

# KUKA

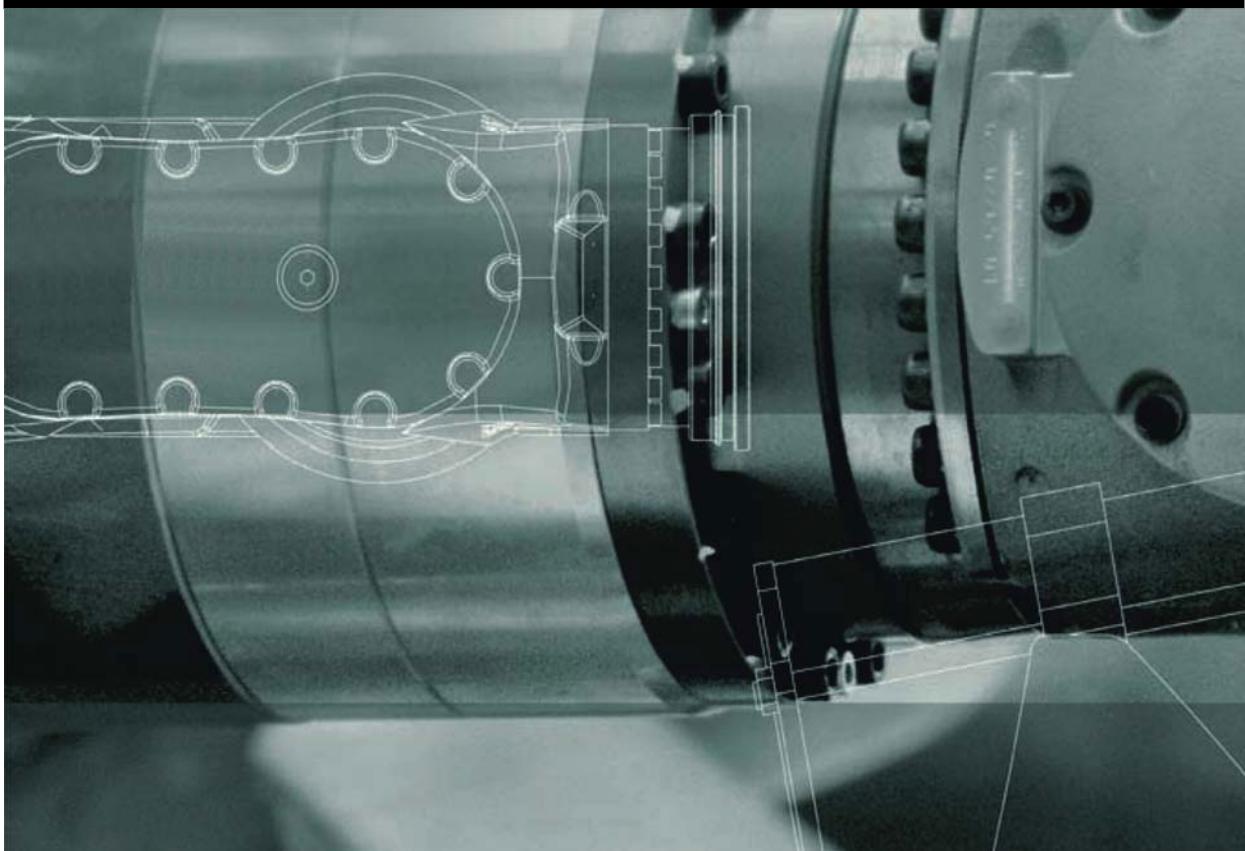
Robots

KUKA Deutschland GmbH

## KR AGILUS sixx

**With W and C Variants**

**Assembly Instructions**



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Version: MA KR AGILUS sixx V14



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

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

Subject to technical alterations without an effect on the function.

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# 1 Introduction

## 1.1 Industrial robot documentation

The industrial robot documentation consists of the following parts:

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

Each of these sets of instructions is a separate document.

## 1.2 Representation of warnings and notes

### Safety

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



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



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



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



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



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

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

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



**SAFETY INSTRUCTIONS** The following procedure must be followed exactly!

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

### Notices

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



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

## 1.3 Terms used

Term	Description
MEMD	Micro Electronic Mastering Device
KL	KUKA linear unit

Term	Description
micro RDC	micro Resolver Digital Converter
smartPAD	The smartPAD teach pendant has all the operator control and display functions required for operating and programming the industrial robot.

## 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

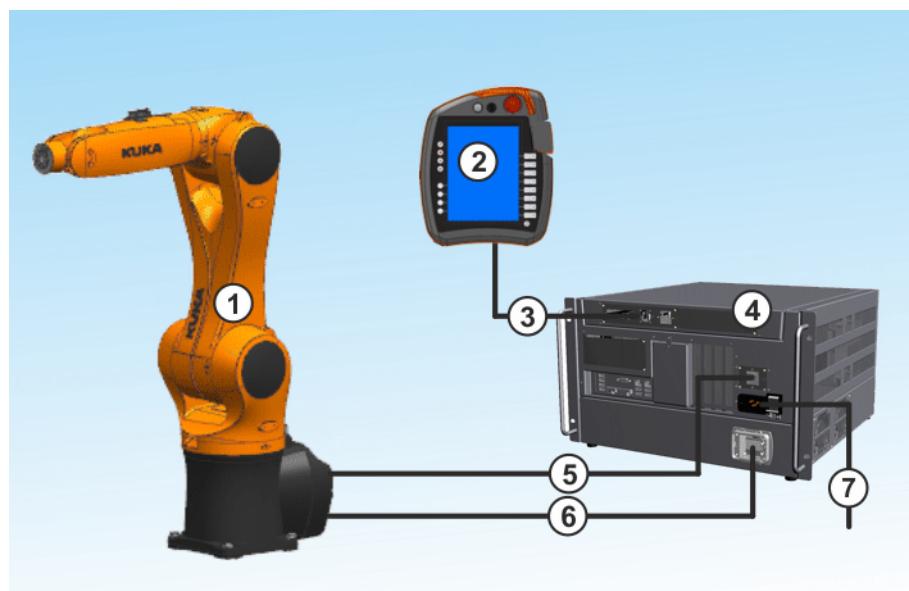
A robot system (**>>> Fig. 3-1**) comprises all the assemblies of an industrial robot, including the manipulator (mechanical system and electrical installations), control cabinet, connecting cables, end effector (tool) and other equipment. The KR AGILUS sixx product family consists of the following types:

- KR 6 R700 sixx
- KR 6 R900 sixx
- KR 10 R900 sixx
- KR 10 R1100 sixx

The robots are also available as W and C variants (wall-mounted and ceiling-mounted versions).

An industrial robot of this type comprises the following components:

- Manipulator
- Robot controller
- smartPAD teach pendant
- Connecting cables
- Software
- Options, accessories



**Fig. 3-1: Example of an industrial robot**

- 1 Manipulator
- 2 smartPAD control panel
- 3 Connecting cable, smartPAD
- 4 Robot controller
- 5 Connecting cable, data cable
- 6 Connecting cable, motor cable
- 7 Device connection cable

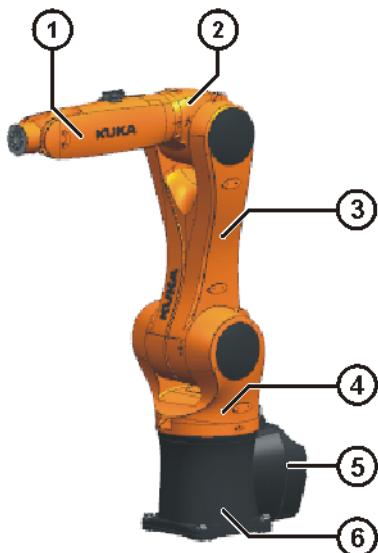
### 3.2 Description of the manipulator

#### Overview

The manipulators (= robot arm and electrical installations) of the variants are designed as 6-axis jointed-arm kinematic systems made of cast light alloy. Each axis is fitted with a brake. All motor units and current-carrying cables are protected against dirt and moisture beneath screwed-on cover plates.

The manipulators consist of the following main assemblies:

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



**Fig. 3-2: Principal components**

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

#### In-line wrist A4, A5, A6

The robot is fitted with a 3-axis in-line wrist. The in-line wrist consists of axes 4, 5 and 6.

There are three 5/2-way solenoid valves and a CAT5 data cable in the in-line wrist that can be used for controlling tools.

The in-line wrist also accommodates the 10-contact circular connector of the wrist I/O cable and interface A4 for the energy supply system.

#### Arm A3

The arm is the link between the in-line wrist and the link arm. The arm is driven by the motor of axis 3.

#### Link arm A2

The link arm is the assembly located between the arm and the rotating column. It houses the motor and gear unit of axis 2. The supply lines of the energy supply system and the cable set for axes 2 to 6 are routed through the link arm.

#### Rotating column A1

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.

<b>Base frame</b>	The base frame is the base of the robot. Interface A1 is located at the rear of the base frame. It constitutes the interface for the connecting cables between the robot, the controller and the energy supply system.
<b>Electrical installations</b>	The electrical installations include all the motor and data cables for the motors of axes 1 to 6, as well as the connections for the internal energy supply system and external axes A7 and A8. All connections are pluggable. The electrical installations also include the RDC, which is integrated into the robot. 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.
<b>Options</b>	The robot can be fitted and operated with various options, e.g. working range limitation A1 or brake release device. The option is described in separate documentation.



## 4 Technical data

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

<b>Robot</b>	<b>Technical data</b>
KR 6 sixx	
KR 6 R700 sixx	Basic data (►►► 4.1 "Basic data, KR 6 sixx" Page 16)
■ KR 6 R700 sixx	
■ KR 6 R700 sixx W	
■ KR 6 R700 sixx C	
KR 6 R900 sixx	Axis data (►►► 4.2 "Axis data, KR 6 sixx" Page 18)
■ KR 6 R900 sixx	
■ KR 6 R900 sixx W	
■ KR 6 R900 sixx C	
	Payloads (►►► 4.3 "Payloads, KR 6 sixx" Page 25)
	Foundation data (►►► 4.4 "Foundation data, KR 6 sixx" Page 28)
	Plates and labels (►►► 4.9 "Plates and labels" Page 44)
	Stopping distances ■ KR 6 R700 sixx and KR 6 R700 sixx C (►►► 4.10.3 "Stopping distances and times, KR 6 R700 sixx and KR 6 R700 sixx C" Page 48)
	■ KR 6 R700 sixx W (►►► 4.10.4 "Stopping distances and times, KR 6 R700 sixx W" Page 53)
	■ KR 6 R900 sixx and KR 6 R900 sixx C (►►► 4.10.5 "Stopping distances and times, KR 6 R900 sixx and KR 6 R900 sixx C" Page 59)
	■ KR 6 R900 sixx W (►►► 4.10.6 "Stopping distances and times, KR 6 R900 sixx W" Page 65)

<b>Robot</b>	<b>Technical data</b>
KR 10 sixx	

Robot	Technical data
KR 10 R900 sixx	Basic data (>>> 4.5 "Basic data, KR 10 sixx" Page 30)
■ KR 10 R900 sixx	Axis data (>>> 4.6 "Axis data, KR 10 sixx" Page 32)
■ KR 10 R900 sixx W	
■ KR 10 R900 sixx C	
KR 10 R1100 sixx	Payloads (>>> 4.7 "Payloads, KR 10 sixx" Page 39)
■ KR 10 R1100 sixx	Foundation data (>>> 4.8 "Foundation data, KR 10 sixx" Page 42)
■ KR 10 R1100 sixx W	
■ KR 10 R1100 sixx C	
	Plates and labels (>>> 4.9 "Plates and labels" Page 44)
	Stopping distances
	■ KR 10 R900 sixx and KR 10 R900 sixx C (>>> 4.10.7 "Stopping distances and times, KR 10 R900 sixx and KR 10 R1100 sixx" Page 71)
	■ KR 10 R900 sixx W (>>> 4.10.8 "Stopping distances and times, KR 10 R900 sixx W and KR 10 R1100 sixx W" Page 77)
	■ KR 10 R1100 sixx and KR 10 R1100 sixx C (>>> 4.10.7 "Stopping distances and times, KR 10 R900 sixx and KR 10 R1100 sixx" Page 71)
	■ KR 10 R1100 sixx W (>>> 4.10.8 "Stopping distances and times, KR 10 R900 sixx W and KR 10 R1100 sixx W" Page 77)

#### 4.1 Basic data, KR 6 sixx

<b>Basic data</b>	Type	KR 6 R700 sixx KR 6 R700 sixx W KR 6 R700 sixx C KR 6 R900 sixx KR 6 R900 sixx W KR 6 R900 sixx C
	Number of axes	6
	Number of controlled axes	6
	Volume of working envelope	KR 6 R700 sixx: 1.36 m <sup>3</sup> KR 6 R700 sixx W: 1.36 m <sup>3</sup> KR 6 R700 sixx C: 1.36 m <sup>3</sup> KR 6 R900 sixx: 2.85 m <sup>3</sup> KR 6 R900 sixx W: 2.85 m <sup>3</sup> KR 6 R900 sixx C: 2.85 m <sup>3</sup>
	Pose repeatability (ISO 9283)	±0.03 mm

Working envelope reference point	Intersection of axes 4 and 5
Weight	KR 6 R700 sixx: approx. 50 kg KR 6 R700 sixx W: approx. 50 kg KR 6 R700 sixx C: approx. 50 kg KR 6 R900 sixx: approx. 52 kg KR 6 R900 sixx W: approx. 52 kg KR 6 R900 sixx C: approx. 52 kg
Principal dynamic loads	See Foundation loads
Protection rating of the robot	IP 54 Ready for operation, with connecting cables plugged in (according to EN 60529)
Protection rating of the in-line wrist	IP 54
Sound level	< 70 dB (A) outside the working envelope
Mounting position	Floor, wall, ceiling
Footprint	320 mm x 320 mm
Permissible angle of inclination	-
Standard colors	Base (stationary) and covers on link arm: black (RAL 9011); moving parts: KUKA orange 2567
Controller	KR C4 compact
Transformation name	KR 6 R700 sixx: KR6R700 C4SR FLR KR 6 R700 sixx W: KR6R700 C4SR WLL KR 6 R700 sixx C: KR6R700 C4SR CLG KR 6 R900 sixx: KR6R900 C4SR FLR KR 6 R900 sixx W: KR6R900 C4SR WLL KR 6 R900 sixx C: KR6R900 C4SR CLG

**Ambient conditions**

Operation	278 K to 318 K (+5 °C to +45 °C) No condensation permissible.
Storage and transportation	-40 °C to +60 °C (233 K to 333 K)
Ambient conditions	Relative air humidity ≤ 90% DIN EN 60721-3-3, Class 3K3
Altitude	<ul style="list-style-type: none"> <li>■ up to 1000 m above mean sea level with no reduction in power</li> <li>■ 1000 m ... 4000 m above mean sea level with a reduction in power of 5%/1000 m</li> </ul>

## Connecting cables

Cable designation	Connector designation robot controller - robot	Interface with robot
Motor cable	X20 - X30	Han Yellock 30
Data cable	X21 - X31	Han Q12
Data cable CAT5 (can be ordered as an option)	X65/X66 - XPN1	M12 connector
Connecting cable, external axes A7 and A8 (can be ordered as an option)	XP7 - XP7.1 XP8 - XP8.1	Connector M17 in each case
Ground conductor, equi-potential bonding (can be ordered as an option)		M4 ring cable lug

Only resolvers can be connected to the connections XP7.1 and XP8.1.

Cable lengths	
Standard	4 m
Option	1 m, 7 m, 15 m, 25 m

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

## 4.2 Axis data, KR 6 sixx

### Axis data

The following axis data are valid for the robots:

- KR 6 R700 sixx
- KR 6 R700 sixx W
- KR 6 R700 sixx C
- KR 6 R900 sixx
- KR 6 R900 sixx W
- KR 6 R900 sixx C

Axis	Range of motion, software-limited	Speed with rated payload
1	+/-170°	360 °/s
2	+45° to -190°	300 °/s
3	+156° to -120°	360 °/s
4	+/-185°	381 °/s
5	+/-120°	388 °/s
6	+/-350°	615 °/s



In the case of manipulators with a payload of 6 kg and a reach of R700, not every angle for axis A4 can be reached in the end position.

