



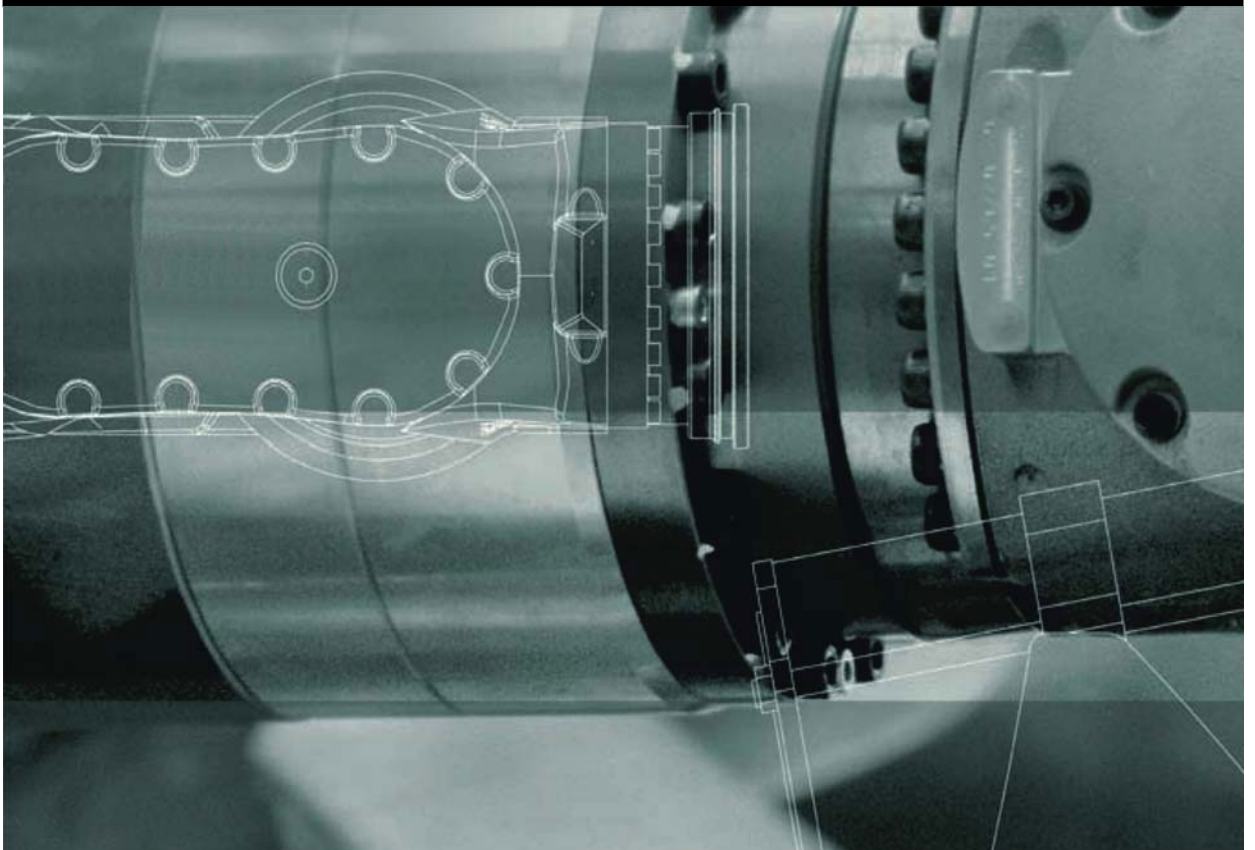
Robots

KUKA Roboter GmbH

KR 20-3

With C Variants

Assembly Instructions



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Version: MA KR 20-3 V1



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

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

Subject to technical alterations without an effect on the function.

Translation of the original documentation

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

Hints

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 or 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.:

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

NOTICE

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

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 Roboter 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 product family (model) KR 20-3 comprises the robot variants:

- KR 20-3
- KR 20-3 C

An industrial robot of this product family comprises the following components:

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

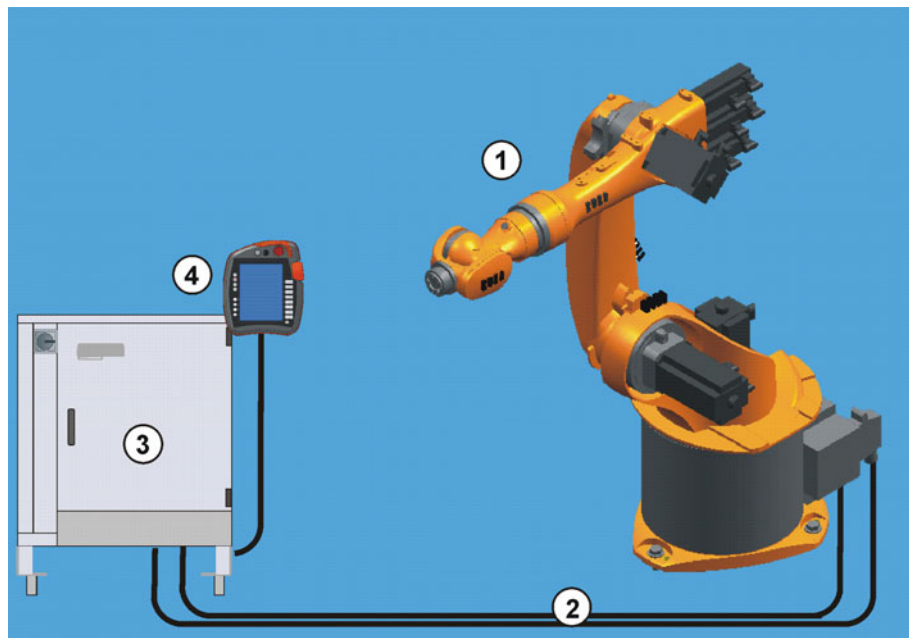


Fig. 3-1: Example of a robot system

- | | |
|---------------------|-------------------------------------|
| 1 Manipulator | 3 Robot controller |
| 2 Connecting cables | 4 Teach pendant KCP (KUKA smartPAD) |

3.2 Description of the manipulator

Overview

The manipulators (manipulator = robot arm and electrical installations) (>>> Fig. 3-2) of the KR 20-3 model 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

- Electrical installations

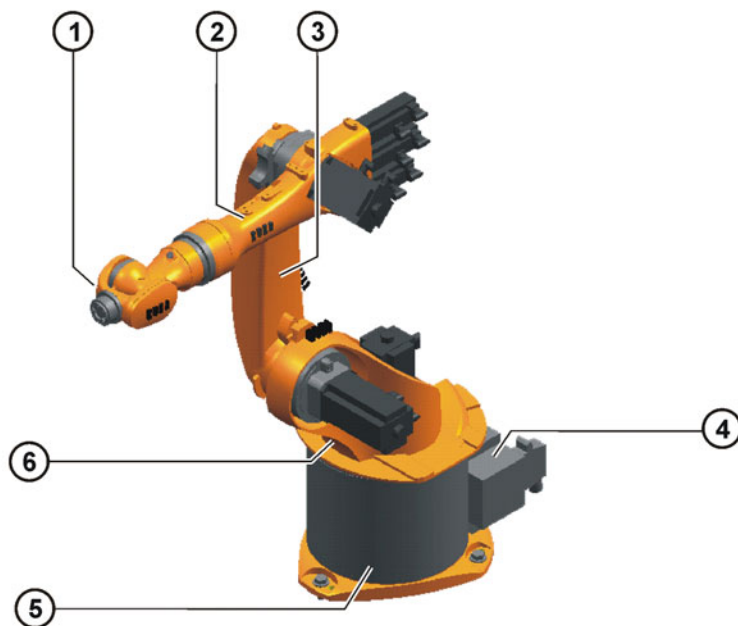


Fig. 3-2: Main assemblies of the manipulator

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

In-line wrist

The robot can be equipped with a triple-axis in-line wrist for a payload of 20 kg. The in-line wrist is screwed to the arm via the flange. End effectors are attached to the mounting flange of axis 6. Each axis has a measuring device, through which the mechanical zero of the respective axis can be checked by means of an electronic probe (accessory) and transferred to the controller. Directions of rotation, axis data and permissible loads can be found in Chapter (>>> 4 "Technical data" Page 13).

The in-line wrist is driven by the motors on the rear of the arm by means of toothed belts (A4 and A5) and shafts. The drive power within the in-line wrist is transmitted by means of bevel and spur gear units.

The mounting flange conforms, with minimal deviations, to ISO 9409-1:2004.

Arm

The arm of this robot variant is designed as a cast hollow structural element with interfaces to the in-line wrist and link arm. The interfaces are screwed connections. The coaxial, one-piece drive shafts for axes 4 to 6 are mounted in the arm housing. Wrist axes A4 and A5 are driven by the wrist axis motors (drive units) via toothed belts, while axis A6 is driven directly via a push-fit connection.

The three drive units for the wrist axes are located at the rear of the arm housing and are arranged one above the other.

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.

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.

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 installed in the base frame.

Also located on the base frame are the junction boxes for the motor and data cable and the energy supply system.

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 and MFH with the connectors for the motor and data 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. The ground conductors to the robot are connected to the base frame by means of ring cable lugs and threaded pins.

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, or working range limitation systems for A1. The options are described in separate documentation.

4 Technical data

4.1 Technical data, KR 20-3

4.1.1 Basic data, KR 20-3

Basic data

	KR 20-3
Number of axes	6
Number of controlled axes	6
Volume of working envelope	14.5 m ³
Pose repeatability (ISO 9283)	± 0.05 mm
Weight	approx. 254 kg
Rated payload	20 kg
Maximum reach	1611 mm
Protection rating	IP65
Protection rating, in-line wrist	IP65
Sound level	< 75 dB (A)
Mounting position	Floor
Footprint	575 mm x 535 mm
Permissible angle of inclination	≤ 5 °
Default color	Moving parts: KUKA orange 2567; Base frame cover: black (RAL 9005)
Controller	KR C4
Transformation name	KR C4: KR20_3 C4 FLR ZH16_2

Ambient conditions

Humidity class	3k3, DIN EN 60721-3-3
Ambient temperature	
During operation	5 °C to 55 °C (278 K to 328 K)
During storage/transportation	-40 °C to 60 °C (233 K to 333 K)

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”.

4.1.2 Axis data, KR 20-3

Axis data

Range of motion	
A1	$\pm 185^\circ$
A2	$-155^\circ / 35^\circ$
A3	$-130^\circ / 154^\circ$
A4	$\pm 350^\circ$
A5	$\pm 130^\circ$
A6	$\pm 350^\circ$
Speed with rated payload	
A1	156 °/s
A2	156 °/s
A3	156 °/s
A4	330 °/s
A5	332 °/s
A6	616 °/s

The direction of motion and the arrangement of the individual axes may be noted from the following diagram.

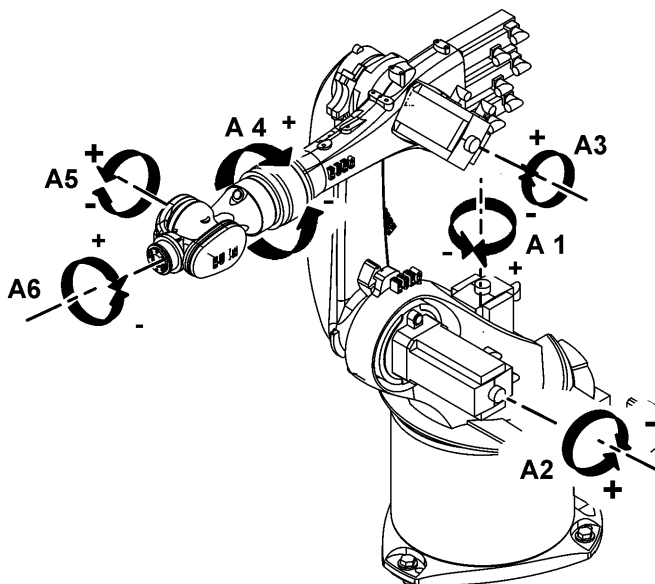


Fig. 4-1: Direction of rotation of robot axes

Mastering positions

Mastering position	
A1	0 °
A2	-90 °
A3	90 °
A4	0 °
A5	0 °
A6	0 °

Working envelope

The following diagrams show the shape and size of the working envelope for these variants of this product family.

The reference point for the working envelope is the intersection of axes 4 and 5.

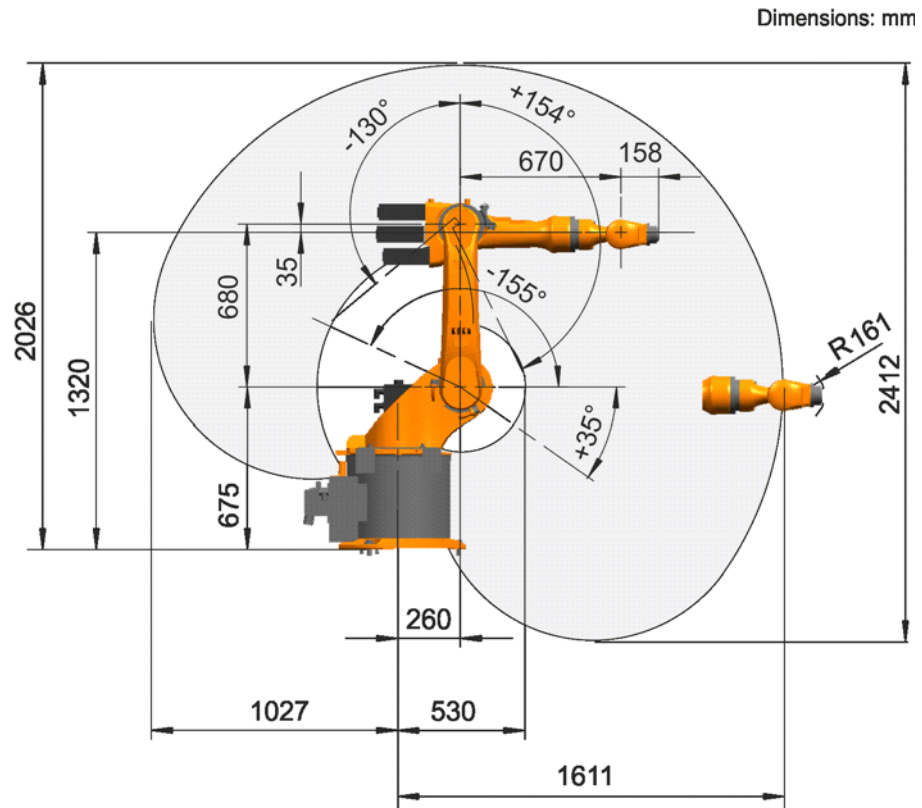


Fig. 4-2: Work envelope, side view, KR 20-3

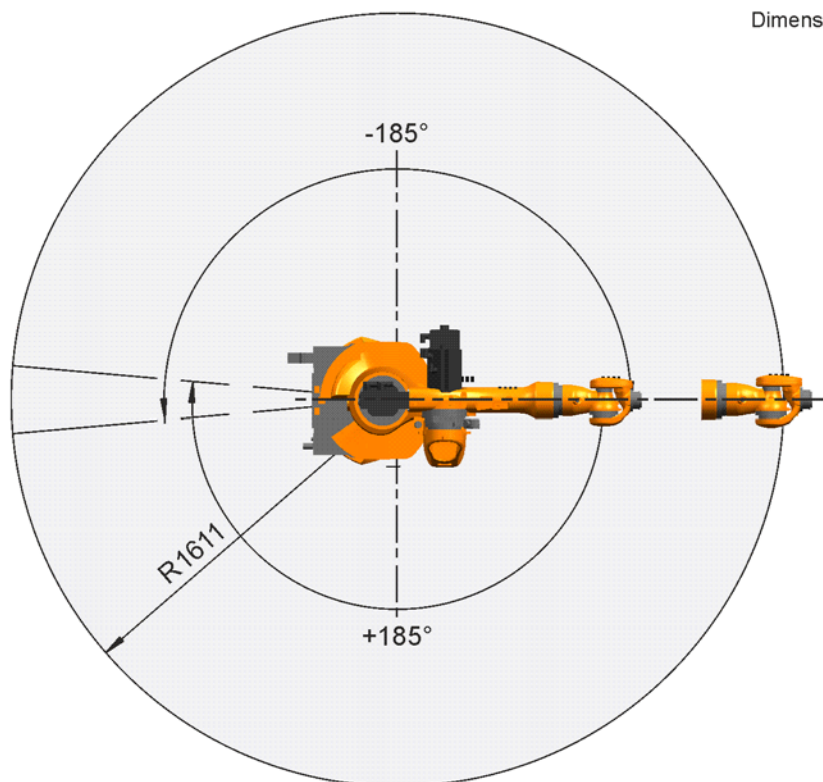


Fig. 4-3: Work envelope, top view, KR 20-3

4.1.3 Payloads, KR 20-3

Payloads

Rated payload	20 kg
Rated mass moment of inertia	0.36 kgm ²
Rated total load	30 kg
Rated supplementary load, base frame	0 kg
Maximum supplementary load, base frame	0 kg
Rated supplementary load, rotating column	0 kg
Maximum supplementary load, rotating column	20 kg
Rated supplementary load, link arm	0 kg
Maximum supplementary load, link arm	20 kg
Rated supplementary load, arm	10 kg
Maximum supplementary load, arm	10 kg
Nominal distance to load center of gravity	
Lxy	100 mm
Lz	120 mm

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.

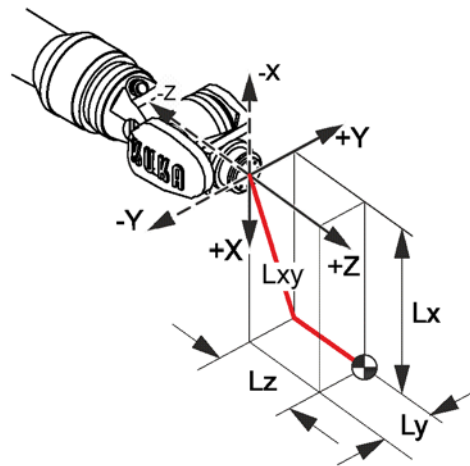


Fig. 4-4: Load center of gravity

Payload diagram

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 the KUKA Roboter 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!

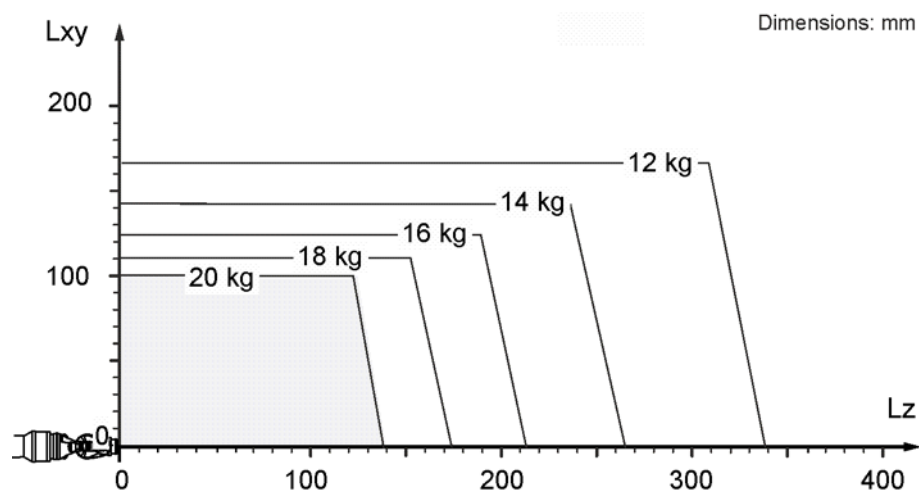


Fig. 4-5: Payload diagram

In-line wrist

In-line wrist type	ZH16-2
Mounting flange	see drawing

Mounting flange

Mounting flange (hole circle)	50 mm
Screw grade	10.9
Screw size	M6
Number of fastening threads	7
Grip length	1.5 x nominal diameter

Depth of engagement	min. 6 mm, max. 10 mm
Locating element	6 ^{H7}

The mounting flange is depicted 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.

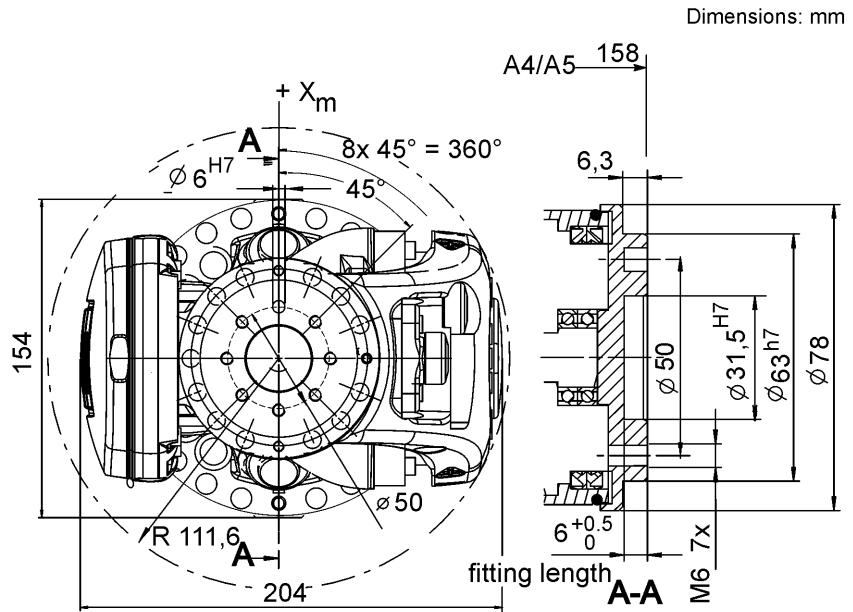


Fig. 4-6: Mounting flange, IW 16

Supplementary load

The robot can carry supplementary loads on the arm, link arm and rotating column. 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.

