increase the tightening torque to 640 Nm.
7. Remove the fork lift truck.
8. Insert 4 M24x65-8.8 hexagon bolts with conical spring washers.
9. Tighten 4 hexagon bolts (6) with torque wrench. Gradually increase the tightening torque to 640 Nm.
10. Connect motor cable X30 (3) and data cable X31.
11. Connect the ground conductor between the robot controller and the robot to the ground conductor connection.
12. Connect the ground conductor between the system component and the robot to the ground conductor connection.

13. Check the equipotential bonding in accordance with VDE 0100 and EN 60204-1.



Further information is contained in the assembly or operating instructions for the robot controller.

14. Connect compressed air supply to the pressure regulator and set the pressure regulator to zero; F variant only.
15. Open compressed air supply and set pressure regulator to 0.01 MPa (0.1 bar); F variant only.
16. Mount tooling, if required.
17. Retighten the hexagon bolts with a torque wrench after 100 hours of operation.

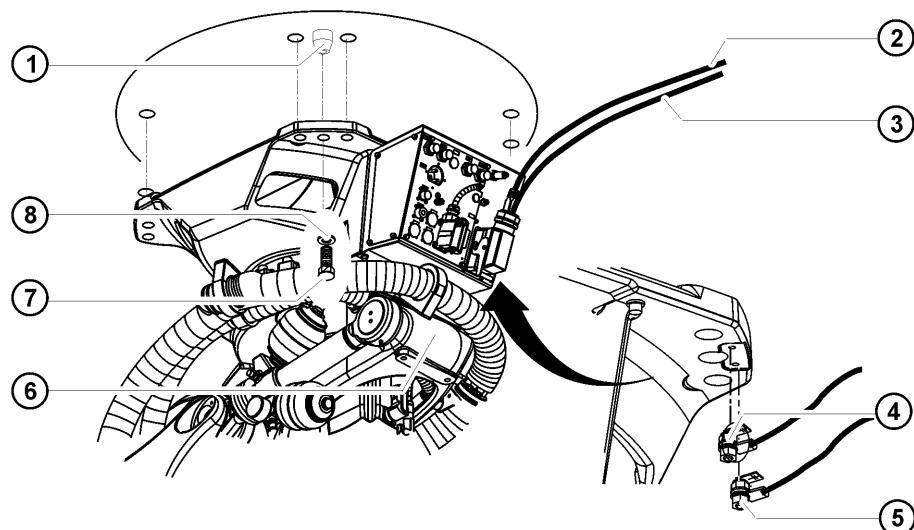


Fig. 8-3: Installing the robot

1	Pin	5	Ground conductor connection, robot controller
2	Data cable	6	Rotating column
3	Motor cable	7	Hexagon bolts
4	Ground conductor connection	8	Conical spring washers

Put the robot into operation in accordance with the "Start-up" chapter of the operating and programming instructions for the System Software and/or the assembly instructions or operating instructions for the robot controller.

NOTICE

Incorrectly adjusted pressure regulators or operation with no pressure regulator may result in damage to the robot. For this reason, the robot may only be operated with a correctly adjusted pressure regulator and with the compressed air supply connected.

8.5 Description of the connecting cables

Configuration

The connecting cables are used to transfer power and signals between the robot controller and the robot (>>>> Fig. 8-4).

The connecting cables comprise:

- Motor cable
- Data cable

- Ground conductor, optional

Interface

For connection of the connecting cables between the robot controller and the robot, the following connectors are available at the interfaces:

Cable designation	Connector designation robot controller - robot	Connection
Motor cable	X20 - X30	HAN size 24
Data cable	X21 - X31	Rectangular connector
Ground conductor, optional		M8 ring cable lug

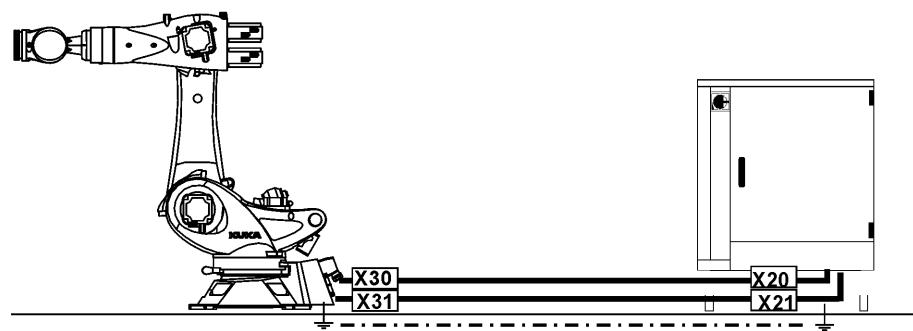
**Standard
connecting cable**

Fig. 8-4: Connecting cables, overview

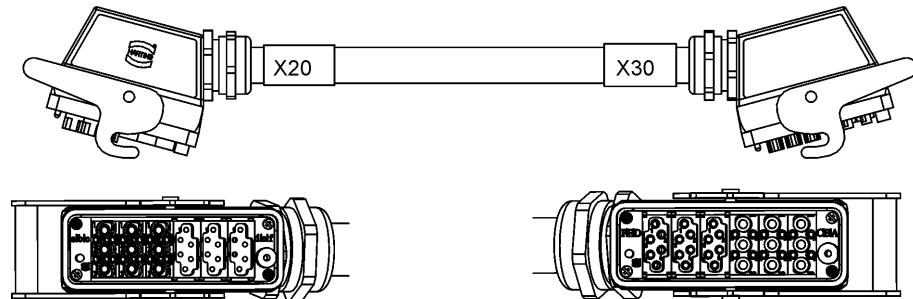


Fig. 8-5: Connecting cable, motor cable, X20 - X30

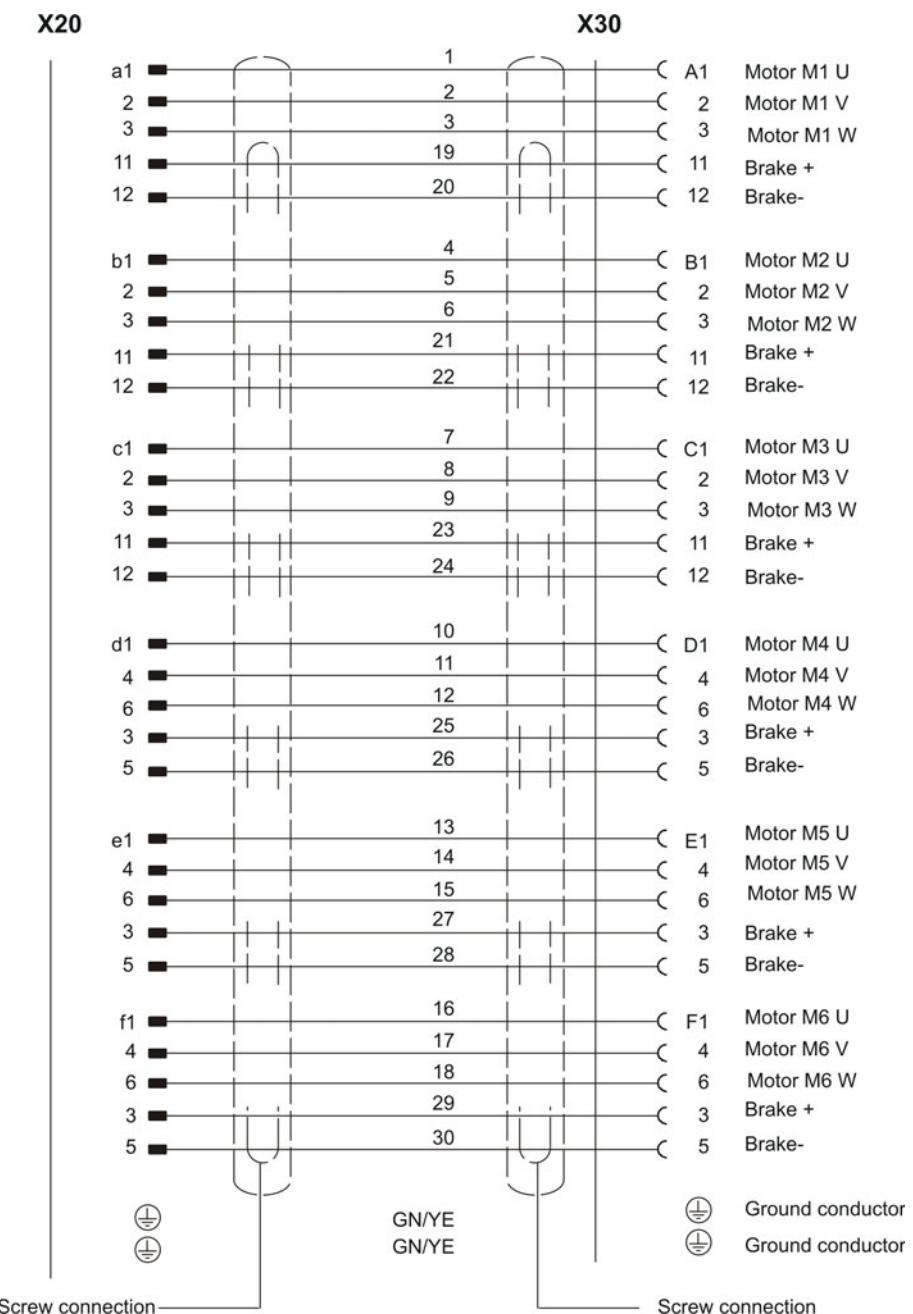


Fig. 8-6: Connecting cable, wiring diagram, motor cable

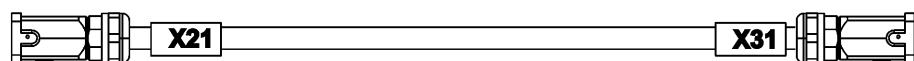
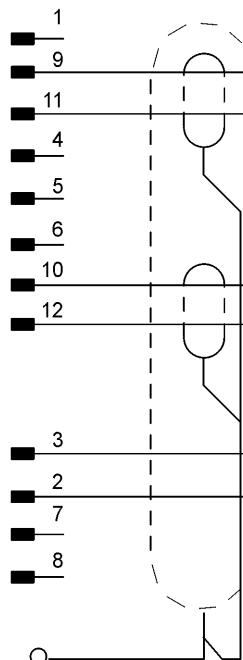


Fig. 8-7: Connecting cable, data cable X21 - X31

X21



X31

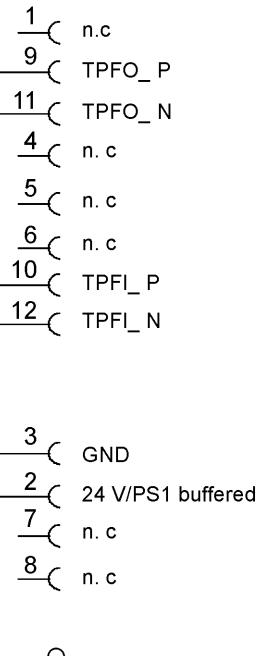


Fig. 8-8: Connecting cable, wiring diagram, data cable X21 - X31

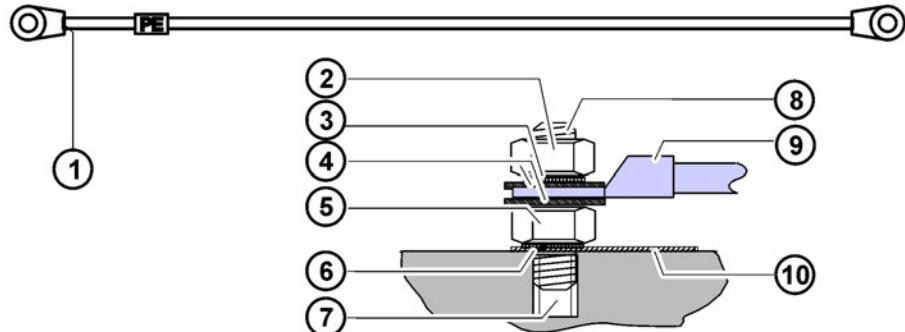


Fig. 8-9: Connecting cable, ground conductor

- | | | | |
|---|--------------------------|----|---|
| 1 | Ground conductor | 6 | Conical spring washer |
| 2 | Hexagon nut | 7 | Robot |
| 3 | Conical spring washer 2x | 8 | Setscrew |
| 4 | Plain washer 2x | 9 | Ground conductor connection,
M8 ring cable lug |
| 5 | Hexagon nut | 10 | Ground plate |

8.6 Moving the manipulator without drive energy

Description

The release device (optional) can be used for moving the manipulator after an accident or malfunction without drive energy.

This option is only for use in exceptional circumstances and emergencies, e.g. for freeing people.

Precondition

- Robot controller is switched off.

Procedure**SAFETY
INSTRUCTIONS**

The following procedure must be followed exactly!

1. Remove the protective cap from the motor ([>>> Fig. 8-10](#)).
2. 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.

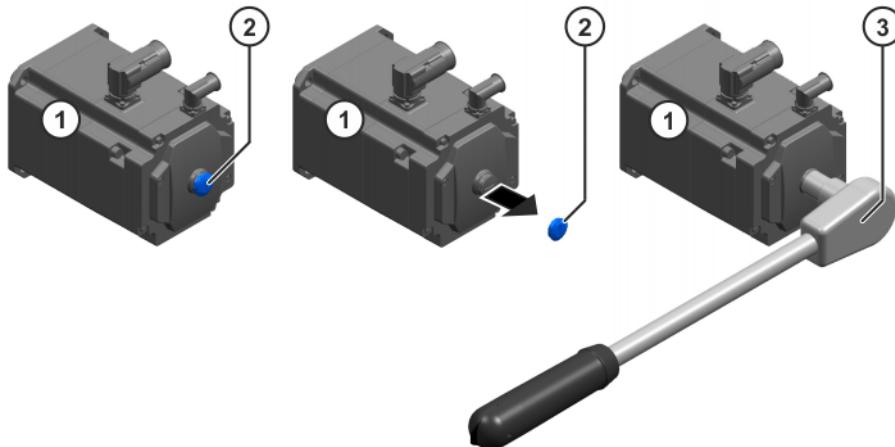


Fig. 8-10: Fitting the release device onto the motor

1 Motor

3 Release device

2 Protective cap



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 motor must be exchanged.



WARNING If a robot axis has been moved by the release device/rechargeable screwdriver with torque bracket, all robot axes must be remastered. Injuries or damage to property may otherwise result.

9 Maintenance

9.1 Maintenance table

Description Lubrication is performed either at the specified maintenance intervals or every 5 years after delivery. With a maintenance interval of 10,000 operating hours, for example, the first maintenance (oil change) is performed either after 10,000 operating hours or 5 years after delivery, 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](#)). KUKA must be consulted in the event of deviations in working conditions or the use of special functions or applications.

Special maintenance intervals apply for F variant robots.

During the oil change, the robot must be fastened to the floor.



Further information can be found in the section "Information for planning".

If the robot is fitted with a KUKA energy supply system (optional), additional maintenance work must be carried out.

NOTICE

Only lubricants approved by KUKA Deutschland GmbH may be used. Non-approved lubricants may cause premature wear and failure of assemblies.

If oil temperatures of more than 333 K (60 °C) are reached during operation, shorter maintenance intervals must be observed; for this, consultation with KUKA Deutschland GmbH is necessary.

NOTICE

Repair, maintenance and cleaning work on CR-variant robots may only be conducted outside cleanrooms. Cleaning operations are to be carried out with cleaning agents suitable for use in the cleanroom. The instructions of the cleanroom user must be observed.



When draining the oil, remember that the quantity drained is dependent on time and temperature. The quantity of oil drained must be determined. Only this quantity of oil may be used when refilling. The oil quantities specified are the actual amounts of oil in the gear unit at first filling. If less than 70% of the specified oil quantity flows out, flush the gear unit with the determined quantity of drained oil once, then pour in the amount of oil that was drained. During the flushing procedure, move the axis at jog velocity throughout the entire axis range.

Precondition

- The maintenance points must be freely accessible.
- Remove the tools and any additional items of equipment if they impede maintenance work.

WARNING When carrying out the following work, the robot must be moved several times between the individual work steps. While work is being carried out on the robot, it must always be secured by activating the EMERGENCY STOP device. Unintentional robot motions can cause injuries and damage to property. If work is carried out on an operational robot that is switched on, the robot must only be moved at reduced velocity. It must be possible to stop the robot at any time by activating an EMERGENCY STOP device. Operation must be limited to what is absolutely necessary. Warn all persons concerned before switching on and moving the robot.

Maintenance symbols



Oil change



Lubricate with grease gun



Lubricate with brush



Tighten screw/nut



Check component, visual inspection

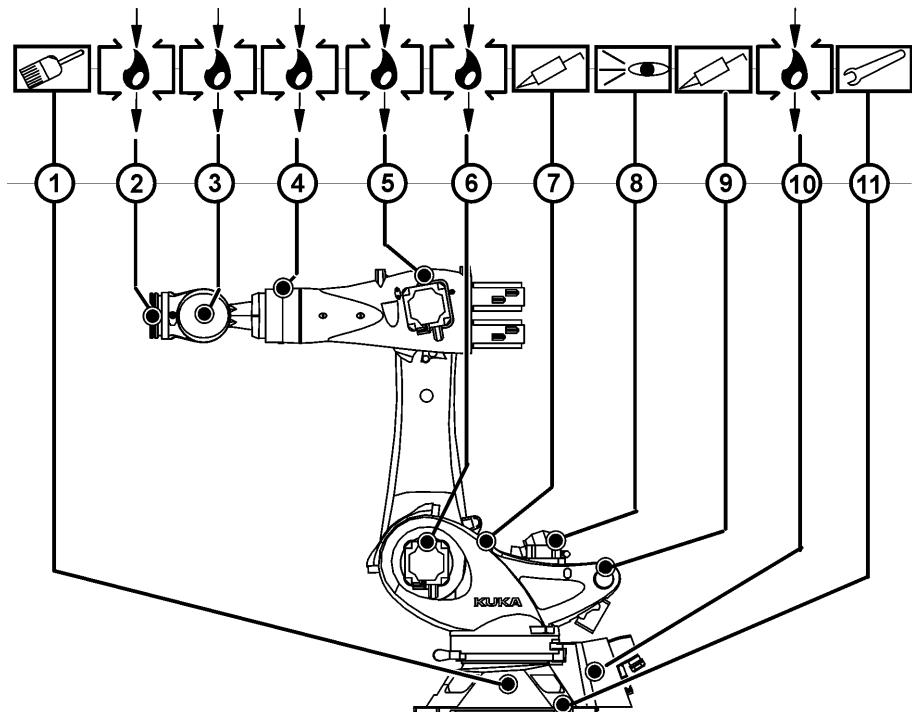


Fig. 9-1: Maintenance work, KR QUANTEC extra

**Maintenance
table, KR prime
with
IW 150/180/210**

Interval	Item	Activity	Lubricant
Once only, after 100 h	11	Check bolts; M _A 640 Nm	
5,000 h or 1 year at the latest 1)	7	Counterbalancing system bearing, link arm, lubricate. Grease nipples in the mid- dle position and at the plus and minus end positions of axis 2.	SKF LGEP 2 Art. no. 00-119-990 10 cm ³
5,000 h or 1 year at the latest 1)	9	Counterbalancing system bearing, rotating column, lubricate. Grease nipples in the mid- dle position and at the plus and minus end positions of axis 2.	SKF LGEP 2 Art. no. 00-119-990 10 cm ³
5,000 h	8	Counterbalancing system, check pressure. Setpoint, tolerance -5 bar	Hyspin ZZ 46 Art. no. 83-236-202
10,000 h	1	Grease cables of cable set and energy supply system. (>>> 9.8 "Greasing the cab- ble set" Page 175)	Grease RB 2 00-101-456 200 cm ³
20,000 h or 5 years at the latest	2	Perform oil change on gear unit A6. (>>> 9.7 "Oil change in A6" Page 172)	RV OIL SB150 Art. no. 00-255-994 1.000 l
20,000 h or 5 years at the latest	3	Perform oil change on gear unit A5. (>>> 9.6 "Oil change in A5" Page 170)	RV OIL SB150 Art. no. 00-255-994 0.900 l
20,000 h or 5 years at the latest	4	Perform oil change on gear unit A4. (>>> 9.5 "Oil change in A4" Page 168)	RV OIL SB150 Art. no. 00-255-994 2.100 l
20,000 h or 5 years at the latest	5	Perform oil change on gear unit A3. (>>> 9.4 "Oil change in A3" Page 166)	RV OIL SB150 Art. no. 00-255-994 1.800 l
20,000 h or 5 years at the latest	6	Perform oil change on gear unit A2. (>>> 9.3 "Oil change in A2" Page 164)	RV OIL SB150 Art. no. 00-255-994 2.900 l
20,000 h or 5 years at the latest	10	Perform oil change on gear unit A1. (>>> 9.2 "Oil change in A1" Page 161)	RV OIL SB150 Art. no. 00-255-994 6.500 l

1) In the case of frequently recurring, short-distance movements, the maintenance interval is 3000 hours.

**Maintenance
table, KR prime
with IW 210/240**

Interval	Item	Activity	Lubricant
Once only, after 100 h	11	Check bolts M _A 640 Nm	
5,000 h or 1 year at the latest 1)	7	Counterbalancing system bearing, link arm, lubricate. Grease nipples in the mid- dle position and at the plus and minus end positions of axis 2.	SKF LGEP 2 Art. no. 00-119-990 10 cm ³
5,000 h or 1 year at the latest 1)	9	Counterbalancing system bearing, rotating column, lubricate. Grease nipples in the mid- dle position and at the plus and minus end positions of axis 2.	SKF LGEP 2 Art. no. 00-119-990 10 cm ³
5,000 h	8	Counterbalancing system, check pressure Setpoint, tolerance -5 bar	Hyspin ZZ 46 Art. no. 83-236-202
10,000 h	1	Grease cables of cable set and energy supply system. (>>> 9.8 "Greasing the cab- ble set" Page 175)	Grease RB 2 00-101-456 200 cm ³
20,000 h or 5 years at the latest	2	Perform oil change on gear unit A6. (>>> 9.7 "Oil change in A6" Page 172)	RV OIL SB150 Art. no. 00-255-994 1.200 l
20,000 h or 5 years at the latest	3	Perform oil change on gear unit A5. (>>> 9.6 "Oil change in A5" Page 170)	RV OIL SB150 Art. no. 00-255-994 1.100 l
20,000 h or 5 years at the latest	4	Perform oil change on gear unit A4. (>>> 9.5 "Oil change in A4" Page 168)	RV OIL SB150 Art. no. 00-255-994 2.100 l
20,000 h or 5 years at the latest	5	Perform oil change on gear unit A3. (>>> 9.4 "Oil change in A3" Page 166)	RV OIL SB150 Art. no. 00-255-994 1.800 l
20,000 h or 5 years at the latest	6	Perform oil change on gear unit A2. (>>> 9.3 "Oil change in A2" Page 164)	RV OIL SB150 Art. no. 00-255-994 2.900 l
20,000 h or 5 years at the latest	10	Perform oil change on gear unit A1. (>>> 9.2 "Oil change in A1" Page 161)	RV OIL SB150 Art. no. 00-255-994 6.500 l

1) In the case of frequently recurring, short-distance movements, the maintenance interval is 3000 hours.

**Maintenance
table, KR prime
CR with
IW 210/240**

Interval	Item	Activity	Lubricant
Once only, after 100 h	11	Check bolts M _A 640 Nm	
5,000 h or 1 year at the latest 1)	7	Counterbalancing system bearing, link arm, lubricate. Grease nipples in the mid- dle position and at the plus and minus end positions of axis 2.	SKF LGEP 2 Art. no. 00-119-990 10 cm ³
5,000 h or 1 year at the latest 1)	9	Counterbalancing system bearing, rotating column, lubricate. Grease nipples in the mid- dle position and at the plus and minus end positions of axis 2.	SKF LGEP 2 Art. no. 00-119-990 10 cm ³
5,000 h	8	Counterbalancing system, check pressure Setpoint, tolerance -5 bar	Hyspin ZZ 46 Art. no. 83-236-202
10,000 h	1	Grease cables of cable set and energy supply system. (>>> 9.8 "Greasing the cab- ble set" Page 175)	Grease RB 2 00-101-456 200 cm ³
20,000 h or 5 years at the latest	2	Perform oil change on gear unit A6. (>>> 9.7 "Oil change in A6" Page 172)	Tribol FoodProof 1800/220 Art. no. 00-125-302 1,200 l
20,000 h or 5 years at the latest	3	Perform oil change on gear unit A5. (>>> 9.6 "Oil change in A5" Page 170)	Tribol FoodProof 1800/220 Art. no. 00-125-302 1,100 l
20,000 h or 5 years at the latest	4	Perform oil change on gear unit A4. (>>> 9.5 "Oil change in A4" Page 168)	Tribol FoodProof 1800/220 Art. no. 00-125-302 2,100 l
20,000 h or 5 years at the latest	5	Perform oil change on gear unit A3. (>>> 9.4 "Oil change in A3" Page 166)	Tribol FoodProof 1800/220 Art. no. 00-125-302 1,800 l
20,000 h or 5 years at the latest	6	Perform oil change on gear unit A2. (>>> 9.3 "Oil change in A2" Page 164)	Tribol FoodProof 1800/220 Art. no. 00-125-302 2,700 l
20,000 h or 5 years at the latest	10	Perform oil change on gear unit A1. (>>> 9.2 "Oil change in A1" Page 161)	Tribol FoodProof 1800/220 Art. no. 00-125-302 6,500 l

1) In the case of frequently recurring, short-distance movements, the maintenance interval is 3000 hours.

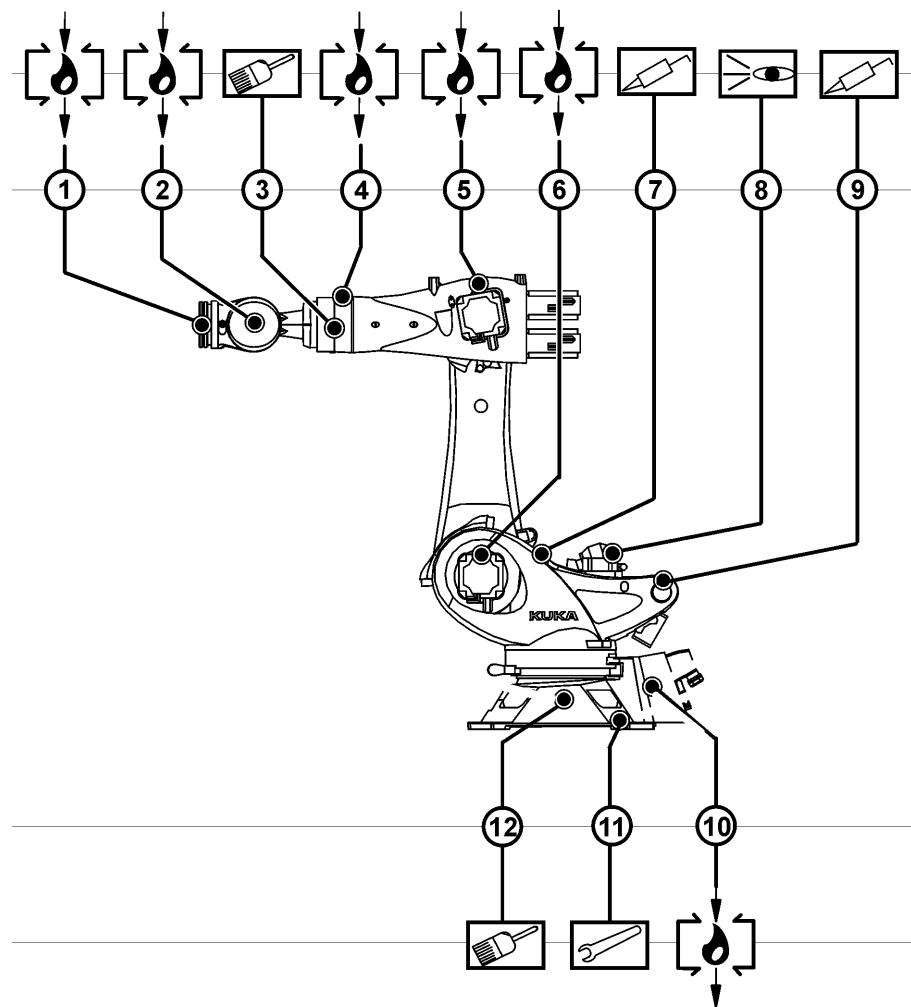


Fig. 9-2: Maintenance work, F variant

Maintenance table, KR prime with IW 210/240, F variant

Interval	Item	Activity	Lubricant
Once only, after 100 h	11	Check bolts; M _A 640 Nm	
2,500 h or 1 year at the latest	7	Counterbalancing system bearing, link arm, lubricate. Grease nipples in the middle position and at the plus and minus end positions of axis 2.	SKF LGEP 2 Art. no. 00-119-990 10 cm ³
2,500 h or 1 year at the latest	9	Counterbalancing system bearing, rotating column, lubricate. Grease nipples in the middle position and at the plus and minus end positions of axis 2.	SKF LGEP 2 Art. no. 00-119-990 10 cm ³
2,500 h or 1 year at the latest	3	O-ring axis 4 Lift O-ring out of groove, clean, re-grease and fit it back into groove.	Olit CLS Art. no. 00-112-315 5 cm ³

Interval	Item	Activity	Lubricant
2,500 h	8	Counterbalancing system, check pressure. Setpoint, tolerance -5 bar	Hyspin ZZ 46 Art. no. 83-236-202
5,000 h	12	Grease cables of cable set and energy supply system. (>>> 9.8 "Greasing the cable set" Page 175)	Grease RB 2 00-101-456 200 cm ³
10,000 h or 5 years at the latest	1	Perform oil change on gear unit A6. (>>> 9.7 "Oil change in A6" Page 172)	RV OIL SB150 Art. no. 00-255-994 1.200 l
10,000 h or 5 years at the latest	2	Perform oil change on gear unit A5. (>>> 9.6 "Oil change in A5" Page 170)	RV OIL SB150 Art. no. 00-255-994 1.100 l
10,000 h or 5 years at the latest	4	Perform oil change on gear unit A4. (>>> 9.5 "Oil change in A4" Page 168)	RV OIL SB150 Art. no. 00-255-994 2.100 l
10,000 h or 5 years at the latest	5	Perform oil change on gear unit A3. (>>> 9.4 "Oil change in A3" Page 166)	RV OIL SB150 Art. no. 00-255-994 1.800 l
10,000 h or 5 years at the latest	6	Perform oil change on gear unit A2. (>>> 9.3 "Oil change in A2" Page 164)	RV OIL SB150 Art. no. 00-255-994 Art. no. 00-255-994 2,700 l
10,000 h or 5 years at the latest	10	Perform oil change on gear unit A1. (>>> 9.2 "Oil change in A1" Page 161)	RV OIL SB150 Art. no. 00-255-994 6.500 l for floor-mounted robots 7.800 l for ceiling-mounted robots

The description of the following oil change work applies to all robot variants, irrespective of the variant shown.