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

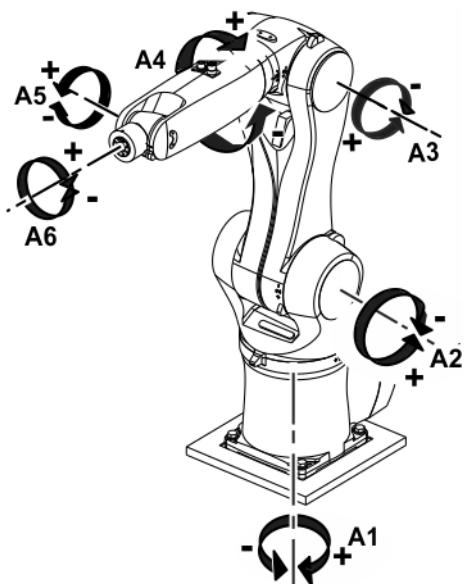


Fig. 4-1: Direction of rotation of robot axes

#### Mastering position

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

#### Working envelope, KR 6 R700 sixx

The following diagrams ([>>> Fig. 4-2](#)) and ([>>> Fig. 4-3](#)) show the shape and size of the working envelope for the robot:

- KR 6 R700 sixx

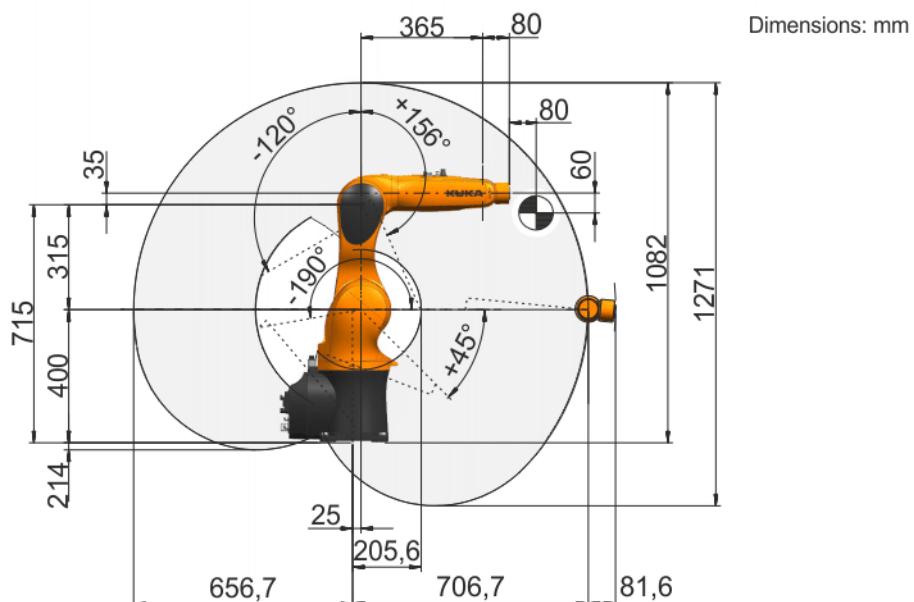
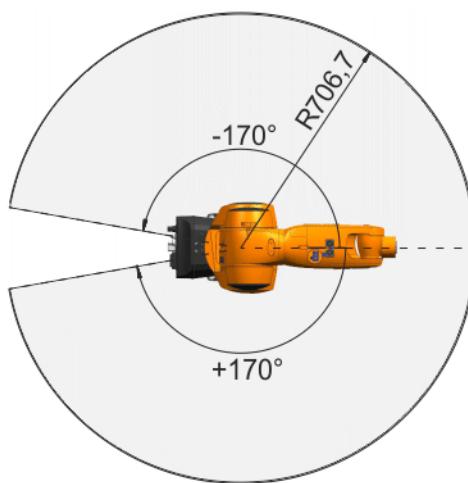


Fig. 4-2: KR 6 R700 sixx, working envelope, side view

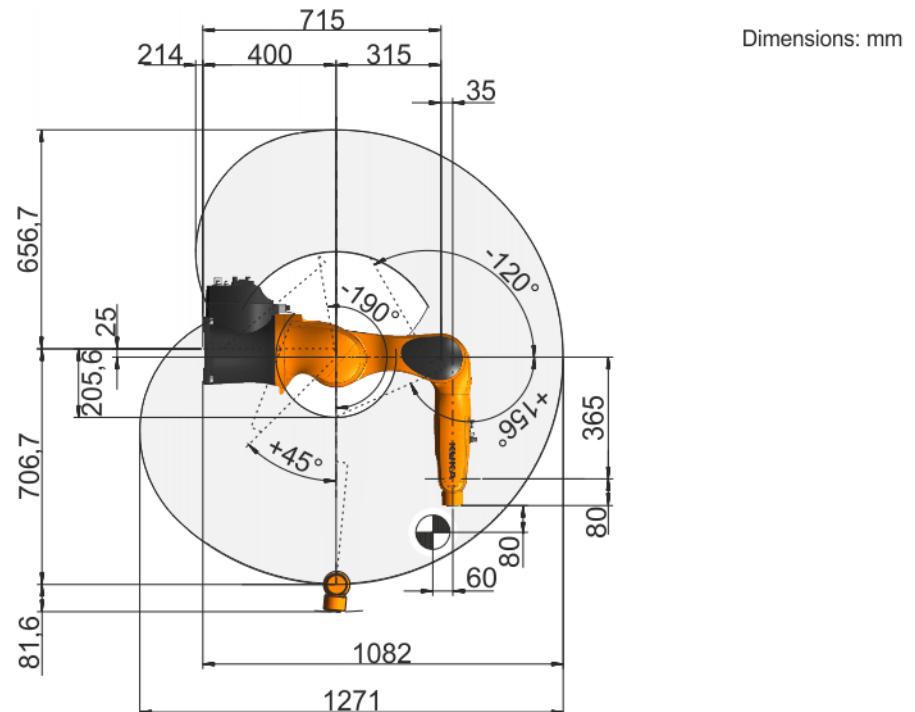


Dimensions: mm

**Fig. 4-3: KR 6 R700 sixx, working envelope, top view**

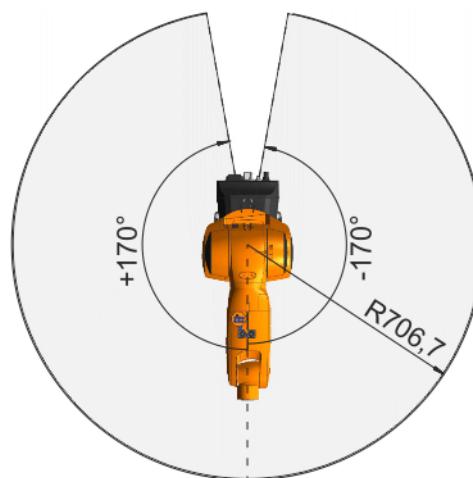
The following diagrams ([>>> Fig. 4-4](#)) and ([>>> Fig. 4-5](#)) show the shape and size of the working envelope for the robot:

- KR 6 R700 sixx W



Dimensions: mm

**Fig. 4-4: KR 6 R700 sixx W working envelope, side view**

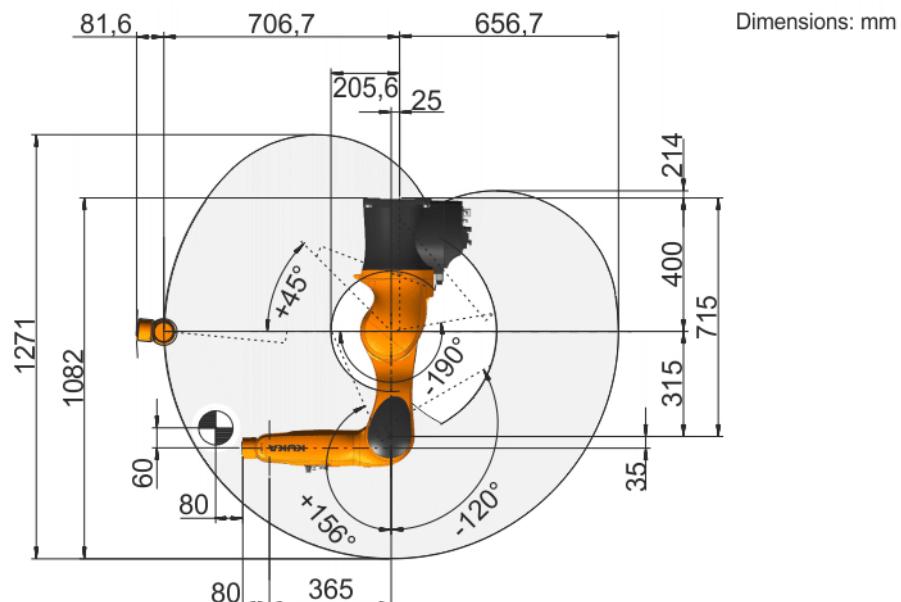


Dimensions: mm

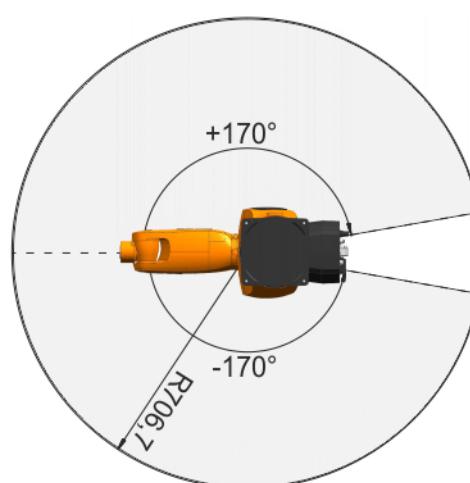
**Fig. 4-5: KR 6 R700 sixx W, working envelope, top view**

The following diagrams ([>>> Fig. 4-6](#)) and ([>>> Fig. 4-7](#)) show the shape and size of the working envelope for the robot:

- KR 6 R700 sixx C



Dimensions: mm

**Fig. 4-6: KR 6 R700 sixx C, working envelope, side view**

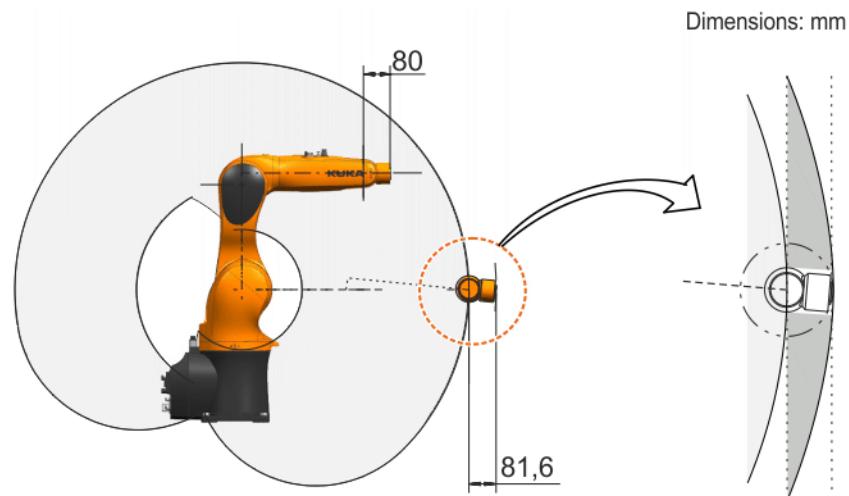
Dimensions: mm

**Fig. 4-7: KR 6 R700 sixx C, working envelope, top view**

**Distance to flange, KR 6 R700 sixx**

The distance to the flange varies according to the position of the robot. The flange distance ([>>> Fig. 4-8](#)) is valid for the following robots:

- KR 6 R700 sixx
- KR 6 R700 sixx W
- KR 6 R700 sixx C

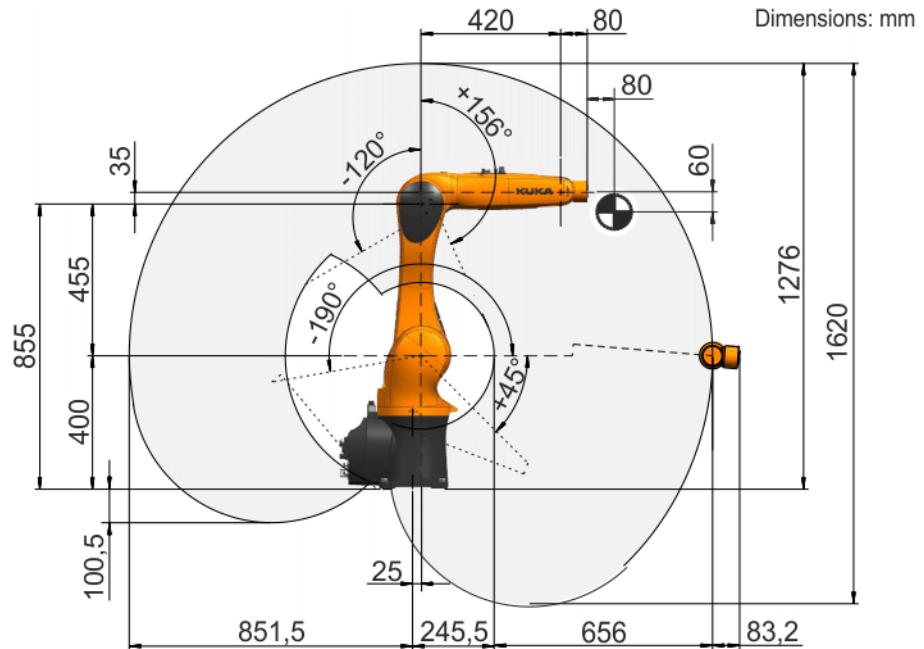


**Fig. 4-8: Distance to flange, KR 6 R700 sixx (with W and C variants)**

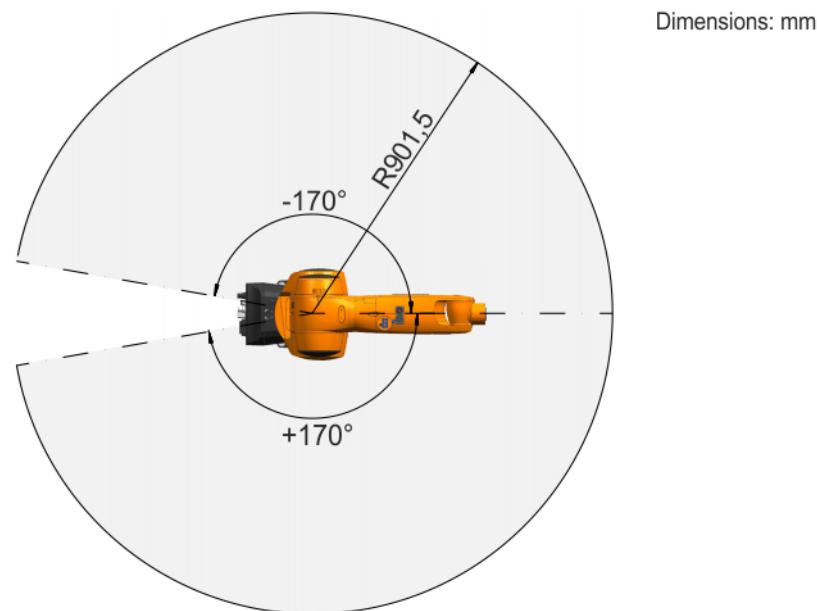
**Working envelope, KR 6 R900 sixx**

The following diagrams ([>>> Fig. 4-9](#)) and ([>>> Fig. 4-10](#)) show the shape and size of the working envelope for the robot:

- KR 6 R900 sixx



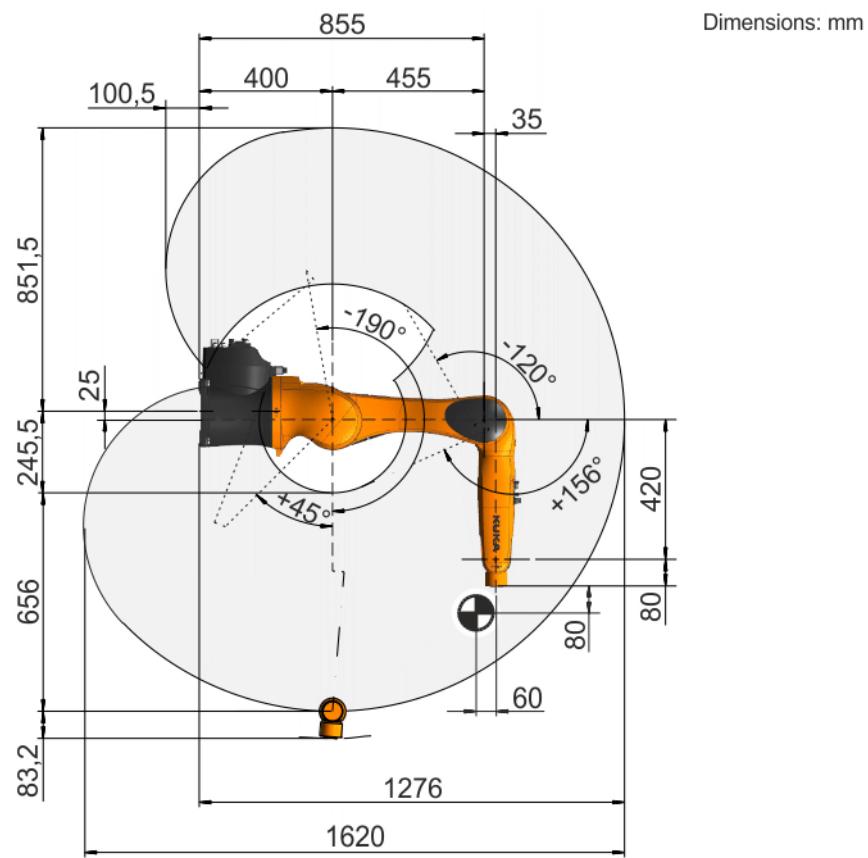
**Fig. 4-9: KR 6 R900 sixx, working envelope, side view**



