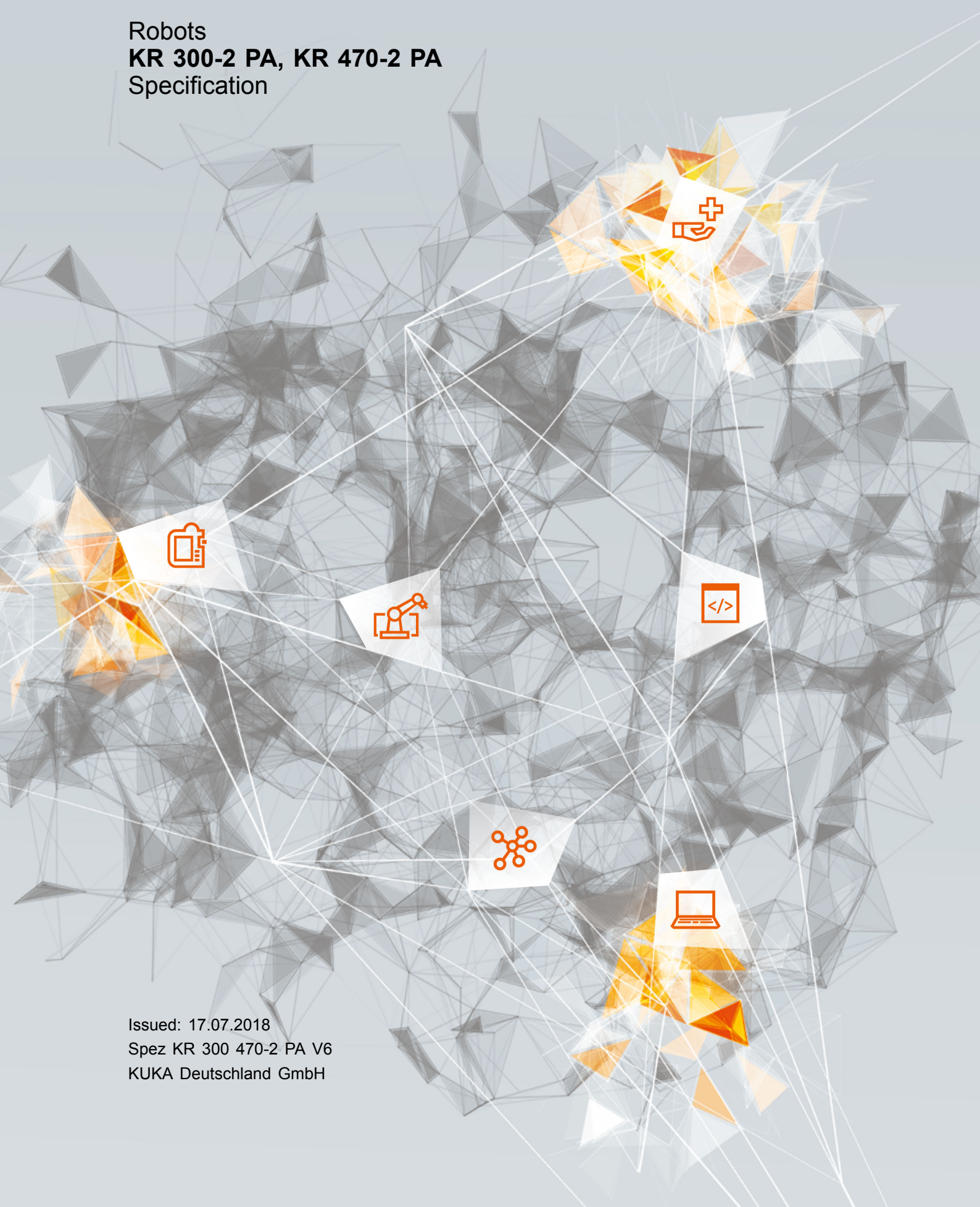


# KUKA



Robots  
**KR 300-2 PA, KR 470-2 PA**  
Specification



Issued: 17.07.2018  
Spez KR 300 470-2 PA V6  
KUKA Deutschland GmbH

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KUKA Deutschland GmbH  
Zugspitzstraße 140  
D-86165 Augsburg  
Germany

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

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

Subject to technical alterations without an effect on the function.

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# 1 Introduction

## 1.1 Industrial robot documentation

The industrial robot documentation consists of the following parts:

- Documentation for the manipulator
- Documentation for the robot controller
- Operating and programming instructions for the System Software
- Instructions for options and accessories
- Parts catalog on storage medium

Each of these sets of instructions is a separate document.

## 1.2 Representation of warnings and notes

### Safety

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



#### DANGER

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



#### WARNING

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



#### CAUTION

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

#### NOTICE

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



These warnings contain references to safety-relevant information or general safety measures.  
These warnings do not refer to individual hazards or individual precautionary measures.

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

#### SAFETY INSTRUCTION

The following procedure must be followed exactly!

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

### Notices

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



Tip to make your work easier or reference to further information.

## 2 Purpose

### 2.1 Target group

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

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



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

### 2.2 Intended use

#### Use

The industrial robot is intended for handling tools and fixtures or for processing and transferring components or products. Use is only permitted under the specified environmental conditions.

#### Misuse

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

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

#### NOTICE

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

#### NOTICE

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



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



## 3 Product description

### 3.1 Overview of the robot system

The industrial robot consists of the following components:

- Manipulator
- Robot controller
- Teach pendant
- Connecting cables
- Software
- Options, accessories

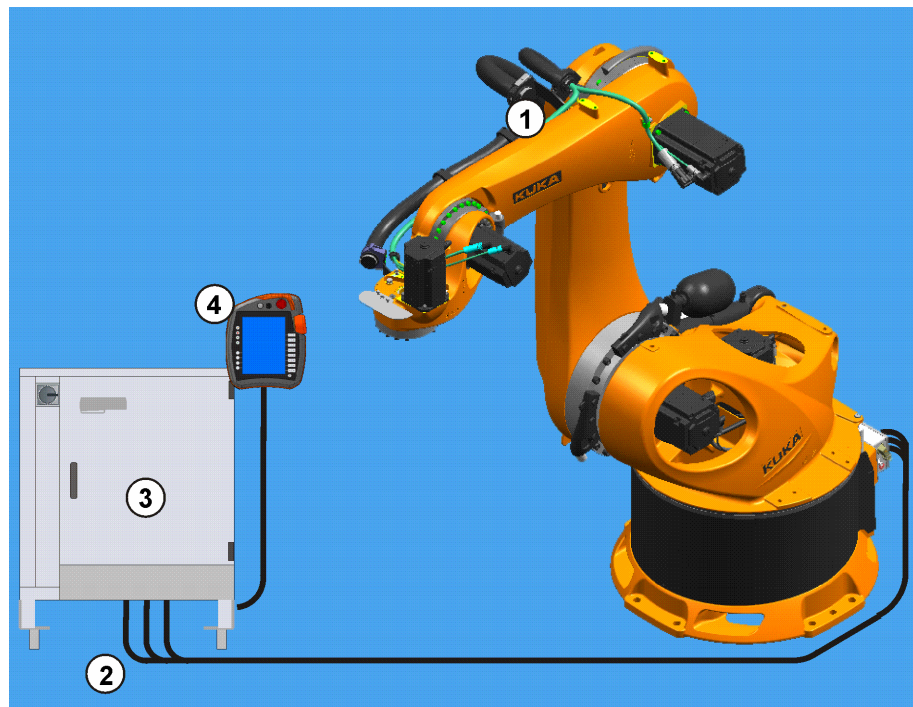


Fig. 3-1: Robot system KR 300, 470-2 PA

- |   |                   |   |                                   |
|---|-------------------|---|-----------------------------------|
| 1 | Robot             | 3 | KR C4 robot controller            |
| 2 | Connecting cables | 4 | Teach pendant KCP (KUKA smartPAD) |

### 3.2 Description of the robot

#### Overview

This robot is designed as a 5-axis jointed-arm kinematic system. The structural components of the robots are made of light alloy and iron castings. The axes are driven by AC servomotors. A hydropneumatic counterbalancing system is used to equalize the load moment about axis 2.

The robot consists of the following principal components (>>> [Fig. 3-2](#)):

- Wrist
- Arm
- Link arm
- Rotating column
- Base frame

- Counterbalancing system
- Electrical installations



**Fig. 3-2: KR 300 470-2 PA: main assemblies**

1	Wrist	5	Electrical installations
2	Arm	6	Base frame
3	Link arm	7	Rotating column
4	Counterbalancing system		

## Wrist

The robot variants KR 300 PA and KR 470 PA robots are equipped with a two-axis wrist for rated payloads of 300 kg and 470 kg, respectively. The wrist is fastened to the arm via a gear unit and motor and is driven by these. The main components of the wrist are the swing frame, axis 6 motor and the corresponding gear unit. The mounting flange embodies the output side of axis 6. The motor unit consists of a brushless AC servomotor with a permanent-magnet single-disk brake and hollow-shaft resolver, both integrated. The permanent-magnet single-disk brake performs a holding function when the servomotor is at rest and contributes to the braking of axis 6 in the event of short-circuit braking (e.g. if one or more of the enabling switches is released while in Test mode). Short-circuit braking must not be used to stop the robot under normal circumstances. End effectors can be attached to the mounting flange of axis 6. The wrist is designed as a hollow-shaft wrist and features a through-hole with a diameter of 60 mm.

The assembly also has a gauge mount with a gauge cartridge, through which the mechanical zero of the axis can be determined by means of a dial gauge or an electronic probe (accessory) and transferred to the controller.



## Arm

The arm is the transmission element between the wrist and the link arm. The swing frame of the wrist is mounted on the arm via gear unit A5. This motor/gear combination embodies axis 5, which cannot be freely controlled during operation. The arm is driven by an AC servomotor via a gear unit that is installed between the arm and the link arm. This gear unit is also the bearing for the arm. The maximum permissible swivel angle is mechanically limited by a stop for each direction, plus and minus. The buffers are attached to the arm. The corresponding stops are situated on the link arm.

## Link arm

The link arm is the assembly located between the arm and the rotating column. It is mounted on one side of the rotating column via the gear unit of axis 2 and is driven by an AC servomotor. During motion about axis 2, the link arm moves about the stationary rotating column. The cable harness of the electrical installations is routed inside the link arm and is mounted in hinged clamps.

## 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. It is screwed to the base frame via the gear unit of axis 1. The AC servomotor for driving axis 1 is mounted inside the rotating column. The counterbearing for the counterbalancing system is integrated into the rear of the rotating column housing. The fork slots are also screwed to the rotating column if the robot is transported using a fork lift truck.

## Base frame

The base frame is the base of the robot. It is screwed to the mounting base. The interfaces for the electrical installations and the energy supply systems (accessory) are housed in the base frame. The base frame and rotating column are connected via the gear unit of axis 1. The flexible tube for the electrical installations and the energy supply system is accommodated in the base frame.

## Counterbalancing system

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

## Electrical installations

The electrical installations are described in Chapter .

## 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. The options are described in separate documentation.

## 4 Technical data

### 4.1 Basic data

#### Basic data

Type	KR 300-2 PA KR 470-2 PA
Number of axes	5
Work envelope volume	73.5 m <sup>3</sup>
Pose repeatability (ISO 9283)	KR 300-2 PA ±0.08 mm KR 470-2 PA ±0.08 mm
Work envelope reference point	Intersection of axis 6 with the mounting flange face
Reach	3,150 mm
Weight of robot	2,150 kg
Weight of transport frame	212 kg
Principal dynamic loads	See "Loads acting on the mounting base"
Protection rating of the robot	IP65 ready for operation, with connecting cables plugged in (according to EN 60529)
Protection rating of the wrist	IP65
Sound level	< 72 dB (A) outside the working envelope
Mounting position	Ground
Surface finish, paintwork	Base (stationary) and counterbalancing system: RAL 9005; moving parts: KUKA orange 2567

#### Ambient temperature, standard

Operation	273 K to 328 K (0 °C to +55 °C)
Storage and transportation	233 K to 333 K (-40 °C to +60 °C)
Start-up	In the case of start-up in the range of 273 K to 288 K (0 °C to +15 °C), the robot may have to be warmed up. Other temperature limits available on request.
Ambient conditions	DIN EN 60721-3-3, Class 3K3

Further information about temperatures, duty cycle, set-up, etc. can be obtained from KUKA Technical Support. No restrictions in operating mode T1.

## Connecting cables

Cable designation	Connector designation	Interface with robot
Motor cable	X20.1 - X30.1	Harting connectors at both ends
Motor cable	X20.4 - X30.4	Harting connectors at both ends
Control cable	X21 - X31	HAN 3A EMC at both ends
Ground conductor / equipotential bonding 16 mm <sup>2</sup> (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	10x D	

For detailed specifications of the connecting cables, see (>>> [6.5 "Connecting cables and interfaces" Page 57](#)).

## 4.2 Axis data

### Axis data

The following data are valid for the robot KR 300-2 PA.

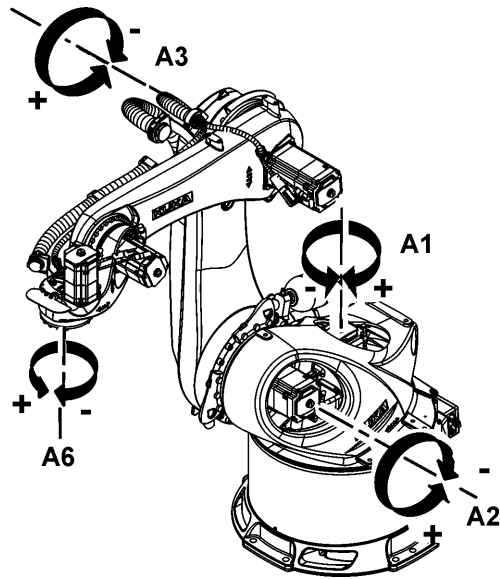
Axis	Range of motion, software-limited	Speed with rated payload
1	+/-185°	97.5 °/s
2	+20° to -130°	91.0 °/s
3	+155° to -0°*	89.0 °/s
5	Axis not actively selectable	
6	+/-350°	177.0 °/s

The following data are valid for the robot KR 470-2 PA.

Axis	Range of motion, software-limited	Speed with rated payload
1	+/-185°	84.0 °/s
2	+20° to -130°	78.0 °/s
3	+155° to -0°*	73.0 °/s
5	Axis not actively selectable	
6	+/-350°	177.0 °/s

\* Maximum value, referred to the link arm, depending on the position of axis 2

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

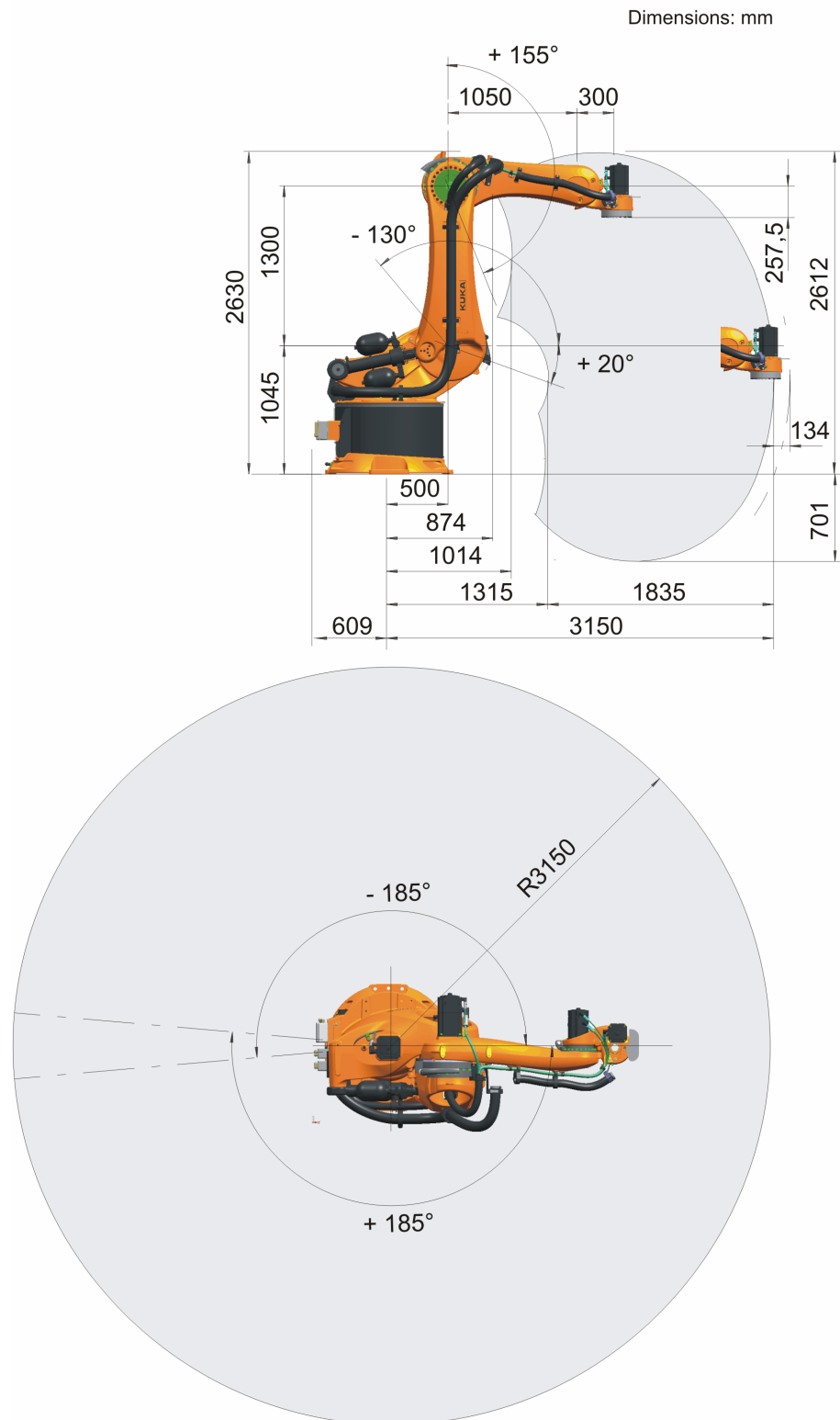


**Fig. 4-1: Direction of rotation of robot axes**

### Working envelope

The diagram (>>> [Fig. 4-2](#)) shows the shape and size of the working envelope.