9.2 Oil change in A1

Description

The following sections describe the gear oil change for floor-mounted robots. The description also applies to ceiling-mounted robots (C variant). If the ceiling-mounted robot is currently installed on the ceiling, the procedure is to be applied analogously, but with the filler and drain holes reversed.

In the case of ceiling-mounted robots, there is an additional oil hose for draining the oil.

Preconditions

- The gear unit is at operating temperature.
- The oil filler hole (magnetic screw plug) in the rotating column is freely accessible; any covers must be removed beforehand.

CAUTION

If the oil change is carried out immediately after the robot has stopped operating, the oil temperature and the surface temperature are liable to be high and could result in burn injuries. When gear units are at operating temperature, the oil chamber may be pressurized. Before draining the oil, loosen the uppermost screw plug just enough to relieve the pressure, then tighten the screw plug again slightly. Wear protective gloves.

WARNING

Unintentional robot motions can cause injuries and damage to property. If work is carried out on an operational robot, the robot must be secured by activating the EMERGENCY STOP device.
Warn all persons concerned before starting to put it back into operation.

9.2.1 Draining the gear oil on A1

1. Remove 4 Allen screws with conical spring washers, and take off interface A1 or cover .
2. Pull out the oil drain hose.
3. Place a suitable receptacle under the oil drain hose.
4. Unscrew the union nut of the oil drain hose.
5. Remove the magnetic screw plug. In the case of C variants, there is an oil drain hose available.
6. Drain the oil.
7. Measure the amount of oil drained and store or dispose of the used oil in accordance with the pertinent regulations.
8. Check the magnetic screw plug for deposits; take appropriate measures if necessary.

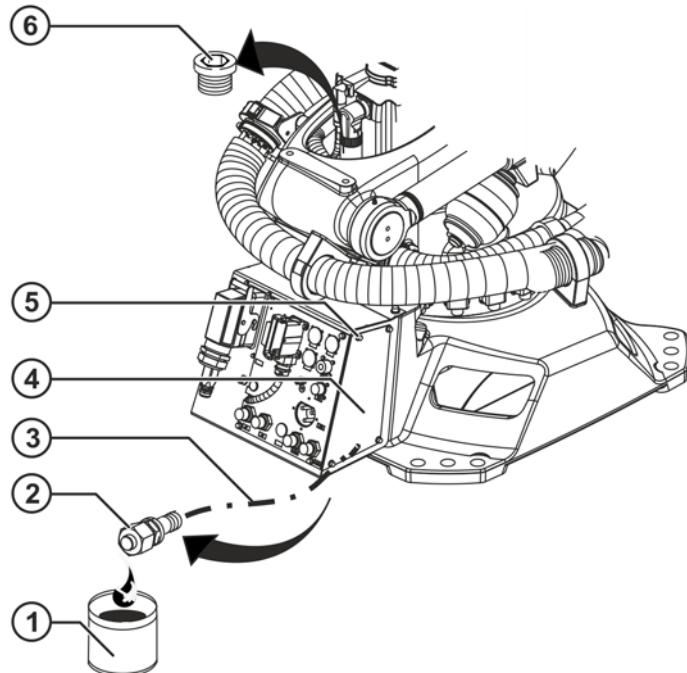


Fig. 9-3: Draining the oil from A1

1 Collection receptacle

4 Cover

2	Union nut	5	Allen screw
3	Oil drain hose	6	Magnetic screw plug; oil drain hose for C variant

9.2.2 Filling the gear oil on A1

1. Connect the oil pump to the oil drain hose.
2. Pour in the specified amount of oil via the oil drain hose; the chamber fills from the bottom.
3. Clean the magnetic screw plug and check the sealing element; exchange the magnetic screw plug if damaged.
4. Insert and tighten the magnetic screw plug; $M_A = 25 \text{ Nm}$.
5. Remove the oil pump.
6. Screw the union nut onto the oil drain hose and tighten; then check for leaks.
7. Stow the oil drain hose in the base frame.
8. On C variant only: Screw the sealing cap onto the oil drain hose and tighten; then check for leaks.
Stow the oil drain hose in the rotating column.
9. Mount interface A1 or cover and fasten it with 4x M6x16 Allen screws and conical spring washers.

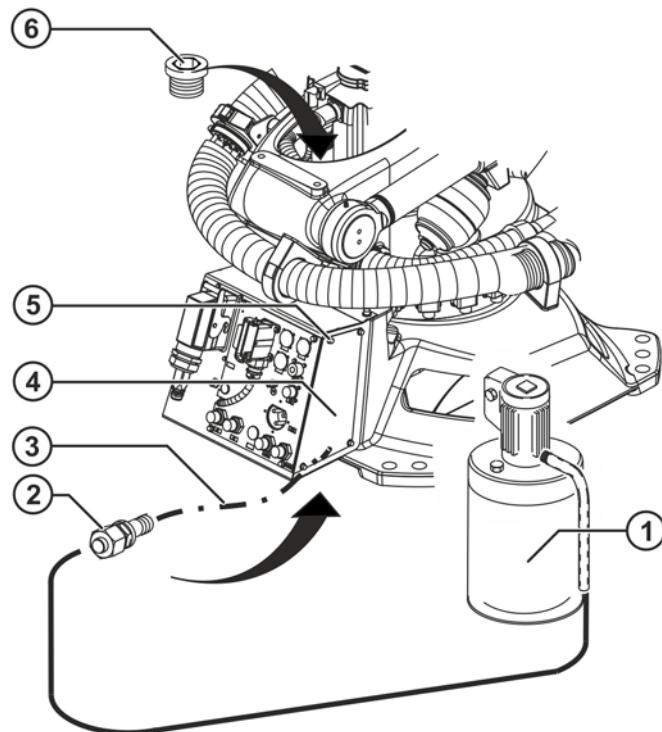


Fig. 9-4: Filling with oil on A1

1	Oil pump	4	Cover
2	Union nut	5	Allen screw
3	Oil drain hose	6	Magnetic screw plug; oil drain hose for C variant

9.3 Oil change in A2

Description

The following sections describe the gear oil change for floor-mounted robots. The description also applies to ceiling-mounted robots (C variant). If the ceiling-mounted robot is currently installed on the ceiling, the procedure is to be applied analogously, but with the filler and drain holes reversed.

Precondition

- The robot is in a position in which the oil filler and drain holes on the axis 2 gear unit are accessible.
- The gear unit is at operating temperature.



CAUTION If the oil change is carried out immediately after the robot has stopped operating, the oil temperature and the surface temperature are liable to be high and could result in burn injuries. When gear units are at operating temperature, the oil chamber may be pressurized. Before draining the oil, loosen the uppermost screw plug just enough to relieve the pressure, then tighten the screw plug again slightly. Wear protective gloves.



WARNING Unintentional robot motions can cause injuries and damage to property. If work is carried out on an operational robot, the robot must be secured by activating the EMERGENCY STOP device.

Warn all persons concerned before starting to put it back into operation.

9.3.1 Draining the gear oil on A2

Procedure

1. Pull the oil drain hose ([>>> Fig. 9-5](#)) out of the rotating column.
2. Release and unscrew the union nut.
3. Place a suitable receptacle under the oil drain hose and remove the magnetic screw plug.
4. Catch the oil in the receptacle as it drains out.
5. Measure the amount of oil drained and store or dispose of the used oil in accordance with the pertinent regulations.
6. Check the magnetic screw plug for deposits; take appropriate measures if necessary.

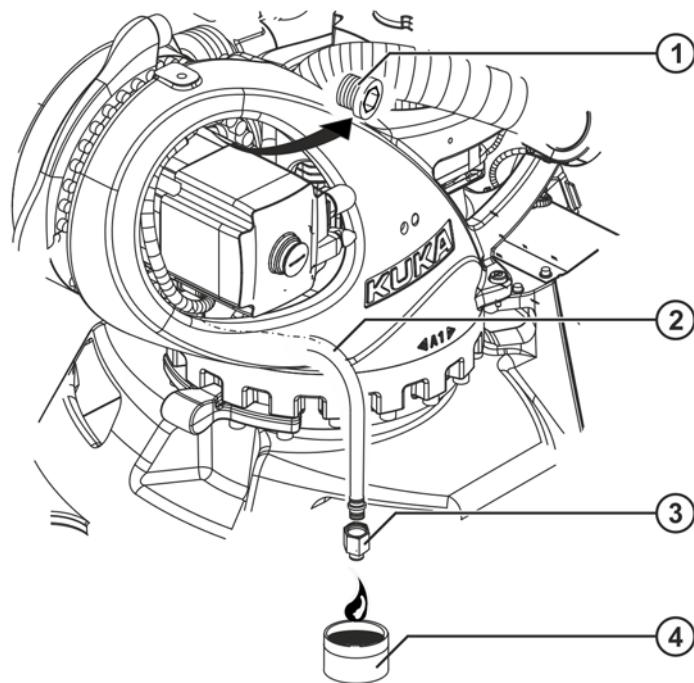


Fig. 9-5: Draining the gear oil from A2

- | | | | |
|---|---------------------|---|-----------------------|
| 1 | Magnetic screw plug | 3 | Union nut |
| 2 | Oil drain hose | 4 | Collection receptacle |

9.3.2 Filling with gear oil on A2

Procedure

1. Connect the oil pump to the oil drain hose.
2. Pour in the specified amount of oil via the oil drain hose; the chamber fills from the bottom.
3. Clean the M18x1.5 magnetic screw plug and check the sealing element; exchange the magnetic screw plug if damaged.
4. Insert and tighten the magnetic screw plug; $M_A = 20 \text{ Nm}$.
5. Remove the oil pump.
6. Screw the union nut onto the oil drain hose and tighten.
7. Push the oil drain hose back into the rotating column.
8. Check the magnetic screw plug and sealing cap for leaks.

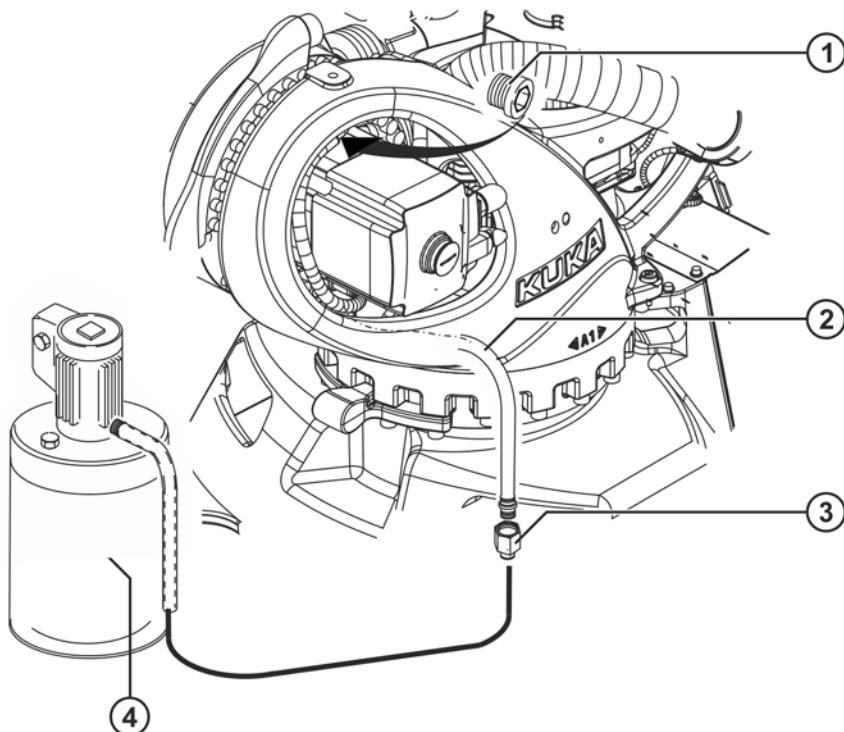


Fig. 9-6: Filling with oil on A2

- | | |
|-----------------------|-------------|
| 1 Magnetic screw plug | 3 Union nut |
| 2 Oil drain hose | 4 Oil pump |

9.4 Oil change in A3

Description

The following sections describe the gear oil change for floor-mounted robots. The description also applies to ceiling-mounted robots (C variant). If the ceiling-mounted robot is currently installed on the ceiling, the procedure is to be applied analogously, but with the filler and drain holes reversed.

Preconditions

- The robot is in a position in which the oil filler and drain holes on the axis 3 gear unit are accessible.
- The gear unit is at operating temperature.
- Axis 3 is in a horizontal position.

CAUTION

If the oil change is carried out immediately after the robot has stopped operating, the oil temperature and the surface temperature are liable to be high and could result in burn injuries. When gear units are at operating temperature, the oil chamber may be pressurized. Before draining the oil, loosen the uppermost screw plug just enough to relieve the pressure, then tighten the screw plug again slightly. Wear protective gloves.

WARNING

Unintentional robot motions can cause injuries and damage to property. If work is carried out on an operational robot, the robot must be secured by activating the EMERGENCY STOP device.
Warn all persons concerned before starting to put it back into operation.

9.4.1 Draining the gear oil on A3

Procedure

1. Place a suitable receptacle (**>>>** Fig. 9-7) under the lower magnetic screw plug and remove the magnetic screw plug.
It is easier to drain the oil if an M16x1.5 oil drain hose is screwed into the tapped hole of the magnetic screw plug.
2. Remove the upper magnetic screw plug.
3. Catch the oil in the receptacle as it drains out.
4. Measure the amount of oil drained and store or dispose of the used oil in accordance with the pertinent regulations.
5. Check both magnetic screw plugs for deposits; take appropriate measures if necessary.

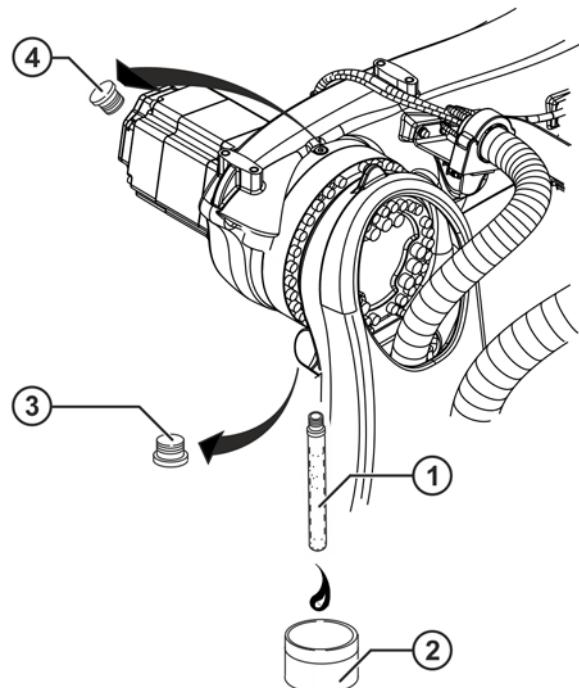


Fig. 9-7: Draining the oil from A3

- | | |
|-------------------------|-----------------------------|
| 1 Oil drain hose | 3 Lower magnetic screw plug |
| 2 Collection receptacle | 4 Upper magnetic screw plug |

9.4.2 Filling with gear oil on A3

Procedure

1. Connect the oil pump to the oil drain hose.
2. Pour in the specified amount of oil via the oil drain hose; the chamber fills from the bottom.
3. Clean both M16x1.5 magnetic screw plugs and check the sealing elements; exchange magnetic screw plugs if damaged.
4. Insert and tighten the upper M16x1.5 magnetic screw plug; $M_A = 20 \text{ Nm}$.
5. Remove the oil pump.
6. Remove the oil drain hose, and insert and tighten the lower M16x1.5 magnetic screw plug; $M_A = 20 \text{ Nm}$.
7. Check both magnetic screw plugs for leaks.

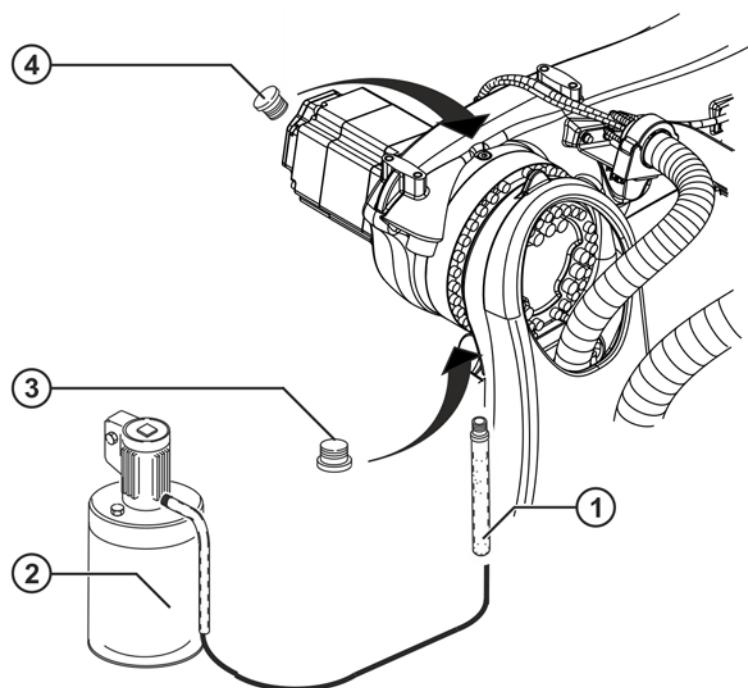


Fig. 9-8: Filling with oil on A3

- | | |
|------------------|-----------------------------|
| 1 Oil drain hose | 3 Lower magnetic screw plug |
| 2 Oil pump | 4 Upper magnetic screw plug |

9.5 Oil change in A4

Description

The following sections describe the gear oil change for floor-mounted robots. The description also applies to ceiling-mounted robots (C variant). If the ceiling-mounted robot is currently installed on the ceiling, the procedure is to be applied analogously, but with the filler and drain holes reversed.

Precondition

- The gear unit is at operating temperature.
- Axis 3 is in a horizontal position.

CAUTION If the oil change is carried out immediately after the robot has stopped operating, the oil temperature and the surface temperature are liable to be high and could result in burn injuries. When gear units are at operating temperature, the oil chamber may be pressurized. Before draining the oil, loosen the uppermost screw plug just enough to relieve the pressure, then tighten the screw plug again slightly. Wear protective gloves.

WARNING Unintentional robot motions can cause injuries and damage to property. If work is carried out on an operational robot, the robot must be secured by activating the EMERGENCY STOP device.
Warn all persons concerned before starting to put it back into operation.

9.5.1 Draining the gear oil on A4

Procedure

1. Place a suitable receptacle (**>>>** Fig. 9-9) under the lower magnetic screw plug and remove the lower magnetic screw plug. It is easier to drain the oil if an M18x1.5 oil drain hose is screwed into the tapped hole of the magnetic screw plug.

2. Remove the upper magnetic screw plug.
3. Catch the oil in the receptacle as it drains out.
4. Measure the amount of oil drained and store or dispose of the used oil in accordance with the pertinent regulations.
5. Check both magnetic screw plugs for deposits; take appropriate measures if necessary.
6. Remove the oil drain hose if necessary.

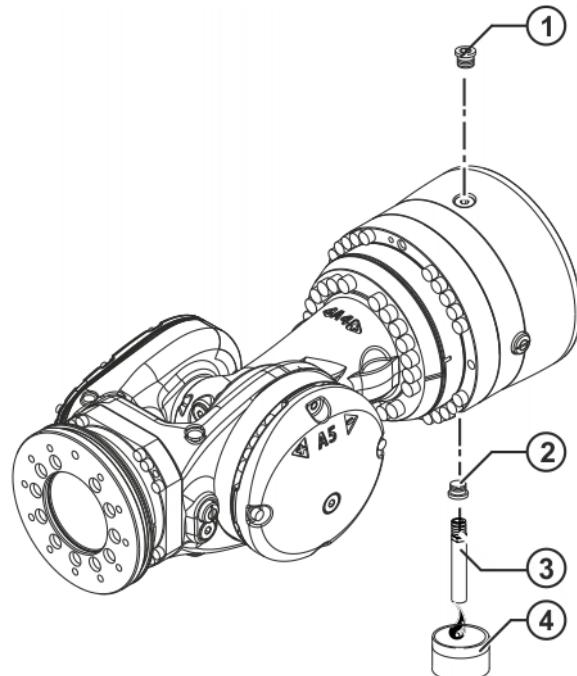


Fig. 9-9: Draining the oil from A4

- 1 Upper magnetic screw plug
- 2 Lower magnetic screw plug
- 3 Oil drain hose
- 4 Collection receptacle

9.5.2 Filling the gear oil on A4

Procedure

1. Clean both M18x1.5 magnetic screw plugs and check the sealing element; exchange magnetic screw plugs if damaged.
2. Insert and tighten the lower M18x1.5 magnetic screw plug; $M_A = 20 \text{ Nm}$.
3. Pour in, from above, the same amount of oil as was drained.
4. Insert and tighten the upper M18x1.5 magnetic screw plug, $M_A = 20 \text{ Nm}$.
5. Check both magnetic screw plugs for leaks.

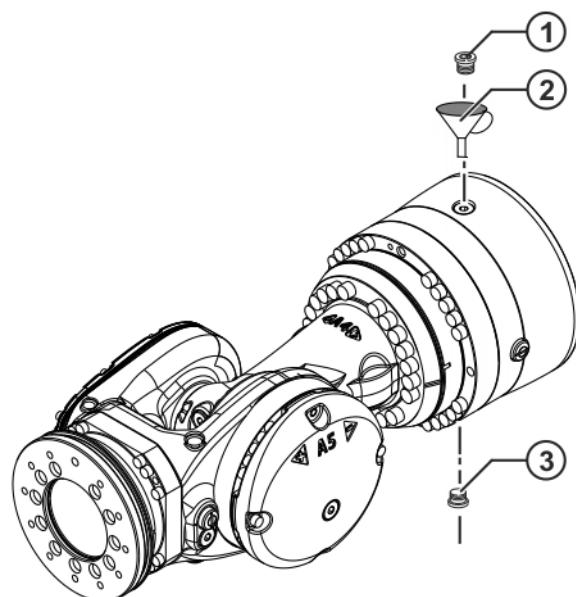


Fig. 9-10: Filling with oil on A4

- 1 Upper magnetic screw plug
- 2 Funnel
- 3 Lower magnetic screw plug

9.6 Oil change in A5

Description

The following sections describe the gear oil change for floor-mounted robots. The description also applies to ceiling-mounted robots (C variant). If the ceiling-mounted robot is currently installed on the ceiling, the procedure is to be applied analogously, but with the directions of motion of the axes reversed.

Precondition

- The gear unit is at operating temperature.
- Axis 3 is in a horizontal position.

CAUTION If the oil change is carried out immediately after the robot has stopped operating, the oil temperature and the surface temperature are liable to be high and could result in burn injuries. When gear units are at operating temperature, the oil chamber may be pressurized. Before draining the oil, loosen the uppermost screw plug just enough to relieve the pressure, then tighten the screw plug again slightly. Wear protective gloves.

WARNING When carrying out the following work, the robot must be moved several times between the individual work steps. While work is being carried out on the robot, it must always be secured by activating the EMERGENCY STOP device. Unintentional robot motions can cause injuries and damage to property. If work is carried out on an operational robot that is switched on, the robot must only be moved at reduced velocity. It must be possible to stop the robot at any time by activating an EMERGENCY STOP device. Operation must be limited to what is absolutely necessary. Warn all persons concerned before switching on and moving the robot.

9.6.1 Draining the gear oil on A5

Procedure

1. Put the robot into operation, move axis 4 to the +90° position and axis 5 to the +45° position, and then secure the robot.
2. Place a suitable receptacle under the lower magnetic screw plug and remove the lower magnetic screw plug.
It is easier to drain the oil if an M18x1.5 oil drain hose is screwed into the tapped hole of the magnetic screw plug.
3. Remove the side magnetic screw plug.
4. Catch the oil in the receptacle as it drains out.
5. Measure the amount of oil drained and store or dispose of the used oil in accordance with the pertinent regulations.
6. Remove the oil drain hose if necessary.
7. Check the magnetic screw plugs for deposits; take appropriate measures if necessary.
8. Clean both M18x1.5 magnetic screw plugs and check the sealing element; exchange magnetic screw plugs if damaged.
9. Insert and tighten the side M18x1.5 magnetic screw plug; $M_A = 20 \text{ Nm}$.
10. Put the robot into operation, move axis 4 to the -90° position and axis 5 to the 0° position, and then secure the robot by activating the EMERGENCY STOP device.

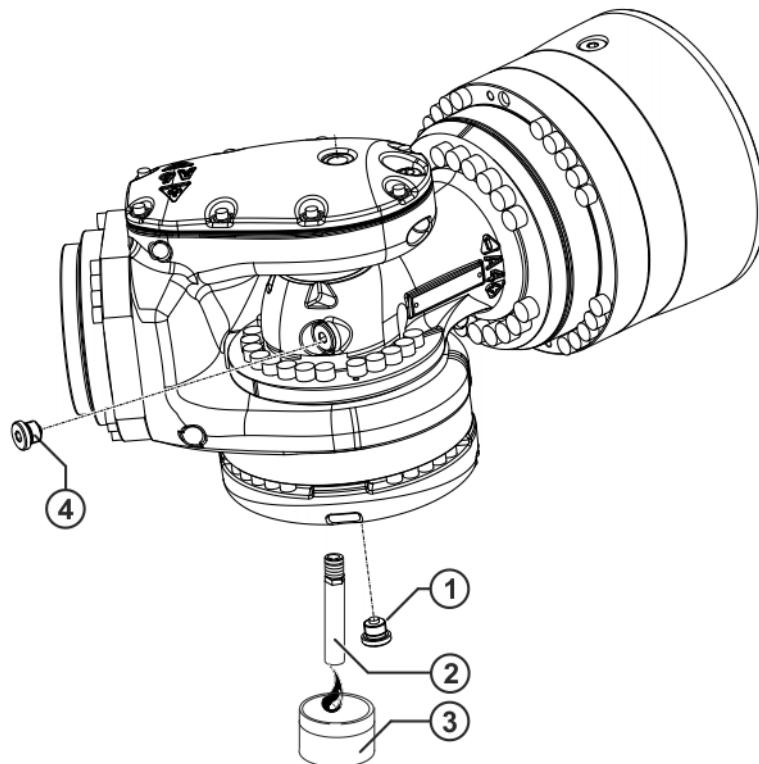


Fig. 9-11: Draining the oil from A5

- 1 Lower magnetic screw plug
- 2 Oil drain hose
- 3 Collection receptacle
- 4 Magnetic screw plug on the side

9.6.2 Filling gear unit A5 with gear oil

Procedure

1. Pour in, from above, the same amount of oil as was drained.
2. Insert and tighten the upper M18x1.5 magnetic screw plug, $M_A = 20 \text{ Nm}$.
3. Check both magnetic screw plugs for leaks.