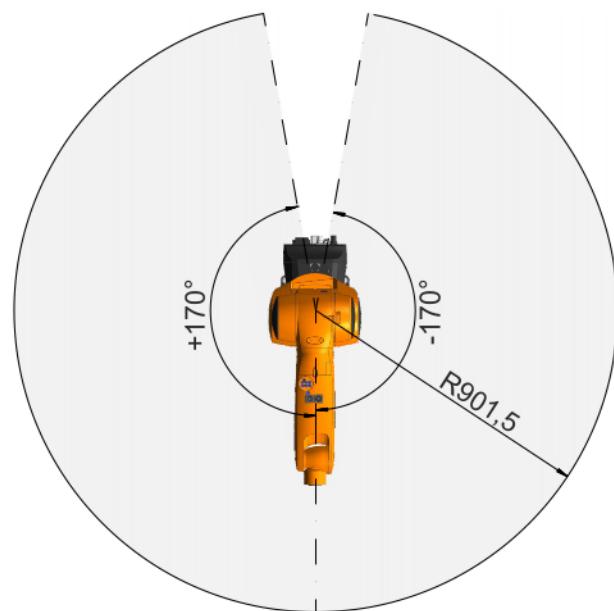
**Fig. 4-10: KR 6 R900 sixx, working envelope, top view**

The following diagrams ([>>> Fig. 4-11](#)) and ([>>> Fig. 4-12](#)) show the shape and size of the working envelope for the robot:

- KR 6 R900 sixx W



**Fig. 4-11: KR 6 R900 sixx W, working envelope, side view**

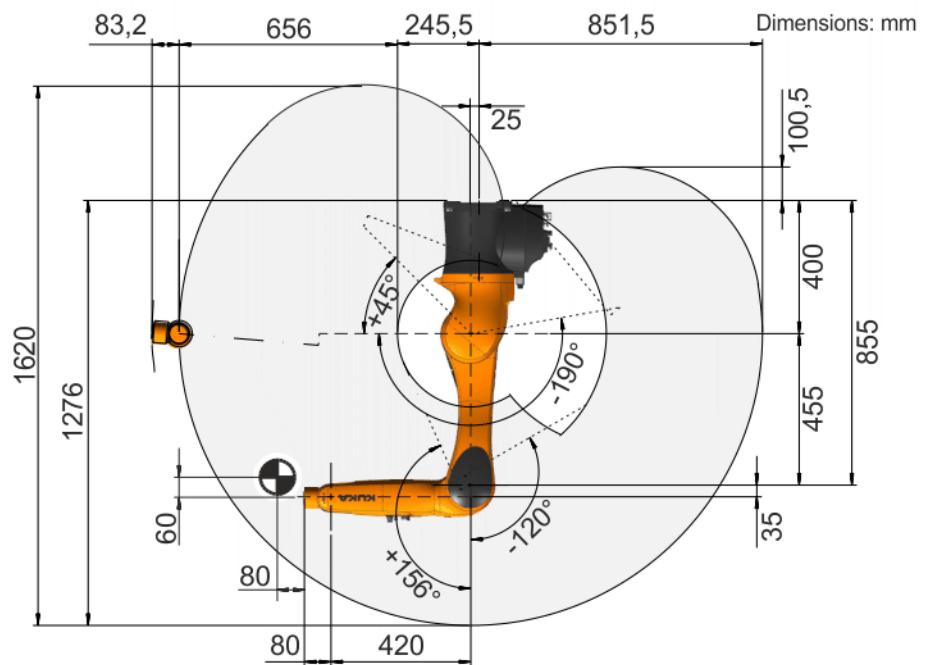


Dimensions: mm

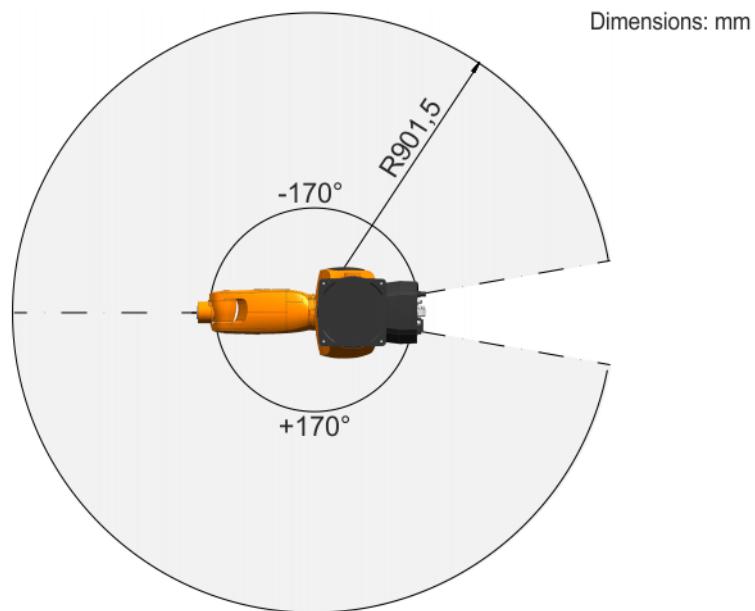
**Fig. 4-12: KR 6 R900 sixx W, working envelope, top view**

The following diagrams ([>>> Fig. 4-13](#)) and ([>>> Fig. 4-14](#)) show the shape and size of the working envelope for the robot:

- KR 6 R900 sixx C



**Fig. 4-13: KR 6 R900 sixx C, working envelope, side view**

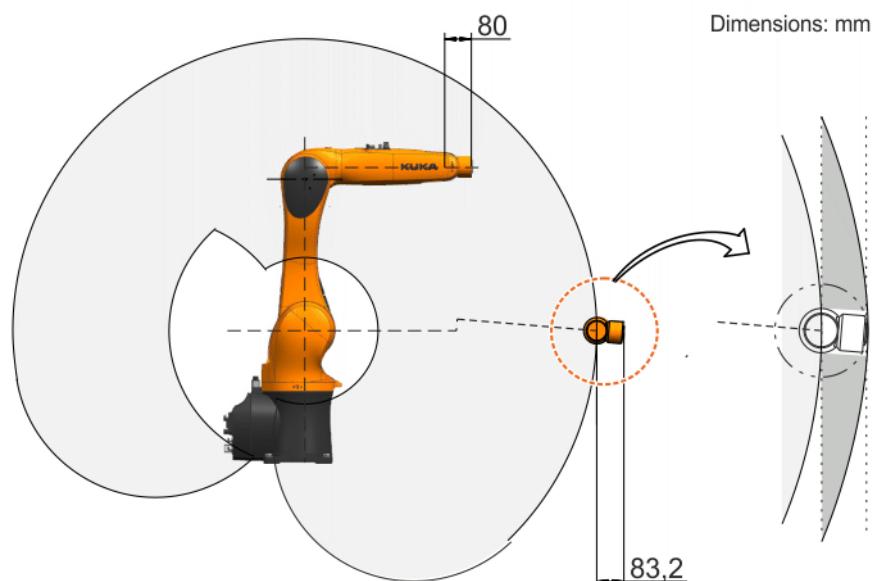


**Fig. 4-14: KR 6 R900 sixx C, working envelope, top view**

**Distance to  
flange, KR 6 R900  
sixx**

The distance to the flange varies according to the position of the robot. The flange distance ([>>> Fig. 4-15](#)) is valid for the following robots:

- KR 6 R900 sixx
- KR 6 R900 sixx W
- KR 6 R900 sixx C



**Fig. 4-15: Distance to flange, KR 6 R900 sixx (with W and C variants)**

### 4.3 Payloads, KR 6 sixx

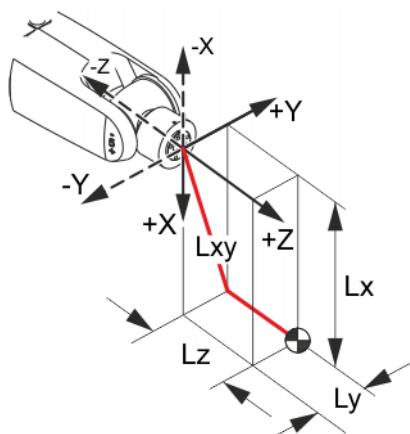
#### Payloads

A distinction is made between the nominal and maximum payload. At the nominal payload, the manipulator is rated for optimal cycle times and accuracy.

Robot	KR 6 R700 sixx KR 6 R700 sixx W KR 6 R700 sixx C KR 6 R900 sixx KR 6 R900 sixx W KR 6 R900 sixx C
In-line wrist	KR 6 R700 sixx: IW 6 R700 KR 6 R900 sixx: IW 6/10 R900
Rated payload	3 kg
Maximum payload	6 kg
Distance of the load center of gravity $L_{xy}$	60 mm
Distance of the load center of gravity $L_z$	80 mm
Max. total load	6 kg
Supplementary load	The sum of all loads mounted on the robot must not exceed the maximum total load.

**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.



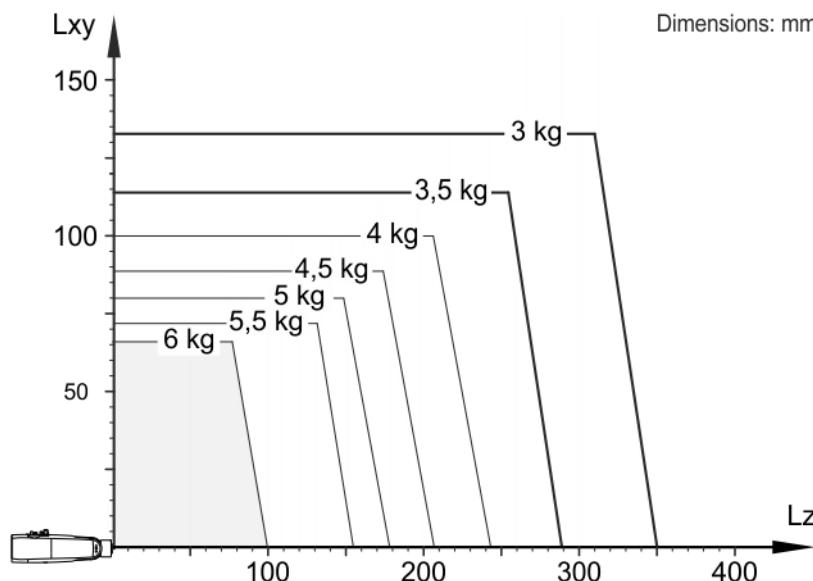
**Fig. 4-16: Load center of gravity**

**Payload diagram**

Permissible mass inertia at the design point ( $L_x$ ,  $L_y$ ,  $L_z$ ) is  $0.045 \text{ kgm}^2$ .

The following figure (=> Fig. 4-17) shows the payload diagram for the following robots:

- KR 6 R700 sixx
- KR 6 R700 sixx W
- KR 6 R700 sixx C
- KR 6 R900 sixx
- KR 6 R900 sixx W
- KR 6 R900 sixx C



**Fig. 4-17: Payload diagram, payload 6 kg**

**NOTICE**

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

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

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

#### Mounting flange

Mounting flange	31.5 mm
Screw grade	12.9
Screw size	M5
Number of fastening screws	7
Clamping length	min. 1.5 x nominal diameter
Depth of engagement	min. 5.5 mm, max. 7 mm
Locating element	5 H7
Standard	See diagram. ( <a href="#">&gt;&gt;&gt; Fig. 4-18</a> )

The mounting flange is depicted with axis 6 in the zero position ([>>> Fig. 4-18](#)) The symbol  $X_m$  indicates the position of the locating element in the zero position.

Dimensions: mm

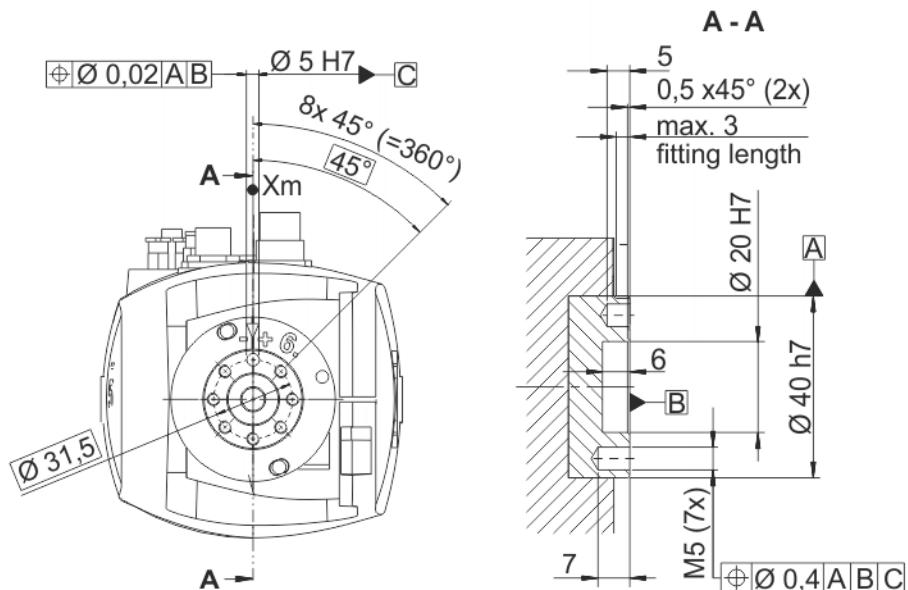


Fig. 4-18: Mounting flange

#### 4.4 Foundation data, KR 6 sixx

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

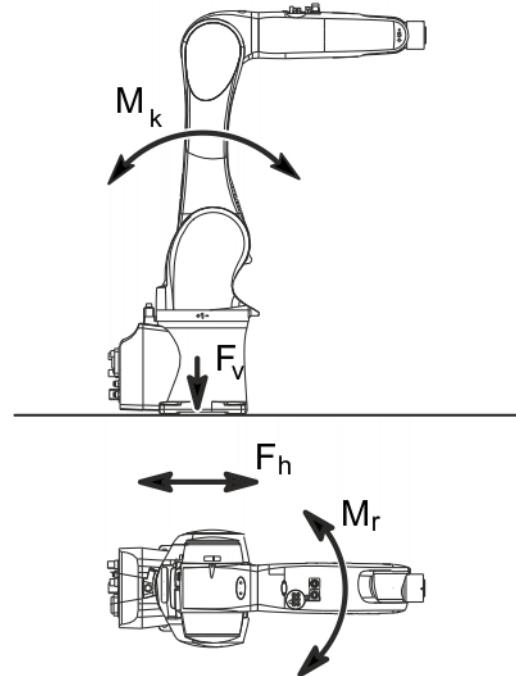


Fig. 4-19: Loads acting on the foundation, floor mounting

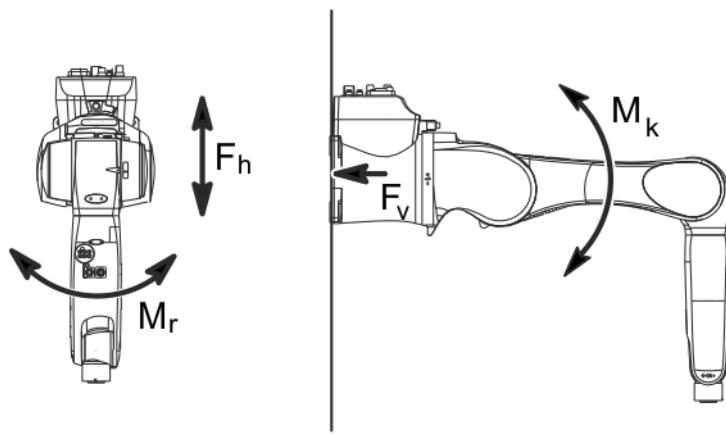


Fig. 4-20: Loads acting on the foundation, wall mounting

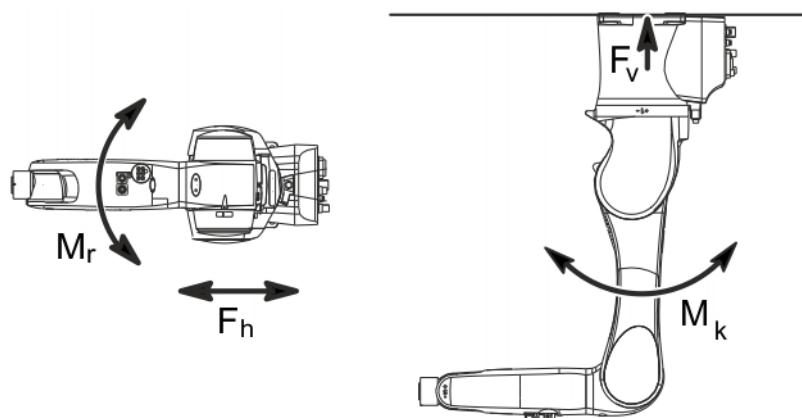


Fig. 4-21: Loads acting on the foundation, ceiling mounting

Type of load	Force/torque/mass	
	Normal operation	Maximum load
$F_v$ = vertical force	$F_{v \text{ normal}} = 967 \text{ N}$	$F_{v \text{ max}} = 1297 \text{ N}$
$F_h$ = horizontal force	$F_{h \text{ normal}} = 1223 \text{ N}$	$F_{v \text{ max}} = 1362 \text{ N}$
$M_k$ = tilting moment	$M_{k \text{ normal}} = 788 \text{ Nm}$	$M_{k \text{ max}} = 1152 \text{ Nm}$
$M_r$ = torque	$M_{r \text{ normal}} = 367 \text{ Nm}$	$M_{r \text{ max}} = 880 \text{ Nm}$
Total mass for foundation load	KR 6 R700 sixx: 56 kg KR 6 R900 sixx: 58 kg	
Robot	KR 6 R700 sixx: 50 kg KR 6 R900 sixx: 52 kg	
Total load for foundation load (suppl. load on arm + rated payload)	KR 6 R700 sixx: 6 kg KR 6 R900 sixx: 6 kg	