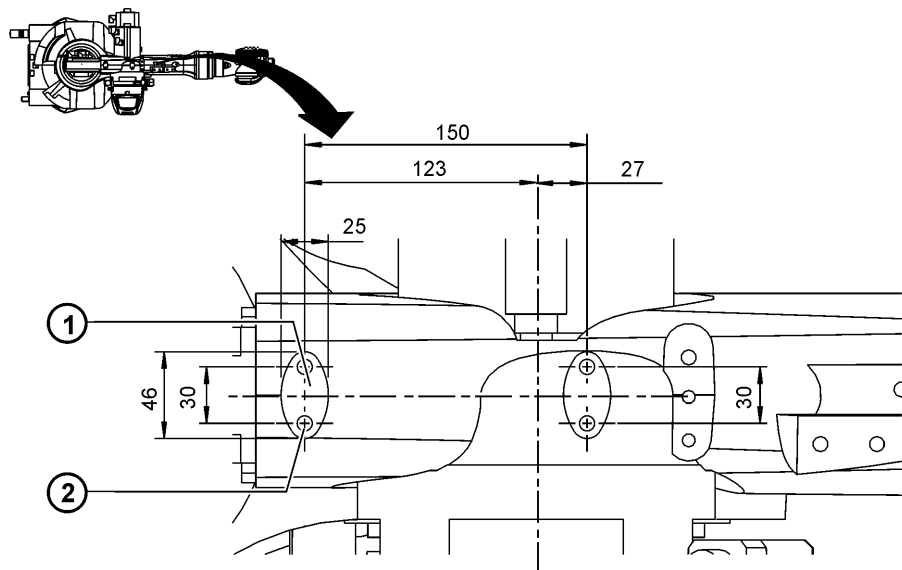


Fig. 4-7: Fastening the supplementary load on the arm

- 1 Mounting surface
- 2 Fastening threads: M8, 12 deep

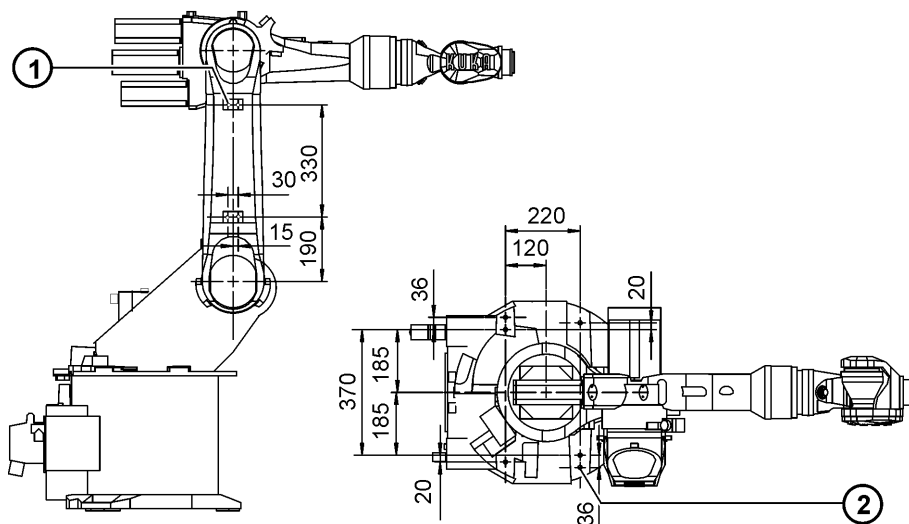


Fig. 4-8: Fastening the supplementary load on the link arm/rotating column

- 1 Fastening threads: M8, 8 deep, 4x
- 2 Fastening threads: M12, 18 deep, 6x

4.1.4 Loads acting on the foundation, KR 20-3

Loads acting on the foundation

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

Vertical force F(v)	
F(v normal)	3400 N
F(v max)	4600 N
Horizontal force F(h)	
F(h normal)	1650 N
F(h max)	5000 N
Tilting moment M(k)	
M(k normal)	3250 Nm
M(k max)	5200 Nm
Torque about axis 1 M(r)	
M(r normal)	2550 Nm
M(r max)	4200 Nm

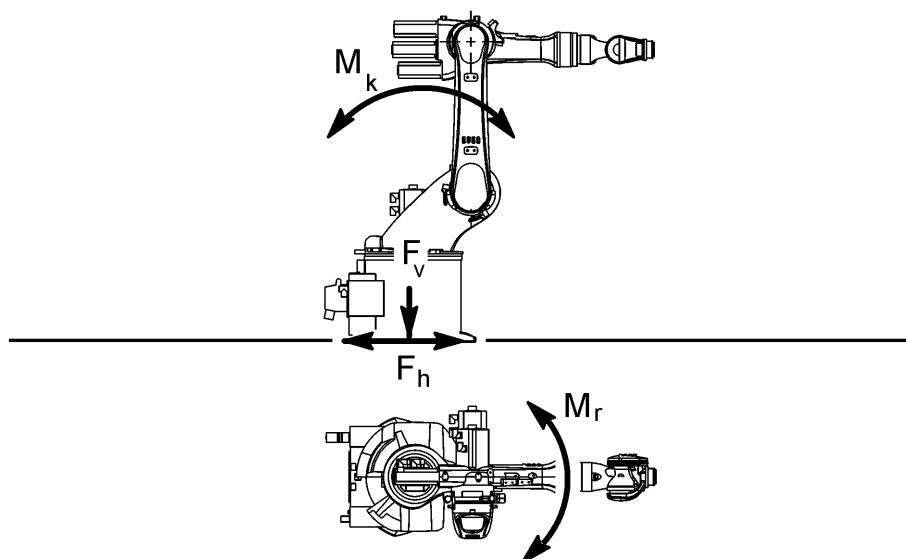


Fig. 4-9: Loads acting on the foundation, floor

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 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 .

4.2 Technical data, KR 20-3 C

4.2.1 Basic data, KR 20-3 C

Basic data

	KR 20-3 C
Number of axes	6
Number of controlled axes	6
Volume of working envelope	14.5 m ³
Pose repeatability (ISO 9283)	± 0.05 mm
Weight	approx. 254 kg
Rated payload	20 kg
Maximum reach	1611 mm
Protection rating	IP65
Protection rating, in-line wrist	IP65
Sound level	< 75 dB (A)
Mounting position	Ceiling
Footprint	575 mm x 535 mm
Permissible angle of inclination	≤ 0 °
Default color	Moving parts: KUKA orange 2567; Base frame cover: black (RAL 9005)

	KR 20-3 C
Controller	KR C4
Transformation name	KR C4: KR20_3 C\$ CLG ZH16_2

Ambient conditions

Humidity class	3k3, DIN EN 60721-3-3
Ambient temperature	
During operation	5 °C to 55 °C (278 K to 328 K)
During storage/transportation	-40 °C to 60 °C (233 K to 333 K)

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".

4.2.2 Axis data, KR 20-3 C**Axis data**

Range of motion	
A1	±185 °
A2	-155 ° / 35 °
A3	-130 ° / 154 °
A4	±350 °
A5	±130 °
A6	±350 °
Speed with rated payload	
A1	156 °/s
A2	156 °/s
A3	156 °/s
A4	330 °/s
A5	332 °/s
A6	616 °/s

The direction of motion and the arrangement of the individual axes may be noted from the following diagram.

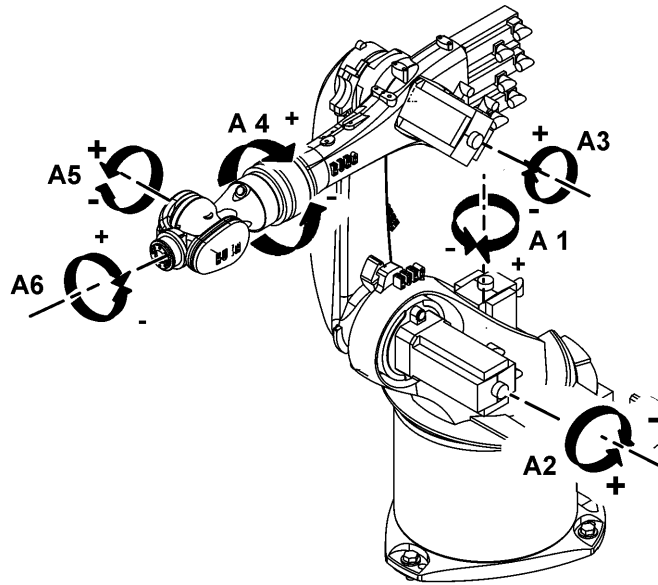


Fig. 4-10: Direction of rotation of robot axes

Mastering positions

Mastering position	
A1	0 °
A2	-90 °
A3	90 °
A4	0 °
A5	0 °
A6	0 °

Working envelope

The following diagrams show the shape and size of the working envelope for these variants of this product family.

The reference point for the working envelope is the intersection of axes 4 and 5.

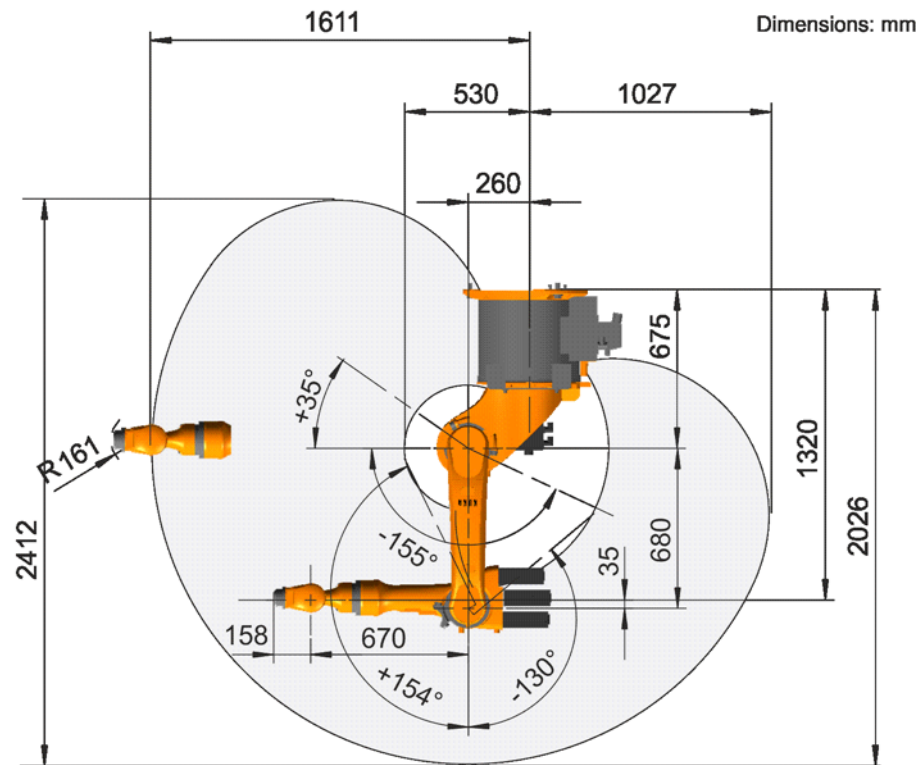


Fig. 4-11: Working envelope, side view, KR 20-3 C

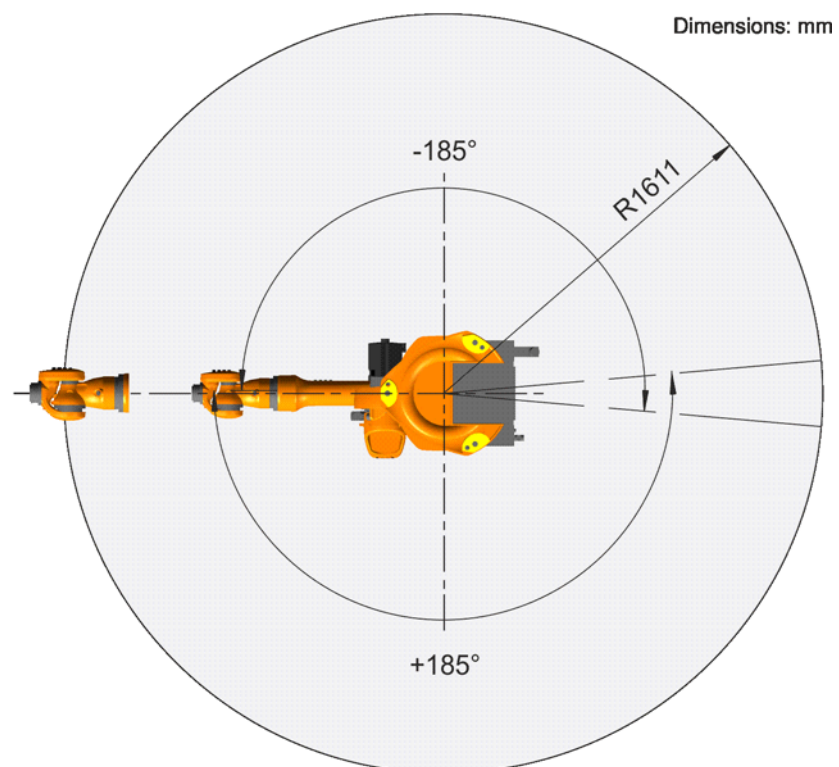


Fig. 4-12: Work envelope, top view, KR 20-3 C

4.2.3 Payloads, KR 20-3 C

Payloads

Rated payload	20 kg
Rated mass moment of inertia	0.36 kgm ²

Rated total load	30 kg
Rated supplementary load, base frame	0 kg
Maximum supplementary load, base frame	0 kg
Rated supplementary load, rotating column	0 kg
Maximum supplementary load, rotating column	20 kg
Rated supplementary load, link arm	0 kg
Maximum supplementary load, link arm	20 kg
Rated supplementary load, arm	10 kg
Maximum supplementary load, arm	10 kg
Nominal distance to load center of gravity	
Lxy	100 mm
Lz	120 mm

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.

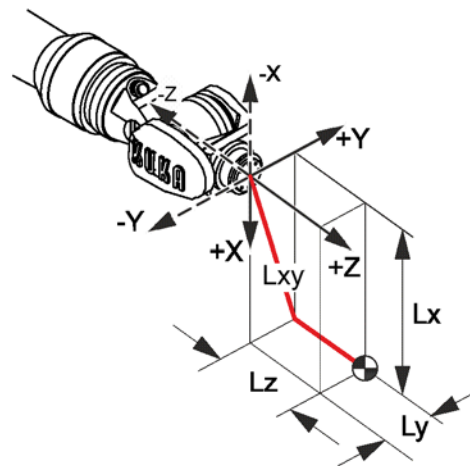


Fig. 4-13: Load center of gravity

Payload diagram

NOTICE	<p>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 the KUKA Roboter GmbH must be consulted beforehand.</p> <p>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.</p> <p>The mass inertia must be verified using KUKA.Load. It is imperative for the load data to be entered in the robot controller!</p>
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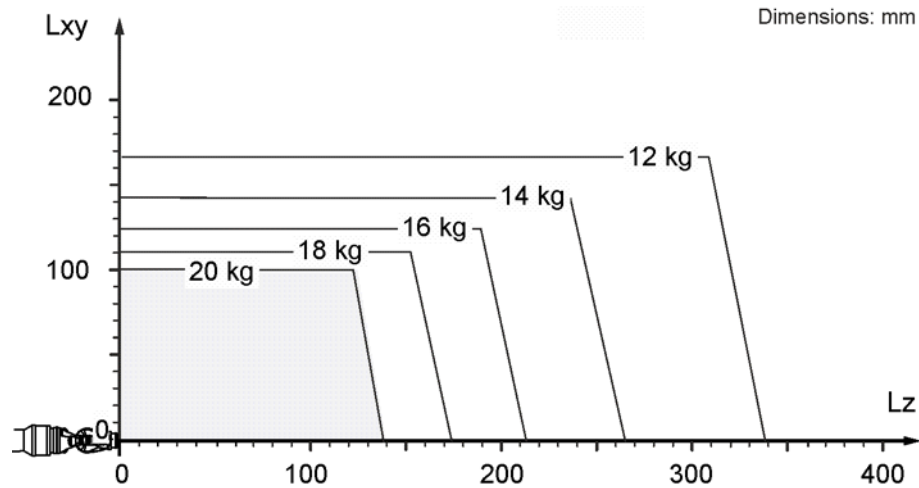


Fig. 4-14: Payload diagram

In-line wrist

In-line wrist type	ZH16-2
Mounting flange	see drawing

Mounting flange

Mounting flange (hole circle)	50 mm
Screw grade	10.9
Screw size	M6
Number of fastening threads	7
Grip length	1.5 x nominal diameter
Depth of engagement	min. 6 mm, max. 10 mm
Locating element	6 ^{H7}

The mounting flange is depicted 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.

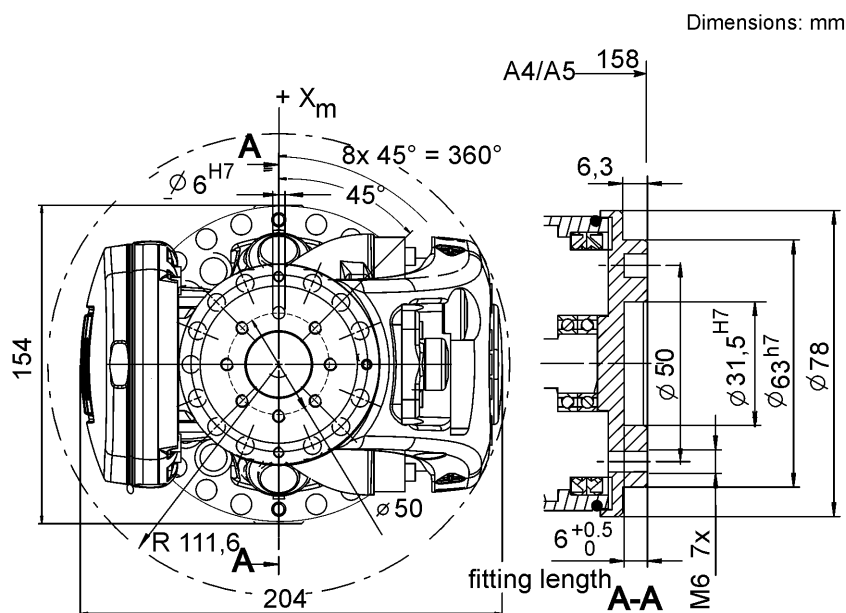


Fig. 4-15: Mounting flange, IW 16

Supplementary load

The robot can carry supplementary loads on the arm, link arm and rotating column. 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.