The reference point for the working envelope is the intersection of axis 6 with the mounting flange face.



**Fig. 4-2: Working envelope: KR 300 470 PA**

### 4.3 Payloads

#### Payloads

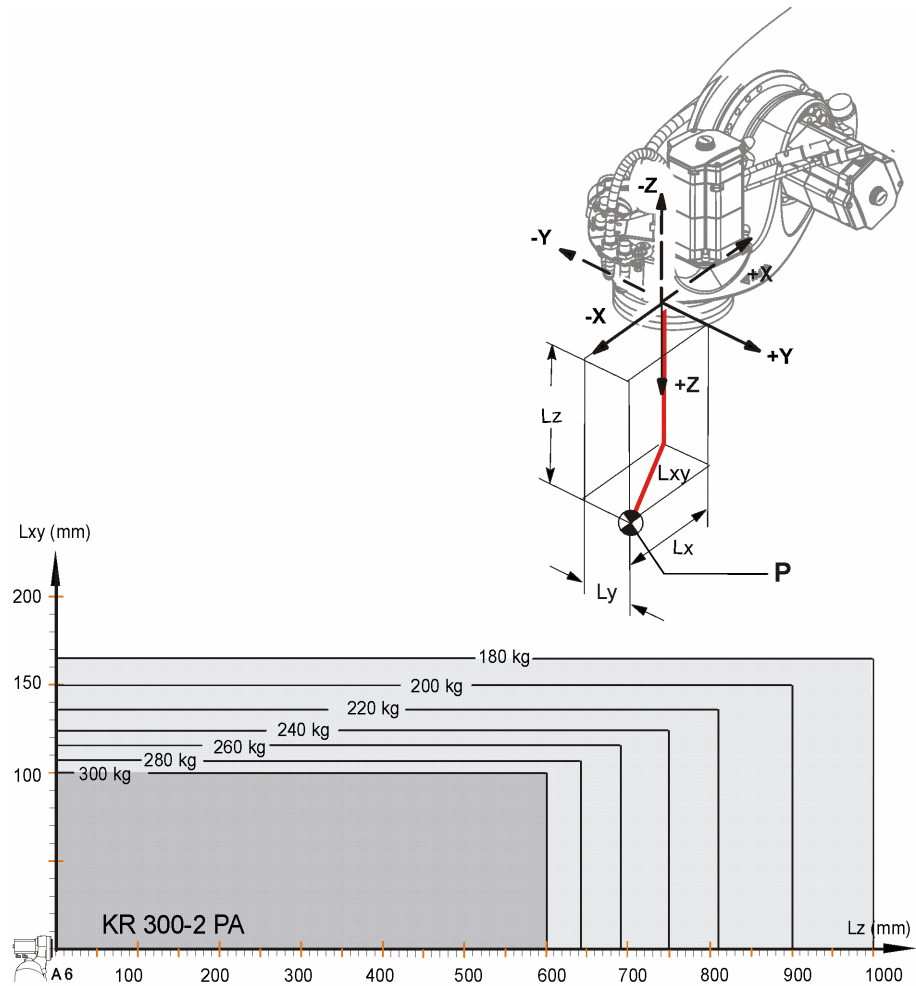
Robot	KR 300-2 PA	KR 470-2 PA
Wrist	Hollow-shaft wrist	Hollow-shaft wrist
Rated payload	300 kg	470 kg
Distance of the load center of gravity $L_z$	300 mm	300 mm
Distance of the load center of gravity $L_{xy}$	100 mm	100 mm
Permissible moment of inertia	150 kgm <sup>2</sup>	235 kgm <sup>2</sup>
Max. total load	350 kg	520 kg
Supplementary load, arm	50 kg	50 kg
Supplementary load, link arm	0 kg	0 kg
Supplementary load, rotating column	0 kg	0 kg

#### Load center of gravity P

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.



**Payload diagram**



**Fig. 4-3: Payload diagram for KR 300-2 PA**

**NOTICE**

This loading curve corresponds to the maximum load capacity. Both values (payload and mass moment of inertia) must be checked in all cases. Exceeding this capacity will reduce the service life of the robot and overload the motors and the gears; in any such case KUKA Deutschland GmbH must be consulted beforehand.

The values determined here are necessary for planning the robot application. For commissioning the robot, additional input data are required in accordance with the operating and programming instructions of the KUKA System Software.

The mass inertia must be verified using KUKA.Load. It is imperative for the load data to be entered in the robot controller!

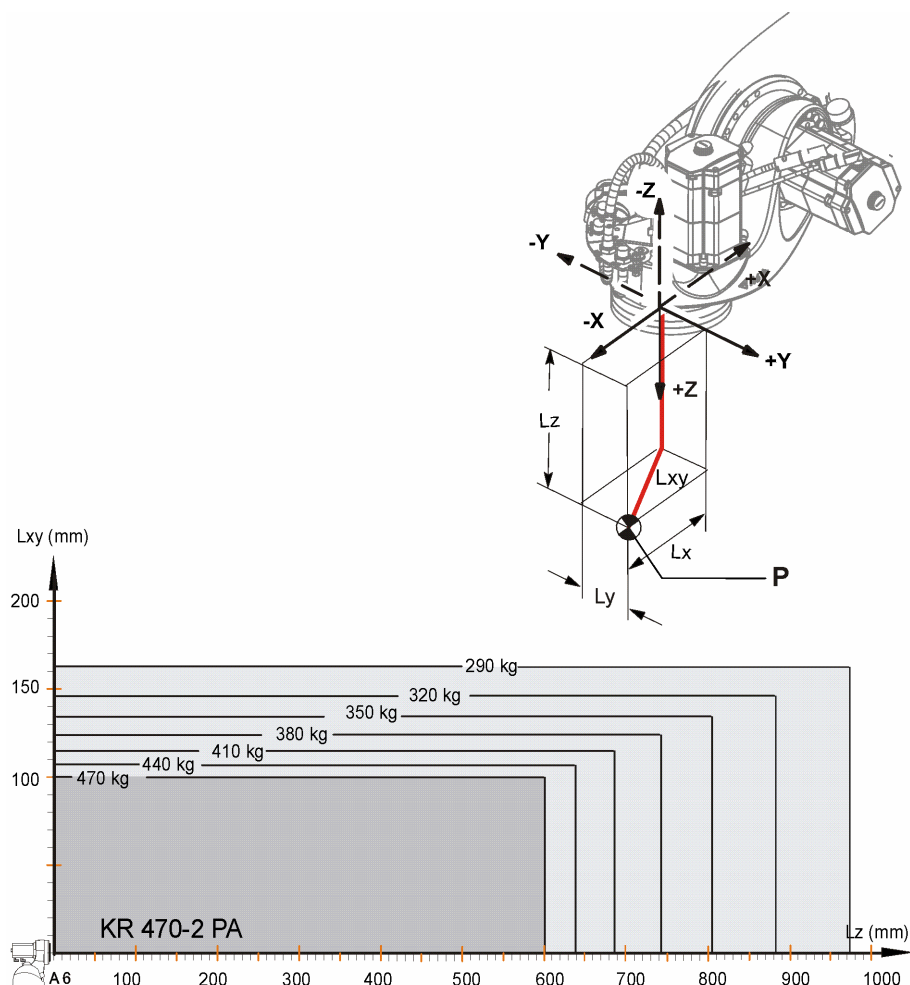
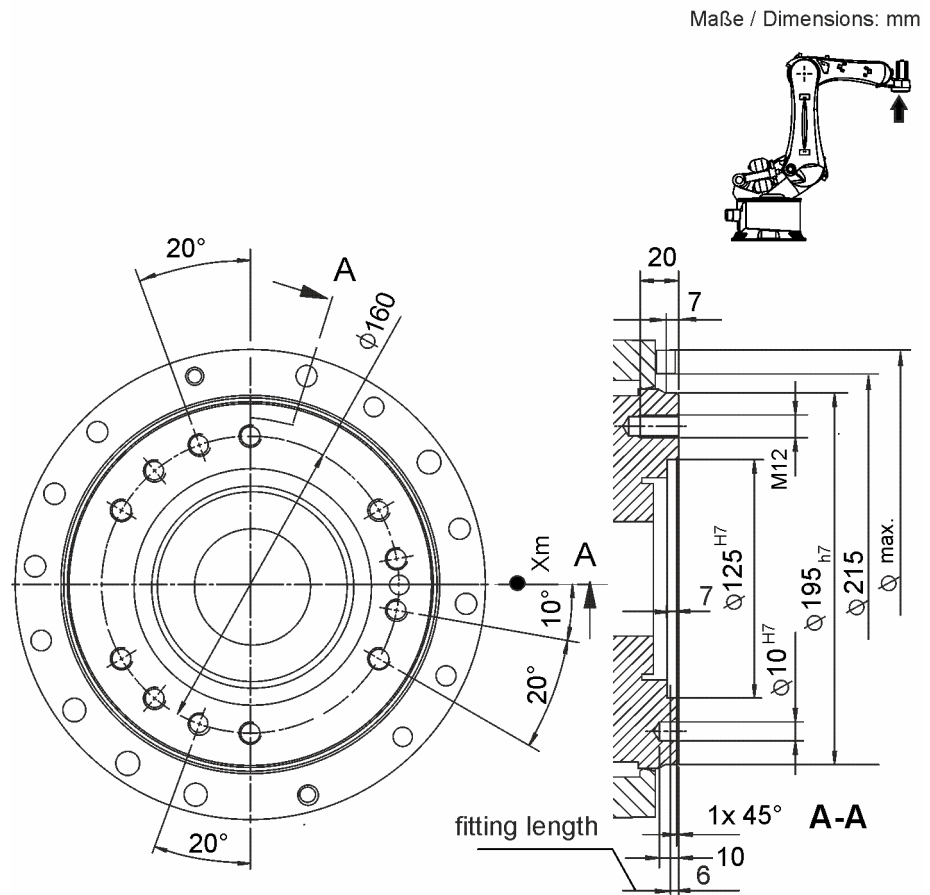


Fig. 4-4: Payload diagram for KR 470-2 PA

Mounting flange

Mounting flange	similar to DIN/ISO 9409-1-A160*
Screw grade	10.9
Screw size	M12
Clamping length	1.5 x nominal diameter
Depth of engagement	min. 15 mm, max. 19.5 mm
Locating element	10 H7
Through-hole for energy supply system	ø 60 mm

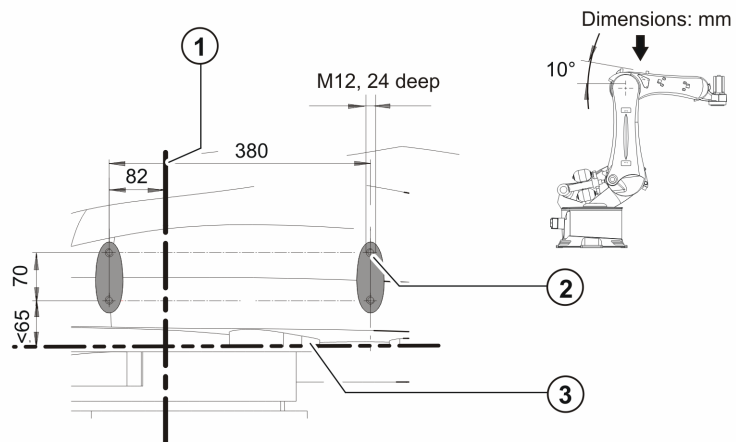
\*The inner locating diameter is ø 125 H7. This deviates from the standard. The mounting flange is depicted with axis 6 in the zero position (>>> Fig. 4-5). The symbol X<sub>m</sub> indicates the position of the locating element (bushing) in the zero position.



**Fig. 4-5: Mounting flange**

**Supplementary load**

The robot can carry supplementary loads on the arm. When mounting the supplementary loads, be careful to observe the maximum permissible total load. The dimensions and positions of the installation options can be seen in the diagram. All other threads and holes on the robot are not suitable for attaching additional loads .



**Fig. 4-6: Supplementary load on arm**

- 1 Axis 3
- 2 Fastening thread
- 3 Interference contour on right

#### 4.4 Foundation data

##### Foundation loads

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

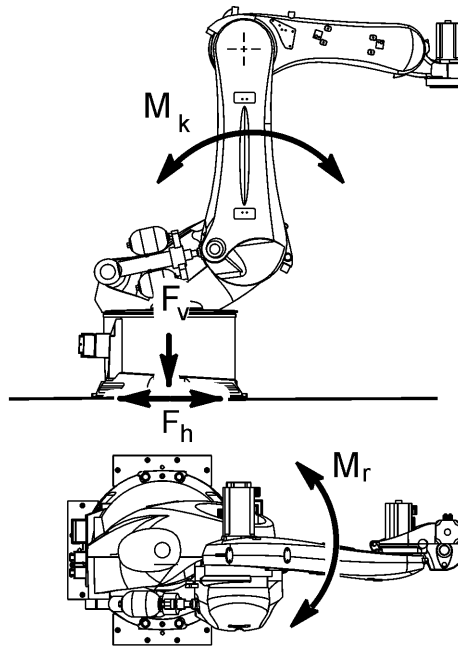


Fig. 4-7: Loads acting on the foundation

Type of load	Force/torque/mass
$F_v$ = vertical force	$F_{v \text{ normal}} = 36,000 \text{ N}$ $F_{v \text{ max}} = 40,500 \text{ N}$
$F_h$ = horizontal force	$F_{h \text{ normal}} = 10,500 \text{ N}$ $F_{h \text{ max}} = 23,500 \text{ N}$
$M_k$ = tilting moment	$M_{k \text{ normal}} = 47,000 \text{ Nm}$ $M_{k \text{ max}} = 84,500 \text{ Nm}$
$M_r$ = torque	$M_{r \text{ normal}} = 20,500 \text{ Nm}$ $M_{r \text{ max}} = 45,500 \text{ Nm}$
Total mass for foundation load	for KR 300 PA: 2,290 kg for KR 470: 2,410 kg
Robot	1940 kg
Total mass for foundation load	for KR 300 PA: 350 kg for KR 470 PA: 520 kg



The supplementary loads are not taken into consideration in the calculation of the foundation load. These supplementary loads must be taken into consideration for  $F_v$ .

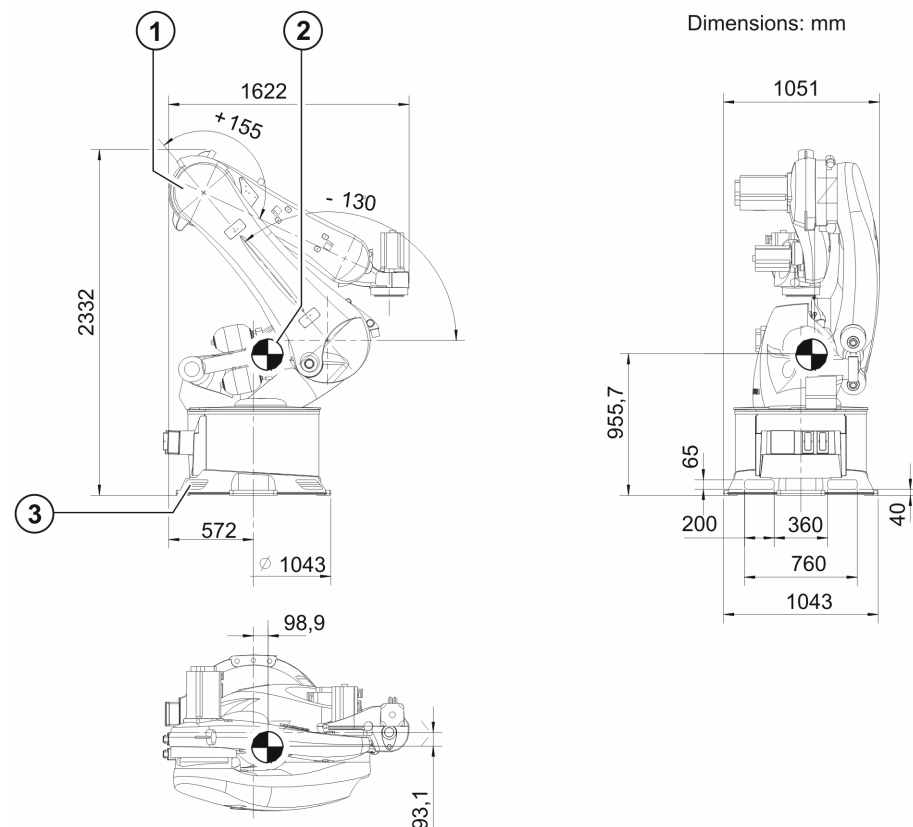
## Grade of concrete for foundations

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 bedplate/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

## 4.5 Transport dimensions

The transport dimensions (>>> Fig. 4-8) for the robot can be noted from the following diagram. 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. 4-8: Transport dimensions**

- 1 Robot
- 2 Center of gravity
- 3 Fork slots

## 4.6 Plates and labels

### Plates and labels

The following plates and labels are attached to the robot. They must not be removed or rendered illegible. Illegible plates and labels must be replaced.