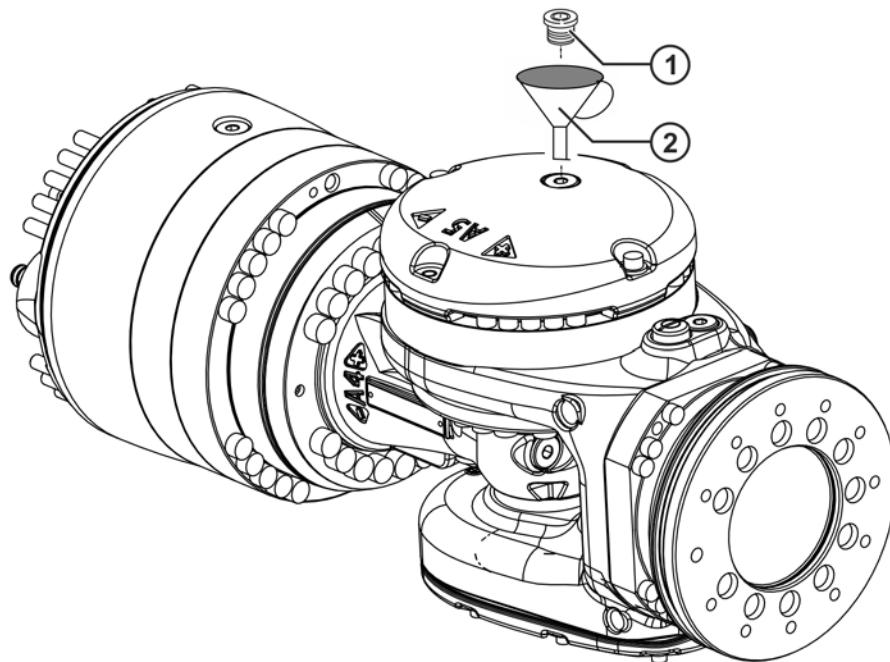


Fig. 9-12: Filling with oil on A5

- 1 Magnetic screw plug
- 2 Funnel

9.7 Oil change in A6

Description

The following sections describe the gear oil change for floor-mounted robots. The description also applies to ceiling-mounted robots (C variant). If the ceiling-mounted robot is currently installed on the ceiling, the procedure is to be applied analogously, but with the directions of motion of the axes reversed.

Precondition

- The gear unit is at operating temperature.
- Axis 3 is in a horizontal position.



CAUTION If the oil change is carried out immediately after the robot has stopped operating, the oil temperature and the surface temperature are liable to be high and could result in burn injuries. When gear units are at operating temperature, the oil chamber may be pressurized. Before draining the oil, loosen the uppermost screw plug just enough to relieve the pressure, then tighten the screw plug again slightly. Wear protective gloves.

WARNING

When carrying out the following work, the robot must be moved several times between the individual work steps. While work is being carried out on the robot, it must always be secured by activating the EMERGENCY STOP device. Unintentional robot motions can cause injuries and damage to property. If work is carried out on an operational robot that is switched on, the robot must only be moved at reduced velocity. It must be possible to stop the robot at any time by activating an EMERGENCY STOP device. Operation must be limited to what is absolutely necessary.

Warn all persons concerned before switching on and moving the robot.

9.7.1 Draining the gear oil on A6

1. Put the robot into operation, move axis 4 to the -90° position, and then secure the robot.
2. Place a suitable receptacle ([>>> Fig. 9-13](#)) under the lower magnetic screw plug and remove the magnetic screw plug.
It is easier to drain the oil if an M18x1.5 oil drain hose is screwed into the tapped hole of the magnetic screw plug.
3. Remove the upper magnetic screw plug.
4. Catch the oil in the receptacle as it drains out.
5. Measure the amount of oil drained and store or dispose of the used oil in accordance with the pertinent regulations.
6. Remove the oil drain hose if necessary.
7. Check the magnetic screw plugs for deposits; take appropriate measures if necessary.
8. Clean both M18x1.5 magnetic screw plugs and check the sealing element; exchange magnetic screw plugs if damaged.
9. Insert and tighten the lower M18x1.5 magnetic screw plug; $M_A = 20 \text{ Nm}$.
10. Put the robot into operation, move axis 4 to the +90° position, and then secure the robot.

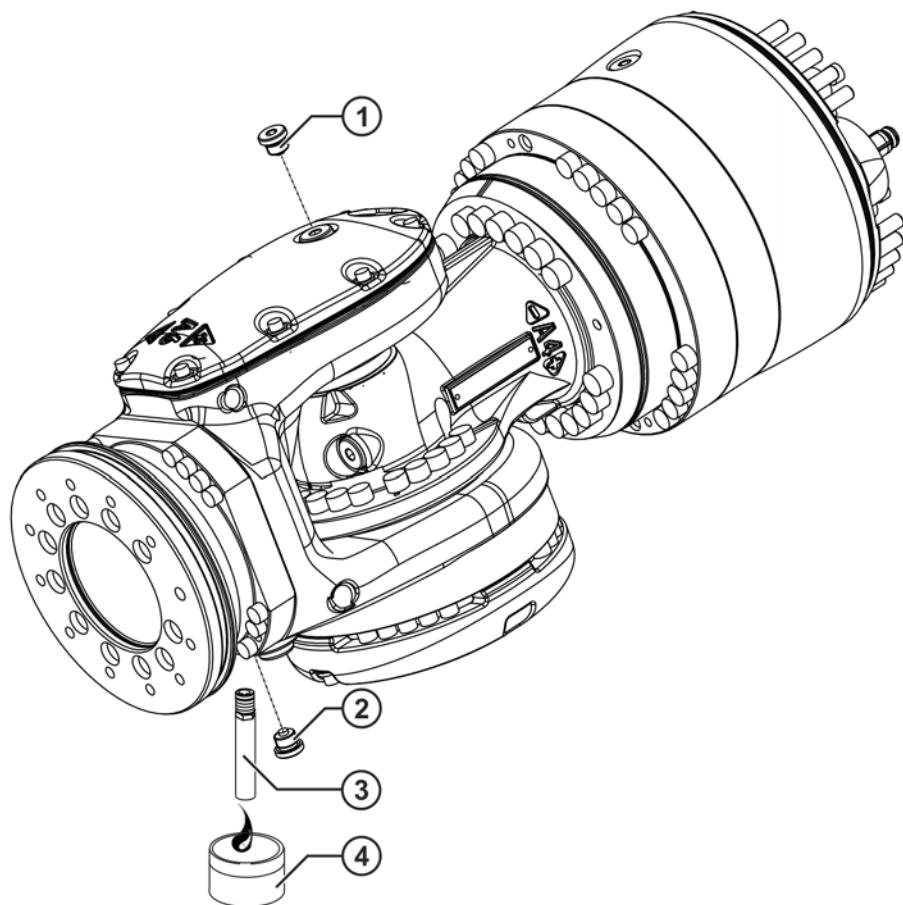


Fig. 9-13: Draining the oil from A6

- | | | | |
|---|---------------------------|---|-----------------------|
| 1 | Upper magnetic screw plug | 3 | Oil drain hose |
| 2 | Lower magnetic screw plug | 4 | Collection receptacle |

9.7.2 Filling the gear oil on A6

1. Pour in, from above, the same amount of oil as was drained.
2. Insert and tighten the upper M18x1.5 magnetic screw plug, $M_A = 20 \text{ Nm}$.
3. Check both magnetic screw plugs for leaks.

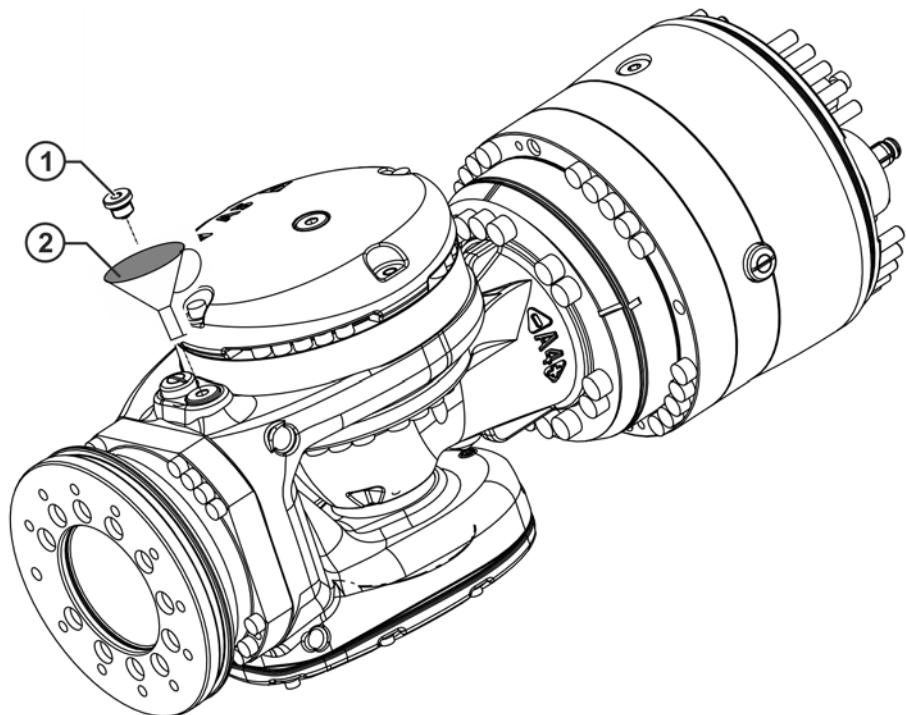


Fig. 9-14: Filling with oil on A6

- 1 Magnetic screw plug
- 2 Funnel

9.8 Greasing the cable set

Precondition

- The robot is accessible in the area of axis 1

WARNING

Unintentional robot motions can cause injuries and damage to property. If work is carried out on an operational robot, the robot must be secured by activating the EMERGENCY STOP device.

Warn all persons concerned before starting to put it back into operation.

Procedure

1. Remove 4 Allen screws and conical spring washers, and take off the cover. If necessary, interface A1 can additionally be carefully pulled back.
2. Clean the cables between the push-in module and the inlet of the hollow shaft of axis 1.
3. Apply cable grease evenly to the cables using a brush and by hand. Wear protective gloves.
4. Store used grease and grease residues in accordance with the regulations or dispose of it with minimum environmental impact.
5. Mount the cover and fasten it with 4 Allen screws with conical spring washers.
6. If applicable, carefully insert interface A1 again and fasten it with 4 Allen screws and conical spring washers.

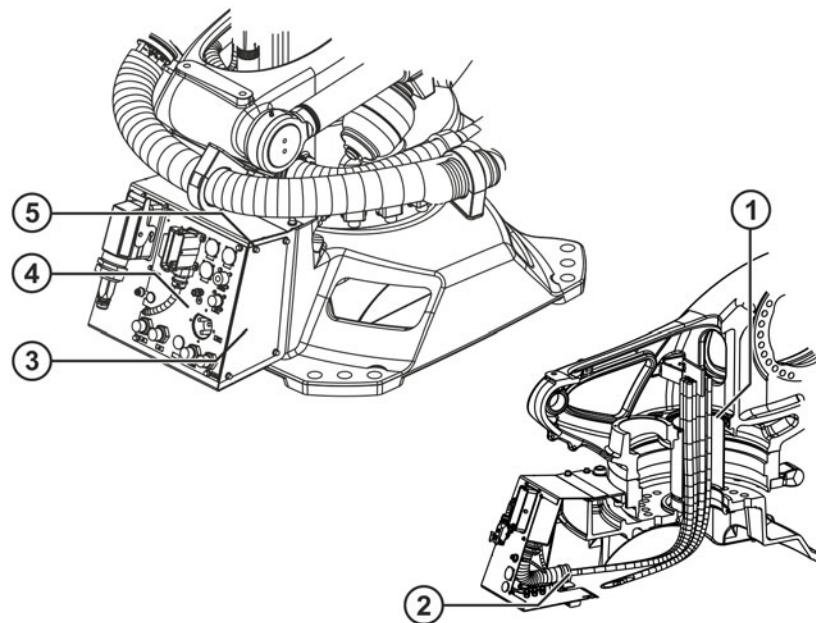


Fig. 9-15: Greasing the cable set

- | | |
|---------------------------------|----------------|
| 1 Inlet of hollow shaft | 4 Interface A1 |
| 2 Push-in module, flexible tube | 5 Allen screws |
| 3 Cover | |

9.9 Checking the counterbalancing system

Description The following describes those tasks which must be carried out at the intervals specified in the maintenance table.

Precondition

- The robot is operational and can be moved at jog velocity.
- There is no hazard posed by system components or other robots.
- The robot is secured if work is being performed directly on the robot.

⚠ WARNING

When carrying out the following work, the robot must be moved several times between the individual work steps. While work is being carried out on the robot, it must always be secured by activating the EMERGENCY STOP device.

Unintentional robot motions can cause injuries and damage to property. If work is carried out on an operational robot that is switched on, the robot must only be moved at reduced velocity. It must be possible to stop the robot at any time by activating an EMERGENCY STOP device. Operation must be limited to what is absolutely necessary.

Warn all persons concerned before switching on and moving the robot.

Procedure	Activity	Required condition	Corrective measure
	Inspect hydraulic system. Move the robot and check the hydraulic oil pressure.	The pressure gauge must show the following value: Floor-mounted robot: Link arm in -90° position; hydraulic oil pressure 176 bar Ceiling-mounted robot: Link arm in -90° position; hydraulic oil pressure 295 bar	Adjust the counterbalancing system (>>> 10.3 "Filling and adjusting the counterbalancing system" Page 180).
	Check the add-on parts for damage and ensure that they are clean and do not leak.	The add-on parts must not be damaged or leak.	Clean the counterbalancing system, identify and eliminate any leaks. If necessary, exchange the counterbalancing system.
	Check the condition of the collar.	The collar must not be damaged or fouled.	Clean or exchange the collar (>>> 11.7 "Exchanging the counterbalancing system on a floor-mounted robot" Page 201) (>>> 11.8 "Exchanging the counterbalancing system on a ceiling-mounted robot" Page 207).

9.10 Cleaning the robot

Description The robot must be cleaned in compliance with the instructions given here in order to prevent damage. These instructions only refer to the robot. 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 agents.
- Do not use steam or refrigerants for cleaning.
- Do not use high-pressure cleaners.
- It must be ensured that no cleaning agent enters electrical or mechanical system components.
- Personnel protection measures must be taken.



Unintentional robot motions can cause injuries and damage to property. If work is carried out on an operational robot, the robot must be secured by activating the EMERGENCY STOP device.

Warn all persons concerned before starting to put it back into operation.

Procedure 1. Shut down the robot.

2. If necessary, 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 robot.
5. Fully remove all cleaning agents from the robot.
6. Clean any areas of corrosion and reapply corrosion protection.
7. Remove cleaning agents and equipment from the workspace of the robot.
8. Dispose of cleaning agents in accordance with the pertinent regulations.
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. Only put fully functional robots and systems back into operation.

10 Setting

10.1 Counterbalancing system

Description Depending on various causes, the following work may be required on the counterbalancing system: These instructions apply to floor-mounted robots and ceiling-mounted robots that are screwed to the floor.

Cause	Activity	Description
The counterbalancing system must be depressurized	Depressurize the counter-balancing system	
Incorrect pressure	Top up the gas and oil pressure	
The counterbalancing system has been drained and must be refilled	Top up the gas and oil pressure	

10.2 Depressurizing the counterbalancing system

Description These instructions are valid for all installation positions.

- A high-pressure hose and collection receptacle must be available.
- The robot must be correctly bolted to the floor or ceiling.



When carrying out the following work, the robot must be moved several times between the individual work steps. While work is being carried out on the robot, it must always be secured by activating the EMERGENCY STOP device. Unintentional robot motions can cause injuries and damage to property. If work is carried out on an operational robot that is switched on, the robot must only be moved at reduced velocity. It must be possible to stop the robot at any time by activating an EMERGENCY STOP device. Operation must be limited to what is absolutely necessary. Warn all persons concerned before switching on and moving the robot.

Procedure

1. Move the link arm into a vertical position and secure it using a crane ([>>> Fig. 10-1](#)); position for ceiling-mounted robots: -140°. The link arm must not be able to move after reducing the oil pressure.

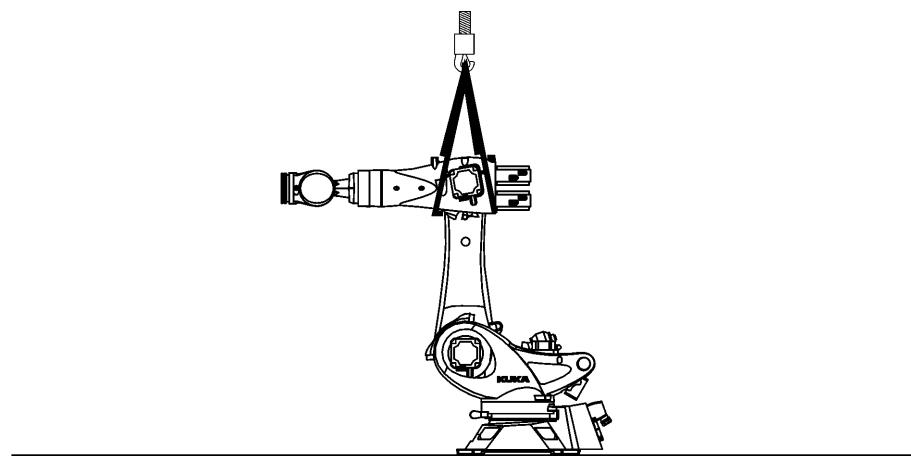


Fig. 10-1: Securing the link arm

2. Remove the screw cap and connect the tube to the vent valve (**>>> Fig. 10-2**).
In the case of ceiling-mounted robots: Remove the screw cap from the second vent valve and connect a second hose.
3. Drain the hydraulic oil into the collection receptacle.
The draining process is complete when the pressure gage indicating the oil pressure reads zero and no more oil flows into the receptacle.
4. Store used hydraulic oil in accordance with the regulations and dispose of it with minimum environmental impact.

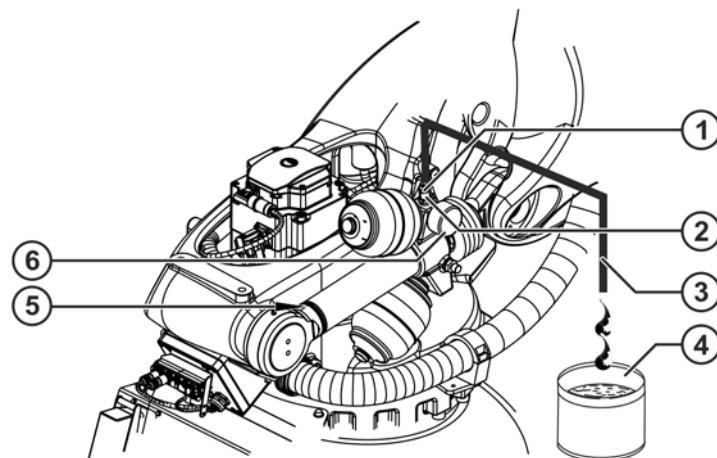


Fig. 10-2: Draining the hydraulic oil

- | | |
|-----------------|----------------------------|
| 1 Screw cap | 4 Collection receptacle |
| 2 Vent valve | 5 2. Vent valve |
| 3 Hose | 6 Manometer |

10.3 Filling and adjusting the counterbalancing system

Description

These instructions apply to floor-mounted robots, ceiling-mounted robots that are bolted to the floor and ceiling-mounted robots that are bolted to the ceiling. The procedure is the same for all installation positions, with the exception of the following differences for ceiling-mounted robots:

- The link arm position for pressure adjustment is -140°.
- Additional venting on cylinder base, on the piston side

The pressure settings for the relevant robots can be taken from the following table. The specified pressure settings apply also to the F variants.

Robot	P _{Gas}	P _{Oil vertical}
KR 240 R2700 prime	156 bar	176 bar
KR 240 R2500 prime	156 bar	176 bar
KR 210 R2700 prime	156 bar	176 bar
KR 180 R2900 prime	156 bar	176 bar
KR 150 R3100 prime	156 bar	176 bar
KR 210 R2700 prime C	120 bar	205 bar

Preconditions

- A high-pressure hose and collection receptacle must be available.
- A nitrogen cylinder with pressure reducer must be available. Minimum pressure 170 bar.
- An accumulator filling device must be available.
- A hydraulic pump must be available.



When carrying out the following work, the robot must be moved several times between the individual work steps. While work is being carried out on the robot, it must always be secured by activating the EMERGENCY STOP device. Unintentional robot motions can cause injuries and damage to property. If work is carried out on an operational robot that is switched on, the robot must only be moved at reduced velocity. It must be possible to stop the robot at any time by activating an EMERGENCY STOP device. Operation must be limited to what is absolutely necessary. Warn all persons concerned before switching on and moving the robot.

Procedure

1. Move the link arm into a vertical position and secure it using a crane ([>>> Fig. 10-3](#)). Move the ceiling-mounted robot into the -140° position. The link arm must not be able to move after reducing the hydraulic oil pressure.

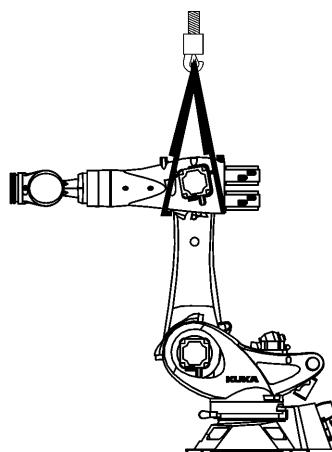


Fig. 10-3: Securing the link arm

2. Remove the screw cap and connect the hose to the vent valve ([>>> Fig. 10-4](#)).
3. Place a suitable receptacle under the hose and collect the hydraulic oil.

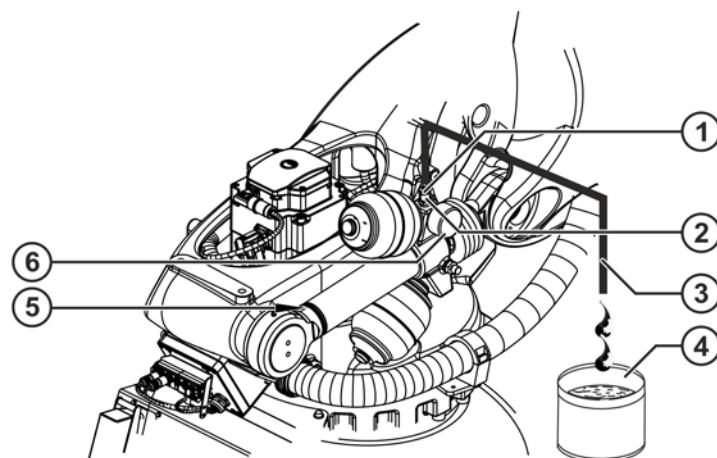


Fig. 10-4: Draining the hydraulic oil

1	Screw cap	4	Collection receptacle
2	Vent valve	5	2nd vent valve (ceiling)
3	Hose	6	Pressure gauge

4. Drain the oil until the pressure gauge reads zero.

The oil side of the diaphragm accumulator is now depressurized and can be vented during subsequent filling of the gas side.

Leave hose connected to the vent valve and leave the vent valve open.

5. Connect the filling and testing device (accessory) for the diaphragm accumulator to a standard commercial nitrogen cylinder via the hose and a pressure reducer.



Further information about the filling and testing device can be found in the supplier documentation.

6. Set the pressure reducer to P_{Gas} .



For safety reasons, the Allen screw on the accumulator may under no circumstances be unscrewed by more than a quarter of a turn without the filling and testing device being connected. The pressure in the accumulator may never be adjusted without the filling and testing device connected.

7. Remove the protective caps (>>>> Fig. 10-5) from the diaphragm accumulator and unscrew the Allen screw slightly (without a torque wrench, by a quarter of a turn at the most).

No gas must be allowed to escape. If, in spite of care being taken, gas does escape (hissing sound!), the sealing ring of Allen screw must be replaced. This must only be done when the diaphragm accumulator is completely depressurized.

8. Connect the filling and testing device to the gas connection of the diaphragm accumulator. Turn the gas valve rod counterclockwise, thereby opening the gas connection via the Allen screw; a full turn is necessary after the start of pointer deflection on the pressure gauge of the filling and testing device.

The pressure gauge on the counterbalancing system indicates the nitrogen pressure in the diaphragm accumulator. If the nitrogen pressure is too low, continue from step 9. If the nitrogen pressure is greater than P_{Gas} , continue from step 10.

9. Open the shut-off valve on the nitrogen cylinder and raise the nitrogen pressure to $P_{Gas} + 10$ bar.

10. Close the shut-off valve.
11. Open the pressure relief valve and discharge nitrogen until the specified pressure of P_{Gas} is reached.
The reading on the pressure gauge must be rechecked after 2 to 3 minutes and the nitrogen pressure corrected if necessary.
12. Turn the Allen screw clockwise by means of the gas valve rod and tighten it. Then open the pressure relief valve and discharge the remaining pressure in the hose.
13. Disconnect filling and testing device from diaphragm accumulator.
The filling and testing device may only be disconnected if the Allen screw has been tightened by means of the gas valve rod.
14. Firmly retighten the Allen screw; $M_A = 20 \text{ Nm}$.

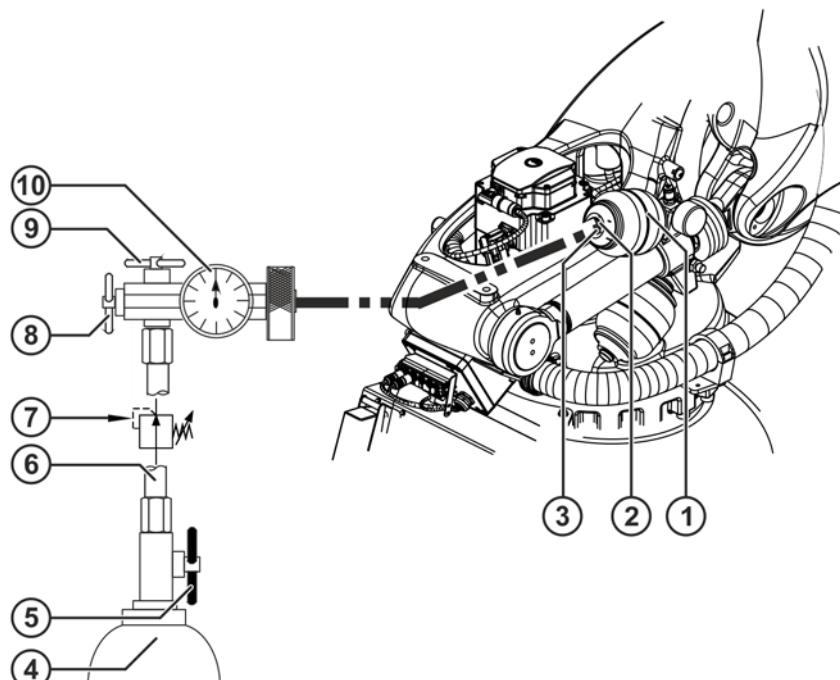


Fig. 10-5: Setting the gas pressure

1	Protective cap	6	Hose
2	Allen screw	7	Pressure reducer
3	Diaphragm accumulator	8	Gas valve rod
4	Nitrogen cylinder	9	Pressure relief valve
5	Shut-off valve	10	Pressure gauge

15. Screw on the protective caps.
16. Carry out steps 7 to 15 for the second diaphragm accumulator.
17. Release and remove the hose on the nitrogen cylinder.
18. Unscrew the screw cap on the filler neck (**>>>** Fig. 10-6) and connect the hydraulic hose.
The hydraulic hose must already be free from air.
19. Dip the high-pressure hose into the liquid in the collection receptacle.
20. Put the hydraulic pump into operation and allow hydraulic oil to flow out into the collection receptacle until no more bubbles escape.
The reservoir of the hydraulic pump must only be filled with filtered Hyspin ZZ 46 (filter gauge 3 µm).
21. Close the vent valve at the vent connection.

22. In the case of ceiling-mounted robots, carry out steps 18 to 22 for the second vent connection.
23. Continue to operate the hydraulic pump until the hydraulic oil pressure is approx. 10 bar above the specified value of P_{Oil} . Then lower the pump pressure to "0". Do not exceed the pressure, as the bursting disc ruptures at a pressure of 210 bar (for ceiling-mounted robots: 310 bar)!
24. After approx. 10 minutes, check the hydraulic oil pressure and reduce it to P_{Oil} by opening the vent valve.
25. Unscrew the hydraulic hose and screw the screw cap back onto the filler neck.
26. Unscrew the high-pressure hose and screw the screw cap back onto the vent connection.
27. Unscrew the screw plug from the underside of the counterbalancing system and remove any leaked oil; then screw the screw plug back in and tighten with M_A 20 Nm.
28. Remove crane and elements securing the link arm.
29. Move robot about axis 2.
30. Check the counterbalancing system for leaks.
31. Check the counterbalancing system for pressure loss or leaks.

The pressure must be unchanged and there must be no visible leaks. Otherwise, the adjustment process must be repeated or the counterbalancing system exchanged.