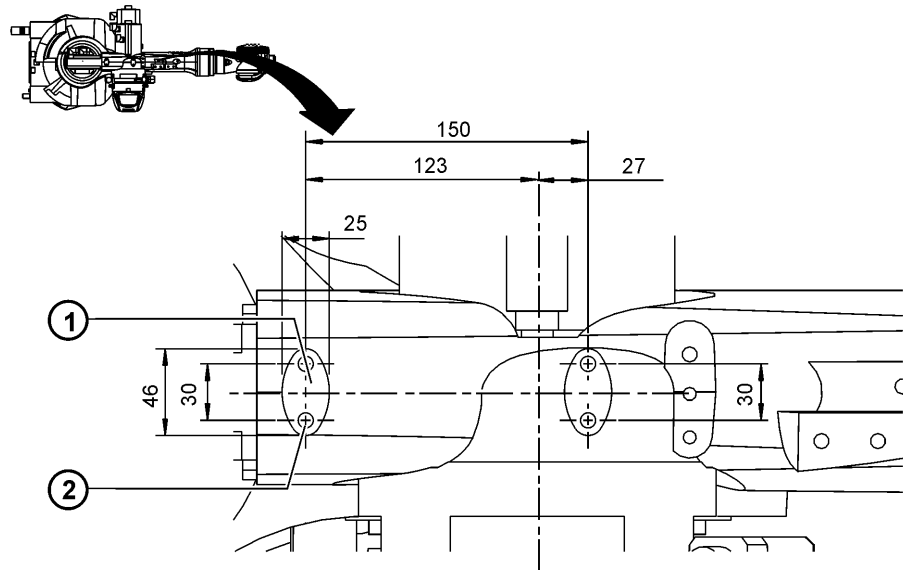


Fig. 4-16: Fastening the supplementary load on the arm

- 1 Mounting surface
- 2 Fastening threads: M8, 12 deep

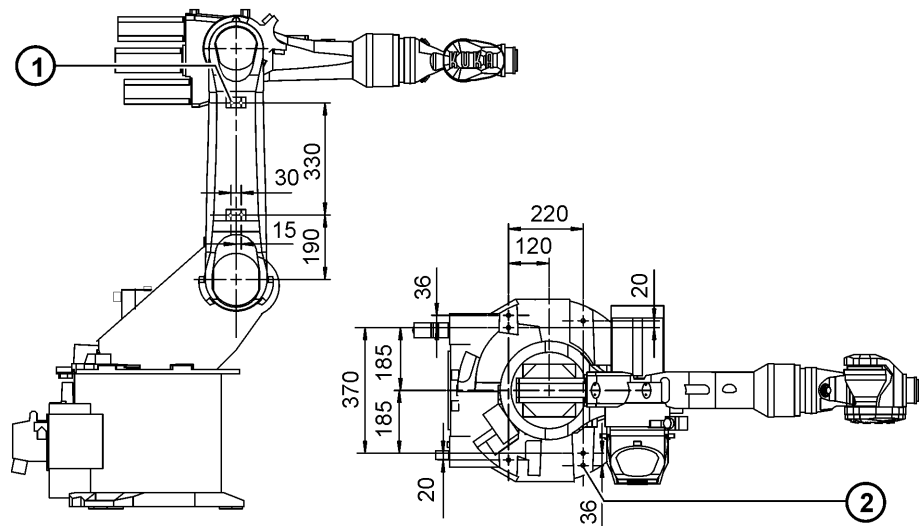


Fig. 4-17: Fastening the supplementary load on the link arm/rotating column

- 1 Fastening threads: M8, 8 deep, 4x
- 2 Fastening threads: M12, 18 deep, 6x

4.2.4 Loads acting on the foundation, KR 20-3 C

Loads acting on the foundation

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

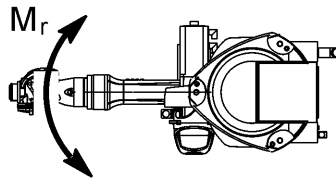
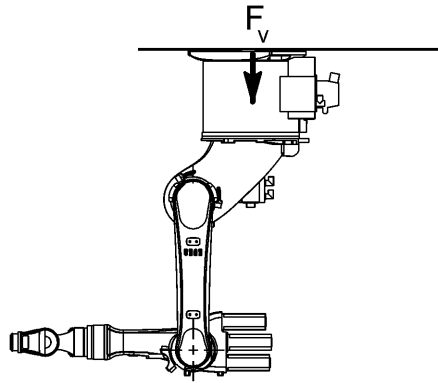


Fig. 4-18: Loads acting on the foundation, ceiling

Vertical force $F(v)$	
$F(v)$ normal)	3400 N
$F(v)$ max)	4600 N
Horizontal force $F(h)$	
$F(h)$ normal)	1650 N
$F(h)$ max)	5200 N
Tilting moment $M(k)$	
$M(k)$ normal)	3250 Nm
$M(k)$ max)	5200 Nm
Torque about axis 1 $M(r)$	
$M(r)$ normal)	2550 Nm
$M(r)$ max)	4200 Nm

⚠ 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 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 .

4.3 Transport dimensions

The transport dimensions for the robots can be noted from the following diagrams. The position of the center of gravity and the weight vary according to the specific configuration. The specified dimensions refer to the robot without equipment. The following diagram shows the dimensions of the robot when it stands on the floor without wooden transport blocks.

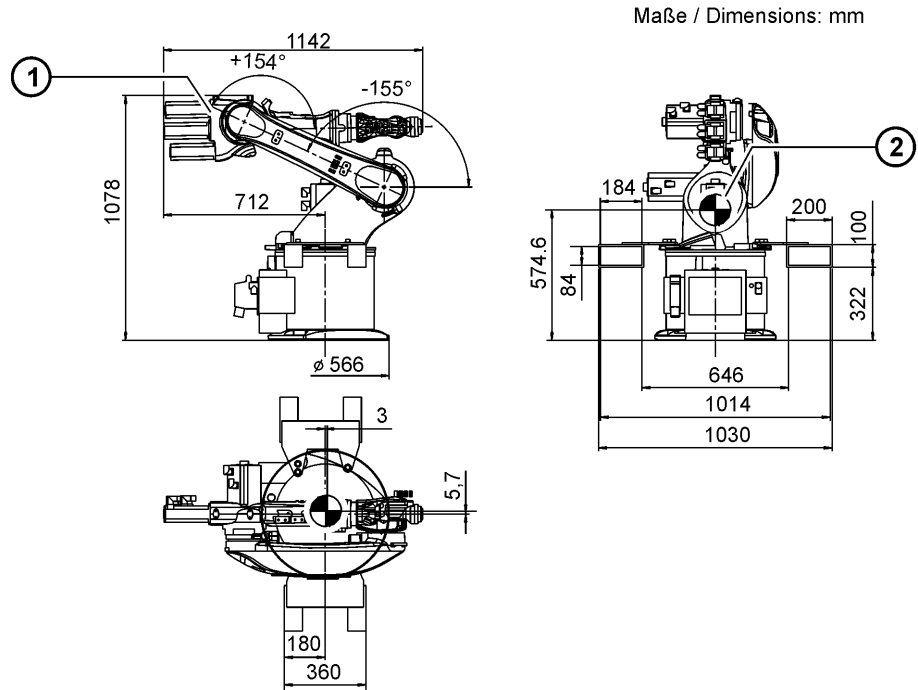


Fig. 4-19: Transport dimensions, KR 20-3

1 Robot

2 Center of gravity

For transporting ceiling-mounted robots in the mounting position, a transport frame is provided, which can be picked up using a crane attached to 2 eye-bolts, or with a fork lift truck.

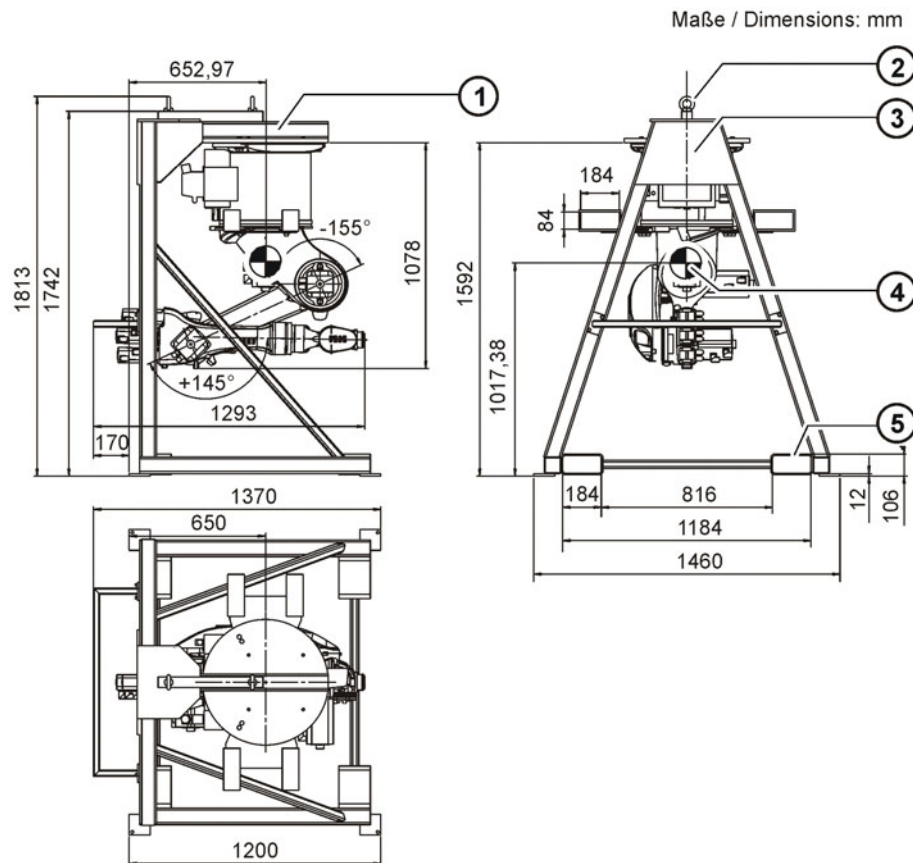


Fig. 4-20: Transport dimensions, KR 20-3 C

- | | |
|---|---------------------|
| 1 Robot | 4 Center of gravity |
| 2 Eyebolts | 5 Fork slots |
| 3 Transport frame for ceiling-mounted robot | |

4.4 Plates and labels

Plates and labels The following plates and labels (>>> Fig. 4-21) are attached to the robot. They must not be removed or rendered illegible. Illegible plates and labels must be replaced. The plates and labels depicted here are valid for all robots of this robot model.

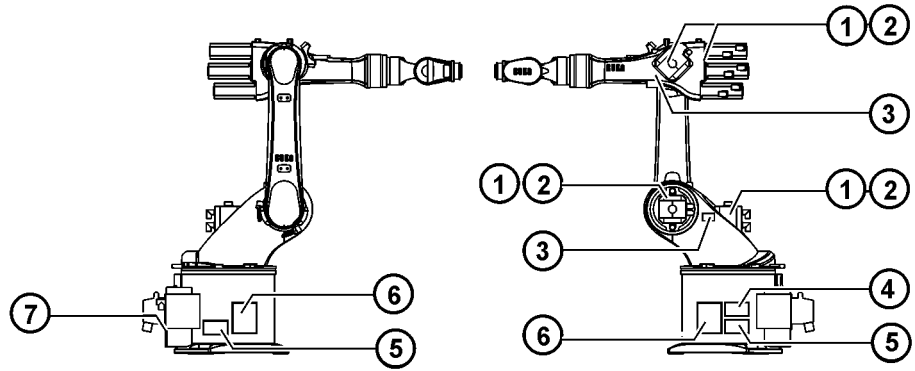









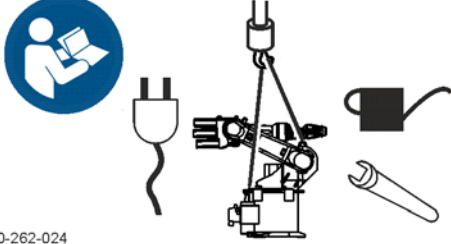

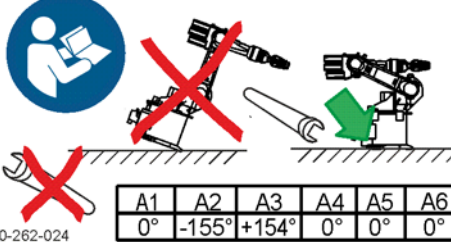
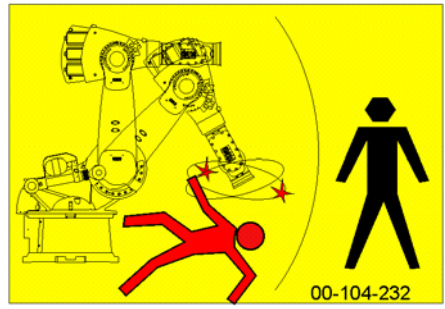
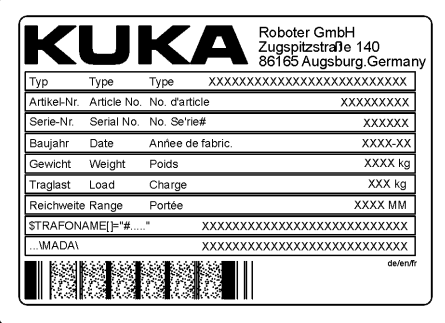


Fig. 4-21: Location of plates and labels

Item	Description								
1	 <p>High voltage Any improper handling can lead to contact with current-carrying components. Electric shock hazard!</p>								
2	 <p>Hot surface During operation of the robot, surface temperatures may be reached that could result in burn injuries. Protective gloves must be worn!</p>								
3	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="text-align: center; vertical-align: middle;">  </td> <td style="text-align: center; vertical-align: middle;">  <p style="font-size: small; margin-top: 5px;">00-262-024</p> </td> </tr> <tr> <td style="text-align: center; background-color: #ffff00;">⚠ CAUTION</td> <td>Before removing the motor, secure robot axis to prevent it from turning!</td> </tr> <tr> <td style="text-align: center; background-color: #ffff00;">⚠ ATTENTION</td> <td>Avant de retirer le moteur, protéger l'axe du robot contre le basculement!</td> </tr> <tr> <td style="text-align: center; background-color: #ffff00;">⚠ VORSICHT</td> <td>Vor Entfernen des Motors, Roboterachse gegen Bewegungen sichern!</td> </tr> </table> <p>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!</p>		 <p style="font-size: small; margin-top: 5px;">00-262-024</p>	⚠ CAUTION	Before removing the motor, secure robot axis to prevent it from turning!	⚠ ATTENTION	Avant de retirer le moteur, protéger l'axe du robot contre le basculement!	⚠ VORSICHT	Vor Entfernen des Motors, Roboterachse gegen Bewegungen sichern!
	 <p style="font-size: small; margin-top: 5px;">00-262-024</p>								
⚠ CAUTION	Before removing the motor, secure robot axis to prevent it from turning!								
⚠ ATTENTION	Avant de retirer le moteur, protéger l'axe du robot contre le basculement!								
⚠ VORSICHT	Vor Entfernen des Motors, Roboterachse gegen Bewegungen sichern!								

Item	Description																		
4	<div style="display: flex; justify-content: space-between;"> <div style="width: 20%; text-align: center;">  </div> <div style="width: 75%;">  <p style="font-size: small;">00-262-024</p> </div> </div> <table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="background-color: yellow; text-align: center;">⚠ CAUTION</td> <td>Secure the system before beginning work on the robot. Read and observe the safety instructions!</td> </tr> <tr> <td style="background-color: yellow; text-align: center;">⚠ ATTENTION</td> <td>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="background-color: yellow; text-align: center;">⚠ VORSICHT</td> <td>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	<div style="display: flex; justify-content: space-between;"> <div style="width: 20%; text-align: center;">  </div> <div style="width: 75%;">  <p style="font-size: small;">00-262-024</p> <table border="1" style="margin-left: auto; margin-right: auto; border-collapse: collapse;"> <thead> <tr> <th>A1</th> <th>A2</th> <th>A3</th> <th>A4</th> <th>A5</th> <th>A6</th> </tr> </thead> <tbody> <tr> <td>0°</td> <td>-155°</td> <td>+154°</td> <td>0°</td> <td>0°</td> <td>0°</td> </tr> </tbody> </table> </div> </div> <table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="background-color: yellow; text-align: center;">⚠ CAUTION</td> <td>Move the robot into its transport position before removing the mounting base!</td> </tr> <tr> <td style="background-color: yellow; text-align: center;">⚠ ATTENTION</td> <td>Amener le robot en position de transport avant de défaire la fixation aux fondations!</td> </tr> <tr> <td style="background-color: yellow; text-align: center;">⚠ VORSICHT</td> <td>Roboter vor Lösen der Fundamentbefestigung in Transportstellung bringen!</td> </tr> </table> <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°	-155°	+154°	0°	0°	0°	⚠ CAUTION	Move the robot into its transport position before removing the mounting base!	⚠ ATTENTION	Amener le robot en position de transport avant de défaire la fixation aux fondations!	⚠ VORSICHT	Roboter vor Lösen der Fundamentbefestigung in Transportstellung bringen!
A1	A2	A3	A4	A5	A6														
0°	-155°	+154°	0°	0°	0°														
⚠ CAUTION	Move the robot into its transport position before removing the mounting base!																		
⚠ ATTENTION	Amener le robot en position de transport avant de défaire la fixation aux fondations!																		
⚠ VORSICHT	Roboter vor Lösen der Fundamentbefestigung in Transportstellung bringen!																		

Item	Description
6	 <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>
7	 <p>Identification plate Content according to Machinery Directive.</p>

4.5 Stopping distances and times

4.5.1 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 triggered. It is therefore advisable to check the stopping distance at least once a year.

4.5.2 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 and is displayed on the KCP.
POV	Program override (%) = velocity of the robot motion. This value can be entered in the controller via the KCP and is displayed on the KCP.
Extension	Distance (l in %) (>>> Fig. 4-22) 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	The KCP teach pendant has all the operator control and display functions required for operating and programming the robot system.

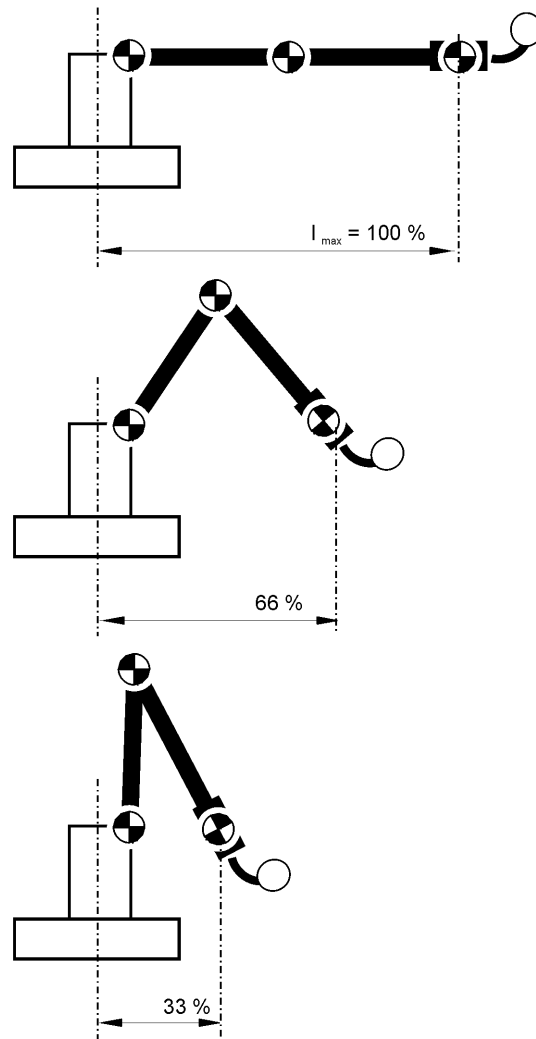


Fig. 4-22: Extension

4.5.3 Stopping distances and times, KR 20-3

4.5.3.1 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	39.35	0.353
Axis 2	37.46	0.330
Axis 3	27.64	0.214