**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  $F_V$ .

#### 4.5 Basic data, KR 10 sixx

<b>Basic data</b>	Type	KR 10 R900 sixx KR 10 R900 sixx W KR 10 R900 sixx C KR 10 R1100 sixx KR 10 R1100 sixx W KR 10 R1100 sixx C
Number of axes	6	
Number of controlled axes	6	
Volume of working envelope		KR 10 R900 sixx: 2.85 m <sup>3</sup> KR 10 R900 sixx W: 2.85 m <sup>3</sup> KR 10 R900 sixx C: 2.85 m <sup>3</sup> KR 10 R1100 sixx: 5.20 m <sup>3</sup> KR 10 R1100 sixx W: 5.20 m <sup>3</sup> KR 10 R1100 sixx C: 5.20 m <sup>3</sup>
Pose repeatability (ISO 9283)		±0.03 mm
Working envelope reference point		Intersection of axes 4 and 5
Weight		KR 10 R900 sixx: approx. 52 kg KR 10 R900 sixx W: approx. 52 kg KR 10 R900 sixx C: approx. 52 kg KR 10 R1100 sixx: approx. 55 kg KR 10 R1100 sixx W: approx. 55 kg KR 10 R1100 sixx C: approx. 55 kg
Principal dynamic loads		See Foundation loads
Protection rating of the robot		IP 54 Ready for operation, with connecting cables plugged in (according to EN 60529)
Protection rating of the in-line wrist		IP 54
Sound level		< 70 dB (A) outside the working envelope

Mounting position	Floor, wall, ceiling
Footprint	320 mm x 320 mm
Permissible angle of inclination	-
Standard colors	Base (stationary) and covers on link arm: black (RAL 9011); moving parts: KUKA orange 2567
Controller	KR C4 compact
Transformation name	KR 10 R900 sixx: KR10R900 C4SR FLR KR 10 R900 sixx W: KR10R900 C4SR WLL KR 10 R900 sixx C: KR10R900 C4SR CLG KR 10 R1100 sixx: KR10R1100 C4SR FLR KR 10 R1100 sixx W: KR10R1100 C4SR WLL KR 10 R1100 sixx C: KR10R1100 C4SR CLG

**Ambient conditions**

Operation	278 K to 318 K (+5 °C to +45 °C) No condensation permissible.
Storage and transportation	-40 °C to +60 °C (233 K to 333 K)
Ambient conditions	Relative air humidity ≤ 90% DIN EN 60721-3-3, Class 3K3
Altitude	<ul style="list-style-type: none"> <li>■ up to 1000 m above mean sea level with no reduction in power</li> <li>■ 1000 m ... 4000 m above mean sea level with a reduction in power of 5%/1000 m</li> </ul>

**Connecting cables**

Cable designation	Connector designation robot controller - robot	Interface with robot
Motor cable	X20 - X30	Han Yellock 30
Data cable	X21 - X31	Han Q12
Data cable CAT5 (can be ordered as an option)	X65/X66 - XPN1	M12 connector
Connecting cable, external axes A7 and A8 (can be ordered as an option)	XP7 - XP7.1 XP8 - XP8.1	Connector M17 in each case
Ground conductor, equipotential bonding (can be ordered as an option)		M4 ring cable lug

Only resolvers can be connected to the connections XP7.1 and XP8.1.

	Cable lengths
Standard	4 m
Option	1 m, 7 m, 15 m, 25 m

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

## 4.6 Axis data, KR 10 sixx

### Axis data

The following axis data are valid for the robots:

- KR 10 R900 sixx
- KR 10 R900 sixx W
- KR 10 R900 sixx C
- KR 10 R1100 sixx
- KR 10 R1100 sixx W
- KR 10 R1100 sixx C

Axis	Range of motion, software-limited	Velocity with rated payload
1	+/-170°	300 °/s
2	+45° to -190°	225 °/s
3	+156° to -120°	225 °/s
4	+/-185°	381 °/s
5	+/-120°	311 °/s
6	+/-350°	492 °/s

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

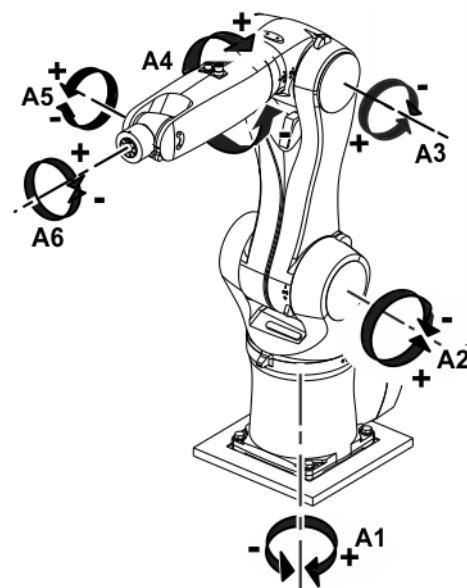


Fig. 4-22: Direction of rotation of robot axes

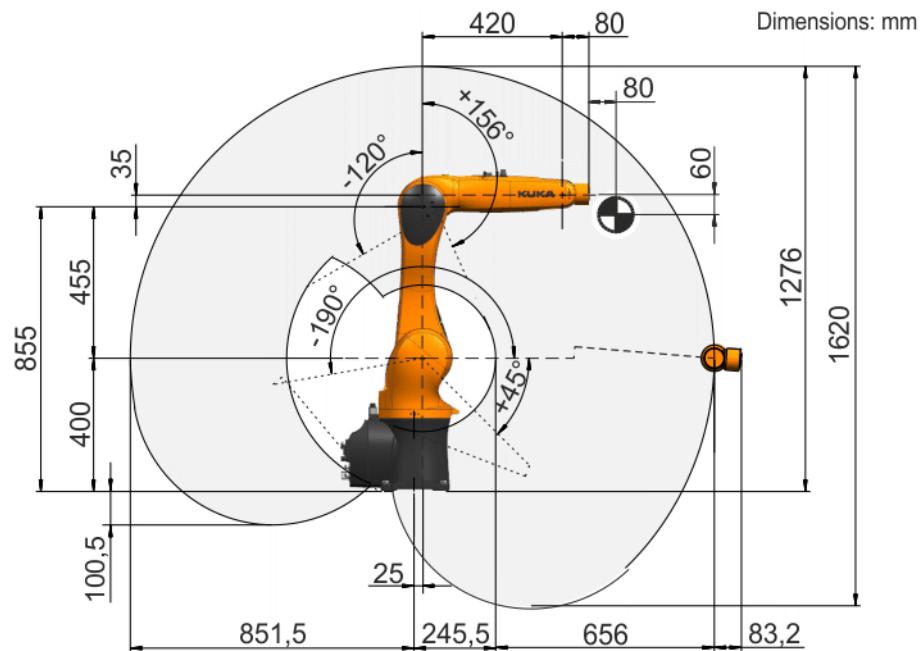
### Mastering position

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

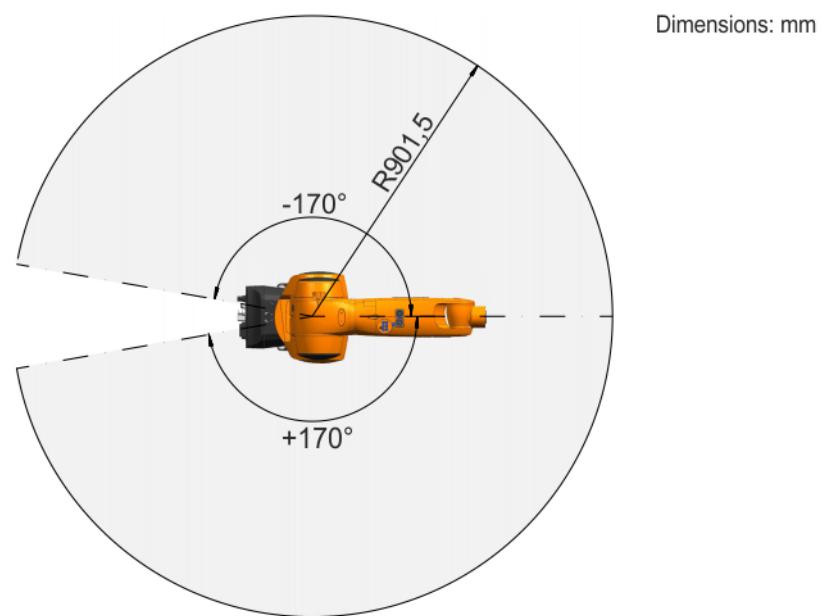
### Working envelope, KR 10 R900 sixx

The following diagrams ([>>> Fig. 4-23](#) ) and ([>>> Fig. 4-24](#) ) show the shape and size of the working envelope for the robot:

- KR 10 R900 sixx



**Fig. 4-23: KR 10 R900 sixx, working envelope, side view**



**Fig. 4-24: KR 10 R900 sixx, working envelope, top view**

The following diagrams ([>>> Fig. 4-25](#)) and ([>>> Fig. 4-26](#)) show the shape and size of the working envelope for the robot:

- KR 10 R900 sixx W

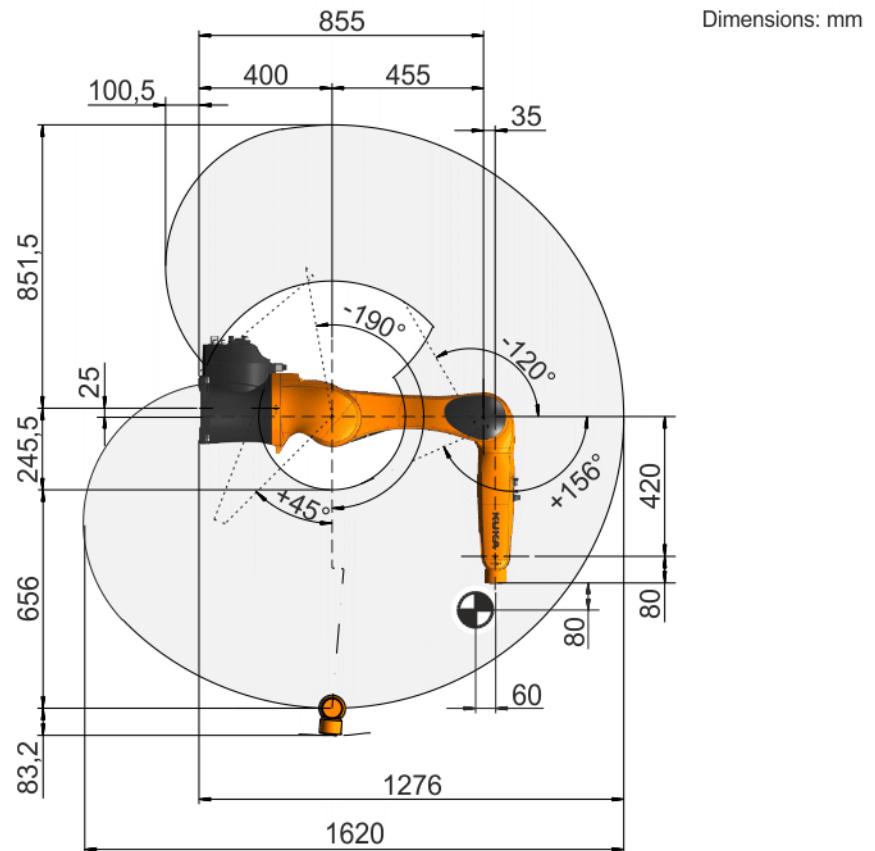


Fig. 4-25: KR 10 R900 sixx W, working envelope, side view

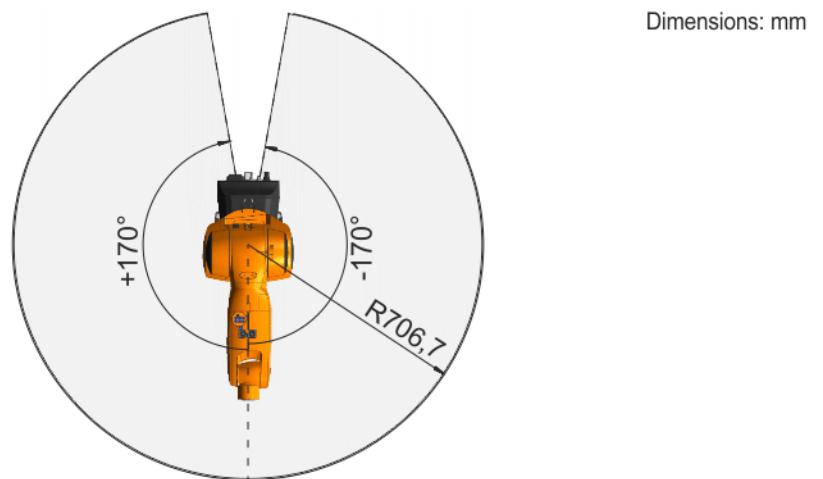


Fig. 4-26: KR 10 R900 sixx W, working envelope, top view

The following diagrams ([>>> Fig. 4-27](#)) and ([>>> Fig. 4-28](#)) show the shape and size of the working envelope for the robot:

- KR 10 R900 sixx C

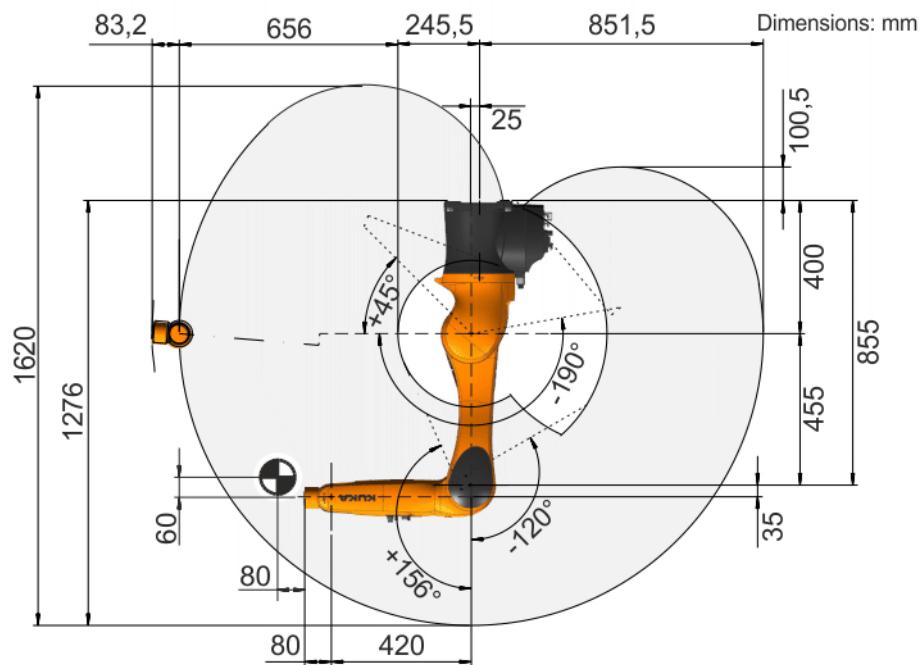


Fig. 4-27: KR 10 R900 sixx C, working envelope, side view

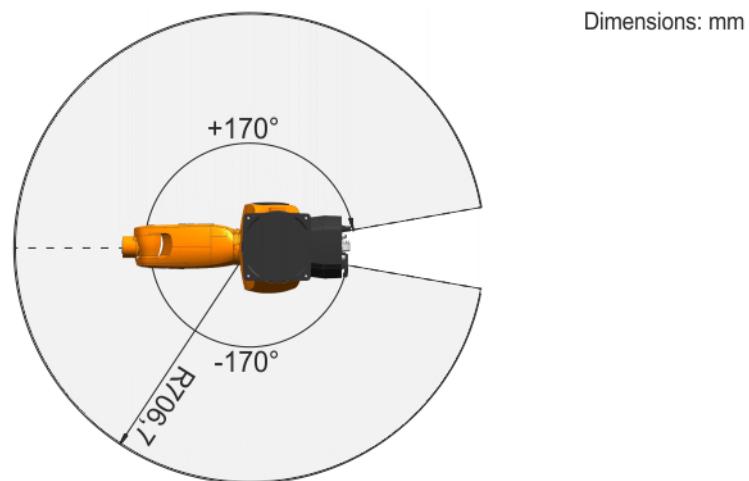


Fig. 4-28: KR 10 R900 sixx C, working envelope, top view

**Distance to flange, KR 10 R900 sixx**

The distance to the flange varies according to the position of the robot. The flange distance (>>>> Fig. 4-29) is valid for the following robots:

- KR 10 R900 sixx
- KR 10 R900 sixx W
- KR 10 R900 sixx C

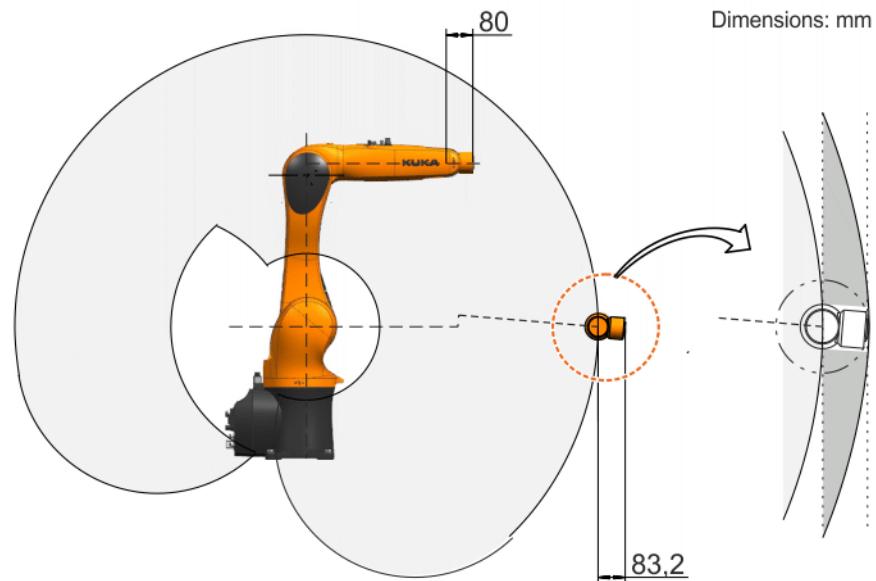


Fig. 4-29: Distance to flange, KR 10 R900 sixx (with W and C variants)

#### Working envelope, KR 10 R1100 sixx

The following diagrams ([>>> Fig. 4-30](#)) and ([>>> Fig. 4-31](#)) show the shape and size of the working envelope for the robot:

- KR 10 R1100 sixx

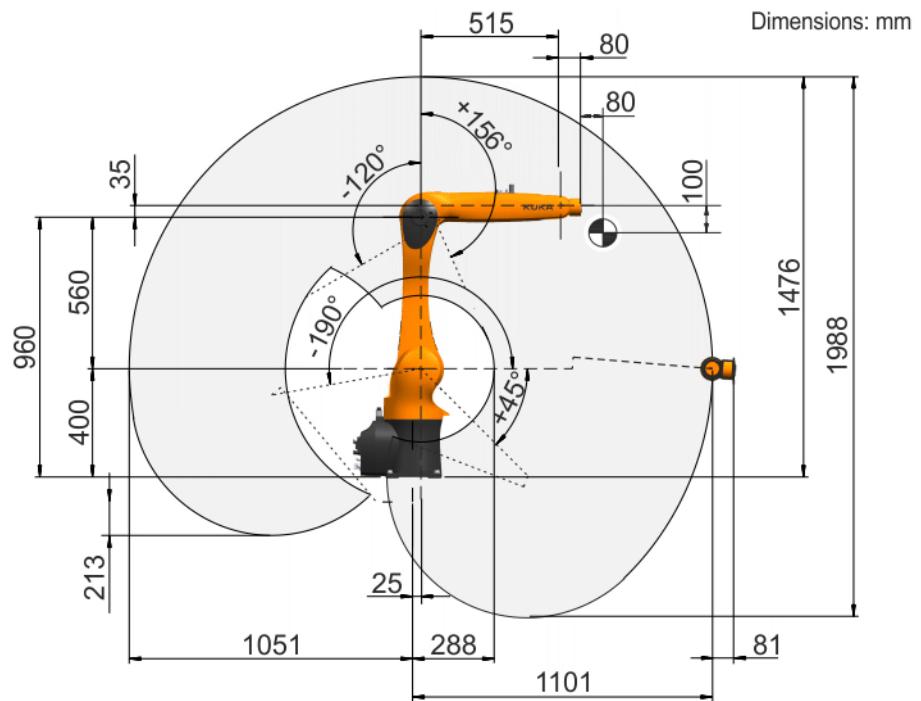
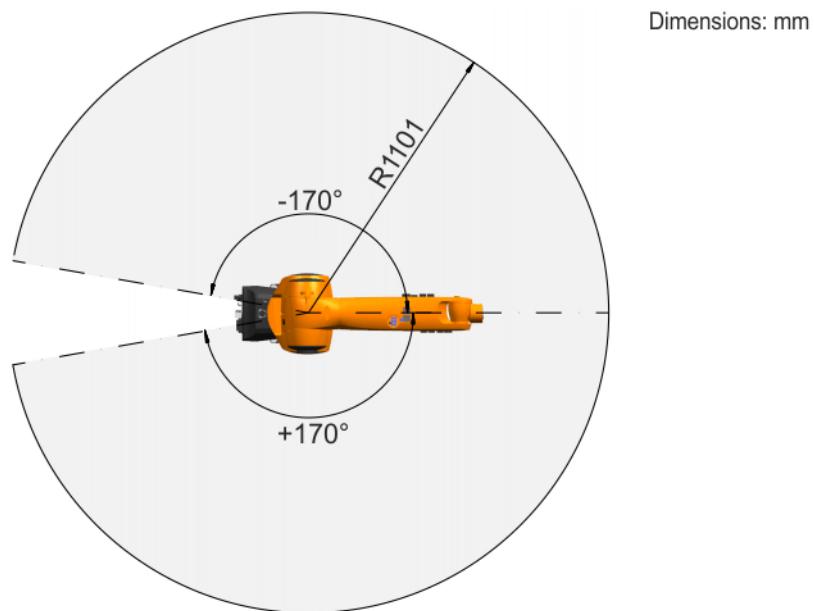


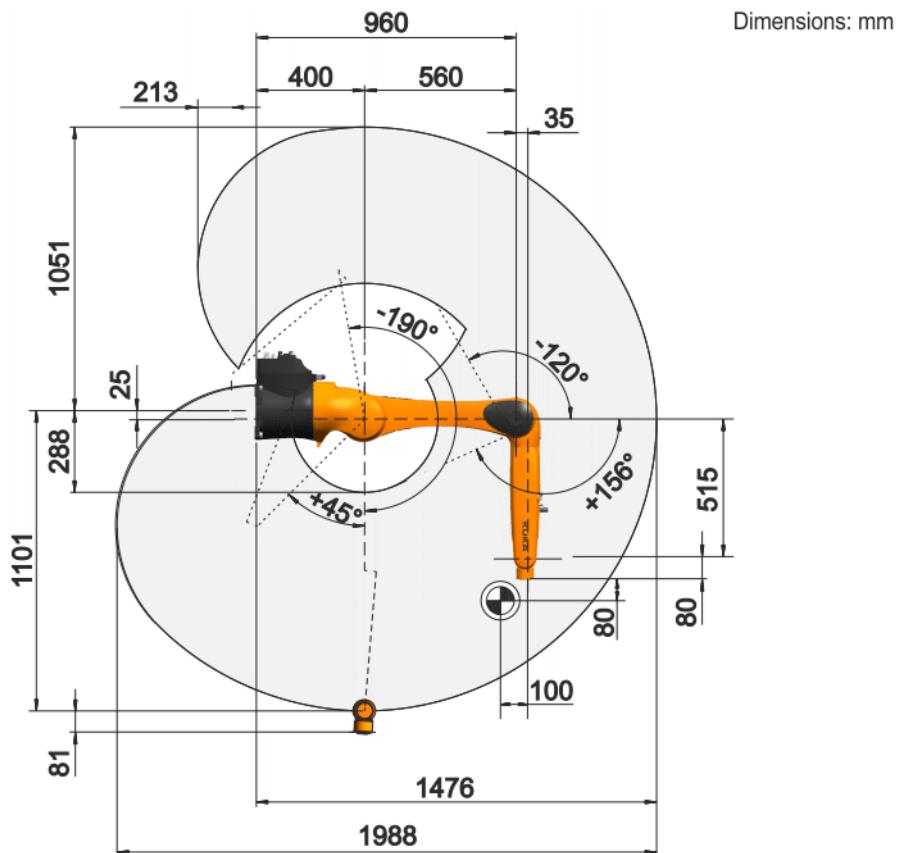
Fig. 4-30: KR 10 R1100 sixx, working envelope, side view



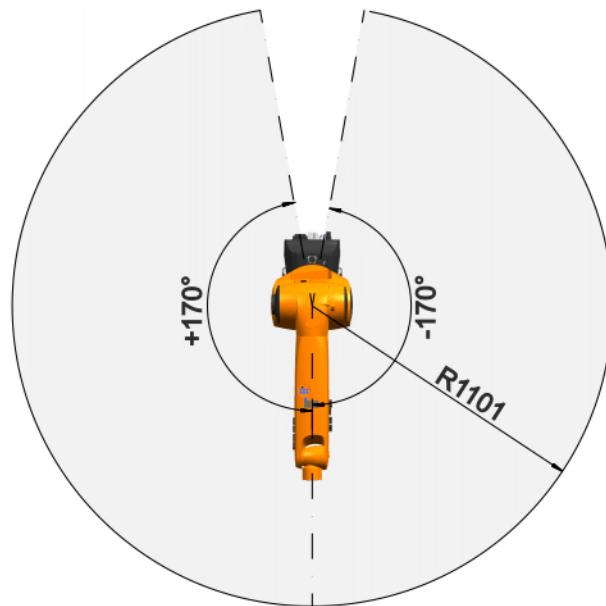
**Fig. 4-31: KR 10 R1100 sixx, working envelope, top view**

The following diagrams ([>>> Fig. 4-32](#)) and ([>>> Fig. 4-33](#)) show the shape and size of the working envelope for the robot:

- KR 10 R1100 sixx W



**Fig. 4-32: KR 10 R1100 sixx W, working envelope, side view**

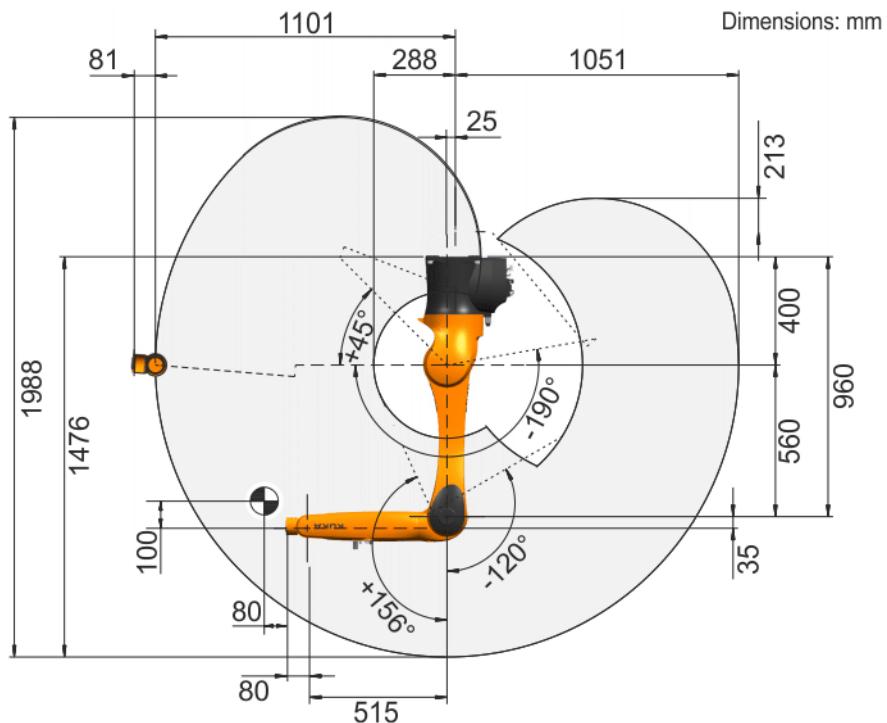


Dimensions: mm

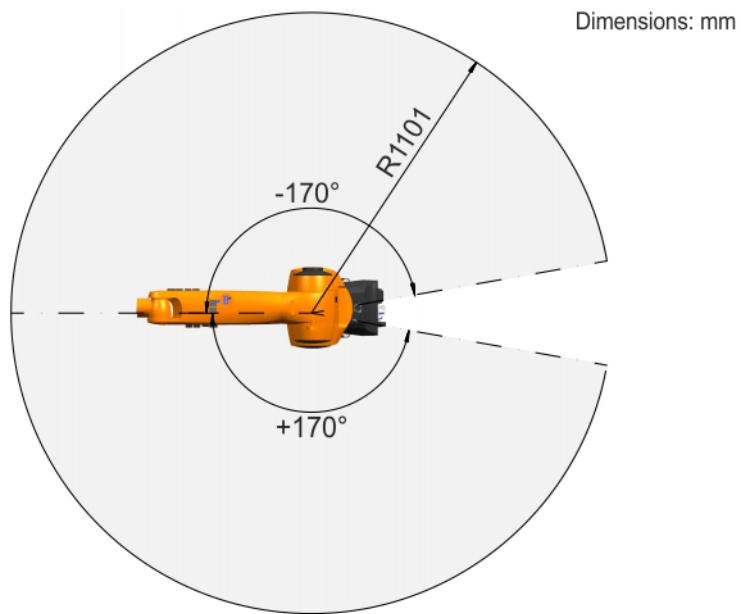
**Fig. 4-33: KR 10 R1100 sixx W, working envelope, top view**

The following diagrams ([>>> Fig. 4-34](#)) and ([>>> Fig. 4-35](#)) show the shape and size of the working envelope for the robot:

■ KR 10 R1100 sixx C



**Fig. 4-34: KR 10 R1100 sixx C, working envelope, side view**

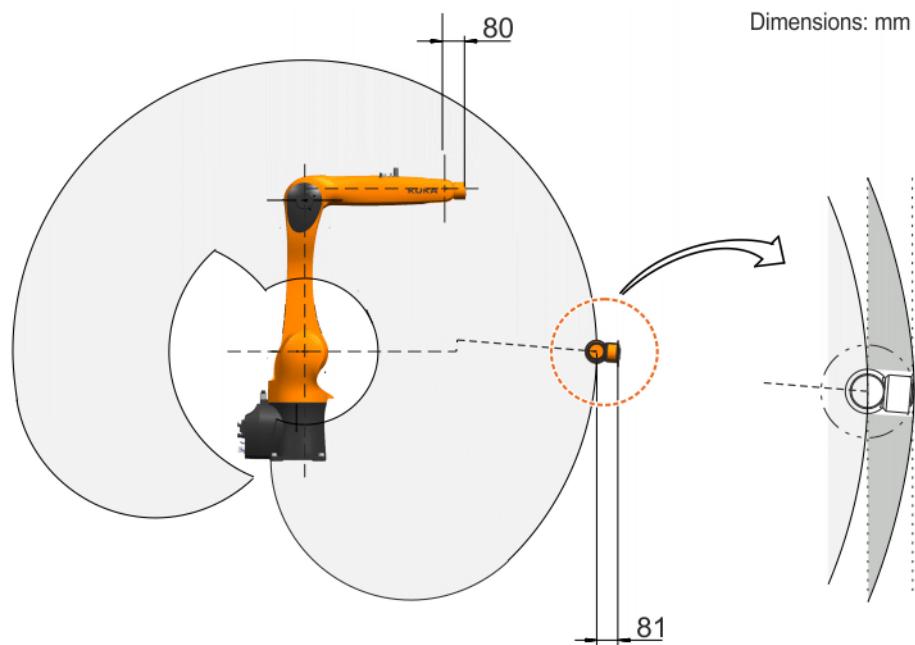


**Fig. 4-35: KR 10 R1100 sixx C, working envelope, top view**

#### Distance to flange, KR 10 R1100 sixx

The distance to the flange varies according to the position of the robot. The flange distance ([>>> Fig. 4-36](#)) is valid for the following robots:

- KR 10 R1100 sixx
- KR 10 R1100 sixx W
- KR 10 R1100 sixx C



**Fig. 4-36: Distance to flange, KR 10 R1100 sixx (with W and C variants)**

## 4.7 Payloads, KR 10 sixx

### Payloads

A distinction is made between the nominal and maximum payload. At the nominal payload, the manipulator is rated for optimal cycle times and accuracy.

Robot	KR 10 R900 sixx KR 10 R900 sixx W KR 10 R900 sixx C KR 10 R1100 sixx KR 10 R1100 sixx W KR 10 R1100 sixx C
In-line wrist	KR 10 R900 sixx: IW 6/10 R900 KR 10 R1100 sixx: IW 10 R1100
Rated payload	5 kg
Maximum payload	10 kg
Distance of the load center of gravity $L_{xy}$	100 mm
Distance of the load center of gravity $L_z$	80 mm
Max. total load	10 kg
Supplementary load	The sum of all loads mounted on the robot must not exceed the maximum total load.