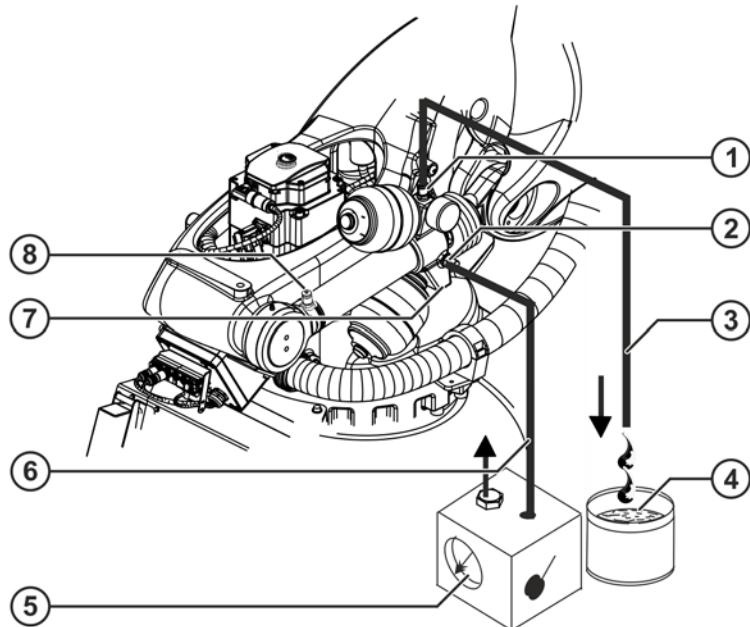


Fig. 10-6: Topping up the hydraulic oil

1	Vent connection	5	Hydraulic pump
2	Filler neck	6	Hydraulic hose
3	High-pressure hose	7	Screw plug
4	Collection receptacle		

11 Repair

NOTICE

Repair, maintenance and cleaning work on CR-variant robots may only be conducted outside cleanrooms. Cleaning operations are to be carried out with cleaning agents suitable for use in the cleanroom. The instructions of the cleanroom user must be observed.

⚠ CAUTION

For screwed connections, the fastening screws (standard, strength class 8.8) are to be tightened with the tightening torques specified in the appendix ([>>> 14 "Appendix" Page 235](#)). Tightening torques deviating from these values are specified directly. The specified screw sizes and strength classes are those valid at the copy deadline. The specifications contained in the Parts Catalog are, however, always to be taken as the most up-to-date information. Screws of strength class 10.9 and higher may only be tightened once with the rated tightening torque. When the screws are first slackened they must be replaced with new ones.

Further information about KUKA tightening torques can be found in the Appendix ([>>> 14 "Appendix" Page 235](#)).

11.1 Exchanging motor A1

Description

The following instructions describe the exchange of motor A1 for floor-mounted robots. The description also applies to ceiling-mounted robots (C variant). If the ceiling-mounted robot is currently installed on the ceiling, the procedure is to be applied analogously. The motor must be supported from beneath and the vertically hanging link arm must be secured against motion.

Precondition

- The robot is secured against motions of axis 1.
- The motor is freely accessible; any covers must be removed beforehand.

⚠ WARNING

Unintentional robot motions can cause injuries and damage to property. If work is carried out on an operational robot, the robot must be secured by activating the EMERGENCY STOP device.

Warn all persons concerned before starting to put it back into operation.

⚠ CAUTION

If the motor change is carried out immediately after the robot has stopped operating, the surface temperatures of the motor are liable to be high and could result in burn injuries. Protective gloves must be worn.

⚠ WARNING

When removing or installing the motor, care must be taken to avoid injury to hands by crushing. Protective gloves must be worn.

NOTICE

When installing the motor, it must be ensured that the toothings of the motor and gear unit are not damaged. Increased wear and premature failure may result.

11.1.1 Removing the motor on axis 1

Procedure

1. Release and unplug connectors XM1 and XP1 at the sockets ([>>> Fig. 11-1](#)).
2. Remove 4 Allen screws.

3. Release and lift out motor A1, being careful not to tilt it.
4. Remove the seal between the motor and the motor mount; for F variant only.
5. Dispose of motor A1.
6. Cover the input shaft and protect it against fouling.

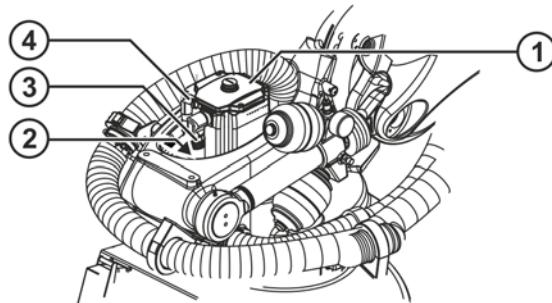


Fig. 11-1: Removing motor A1

- | | |
|----------------|-----------------|
| 1 Motor A1 | 3 Connector XM1 |
| 2 Allen screws | 4 Connector XP1 |

11.1.2 Installing the motor on axis 1

Procedure

1. Remove corrosion protection from new motor A1, if applicable (>>> Fig. 11-2).
2. Clean the toothing of the motor and the gear unit before installation and apply a thin but continuous coat of Microlube GL 261 grease.
3. Clean the mounting surface of motor A1 on the motor mount.
4. Check the condition of the O-ring on the motor shaft. The additional back-up ring must be present.
5. Fit seal on motor mount; F variant only.
6. Position sockets XM1 and XP1 as shown in the illustration.
7. Insert motor A1; do not tilt while it is being installed.



Insertion of motor can be facilitated by turning it gently about its rotational axis.

8. Insert 4 M12x25-8.8 Allen screws.
9. Tighten 4 Allen screws with a torque wrench in diagonally opposite sequence. Gradually increase the tightening torque to a value of 78 Nm.
10. Plug connectors XM1 and XP1 into the sockets.
11. Remove safeguards against the robot turning about axis 1.
12. Carry out mastering of axis 1.



Detailed information about mastering is contained in the operating and programming instructions for end users or system integrators.

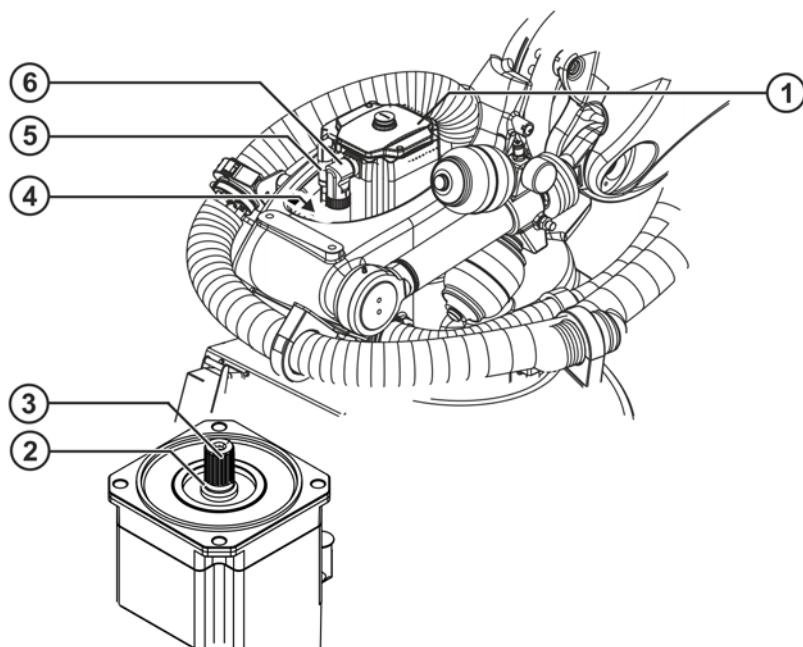


Fig. 11-2: Installing motor A1

- | | | | |
|---|--------------------------|---|---------------|
| 1 | Motor A1 | 4 | Allen screws |
| 2 | O-ring with back-up ring | 5 | Connector XM1 |
| 3 | Toothring | 6 | Connector XP1 |

11.2 Exchanging motor A2

Description

The following describes the removal and installation of motor A2 for floor-mounted robots. The description also applies to ceiling-mounted robots (C variant); the same procedure is to be applied analogously. The motor must be supported from beneath and the vertically hanging link arm must be secured against motion.

Precondition

- The robot is secured against rotational motions about axis 2.

WARNING Unintentional robot motions can cause injuries and damage to property. If work is carried out on an operational robot, the robot must be secured by activating the EMERGENCY STOP device.
Warn all persons concerned before starting to put it back into operation.

CAUTION If the motor change is carried out immediately after the robot has stopped operating, the surface temperatures of the motor are liable to be high and could result in burn injuries. Protective gloves must be worn.

WARNING When removing or installing the motor, care must be taken to avoid injury to hands by crushing. Protective gloves must be worn.

NOTICE When installing the motor, it must be ensured that the toothring of the motor and gear unit is not damaged. Increased wear and premature failure may result.

11.2.1 Removing the motor on axis 2

Procedure

1. Secure the link arm using a rope sling (**>>> Fig. 11-3**).
2. Raise the rope sling until it is ensured that the link arm cannot move after removal of the motor.

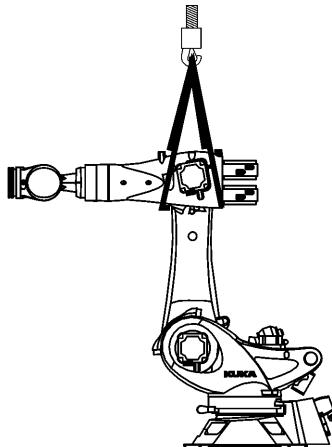


Fig. 11-3: Securing the link arm

3. Release and unplug connectors XM2 and XP2 at the sockets (**>>> Fig. 11-4**).
4. Place the rope sling around motor A2 and raise it using the crane until the weight of motor A2 is supported by the rope sling.
5. Remove 4 Allen screws.
6. Release and pull out motor A2, being careful not to tilt it.
7. Remove the seal between the motor and the motor mount; for F variant only.
8. If the motor on A2 is not to be reinstalled, it must be set down and protected against corrosion before being put into storage.

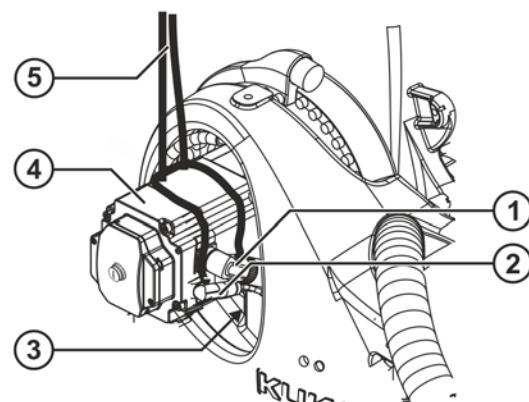


Fig. 11-4: Removing motor A2

- | | | | |
|---|---------------|---|------------|
| 1 | Connector XM2 | 4 | Motor A2 |
| 2 | Connector XP2 | 5 | Rope sling |
| 3 | Allen screws | | |

11.2.2 Installing the motor on axis 2

Procedure

1. Remove all protective coatings and oil from the new motor A2 (**>>> Fig. 11-5**).

2. Clean the toothing of motor A2 and gear unit before installation and apply a thin but continuous coat of Microlube GL 261 grease.
3. Clean the mounting surface of motor A2 on the gear unit.
4. Check the condition of the O-ring on the motor shaft.
5. Position sockets XM2 and XP2 as shown in the diagram.
6. With the rope sling, pick up and insert motor A2, together with the seal (only F variant), being careful not to tilt it.



Insertion of motor can be facilitated by turning it gently about its rotational axis.

7. Insert 4 M12x25-8.8 Allen screws.
8. Tighten 4 Allen screws with a torque wrench in diagonally opposite sequence. Gradually increase the tightening torque to a value of 78 Nm.
9. Slacken and remove the rope sling.
10. Plug connectors XM2 and XP2 into the sockets.
11. Remove elements securing the link arm.
12. Carry out mastering of axis 2.



Detailed information about mastering is contained in the operating and programming instructions for end users or system integrators.

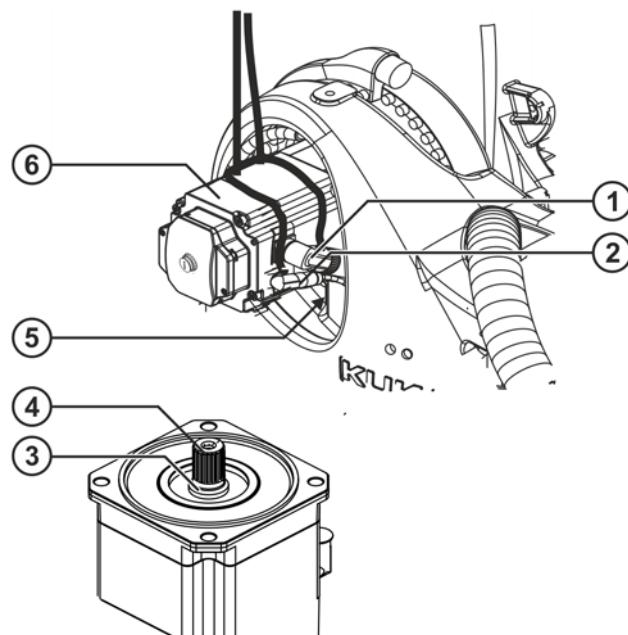


Fig. 11-5: Installing motor A2

1	Connector XM2	4	Toothing
2	Connector XP2	5	Allen screws
3	O-ring	6	Motor A2

11.3 Exchanging motor A3

Description

The following describes the removal of motor A3 for floor-mounted robots. The description also applies to ceiling-mounted robots (C variant). If the ceiling-mounted robot is currently installed on the ceiling, the procedure is to be applied analogously. The motor must be supported from beneath and the arm must be secured against motion.

Precondition

- The robot is secured against rotational motions about axis 3.

WARNING

Unintentional robot motions can cause injuries and damage to property. If work is carried out on an operational robot, the robot must be secured by activating the EMERGENCY STOP device.

Warn all persons concerned before starting to put it back into operation.

CAUTION

If the motor change is carried out immediately after the robot has stopped operating, the surface temperatures of the motor are liable to be high and could result in burn injuries. Protective gloves must be worn.

WARNING

When removing or installing the motor, care must be taken to avoid injury to hands by crushing. Protective gloves must be worn.

NOTICE

When installing the motor, it must be ensured that the toothed belt of the motor and gear unit is not damaged. Increased wear and premature failure may result.

11.3.1 Removing the motor on axis 3**Procedure**

1. Secure the arm using a rope sling ([>>> Fig. 11-6](#)).
2. Raise the rope sling until it is ensured that the arm cannot move after removal of the motor.

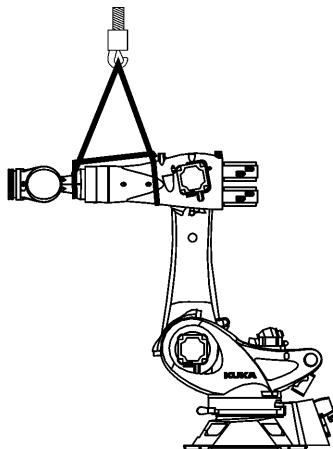


Fig. 11-6: Securing the arm

3. Release and unplug connectors XM3 and XP3 at the sockets ([>>> Fig. 11-7](#)).
4. Place the rope sling around motor A3 and raise it using the crane until the weight of motor A3 is supported by the rope sling.
5. Remove 4 Allen screws.
6. Release and pull out motor A3, being careful not to tilt it.
7. Remove the seal between the motor and the arm; for F variant only.
8. If the motor on A3 is not to be reinstalled, it must be set down and protected against corrosion before being put into storage.

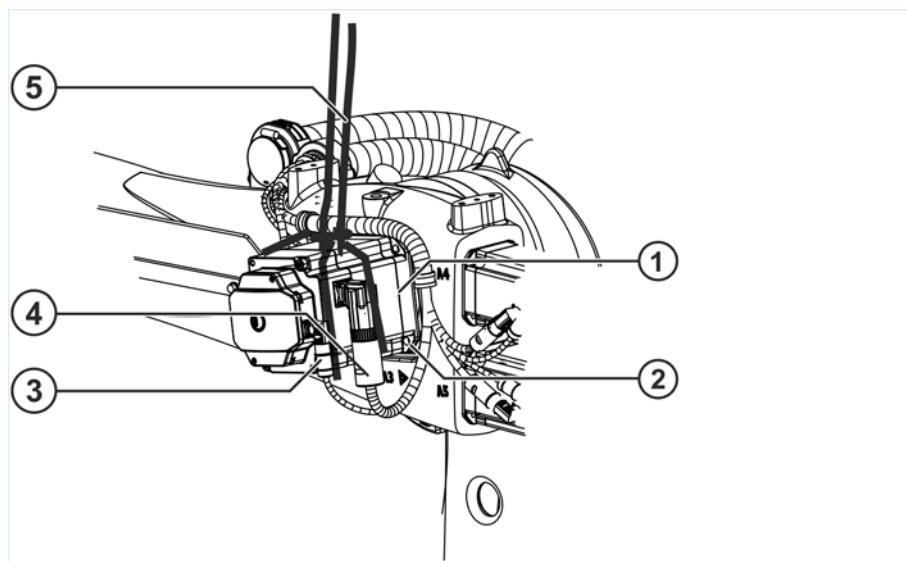


Fig. 11-7: Removing motor A3

- | | | | |
|---|---------------|---|---------------|
| 1 | Motor A3 | 4 | Connector XM3 |
| 2 | Allen screws | 5 | Rope sling |
| 3 | Connector XP3 | | |

11.3.2 Installing the motor on axis 3

Procedure

1. Remove all protective coatings and oil from the new motor A3.
2. Clean the toothing of motor A3 and gear unit before installation and apply a thin but continuous coat of Microlube GL 261 grease (>>> Fig. 11-8).
3. Clean the mounting surface of motor A3 on the gear unit.
4. Check the condition of the O-ring on the motor shaft.
5. Position sockets XM3 and XP3 as shown in the illustration.
6. With the rope sling, pick up and insert motor A3, together with the seal (only F variant), being careful not to tilt it.



Insertion of motor can be facilitated by turning it gently about its rotational axis.

7. Insert 4 M12x35-8.8 Allen screws.
8. Tighten 4 Allen screws with a torque wrench in diagonally opposite sequence. Gradually increase the tightening torque to a value of 78 Nm.
9. Slacken and remove the rope sling.
10. Plug connectors XM3 and XP3 into the sockets.
11. Remove elements securing the arm.
12. Carry out mastering of axis 3.



Detailed information about mastering is contained in the operating and programming instructions for end users or system integrators.

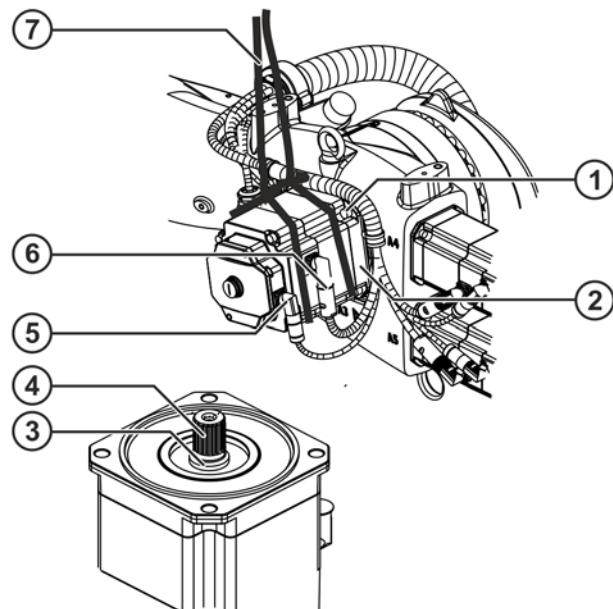


Fig. 11-8: Installing motor A3

- | | | | |
|---|--------------|---|---------------|
| 1 | Motor A3 | 5 | Connector XP3 |
| 2 | Allen screws | 6 | Connector XM3 |
| 3 | O-ring | 7 | Rope sling |
| 4 | Toothing | | |

11.4 Exchanging motor A4

Description

The following describes the removal of motor A4 for floor-mounted robots. The description also applies to ceiling-mounted robots (C variant). If the ceiling-mounted robot is currently installed on the ceiling, the procedure is to be applied analogously.

Precondition

- Tools are dismounted or secured so that they cannot move once the motor has been removed.
- The arm is positioned horizontally.
- All wrist axes should, if possible, be in their zero positions.



WARNING Unintentional robot motions can cause injuries and damage to property. If work is carried out on an operational robot, the robot must be secured by activating the EMERGENCY STOP device.
Warn all persons concerned before starting to put it back into operation.



CAUTION If the motor change is carried out immediately after the robot has stopped operating, the surface temperatures of the motor are liable to be high and could result in burn injuries. Protective gloves must be worn.



WARNING When removing or installing the motor, care must be taken to avoid injury to hands by crushing. Protective gloves must be worn.



NOTICE When installing the motor, it must be ensured that the toothed coupling of the motor and connecting shaft is not damaged.

NOTICE

When installing components and assemblies, the fastening screws (standard, strength class 8.8 and 10.9) must be tightened with the specified KUKA tightening torque. Exceptions to this will be clearly marked.

The specified screw sizes and strength classes are those valid at the copy deadline.

Screws of strength class 10.9 and higher may only be tightened once with the rated tightening torque. When the screws are first slackened they must be replaced with new ones.

11.4.1 Removing the motor on axis 4

Procedure

1. Release and unplug connectors XM4 and XP4 at the sockets (**>>> Fig. 11-9**).
2. Place the rope sling around motor A4 and raise it using the crane until the weight of motor A4 is supported by the rope sling.
3. Remove 4 Allen screws.
4. Release motor A4 and pull it out together with the connecting shaft, being careful not to tilt it.
5. Remove the seal between the motor and the arm; for F variant only.
6. Set down motor A4.

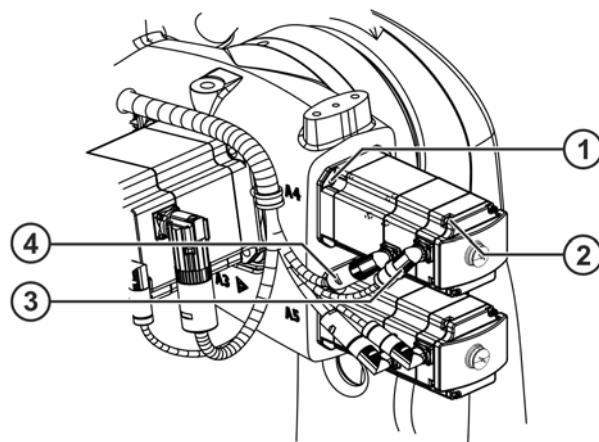


Fig. 11-9: Removing motor A4

1	Allen screws	3	Connector XP4
2	Motor A4	4	Connector XM4

The following two work steps are only to be carried out if motor A4 is not to be reinstalled.

7. Slacken the setscrew (**>>> Fig. 11-10**) until the connecting shaft can be pulled off the toothring. Pull off the connecting shaft.
8. Remove the Allen screw from the shaft stub and take off the axial retainer.
9. If the motor on A4 is not to be reinstalled, it must be protected against corrosion before being put into storage.

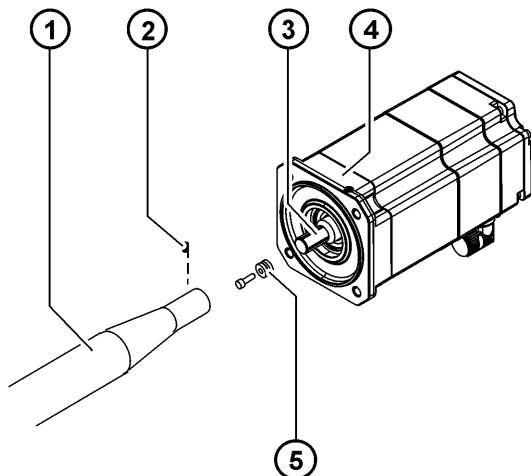


Fig. 11-10: Motor with connecting shaft

- | | | | |
|---|------------------|---|----------------|
| 1 | Connecting shaft | 4 | Motor A4 |
| 2 | Setscrew | 5 | Axial retainer |
| 3 | Shaft stub | | |

11.4.2 Installing the motor on axis 4

Procedure

1. Remove corrosion protection from the new motor A4 ([>>> Fig. 11-11](#)).
2. Apply Drei Bond 1342 to the M5x20-10.9 Allen screw.
3. Mount the axial retainer and fasten it with an M5x20-10.9 Allen screw.
4. Clean the toothing on motor A4 and on the connecting shaft before installation and apply a thin but continuous coat of Microlube GL 261 grease.

NOTICE

When installing the motor, it must be ensured that the toothing of the motor and connecting shaft is not damaged.

5. Fit the connecting shaft onto motor A4.
If grease is pushed into the tapped hole for the setscrew, it must be removed from the tapped hole.
6. Insert the M4x8-8.8 setscrew into the connecting shaft and hand-tighten until it contacts the base.
The setscrew must engage with the groove in the axial retainer.
7. After tightening the setscrew, unscrew it by $\frac{1}{4}$ turn.
The connecting shaft has minimal, slightly noticeable axial play.

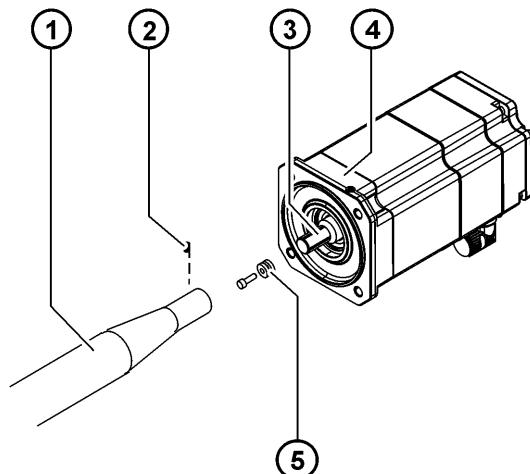


Fig. 11-11: Motor with connecting shaft

- | | | | |
|---|------------------|---|----------------|
| 1 | Connecting shaft | 4 | Motor A5 |
| 2 | Setscrew | 5 | Axial retainer |
| 3 | Shaft stub | | |
8. Clean the mounting surface (**>>> Fig. 11-12**) for motor A4 on the arm.
 9. Position sockets XM4 and XP4 so that they are located on the left-hand side after the motor has been inserted into the arm.
 10. Lift motor A4 with a rope sling and insert it into the arm together with the seal (F variant only), being careful not to tilt it and ensuring that the connecting shafts (toothings) are correctly engaged.



Insertion of motor can be facilitated by turning it gently about its rotational axis.

11. Insert 4 M8x25-8.8 Allen screws.
12. Tighten 4 Allen screws with a torque wrench in diagonally opposite sequence. Gradually increase the tightening torque to a value of 23 Nm.
13. Slacken and remove the rope sling.
14. Plug connectors XM4 and XP4 into the sockets.
15. Remove elements securing the tooling.
16. Carry out mastering of axis 4.



Detailed information about mastering is contained in the operating and programming instructions for end users or system integrators.

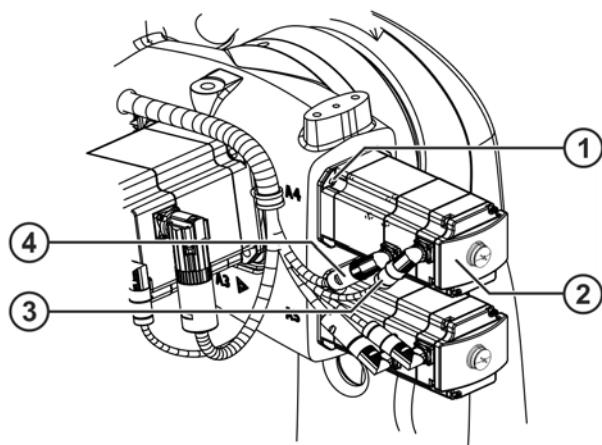


Fig. 11-12: Installing motor A4

- | | |
|-------------------|--------------------|
| 1 Allen screws | 3 Connector XP4 |
| 2 Motor A4 | 4 Connector XM4 |

11.5 Exchanging motor A5

Description The following instructions describe the removal and installation of motor A5.

Precondition

- Tools are dismounted or secured so that they cannot move once the motor has been removed.
- The arm is positioned horizontally.
- All wrist axes should, if possible, be in their zero positions.

WARNING

Unintentional robot motions can cause injuries and damage to property. If work is carried out on an operational robot, the robot must be secured by activating the EMERGENCY STOP device.

Warn all persons concerned before starting to put it back into operation.

CAUTION

If the motor change is carried out immediately after the robot has stopped operating, the surface temperatures of the motor are liable to be high and could result in burn injuries. Protective gloves must be worn.

WARNING

When removing or installing the motor, care must be taken to avoid injury to hands by crushing. Protective gloves must be worn.

NOTICE

When installing the motor, it must be ensured that the toothings of the motor and connecting shaft is not damaged.

NOTICE

When installing components and assemblies, the fastening screws (standard, strength class 8.8 and 10.9) must be tightened with the specified KUKA tightening torque. Exceptions to this will be clearly marked.

The specified screw sizes and strength classes are those valid at the copy deadline.

Screws of strength class 10.9 and higher may only be tightened once with the rated tightening torque. When the screws are first slackened they must be replaced with new ones.