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

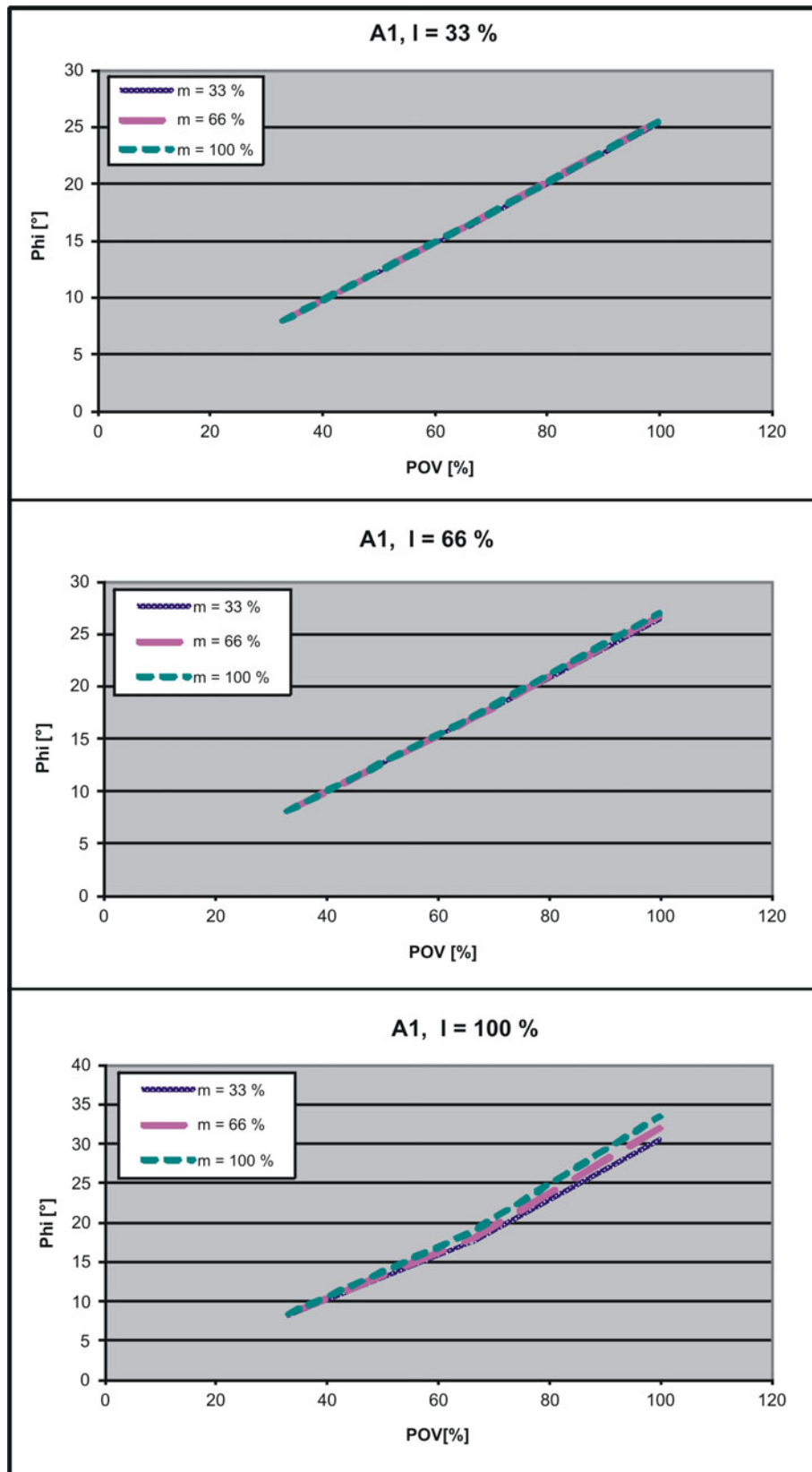


Fig. 4-23: Stopping distances for STOP 1, axis 1

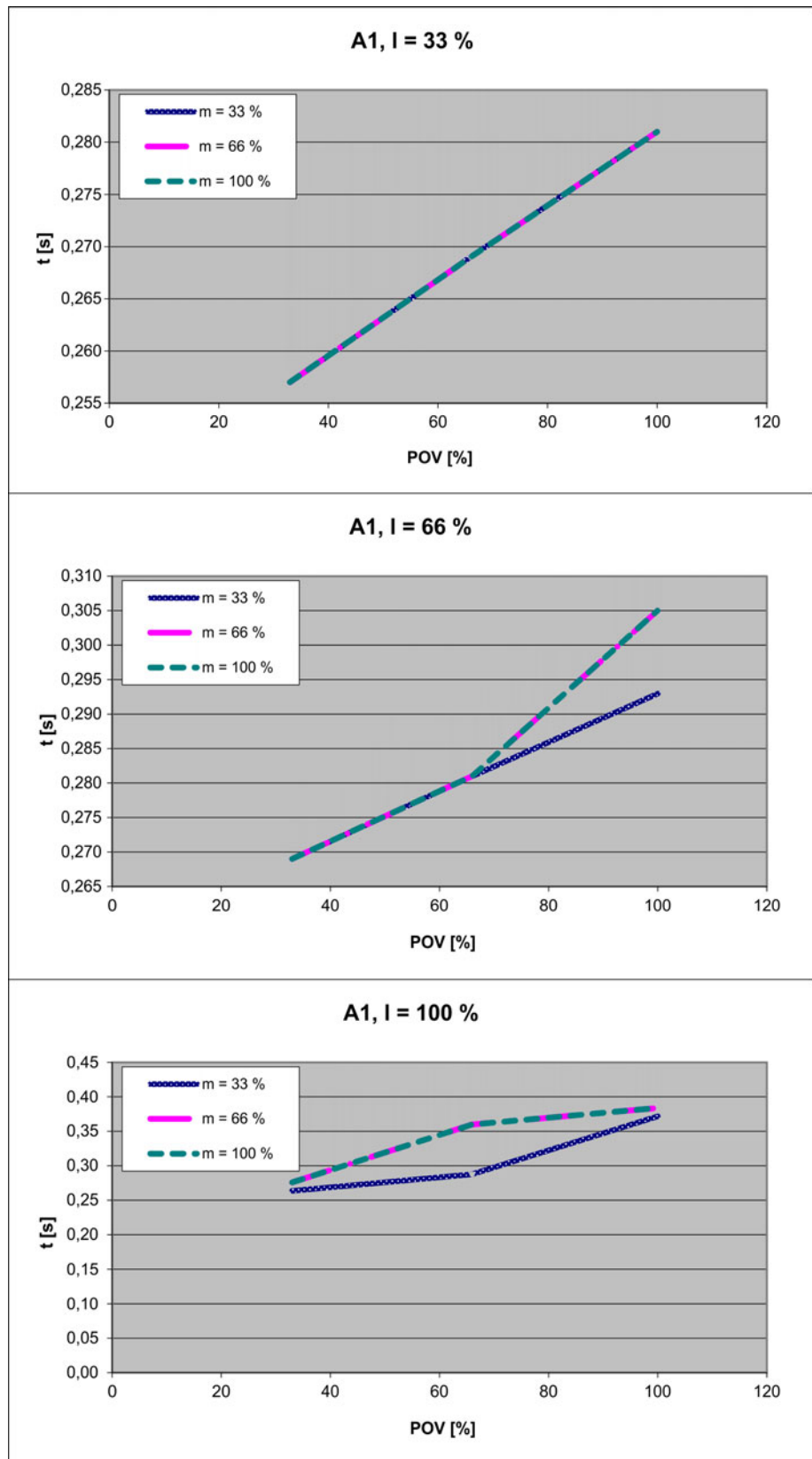


Fig. 4-24: Stopping times for STOP 1, axis 1

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

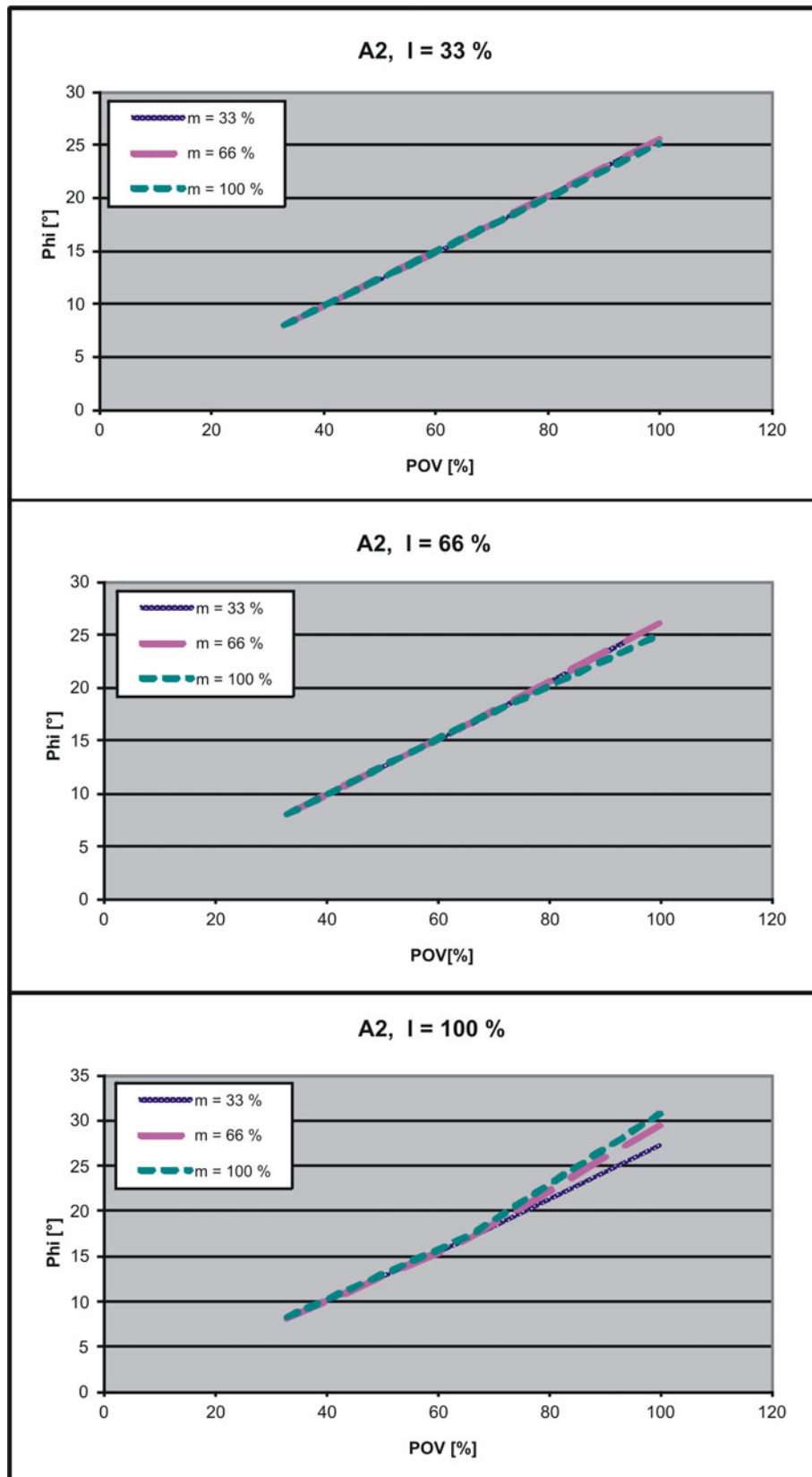


Fig. 4-25: Stopping distances for STOP 1, axis 2

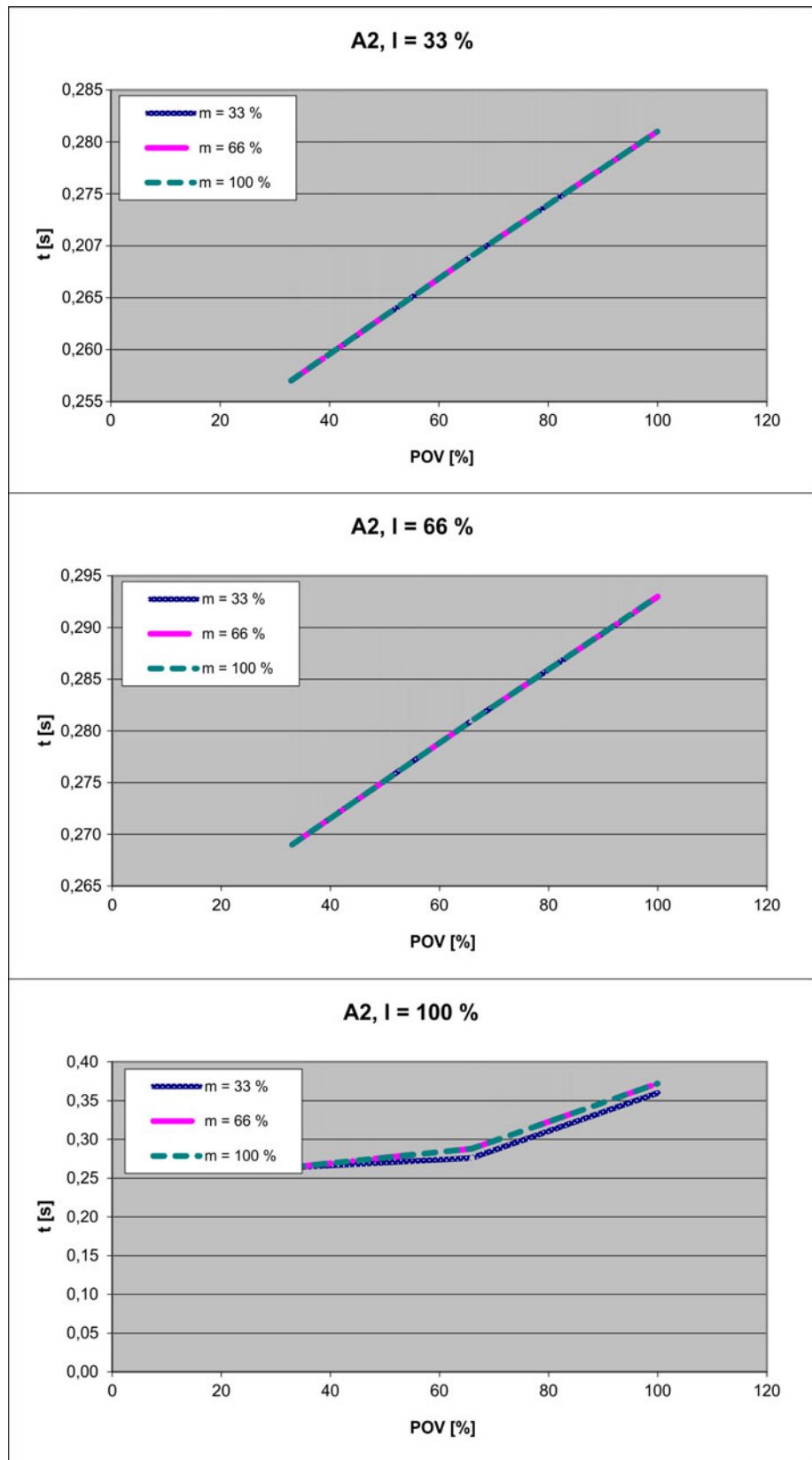


Fig. 4-26: Stopping times for STOP 1, axis 2

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

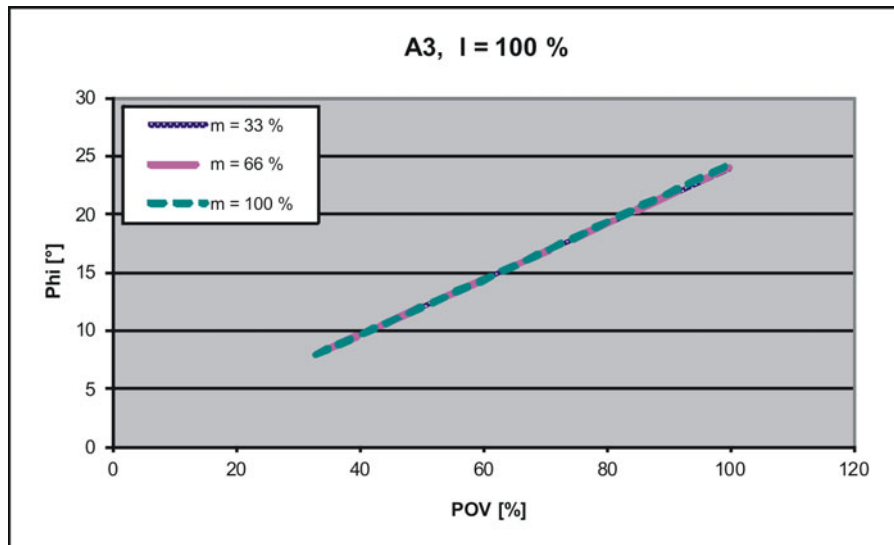


Fig. 4-27: Stopping distances for STOP 1, axis 3

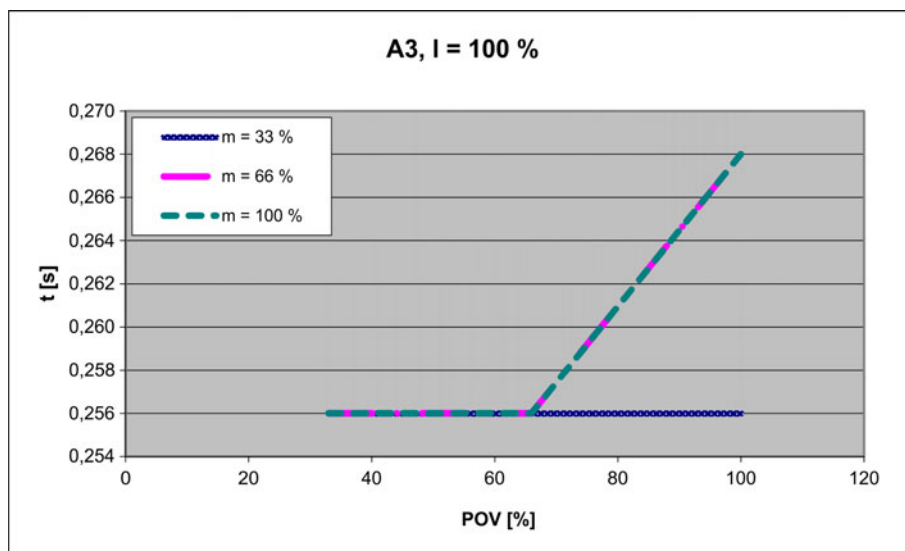


Fig. 4-28: Stopping times for STOP 1, axis 3

4.5.4 Stopping distances and times, KR 20-3 C

4.5.4.1 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	41.38	0.368
Axis 2	40.58	0.346
Axis 3	31.78	0.242