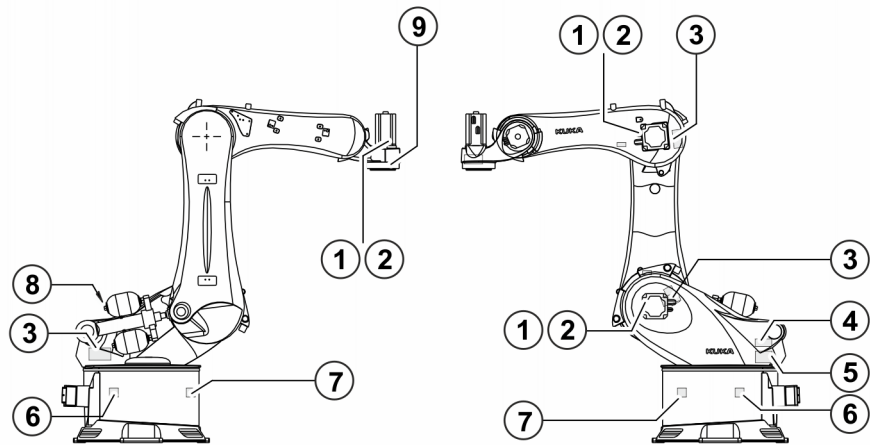



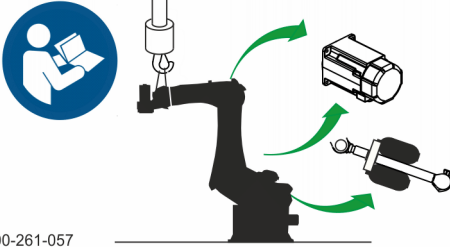




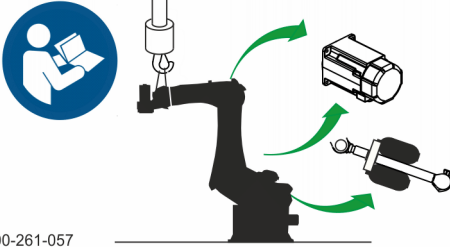




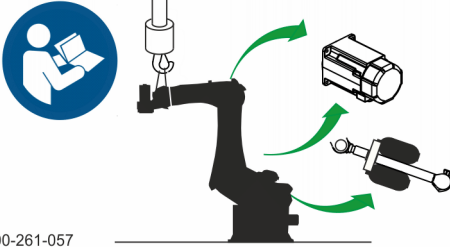



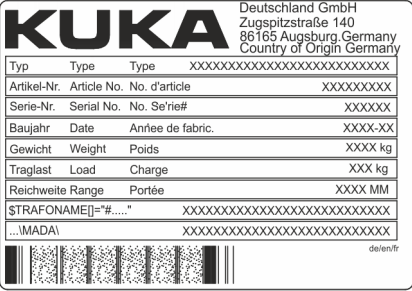
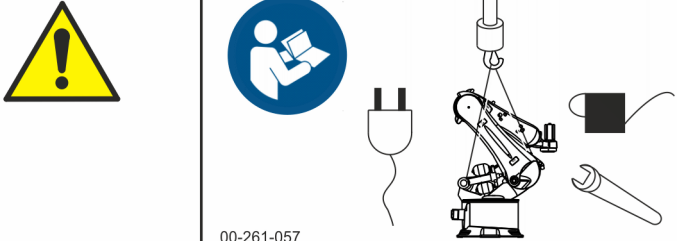
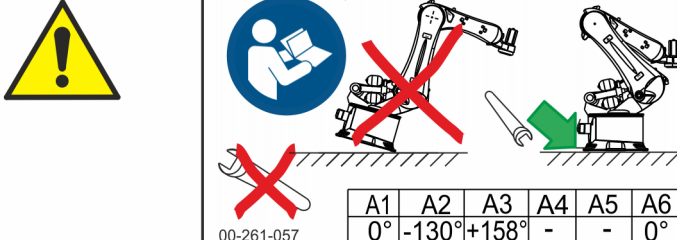
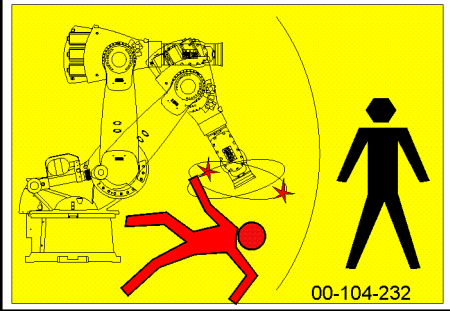

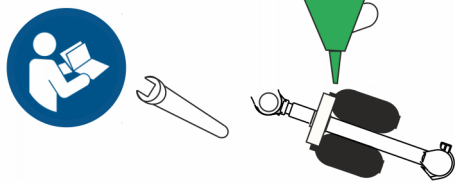

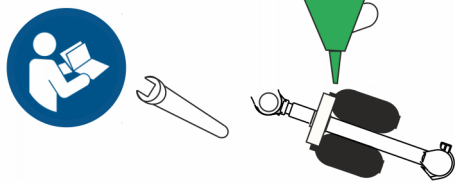

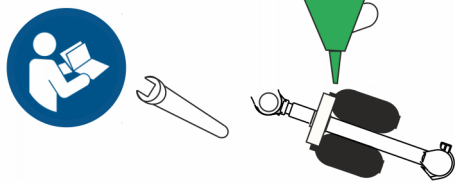


Fig. 4-9: Location of plates and labels

Item	Description								
1	 <p><b>High voltage</b> Any improper handling can lead to contact with current-carrying components. Electric shock hazard!</p>								
2	 <p><b>Hot surface</b> 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 data-bbox="592 1308 887 1592" style="text-align: center; vertical-align: middle;">  </td> <td data-bbox="887 1308 1362 1592">  <p style="font-size: small;">00-261-057</p> </td> </tr> <tr> <td data-bbox="592 1592 887 1671" style="background-color: yellow; text-align: center;">  <b>CAUTION</b> </td> <td data-bbox="887 1592 1362 1671"> <p><b>Before removing the motor or counterbalancing system, secure robot axis to prevent it from moving!</b></p> </td> </tr> <tr> <td data-bbox="592 1671 887 1749" style="background-color: yellow; text-align: center;">  <b>ATTENTION</b> </td> <td data-bbox="887 1671 1362 1749"> <p><b>Avant de retirer le moteur ou le système d'équilibrage, protéger l'axe du robot pour éviter tout mouvement!</b></p> </td> </tr> <tr> <td data-bbox="592 1749 887 1827" style="background-color: yellow; text-align: center;">  <b>VORSICHT</b> </td> <td data-bbox="887 1749 1362 1827"> <p><b>Vor Entfernen des Motors oder des Gewichtsausgleichs, Roboterachse gegen Bewegungen sichern!</b></p> </td> </tr> </table> <p><b>Secure the axes</b> Before exchanging any motor or counterbalancing system, 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;">00-261-057</p>	 <b>CAUTION</b>	<p><b>Before removing the motor or counterbalancing system, secure robot axis to prevent it from moving!</b></p>	 <b>ATTENTION</b>	<p><b>Avant de retirer le moteur ou le système d'équilibrage, protéger l'axe du robot pour éviter tout mouvement!</b></p>	 <b>VORSICHT</b>	<p><b>Vor Entfernen des Motors oder des Gewichtsausgleichs, Roboterachse gegen Bewegungen sichern!</b></p>
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4	<div data-bbox="592 215 1050 539" style="border: 1px solid black; padding: 5px;">  <p style="text-align: right; margin-right: 10px;">Deutschland GmbH Zugspitzstraße 140 86165 Augsburg, Germany Country of Origin Germany</p> <table border="1" style="width: 100%; border-collapse: collapse; font-size: 8px;"> <tr> <td>Typ</td><td>Type</td><td>Type</td><td>XXXXXXXXXXXXXXXXXXXXXXXXXX</td></tr> <tr> <td>Artikel-Nr.</td><td>Article No.</td><td>No. d'article</td><td>XXXXXXXXXX</td></tr> <tr> <td>Serie-Nr.</td><td>Serial No.</td><td>No. Série#</td><td>XXXXXX</td></tr> <tr> <td>Baujahr</td><td>Date</td><td>Année de fabric.</td><td>XXXX-XX</td></tr> <tr> <td>Gewicht</td><td>Weight</td><td>Poids</td><td>XXXX kg</td></tr> <tr> <td>Traglast</td><td>Load</td><td>Charge</td><td>XXX kg</td></tr> <tr> <td>Reichweite</td><td>Range</td><td>Portée</td><td>XXXX MM</td></tr> <tr> <td colspan="2">STRAFONAME[]=#....."</td> <td colspan="2">XXXXXXXXXXXXXXXXXXXXXXXXXX</td> </tr> <tr> <td colspan="2">...MADA)</td> <td colspan="2">XXXXXXXXXXXXXXXXXXXXXXXXXX</td> </tr> </table> <p style="text-align: right; font-size: 8px;">de/en/fr</p> </div> <p><b>Identification plate</b> Content according to Machinery Directive.</p>	Typ	Type	Type	XXXXXXXXXXXXXXXXXXXXXXXXXX	Artikel-Nr.	Article No.	No. d'article	XXXXXXXXXX	Serie-Nr.	Serial No.	No. Série#	XXXXXX	Baujahr	Date	Année de fabric.	XXXX-XX	Gewicht	Weight	Poids	XXXX kg	Traglast	Load	Charge	XXX kg	Reichweite	Range	Portée	XXXX MM	STRAFONAME[]=#....."		XXXXXXXXXXXXXXXXXXXXXXXXXX		...MADA)		XXXXXXXXXXXXXXXXXXXXXXXXXX	
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Item	Description								
7	 <p><b>Danger zone</b> Entering the danger zone of the robot is prohibited if the robot is in operation or ready for operation. Risk of injury!</p>								
8	<table border="1" data-bbox="592 663 1362 1160"> <tr> <td data-bbox="592 663 884 943">  </td> <td data-bbox="884 663 1362 943">  <p><b>p &gt; 14 MPa (140 bar)</b> 00-261-057</p> </td> </tr> <tr> <td data-bbox="592 943 884 1021"> <p><b>CAUTION</b></p> </td> <td data-bbox="884 943 1362 1021"> <p>Counterbalancing system pressurized – read and observe safety instructions before beginning work!</p> </td> </tr> <tr> <td data-bbox="592 1021 884 1099"> <p><b>ATTENTION</b></p> </td> <td data-bbox="884 1021 1362 1099"> <p>Le système d'équilibrage est sous pression, lire et respecter les remarques relatives à la sécurité avant d'effectuer des travaux!</p> </td> </tr> <tr> <td data-bbox="592 1099 884 1160"> <p><b>VORSICHT</b></p> </td> <td data-bbox="884 1099 1362 1160"> <p>Gewichtsausgleich unter Druck, vor Arbeiten Sicherheitshinweise lesen und beachten!</p> </td> </tr> </table> <p><b>Counterbalancing system</b> The system is pressurized with oil and nitrogen. Read and follow the assembly and operating instructions before commencing work on the counterbalancing system. Risk of injury!</p>		 <p><b>p &gt; 14 MPa (140 bar)</b> 00-261-057</p>	<p><b>CAUTION</b></p>	<p>Counterbalancing system pressurized – read and observe safety instructions before beginning work!</p>	<p><b>ATTENTION</b></p>	<p>Le système d'équilibrage est sous pression, lire et respecter les remarques relatives à la sécurité avant d'effectuer des travaux!</p>	<p><b>VORSICHT</b></p>	<p>Gewichtsausgleich unter Druck, vor Arbeiten Sicherheitshinweise lesen und beachten!</p>
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9	<table border="1" data-bbox="592 1346 1123 1644"> <tr> <td data-bbox="592 1346 852 1435"> <p><b>Schrauben</b> <b>Einschraubtiefe</b> <b>Klemmlänge</b></p> </td> <td data-bbox="852 1346 1123 1435"> <p><b>M12 Qualität 10.9</b> <b>min.15mm max. 19,5mm</b> <b>min. 15mm</b></p> </td> </tr> <tr> <td data-bbox="592 1435 852 1525"> <p><b>Fastening screws</b> <b>Engagement length</b> <b>Screw grip</b></p> </td> <td data-bbox="852 1435 1123 1525"> <p><b>M12 quality 10.9</b> <b>min. 15mm max. 19,5mm</b> <b>min. 15mm</b></p> </td> </tr> <tr> <td data-bbox="592 1525 852 1644"> <p><b>Vis</b> <b>Longueur vissée</b> <b>Longueur de serrage</b></p> </td> <td data-bbox="852 1525 1123 1644"> <p><b>M12 qualité 10.9</b> <b>min. 15mm max. 19,5mm</b> <b>min. 15mm</b> Art.Nr. 00-180-008</p> </td> </tr> </table> <p><b>Mounting flange on in-line wrist</b> The values specified on this plate apply for the installation of tools on the mounting flange of the wrist and must be observed.</p>	<p><b>Schrauben</b> <b>Einschraubtiefe</b> <b>Klemmlänge</b></p>	<p><b>M12 Qualität 10.9</b> <b>min.15mm max. 19,5mm</b> <b>min. 15mm</b></p>	<p><b>Fastening screws</b> <b>Engagement length</b> <b>Screw grip</b></p>	<p><b>M12 quality 10.9</b> <b>min. 15mm max. 19,5mm</b> <b>min. 15mm</b></p>	<p><b>Vis</b> <b>Longueur vissée</b> <b>Longueur de serrage</b></p>	<p><b>M12 qualité 10.9</b> <b>min. 15mm max. 19,5mm</b> <b>min. 15mm</b> Art.Nr. 00-180-008</p>		
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**4.7 REACH duty to communicate information acc. to Art. 33 of Regulation (EC) 1907/2006**

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

## 4.8 Stopping distances and times

### 4.8.1 General information

Information concerning the data:

- The stopping distance is the angle traveled by the robot from the moment the stop signal is triggered until the robot comes to a complete standstill.
- The stopping time is the time that elapses from the moment the stop signal is triggered until the robot comes to a complete standstill.
- The data are given for the main axes A1, A2 and A3. The main axes are the axes with the greatest deflection.
- Superposed axis motions can result in longer stopping distances.
- Stopping distances and stopping times in accordance with DIN EN ISO 10218-1, Annex B.
- Stop categories:
  - Stop category 0 » STOP 0
  - Stop category 1 » STOP 1 according to IEC 60204-1
- The values specified for Stop 0 are guide values determined by means of tests and simulation. They are average values which conform to the requirements of DIN EN ISO 10218-1. The actual stopping distances and stopping times may differ due to internal and external influences on the braking torque. It is therefore advisable to determine the exact stopping distances and stopping times where necessary under the real conditions of the actual robot application.
- Measuring technique  
The stopping distances were measured using the robot-internal measuring technique.
- The wear on the brakes varies depending on the operating mode, robot application and the number of STOP 0 stops triggered. It is therefore advisable to check the stopping distance at least once a year.

### 4.8.2 Terms used

Term	Description
m	Mass of the rated load and the supplementary load on the arm.
Phi	Angle of rotation (°) about the corresponding axis. This value can be entered in the controller via the KCP/smartPAD and can be displayed on the KCP/smartPAD.
POV	Program override (%) = velocity of the robot motion. This value can be entered in the controller via the KCP/smartPAD and can be displayed on the KCP/smartPAD.
Extension	Distance (l in %) (>>> <i>Fig. 4-10</i> ) between axis 1 and the intersection of axes 4 and 5. With parallelogram robots, the distance between axis 1 and the intersection of axis 6 and the mounting flange.
KCP	KUKA Control Panel

Term	Description
	Teach pendant for the KR C2/KR C2 edition2005 The KCP has all the operator control and display functions required for operating and programming the industrial robot.
smartPAD	Teach pendant for the KR C4 The smartPAD has all the operator control and display functions required for operating and programming the industrial robot.