**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.

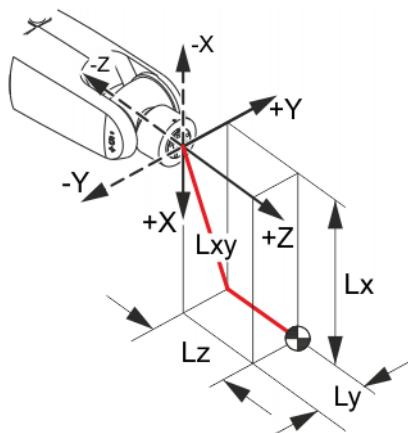


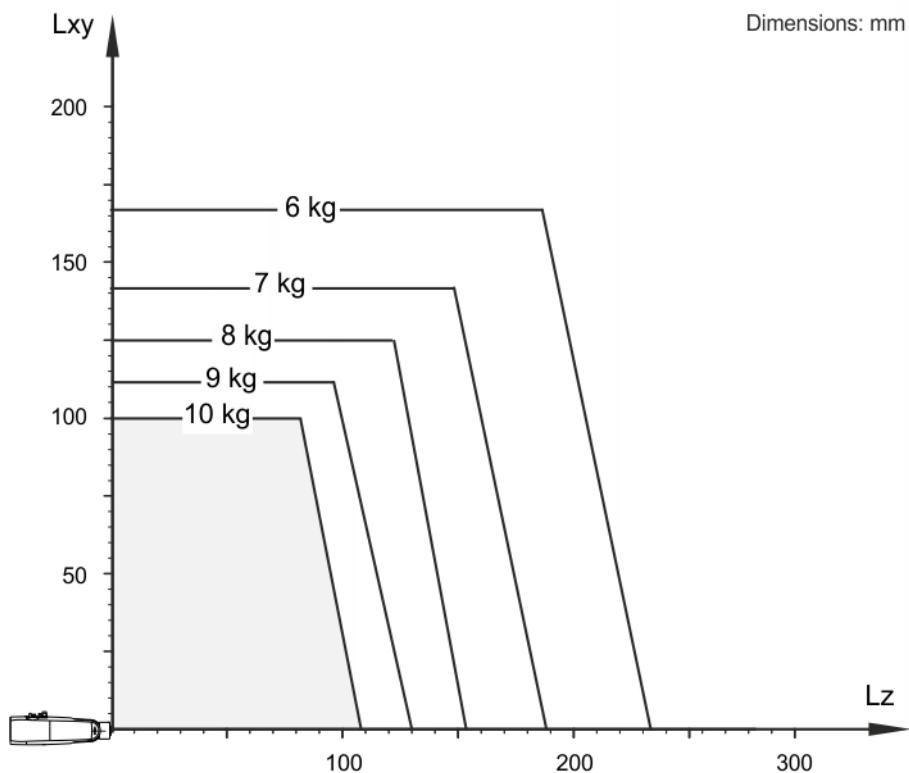
Fig. 4-37: Load center of gravity

**Payload diagram**

Permissible mass inertia at the design point ( $L_x$ ,  $L_y$ ,  $L_z$ ) is  $0.045 \text{ kgm}^2$ .

The following figure (=> Fig. 4-38 ) shows the payload diagram for the following robots:

- KR 10 R900 sixx
- KR 10 R900 sixx W
- KR 10 R900 sixx C
- KR 10 R1100 sixx
- KR 10 R1100 sixx W
- KR 10 R1100 sixx C



**Fig. 4-38: Payload diagram, payload 10 kg**

**NOTICE**

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

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

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

#### Mounting flange

Mounting flange	31.5 mm
Screw grade	12.9
Screw size	M5
Number of fastening screws	7
Clamping length	min. 1.5 x nominal diameter
Depth of engagement	min. 5.5 mm, max. 7 mm
Locating element	5 H7
Standard	See diagram. ( <a href="#">&gt;&gt;&gt; Fig. 4-39</a> )

The mounting flange is depicted with axis 6 in the zero position ([>>> Fig. 4-39](#)) The symbol X<sub>m</sub> indicates the position of the locating element in the zero position.

Dimensions: mm

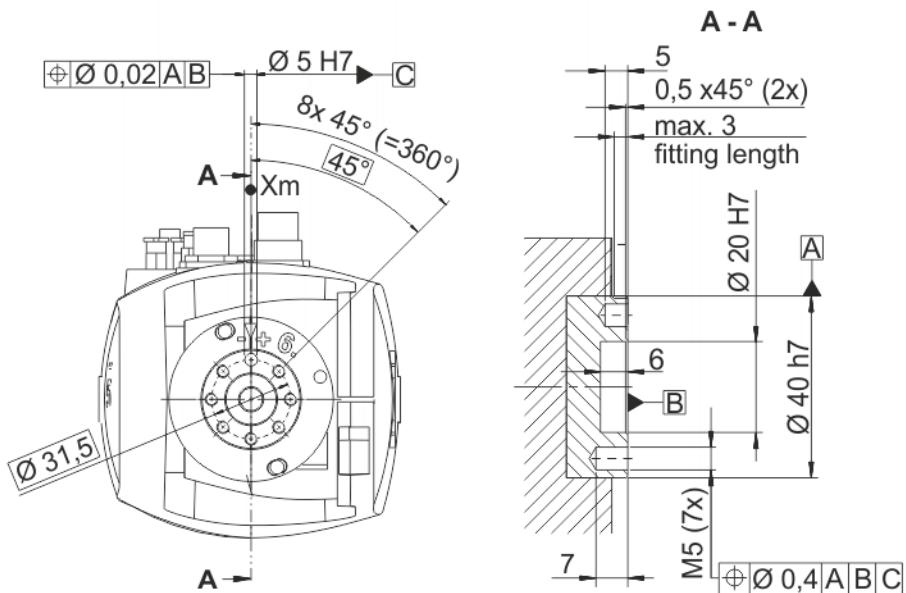


Fig. 4-39: Mounting flange

#### 4.8 Foundation data, KR 10 sixx

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

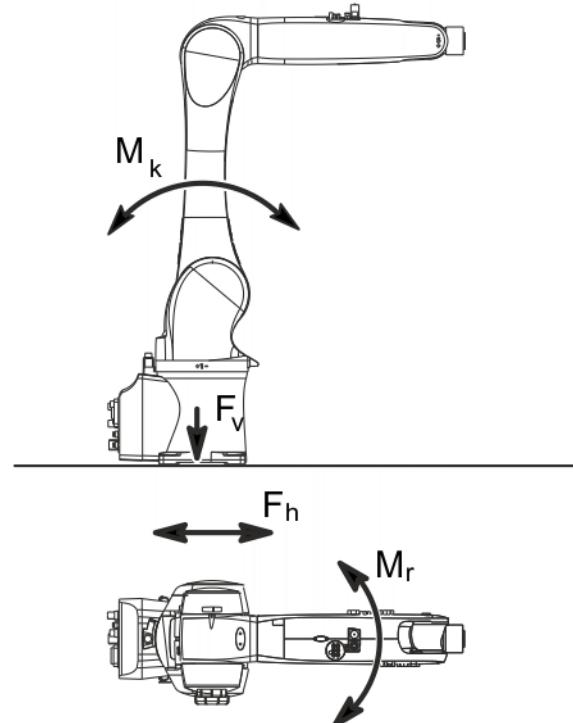


Fig. 4-40: Loads acting on the foundation, floor mounting

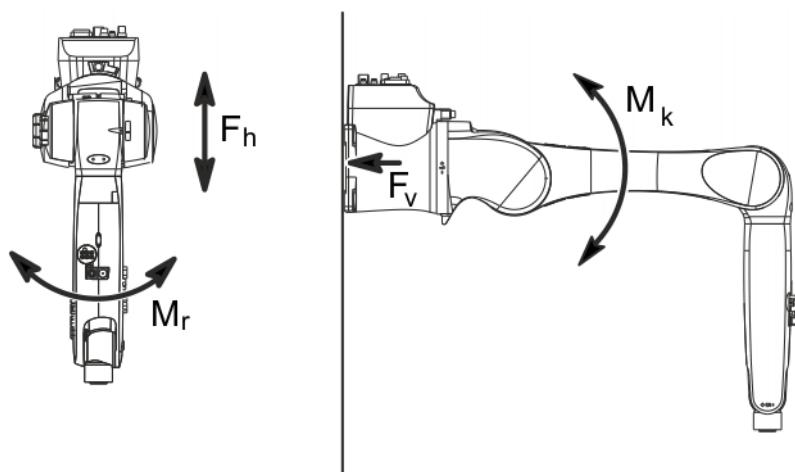


Fig. 4-41: Loads acting on the foundation, wall mounting

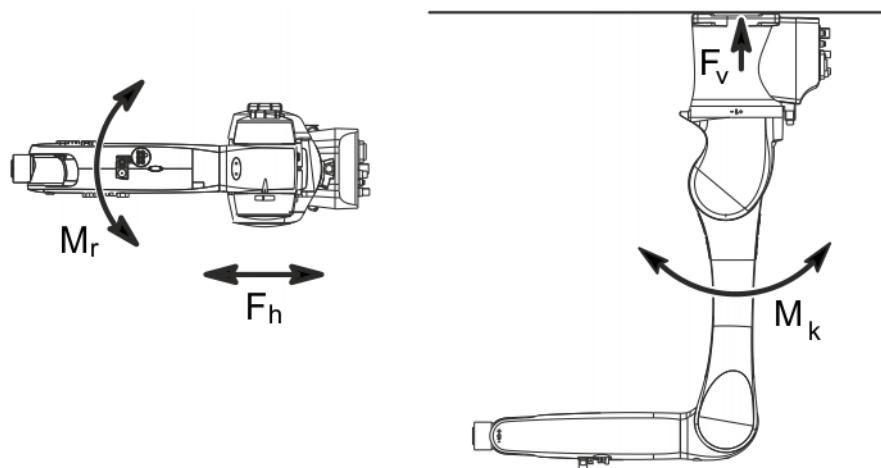


Fig. 4-42: Loads acting on the foundation, ceiling mounting

Type of load	Force/torque/mass	
	Normal operation	Maximum load
$F_v$ = vertical force	$F_v$ normal = 967 N	$F_v$ max = 1297 N
$F_h$ = horizontal force	$F_h$ normal = 1223 N	$F_h$ max = 1362 N
$M_k$ = tilting moment	$M_k$ normal = 788 Nm	$M_k$ max = 1152 Nm
$M_r$ = torque	$M_r$ normal = 367 Nm	$M_r$ max = 880 Nm
Total mass for foundation load	KR 10 R900 sixx: 62 kg KR 10 R1100 sixx: 65 kg	
Robot	KR 10 R900 sixx: 52 kg KR 10 R1100 sixx: 55 kg	
Total load for foundation load (suppl. load on arm + rated payload)	KR 10 R900 sixx: 10 kg KR 10 R1100 sixx: 10 kg	

**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  $F_V$ .

#### 4.9 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.

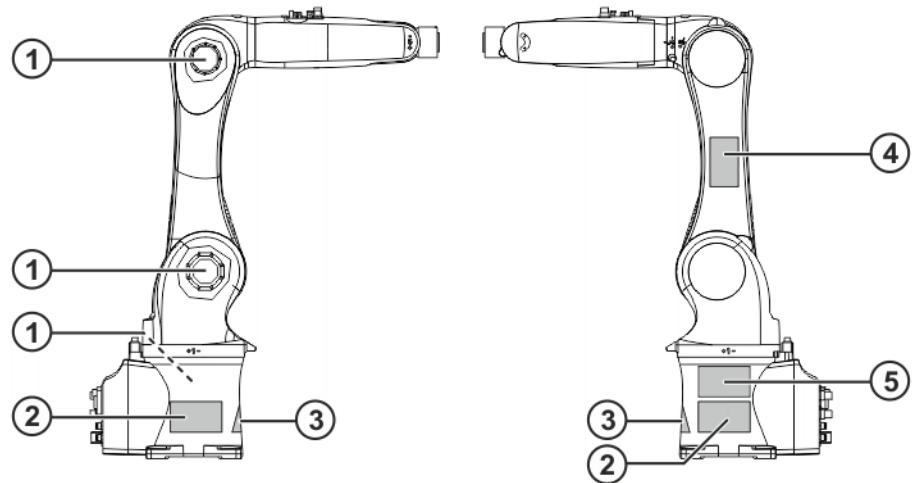
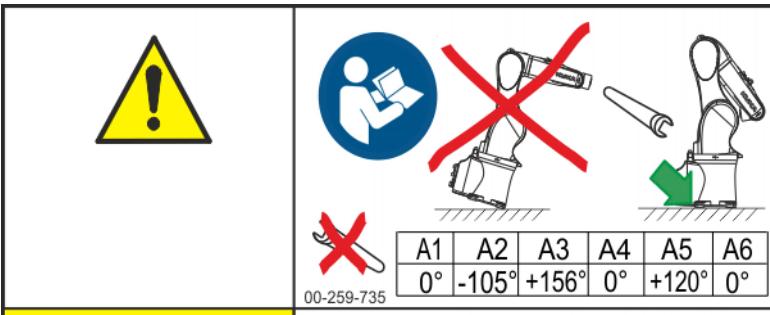
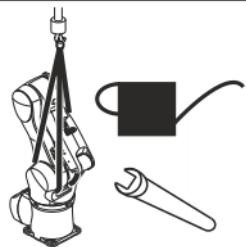
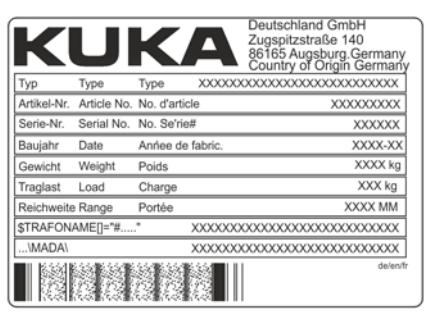


Fig. 4-43: Plates and labels

Item	Description												
1	 <p><b>Secure the axes</b> 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>												
2	 <table border="1"> <tr> <td>A1</td> <td>A2</td> <td>A3</td> <td>A4</td> <td>A5</td> <td>A6</td> </tr> <tr> <td>0°</td> <td>-105°</td> <td>+156°</td> <td>0°</td> <td>+120°</td> <td>0°</td> </tr> </table> <p><b>CAUTION</b> Move the robot into its transport position before removing the mounting base!  <b>ATTENTION</b> Amener le robot en position de transport avant de défaire la fixation aux fondations!  <b>VORSICHT</b> Roboter vor Lösen der Fundamentbefestigung in Transportstellung bringen!</p> <p><b>Transport position</b> 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°	-105°	+156°	0°	+120°	0°
A1	A2	A3	A4	A5	A6								
0°	-105°	+156°	0°	+120°	0°								
3	 <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>												

Item	Description																																				
4	   <p>00-259-735</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="padding: 5px; background-color: yellow;"><b>CAUTION</b></td> <td style="padding: 5px;">Secure the system before beginning work on the robot. Read and observe the safety instructions!</td> </tr> <tr> <td style="padding: 5px; background-color: yellow;"><b>ATTENTION</b></td> <td style="padding: 5px;">Bloquer le système avant d'effectuer des travaux sur le robot. Lire et respecter les remarques relatives à la sécurité!</td> </tr> <tr> <td style="padding: 5px; background-color: yellow;"><b>VORSICHT</b></td> <td style="padding: 5px;">Vor Arbeiten am Roboter, System sichern. Sicherheitshinweise lesen und beachten!</td> </tr> </table> <p><b>Work on the robot</b> Before start-up, transportation or maintenance, read and follow the assembly and operating instructions.</p>	<b>CAUTION</b>	Secure the system before beginning work on the robot. Read and observe the safety instructions!	<b>ATTENTION</b>	Bloquer le système avant d'effectuer des travaux sur le robot. Lire et respecter les remarques relatives à la sécurité!	<b>VORSICHT</b>	Vor Arbeiten am Roboter, System sichern. Sicherheitshinweise lesen und beachten!																														
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5	 <p><b>KUKA</b> Deutschland GmbH Zugspitzstraße 140 86165 Augsburg Germany Country of Origin Germany</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td>Typ</td> <td>Type</td> <td>Type</td> <td>XXXXXXXXXXXXXXXXXXXXXXXXXXXXXX</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 Range</td> <td></td> <td>Portée</td> <td>XXXX MM</td> </tr> <tr> <td colspan="2">STRAFONAME[]="#...."</td> <td></td> <td>XXXXXXXXXXXXXXXXXXXXXXXXXXXXXX</td> </tr> <tr> <td colspan="2">...IMADA</td> <td></td> <td>XXXXXXXXXXXXXXXXXXXXXXXXXXXXXX</td> </tr> </table> <p>de/en/fr</p> <p><b>Identification plate</b> Content according to Machinery Directive.</p>	Typ	Type	Type	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	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[]="#...."			XXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	...IMADA			XXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
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STRAFONAME[]="#...."			XXXXXXXXXXXXXXXXXXXXXXXXXXXXXX																																		
...IMADA			XXXXXXXXXXXXXXXXXXXXXXXXXXXXXX																																		

## 4.10 Stopping distances and times

### 4.10.1 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.

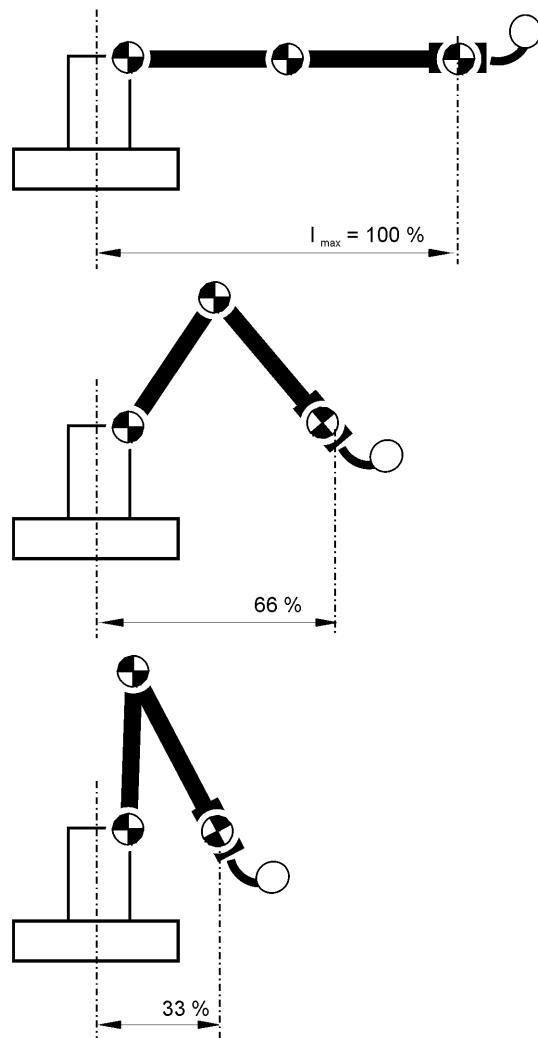
■ Measuring technique

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.