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

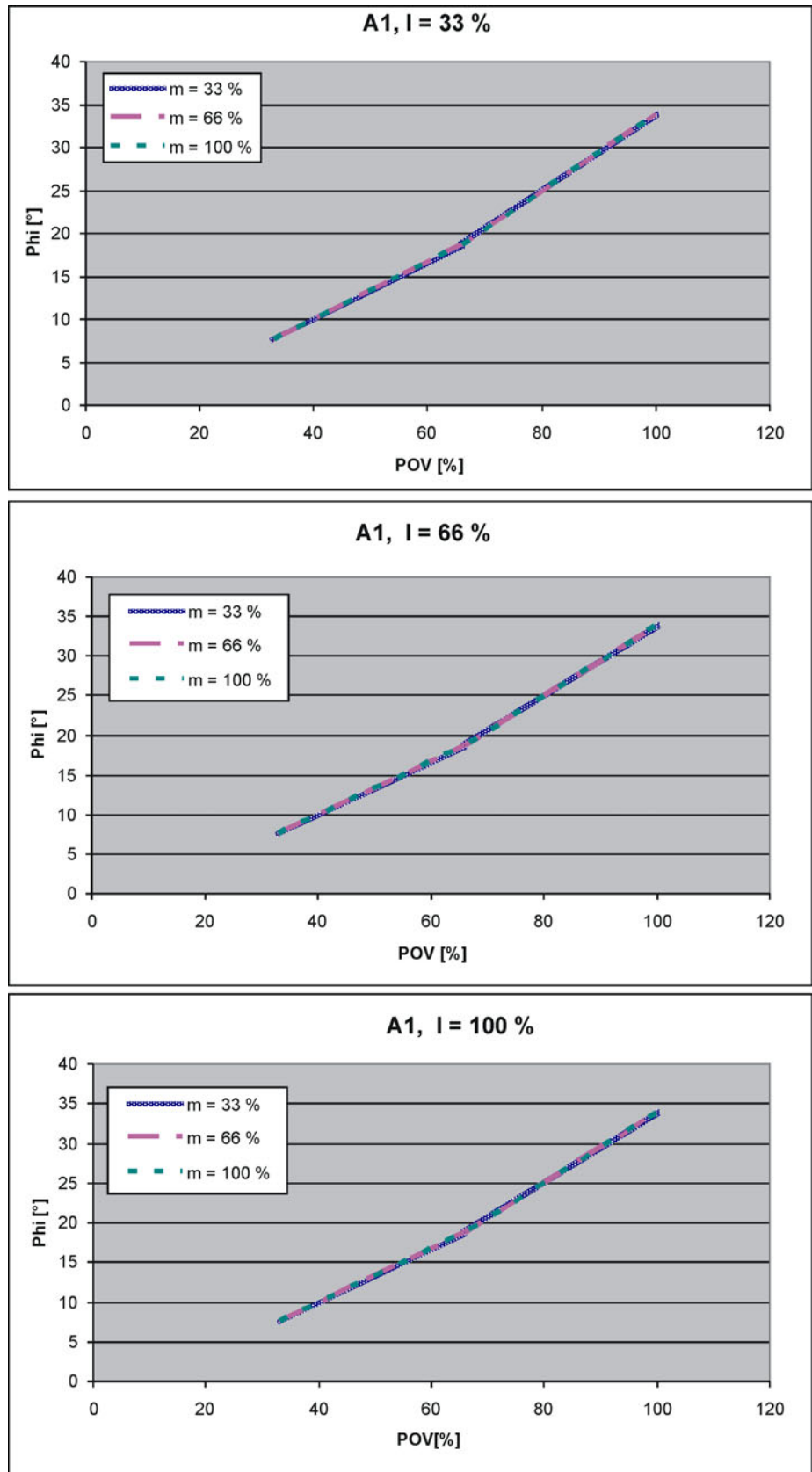


Fig. 4-29: Stopping distances for STOP 1, axis 1

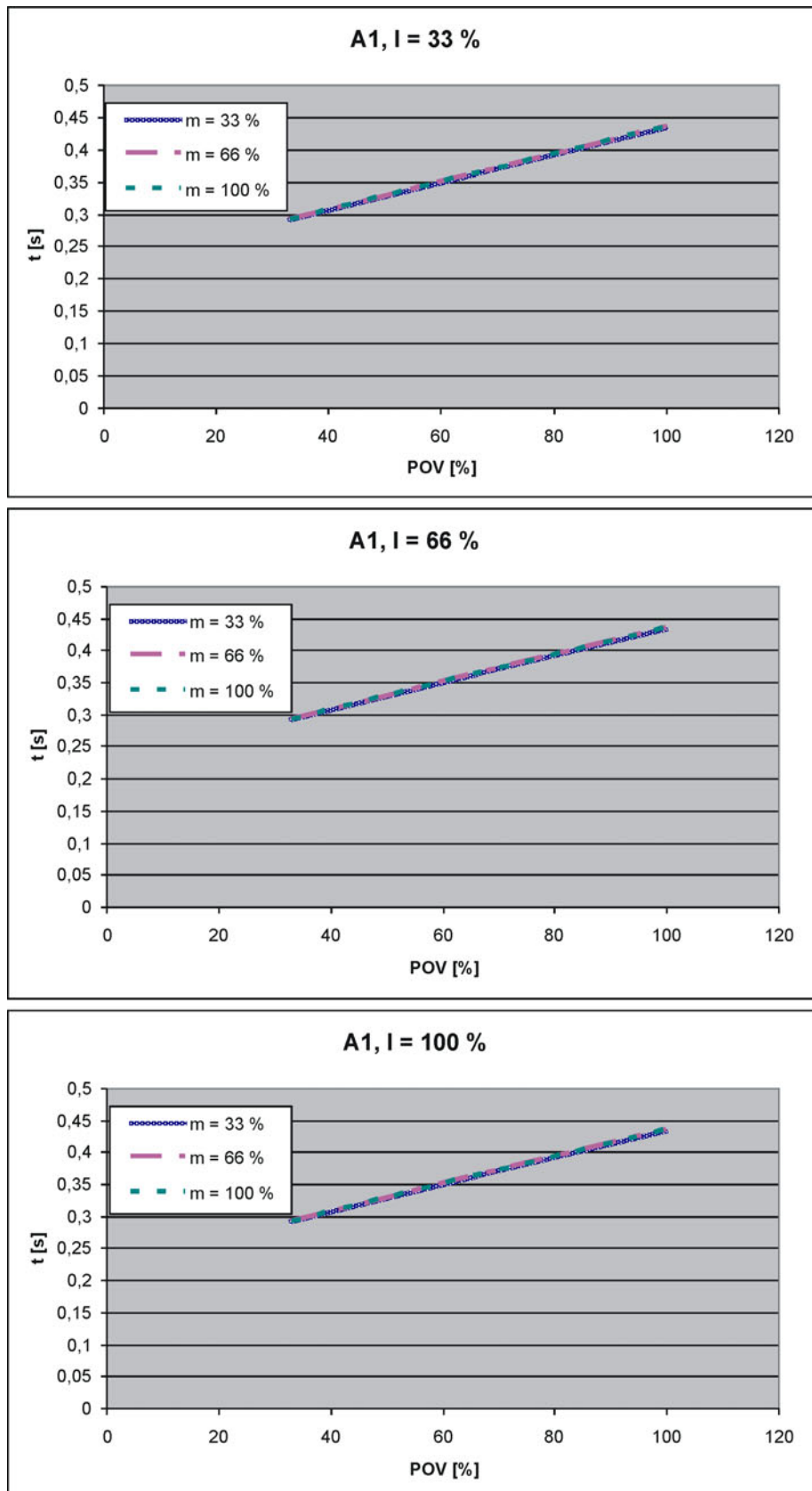


Fig. 4-30: Stopping times for STOP 1, axis 1

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

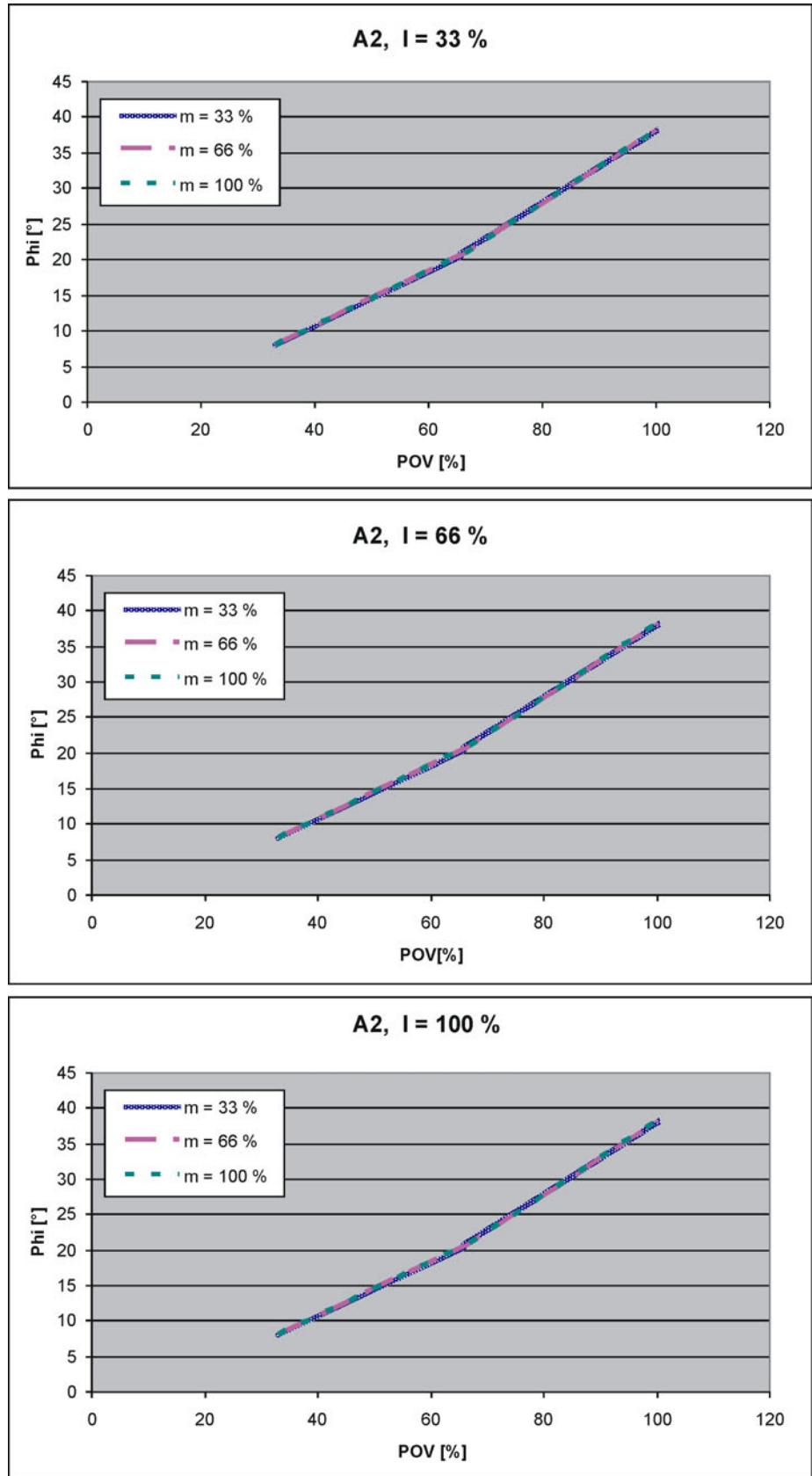


Fig. 4-31: Stopping distances for STOP 1, axis 2

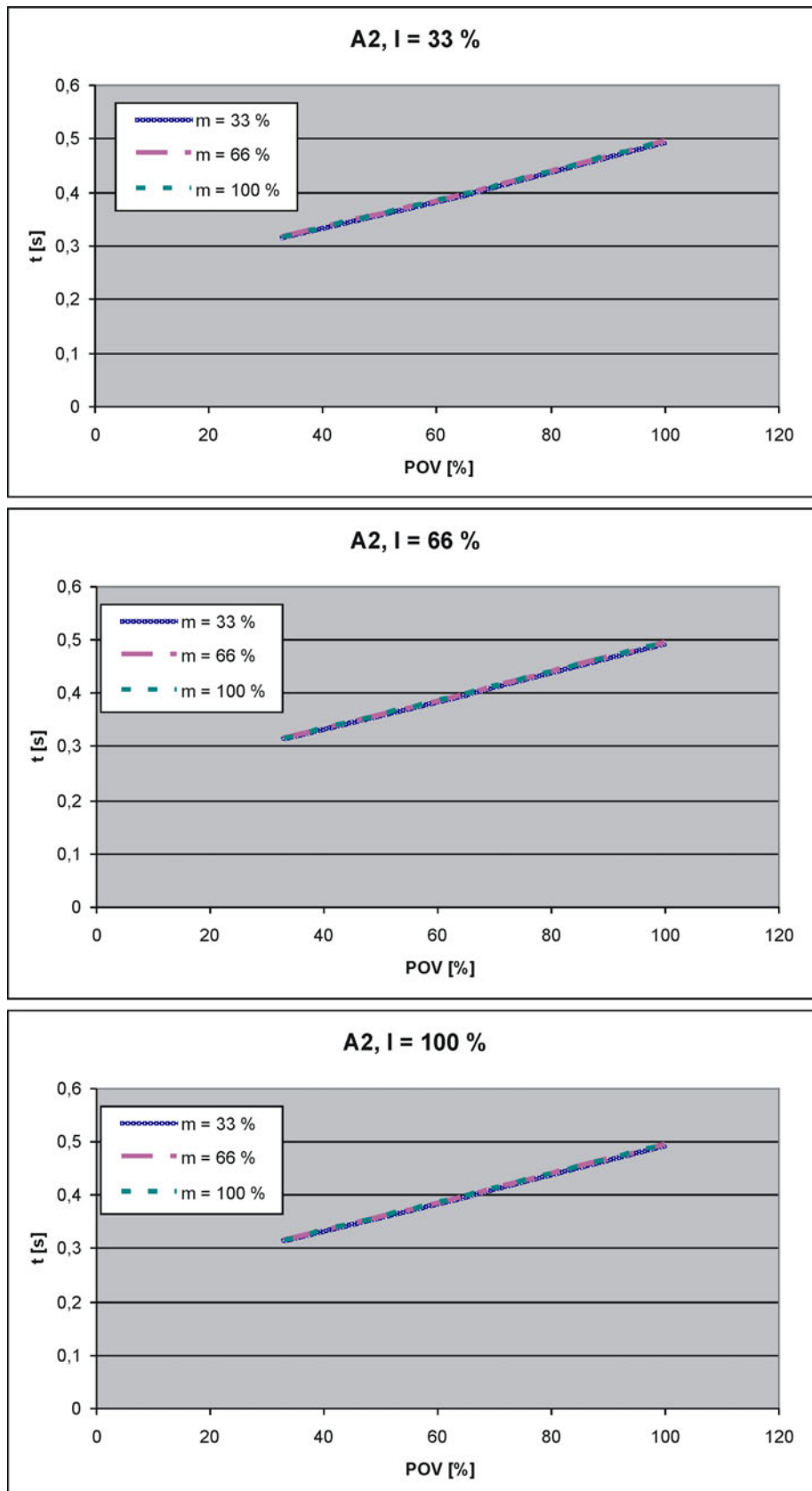


Fig. 4-32: Stopping times for STOP 1, axis 2

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

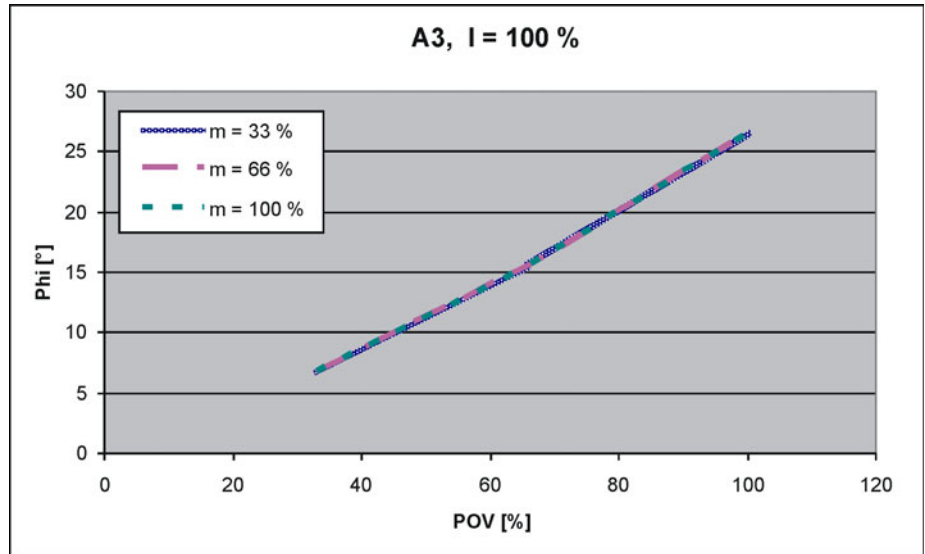


Fig. 4-33: Stopping distances for STOP 1, axis 3

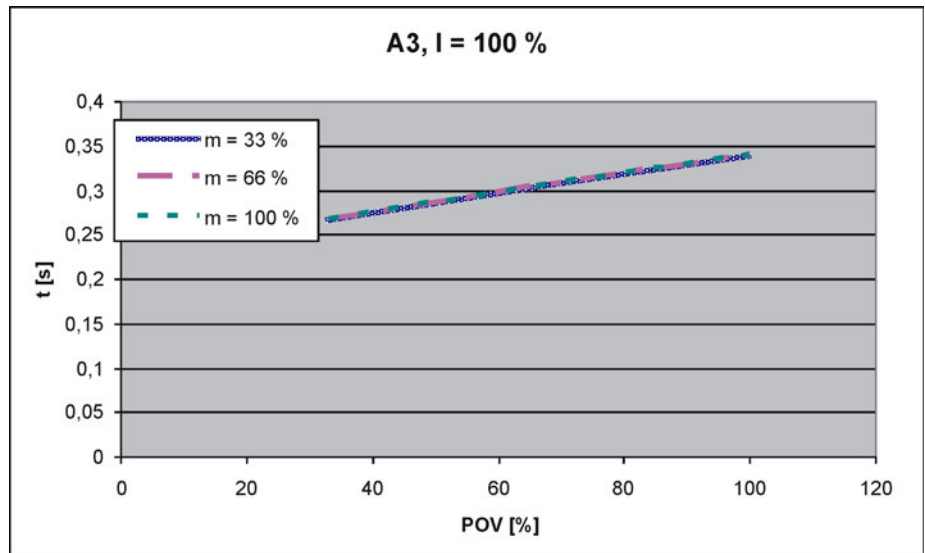


Fig. 4-34: Stopping times for STOP 1, axis 3

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

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

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

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

5.1.2 Intended use of the industrial robot

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

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.:

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

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 an assessment of conformity.

Declaration of conformity

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

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

Declaration of incorporation

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

The declaration of incorporation declares that the start-up of the partly completed machinery 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 robot 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.
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	Motion axis which is not part of the manipulator but which is controlled using the robot controller, e.g. KUKA linear unit, turn-tilt table, Posiflex.

5.2 Personnel

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

- User

- Personnel



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

User

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

- The user must comply with his monitoring obligations.
- The user must carry out instructions 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
 - Operator
 - Cleaning personnel



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

System integrator

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

The system integrator is responsible for the following tasks:

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

Operator

The operator must meet the following preconditions:

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



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 range limitation (optional)
- Axis range monitoring (optional)
- Release device (optional)
- Labeling of danger areas

Not all equipment is relevant for every mechanical component.

5.4.1 Mechanical end stops

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.


 **WARNING** If the manipulator or an external axis hits an obstruction or a mechanical end stop or axis range limitation, the manipulator can no longer be operated safely. The manipulator must be taken out of operation and KUKA Roboter GmbH must be consulted before it is put back into operation (>>> 11 "KUKA Service" Page 101).

5.4.2 Mechanical axis range limitation (optional)

Some manipulators can be fitted with mechanical axis range limitation in axes A1 to A3. The adjustable axis range limitation systems restrict the working range to the required minimum. This increases personal safety and protection of the system.

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


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

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


5.4.3 Axis range monitoring (optional)

Some manipulators can be fitted with dual-channel axis range monitoring systems in main axes A1 to A3. The positioner axes may be fitted with additional axis range monitoring systems. The safety zone for an axis can be adjusted

and monitored using an axis range monitoring system. This increases personal safety and protection of the system.

 This option is not available for the KR C4. This option is not available for all robot models. Information on specific robot models can be obtained from KUKA Roboter GmbH.


5.4.4 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 Roboter 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.

5.4.5 Labeling on the industrial robot

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

Labeling on the industrial robot consists of:

- 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/smartPADs 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 modifications 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 Roboter GmbH, are integrated into the industrial robot, the user is responsible for ensuring that these components do not adversely affect or disable safety functions.

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.

Machine data

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

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

5.5.4 Manual mode

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

- Jog mode
- Teaching
- Programming
- Program verification

The following must be taken into consideration in manual mode:

- If the drives are not required, they must be switched off to prevent the manipulator or the external axes (optional) from being moved unintentionally.
- New or modified programs must always be tested first in Manual Reduced Velocity mode (T1).
- The manipulator, tooling or external axes (optional) must never touch or project beyond the safety fence.
- 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 Manual Reduced Velocity.
- Teaching and programming are not permissible in this operating mode.
- Before commencing the test, the operator must ensure that the enabling devices are operational.
- The operator must be positioned outside the danger zone.
- There must be no other persons inside the safeguarded area. It is the responsibility of the operator to ensure this.

5.5.5 Automatic mode

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

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

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

5.5.6 Maintenance and repair

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

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

Robot controller

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

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

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

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

Counterbalancing system

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

The hydropneumatic and gas cylinder counterbalancing systems are pressure equipment and, as such, are subject to obligatory equipment monitoring 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 that our customers regularly request up-to-date safety data sheets from the manufacturers of hazardous substances.

5.5.7 Decommissioning, storage and disposal

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

5.6 Applied norms and regulations

Name	Definition	Edition
2006/42/EC	Machinery Directive: Directive 2006/42/EC of the European Parliament and of the Council of 17 May 2006 on machinery, and amending Directive 95/16/EC (recast)	2006
2004/108/EC	EMC Directive: Directive 2004/108/EC of the European Parliament and of the Council of 15 December 2004 on the approximation of the laws of the Member States relating to electromagnetic compatibility and repealing Directive 89/336/EEC	2004

97/23/EC	Pressure Equipment Directive: Directive 97/23/EC of the European Parliament and of the Council of 29 May 1997 on the approximation of the laws of the Member States concerning pressure equipment (Only applicable for robots with hydropneumatic counterbalancing system.)	1997
EN ISO 13850	Safety of machinery: Emergency stop - Principles for design	2008
EN ISO 13849-1	Safety of machinery: Safety-related parts of control systems - Part 1: General principles of design	2008
EN ISO 13849-2	Safety of machinery: Safety-related parts of control systems - Part 2: Validation	2012
EN ISO 12100	Safety of machinery: General principles of design, risk assessment and risk reduction	2010
EN ISO 10218-1	Industrial robots: Safety Note: Content equivalent to ANSI/RIA R.15.06-2012, Part 1	2011
EN 614-1 + A1	Safety of machinery: Ergonomic design principles - Part 1: Terms and general principles	2009
EN 61000-6-2	Electromagnetic compatibility (EMC): Part 6-2: Generic standards; Immunity for industrial environments	2005
EN 61000-6-4 + A1	Electromagnetic compatibility (EMC): Part 6-4: Generic standards; Emission standard for industrial environments	2011
EN 60204-1 + A1	Safety of machinery: Electrical equipment of machines - Part 1: General requirements	2009

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 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

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

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 following variant is available:

- Mounting base with centering (resin cartridge)

Both mounting base variants consist of:

- Bedplates
- Resin-bonded anchors
- Fastening elements

These mounting variants require a level and smooth surface on a concrete foundation with adequate load bearing capacity.

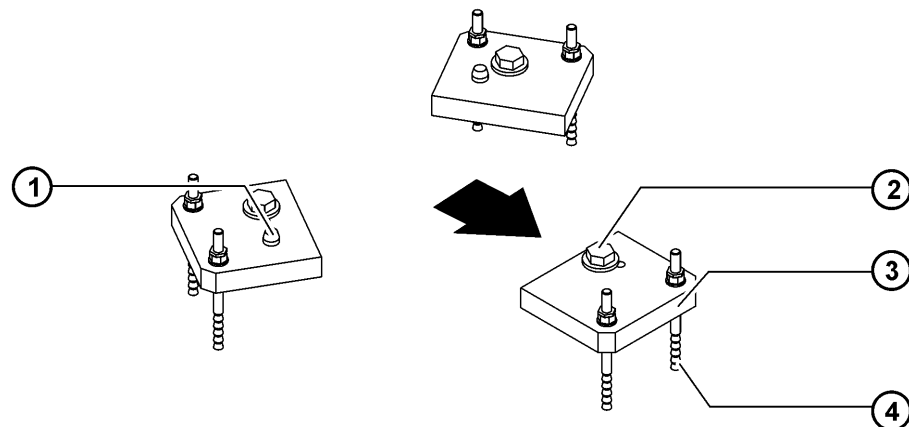


Fig. 6-1: Mounting base with centering

- 1 Locating pin for centering
- 2 Hexagon bolt
- 3 Bedplate
- 4 Resin-bonded anchor

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 illustration (>>> Fig. 6-2) provides all the necessary information on the mounting base, together with the required foundation data.