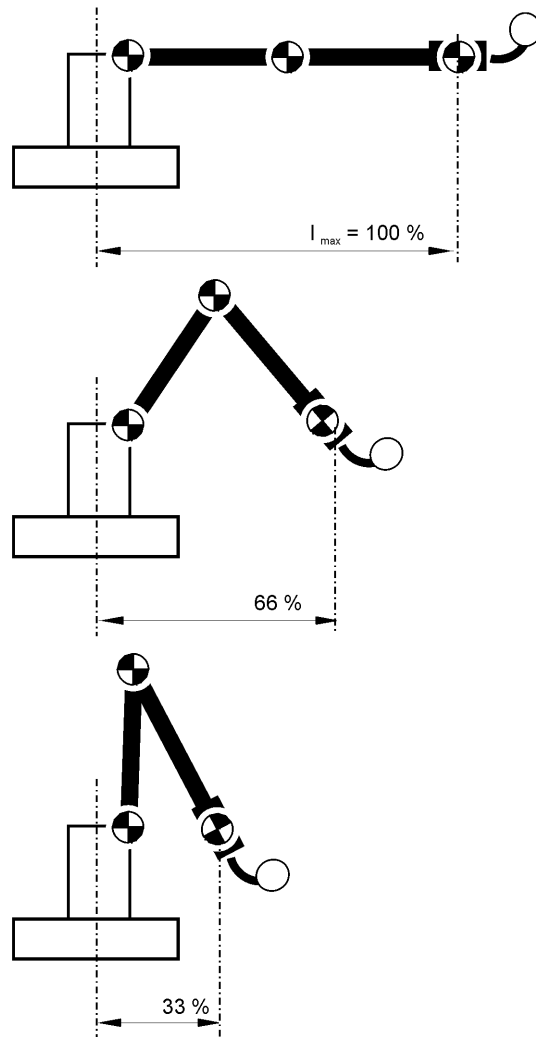


Fig. 4-10: Extension

### 4.8.3 Stopping distance and stopping times for KR 300 PA

#### 4.8.3.1 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		
Axis 2		
Axis 3		

No data are currently available for STOP 0 for axes 1-3.