11.5.1 Removing the motor on axis 5

Procedure

1. Release and unplug connectors XM5 and XP5 at the sockets (**>>> Fig. 11-13**).
2. Place the rope sling around motor A5 and raise it using the crane until the weight of motor A5 is supported by the rope sling.
3. Remove 4 Allen screws.
4. Release motor A5 and pull it out together with the connecting shaft, being careful not to tilt it.
5. Remove the seal between the motor and the arm; for F variant only.
6. Set down motor A5.

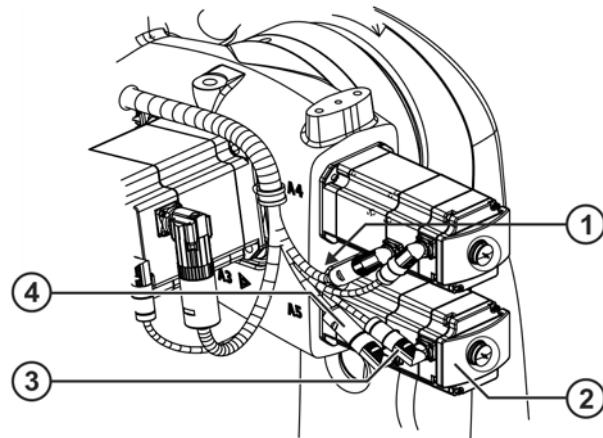


Fig. 11-13: Removing motor A5

- | | |
|-------------------|--------------------|
| 1 Allen screws | 3 Connector XP5 |
| 2 Motor A5 | 4 Connector XM5 |

The following two work steps are only to be carried out if motor A5 is not to be reinstalled.

7. Slacken the setscrew (**>>> Fig. 11-14**) until the connecting shaft can be pulled off the toothring. Pull off the connecting shaft.
8. Remove the Allen screw from the shaft stub and take off the axial retainer.
9. If motor A5 is not to be reinstalled, it must be protected against corrosion before being put into storage.

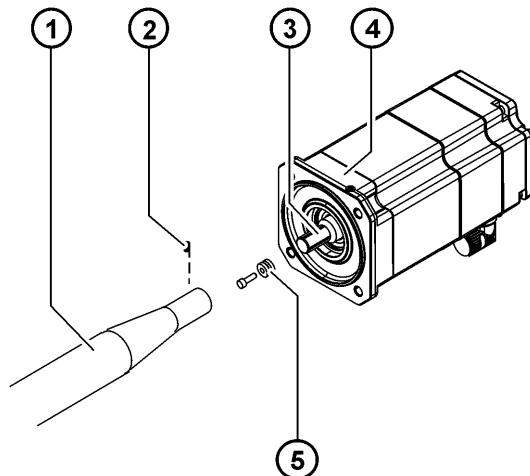


Fig. 11-14: Motor with connecting shaft

- | | | | |
|---|------------------|---|----------------|
| 1 | Connecting shaft | 4 | Motor A5 |
| 2 | Setscrew | 5 | Axial retainer |
| 3 | Toothring | | |

11.5.2 Installing the motor on axis 5

Procedure

1. Remove corrosion protection from the new motor A5 ([>>> Fig. 11-15](#)).
2. Apply Drei Bond 1342 to the M5x20-10.9 Allen screw.
3. Mount the axial retainer and fasten it with an M5x20-10.9 Allen screw.
4. Clean the toothring on motor A5 and on the connecting shaft before installation and apply a thin but continuous coat of Microlube GL 261 grease.

NOTICE

When installing the motor, it must be ensured that the toothring of the motor and connecting shaft is not damaged.

5. Fit the connecting shaft onto motor A5.
If grease is pushed into the tapped hole for the setscrew, it must be removed from the tapped hole.
6. Insert the M4x8-8.8 setscrew into the connecting shaft and hand-tighten until it contacts the base.
The setscrew must engage with the groove in the axial retainer.
7. After tightening the setscrew, unscrew it by $\frac{1}{4}$ turn.
The connecting shaft has minimal, slightly noticeable axial play.

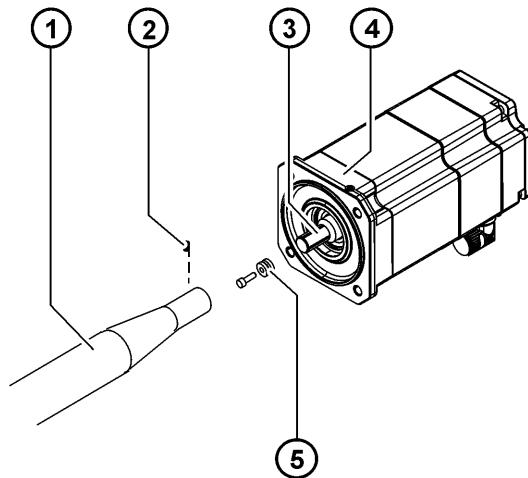


Fig. 11-15: Motor with connecting shaft

- | | | | |
|---|------------------|---|----------------|
| 1 | Connecting shaft | 4 | Motor A5 |
| 2 | Setscrew | 5 | Axial retainer |
| 3 | Shaft stub | | |

8. Clean the mounting surface for motor A5 on the arm ([>>> Fig. 11-13](#)).
9. Position sockets XM5 and XP5 so that they are located on the left-hand side after the motor has been inserted into the arm.
10. Lift motor A5 with a rope sling and insert it into the arm together with the seal (F variant only), being careful not to tilt it and ensuring that the connecting shafts (toothring) are correctly engaged in the in-line wrist.



Insertion of motor can be facilitated by turning it gently about its rotational axis.

- The rope sling can only be used if motor A4 is not installed. Otherwise, use suitable handling equipment to bring motor A5 to the site of installation and insert it.
11. Insert 4 M8x25-8.8 Allen screws.
 12. Tighten 4 Allen screws with a torque wrench in diagonally opposite sequence. Gradually increase the tightening torque to a value of 23 Nm.
 13. If applicable, slacken and remove the rope sling.
 14. Plug connectors XM5 and XP5 into the sockets.
 15. Remove elements securing the tooling.
 16. Carry out mastering of axis 5.



Detailed information about mastering is contained in the operating and programming instructions for end users or system integrators.

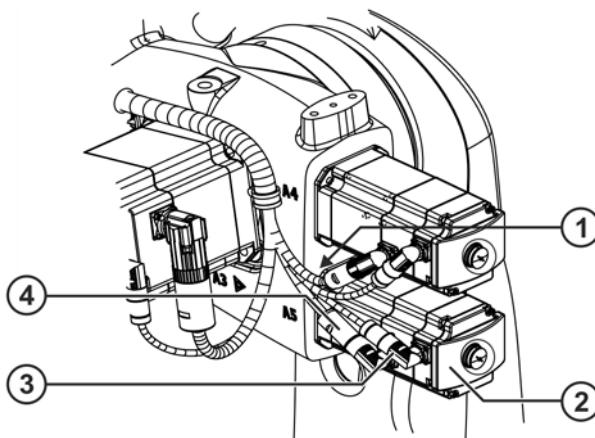


Fig. 11-16: Installing motor A5

- | | | | |
|---|--------------|---|---------------|
| 1 | Allen screws | 3 | Connector XP5 |
| 2 | Motor A5 | 4 | Connector XM5 |

11.6 Exchanging motor A6

Description

The following instructions describe the exchange of motor A6.

Precondition

- The in-line wrist is removed.



WARNING When work is performed on this system, live parts and unintentional robot motions can cause injuries and damage to property. If work is carried out on an operable system, the main switch on the control cabinet must be turned to the OFF position and secured with a padlock to prevent unauthorized persons from switching it on again. Warn all persons concerned before putting the system back into operation.



CAUTION If the motor change is carried out immediately after the robot has stopped operating, the surface temperatures of the motor are liable to be high and could result in burn injuries. Protective gloves must be worn.

WARNING

When removing or installing the motor, care must be taken to avoid injury to hands by crushing. Protective gloves must be worn.

NOTICE

When installing the motor, it must be ensured that the toothed belt of the motor and gear unit is not damaged. Increased wear and premature failure may result.

11.6.1 Removing the motor on axis 6

Procedure

1. Remove 4 Allen screws (**>>>** Fig. 11-17).
2. Release motor A6 and pull it out of the in-line wrist, being careful not to tilt it.
3. If the motor on A6 is not to be reinstalled, it must be set down and protected against corrosion before being put into storage.

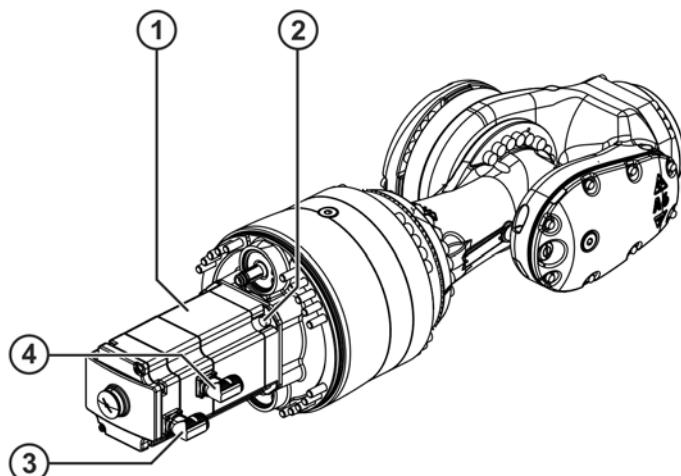


Fig. 11-17: Removing motor A6

- 1 Motor A6
2 Allen screws

- 3 Connector XP6
4 Connector XM6

11.6.2 Installing the motor on axis 6

Procedure

1. Remove corrosion protection from the new motor A6.
2. Clean the toothed belt on motor A6 and in the gear unit of the in-line wrist before installation and apply a thin but continuous coat of Microlube GL 261 grease (**>>>** Fig. 11-18).
3. Clean the mounting surface for motor A6 on the in-line wrist.
4. Position connectors XM5 and XP5 so that they are located on the right-hand side after the motor has been inserted into the in-line wrist.
5. Insert motor A6 into the in-line wrist, taking care not to tilt it.



Insertion of motor can be facilitated by turning it gently about its rotational axis.

6. Insert 4 M8x25-8.8 Allen screws. Tighten 4 Allen screws with a torque wrench in diagonally opposite sequence.
Gradually tighten the 4 M8x25-8.8 Allen screws to the correct tightening torque with the torque wrench.
7. Install the in-line wrist (**>>>** 11.9.2 "Installing the in-line wrist" Page 215).

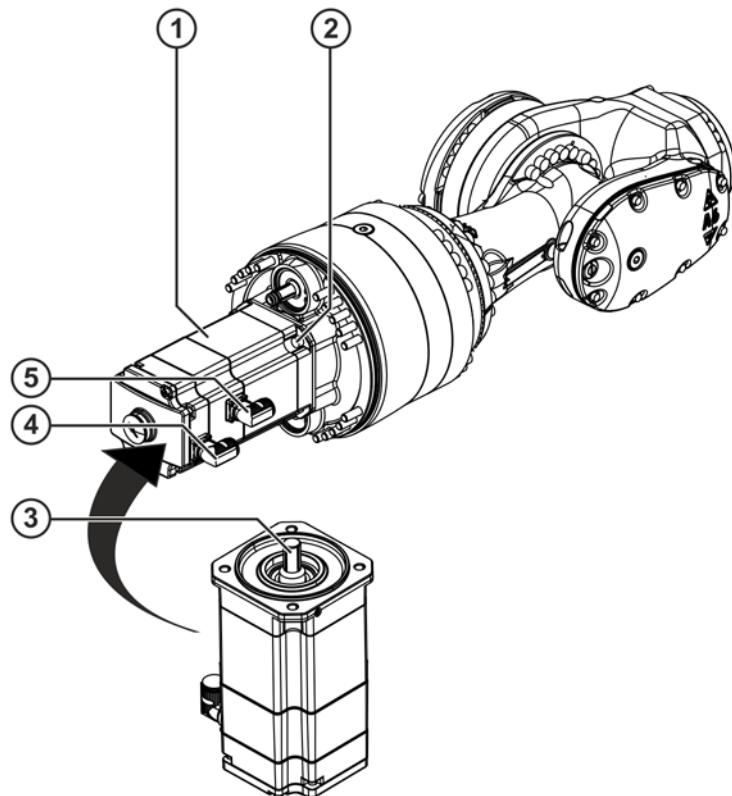


Fig. 11-18: Installing motor A6

- | | | | |
|---|--------------|---|---------------|
| 1 | Motor A6 | 4 | Connector XP6 |
| 2 | Allen screws | 5 | Connector XM6 |
| 3 | Toothring | | |

11.7 Exchanging the counterbalancing system on a floor-mounted robot

Preconditions

- The robot is in the mechanical zero position.
- It must be possible to move the robot about axis 2.
- The robot must be correctly bolted to the floor.
- Any items of equipment that are likely to impede the removal and installation work have been removed.
- The new counterbalancing system is correctly filled.

⚠ WARNING

When carrying out the following work, the robot must be moved several times between the individual work steps. While work is being carried out on the robot, it must always be secured by activating the EMERGENCY STOP device.

Unintentional robot motions can cause injuries and damage to property. If work is carried out on an operational robot that is switched on, the robot must only be moved at reduced velocity. It must be possible to stop the robot at any time by activating an EMERGENCY STOP device. Operation must be limited to what is absolutely necessary.

Warn all persons concerned before switching on and moving the robot.

WARNING

When removing or installing the counterbalancing system, care must be taken to avoid injury to arms, hands and fingers by crushing. Wear gloves and secure the counterbalancing system so that it cannot fall down or move unexpectedly.

The counterbalancing system weighs approx. 40 kg.

The counterbalancing system is pressurized. Particular caution must therefore be exercised and special knowledge put to effect when any work is performed on this system. Any improper handling constitutes a danger to life and limb.

11.7.1 Removing the counterbalancing system on a floor-mounted robot

Procedure

1. Slacken the worm drive clip and push the bellows backwards (=> Fig. 11-19).
2. Move the link arm in the plus direction until the spacer can be inserted between the cylinder and the articulated head.
3. Secure the robot by pressing the E-STOP device.
4. Place spacer onto the free piston rod between the articulated head and the hydraulic cylinder.
5. Put the robot into operation and move the link arm carefully in the minus direction until the spacer is just clamped.

CAUTION

If the link arm is moved any further in the minus direction with the spacer inserted, this will result in damage to the counterbalancing system, link arm or rotating column.

6. Secure the robot by pressing the E-STOP device.
7. Secure the counterbalancing system with a rope sling and a crane and move the crane until the weight is supported by the rope sling.
8. Remove 4 Allen screws and conical spring washers, and take off the retaining plate.

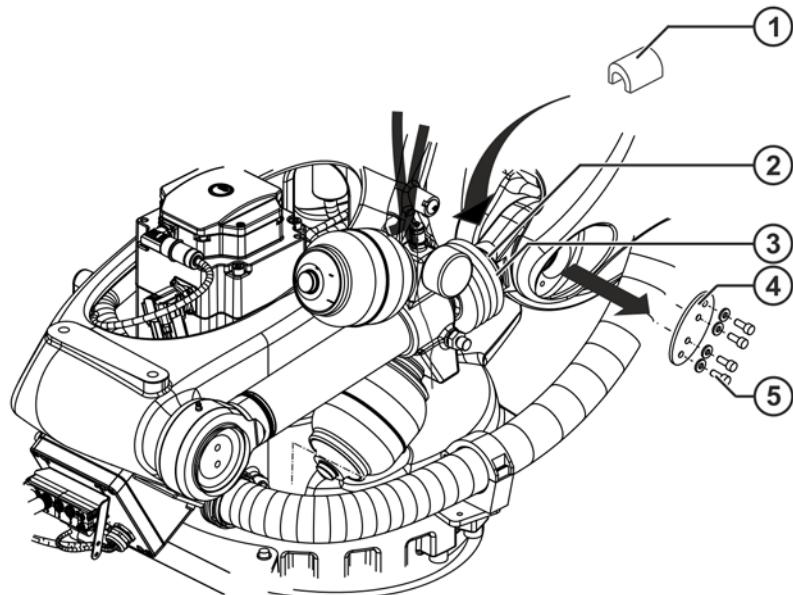


Fig. 11-19: Removing the counterbalancing system: spacer

- | | | | |
|---|-----------------|---|-------------|
| 1 | Spacer | 4 | Lock washer |
| 2 | Worm drive clip | 5 | Allen screw |
| 3 | Bellows | | |

9. Secure link arm using a rope sling and crane ([>>> Fig. 11-20](#)).

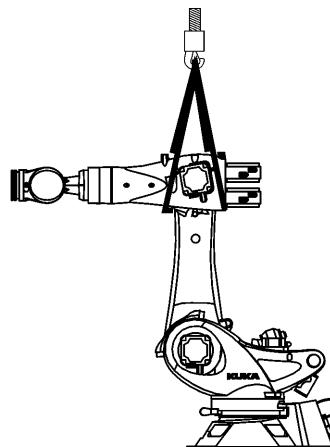


Fig. 11-20: Securing the link arm

10. Remove 2 Allen screws and lock washers, and take the cover off the rotating column ([>>> Fig. 11-21](#)).

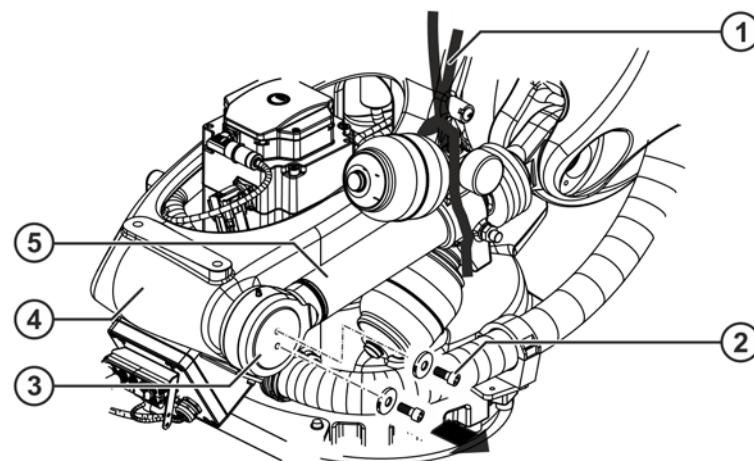


Fig. 11-21: Removing the counterbalancing system: rotating column

1	Rope sling	4	Rotating column
2	Allen screw	5	Counterbalancing system
3	Cover		

11. Insert the pin locator on the right-hand side between the articulated head and the link arm ([>>> Fig. 11-22](#)).
12. Pull the pin out of the link arm using an M16 pin extractor.
The pin is out of the precision fit area when it has been pulled out approx. 25 mm.
13. Put the robot into operation and move the link arm carefully in the plus direction until the articulated head is free. When moving the link arm, move the crane and rope sling at the same time, so that the weight of the arm is supported by the crane.
14. Secure the robot by pressing the E-STOP device.
15. Swivel the counterbalancing system up and out of the link arm, moving the crane and rope sling at the same time.
16. Take off the pin locator, thrust ring and spacer ring that are now loose.

CAUTION

When forcing the counterbalancing system off the rotating column, an unfavorable position of the center of gravity may cause the counterbalancing system to move unexpectedly. To avoid injury and damage, the tension and position of the rope must be adjusted as necessary.

17. Force the counterbalancing system off the pin in the rotating column in the direction of the arrow.

While forcing off the counterbalancing system, check the rope tension and if necessary correct it to prevent the components from being tilted.

18. Continue raising the counterbalancing system with the crane and set it down on a suitable support.

19. If the counterbalancing system is not to be reinstalled, it must be protected against corrosion before being put into storage.

If a new counterbalancing system is not being installed immediately, the robot can be moved into a safe position and the rope securing the link arm can be removed. The robot may only be moved again in order to install the new counterbalancing system.

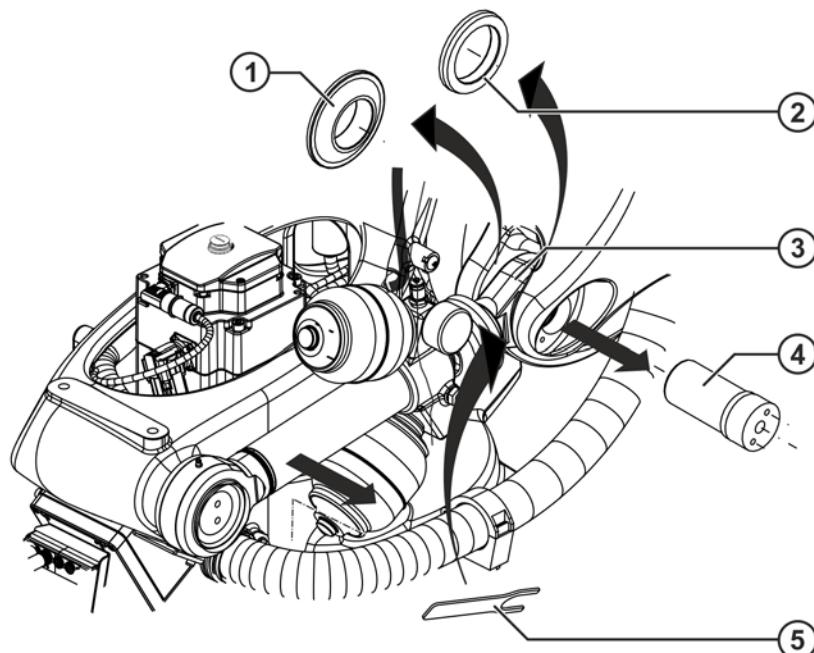


Fig. 11-22: Removing the counterbalancing system: pin

- | | |
|--------------------|---------------|
| 1 Thrust ring | 4 Pin |
| 2 Spacer ring | 5 Pin locator |
| 3 Articulated head | |

11.7.2 Installing the counterbalancing system on a floor-mounted robot

Procedure

1. Remove all protective coatings and oil from the counterbalancing system and check that no part of it is missing.
2. If necessary, put the robot into operation and move the link arm into approximately the minus 85° position.
3. Secure the robot by pressing the E-STOP device.
4. Secure link arm using a rope sling and crane (>>> Fig. 11-23).

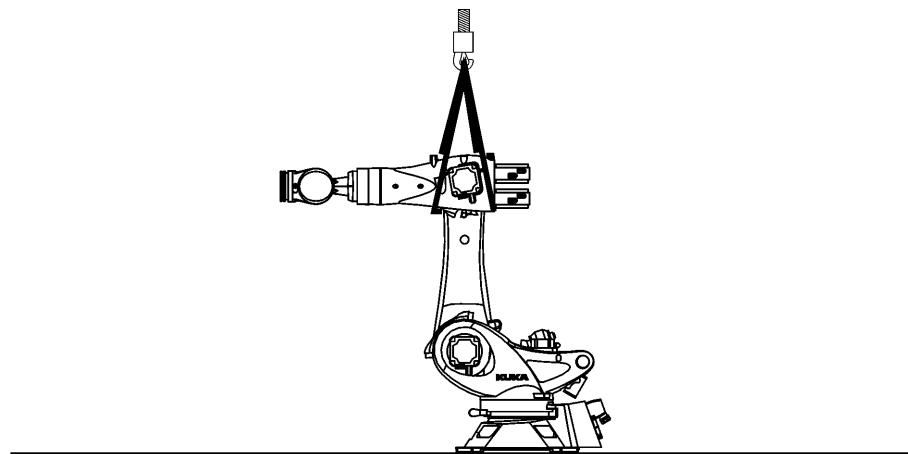


Fig. 11-23: Securing the link arm

5. Lift the counterbalancing system with a rope sling and bring it to the site of installation ([>>> Fig. 11-24](#)).
6. Mount the counterbalancing system sideways on the pin in the rotating column, and align.
7. If necessary, adjust the rope tension.
8. Mount the cover and fasten with two M12x30-10.9 Allen screws and conical spring washers.
9. Tighten the Allen screws with a torque wrench; $M_A = 104 \text{ Nm}$.

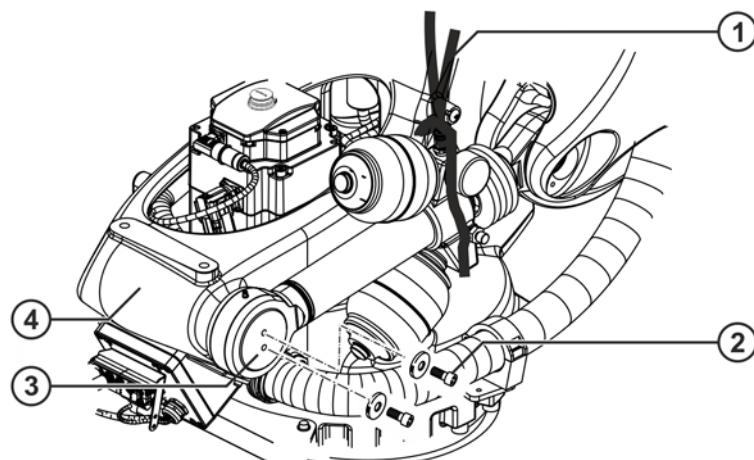


Fig. 11-24: Installing the counterbalancing system: rotating column

1	Rope sling	3	Cover
2	Allen screw	4	Rotating column

10. Put the robot into operation.
11. Move the link arm until the counterbalancing system can be inserted into the link arm. At the same time, move the element securing the link arm accordingly ([>>> Fig. 11-25](#)).
12. Lower the counterbalancing system, insert the articulated head with the thrust ring and spacer ring into the link arm, and align.
Observe installation position of thrust ring and spacer ring!
13. Move the link arm and counterbalancing system until the holes are aligned.
14. Insert the pin with the aid of the device.

15. Mount the retaining plate and fasten it with 4 M8x20-10.9 Allen screws and conical spring washers.
16. Tighten the 4 Allen screws with a torque wrench; $M_A = 31 \text{ Nm}$.
17. Remove the rope sling from the counterbalancing system and the link arm.

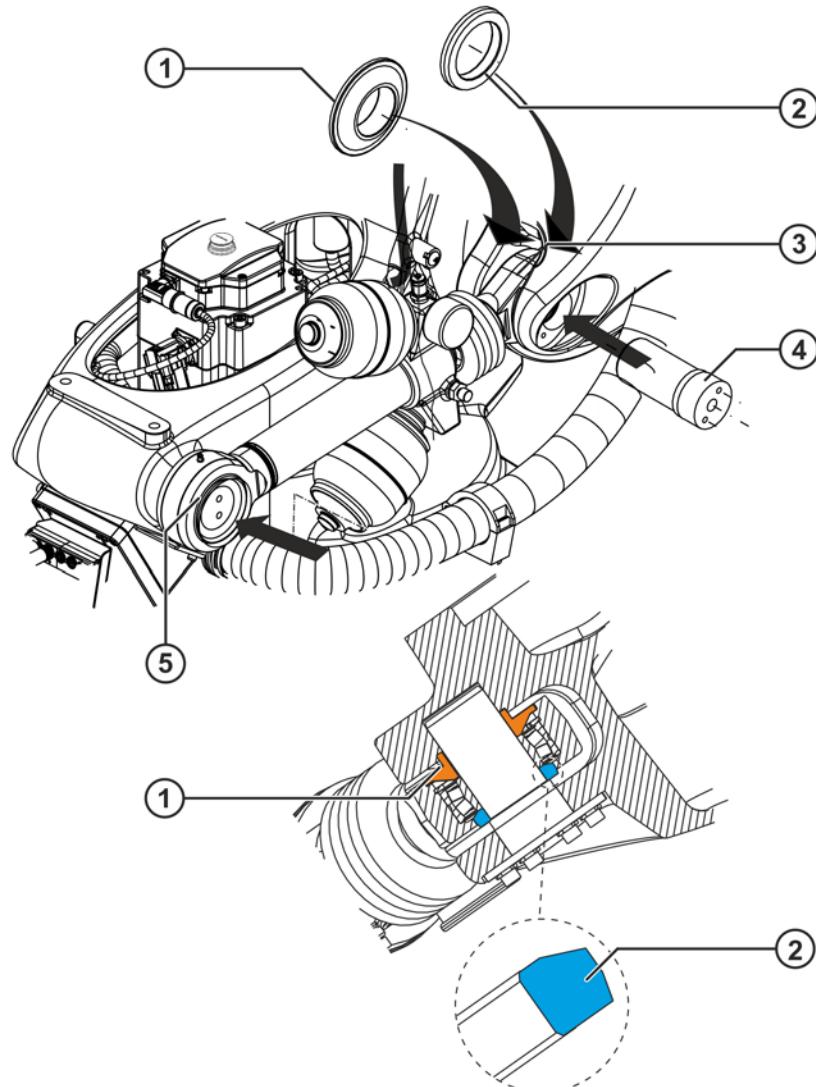


Fig. 11-25: Installing the counterbalancing system: pin

1	Thrust ring	4	Pin
2	Spacer ring	5	Counterbalancing system
3	Articulated head		

18. Put the robot into operation.
19. Move the link arm in the plus direction until the spacer between the cylinder and the articulated head is released, and remove the spacer ([>>> Fig. 11-26](#)).



CAUTION If the link arm is moved any further in the minus direction with the spacer inserted, this will result in damage to the counterbalancing system, link arm or rotating column.

20. Secure the robot by pressing the E-STOP device.
21. Mount the bellows on the cylinder and the articulated head and fasten with worm drive clips.
22. Check the pressure on the counterbalancing system .