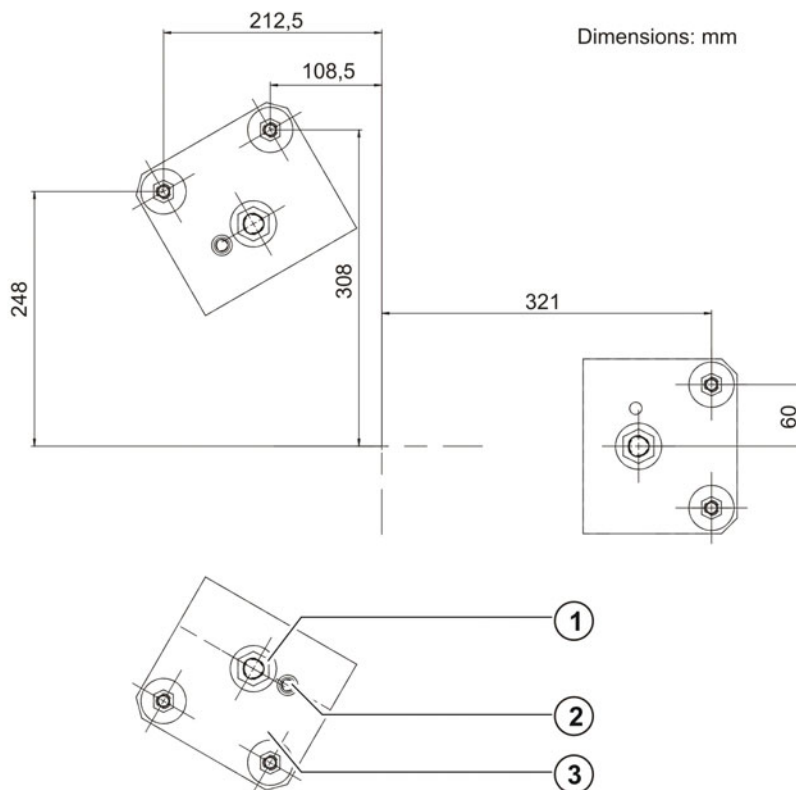


Fig. 6-2: Mounting base with centering, dimensioned drawing

- 1 Hexagon bolt
- 2 Locating pin
- 3 Bedplate

To ensure that the anchor forces are safely transmitted to the foundation, observe the dimensions for concrete foundations specified in the following illustration (>>> Fig. 6-3).

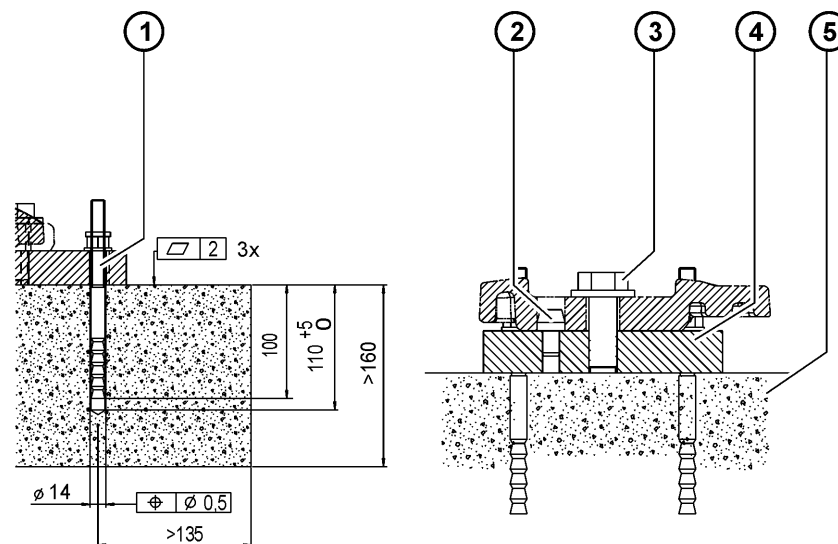


Fig. 6-3: Cross-section of foundations

- | | | | |
|---|--------------|---|---------------------|
| 1 | Anchor | 4 | Bedplate |
| 2 | Locating pin | 5 | Concrete foundation |
| 3 | Hexagon bolt | | |

6.3 Machine frame mounting with centering

Description

The machine frame mounting (>>> Fig. 6-4) with centering is used for installing the robot on a steel structure provided by the customer or on a carriage of a KUKA linear unit. The mounting surface for the robot must be machined and of an appropriate quality. The robot is fastened to the machine frame mounting option using 3 hexagon bolts. Two locating pins are used for centering.

The machine frame mounting assembly consists of:

- Locating pins
- Hexagon bolts with conical spring washers

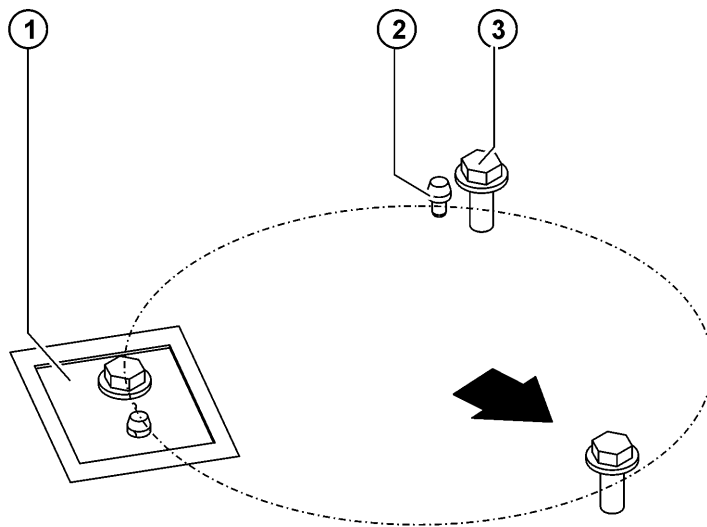


Fig. 6-4: Machine frame mounting

- 1 Mounting surface
- 2 Locating pin
- 3 Hexagon bolt with conical spring washer

Dimensioned drawing

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

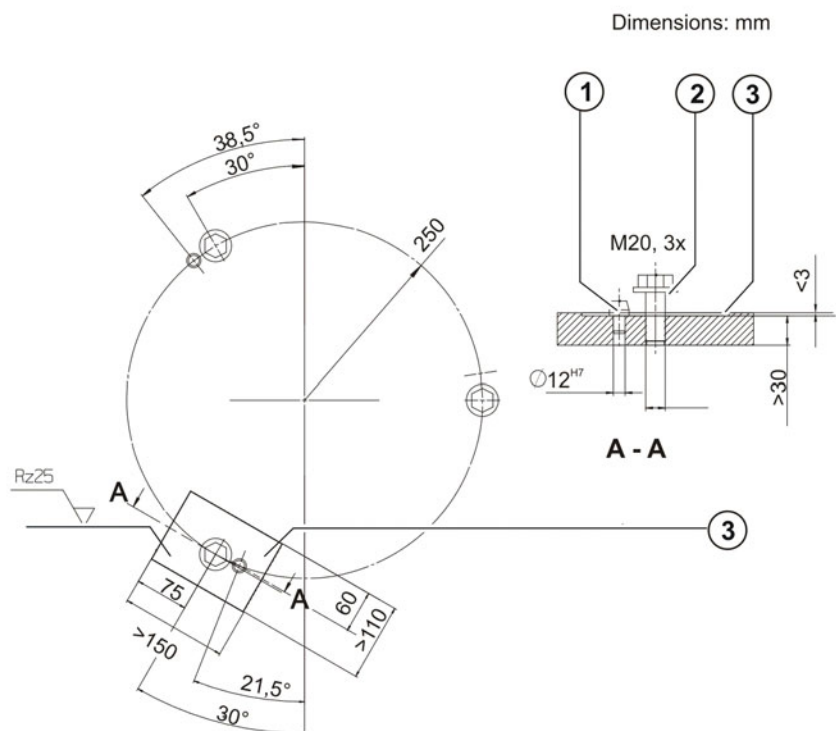


Fig. 6-5: Machine frame mounting, dimensioned drawing

- 1 Locating pin
- 2 Hexagon bolt
- 3 Mounting surface, machined

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 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.

7 Transportation

7.1 Transporting the robot

Move the robot into its transport position (>>> Fig. 7-1) each time it is transported. 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 transport position is the same for all robots of this model. The robot is in the transport position when the axes are in the following positions:

Axis	A1	A2	A3	A4	A5	A6
Angle	0°	-155°	+154°	0°	0°	0°

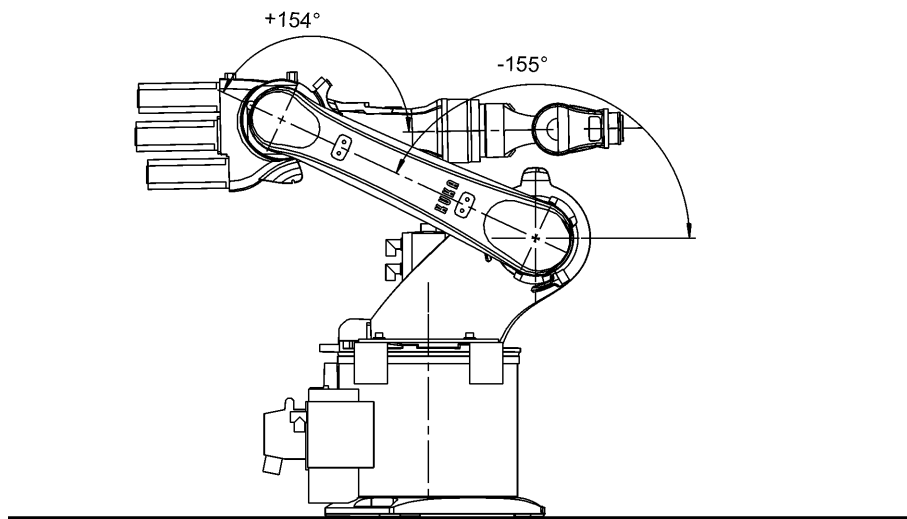


Fig. 7-1: Transport position

Transport dimensions

The transport dimensions for the robot can be noted from the following figures. The position of the center of gravity and the weight vary according to the specific configuration. The specified dimensions refer to the robot without equipment.

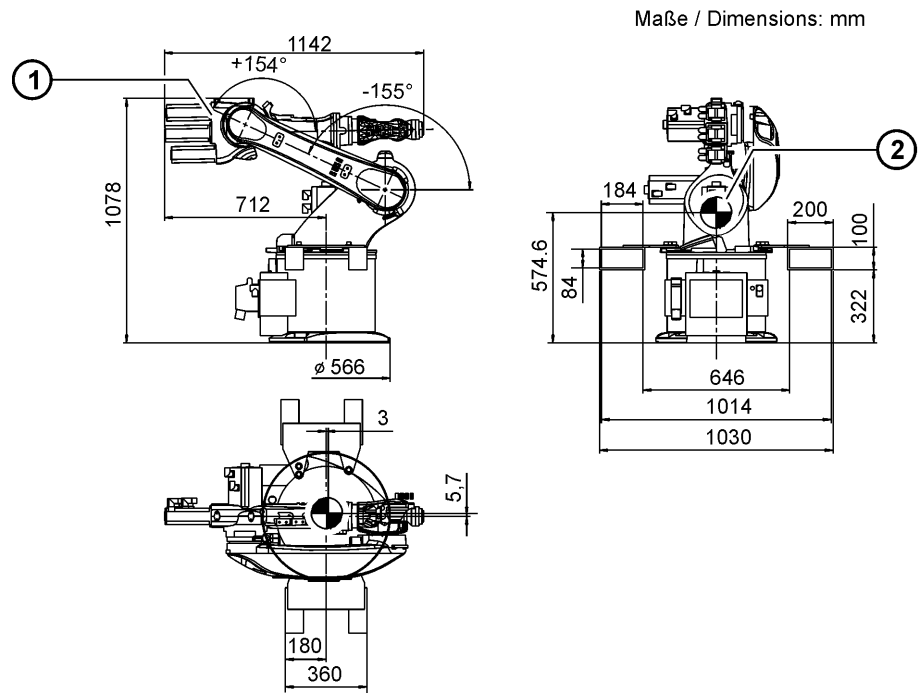


Fig. 7-2: Transport dimensions, KR 20-3

1 Robot

2 Center of gravity

Ceiling-mounted robots can also be transported in a transport frame, already in the correct orientation. The transport frame can be picked up with a fork lift truck via the integrated fork slots, or with a crane via eyebolts. The combined weight of the robot and transport frame is approx. 450 kg.

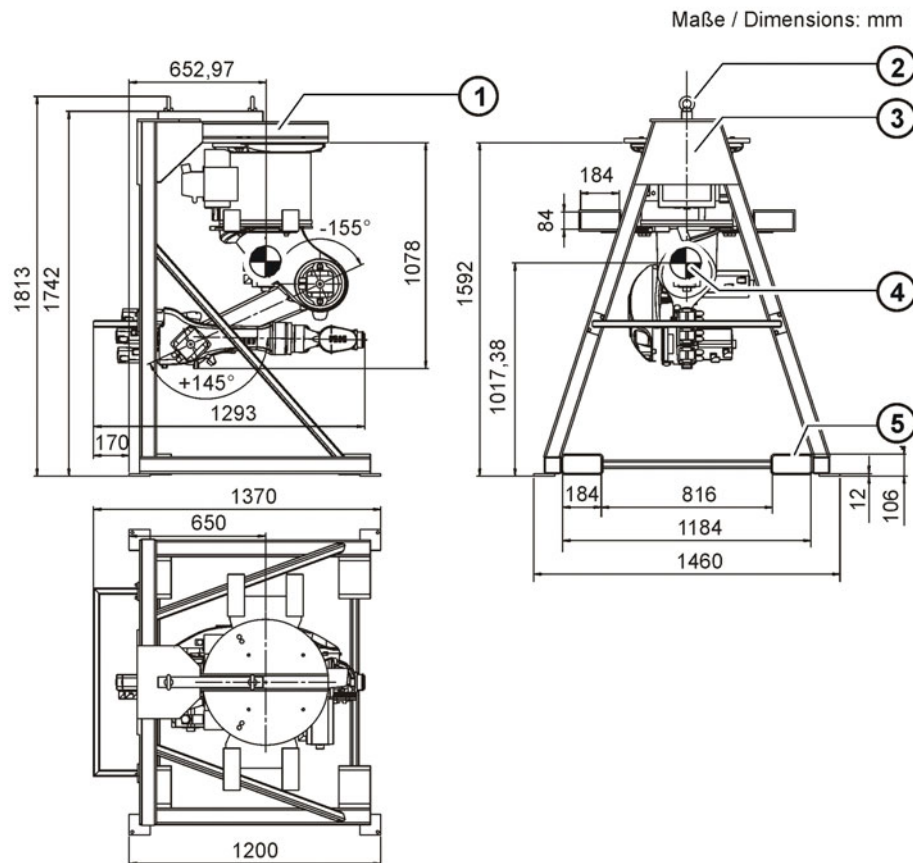


Fig. 7-3: Transport dimensions, KR 20-3 C

- 1 Robot
- 2 Eyebolts
- 3 Transport frame for ceiling-mounted robot
- 4 Center of gravity
- 5 Fork slots

Transportation

The floor-mounted robot is transported using a crane or by fork lift truck. Without the transport frame, the ceiling-mounted robot can only be transported in mounting position by fork lift truck. In the transport frame, transportation with fork lift truck or crane is possible.

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), the fork slots must be properly and fully installed. For installation on the ceiling, the robot can only be transported to the installation site using a fork lift truck. The transport frame has two fork slots for lifting it with the forks of a fork lift truck.

The robot must be in the transport position.

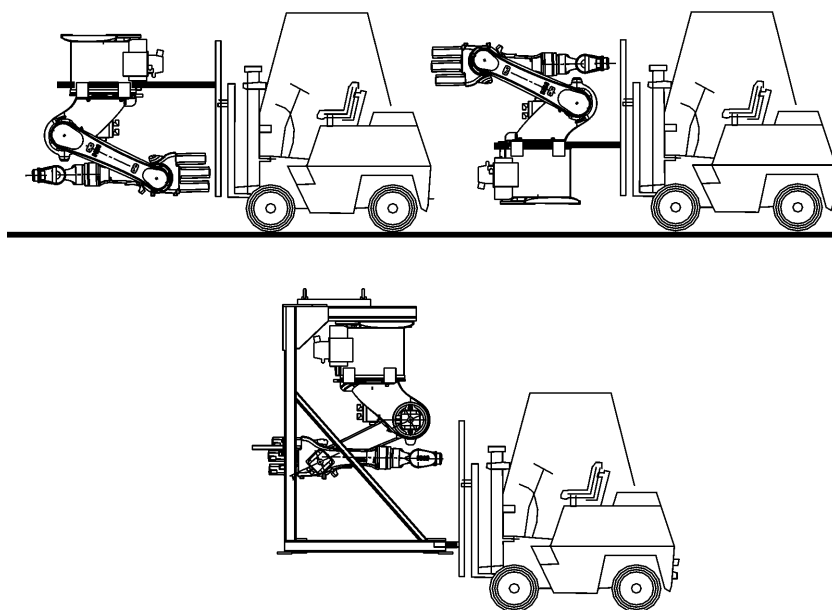


Fig. 7-4: Transportation by fork lift truck

Transportation using lifting tackle

A floor-mounted robot can be transported using a crane and lifting tackle (>>> Fig. 7-5). The robot must be in the transport position. The lifting tackle is attached to 3 eyebolts that are screwed into the rotating column. All ropes of the lifting tackle must be long enough and must be routed in such a way that the robot is not damaged. Installed tools and pieces of equipment can cause undesirable shifts in the center of gravity. These must therefore be removed if necessary.

The eyebolts must be removed from the rotating column after transportation.

⚠ WARNING

The robot may tip during transportation. Risk of personal injury and damage to property.

If the robot is being transported using lifting tackle, special care must be exercised to prevent it from tipping. Additional safeguarding measures must be taken. It is forbidden to pick up the robot in any other way using a crane!

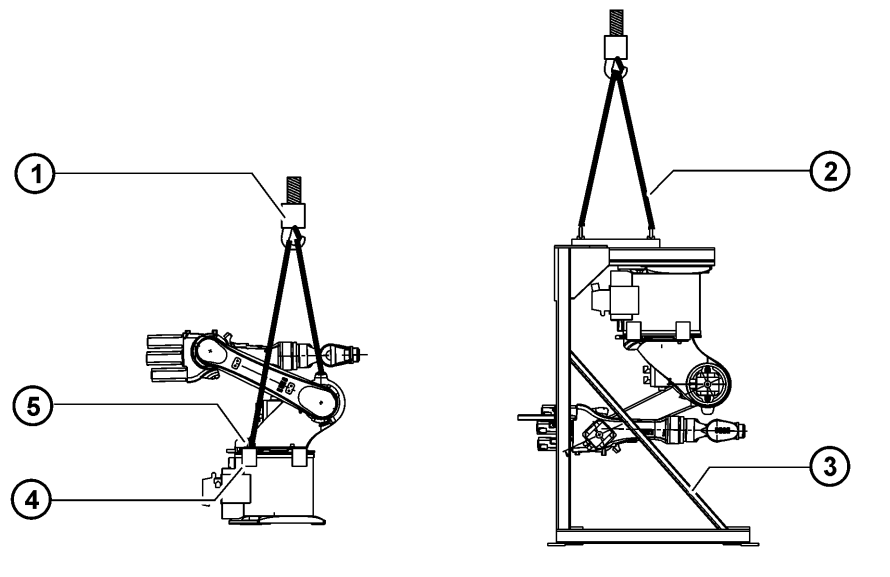


Fig. 7-5: Transportation by crane

- | | | | |
|---|-----------------|---|------------|
| 1 | Crane | 4 | Fork slots |
| 2 | Lifting tackle | 5 | Eyebolt |
| 3 | Transport frame | | |

8 Start-up and recommissioning

8.1 Installation of the mounting base (resin cartridge)

Description	<p>These instructions apply to the variant “mounting base with centering (resin cartridge)”. The robot is fastened to an appropriate concrete foundation using 3 bedplates and resin-bonded anchors.</p> <p>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.</p> <p>When producing foundations from concrete, observe the load-bearing capacity of the ground and the country-specific construction regulations. The quality of the concrete must meet the requirements of the following standard:</p> <ul style="list-style-type: none"> ■ C20/25 according to DIN EN 206-1:2001/DIN 1045-2:2008 <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. Observe also the manufacturer’s instructions for the use of resin-bonded anchors.</p> <p>The following resin cartridge is available for this installation variant:</p> <ul style="list-style-type: none"> ■ Resin cartridge with mixer nozzle for up to seven anchor holes with commercially available caulking gun. <p>Only correctly mixed resin may be used. To ensure this, as much resin as necessary must be rejected after start-up until the emerging resin is homogenous. The same applies to breaks in work (processing time exceeded); if required, a new mixer nozzle must be used.</p>
Preconditions	<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 \varnothing 14 mm bit ■ Use the resin cartridges with a commercially available caulking gun in accordance with the instructions provided 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 3 bedplates to the robot using one M20x55-8.8 hexagon bolt and conical spring washer for each one; $M_A = 370$ Nm. 2 bedplates are fitted with locating pins for centering. 3. Determine the position of the robot on the foundation in relation to the working envelope. 4. Set the robot down on the foundation in its installation position. 5. Align the robot horizontally.