### 4.8.3.2 Stopping distances and stopping times for STOP 1, axis 1

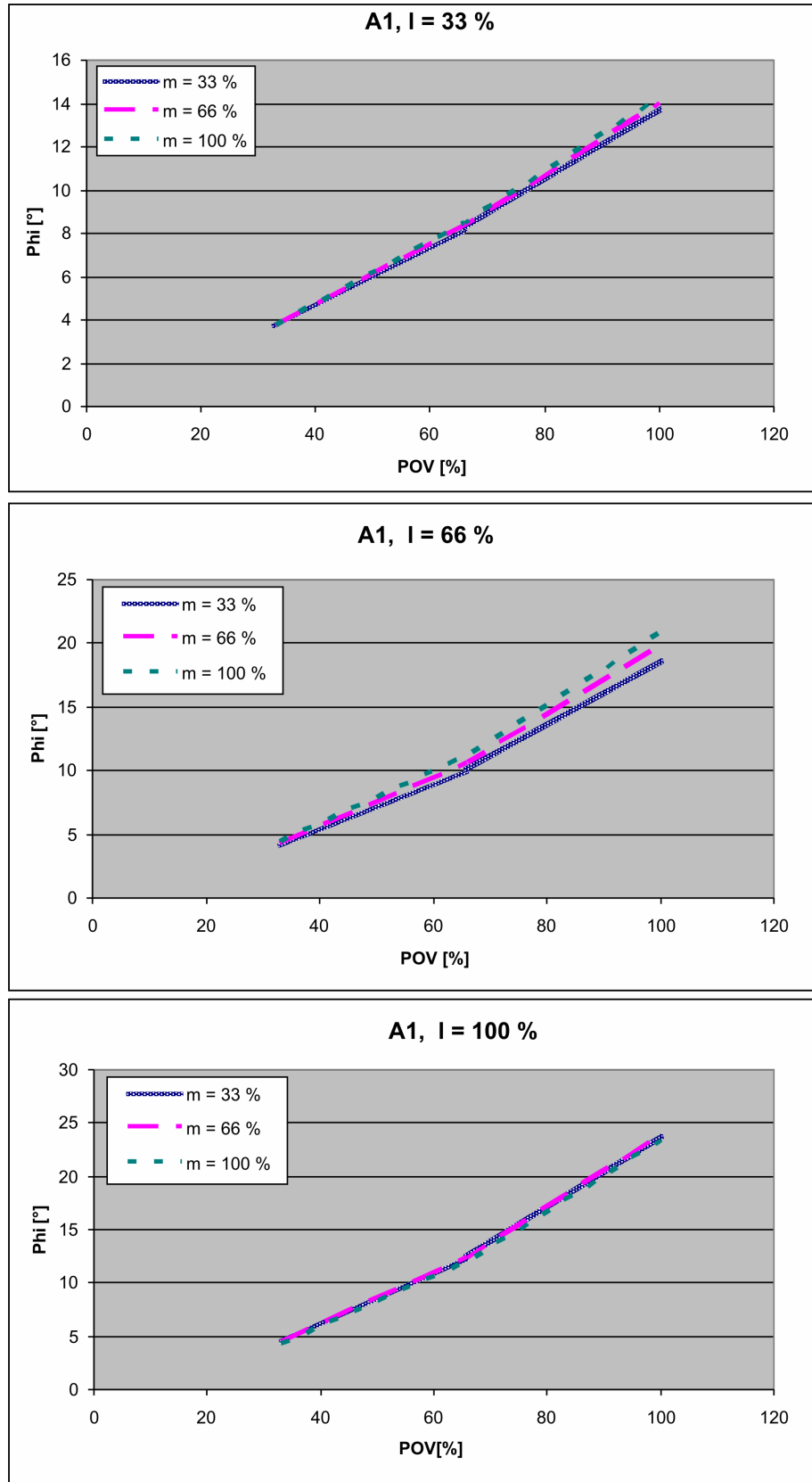


Fig. 4-11: Stopping distances for STOP 1, axis 1



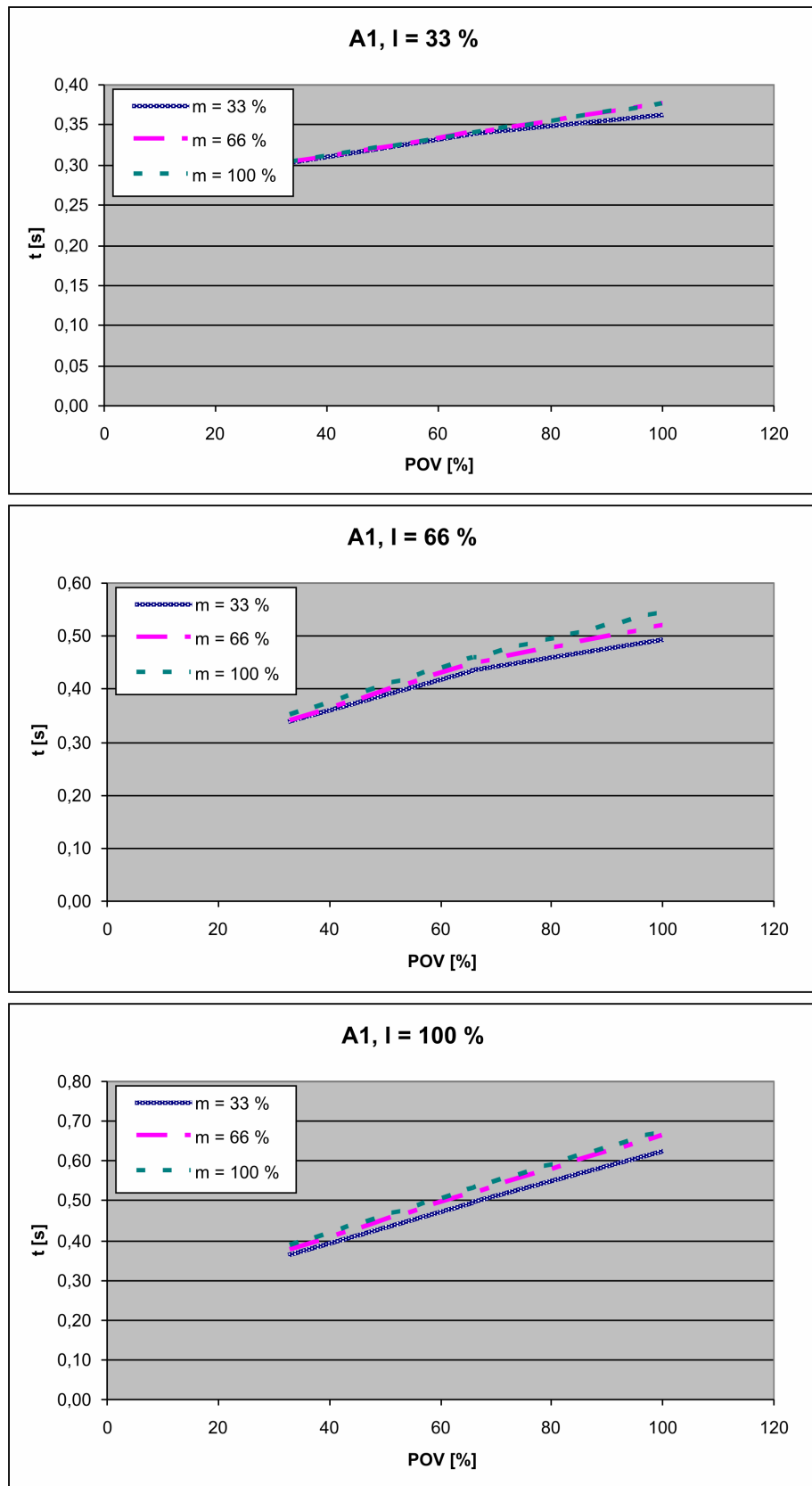


Fig. 4-12: Stopping times for STOP 1, axis 1

### 4.8.3.3 Stopping distances and stopping times for STOP 1, axis 2

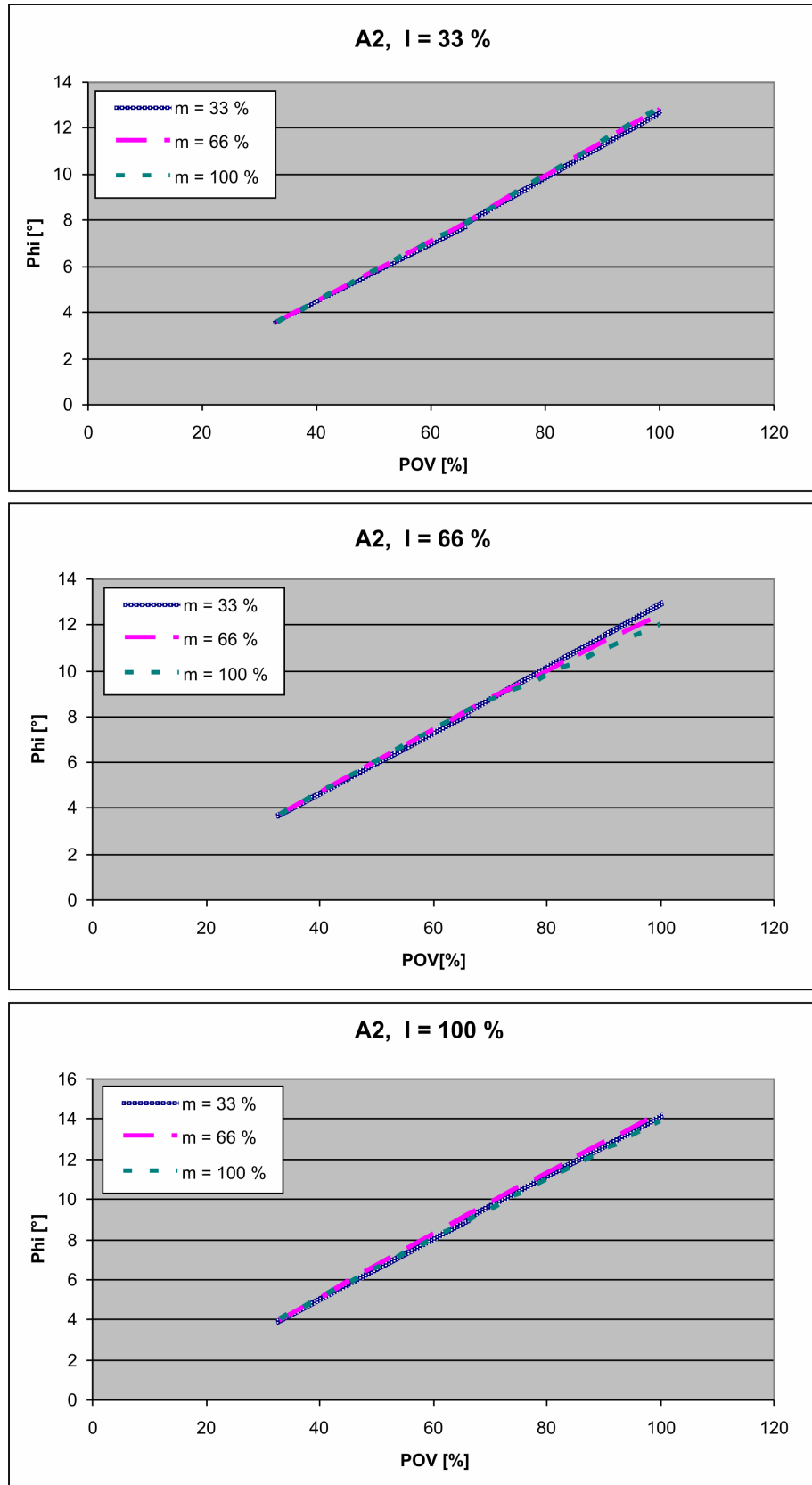


Fig. 4-13: Stopping distances for STOP 1, axis 2

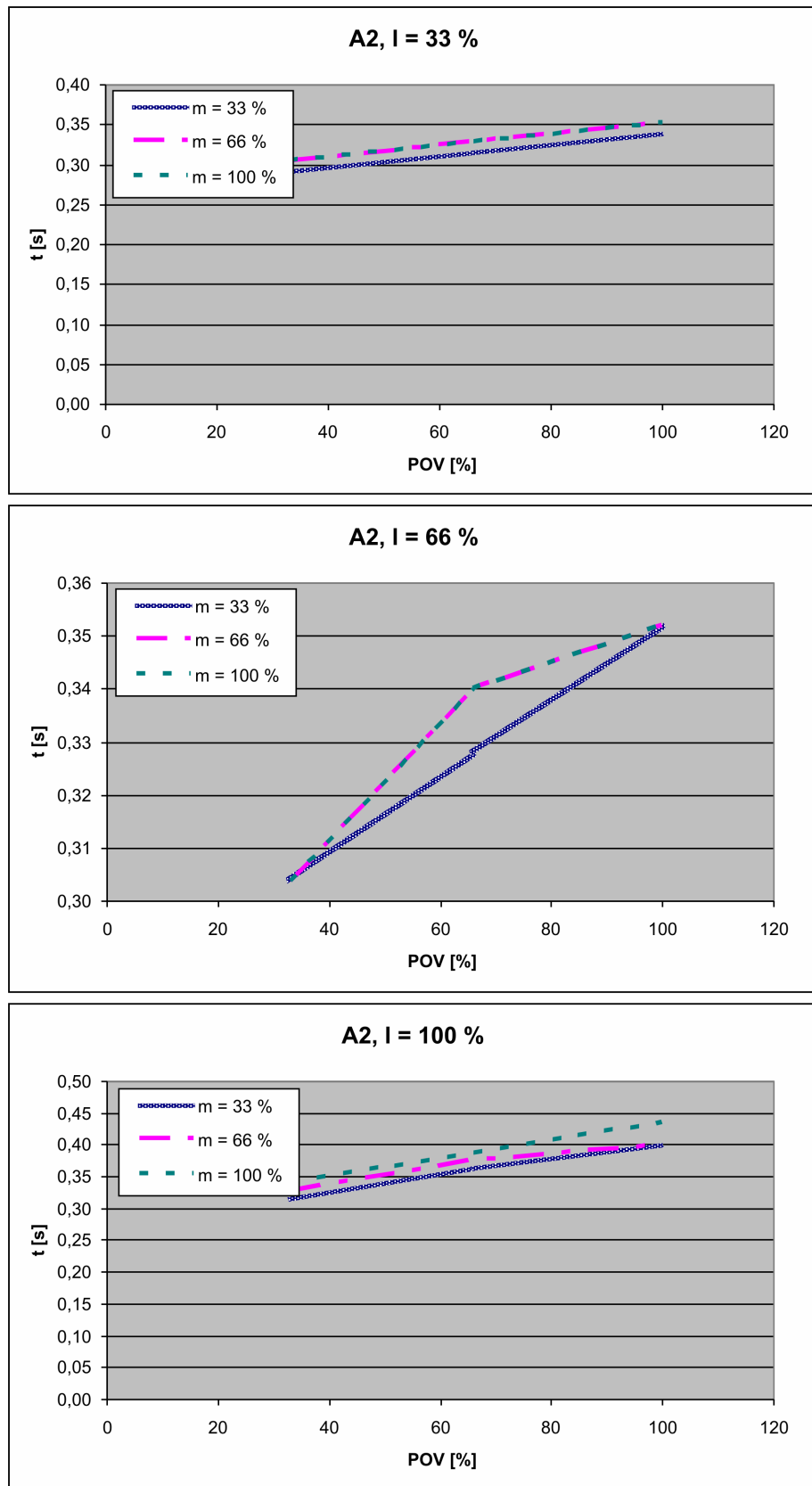


Fig. 4-14: Stopping times for STOP 1, axis 2

### 4.8.3.4 Stopping distances and stopping times for STOP 1, axis 3

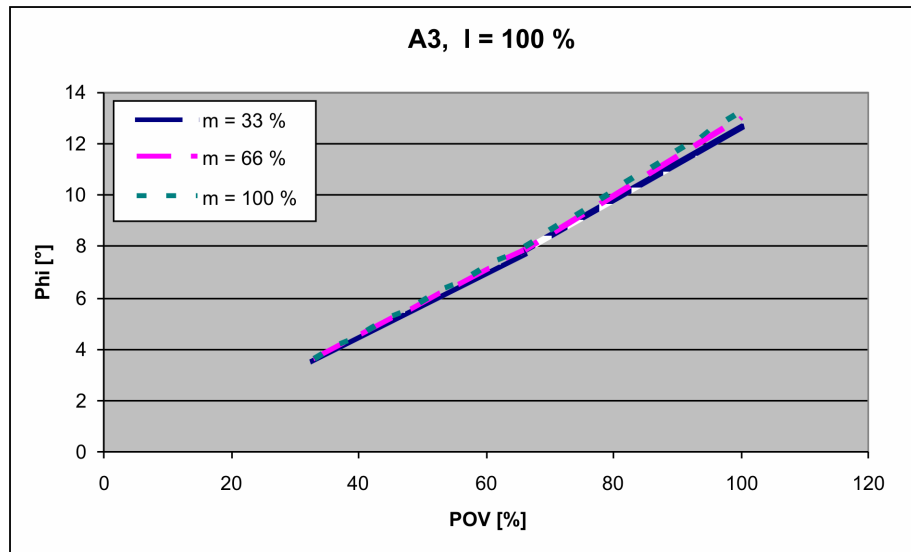


Fig. 4-15: Stopping distances for STOP 1, axis 3

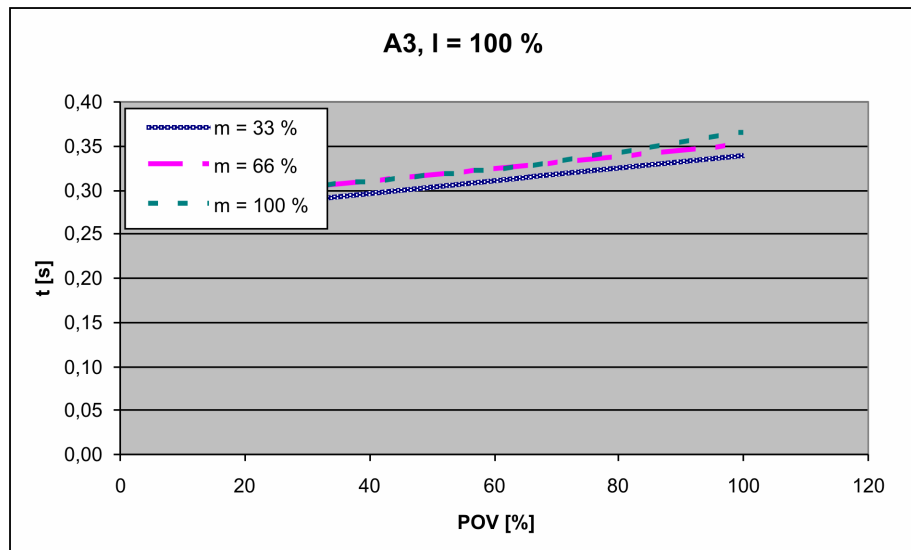


Fig. 4-16: Stopping times for STOP 1, axis 3

### 4.8.4 Stopping distance and stopping times for KR 470 PA

#### 4.8.4.1 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		
Axis 2		
Axis 3		

No data are currently available for STOP 0 for axes 1-3.