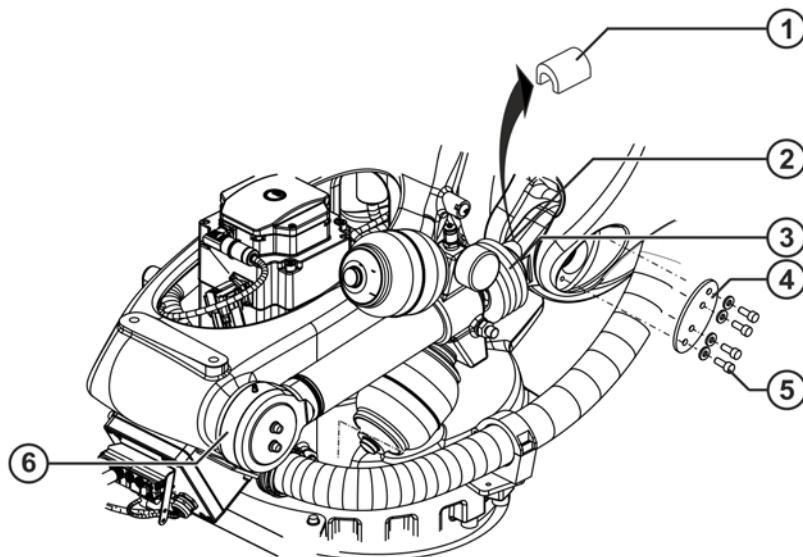


Fig. 11-26: Installing the counterbalancing system: link arm

- | | | | |
|---|-----------------|---|-------------------------|
| 1 | Spacer | 4 | Lock washer |
| 2 | Bellows | 5 | Allen screws |
| 3 | Worm drive clip | 6 | Counterbalancing system |

11.8 Exchanging the counterbalancing system on a ceiling-mounted robot

Description

The following instructions apply to ceiling-mounted robots (C variant). To remove and install the counterbalancing system, the ceiling-mounted robot must be removed from the ceiling and securely fastened to the floor (to the foundation).

Precondition

- It must be possible to move the robot about axis 2.
- The robot must be on the ground and firmly screwed to the mounting base.
- Any tools or items of equipment that are likely to impede the removal work have been removed.
- The pin locator must be available.
- The removal/installation device for CBS pins is available.
- The new counterbalancing system is depressurized (oil pressure) for installation.

⚠ WARNING

When carrying out the following work, the robot must be moved several times between the individual work steps. While work is being carried out on the robot, it must always be secured by activating the EMERGENCY STOP device. Unintentional robot motions can cause injuries and damage to property. If work is carried out on an operational robot that is switched on, the robot must only be moved at reduced velocity. It must be possible to stop the robot at any time by activating an EMERGENCY STOP device. Operation must be limited to what is absolutely necessary. Warn all persons concerned before switching on and moving the robot.

WARNING

When removing or installing the counterbalancing system, care must be taken to avoid injury to arms, hands and fingers by crushing. Wear gloves and secure the counterbalancing system so that it cannot fall down or move unexpectedly.

The counterbalancing system weighs approx. 40 kg.

The counterbalancing system is pressurized. Particular caution must therefore be exercised and special knowledge put to effect when any work is performed on this system. Any improper handling constitutes a danger to life and limb.

11.8.1 Removing the counterbalancing system on a ceiling-mounted robot

Procedure

1. Put the robot into operation and move the link arm into the minus 90° position ([>>> Fig. 11-27](#)).
2. Secure the robot by pressing the E-STOP device.
3. Relieve the counterbalancing system by reducing the oil pressure .
4. Secure the counterbalancing system with a rope sling and a crane and move the crane until the weight is supported by the rope sling.
5. Remove 4 Allen screws and conical spring washers, and take off the retaining plate.

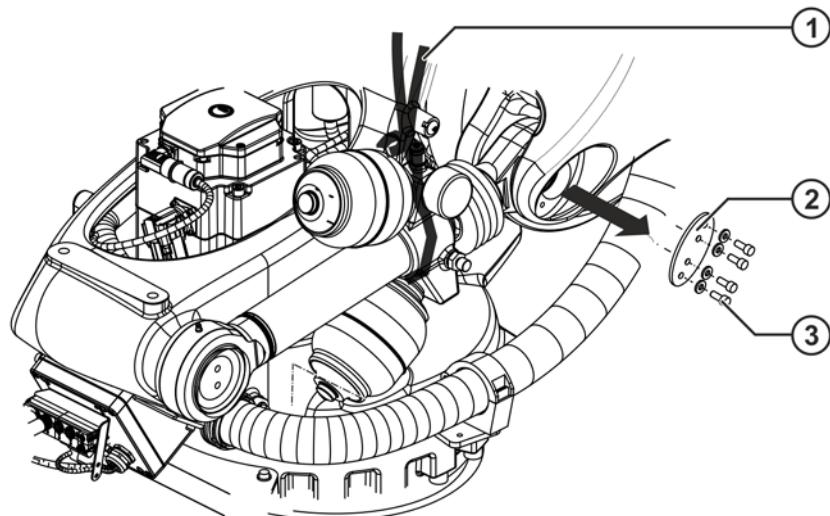


Fig. 11-27: Removing the counterbalancing system on a ceiling-mounted robot

- 1 Rope sling
2 Lock washer

- 3 Allen screws

6. Secure link arm using a rope sling and crane ([>>> Fig. 11-28](#)).

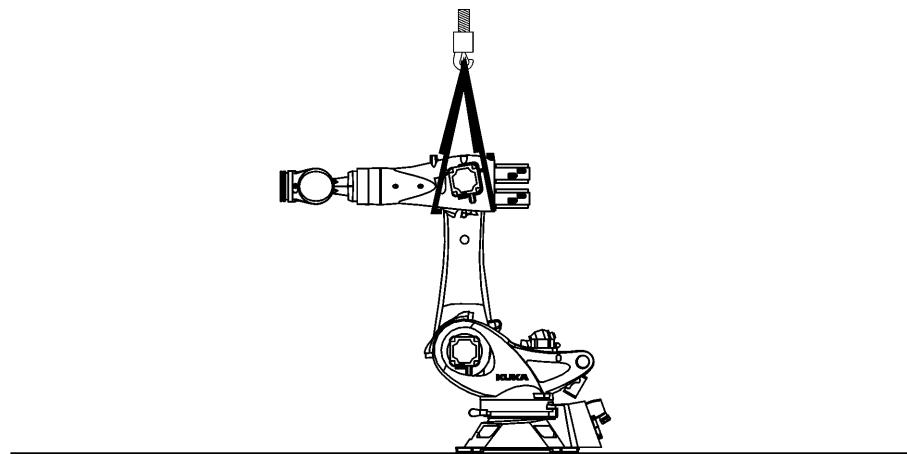


Fig. 11-28: Securing the link arm

7. Remove 2 Allen screws and lock washers, and take the cover off the rotating column (=>> Fig. 11-29).

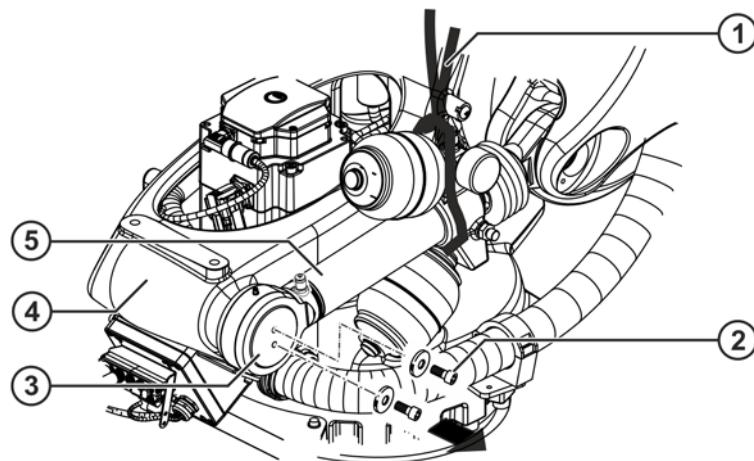


Fig. 11-29: Removing the counterbalancing system on a ceiling-mounted robot, rotating column

- | | | | |
|---|--------------|---|-------------------------|
| 1 | Rope sling | 4 | Rotating column |
| 2 | Allen screws | 5 | Counterbalancing system |
| 3 | Cover | | |
8. Insert the pin locator on the right-hand side between the articulated head and the link arm (=>> Fig. 11-30).
 9. Pull the pin out of the link arm using an M16 pin extractor.
The pin is out of the precision fit area when it has been pulled out approx. 25 mm.
 10. Put the robot into operation and move the link arm carefully in the plus direction until the articulated head is free. When moving the link arm, move the crane and rope sling at the same time, so that the weight of the arm is supported by the crane.
 11. Secure the robot by pressing the E-STOP device.
 12. Swivel the counterbalancing system up and out of the link arm, moving the crane and rope sling at the same time.
 13. Take off the pin locator, thrust ring and spacer ring that are now loose.

CAUTION

When forcing the counterbalancing system off the rotating column, an unfavorable position of the center of gravity may cause the counterbalancing system to move unexpectedly. To avoid injury and damage, the tension and position of the rope must be adjusted as necessary.

14. Force the counterbalancing system off the pin in the rotating column in the direction of the arrow.

While forcing off the counterbalancing system, check the rope tension and if necessary correct it to prevent the components from being tilted.

15. Continue raising the counterbalancing system with the crane and set it down on a suitable support.

16. If the counterbalancing system is not to be reinstalled, it must be protected against corrosion before being put into storage.

If a new counterbalancing system is not being installed immediately, the robot can be moved into a safe position and the rope securing the link arm can be removed. The robot may only be moved again in order to install the new counterbalancing system.

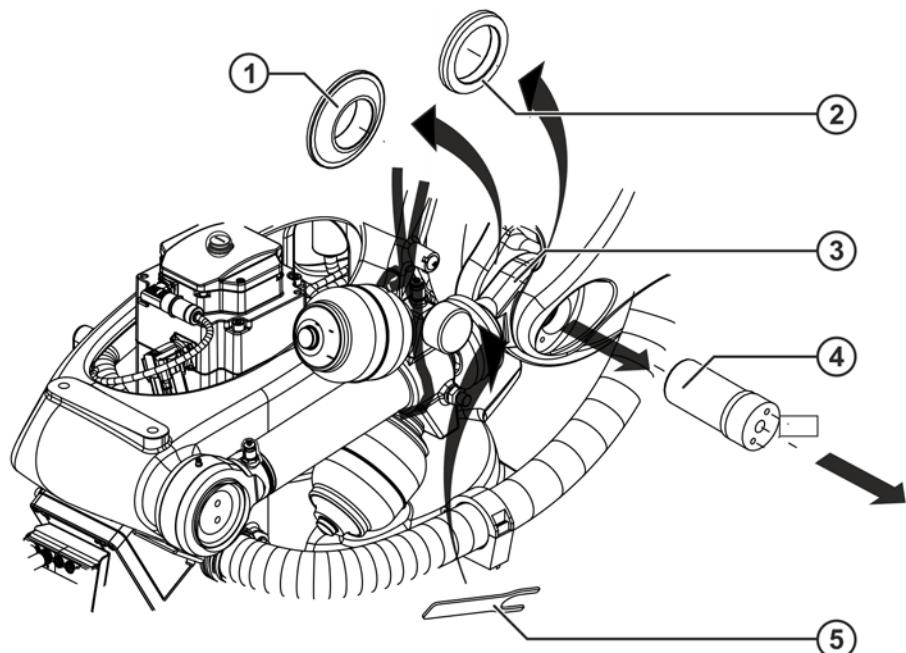


Fig. 11-30: Removing the counterbalancing system on a ceiling-mounted robot: pin

- | | |
|--------------------|---------------|
| 1 Thrust ring | 4 Pin |
| 2 Spacer ring | 5 Pin locator |
| 3 Articulated head | |

11.8.2 Installing the counterbalancing system on a ceiling-mounted robot

Procedure

1. Remove all protective coatings and oil from the counterbalancing system and check that no part of it is missing.
2. If necessary, put the robot into operation and move the link arm into approximately the minus 90° position.
3. Secure the robot by pressing the E-STOP device.
4. Secure link arm using a rope sling and crane (>>> Fig. 11-31).

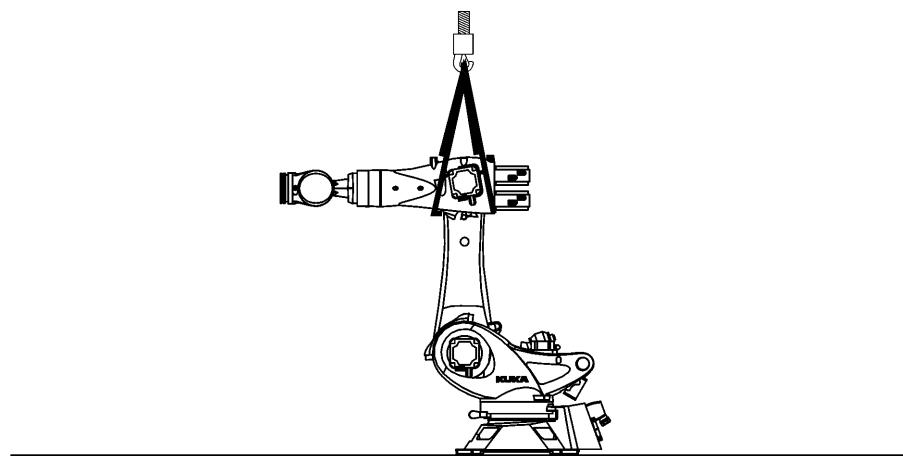


Fig. 11-31: Securing the link arm

5. Lift the counterbalancing system with a rope sling and bring it to the site of installation (>>> Fig. 11-32).
6. Mount the counterbalancing system sideways on the pin in the rotating column, and align.
7. If necessary, adjust the rope tension.
8. Mount the cover and fasten with two M12x30-10.9 Allen screws and conical spring washers.
9. Tighten the Allen screws with a torque wrench; $M_A = 104 \text{ Nm}$.

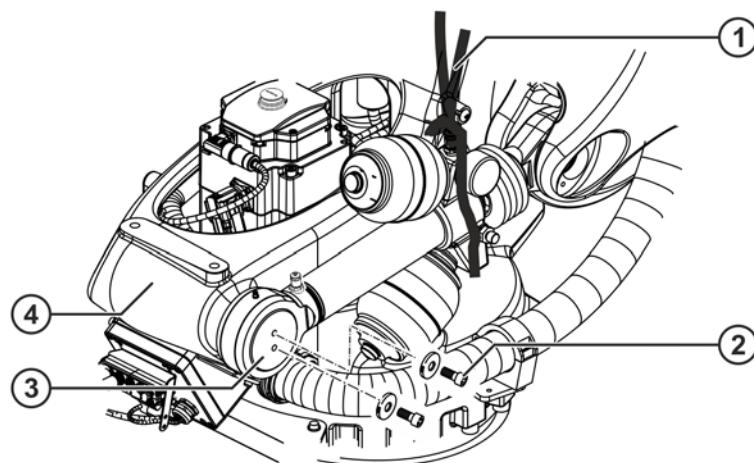


Fig. 11-32: Installing the counterbalancing system on a ceiling-mounted robot, rotating column

- | | |
|------------------|---------------------|
| 1 Rope sling | 3 Cover |
| 2 Allen screws | 4 Rotating column |

10. Put the robot into operation.
11. Move the link arm until the counterbalancing system can be inserted into the link arm. At the same time, move the element securing the link arm accordingly (>>> Fig. 11-33).
12. Lower the counterbalancing system, insert the articulated head with the thrust ring and spacer ring into the link arm, and align. Observe installation position of thrust ring and spacer ring!
13. Move the link arm and counterbalancing system until the holes are aligned.

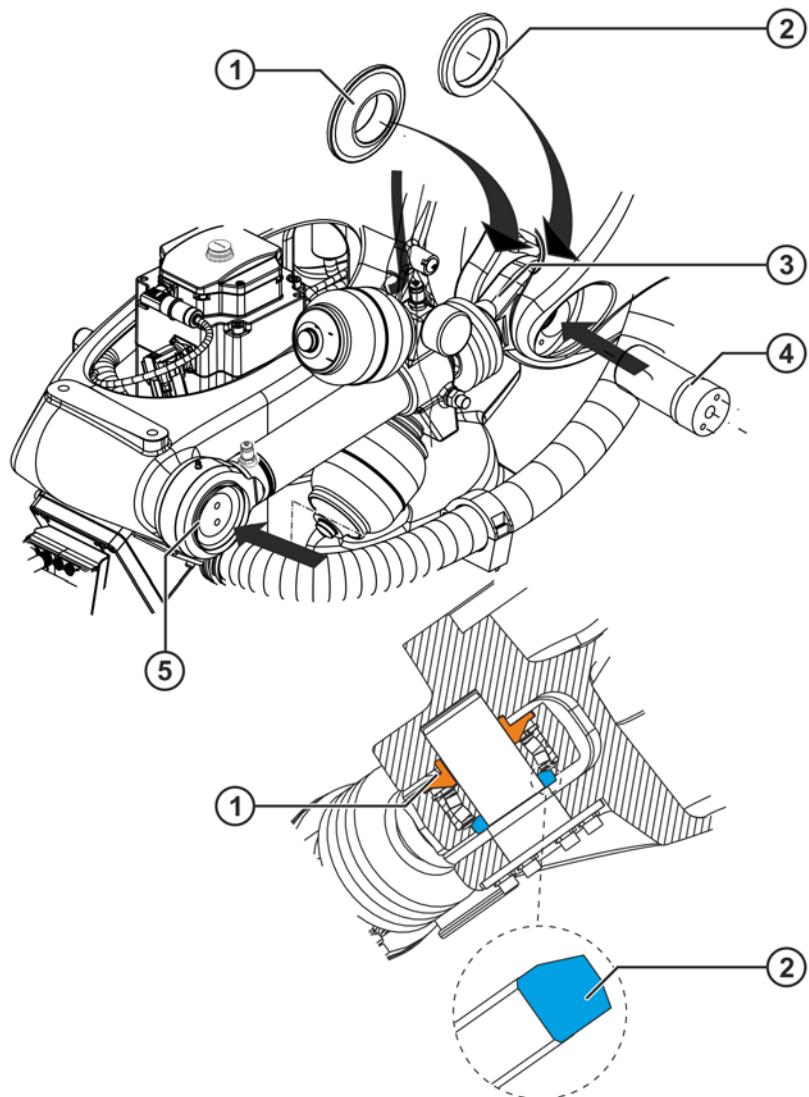


Fig. 11-33: Installing the counterbalancing system on a ceiling-mounted robot: pin

1	Thrust ring	4	Pin
2	Spacer ring	5	Counterbalancing system
3	Articulated head		

14. Insert the pin with the aid of the device (>>> Fig. 11-33).
15. Mount the retaining plate and fasten it with 4 M8x20-10.9 Allen screws and conical spring washers.
16. Tighten the 4 Allen screws with a torque wrench; $M_A = 31 \text{ Nm}$.
17. Remove the rope sling from the counterbalancing system and the link arm.
18. Put the robot into operation and move the link arm into the minus 90° position.
19. Secure the robot by pressing the E-STOP device.
20. Fill with hydraulic oil and adjust oil pressure .

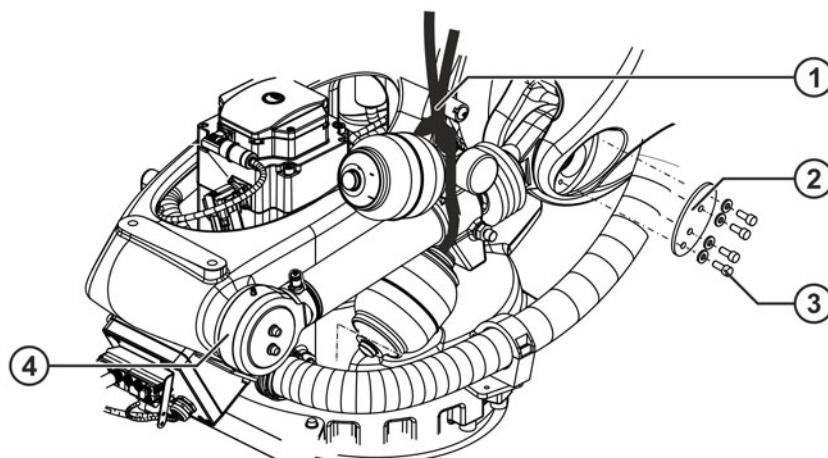


Fig. 11-34: Installing the counterbalancing system on a ceiling-mounted robot: link arm

- 1 Rope sling
- 2 Lock washer

- 3 Allen screws
- 4 Counterbalancing system

11.9 Exchanging the in-line wrist

Description All of the in-line wrist variants are installed in the same way, irrespective of the payload or arm length. In the following description, only the removal of the IW 270/300 in-line wrist will be described.

Preconditions

- The arm is in the horizontal position.
- Axes 4, 5 and 6 should, if possible, be in their zero positions.
- Remove the payload (tool or device) from the in-line wrist.
- A crane, appliance or rope with adequate carrying capacity must be available.

WARNING When work is performed on this system, live parts and unintentional robot motions can cause injuries and damage to property. If work is carried out on an operable system, the main switch on the control cabinet must be turned to the OFF position and secured with a padlock to prevent unauthorized persons from switching it on again. Warn all persons concerned before putting the system back into operation.

DANGER If a defective Load Lifting Attachment is used, the load may fall off or start to swing. Severe injuries or damage to property may result.

- Before using the Load Lifting Attachment, check for damage (e.g. corrosion, deformation, cracks) and exchange parts if necessary.
- Only use lifting tackle with a sufficient load-bearing capacity.

11.9.1 Removing the in-line wrist

Procedure

1. Fasten the lifting device to the in-line wrist and the crane. ([>>> Fig. 11-35](#)).

WARNING The in-line wrist and the arm can be damaged or persons injured if the in-line wrist is not safely secured. The in-line wrist weighs approx. 130 kg. The crane and rope must therefore be able to support this load safely.

2. Release and unplug connectors XM5 and XP5 at the sockets.
3. Move the crane until the weight of the in-line wrist is supported by the crane.
4. Unscrew 4 M8x25-8.8 Allen screws each from motor A4 and motor A5.
5. Release the motors and pull them out together with the corresponding connecting shafts, being careful not to tilt them.
6. Set motors A4 and A5 with the connecting shafts down on a suitable support surface.
7. Remove 20 Allen screws. In the same hole circle there are also two M6 Allen screws, one at the top and one at the bottom; these must not be slackened.
8. Pull the in-line wrist out of the arm until connectors XM6 and XP6 are accessible.
Do not tilt it when removing it. The gap between the arm and the in-line wrist must be uniform at all times round the entire circumference. Also move the crane at the same time as pulling out the in-line wrist. The connecting shafts must not be subjected to any load while the in-line wrist is being pulled out.
9. Release and unplug connectors XM6 and XP6.
10. Place in-line wrist on suitable support.
11. Slacken 2 setscrews on each connecting shaft until the connecting shaft can be pulled off. This step is only to be carried out if the in-line wrist is not to be reinstalled immediately.
12. If the in-line wrist is not to be reinstalled, it must be protected against corrosion before being put into storage.

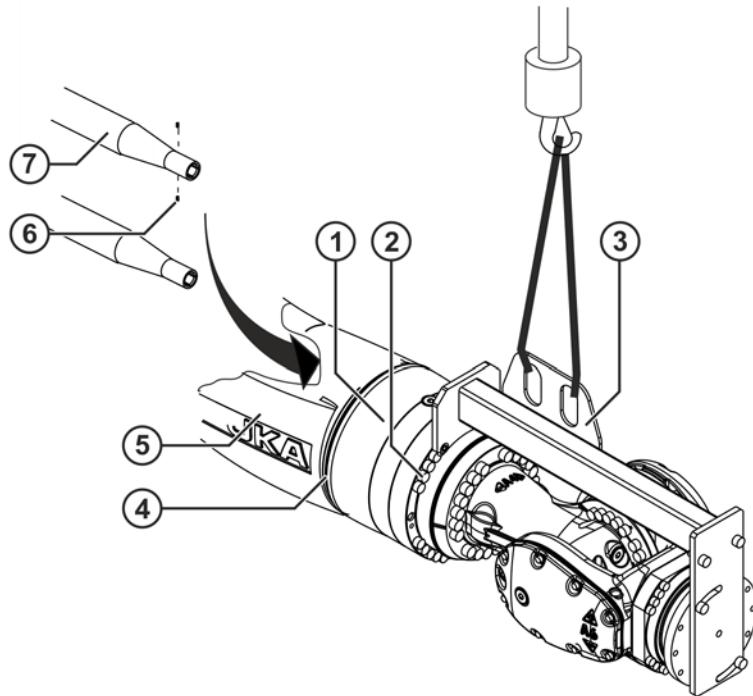


Fig. 11-35: Removing the in-line wrist

1	In-line wrist	5	Arm
2	Allen screws	6	Setscrews
3	Lifting device	7	Connecting shafts
4	Gap		

11.9.2 Installing the in-line wrist

Procedure

1. Remove all protective coatings and oil from new in-line wrist, if applicable.
Clean all toothing before installation and apply a thin but continuous coat of Microlube 261.

NOTICE

When installing the in-line wrist, it must be ensured that the toothing of the in-line wrist and connecting shafts is not damaged. Increased wear and premature failure may result.

2. Mount both connecting shafts on the in-line wrist
3. Clean the M4x8 setscrews on both sides, apply Drei Bond 1342 locking agent and insert them.
4. Tighten the setscrews evenly by hand; $M_A = 2.8 \text{ Nm}$.
5. Fasten the lifting device to the in-line wrist.

WARNING

The in-line wrist and the arm can be damaged or persons injured if the in-line wrist is not safely secured. The in-line wrist weighs approx. 130 kg. The crane and rope must therefore be able to support this load safely.

6. Pick up the in-line wrist with the crane, bring it to the installation site and ensure that axes 4 and 6 are in their zero positions.
7. Ensure that the connecting shafts are not damaged or subjected to any load during transportation and insertion.
8. Insert the in-line wrist into the arm until the connectors can be plugged in.
9. Plug in connectors XP6 and XM6 and then insert the in-line wrist all the way into the arm.
Ensure that the cables are in the correct position in the arm. The position can be checked through the openings for the motors.
10. Insert 20 M10x200-10.9 Allen screws.
11. Tighten 20 Allen screws with a torque wrench in diagonally opposite sequence. Gradually increase the tightening torque to a value of 60 Nm.

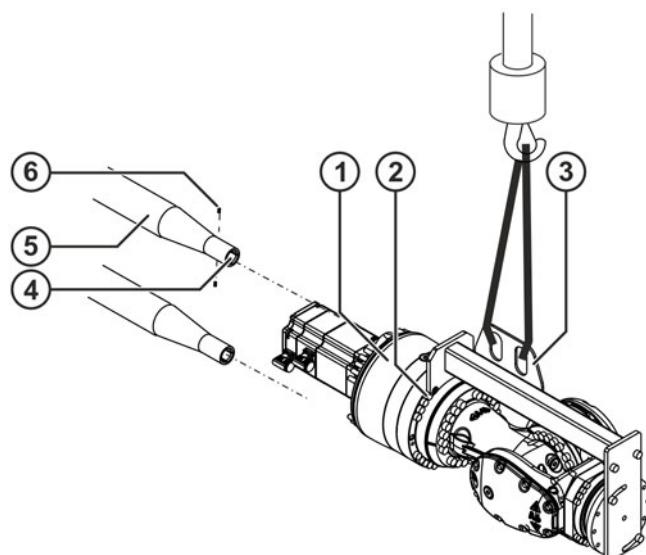


Fig. 11-36: Installing the in-line wrist

- | | |
|------------------|--------------------|
| 1 In-line wrist | 4 Tothing |
| 2 Allen screws | 5 Connecting shaft |
| 3 Lifting device | 6 Setscrews |

12. Remove the lifting device or rope sling.

13. Insert motors A4 and A5, including connecting shafts, being careful not to tilt them. Make sure that the toothings of the connecting shafts are fitted correctly in the in-line wrist.
14. Carry out mastering of axes 4, 5 and 6.



Detailed information about mastering is contained in the operating and programming instructions for end users or system integrators.

11.10 Description of the electrical installations (robot)

Overview

The electrical installations of the robot consist of:

- Cable set
- Multi-function housing MFH for motor cable
- Junction box for data cable, RDC box

Description

The electrical installations ([>>> Fig. 11-37](#)) include all the supply and control cables for the motors of axes 1 to 6. All the connections on the motors are screwed plug-and-socket connections. The assembly consists of the cable set, the multi-function housing MFH on the push-in module and the RDC box in the rotating column. The interface for the connecting cables is located at the back of the base frame on the push-in module. The motor cable X30 and the data cable X31 are connected here via plug-in connections. The data and motor cables are routed through the axis 1 gear unit to the motors (XM connectors) or, in the case of the data cables, to the RDC box on the rotating column. From the RDC box, the motors are connected via the XP connectors. The connectors on motors A1 to A5 are freely accessible, whereas the connectors for motor A6 are only accessible after removal of the wrist.