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. Then set the robot down again and align it, removing any excess leveling compound. The area under the hexagon bolt for robot fastening must be kept free from leveling compound. Allow the leveling compound to cure for about 3 hours. The curing time is longer at temperatures below 293 K (+20 °C).

6. Drill 6 anchor holes (>>> Fig. 8-1) through the holes of the bedplates into the foundation.
7. Clean the anchor holes by blowing them out, brushing them and then blowing them out again.
8. Fill the anchor hole with resin (8 scale divisions on the resin cartridge), then insert anchor immediately. The anchor hole must be filled completely. If this is not the case, pull the anchor out immediately, inject additional resin and re-insert the anchor.
9. Perform the insertion procedure for the remaining anchors.

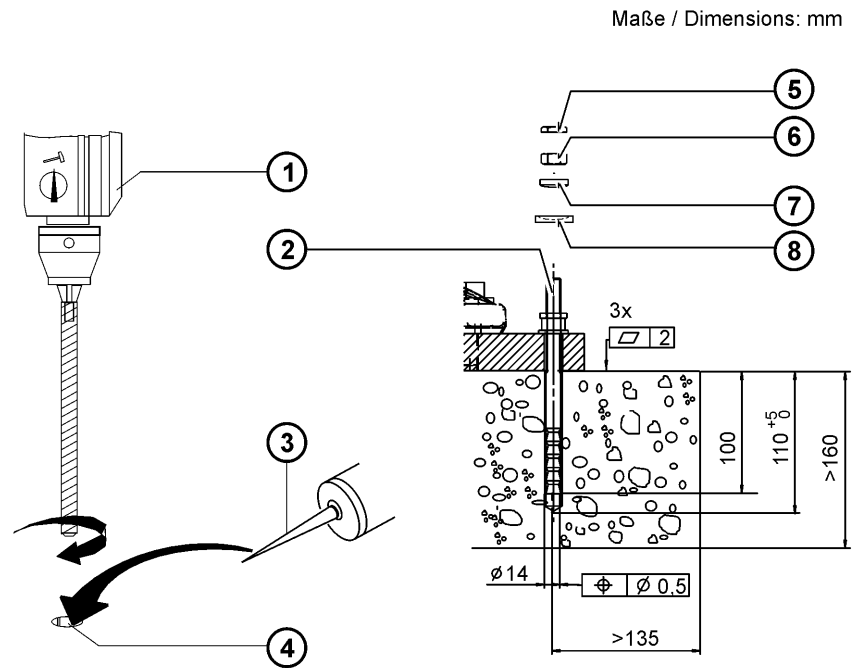


Fig. 8-1: Installation of resin-bonded anchors

- | | |
|----------------|--------------------|
| 1 Drill | 5 Lock nut |
| 2 Anchor | 6 Hexagon nut |
| 3 Mixer nozzle | 7 Spherical washer |
| 4 Anchor hole | 8 Ball cup |

10. Allow the resin to cure. The following processing and curing times must be observed:

Cartridge temperature	Processing time
< 278 K (+5 °C)	Not permissible
278 K (+5 °C)	15 minutes
293 K (+20 °C)	6 minutes

Cartridge temperature	Processing time
303 K (+30 °C)	4 minutes
318 K (+40 °C)	2 minutes

Foundation temperature	Curing time
268 K (-5 °C)	360 minutes
273 K (0 °C)	180 minutes
278 K (+5 °C)	90 minutes
293 K (+20 °C)	35 minutes
303 K (+30 °C)	20 minutes
318 K (+40 °C)	12 minutes

These times apply to dry concrete; in the case of damp concrete, the curing times are doubled.

The resin must not be processed in standing water.

11. For each anchor, fit a washer with ball cup (facing upwards) and spherical washer, then screw on a hexagon nut.
12. Tighten the hexagon nuts with a torque wrench. Gradually increase the tightening torque to a value of 40 Nm.
13. Fit and tighten a lock nut; $M_A = 40 \text{ Nm}$.
14. Fit the mixer nozzle with a filler tube and completely fill the through-hole of the ball cup with resin.
15. Retighten the hexagon nuts after 100 hours of operation.

The robot is now ready for connection.

8.2 Installation of 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**
- The mounting surface is prepared as shown in the diagram (>>> 6.3 "Machine frame mounting with centering" Page 61).
 - The substructure is checked for sufficient safety.
 - The machine frame mounting assembly is complete.
- Procedure**
1. Clean the mounting surface (>>> Fig. 8-2) of the robot.
 2. Check the hole pattern.
 3. Press in 2 locating pins.
 4. Prepare 3 M12x55 hexagon bolts and conical spring washers.

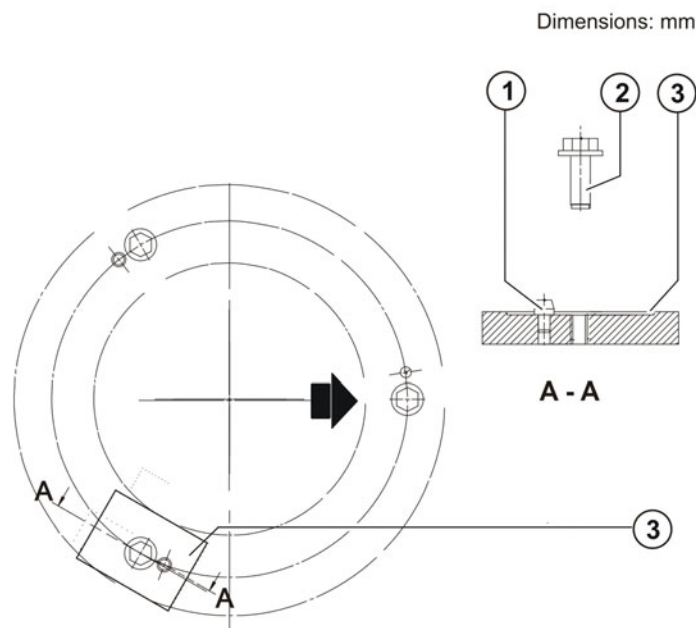


Fig. 8-2: Machine frame mounting

- 1 Locating pin
- 2 Hexagon bolt with conical spring washer
- 3 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 and ceiling, with the mounting variants: mounting base (floor mounting only) and machine frame mounting.

Ceiling-mounted robots are installed in the same way as floor-mounted robots. Ceiling-mounted robots can only be removed from the transport frame and moved to the installation site using the fork slots.

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

Precondition

- The required 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.
- The eyebolts and lifting tackle or the fork slots are attached to the robot (>>> Fig. 8-3).

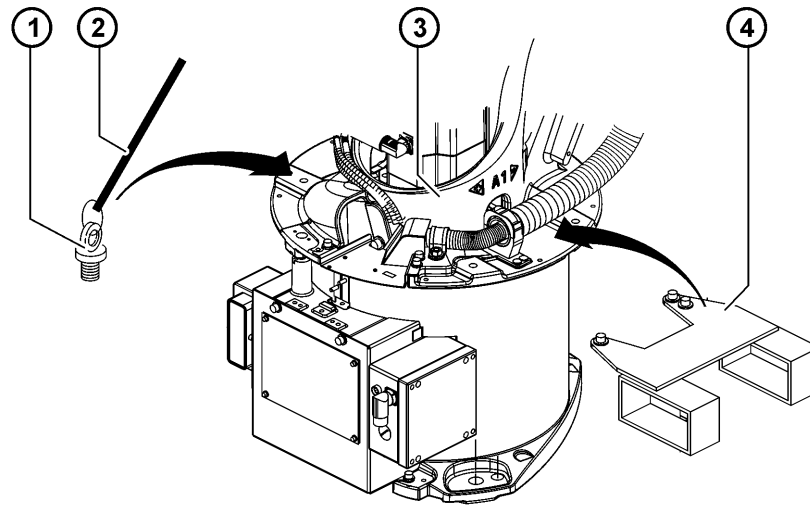


Fig. 8-3: Transporting the robot during installation

- | | |
|-----------------------|-------------------|
| 1 M20 DIN 580 eyebolt | 3 Rotating column |
| 2 Lifting tackle | 4 Fork slots |

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.

Procedure

1. Check that both locating pins (>>> Fig. 8-4) are undamaged and fitted securely.
2. Bring the robot to the installation site by crane or fork lift truck.
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 locating pins.
In the case of a ceiling-mounted robot: press the robot against the ceiling and ensure that it is level.
5. Insert 3 M20x55 hexagon bolts with conical spring washers.
6. Tighten the hexagon bolts with a torque wrench. Gradually increase the tightening torque to 370 Nm.
7. Remove the lifting tackle and eyebolts or the fork slots.
In the case of a ceiling-mounted robot: lower the fork lift truck and remove it from the installation site.
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 30204-1.

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

12. Mount tooling, if required.

13. Retighten the hexagon bolts once with a torque wrench after 100 hours of operation.

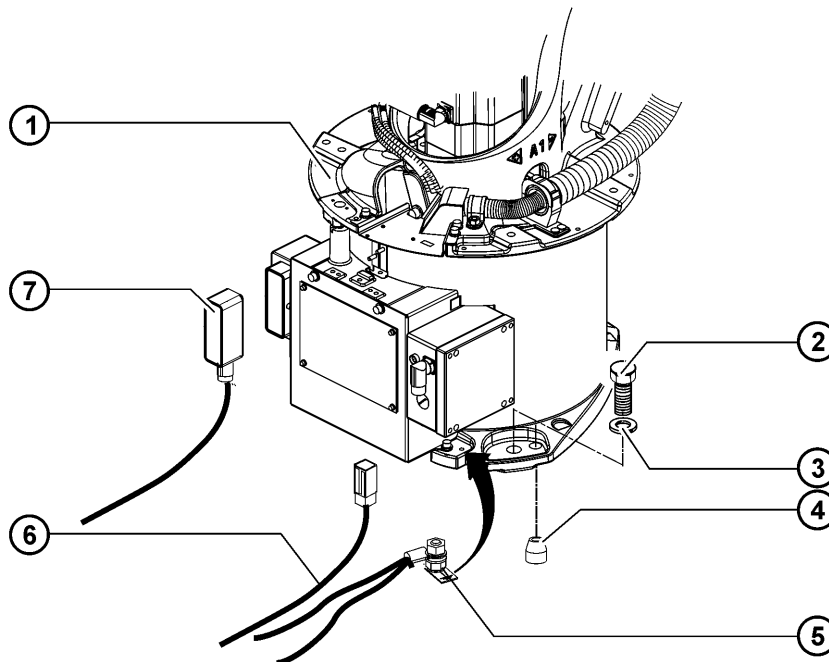


Fig. 8-4: Installing the robot

- | | | | |
|---|-----------------------|---|-----------------------------|
| 1 | Rotating column | 5 | Ground conductor connection |
| 2 | Hexagon bolt | 6 | Data cable |
| 3 | Conical spring washer | 7 | Motor cable |
| 4 | Locating pin | | |

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.

8.4 Description of the connecting cables for KR C4

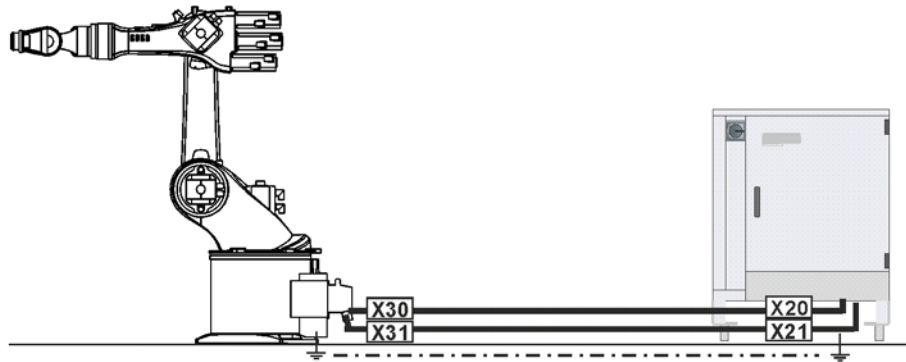
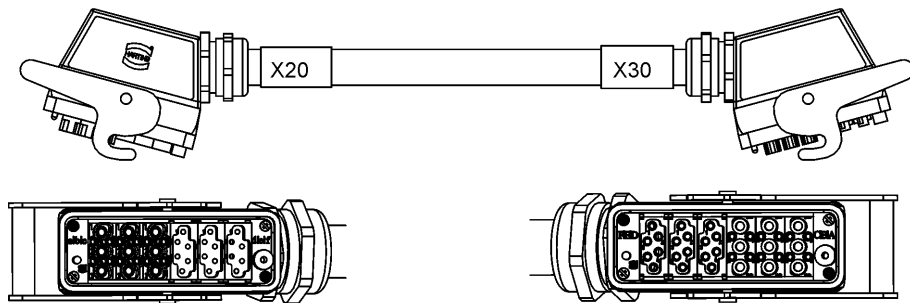
Configuration The connecting cables are used to transfer power and signals between the robot controller and the robot.

The connecting cables comprise:

- Motor cable
- Data cable
- Ground conductor (optional)

Interface For the connection of the connecting cables between the robot controller and the robot, the following connectors are available on the junction boxes.

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. 8-5: Connecting cables, overview****Fig. 8-6: Connecting cable, motor cable, X20 - X30**

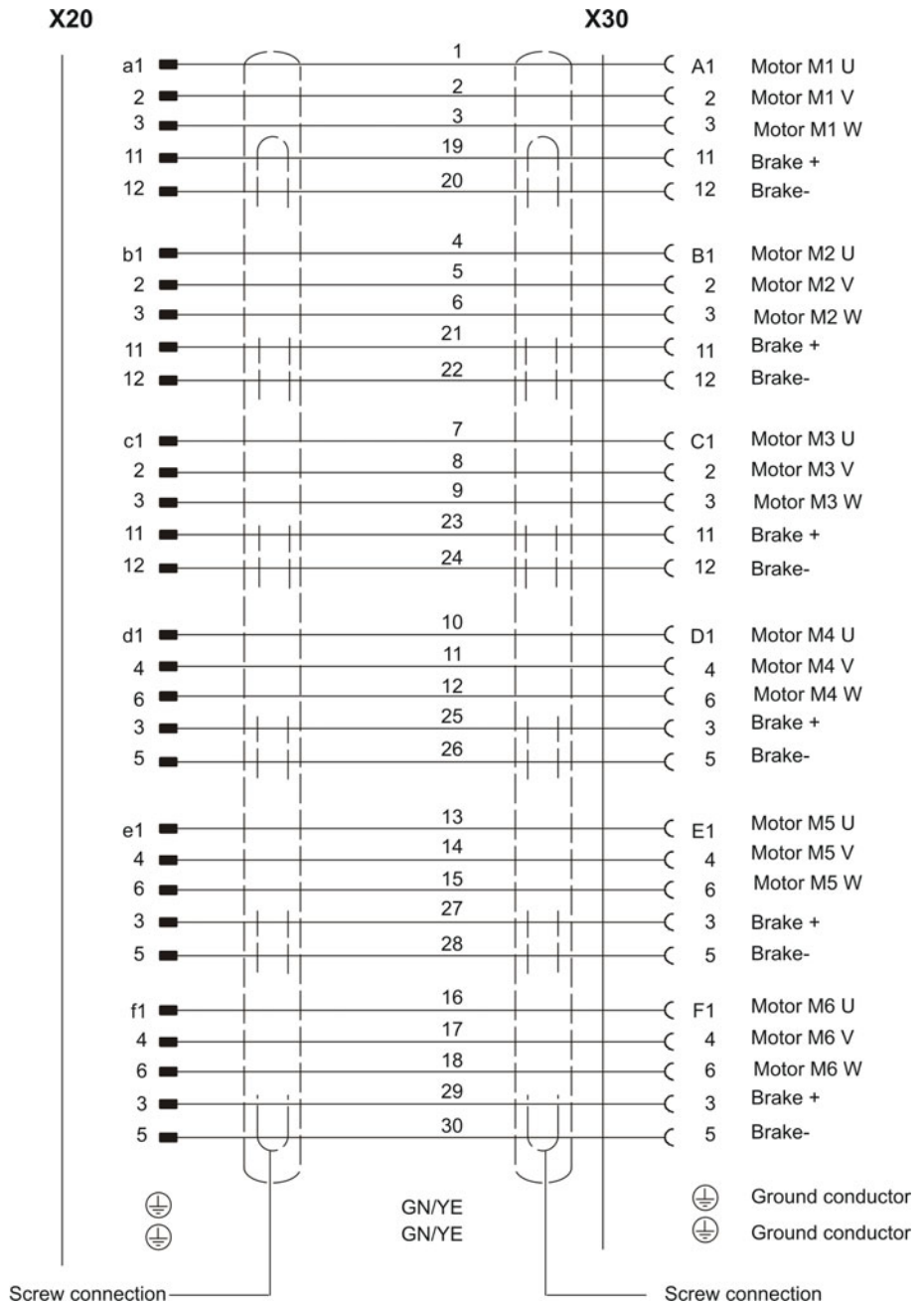


Fig. 8-7: Connecting cable, wiring diagram, motor cable

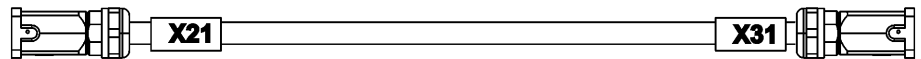


Fig. 8-8: Connecting cable, data cable X21 - X31

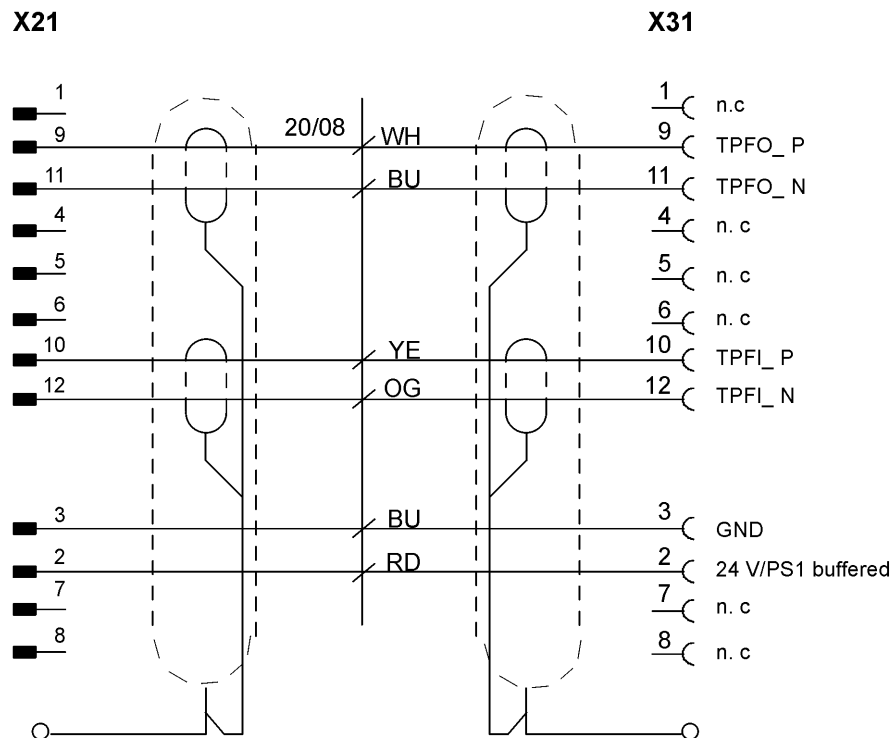


Fig. 8-9: Connecting cable, wiring diagram, data cable X21 - X31

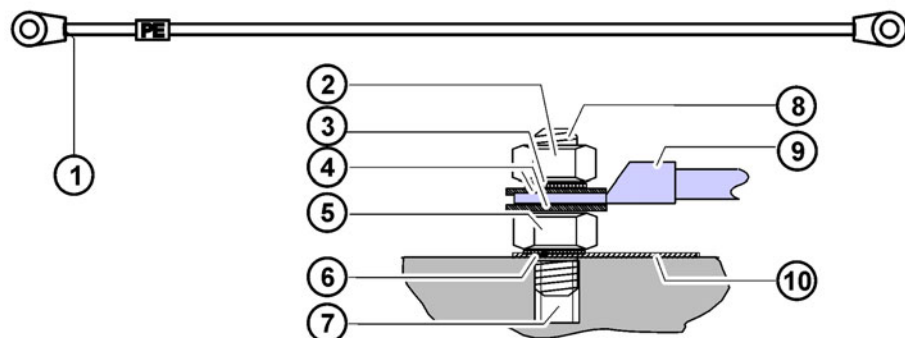


Fig. 8-10: Connecting cable, ground conductor

- | | | | |
|---|--------------------------|----|---|
| 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 |

9 Options

9.1 Working range limitation, supplementary stop (optional)

Description The working range limitation can be used to restrict the available working range about axis 1 in 11.25° steps in both the plus and minus directions. The assembly consists of two stops with the relevant fastening screws.