#### 4.10.2 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 %) ( <a href="#">&gt;&gt;&gt; Fig. 4-44</a> ) between axis 1 and the intersection of axes 4 and 5. With parallelogram robots, the distance between axis 1 and the intersection of axis 6 and the mounting flange.
KCP	KUKA Control Panel Teach pendant for the KR C2/KR C2 edition2005 The KCP has all the operator control and display functions required for operating and programming the industrial robot.
smartPAD	Teach pendant for the KR C4 The smartPAD has all the operator control and display functions required for operating and programming the industrial robot.



**Fig. 4-44: Extension**

#### 4.10.3 Stopping distances and times, KR 6 R700 sixx and KR 6 R700 sixx C

The following values are preliminary values and are valid for the following robots.

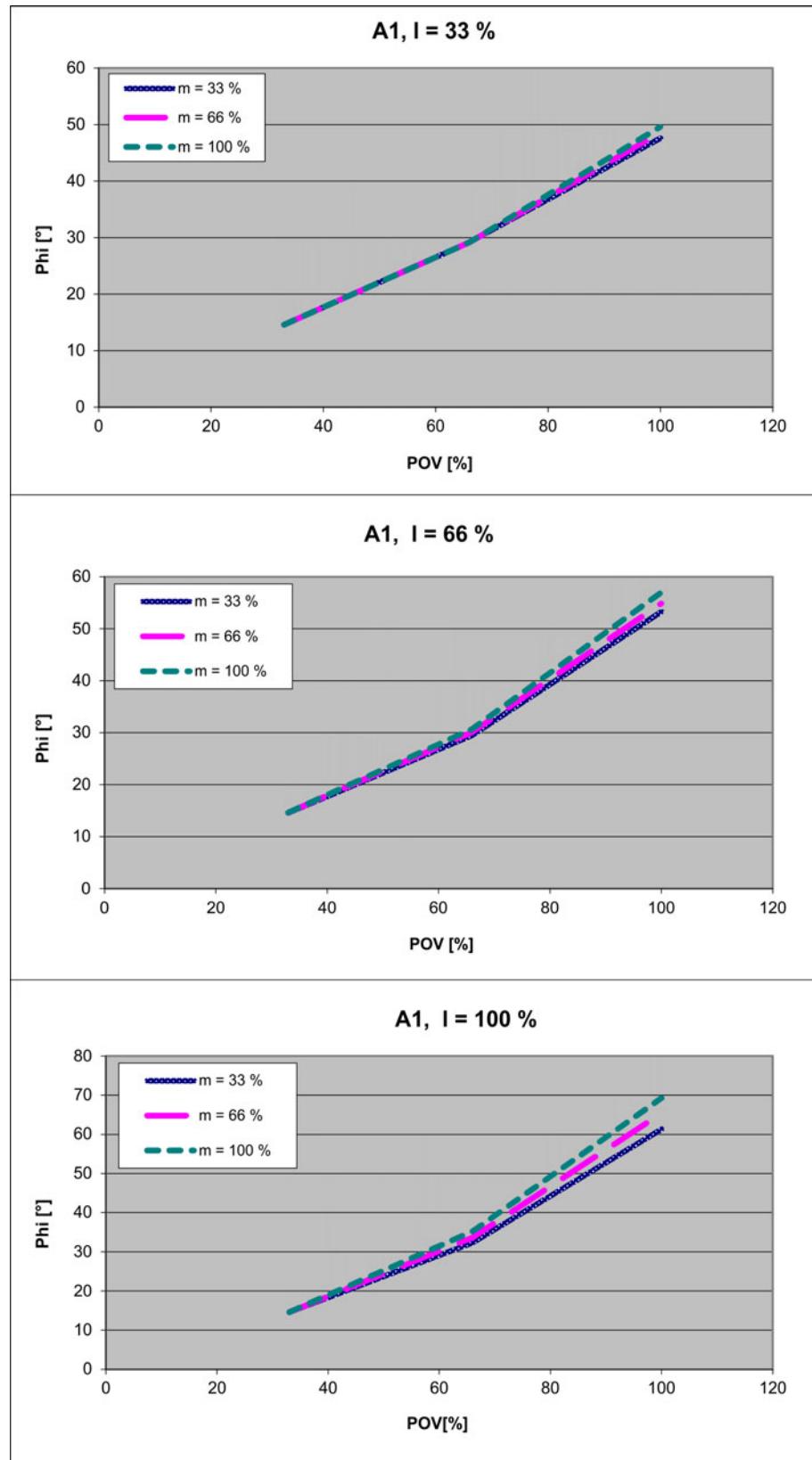
- KR 6 R700 sixx
- KR 6 R700 sixx C

##### 4.10.3.1 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	133.67	0.494
Axis 2	122.43	0.556
Axis 3	79.29	0.371

**4.10.3.2 Stopping distances and stopping times for STOP 1, axis 1****Fig. 4-45: Stopping distances for STOP 1, axis 1**

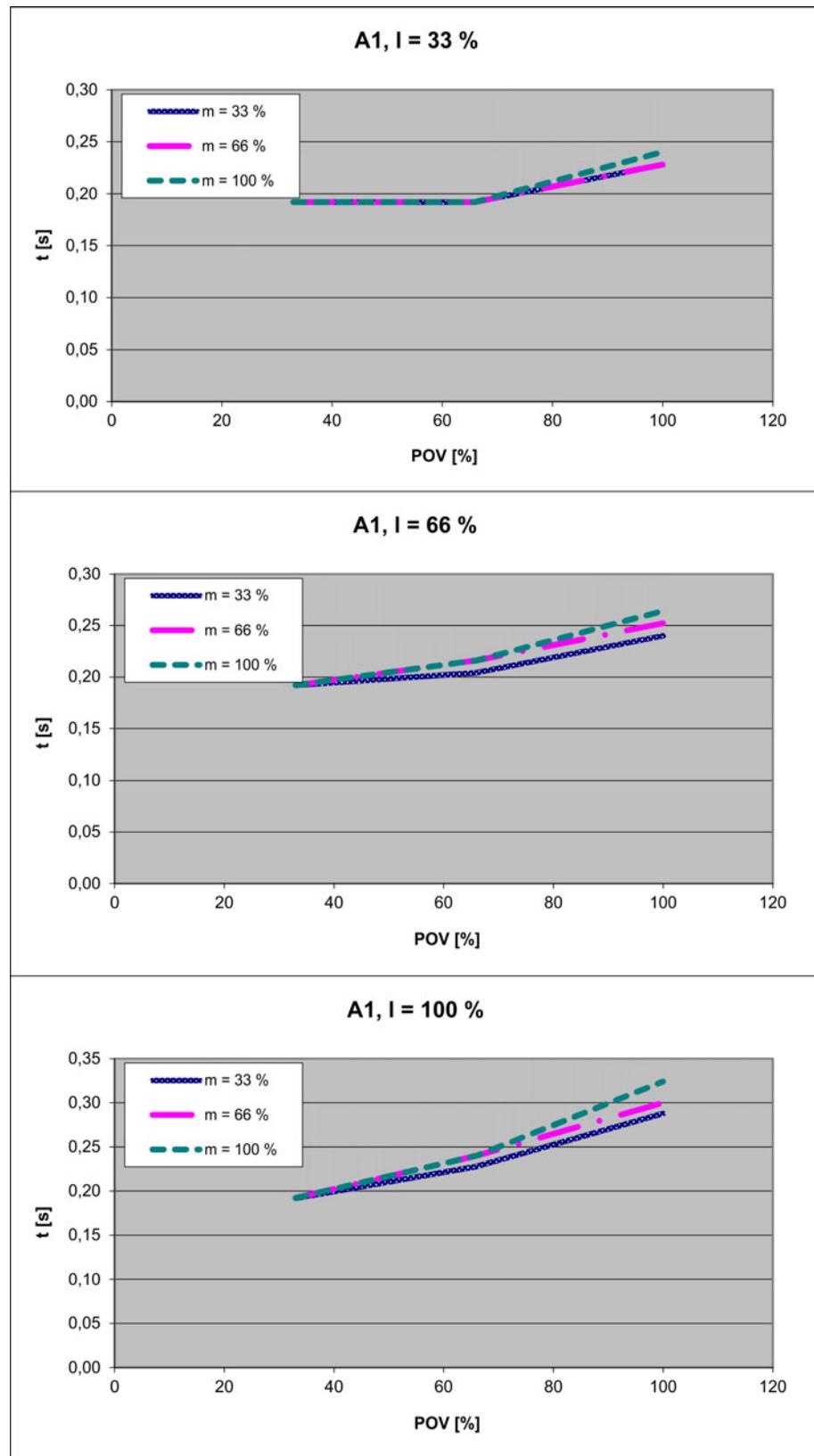
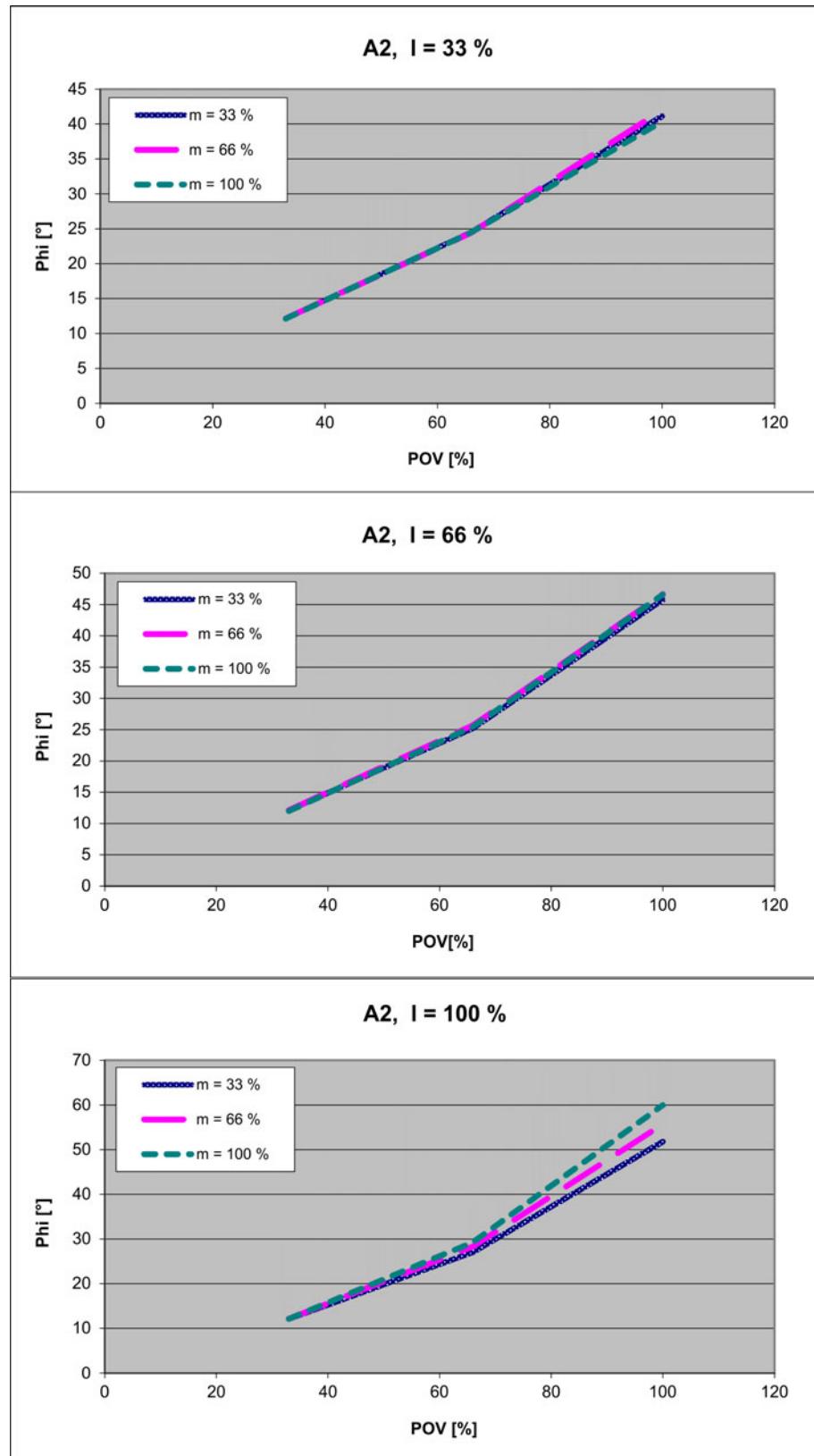


Fig. 4-46: Stopping times for STOP 1, axis 1

**4.10.3.3 Stopping distances and stopping times for STOP 1, axis 2****Fig. 4-47: Stopping distances for STOP 1, axis 2**