The protective circuit is also integrated into the cable set. The ground conductor is connected to the base frame via a ground conductor bolt.

The selected cable routing ensures that the cables are guided without strain or kinking throughout the entire motion range of the robot.

The following diagram gives an overview of the installation and routing of the cables on the manipulator.

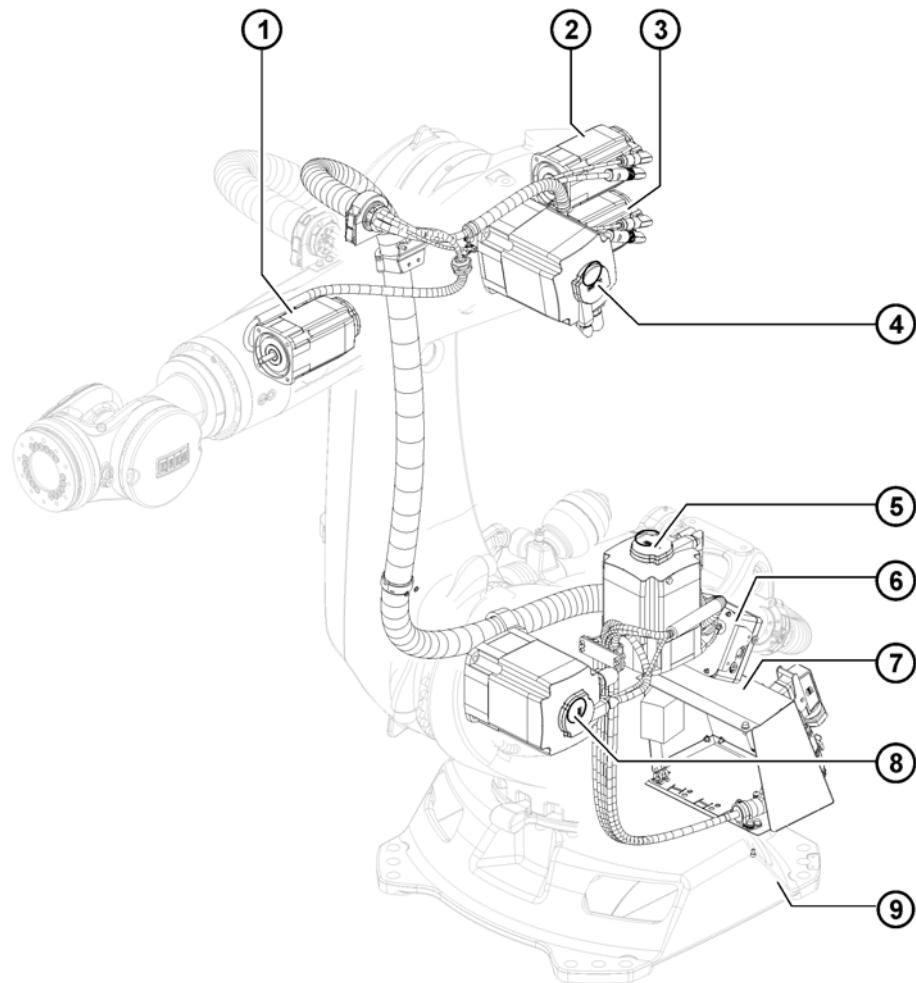


Fig. 11-37: Overview of electrical installations

- | | | | |
|---|--------------|---|----------------|
| 1 | Axis 6 motor | 6 | RDC box |
| 2 | Axis 4 motor | 7 | Push-in module |
| 3 | Axis 5 motor | 8 | Axis 2 motor |
| 4 | Axis 3 motor | 9 | Base frame |
| 5 | Axis 1 motor | | |

Wiring diagrams

Designation	Connection	Figure
Wiring diagram A1	XM1	(>>> Fig. 11-38)
Wiring diagram A2	XM2	(>>> Fig. 11-39)
Wiring diagram A3	XM3	(>>> Fig. 11-40)
Wiring diagram A4	XM4	(>>> Fig. 11-41)
Wiring diagram A5	XM5	(>>> Fig. 11-41)
Wiring diagram A6	XM6	(>>> Fig. 11-43)
Data cable	Wiring diagram, RDC X31	(>>> Fig. 11-44)
Data cable	Wiring diagram, RDC X32	(>>> Fig. 11-45)
Protective circuit	Ring cable lug	(>>> Fig. 11-46)

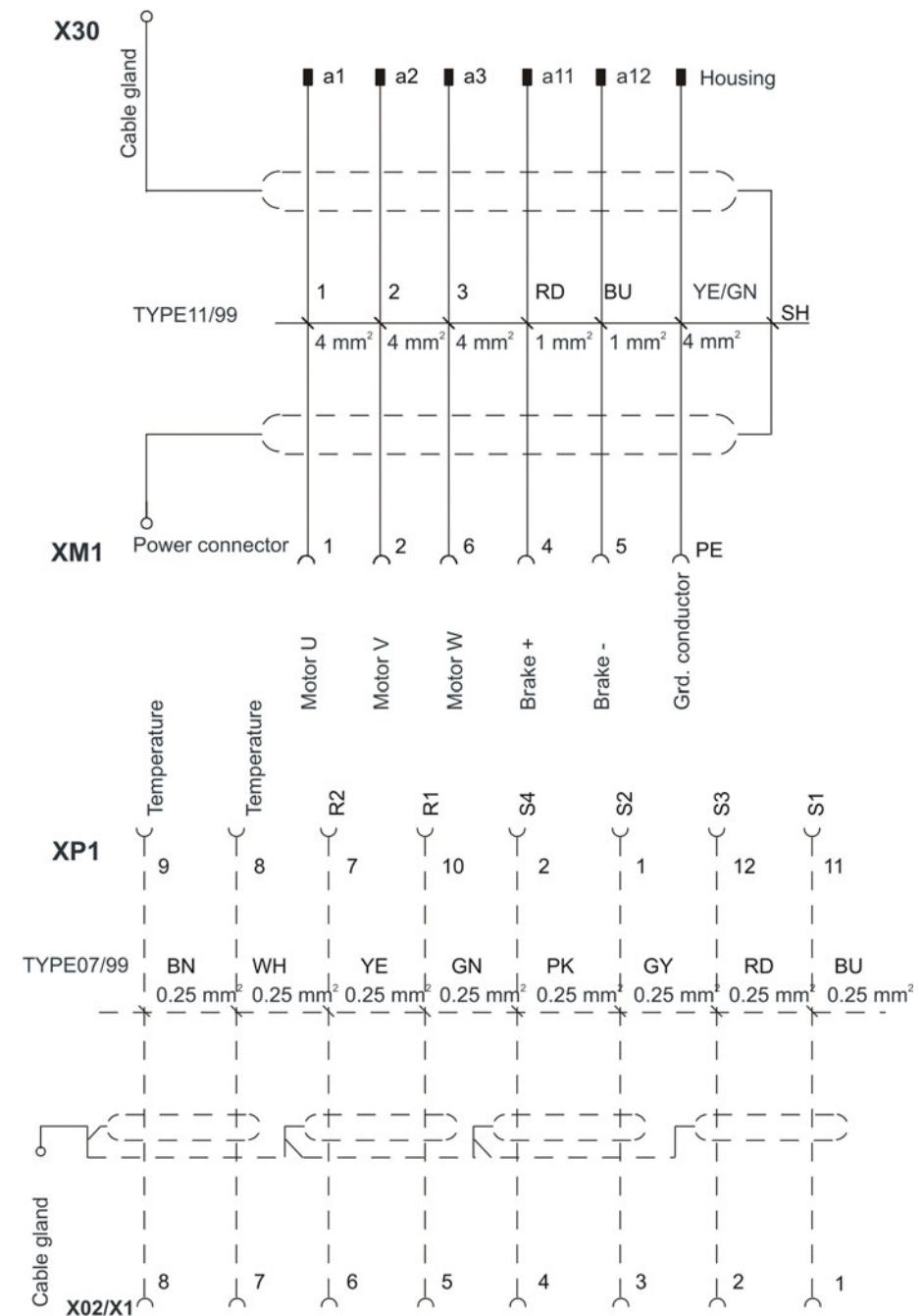


Fig. 11-38: Wiring diagram, axis 1

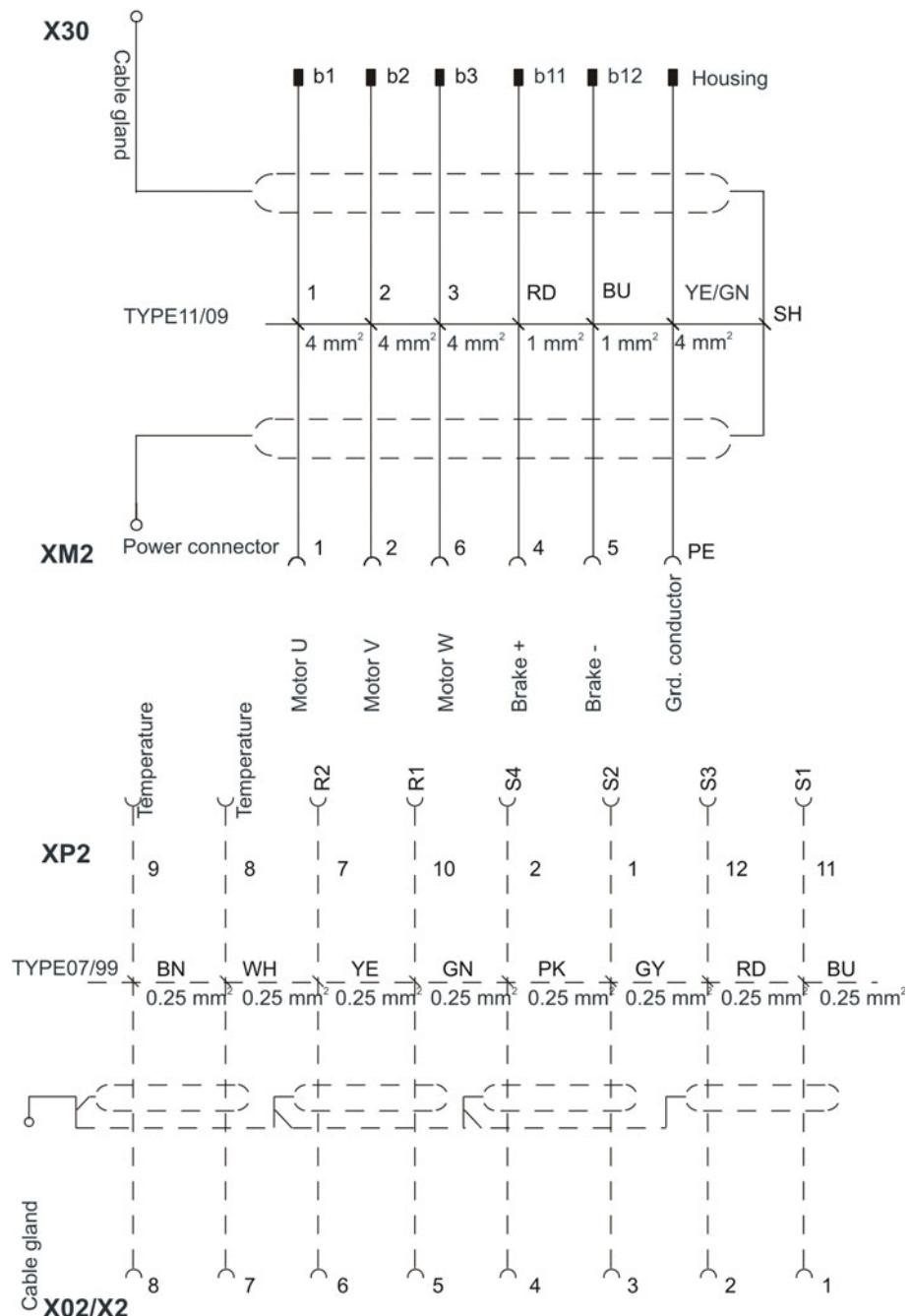


Fig. 11-39: Wiring diagram, axis 2

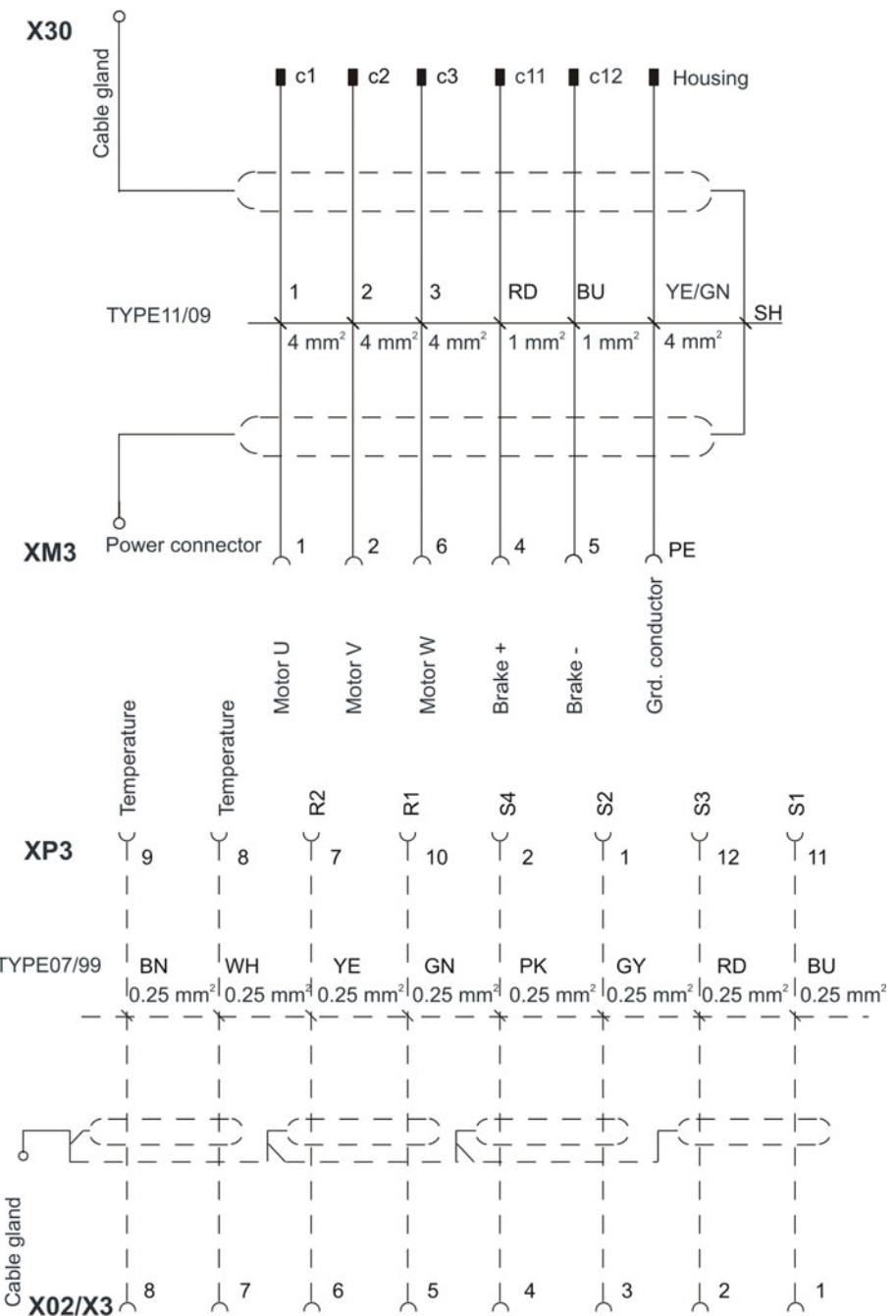


Fig. 11-40: Wiring diagram, axis 3

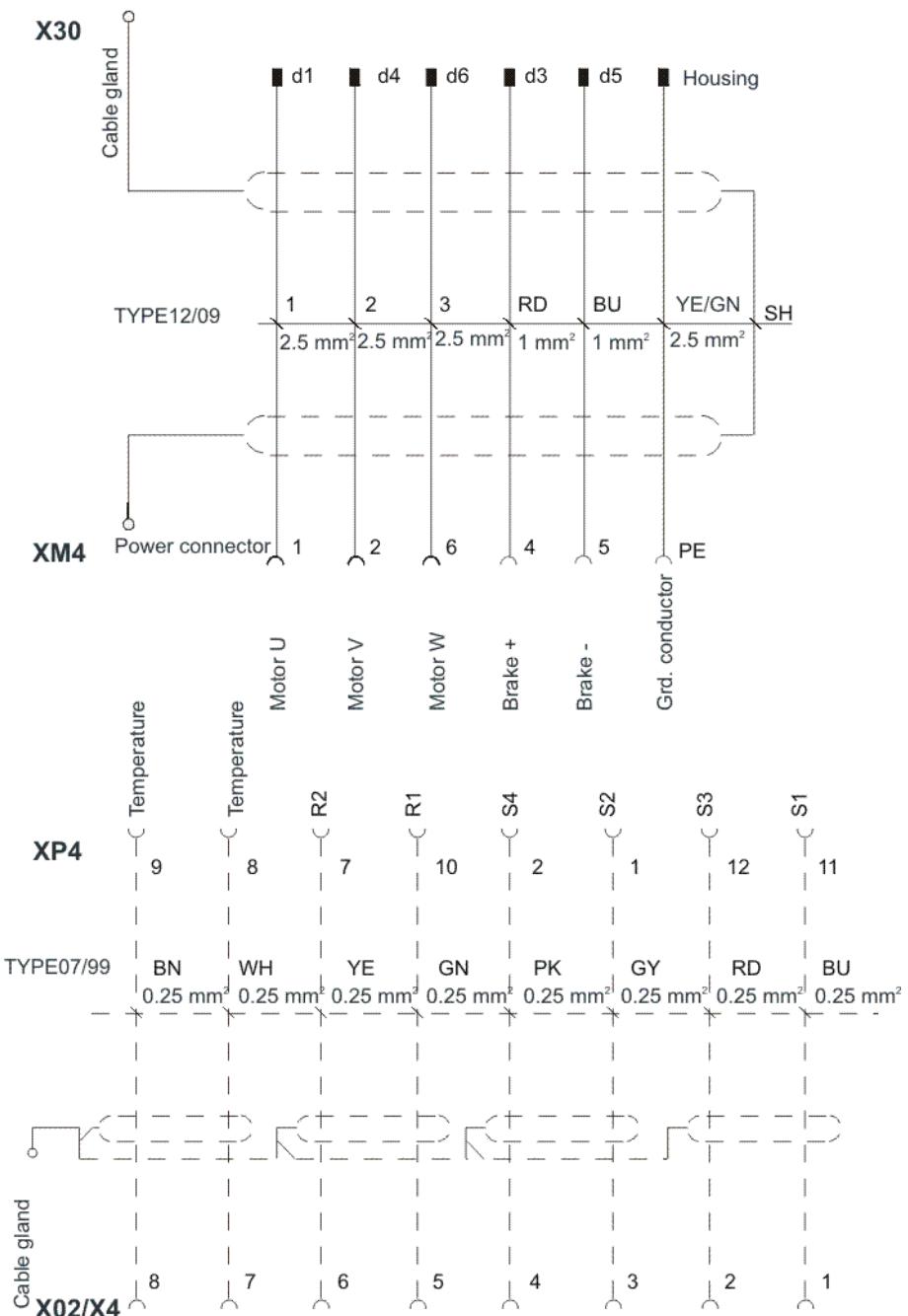


Fig. 11-41: Wiring diagram, axis 4

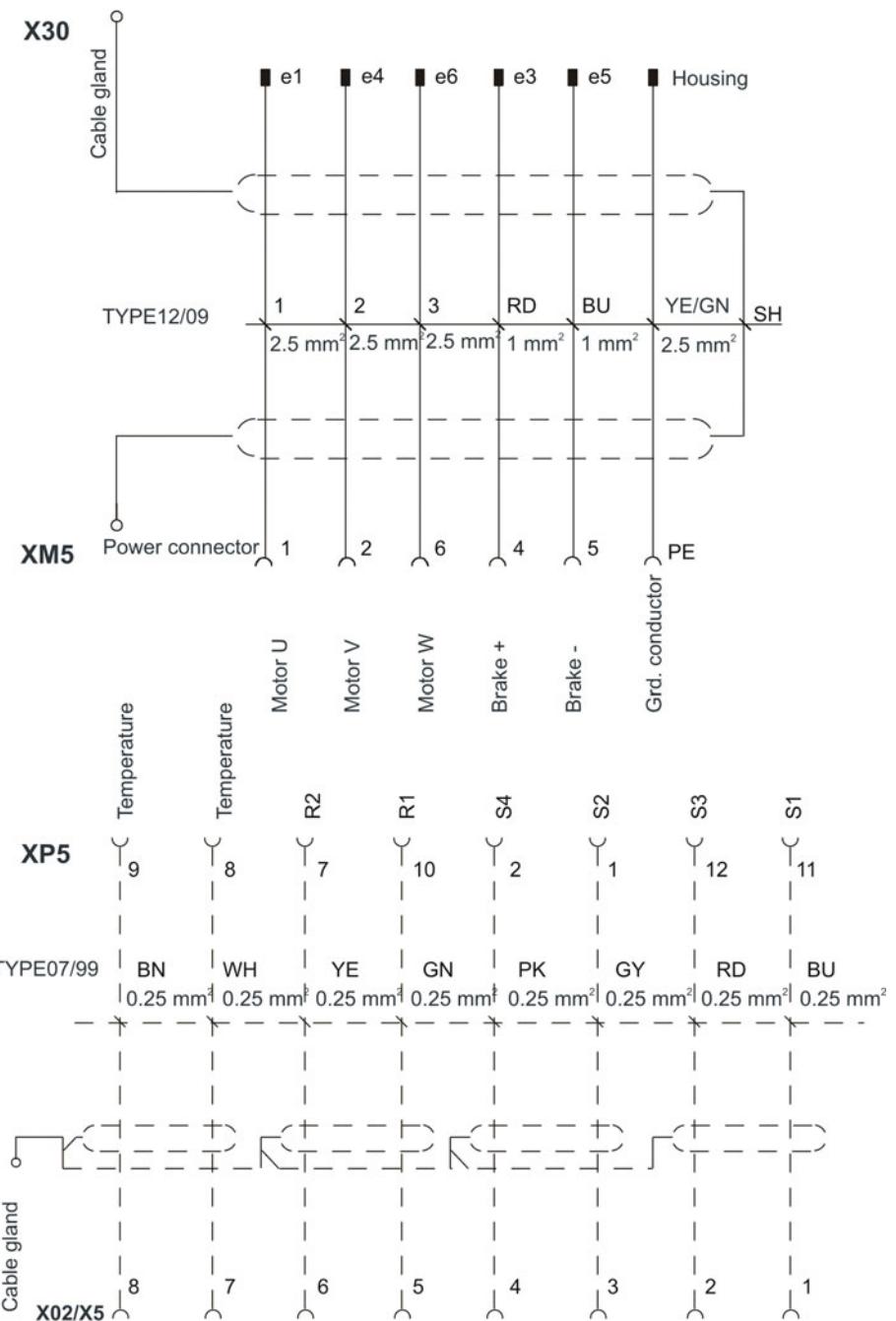


Fig. 11-42: Wiring diagram, axis 5

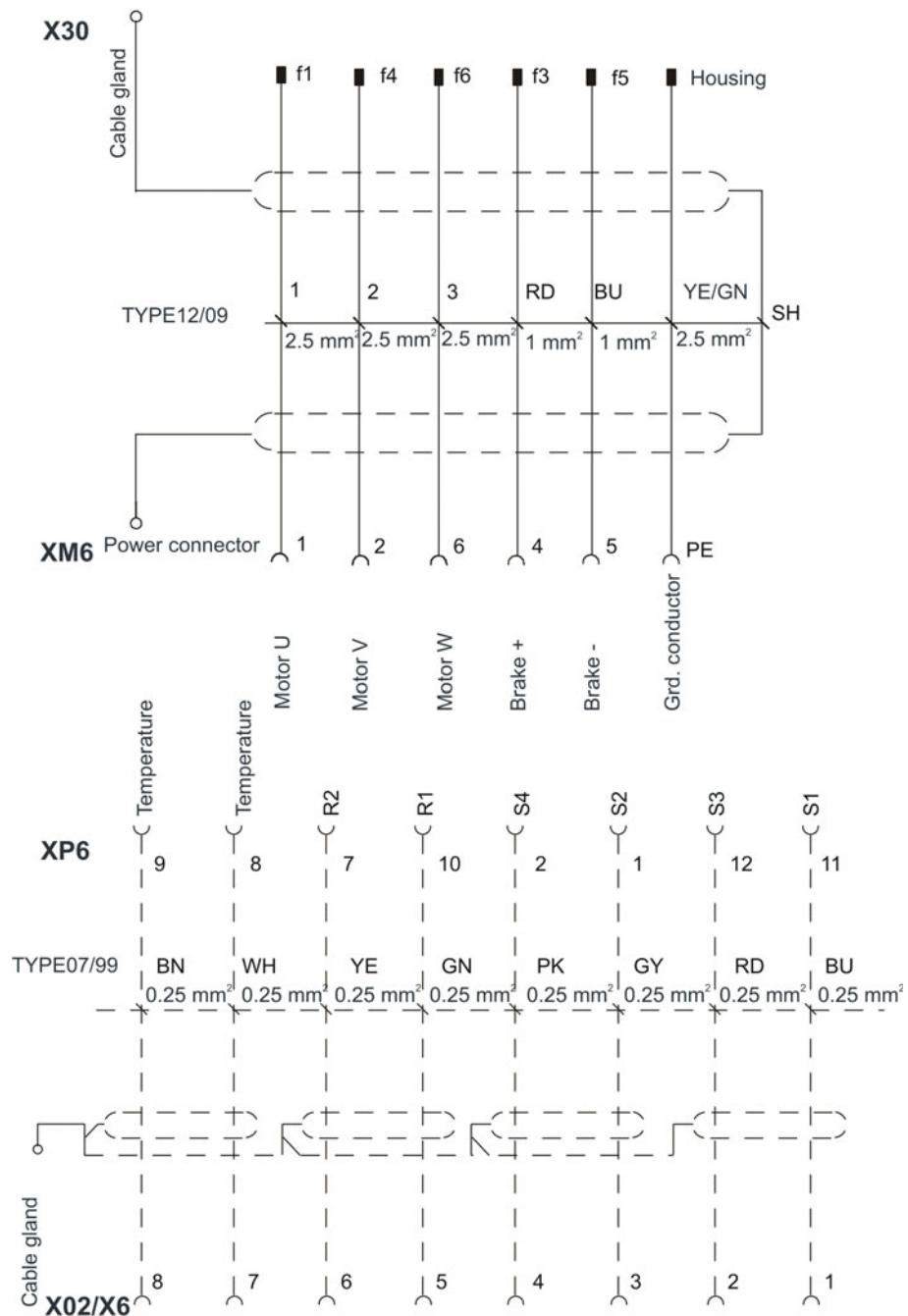


Fig. 11-43: Wiring diagram, axis 6

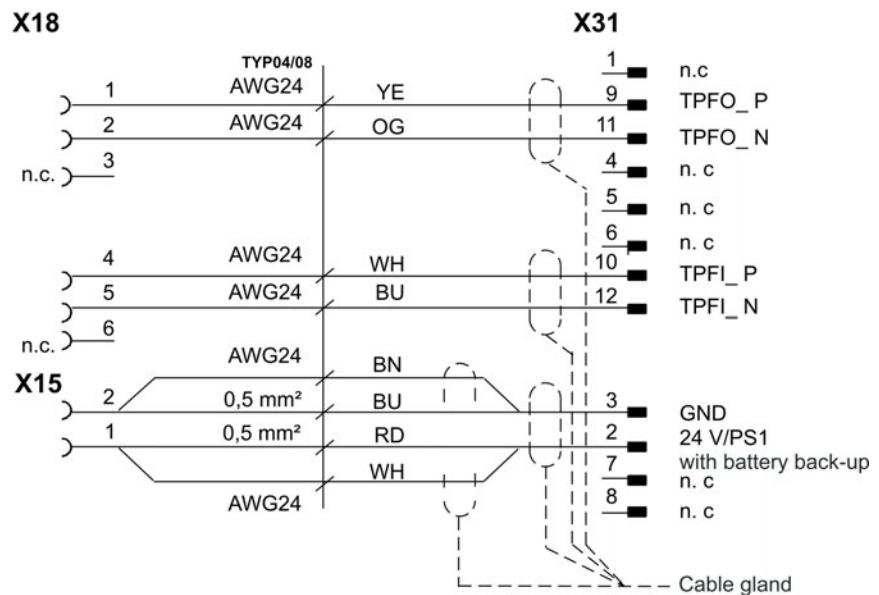


Fig. 11-44: Wiring diagram, RDC X31

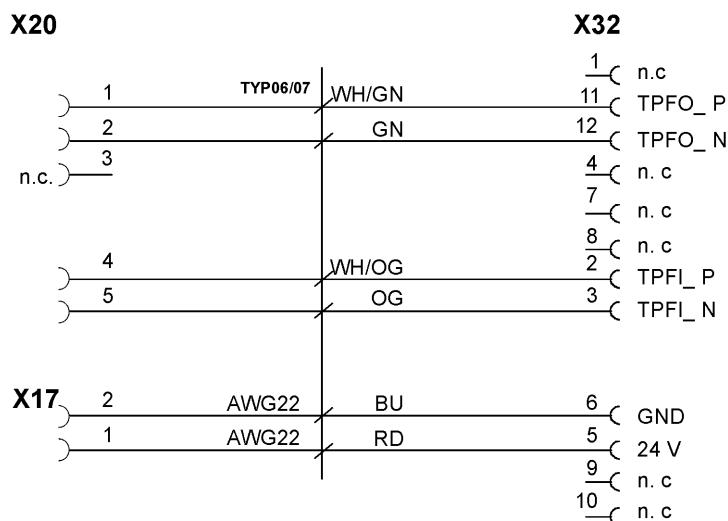
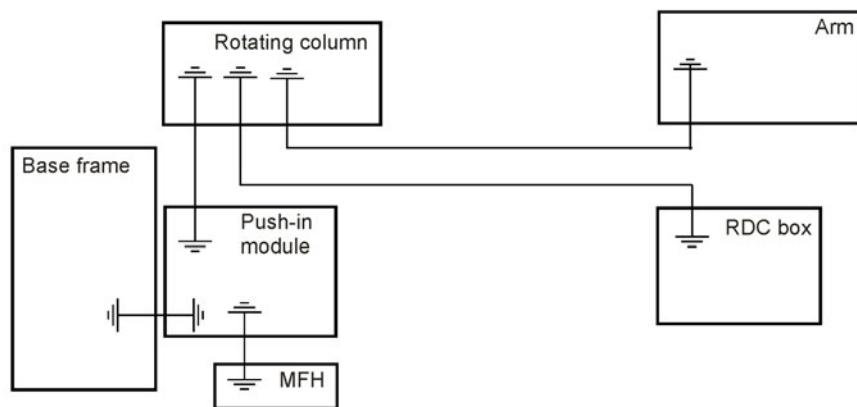


Fig. 11-45: Wiring diagram, RDC X32



All ground conductor cross-sections 10 mm²

Fig. 11-46: Wiring diagram, protective circuit

12 Decommissioning, storage and disposal

12.1 Decommissioning, floor-mounted robots

Description This section describes all the work required for decommissioning the robot if the robot 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 robot can be transported by means of transport tackle and crane or by fork lift truck.