Depending on the mounting position of the stops, the available range can be set. Due to the trailing stop, there is always a residual range which cannot be limited.

The structure and functional principle are described in separate documentation.

9.2 Energy supply systems (optional)

Description The robot can be equipped with energy supply systems between axis 1 and axis 3 and 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 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.

In addition to standard energy supply systems, application-specific energy supply systems can also be configured. Energy supply systems can also be supplied without supply lines and filled by the user. In this case, the energy supply systems are supplied with interface plates that have not been pre-drilled. Detailed information about this, and about the connector pin allocation, threaded unions, etc., is provided in separate documentation.

10 Appendix

10.1 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 coatings) screws and nuts.

Screw thread	Strength class		
	8.8	10.9	12.9
M1.6	0.17 Nm	0.24 Nm	0.28 Nm
M2	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

Screw thread	Strength class	
	8.8 ISO7991 Hexagon socket	10.9 ISO7380, ISO07381 Fillister head screw with hexa- gon socket
M3	0.8 Nm	0.8 Nm
M4	1.9 Nm	1.9 Nm
M5	3.8 Nm	3.8 Nm

Tighten M5 domed cap nuts with a torque of 4.2 Nm.

10.2 Safety data sheets

10.2.1 Safety data sheet for Optitemp RB1 cable grease

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

Section 1 Designation of substance/formulation and manufacturer

Name of substance/preparation	
Trade name:	Optitemp RB1

Name of substance/preparation	
SDS no.:	455577
Use:	Lubricant

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

Section 2 Composition / Information about the components

Chemical characterization:	Synthetic lubricant and additives. Thickeners.
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Hazardous components:	This product contains no dangerous components above the legally defined limit values.
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Section 3 Possible hazards

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

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

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

Section 4 First aid measures

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

Ingestion:	Do not induce vomiting. If the person is unconscious, do not give anything by mouth. Consult a physician immediately.
Notes to physician:	<p>Treatment should in general be symptomatic and directed at relieving any effects.</p> <p>Note regarding high-pressure applications.</p> <p>Injection into the skin due to contact with a product under high pressure constitutes a major medical emergency. Within a few hours the tissue swells up and becomes discolored and extremely painful, with severe subcutaneous necrosis.</p> <p>Surgical treatment is absolutely imperative. Comprehensive opening of the wound and the tissue beneath it is necessary in order to reduce tissue loss and to prevent or limit lasting damage. The high pressure can cause the product to penetrate extensive areas of tissue layers.</p>

Section 5 Fire-fighting measures

Suitable extinguishing agents:	In the event of a fire: use water spray (mist), foam, dry chemicals or CO ₂ .
Unsuitable extinguishing agents:	Do not use water jets.
Special instructions for extinguishing work:	Contaminated extinguishing water must be collected separately and prevented from entering the drainage system.
Hazardous decomposition products:	Decomposition products include various oxides (e.g. carbon oxides).
Unusual fire/explosion hazards:	This product is not inherently explosive in accordance with the applicable rules.
Special fire-fighting measures:	-
Protection of fire-fighters:	Fire-fighters must wear self-contained positive pressure breathing apparatus (SCBA) and full protective gear.

Section 6 Measures after unintended release

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

Section 7 Handling and storage

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

VCI storage class:	11
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Section 8 Exposure limits and personal protective equipment

Threshold limit values (TLV):	No occupational exposure threshold limit values have been assigned for this product.
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Protective measures	
Limitation and monitoring of exposure in the workplace:	Provide exhaust ventilation or other engineering controls.
Hygiene measures:	Wash hands, forearms and face thoroughly after handling chemical products.
Respiratory protection:	Sufficient ventilation is recommended in industry. If ventilation is insufficient, respiratory protection is useful.
Hand protection:	Wear chemical-resistant gloves (recommended: nitrile gloves) if prolonged or repeated contact is likely.
Eye protection:	Protective goggles with side shields to guard against splashing.
Skin and body:	Wear appropriate clothing to avoid prolonged skin contact.

Section 9 Physical and chemical properties

Physical state:	Paste
Color:	Light beige
Odor:	Slight
Flash point:	Closed cup: >150 °C
Vapor pressure:	<0.01 kPa (<0.075 mm Hg) at 20 °C
Penetration number (0.1 mm)	280 at 25 °C
Melting point/range:	192 °C
Drop point:	>180 °C
Density:	<1000 kg/m ³ (<1 g/cm ³) at 20 °C
Solubility:	Insoluble in water

Section 10 Stability and reactivity

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

Section 11 Toxicological information

Chronic effects:	No particular effects or risks known.
Effects on eyes:	May cause mild eye irritation.

Effects on skin:	Prolonged or repeated contact can dry out the skin and lead to irritation and/or dermatitis. Allergic reactions are possible in the worst case.
Effect if inhaled:	Vapors and aerosols may cause irritation of the mucous membranes of the nose and throat.
Effect if ingested:	May cause nausea, vomiting and diarrhea.

Section 12 Ecological information

Persistence / degradability:	Biodegradable.
Mobility:	The product is non-volatile. Insoluble in water.
Environmental hazards:	Not classified as dangerous.

Section 13 Disposal information

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

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

Packaging	
European Waste Catalog (EWC):	Waste code 15 01 10: Packaging containing the residue of hazardous materials or contaminated by hazardous materials

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

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

Section 14 Transport information

Classification:	Not hazardous as defined by the transport regulations (ADR/RID, ADNR, IMDG, ICAO/IATA).
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Section 15 Regulations

EU regulations:	EC Directives 1999/45/EC and 67/548/EEC
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Labeling requirements	
Risk (R) phrases:	This product is not classified according to the Dangerous Substances Order / EU regulations.
Additional warning labels:	Contains acetic acid, (4-nonylphenoxy). Can cause allergic reactions.

Miscellaneous provisions	
Inventories:	<p>European inventory: All components are listed or exempted.</p> <p>US inventory (TSCA 8b): All components are listed or exempted.</p> <p>Australian inventory (AICS): At least one component is not listed.</p> <p>Canadian inventory: At least one component is not listed.</p> <p>Inventory of Existing Chemical Substances in China (IECSC): At least one component is not listed.</p> <p>Japanese inventory of Existing and New Chemical Substances (ENCS): At least one component is not listed.</p> <p>Korean Existing Chemicals Inventory (KECI): All components are listed or exempted.</p> <p>Philippine Inventory of Chemicals and Chemical Substances (PICCS): All components are listed or exempted.</p>
Classification acc. to the German Administrative Regulation on the Classification of Substances Hazardous to Water into Water Hazard Classes (VwVwS):	1, Annex no. 4

Section 16 Other information

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

10.2.2 Safety data sheet for Microlube GL 261 lubricating grease

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

Section 1 Designation of substance/formulation and manufacturer

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

Manufacturer designation	
Company:	Klüber Lubrication München AG
Address:	Geisenhausenerstr. 7
Postal code:	D-81379 Munich
Country:	Germany
Phone:	+49 (0)89 7876 0

Manufacturer designation	
Fax:	+49 (0)89 7876 333
Information center:	Material Compliance Management
Emergency hotline:	+49 (0)89 7876 700

Section 2 Composition / Information about the components

Chemical characterization:	Mineral oil, lithium special soap, UV indicator
Hazardous components:	This product contains no dangerous components above the legally defined limit values.

Section 3 Possible hazards

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

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

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

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

Section 4 First aid measures

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

Ingestion:	Do not induce vomiting. If the person is unconscious, do not give anything by mouth. Consult a physician immediately.
Notes to physician:	<p>Treatment should in general be symptomatic and directed at relieving any effects.</p> <p>Note regarding high-pressure applications.</p> <p>Injection into the skin due to contact with a product under high pressure constitutes a major medical emergency. Within a few hours the tissue swells up and becomes discolored and extremely painful, with severe subcutaneous necrosis.</p> <p>Surgical treatment is absolutely imperative. Comprehensive opening of the wound and the tissue beneath it is necessary in order to reduce tissue loss and to prevent or limit lasting damage. The high pressure can cause the product to penetrate extensive areas of tissue layers.</p>

Section 5 Fire-fighting measures

Suitable extinguishing agents:	In the event of a fire: use water spray (mist), foam, dry chemicals or CO ₂ .
Unsuitable extinguishing agents:	Do not use water jets.
Special instructions for extinguishing work:	Contaminated extinguishing water must be collected separately and prevented from entering the drainage system.
Hazardous decomposition products:	Decomposition products include various oxides (e.g. carbon oxides).
Unusual fire/explosion hazards:	This product is not inherently explosive in accordance with the applicable rules.
Special fire-fighting measures:	-
Protection of fire-fighters:	Fire-fighters must wear self-contained positive pressure breathing apparatus (SCBA) and full protective gear.

Section 6 Measures after unintended release

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

Section 7 Handling and storage

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

VCI storage class:	11
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Section 8 Exposure limits and personal protective equipment

Threshold limit values (TLV):	No occupational exposure threshold limit values have been assigned for this product.
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Protective measures	
Limitation and monitoring of exposure in the workplace:	Provide exhaust ventilation or other engineering controls.
Hygiene measures:	Wash hands, forearms and face thoroughly after handling chemical products.
Respiratory protection:	Sufficient ventilation is recommended in industry. If ventilation is insufficient, respiratory protection is useful.
Hand protection:	Wear chemical-resistant gloves (recommended: nitrile gloves) if prolonged or repeated contact is likely.
Eye protection:	Protective goggles with side shields to guard against splashing.
Skin and body:	Wear appropriate clothing to avoid prolonged skin contact.

Section 9 Physical and chemical properties

Physical state:	Paste
Color:	Tawny
Odor:	Specific
Flash point:	-
Drop point:	>220 °C (DIN ISO 2176)
Density:	<1,000 kg/m ³ (<1 g/cm ³) at 20 °C
Solubility:	Insoluble in water

Section 10 Stability and reactivity

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

Section 11 Toxicological information

Chronic effects:	No particular effects or risks known.
Effects on eyes:	May cause mild eye irritation.
Effects on skin:	Prolonged or repeated contact can dry out the skin and lead to irritation and/or dermatitis. Allergic reactions are possible in the worst case.

Effect if inhaled:	Vapors and aerosols may cause irritation of the mucous membranes of the nose and throat.
Effect if ingested:	May cause nausea, vomiting and diarrhea.

Section 12 Ecological information

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

Section 13 Disposal information

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

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

Section 14 Transport information

Classification:	Not hazardous as defined by the transport regulations (ADR/RID, ADNR, IMDG, ICAO/IATA).
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Section 15 Regulations

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

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

Section 16 Other information

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

10.2.3 Safety data sheet for lubrication oil VIGO SB150

The following extract from the safety data sheet according to 1907/2006/EEC, Article 31 must be observed.

Section 1 Identification of the substance or mixture and of the company

1.1 Product identifier

Trade name:	VIGO OIL SB150
Article number:	36565

1.2 Relevant identified uses of the substance or mixture and uses advised against

No further relevant information available.

Use of substance or mixture:	Lubricating oil
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1.3 Details of the supplier of the safety data sheet

Manufacturer designation	
Manufacturer/supplier:	Kyodo Yushi Co., Ltd. 2-2-30 Tsujido Kandai, Fujisawa-shi Kanagawa 251-8588 JAPAN Nabtesco Corporation SERVICE CENTER TSU PLANT 594 Katada-cho, Tsu-shi, Mie-ken 514-8533

Department for information:	
Phone:	+81-59-237-4672
Fax:	+81-59-237-4697
e-mail address:	Center@nabtesco.com

1.4 Emergency telephone number

Emergency hotline	+81-59-237-4672
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Section 2 Possible hazards

2.1 Classification of the substance or mixture

Classification acc. to Regulation (EC) No. 1272/2008:	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:	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".
Classification system:	The classification corresponds to the current EC lists, but is supplemented by information from the specialist literature and from the manufacturer.

2.2 Label elements

Labeling in accordance with EEC directives:	The usual precautions when handling chemicals must be observed. The product is not subject to labeling obligations in accordance with EC directives / GefStoffV (German Ordinance on Hazardous Substances).
--	--

2.3 Other hazards

Results of PBT and vPvB assessment	
PBT:	Not applicable
vPvB:	Not applicable

Section 3 Composition / Information about the components

Chemical characterization:	Mixture
Description:	Mixture of the substances listed below with approximate proportions.
Hazardous components:	Not applicable
Additional information:	The exact wording of the hazard statements listed above can be found in (>>> "Section 16" Page 99).

Section 4 First aid measures

- 4.1 Description of first aid measures

General information:	No special measures required.
After inhalation:	Remove to fresh air; consult a doctor if symptoms persist.
After skin contact:	Dab affected areas of the skin with wadding or cellulose material, then wash thoroughly with water and a mild cleanser.
After contact with eyes:	Rinse eyes thoroughly under running water for several minutes with the eyelids open.
After swallowing:	Consult a doctor if symptoms persist.

- 4.2 Most important symptoms and effects, both acute and delayed
No further relevant information available.
- 4.3 Indication of any immediate medical attention and special treatment needed
No further relevant information available.

Section 5 Fire-fighting measures

- 5.1 Extinguishing agents

Suitable extinguishing agents:	CO ₂ , dry powder or water spray. Tackle larger fires with alcohol-resistant foam. Adjust the fire-extinguishing measures to suit the environment.
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- 5.2 Special hazards arising from the substance or mixture
Toxic gases can form when heated or in case of fire.
- 5.3 Advice for fire-fighters

Special protective equipment:	Wear a respirator.
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Section 6 Measures after unintended release

- 6.1 Personal precautions, protective equipment and emergency procedures
High risk of slipping due to leakage/spillage of product.
- 6.2 Environmental protection measures
Prevent from entering the drainage system, surface waters or groundwater.
- 6.3 Methods and material for containment and cleaning up
Bind with absorbent material (e.g. sand, diatomaceous earth, acid binding agent, general-purpose binding agent, sawdust).

- 6.4 Reference to other sections
No hazardous materials are released.
For information on safe handling, see (>>> "Section 7" Page 95).
For information on personal protective equipment, see (>>> "Section 8" Page 95).
For disposal information, see (>>> "Section 13" Page 98).

Section 7 Handling and storage

- 7.1 Precautions for safe handling

Safety measures:	Avoid exposure to heat and direct sunlight. No special measures required.
Instructions relating to fire and explosion protection:	The product forms flammable vapors when heated.

- 7.2 Conditions for safe storage, including any incompatibilities

Storage	
Requirements regarding storage rooms and containers:	No special requirements.
Information on storage with other products:	Keep separately from oxidizing agents.
Further specifications concerning storage conditions:	Protect from contamination.

Storage class	
Classification according to the German Ordinance on Industrial Safety and Health (BetrSichV):	-

- 7.3 Specific end use(s)
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 information, see (>>> "Section 7" Page 95).

- 8.1 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.
Additional information:	These values are based on the lists valid at the time of issue.

- 8.2 Limitation and monitoring of exposure

Personal safety precautions	
General protective and hygiene measures:	The usual precautions when handling chemicals must be observed.
Respiratory protection:	Not necessary if there is a good level of ventilation.

Personal safety precautions	
Hand protection:	<p>Oil-resistant gloves.</p> <p>The glove material must be impermeable and resistant to the product/substance/preparation.</p> <p>Due to a lack of tests, no recommendations can be made regarding glove material for the product/substance/chemical mixture.</p> <p>Glove material is to be selected on the basis of breakthrough times, permeation rates and degradation.</p>
Glove material:	The choice of suitable gloves depends not only on the material but also on additional quality characteristics, which can vary from manufacturer to manufacturer. Due to the fact that the product is a preparation consisting of several substances, it is not possible to predict the resistance of glove materials. The resistance of the materials must therefore be tested prior to use.
Breakthrough time of the glove material:	The precise breakthrough time must be obtained from the glove manufacturer and observed.
Eye protection:	Safety glasses are recommended when pouring the product.

Section 9

Physical and chemical properties

- 9.1 Information on basic physical and chemical properties

General information

Appearance:	
Physical state	Liquid
Color	Green
Odor:	Perceptible
Odor threshold:	Not determined
pH value:	Not determined
Change in state:	Not determined
Melting point/range	
Change in state:	Not determined
Boiling point/range	
Flash point:	234 °C (COC)
Ignition temperature:	Not determined
Decomposition temperature:	Not determined
Risk of explosion:	Not determined
Lower explosion limit:	Not determined
Upper explosion limit:	Not determined
Vapor pressure:	Not determined
Density at 15 °C:	0.87 g/cm ³
Relative density:	Not determined
Vapor density:	Not determined
Evaporation rate:	Not determined
Solubility/miscibility in water:	Insoluble

Partition coefficient (n-octanol/water):	Not determined
Viscosity:	
Dynamic	Not determined
Kinematic	Not determined

- 9.2 Other information
No further relevant information available.

Section 10

Stability and reactivity

- 10.1 Reactivity
- 10.2 Chemical stability
Thermal decomposition / conditions to be avoided:
To avoid thermal decomposition, do not overheat.
- 10.3 Possibility of hazardous reactions
No hazardous reactions known.
- 10.4 Conditions to be avoided
No further relevant information available.
- 10.5 Incompatible materials
No further relevant information available.
- 10.6 Hazardous decomposition products
Carbon monoxide and carbon dioxide
Toxic metal oxide fumes.

Section 11

Toxicological information

- 11.1 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".

With correct handling and use for the designated purpose, and on the basis of our experience and the information available to us, the product does not produce any effects harmful to health.

Section 12

Ecological information

- 12.1 Toxicity
Aquatic toxicity: No further relevant information available.
- 12.2 Persistence and degradability
Not easily biodegradable.
- 12.3 Bioaccumulative potential
No further relevant information available.

- 12.4 Mobility in soil
No further relevant information available.

Additional ecological information:

General information:

Water hazard classification 1 (manufacturer's classification): low hazard to waters.

Prevent from entering groundwater, surface waters or the drainage system in undiluted or large quantities.

- 12.5 Results of PBT and vPvB assessment
PBT: Not applicable
vPvB: Not applicable
- 12.6 Other adverse effects
No further relevant information available.

Section 13 Disposal information

- 13.1 Waste treatment methods

Recommendation:	Transfer to hazardous waste collector or transport to hazardous waste collection site.
Contaminated packaging/ recommendation:	Disposal in accordance with the applicable regulations.

Section 14 Transport information

- 14.1 UN number
ADR, ADN, IMDG, IATA: Not applicable
- 14.2 UN proper shipping name
ADR, ADN, IMDG, IATA: Not applicable
- 14.3 Transport hazard class(es)
ADR, ADN, IMDG, IATA class: Not applicable
- 14.4 Packing group
ADR, IMDG, IATA: Not applicable
- 14.5 Environmental hazards
Marine pollutant: No
- 14.6 Special precautions for user
Not applicable
- 14.7 Transport in bulk according to Annex II of MARPOL73/78 and the IBC Code
Not applicable
- Further information:
UN "Model Regulation": -

Section 15 Regulatory information

- 15.1 Safety, health and environmental regulations/legislation specific for the substance or mixture

National regulations	
Classification according to the German Ordinance on Industrial Safety and Health (BetrSichV)	-
Water hazard classification:	Water hazard class (WGK) 1 (manufacturer's classification): low hazard to waters.

- 15.2 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.

Department issuing data sheet: Product safety department.

Abbreviations and acronyms:

ADR: Accord européen sur le transport des marchandises dangereuses par Route (European Agreement concerning the International Carriage of Dangerous Goods by Road)

IMDG: International Maritime Code for Dangerous Goods

IATA: International Air Transport Association

GHS: Globally Harmonized System of Classification and Labelling of Chemicals

EINECS: European Inventory of Existing Commercial Chemical Substances

ELINCS: European List of Notified Chemical Substances

CAS: Chemical Abstracts Service (division of the American Chemical Society)

GefStoffV: Gefahrstoffverordnung (Ordinance on Hazardous Substances, Germany)

11 KUKA Service

11.1 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	<p>The following information is required for processing a support request:</p> <ul style="list-style-type: none"> ■ 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 <p>The following list gives an indication of the information which is relevant in many cases:</p> <ul style="list-style-type: none"> ■ 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

11.2 KUKA Customer Support

Availability	KUKA Customer Support is available in many countries. Please do not hesitate to contact us if you have any questions.
Argentina	<p>Ruben Costantini S.A. (Agency) Luis Angel Huergo 13 20 Parque Industrial 2400 San Francisco (CBA) Argentina Tel. +54 3564 421033 Fax +54 3564 428877 ventas@costantini-sa.com</p>
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