### 4.8.4.2 Stopping distances and stopping times for STOP 1, axis 1

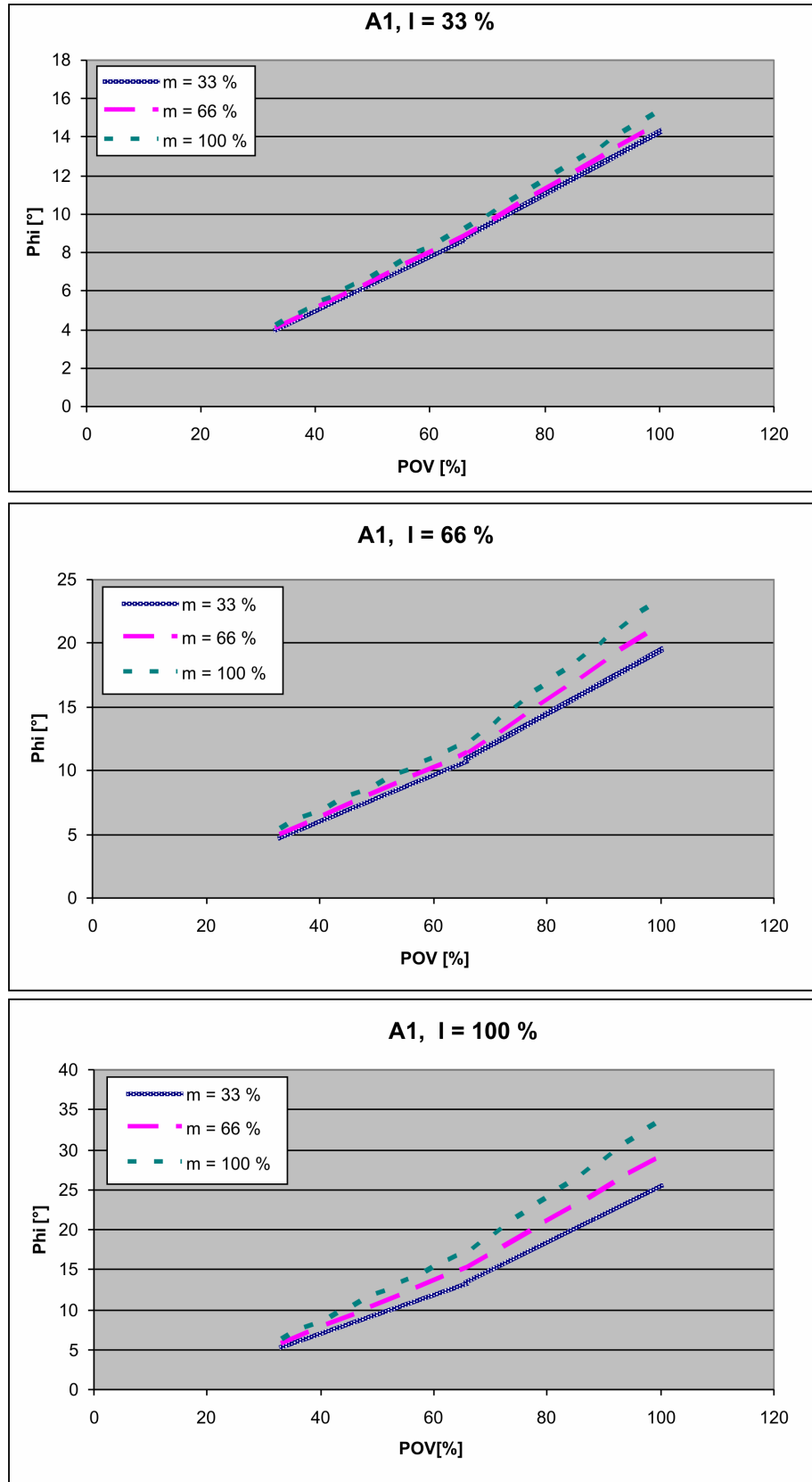


Fig. 4-17: Stopping distances for STOP 1, axis 1



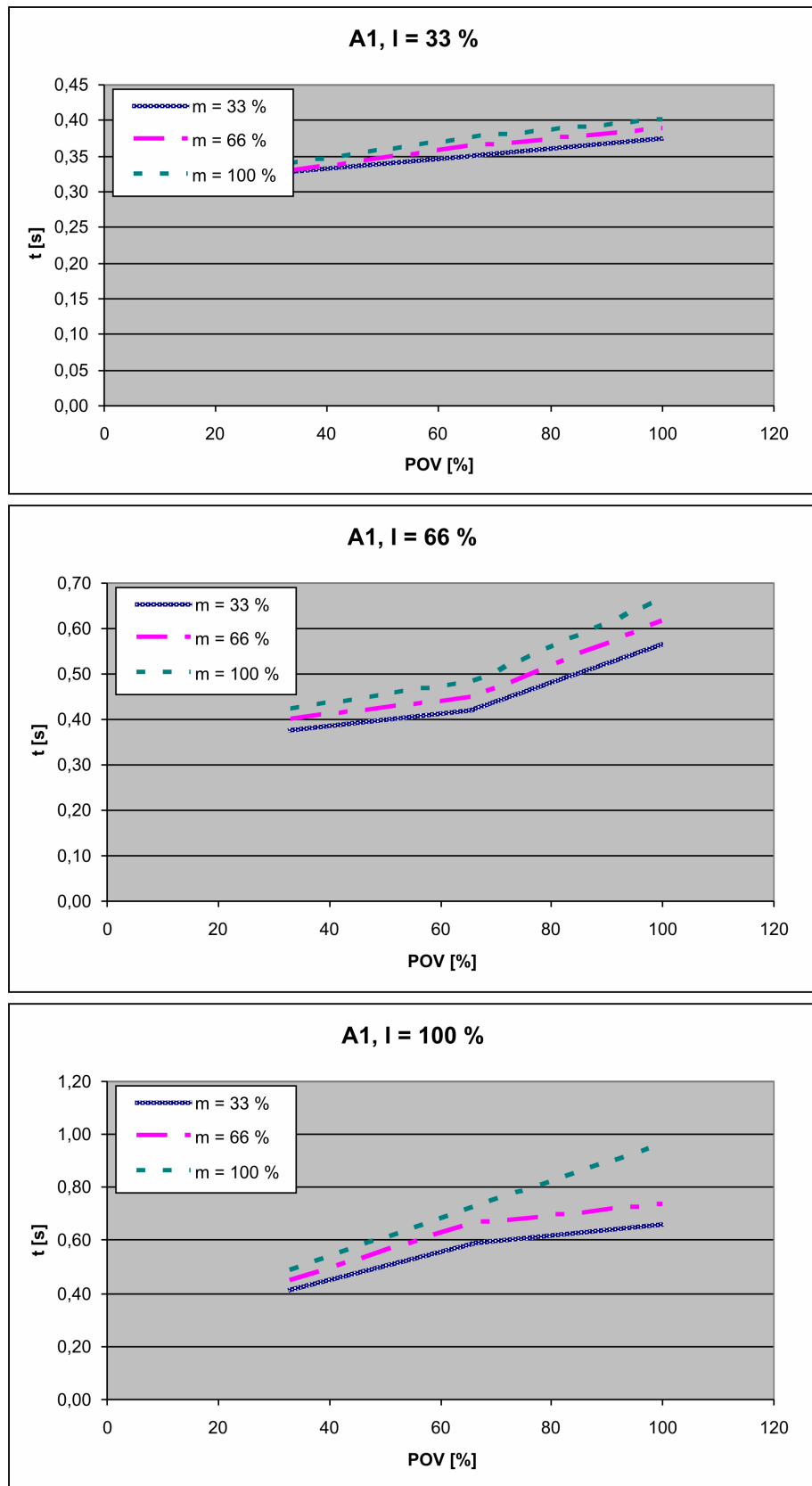


Fig. 4-18: Stopping times for STOP 1, axis 1

### 4.8.4.3 Stopping distances and stopping times for STOP 1, axis 3

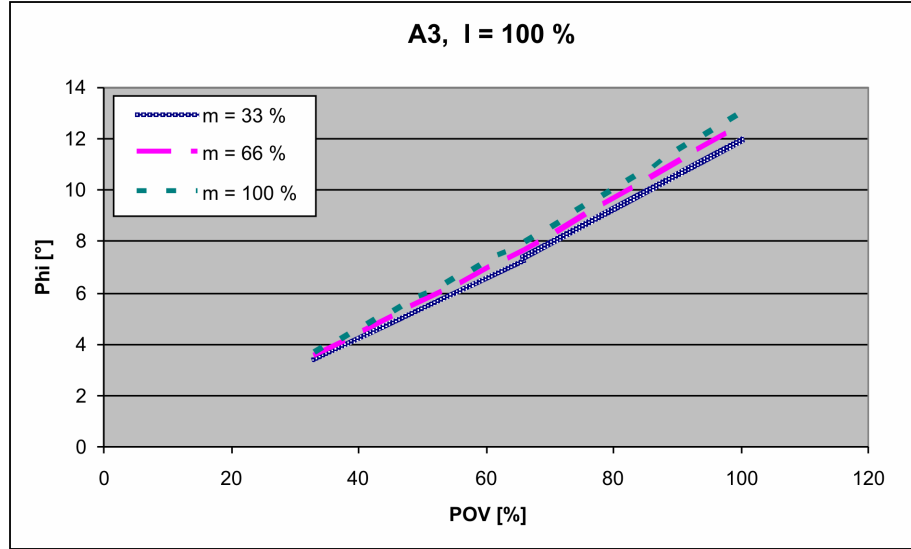


Fig. 4-19: Stopping distances for STOP 1, axis 3

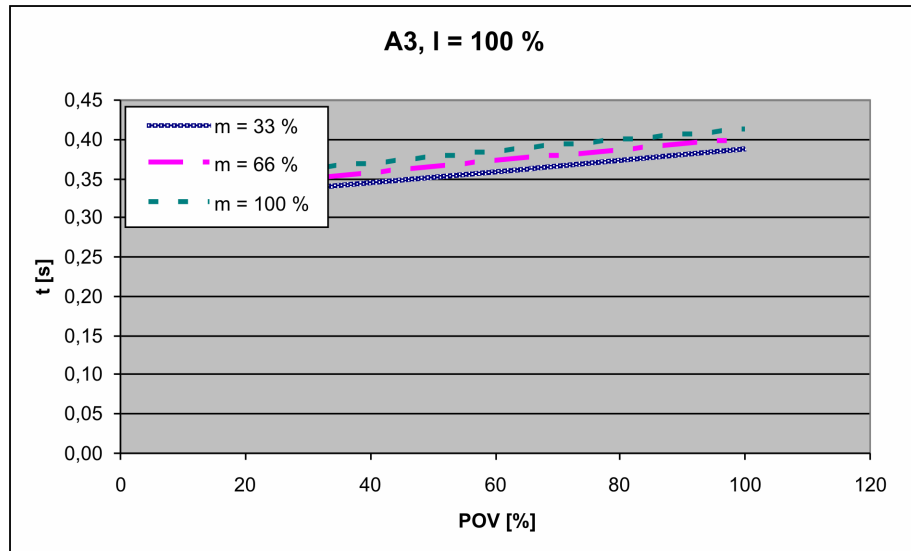


Fig. 4-20: Stopping times for STOP 1, axis 3

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

Technical data

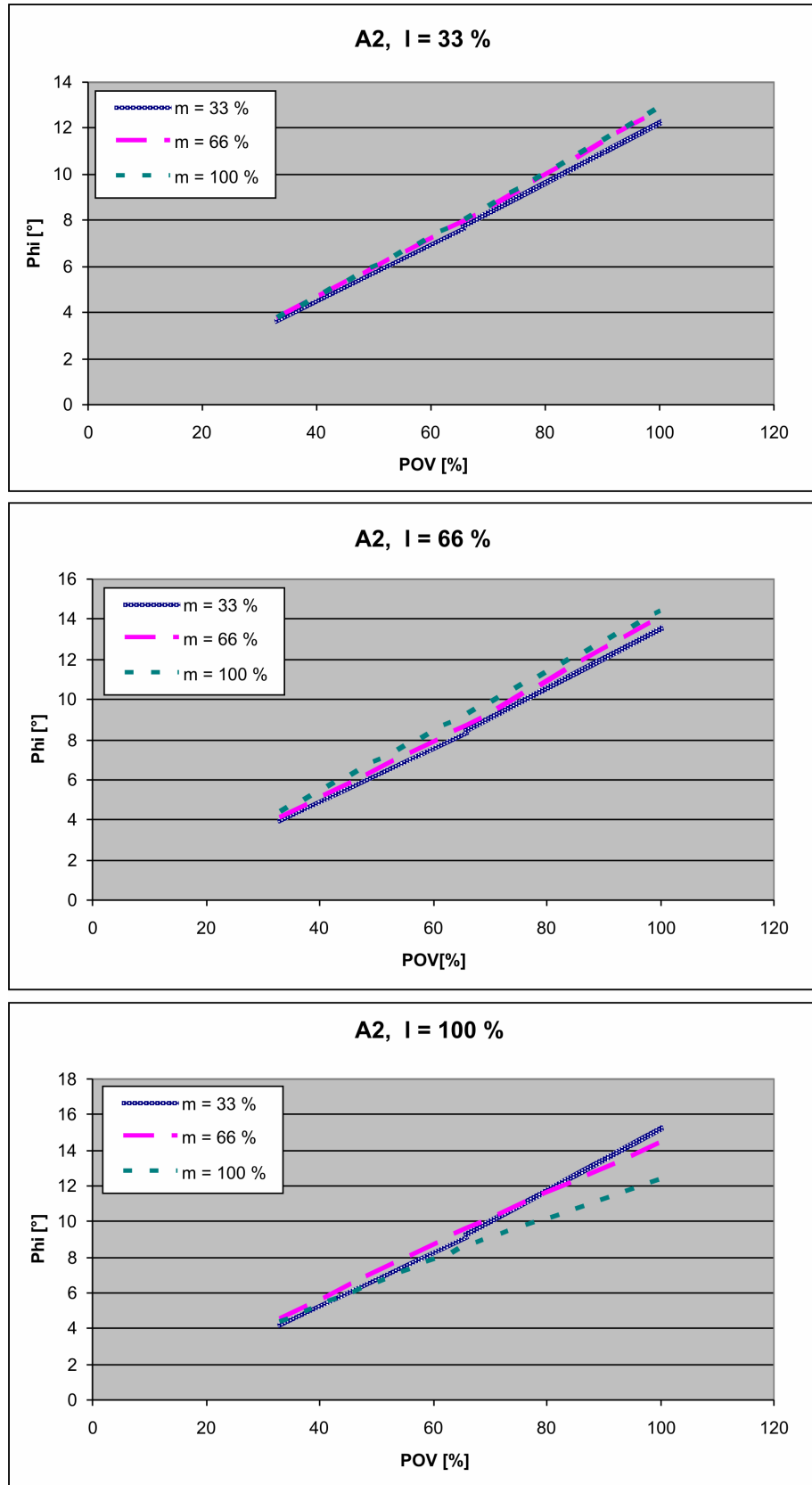


Fig. 4-21: Stopping distances for STOP 1, axis 2

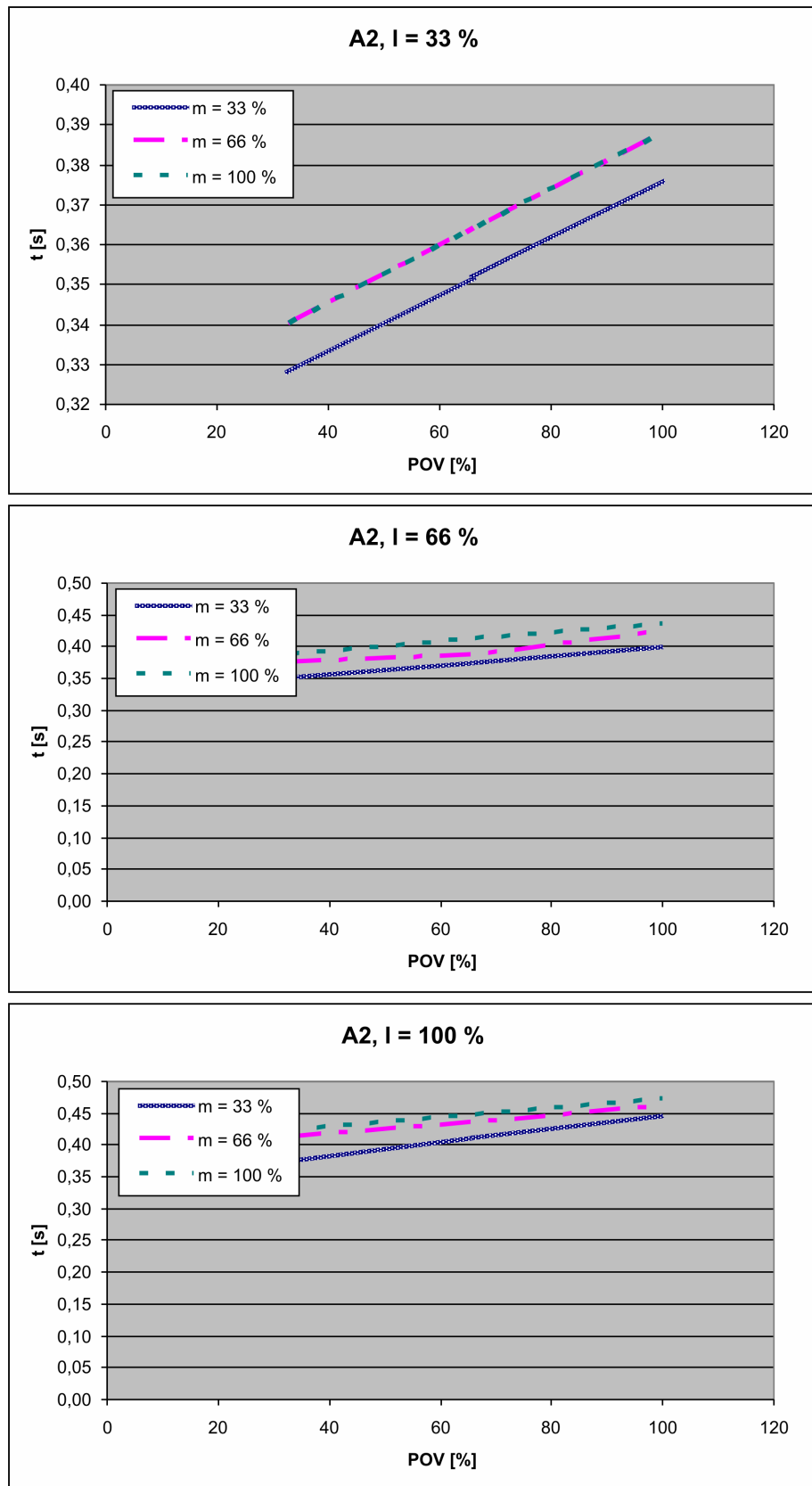


Fig. 4-22: Stopping times for STOP 1, axis 2

## 5 Safety

### 5.1 General



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

This contains all the information provided in this “Safety” chapter. It also contains additional safety information relating to the robot controller which must be observed.

- Where this “Safety” chapter uses the term “industrial robot”, this also refers to the individual mechanical component if applicable.

#### 5.1.1 Liability

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

Components of the industrial robot:

- Manipulator
- Robot controller
- Teach pendant
- Connecting cables
- External axes (optional)  
e.g. linear unit, turn-tilt table, positioner
- Software
- Options, accessories

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

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

#### Safety information

Information about safety may not be construed against KUKA Deutschland GmbH. Even if all safety instructions are followed, this is not a guarantee that the industrial robot will not cause personal injuries or material damage.

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

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

### 5.1.2 Intended use of the industrial robot

The industrial robot is intended exclusively for the use designated in the “Purpose” chapter of the operating instructions or assembly instructions. Any use or application deviating from the intended use is deemed to be misuse and is not allowed. The manufacturer is not liable for any damage resulting from such misuse. The risk lies entirely with the user.

Operation of the industrial robot in accordance with its intended use also requires compliance with the operating and assembly instructions for the individual components, with particular reference to the maintenance specifications.

#### Misuse

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

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

### 5.1.3 EC declaration of conformity and declaration of incorporation

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

- The industrial robot is integrated into a complete system.  
or: The industrial robot, together with other machinery, constitutes a complete system.  
or: All safety functions and safeguards required for operation in the complete machine as defined by the EC Machinery Directive have been added to the industrial robot.
- The complete system complies with the EC Machinery Directive. This has been confirmed by means of a conformity assessment procedure.

#### EC declaration of conformity

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

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

#### Declaration of incorporation

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

The declaration of incorporation declares that the start-up of the partly completed machinery is not allowed until the partly completed machinery has been incorporated into machinery, or has been assembled with other parts to form machinery, and this machinery complies with the terms of the EC Machinery Directive, and the EC declaration of conformity is present in accordance with Annex II A.

### 5.1.4 Terms used

Term	Description
Axis range	Range of each axis, in degrees or millimeters, within which it may move. The axis range must be defined for each axis.
Stopping distance	Stopping distance = reaction distance + braking distance The stopping distance is part of the danger zone.
Workspace	The manipulator is allowed to move within its workspace. The workspace is derived from the individual axis ranges.
Operator (User)	The user of the industrial robot can be the management, employer or delegated person responsible for use of the industrial robot.
Danger zone	The danger zone consists of the workspace and the stopping distances.
Service life	The service life of a safety-relevant component begins at the time of delivery of the component to the customer.  The service life is not affected by whether the component is used in a controller or elsewhere or not, as safety-relevant components are also subject to aging during storage
KCP	KUKA Control Panel  Teach pendant for the KR C2/KR C2 edition2005  The KCP has all the operator control and display functions required for operating and programming the industrial robot.
KUKA smartPAD	see "smartPAD"
Manipulator	The robot arm and the associated electrical installations
Safety zone	The safety zone is situated outside the danger zone.
Safety options	Generic term for options which make it possible to configure additional safe monitoring functions in addition to the standard safety functions.  Example: SafeOperation
smartPAD	Teach pendant for the KR C4  The smartPAD has all the operator control and display functions required for operating and programming the industrial robot.
Stop category 0	The drives are deactivated immediately and the brakes are applied. The manipulator and any external axes (optional) perform path-oriented braking.  <b>Note:</b> 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.  <b>Note:</b> 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.  <b>Note:</b> 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 ( $\leq 250$ mm/s)

Term	Description
T2	Test mode, Manual High Velocity (> 250 mm/s permissible)
External axis	Axis of motion that does not belong to the manipulator, yet is controlled with the same controller. e.g. KUKA linear unit, turn-tilt table, Posiflex

## 5.2 Personnel

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

- User
- Personnel



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

### User

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

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

### Personnel

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

Personnel includes:

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



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

### System integrator

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

The system integrator is responsible for the following tasks:

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



## Operators

The operator must meet the following preconditions:

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



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

### 5.3 Workspace, safety zone and danger zone

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

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

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

### 5.4 Overview of protective equipment

The protective equipment of the mechanical component may include:

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

Not all equipment is relevant for every mechanical component.

#### 5.4.1 Mechanical end stops

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

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



#### WARNING

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

#### 5.4.2 Mechanical axis limitation (optional)

Some manipulators can be fitted with mechanical axis limitation systems in axes A1 to A3. The axis limitation systems restrict the working range to

the required minimum. This increases personal safety and protection of the system.

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

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



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

### 5.4.3 Options for moving the manipulator without drive energy



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

#### Description

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

- Release device (optional)  
The release device can be used for the main axis drive motors and, depending on the robot variant, also for the wrist axis drive motors.
- Brake release device (option)  
The brake release device is designed for robot variants whose motors are not freely accessible.
- Moving the wrist axes directly by hand  
There is no release device available for the wrist axes of variants in the low payload category. This is not necessary because the wrist axes can be moved directly by hand.



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

#### NOTICE

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

### 5.4.4 Labeling on the industrial robot

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

Labeling on the industrial robot consists of:

- Identification plates
- Warning signs
- Safety symbols

- Designation labels
- Cable markings
- Rating plates



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

## 5.5 Safety measures

### 5.5.1 General safety measures

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

It is important to be prepared for possible movements of the industrial robot even after the robot controller has been switched off and locked out. Incorrect installation (e.g. overload) or mechanical defects (e.g. brake defect) can cause the manipulator or external axes to sag. If work is to be carried out on a switched-off industrial robot, the manipulator and external axes must first be moved into a position in which they are unable to move on their own, whether the payload is mounted or not. If this is not possible, the manipulator and external axes must be secured by appropriate means.



#### DANGER

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



#### DANGER

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



#### CAUTION

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

### KCP/smartPAD

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

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



#### WARNING

The operator must ensure that decoupled KCPs/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**

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.

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

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

**Faults**

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

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

**5.5.2 Transportation****Manipulator**

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

Avoid vibrations and impacts during transportation in order to prevent damage to the manipulator.

**Robot controller**

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.

Avoid vibrations and impacts during transportation in order to prevent damage to the robot controller.

## External axis (optional)

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.

### 5.5.3 Start-up and recommissioning

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

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



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



#### WARNING

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



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

#### NOTICE

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

### Function test

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

It must be ensured that:

- The industrial robot is correctly installed and fastened in accordance with the specifications in the documentation.
- There is no damage to the robot that could be attributed to external forces. Example: Dents or abrasion that could be caused by an impact or collision.



### WARNING

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

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

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

## 5.5.4 Manual mode

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

- Jog mode
- Teaching
- Programming
- Program verification

The following must be taken into consideration in manual mode:

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

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

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

- If it can be avoided, there must be no other persons inside the safeguarded area.  
If it is necessary for there to be several persons inside the safeguarded area, the following must be observed:
  - Each person must have an enabling device.
  - All persons must have an unimpeded view of the industrial robot.
  - Eye-contact between all persons must be possible at all times.

- The operator must be so positioned that he can see into the danger area and get out of harm's way.

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

- This mode may only be used if the application requires a test at a velocity higher than possible in T1 mode.
- Teaching and programming are not permissible in this operating mode.
- Before commencing the test, the operator must ensure that the enabling devices are operational.
- The operator must be positioned outside the danger zone.
- There must be no other persons inside the safeguarded area. It is the responsibility of the operator to ensure this.

### 5.5.5 Automatic mode

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

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

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

### 5.5.6 Maintenance and repair

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

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

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

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



### DANGER

Before work is commenced on live parts of the robot system, the main switch must be turned off and secured against being switched on again. The system must then be checked to ensure that it is deenergized.

It is not sufficient, before commencing work on live parts, to execute an EMERGENCY STOP or a safety stop, or to switch off the drives, as this does not disconnect the robot system from the mains power supply. Parts remain energized. Death or severe injuries may result.

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

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

### Robot controller

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

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

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

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

### Counterbalancing system

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

The hydropneumatic and gas cylinder counterbalancing systems are pressure equipment and, as such, are subject to obligatory equipment monitoring and the provisions of the Pressure Equipment Directive.

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

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

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

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

### Hazardous substances

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

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





To ensure safe use of our products, we recommend regularly requesting up-to-date safety data sheets for hazardous substances.

### 5.5.7 Decommissioning, storage and disposal

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

### 5.6 Applied norms and regulations

Name/Edition	Definition
<b>2006/42/EU:2006</b>	<p><b>Machinery Directive:</b></p> <p>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)</p>
<b>2014/68/EU:2014</b>	<p><b>Pressure Equipment Directive:</b></p> <p>Directive 2014/68/EU of the European Parliament and of the Council dated 15 May 2014 on the approximation of the laws of the Member States concerning pressure equipment</p> <p>(Only applicable for robots with hydropneumatic counterbalancing system.)</p>
<b>EN ISO 13850:2015</b>	<p><b>Safety of machinery:</b></p> <p>Emergency stop - Principles for design</p>
<b>EN ISO 13849-1:2015</b>	<p><b>Safety of machinery:</b></p> <p>Safety-related parts of control systems - Part 1: General principles of design</p>
<b>EN ISO 13849-2:2012</b>	<p><b>Safety of machinery:</b></p> <p>Safety-related parts of control systems - Part 2: Validation</p>
<b>EN ISO 12100:2010</b>	<p><b>Safety of machinery:</b></p> <p>General principles of design, risk assessment and risk reduction</p>
<b>EN ISO 10218-1:2011</b>	<p><b>Industrial robots – Safety requirements:</b></p> <p>Part 1: Robot</p> <p><b>Note:</b> Content equivalent to <b>ANSI/RIA R.15.06-2012, Part 1</b></p>
<b>EN 614-1:2006+A1:2009</b>	<p><b>Safety of machinery:</b></p> <p>Ergonomic design principles - Part 1: Terms and general principles</p>
<b>EN 61000-6-2:2005</b>	<p><b>Electromagnetic compatibility (EMC):</b></p> <p>Part 6-2: Generic standards; Immunity for industrial environments</p>
<b>EN 61000-6-4:2007 + A1:2011</b>	<p><b>Electromagnetic compatibility (EMC):</b></p> <p>Part 6-4: Generic standards; Emission standard for industrial environments</p>
<b>EN 60204-1:2006/A1:2009</b>	<p><b>Safety of machinery:</b></p>

## Electrical equipment of machines - Part 1: General requirements

## 6 Planning

### 6.1 Information for planning

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

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

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

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

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

### 6.2 Mounting base for 175 mm concrete thickness

#### Description

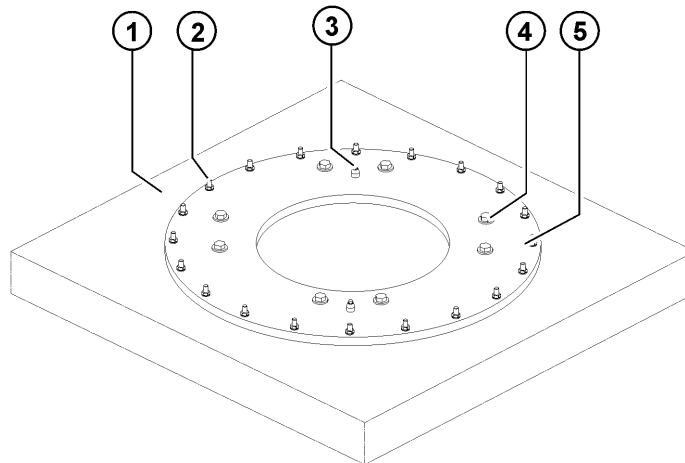
The mounting base with centering (>>> [Fig. 6-1](#)) is used when the robot is fastened to the floor, i.e. directly on a concrete foundation with a thickness of at least 175 mm.

The mounting base consists of:

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

This mounting variant requires a level and smooth surface on a concrete foundation with adequate load bearing capacity. The concrete foundation must be able to accommodate the forces occurring during operation. There must be no layers of insulation or screed between the bedplates and the concrete foundation.

The minimum dimensions must be observed.