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

WARNING When carrying out the following work, the robot must be moved several times between the individual work steps. While work is being carried out on the robot, it must always be secured by activating the EMERGENCY STOP device. Unintentional robot motions can cause injuries and damage to property. If work is carried out on an operational robot that is switched on, the robot must only be moved at reduced velocity. It must be possible to stop the robot at any time by activating an EMERGENCY STOP device. Operation must be limited to what is absolutely necessary. Warn all persons concerned before switching on and moving the robot.

1. Secure the robot.
2. Remove tools and equipment.
3. Put the robot into operation and move it into the transport position ([>>> Fig. 12-1](#)).

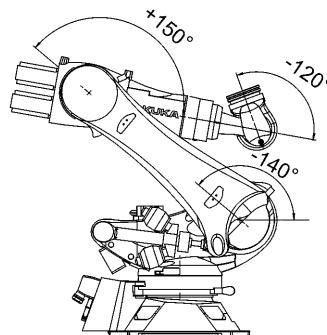


Fig. 12-1: Transport position

4. Secure the robot by activating the E-STOP device and then shut down the robot ([>>> Fig. 12-2](#)).
5. Release and unplug all peripheral connections.
6. Release and unplug the motor cable and data cable connectors.
7. Unscrew the hexagon nut from the ground conductor, take off the washers and lock washers and pull off the ground conductor.
8. Shut off compressed air supply to the robot, disconnect the hose and remove it from the pressure regulator; F variant only.
9. Attach lifting tackle to the robot or prepare the robot for transportation with the fork lift truck . Minimum payload capacity for transportation: approx. 2.0 t.

If, due to its installation position, it is not possible to lift the robot with a fork lift truck or with a crane and lifting tackle, the "Recovery aid" accessory (00-187-214) is available as an option.

10. Unscrew and remove the 8 hexagon bolts and conical spring washers.
11. Lift the robot vertically off the mounting surface and transport it away.
Take care not to damage the two pins when lifting off the robot.

⚠ CAUTION

If the robot is caught on the mounting surface, it may come free abruptly, endangering persons and property. The robot must stand loosely on the mounting surface; completely remove all fastening materials and any adhesives.

12. Prepare the robot for storage.

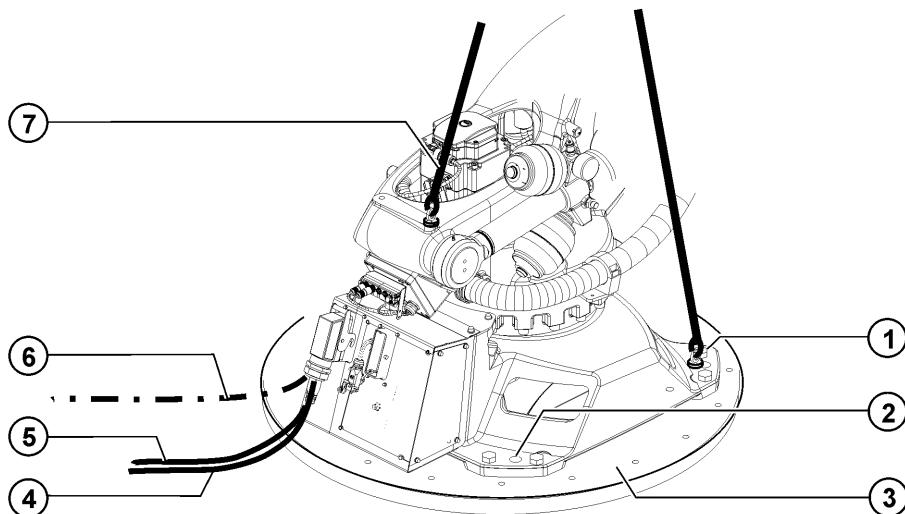


Fig. 12-2: Removing the robot

- | | |
|--------------------|-------------------------|
| 1 Hexagon bolts | 5 Data cable |
| 2 Pin | 6 Ground conductor (2x) |
| 3 Mounting surface | 7 Lifting tackle |
| 4 Motor cable | |

12.2 Decommissioning, ceiling-mounted robots

Description

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

The robot can only be transported by fork lift truck after removal.

Preconditions

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

Procedure

⚠ WARNING

When carrying out the following work, the robot must be moved several times between the individual work steps. While work is being carried out on the robot, it must always be secured by activating the EMERGENCY STOP device. Unintentional robot motions can cause injuries and damage to property. If work is carried out on an operational robot that is switched on, the robot must only be moved at reduced velocity. It must be possible to stop the robot at any time by activating an EMERGENCY STOP device. Operation must be limited to what is absolutely necessary. Warn all persons concerned before switching on and moving the robot.

1. Secure the robot.

2. Remove tools and equipment.
3. Put the robot into operation and move it into the transport position (**>>>** Fig. 12-3).

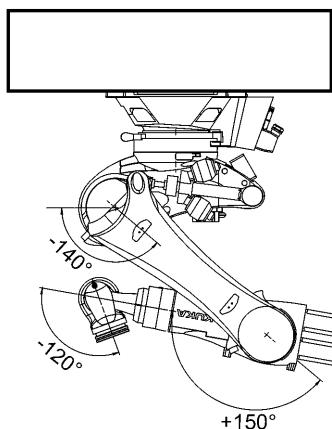


Fig. 12-3: Transport position

4. Secure the robot by activating the E-STOP device and then shut down the robot (**>>>** Fig. 12-4).
5. Release and unplug all peripheral connections.
6. Release and unplug the motor cable and data cable connectors.
7. Unscrew the hexagon nut from the ground conductor, take off the washers and lock washers and pull off the ground conductor.
8. Shut off compressed air supply to the robot, disconnect the hose and remove it from the pressure regulator; F variant only.
9. Move the forks of the fork lift truck into the fork slots in the base frame and press the robot against the ceiling. The fork lift truck must support the weight of the robot. Minimum payload capacity of the fork lift truck: approx. 2.0 t.
10. Slacken the 8 hexagon bolts with conical spring washers until the conical spring washers are free.
11. Lower the robot a few millimeters.



CAUTION If the robot is caught on the mounting surface, it may come free abruptly, endangering persons and property. The robot must stand loosely on the mounting surface; completely remove all fastening materials and any adhesives.

12. Completely remove the 8 hexagon bolts and conical spring washers.
13. Lower the robot vertically and transport it away.
Take care not to damage the two pins when lowering the robot.
14. Mount the robot in the transport frame.
15. Insert 4 M24x65-8.8 hexagon bolts with conical spring washers. Continue pressing the robot against the transport frame until all of the hexagon bolts have been inserted and tightened with a torque wrench.
4 of the 8 fastening bolts are inaccessible due to the fork lift truck. These must be inserted and tightened afterwards.
16. Prepare the robot for storage.

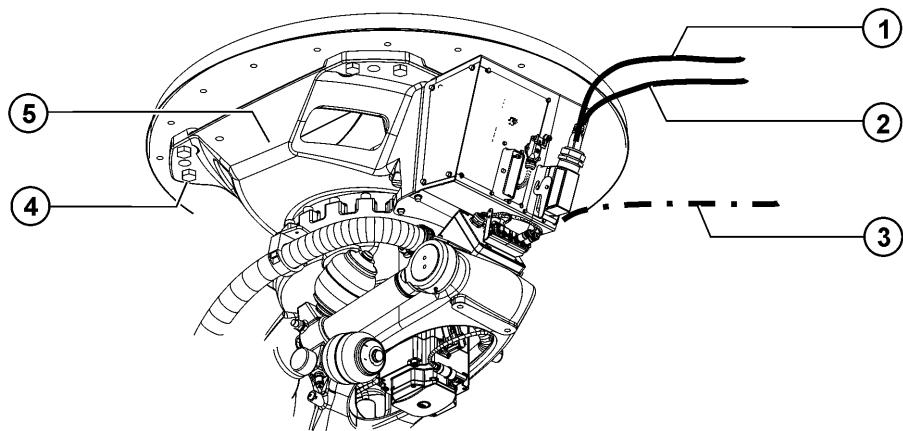


Fig. 12-4: Removing the robot

- | | |
|-------------------------|-----------------|
| 1 Motor cable | 4 Hexagon bolts |
| 2 Data cable | 5 Base frame |
| 3 Ground conductor (2x) | |

12.3 Storage

Description

If the robot 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 robot, especially ones that might knock against other parts.
- Do not leave the robot exposed to direct sunlight while in storage.
- Observe and comply with the permissible temperature ranges for storage.
- Select a storage location in which the packaging materials cannot be damaged.

Procedure

1. Remove tools and equipment.
2. Remove the robot.
3. Clean and dry the robot. No dirt or cleaning agent residue may remain on or in the robot.
4. Perform a visual inspection of the robot.
5. Remove any foreign bodies.
6. Remove any corrosion.
7. Attach all covers to the robot and check that the seals are correctly in place.
8. Seal off electrical connections with suitable covers.
9. Seal hose connections by suitable means.
10. Cover the robot with plastic film and seal it at the base frame against dust. If necessary, add a desiccant beneath the sheeting.

12.4 Disposal

When the manipulator 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 manipulator. All plastic components are marked with a material designation and must be disposed of accordingly.

Material	Subassembly, component	Additional information
Metals		
Cast-iron material	Base frame, rotating column, link arm, wrist main body	
Copper	Cables, wires	
Light alloy casting	In-line wrist housing, spur gear housing, swivel housing, arm	
Steel	Gear units, screws and washers	
Electrical components		
	Electronic components, such as RDC, EDS, etc.	Recycle.
	Motors	Dispose of motors without dismantling.
Plastics		
ETFE	Flexible tube, protective fabric sleeve	
PA 6, PA R AB	Hinged clamps, flexible tubes	
PE 500	End stop buffers	
PU	Hoses	
PUR	Cable sheaths	
Vition, FKM, FPM	O-rings	
Auxiliary substances and consumables		
Gear oil	Gear units, arctic variant	Optigear Synthetic RO 32
Gear oil	Counterbalancing system, arctic variant	Shell Spirax S1 ATF TASA
Gear oil	Gear units, HO variant	Tribol FoodProof 1800/320
Hydraulic oil	Counterbalancing system	Castrol Hyspin ZZ 46
Lubricating grease	Counterbalancing system, bearing on rotating column / link arm; arctic variant	CERAN LT
Lubricating grease	Counterbalancing system, bearing on rotating column / link arm	LGEP 2
Lubricating grease	Gear teeth	Microlube GL 261
Lubricating grease	Cabling	Optitemp RB 2

Material	Subassembly, component	Additional information
Lubricant for food machinery	Cabling, HO variant	Klüberfood NH1 34-401
Lubricating oil	Gear units	RV OIL SB150

NOTICE

The oil "Tribol FoodProof 1800" must not be mixed with other greases or oils because this can lead to undesirable side-effects on disposal.

Up-to-date safety data sheets must be requested from the manufacturers of auxiliary and operating materials .

13 Options

13.1 Mounting flange, adapter (optional)

Description

This mounting flange (adapter) ([>>> Fig. 13-1](#)) can be fitted on the 150/180/210 kg in-line wrist to convert it to a mounting flange with D=160. This enables e.g. tools to be used which are dimensioned for the in-line wrist with the D=160 mounting flange. The design of the flange also allows mounting of the holder A6 of the energy supply systems A3-A6.

When this adapter is mounted, the distance between the intersection of A4/A5 and the face of the mounting flange is offset forward by 25 mm.

The reference point for the load center of gravity remains unchanged and thus corresponds to the values for the in-line wrist IW 150/180/210. The design of the adapter is similar to DIN/ISO 9409-1-A.

The mounting flange is depicted ([>>> Fig. 13-1](#)) with axes 4 and 6 in the zero position. The symbol X_m indicates the position of the locating element (bushing) in the zero position.

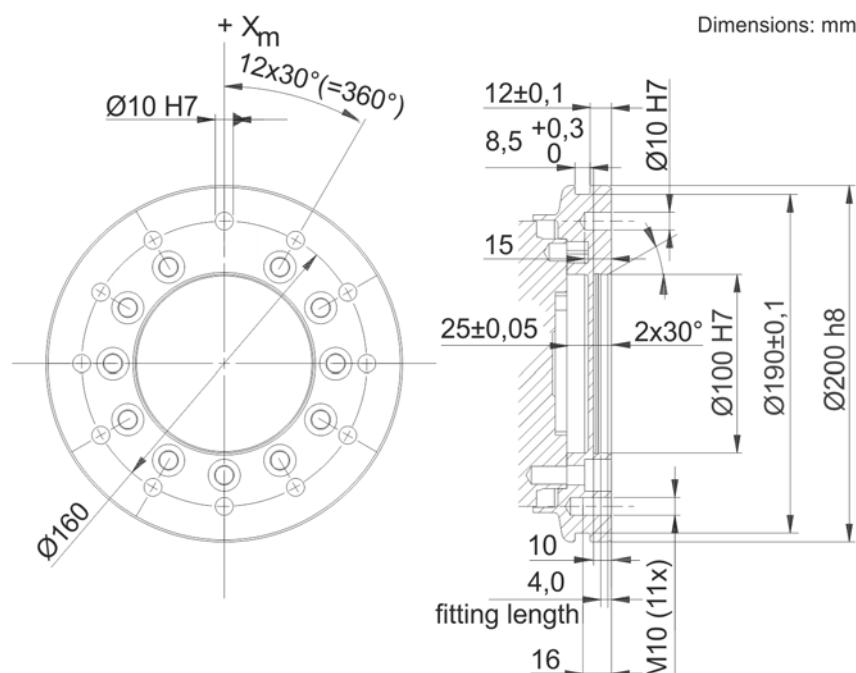


Fig. 13-1: Mounting flange, adapter

1 Fitting length

Mounting flange, adapter	IW 150/180/210 to IW 210/240
Hole circle	160 mm
Screw grade	10.9
Screw size	M10
Number of fastening threads	11
Clamping length	1.5 x nominal diameter
Depth of engagement	min. 12 mm, max. 16 mm
Locating element	10 H7

13.2 Control cable for single axis (optional)

Description	The control cable for single axis is used when additional axes (e.g. KUKA linear unit or turntables) are controlled via the robot. In this case, the control cable is guided from the RDC box through the hollow shaft of axis 1 to a connector interface on the push-in module.
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13.3 Release device (optional)

Description	<p>The release device can be used to move the manipulator manually after an accident or malfunction. The release device can be used for the motors of axes 1 to 5. It cannot be used for axis 6, as this motor is not accessible. It is only for use in exceptional circumstances and emergencies (e.g. for freeing people).</p> <p>The release device is mounted on the base frame of the manipulator. This assembly also includes a ratchet and a set of plates with one plate for each motor. The plate specifies the direction of rotation for the ratchet and shows the corresponding direction of motion of the manipulator.</p>
-------------	--

14 Appendix

14.1 Tightening torques

Tightening torques

The following tightening torques (Nm) are valid for screws and nuts where no other specifications are given.

The specified values apply to lightly oiled black (e.g. phosphated) and coated (e.g. mech. galv., zinc flake plating) screws and nuts.

Thread	Strength class		
	8.8	10.9	12.9
M1.6	0.17 Nm	0.24 Nm	0.28 Nm
	0.35 Nm	0.48 Nm	0.56 Nm
M2.5	0.68 Nm	0.93 Nm	1.10 Nm
M3	1.2 Nm	1.6 Nm	2.0 Nm
M4	2.8 Nm	3.8 Nm	4.4 Nm
M5	5.6 Nm	7.5 Nm	9.0 Nm
M6	9.5 Nm	12.5 Nm	15.0 Nm
M8	23.0 Nm	31.0 Nm	36.0 Nm
M10	45.0 Nm	60.0 Nm	70.0 Nm
M12	78.0 Nm	104.0 Nm	125.0 Nm
M14	125.0 Nm	165.0 Nm	195.0 Nm
M16	195.0 Nm	250.0 Nm	305.0 Nm
M20	370.0 Nm	500.0 Nm	600.0 Nm
M24	640.0 Nm	860.0 Nm	1030.0 Nm
M30	1330.0 Nm	1700.0 Nm	2000.0 Nm

Thread	Strength class	
	8.8 ISO7991 Allen screw	10.9 ISO7380, ISO07381 Fillister head screw
M3	0.8 Nm	0.8 Nm
M4	1.9 Nm	1.9 Nm
M5	3.8 Nm	3.8 Nm

Thread	Strength class	
	10.9 DIN7984 pan head screws	
M4	2.8 Nm	

Tighten M5 domed cap nuts with a torque of 4.2 Nm.

14.2 Tightening torque for stainless steel screws

Tightening torques for stainless steel screws

The tightening torques (Nm) specified here are valid for stainless steel screws and nuts where no other specifications are given.

The specified values are valid for lightly oiled screws and nuts.

Screw size	Stainless steel A4-80	Stainless steel A2-70 and A4- 70	Stainless steel A2-50
M3	1.0	0.8	0.4
M4	2.4	1.9	0.9
M5	4.8	3.8	1.9
M6	8.0	6.4	3.1
M8	19.5	15.5	7.5
M10	38.5	30.5	15.0
M12	66.0	52.0	25.5
M14	106.0	84.0	41.0
M16	165.0	130.0	64.0
M20	320.0	253.0	125.0
M24	557.0	441.0	217.0
M30	1107.0	876.0	--

14.3 Auxiliary and operating materials used

Product designation	Use	Manufacturer designation/Address
Tribol Foodproof 1800/220	Gear oil	Deutsche BP Aktiengesellschaft - Industrial Lubricants & Services Erkelenzer Strasse 20 D-41179 Mönchengladbach Germany
Castrol Hyspin ZZ 46	Hydraulic oil	Deutsche Castrol Vertriebsgesellschaft mbH Max-Born-Str. 2 D-22761 Hamburg Germany
LGEP 2	Lubricating grease	SKF Maintenance Products Postboks 1008 NL-3430 BA Nieuwegein Netherlands
Microlube GL 261	Lubricating grease	Klüber Lubrication München AG Geisenhausenerstr. 7 D-81379 München Germany
Olit CLS	Lubricating grease	Deutsche BP Aktiengesellschaft - Industrial Lubricants & Services Erkelenzer Straße 20 D-41179 Mönchengladbach Germany

Optitemp RB 2	Lubricating grease	Deutsche BP Aktiengesellschaft - Industrial Lubricants & Services Erkelenzer Straße 20 D-41179 Mönchengladbach Germany
RV OIL SB150	Lubricating oil	Kyodo Yushi Co., Ltd. 2-2-30 Tsujido Kandai Fujisawa-shi, Kanagawa 251-8588 Japan



To ensure safe use of our products, we recommend regularly requesting up-to-date safety data sheets from the manufacturers of auxiliary and operating materials.

14.4 Information sheet for products

Section 1 Designation of the product and of the company

- Product identifier:
 - Trade name:
KUKA industrial robot with counterbalancing system (≤ 0.5 kg of nitrogen)
- Relevant identified use of the product that is advised against:
No further relevant information available.
- Use of the product:
Robot for industrial use
- Details of the supplier providing the information sheet:

Manufacturer/supplier:	KUKA Deutschland GmbH
Address:	Zugspitzstrasse 140
Postal code:	D-86165 Augsburg
Country:	Germany
Phone:	+49 821 797 4000
Fax:	+49 821 797 40400
e-mail	info@kuka-roboter.de
Department for information:	KUKA Roboter GmbH Quality Assurance department +49 821 797 1747
Information in case of emergency:	During normal operating hours +49 821 797 1747

- Note on the information sheet for products:

There is no legal obligation to create a safety data sheet for a product. In order to make information typically contained in a safety data sheet available for products, however, the present "Information Sheet for Products" was created.

Your attention is expressly drawn to the fact that the information sheet for products is an information sheet created voluntarily that is not subject to the formal requirements of Regulation (EC) No. 1907/2006 (REACH Regulation).

Section 2 Possible hazards

- Classification of the substance or mixture:
 - Classification acc. to Regulation (EC) No. 1272/2008 (CLP Regulation):

This product is not classified according to the CLP Regulation.
- Classification acc. to Directive 67/548/EEC or Directive 1999/45/EC:

Not applicable
- Particular safety warnings for persons and the environment:

Not applicable
- Classification system:

Not applicable
- Label elements

Labeling acc. to Regulation (EC) No. 1272/2008 (CLP Regulation):	Not applicable
Hazard symbol:	Not applicable
Signal word:	Not applicable
Hazard statements:	Not applicable

- Other hazards
 - Results of PBT and vPvB assessment

PBT	Not applicable
vPvB	Not applicable

Section 3

Composition / Information about the components

- Chemical characterization:

Mixtures

 - Description:

Robot for industrial use
- Hazardous components:

The robot is equipped with a counterbalancing system, filled with **nitrogen of an amount less than or equal to 0.5 kg**.

CAS: 7727-37-9 EINECS: 231-783-9	Nitrogen	Press. Gas, H281 
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The exact wording of the hazard statements listed above can be found in section 16 (**>>>** "Section 16" Page 242).

Section 4

First aid measures

- Description of first aid measures:
 - General information:

No special measures required.
- Most important symptoms and effects, both acute and delayed:

No further relevant information available.
- Indication of any immediate medical attention and special treatment needed:

No further relevant information available.

Section 5**Fire-fighting measures**

- Extinguishing agents:

Suitable extinguishing agents:	Adjust the fire-extinguishing measures to suit the environment.
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- Special hazards arising from the substance or mixture:

No further relevant information available.

- Advice for firefighters:

- Special protective equipment:

No special measures required.

Section 6**Measures after unintended release**

- Personal precautions, protective equipment and emergency procedures:

Not required

- Environmental protection measures:

No special measures required.

- Methods and material for containment and cleaning up:

No special measures required.

- Reference to other sections

For information on safe handling, see section 7 ([>>> "Section 7"](#)
Page 239).

For information on personal protective equipment, see section 8
([>>> "Section 8"](#) Page 239).

For information on disposal, see section 13 ([>>> "Section 13"](#) Page 241).

Section 7**Handling and storage**

- Precautions for safe handling:

No special measures required.

- Instructions relating to fire and explosion protection:

No special measures required.

- Conditions for safe storage, including any incompatibilities:

- Storage

Requirements regarding storage rooms and containers:	No special requirements
Information on storage with other products:	Not required
Further specifications concerning storage conditions:	None

- Specific end uses:

No further relevant information available.

Section 8**Limitation and monitoring of exposure / Personal protective equipment**

- Additional information for the design of technical systems:

No further specifications, see section 7 ([>>> "Section 7"](#) Page 239).

- Control parameters

Components with applicable occupational exposure limit values:

The product contains no relevant amounts of materials that are subject to monitoring of limit values in the workplace.

- Limitation and monitoring of exposure:
 - Personal protective equipment:

Respiratory protection:	Not required
Hand protection:	Chemical protective gloves are not required.
Eye protection:	Not required

Section 9**Physical and chemical properties**

- Information on basic physical and chemical properties:
 - General information

Form:	Solid
Color:	As per product description
Odor:	Odorless
Melting point/range:	Not determined
Flash point:	Not applicable
Auto-ignition:	The product does not auto-ignite.
Risk of explosion:	The product presents no danger of explosion.
Density:	Not determined
Solubility/miscibility in water:	Insoluble
Additional information:	No further information available.

Section 10**Stability and reactivity**

- Possibility of hazardous reactions:
 - No hazardous reactions known.
- Conditions to be avoided
 - No relevant information available.
- Incompatible materials
 - No further relevant information available.
- Hazardous decomposition products
 - No hazardous decomposition products known.

Section 11**Toxicological information**

- Information on toxicological effects:
 - Acute toxicity:

Primary irritation effect on skin:	No irritation
Primary irritation effect on eyes:	No irritation
Sensitization:	No sensitizing effect known.
Additional toxicological information:	The product is not subject to labeling obligations due to the method of calculation in the latest version of the "EC General Classification Directive for Preparations".

Section 12**Ecological information**

- Toxicity:
 - Aquatic toxicity: No further relevant information available.
- Persistence and degradability:
 - No further relevant information available.

- Bioaccumulative potential:
No further relevant information available.
- Mobility in soil:
No further relevant information available.
- Additional ecological information:
General information: No known hazard to water.
- Results of PBT and vPvB assessment:

PBT	Not applicable
vPvB	Not applicable

- Other adverse effects:
No further relevant information available.

Section 13**Disposal information**

- Waste treatment methods:
Recommendation: Speak with manufacturer regarding recycling.
- Contaminated packaging:
Recommendation: Disposal in accordance with the applicable regulations.

Section 14**Transport information**

- UN number
 - ADR, RID, ADN:
Not subject to the provisions [subsection 1.1.3.1.b)]
 - IMDG code, IATA:
UN 3363
- UN proper shipping name:
 - IMDG code:
DANGEROUS GOODS IN MACHINERY, exceeding limited quantities
 - IATA:
DANGEROUS GOODS IN MACHINERY
- Transport hazard classes:
 - ADR, RID, ADN:
Not applicable
 - IMDG code:



Class:	9 Miscellaneous dangerous substances and articles.
Hazard label:	9
Marine pollutants:	No
EMS number:	F-A, S-P
Shipping:	Shipping approval of the German Federal Institute for Materials Research and Testing (BAM)

- IATA:



Class:	9 Miscellaneous dangerous substances and articles.
Hazard label:	9
Shipping:	Packaging instructions 962

- Packaging group:
Not applicable
- UN "Model Regulation":
UN 3363 DANGEROUS GOODS IN MACHINERY, 9

NOTICE: Shipping acc. to IMDG Code (sea freight) or IATA (air freight) only after consultation with KUKA Deutschland GmbH!

NOTICE: Robot with empty counterbalancing system is not subject to the regulations on dangerous goods!

Section 15

Regulatory information

- Chemical safety assessment:
Chemical safety assessment has not been performed.

Section 16

Other information

The information given is based on our present knowledge. However, this shall not constitute a guarantee for any specific product characteristics and shall not establish a legally valid contractual relationship.

- Relevant phrases:
H281: Contains refrigerated gas; may cause cryogenic burns or injury

15 KUKA Service

15.1 Requesting support

Introduction This documentation provides information on operation and operator control, and provides assistance with troubleshooting. For further assistance, please contact your local KUKA subsidiary.

Information **The following information is required for processing a support request:**

- Description of the problem, including information about the duration and frequency of the fault
- As comprehensive information as possible about the hardware and software components of the overall system

The following list gives an indication of the information which is relevant in many cases:

- Model and serial number of the kinematic system, e.g. the manipulator
- Model and serial number of the controller
- Model and serial number of the energy supply system
- Designation and version of the system software
- Designations and versions of other software components or modifications
- Diagnostic package KRCDiag
 - Additionally for KUKA Sunrise: Existing projects including applications
 - For versions of KUKA System Software older than V8: Archive of the software (KRCDiag is not yet available here.)
- Application used
- External axes used

15.2 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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