**Fig. 6-1: Mounting base 175 mm**

- |   |                     |   |              |
|---|---------------------|---|--------------|
| 1 | Concrete foundation | 4 | Hexagon bolt |
| 2 | Resin-bonded anchor | 5 | Bedplate     |
| 3 | Pin                 |   |              |

#### **Grade of concrete for foundations**

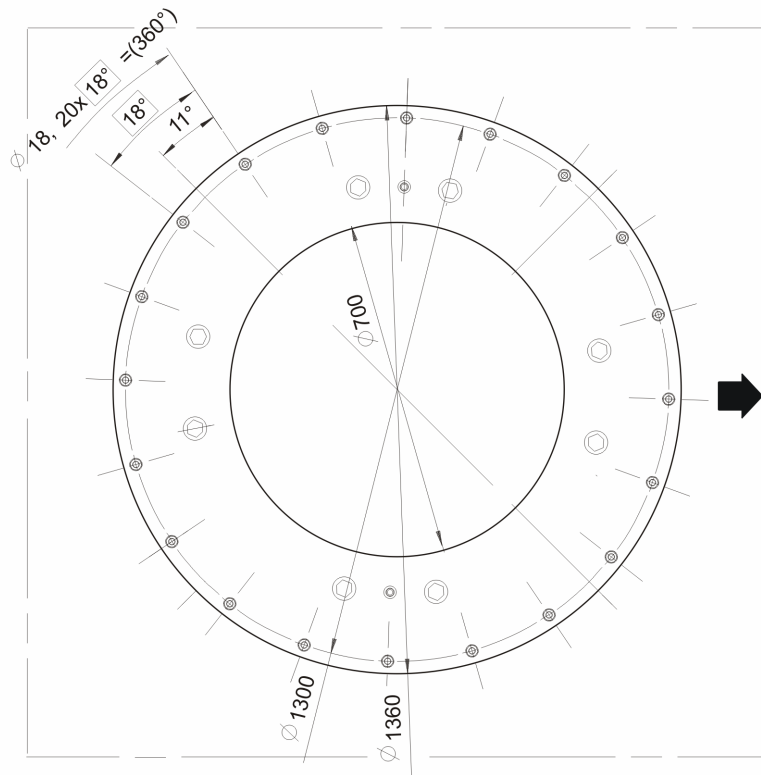
When producing foundations from concrete, observe the load-bearing capacity of the ground and the country-specific construction regulations. There must be no layers of insulation or screed between the bedplate/bedplates and the concrete foundation. The quality of the concrete must meet the requirements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

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

#### **Dimensioned drawing**

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

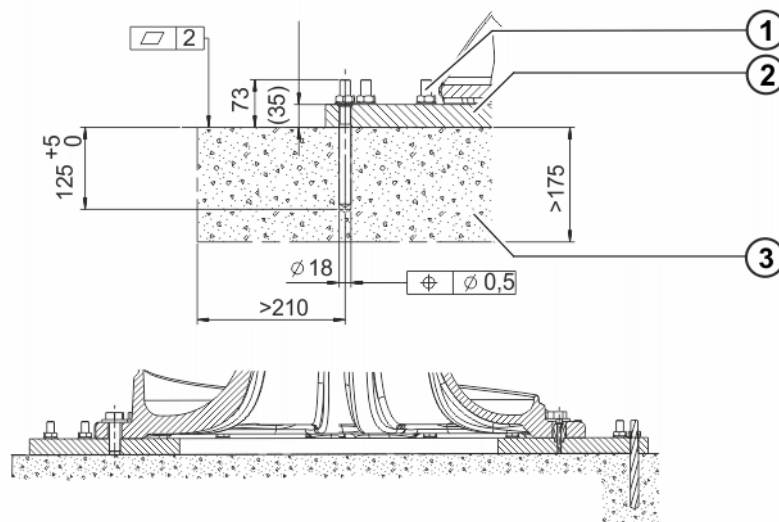
Dimensions: mm



**Fig. 6-2: Mounting base, dimensioned drawing**

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).

Dimensions: mm



**Fig. 6-3: Cross-section of foundation 175 mm**

- 1 Resin-bonded anchor
- 2 Bedplate
- 3 Concrete foundation

### 6.3 Mounting base for 200 mm concrete thickness

#### Description

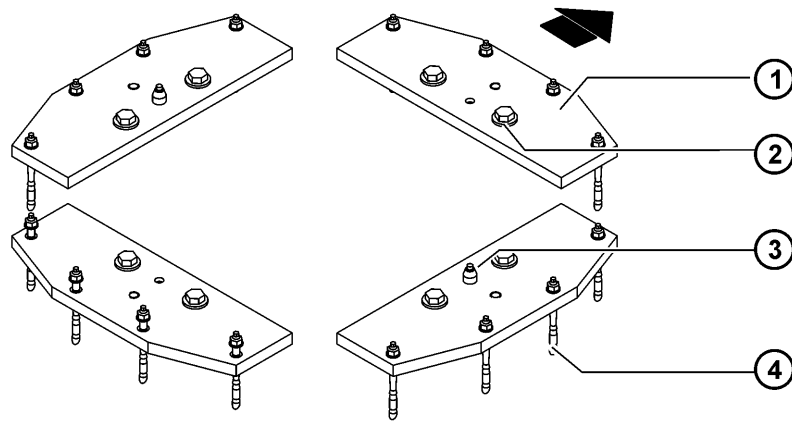
The mounting base with centering (>>> [Fig. 6-4](#)) is used when the robot is fastened to the floor, i.e. directly on a concrete foundation with a thickness of at least 200 mm.

The mounting base with centering consists of:

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

This mounting variant requires a level and smooth surface on a concrete foundation with adequate load bearing capacity. The concrete foundation must be able to accommodate the forces occurring during operation. There must be no layers of insulation or screed between the bedplates and the concrete foundation.

The minimum dimensions must be observed.



**Fig. 6-4: Mounting base 200 mm**

- |                |                        |
|----------------|------------------------|
| 1 Bedplate     | 3 Pin with Allen screw |
| 2 Hexagon bolt | 4 Resin-bonded anchor  |

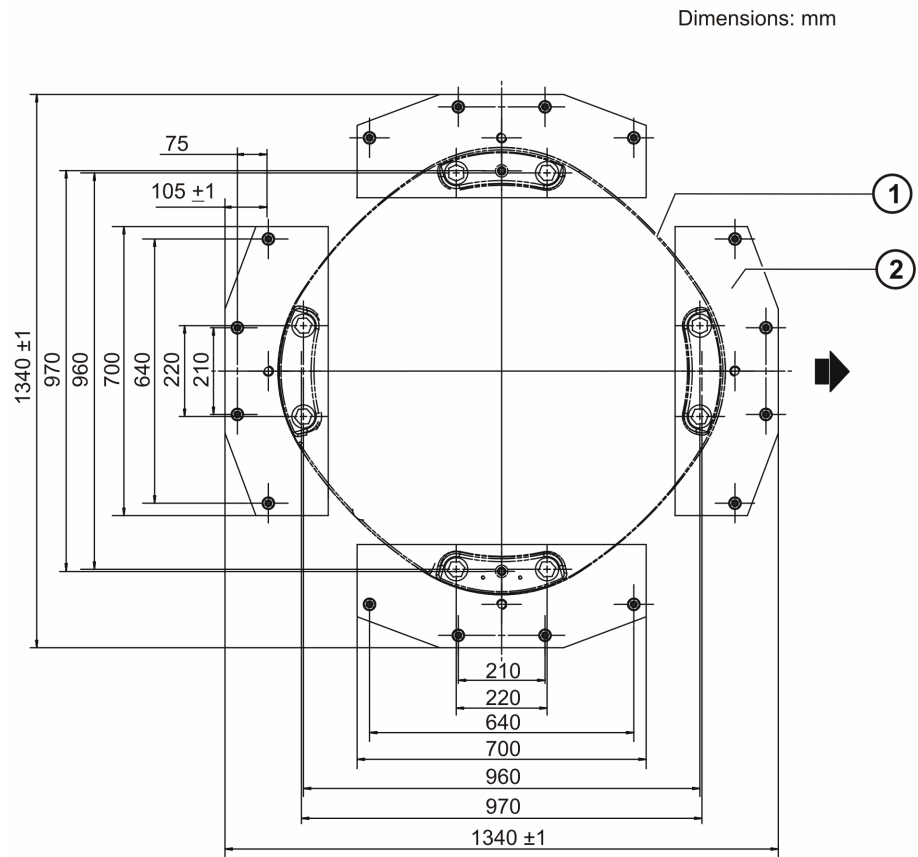
#### Grade of concrete for foundations

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 bedplate/bedplates and the concrete foundation. The quality of the concrete must meet the requirements of the following standard:

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

#### Dimensioned drawing

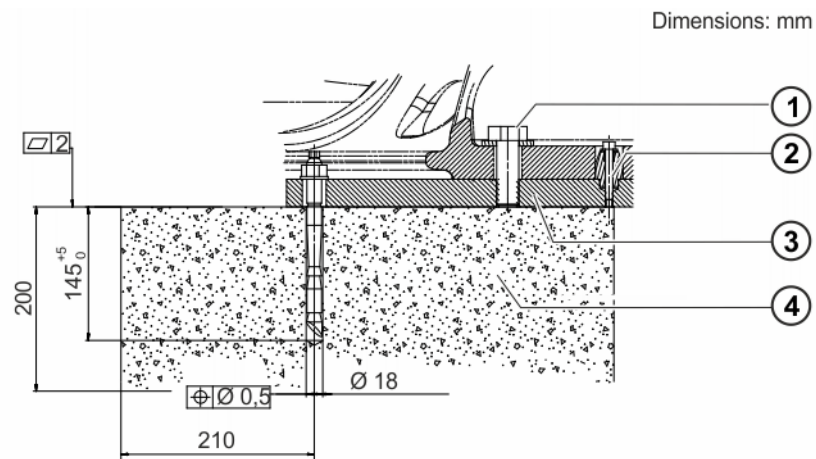
The following illustrations provide all the necessary information on the mounting base, together with the required foundation data.



**Fig. 6-5: Mounting base 200 mm, dimensioned drawing**

- |         |             |
|---------|-------------|
| 1 Robot | 2 Bedplates |
|---------|-------------|

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



**Fig. 6-6: Cross-section of foundation 200 mm**

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

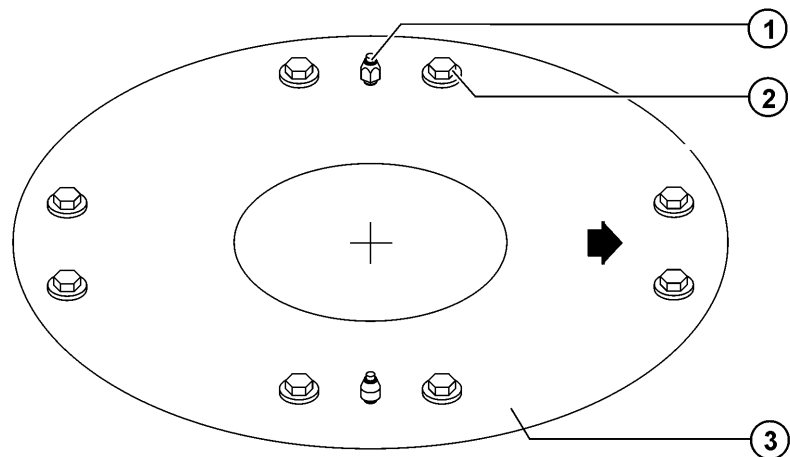
## 6.4 Machine frame mounting

### Description

The machine frame mounting assembly (>>> [Fig. 6-7](#)) with centering is used when the robot is fastened on a steel structure, a booster frame (pedestal) or a KUKA linear unit. It must be ensured that the substructure is able to withstand safely the forces occurring during operation (foundation loads). The following diagram contains all the necessary information that must be observed when preparing the mounting surface.

The machine frame mounting assembly consists of (>>> [Fig. 6-8](#)):

- Pin with fasteners
- Sword pin with fasteners
- Hexagon bolts with conical spring washers

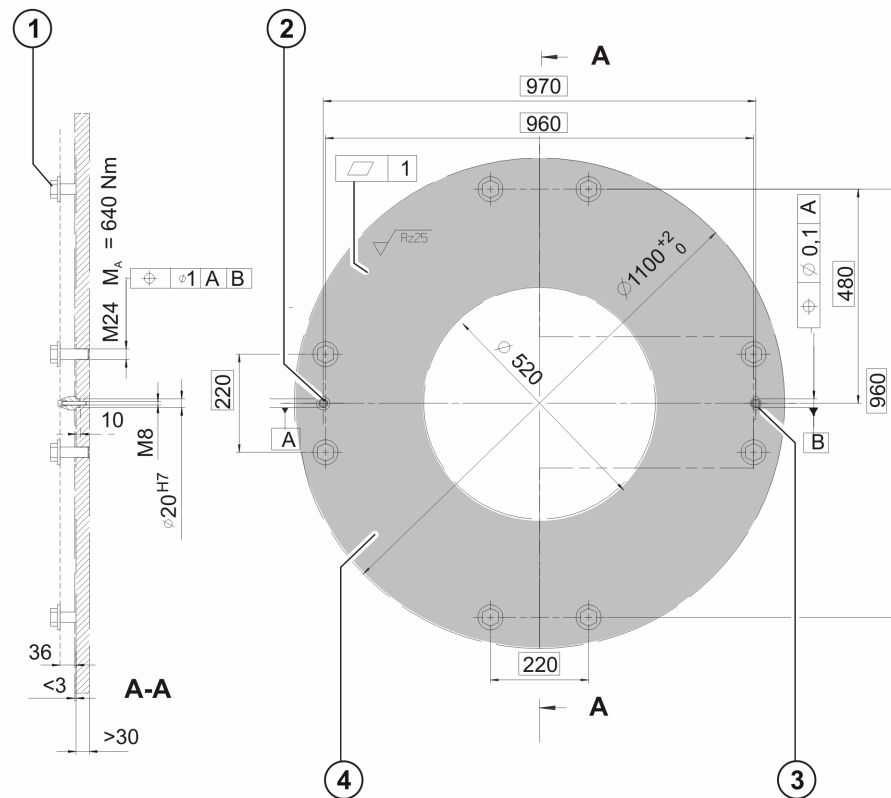


**Fig. 6-7: Machine frame mounting**

- |                     |                    |
|---------------------|--------------------|
| 1 Pin, sword pin    | 3 Mounting surface |
| 2 Hexagon bolt (8x) |                    |



Dimensions: mm



**Fig. 6-8: Machine frame mounting, dimensioned drawing**

- |                     |                    |
|---------------------|--------------------|
| 1 Hexagon bolt (8x) | 3 Pin              |
| 2 Sword pin         | 4 Mounting surface |

## 6.5 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 on the two multi-function housings and the RDC box by means of connectors (>>> Fig. 6-9). The set of connecting cables comprises:

- Motor cable X20.1 - X30.1
- Motor cable X20.4 - X30.4
- Control cable X21 - X31
- Ground conductor, optional



For the connecting cables, a 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 conductor is not part of the scope of supply and can be ordered as an option. The connection must be made by the customer. The tapped holes for connecting the ground conductor are located on the base frame of the robot.

Depending on the specification of the robot, various connecting cables are used. Cable lengths of 7 m, 15 m, 25 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.

The ground conductors are connected via ring cable lugs.

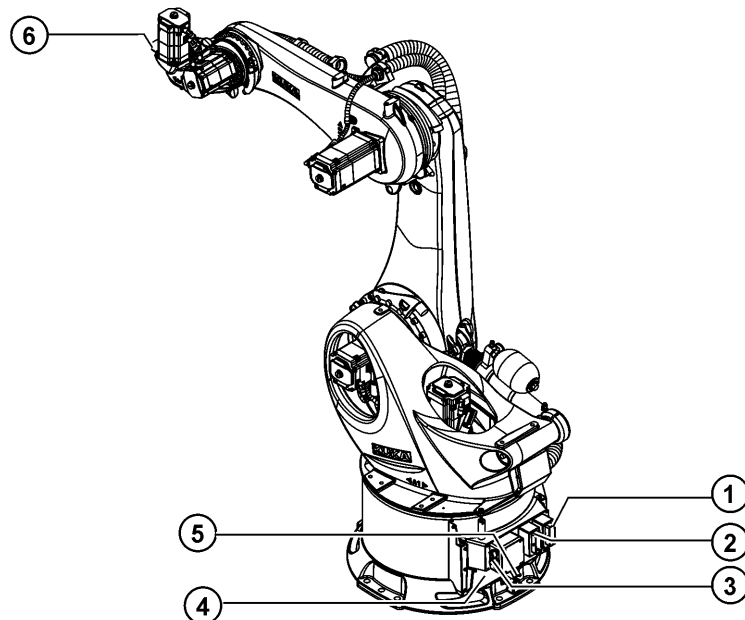
Wiring diagrams, connector pin allocations and connector designations can be found in the section “Description of the connecting cables”.

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

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

### Interface for energy supply systems

The robot can be equipped with an energy supply system between axis 1 and axis 6 and a second energy supply system between axis 6 and the tool. The A1 interface required for this is located on the rear, and the A6 interface is located on the swing frame and on the tool of the robot. The interfaces are equipped with connections for cables and hoses depending on the application. Detailed information on the connector pin allocation, threaded unions, etc. is given in separate documentation.



**Fig. 6-9: Interfaces A1 to A6**

1	Multi-function housing (MFH), X30.1	4	Energy supply system, interface A1
2	Multi-function housing (MFH), X30.4	5	Ground conductor connection M8 ring cable lug
3	Control cable X31	6	Energy supply system, interface A6

## 7 Transportation

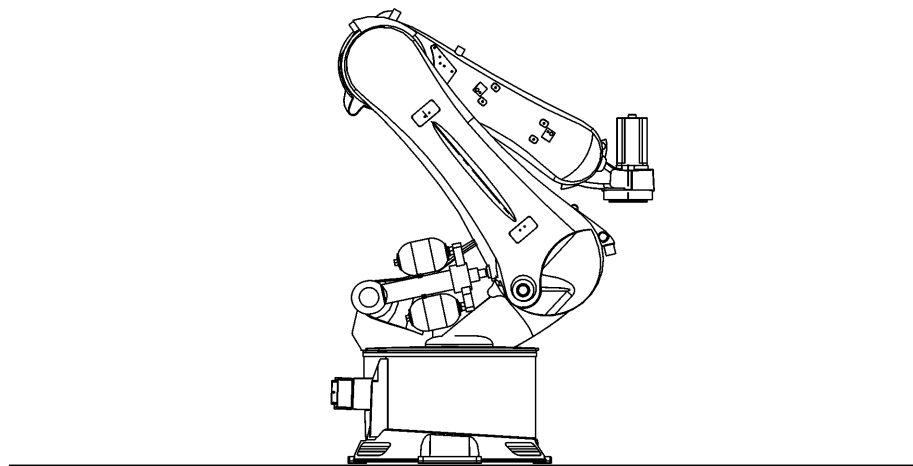
### 7.1 Transporting the robot

Before transporting the robot, always move the robot into its transport position (>>> [Fig. 7-1](#)). It must be ensured that the robot is stable while it is being transported. The robot must remain in its transport position until it has been fastened in position. Before the robot is lifted, it must be ensured that it is free from obstructions. Remove all transport safeguards, such as nails and screws, in advance. First remove any rust or glue on contact surfaces.

#### Transport position

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

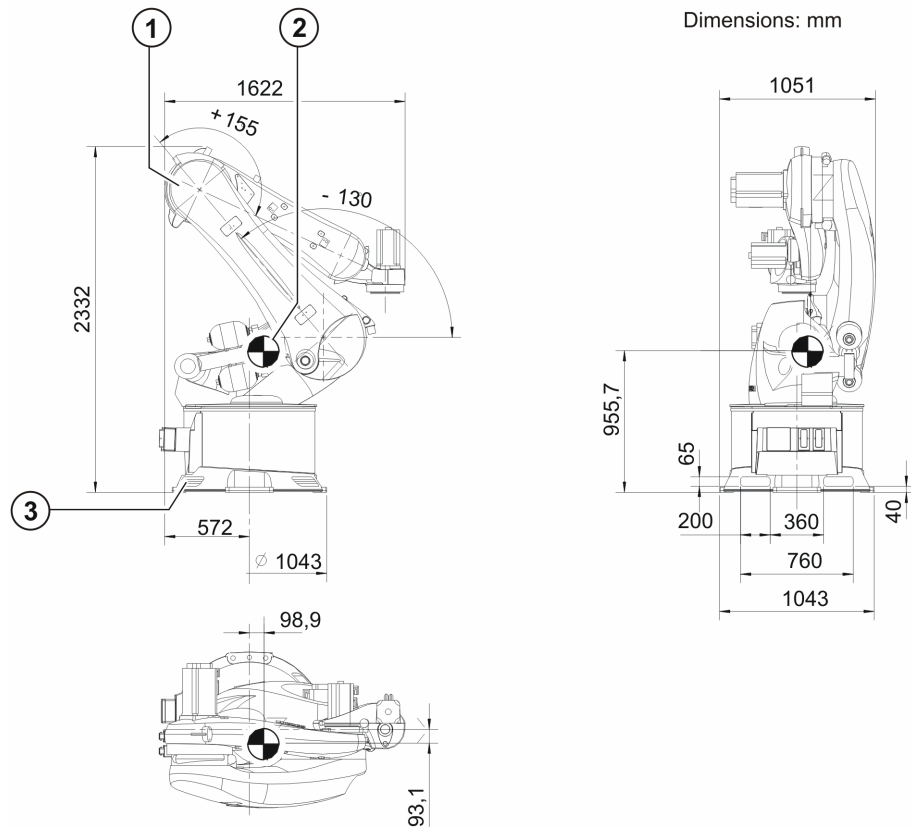
Axis	A1	A2	A3	A6
Transport position	0°	-130°	+155°	0°



**Fig. 7-1: Transport position**

#### Transport dimensions

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



**Fig. 7-2: Transport dimensions**

- 1 Robot
- 2 Center of gravity
- 3 Fork slots

**Transportation**

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



**WARNING**

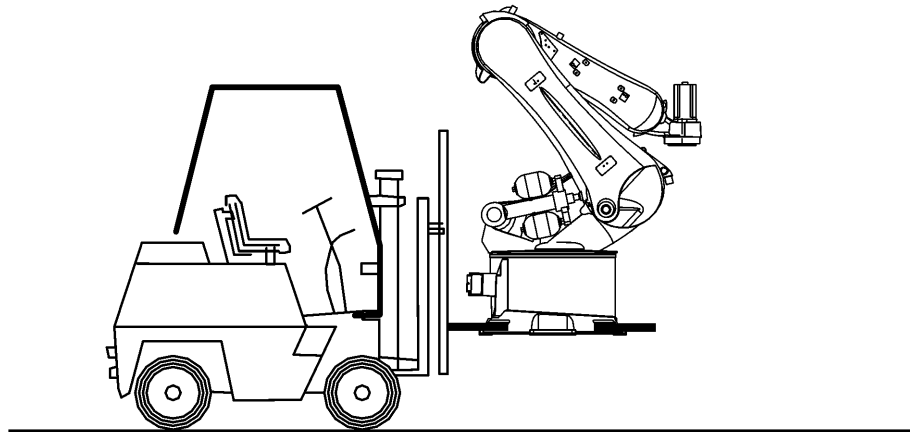
Use of unsuitable handling equipment may result in damage to the robot or injury to persons. Only use authorized handling equipment with a sufficient load-bearing capacity. Only transport the robot in the manner specified here.

**Transportation by fork lift truck**

For transport by fork lift truck (>>> [Fig. 7-3](#)), two fork slots are provided in the base frame. The robot can be picked up by the fork lift truck from the front and rear. The fork lift truck must have a minimum payload capacity of 3.5 t.



Avoid excessive loading of the fork slots through undue inward or outward movement of hydraulically adjustable forks of the fork lift truck.



**Fig. 7-3: Transportation by fork lift truck**

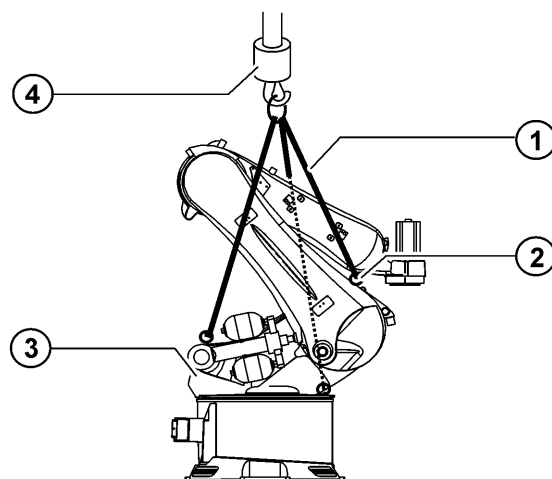
### Transportation using lifting tackle

The robot can also be transported using lifting tackle (>>> [Fig. 7-4](#)). The robot must be in the transport position. The lifting tackle is attached at 3 points to M20 DIN 580 eyebolts. All ropes 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.



#### **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. 7-4: Transportation using lifting tackle**

- |                  |                   |
|------------------|-------------------|
| 1 Lifting tackle | 3 Rotating column |
| 2 M20 eyebolt    | 4 Crane           |

## **8 Options**

### **8.1 Release device (optional)**

#### **Description**

The release device can be used to move the manipulator manually after an accident or malfunction. The release device can be used for all the motors. It is only for use in exceptional circumstances and emergencies (e.g. for freeing people).

The release device is mounted on the base frame of the manipulator. This assembly also includes a ratchet and a set of plates with one plate for each motor. The plate specifies the direction of rotation for the ratchet and shows the corresponding direction of motion of the manipulator.

## 9 KUKA Service

### 9.1 Requesting support

#### Introduction

This documentation provides information on operation and operator control, and provides assistance with troubleshooting. For further assistance, please contact your local KUKA subsidiary.

#### Information

**The following information is required for processing a support request:**

- Description of the problem, including information about the duration and frequency of the fault
- As comprehensive information as possible about the hardware and software components of the overall system

The following list gives an indication of the information which is relevant in many cases:

- Model and serial number of the kinematic system, e.g. the manipulator
- Model and serial number of the controller
- Model and serial number of the energy supply system
- Designation and version of the system software
- Designations and versions of other software components or modifications
- Diagnostic package KRCDiag  
Additionally for KUKA Sunrise: Existing projects including applications  
For versions of KUKA System Software older than V8: Archive of the software (KRCDiag is not yet available here.)
- Application used
- External axes used

### 9.2 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

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

## **Australia**

KUKA Robotics Australia Pty Ltd  
45 Fennell Street  
Port Melbourne VIC 3207  
Australia  
Tel. +61 3 9939 9656  
info@kuka-robotics.com.au  
www.kuka-robotics.com.au

## **Belgium**

KUKA Automatisering + Robots N.V.  
Centrum Zuid 1031  
3530 Houthalen  
Belgium  
Tel. +32 11 516160  
Fax +32 11 526794  
info@kuka.be  
www.kuka.be

## **Brazil**

KUKA Roboter do Brasil Ltda.  
Travessa Claudio Armando, nº 171  
Bloco 5 - Galpões 51/52  
Bairro Assunção  
CEP 09861-7630 São Bernardo do Campo - SP  
Brazil  
Tel. +55 11 4942-8299  
Fax +55 11 2201-7883  
info@kuka-roboter.com.br  
www.kuka-roboter.com.br

## **Chile**

Robotec S.A. (Agency)  
Santiago de Chile  
Chile  
Tel. +56 2 331-5951  
Fax +56 2 331-5952  
robotec@robotec.cl  
www.robotec.cl

## **China**

KUKA Robotics China Co., Ltd.  
No. 889 Kungang Road  
Xiaokunshan Town  
Songjiang District  
201614 Shanghai  
P. R. China  
Tel. +86 21 5707 2688  
Fax +86 21 5707 2603  
info@kuka-robotics.cn  
www.kuka-robotics.com



**Germany**

KUKA Deutschland GmbH  
Zugspitzstr. 140  
86165 Augsburg  
Germany  
Tel. +49 821 797-1926  
Fax +49 821 797-41 1926  
Hotline.robotics.de@kuka.com  
www.kuka.com

**France**

KUKA Automatisme + Robotique SAS  
Techvallée  
6, Avenue du Parc  
91140 Villebon S/Yvette  
France  
Tel. +33 1 6931660-0  
Fax +33 1 6931660-1  
commercial@kuka.fr  
www.kuka.fr

**India**

KUKA India Pvt. Ltd.  
Office Number-7, German Centre,  
Level 12, Building No. - 9B  
DLF Cyber City Phase III  
122 002 Gurgaon  
Haryana  
India  
Tel. +91 124 4635774  
Fax +91 124 4635773  
info@kuka.in  
www.kuka.in

**Italy**

KUKA Roboter Italia S.p.A.  
Via Pavia 9/a - int.6  
10098 Rivoli (TO)  
Italy  
Tel. +39 011 959-5013  
Fax +39 011 959-5141  
kuka@kuka.it  
www.kuka.it

## Japan

KUKA Japan K.K.  
YBP Technical Center  
134 Godo-cho, Hodogaya-ku  
Yokohama, Kanagawa  
240 0005  
Japan  
Tel. +81 45 744 7531  
Fax +81 45 744 7541  
info@kuka.co.jp

## Canada

KUKA Robotics Canada Ltd.  
6710 Maritz Drive - Unit 4  
Mississauga  
L5W 0A1  
Ontario  
Canada  
Tel. +1 905 670-8600  
Fax +1 905 670-8604  
info@kukarobotics.com  
www.kuka-robotics.com/canada

## Korea

KUKA Robotics Korea Co. Ltd.  
RIT Center 306, Gyeonggi Technopark  
1271-11 Sa 3-dong, Sangnok-gu  
Ansan City, Gyeonggi Do  
426-901  
Korea  
Tel. +82 31 501-1451  
Fax +82 31 501-1461  
info@kukakorea.com

## Malaysia

KUKA Robot Automation (M) Sdn Bhd  
South East Asia Regional Office  
No. 7, Jalan TPP 6/6  
Taman Perindustrian Puchong  
47100 Puchong  
Selangor  
Malaysia  
Tel. +60 (03) 8063-1792  
Fax +60 (03) 8060-7386  
info@kuka.com.my

**Mexico**

KUKA de México S. de R.L. de C.V.  
Progreso #8  
Col. Centro Industrial Puente de Vigas  
Tlalnepantla de Baz  
54020 Estado de México  
Mexico  
Tel. +52 55 5203-8407  
Fax +52 55 5203-8148  
info@kuka.com.mx  
www.kuka-robotics.com/mexico

**Norway**

KUKA Sveiseanlegg + Roboter  
Sentrumsvegen 5  
2867 Hov  
Norway  
Tel. +47 61 18 91 30  
Fax +47 61 18 62 00  
info@kuka.no

**Austria**

KUKA CEE GmbH  
Gruberstraße 2-4  
4020 Linz  
Austria  
Tel. +43 732 784 752 0  
Fax +43 732 793 880  
KUKAAustriaOffice@kuka.com  
www.kuka.at

**Poland**

KUKA Roboter CEE GmbH Poland  
Spółka z ograniczoną odpowiedzialnością  
Oddział w Polsce  
Ul. Porcelanowa 10  
40-246 Katowice  
Poland  
Tel. +48 327 30 32 13 or -14  
Fax +48 327 30 32 26  
ServicePL@kuka-roboter.de

**Portugal**

KUKA Robots IBÉRICA, S.A.  
Rua do Alto da Guerra n° 50  
Armazém 04  
2910 011 Setúbal  
Portugal  
Tel. +351 265 729 780  
Fax +351 265 729 782  
info.portugal@kukapt.com  
www.kuka.com

## **Russia**

KUKA Russia OOO  
1-y Nagatinskiy pr-d, 2  
117105 Moskau  
Russia  
Tel. +7 495 665-6241  
support.robotics.ru@kuka.com

## **Sweden**

KUKA Svetsanläggningar + Robotar AB  
A. Odhners gata 15  
421 30 Västra Frölunda  
Sweden  
Tel. +46 31 7266-200  
Fax +46 31 7266-201  
info@kuka.se

## **Switzerland**

KUKA Roboter CEE GmbH  
Linz, Zweigniederlassung Schweiz  
Heinrich Wehrli-Strasse 27  
5033 Buchs  
Switzerland  
Tel. +41 62 837 43 20  
info@kuka-roboter.ch

## **Slovakia**

KUKA CEE GmbH  
organizačná zložka  
Bojnická 3  
831 04 Bratislava  
Slovakia  
Tel. +420 226 212 273  
support.robotics.cz@kuka.com

## **Spain**

KUKA Iberia, S.A.U.  
Pol. Industrial  
Torrent de la Pastera  
Carrer del Bages s/n  
08800 Vilanova i la Geltrú (Barcelona)  
Spain  
Tel. +34 93 8142-353  
comercial@kukarob.es

**South Africa**

Jendamark Automation LTD (Agency)  
76a York Road  
North End  
6000 Port Elizabeth  
South Africa  
Tel. +27 41 391 4700  
Fax +27 41 373 3869  
www.jendamark.co.za

**Taiwan**

KUKA Automation Taiwan Co. Ltd.  
1F, No. 298 Yangguang ST.,  
Nei Hu Dist., Taipei City, Taiwan 114  
Taiwan  
Tel. +886 2 8978 1188  
Fax +886 2 8797 5118  
info@kuka.com.tw

**Thailand**

KUKA (Thailand) Co. Ltd.  
No 22/11-12 H-Cape Biz Sector Onnut  
Sukhaphiban 2 road, Prawet  
Bangkok 10250  
Thailand  
Tel. +66 (0) 90-940-8950  
HelpdeskTH@kuka.com

**Czech Republic**

KUKA Roboter CEE GmbH  
organizační složka  
Pražská 239  
25066 Zdiby  
Czech Republic  
Tel. +420 226 212 273  
support.robotics.cz@kuka.com

**Hungary**

KUKA HUNGÁRIA Kft.  
Fő út 140  
2335 Taksony  
Hungary  
Tel. +36 24 501609  
Fax +36 24 477031  
info@kuka-robotics.hu

**USA**

KUKA Robotics Corporation  
51870 Shelby Parkway  
Shelby Township  
48315-1787  
Michigan  
USA  
Tel. +1 866 873-5852  
Fax +1 866 329-5852  
info@kukarobotics.com  
www.kukarobotics.com

**UK**

KUKA Robotics UK Ltd  
Great Western Street  
Wednesbury West Midlands  
WS10 7LL  
UK  
Tel. +44 121 505 9970  
Fax +44 121 505 6589  
service@kuka-robotics.co.uk  
www.kuka-robotics.co.uk

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