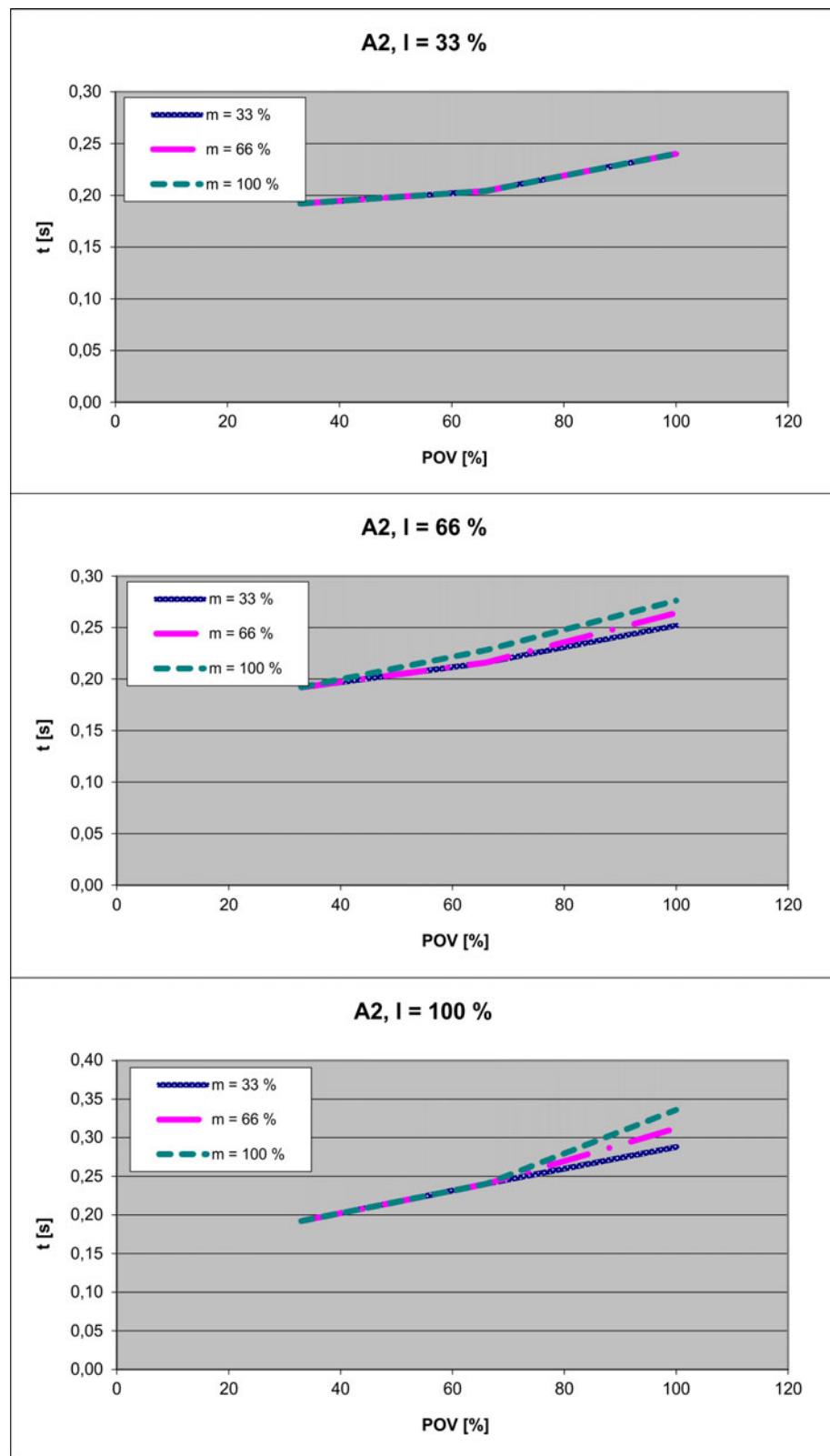


Fig. 4-48: Stopping times for STOP 1, axis 2

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

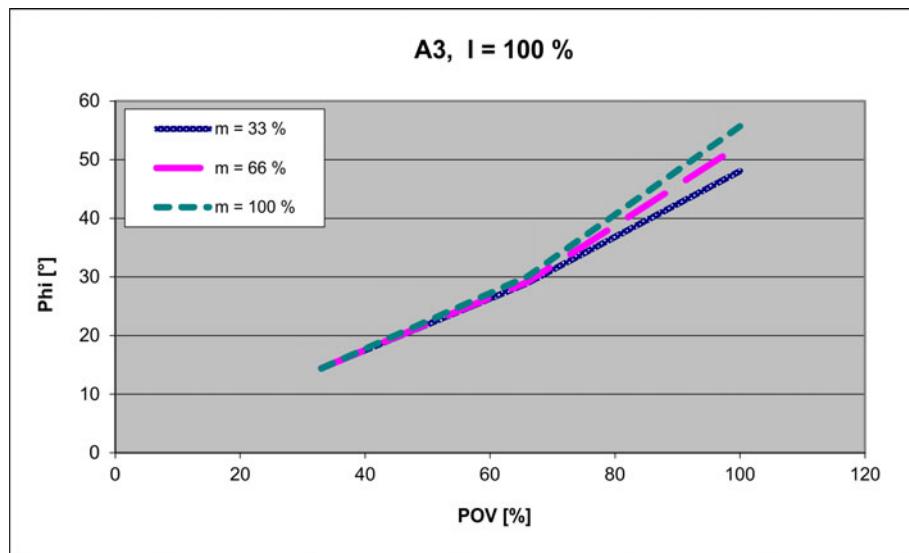


Fig. 4-49: Stopping distances for STOP 1, axis 3

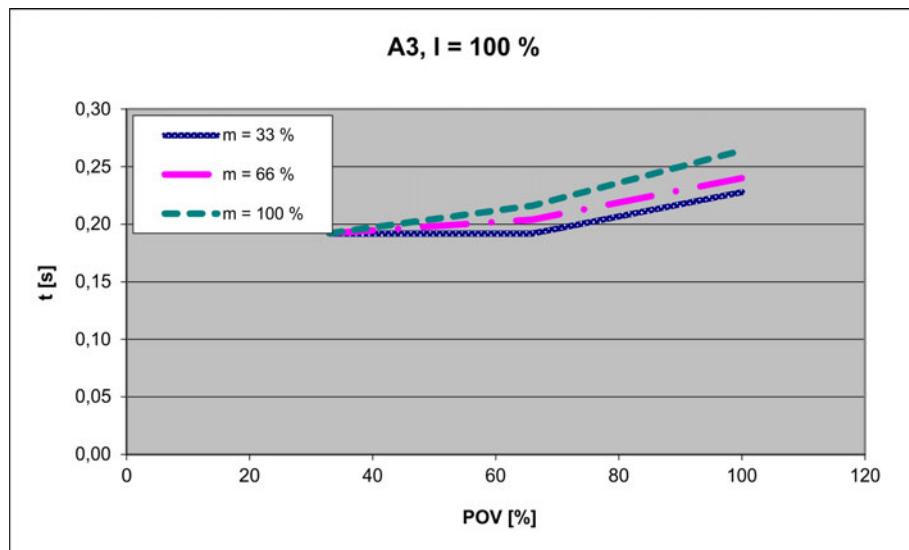


Fig. 4-50: Stopping times for STOP 1, axis 3

#### 4.10.4 Stopping distances and times, KR 6 R700 sixx W

The following values are preliminary values and are valid for the following robots.

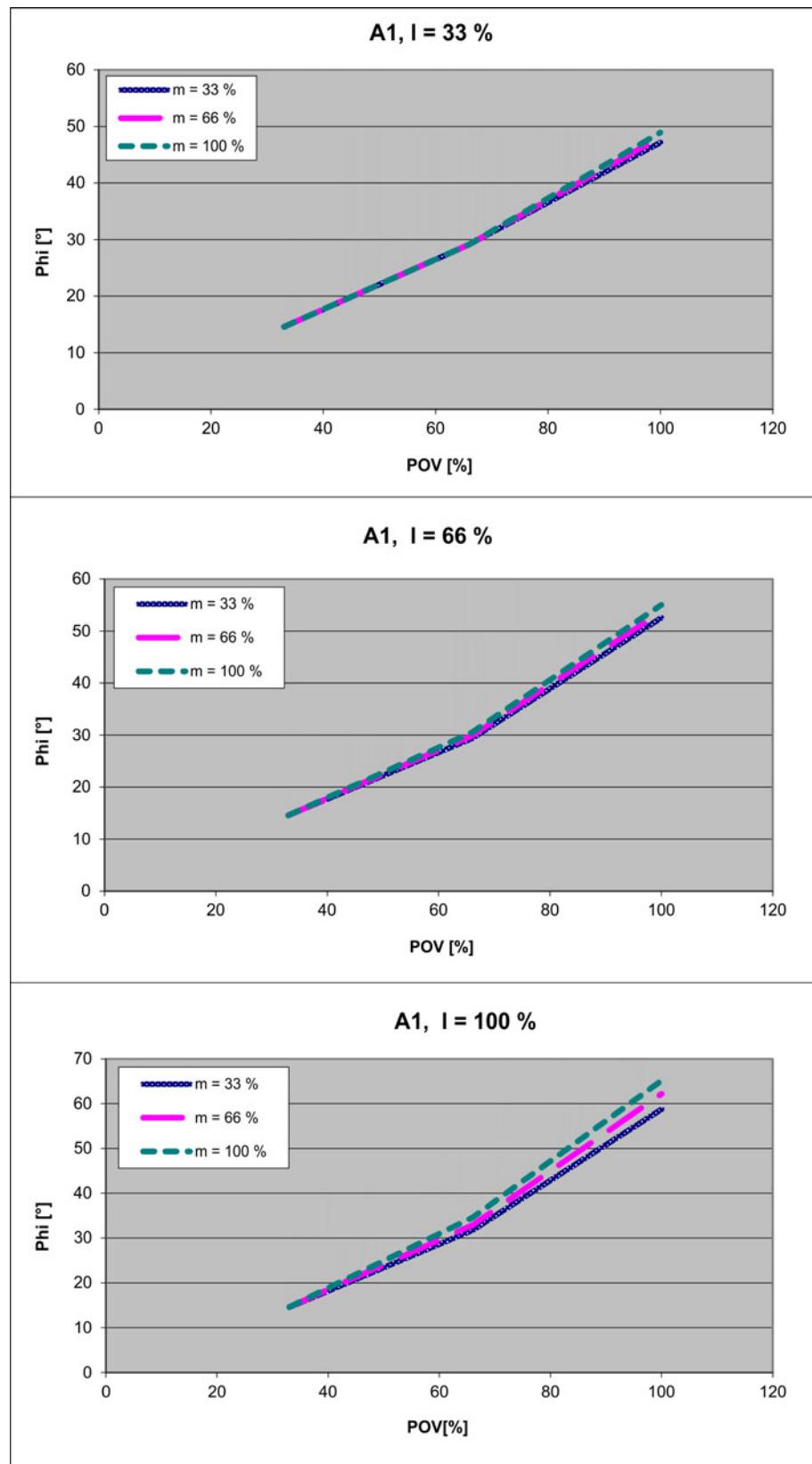
- KR 6 R700 sixx W

##### 4.10.4.1 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)

	<b>Stopping distance (°)</b>	<b>Stopping time (s)</b>
Axis 1	182.04	0.665
Axis 2	68.31	0.377
Axis 3	63.48	0.379

**4.10.4.2 Stopping distances and stopping times for STOP 1, axis 1****Fig. 4-51: Stopping distances for STOP 1, axis 1**

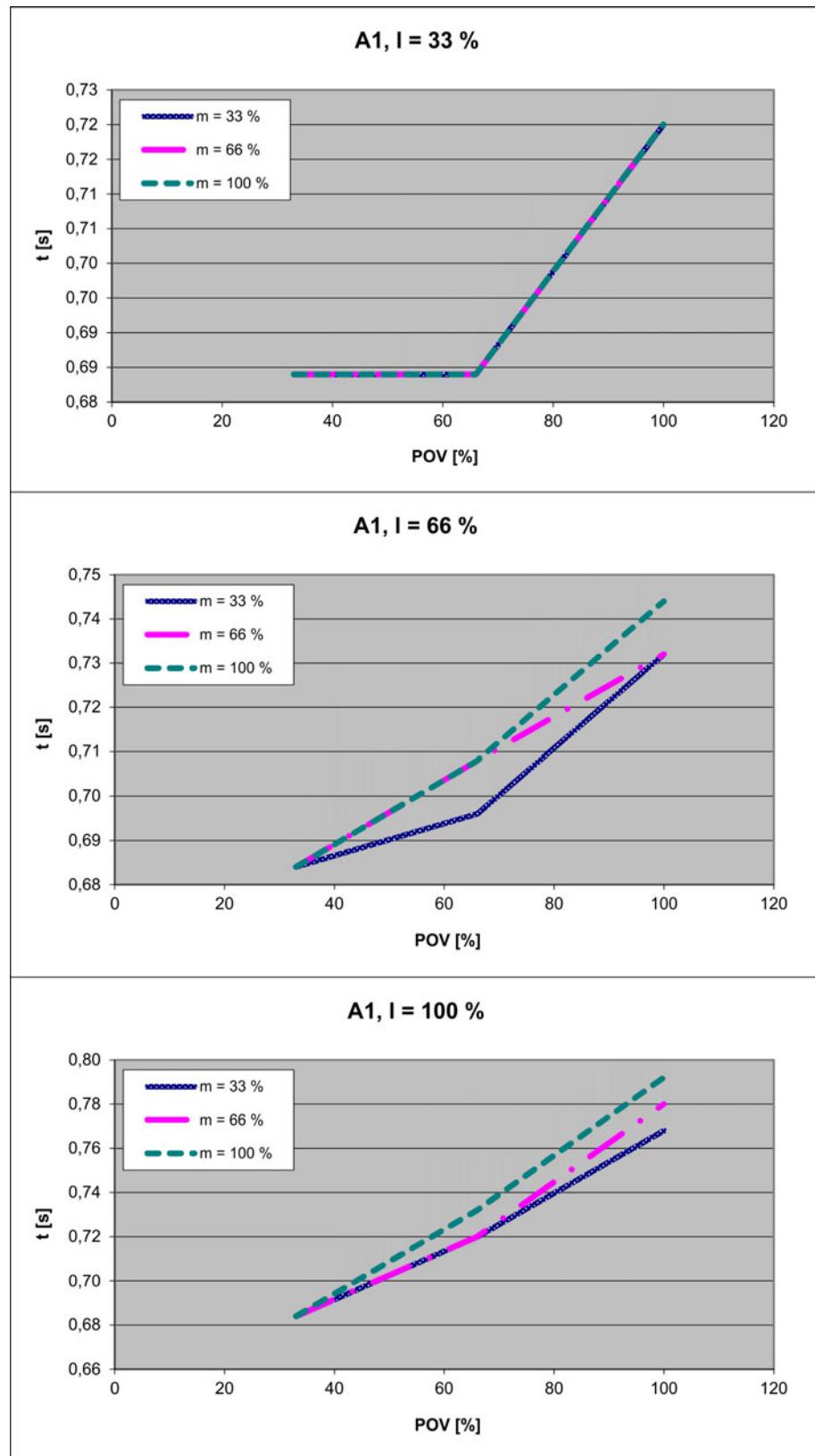
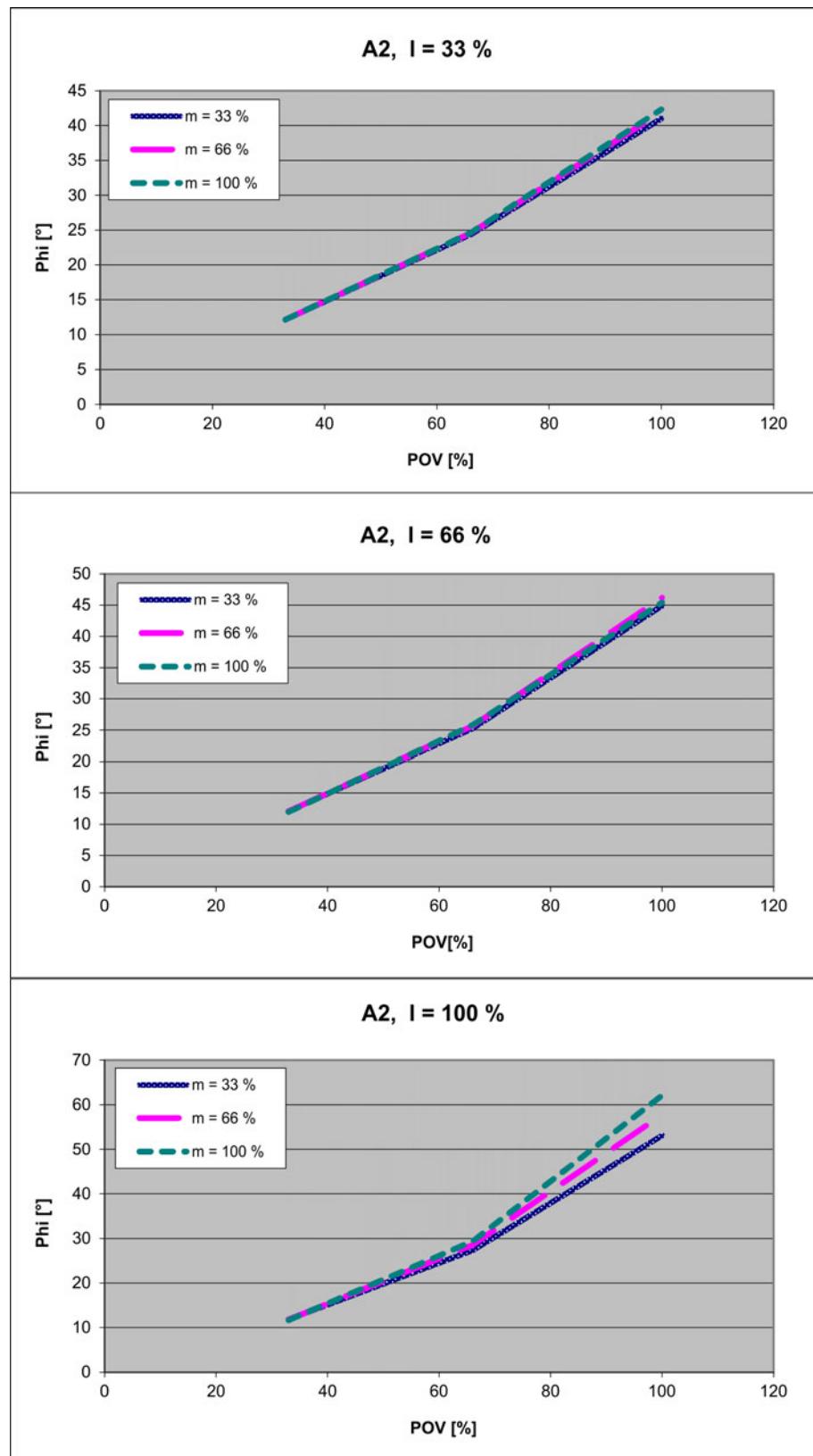


Fig. 4-52: Stopping times for STOP 1, axis 1

**4.10.4.3 Stopping distances and stopping times for STOP 1, axis 2****Fig. 4-53: Stopping distances for STOP 1, axis 1**

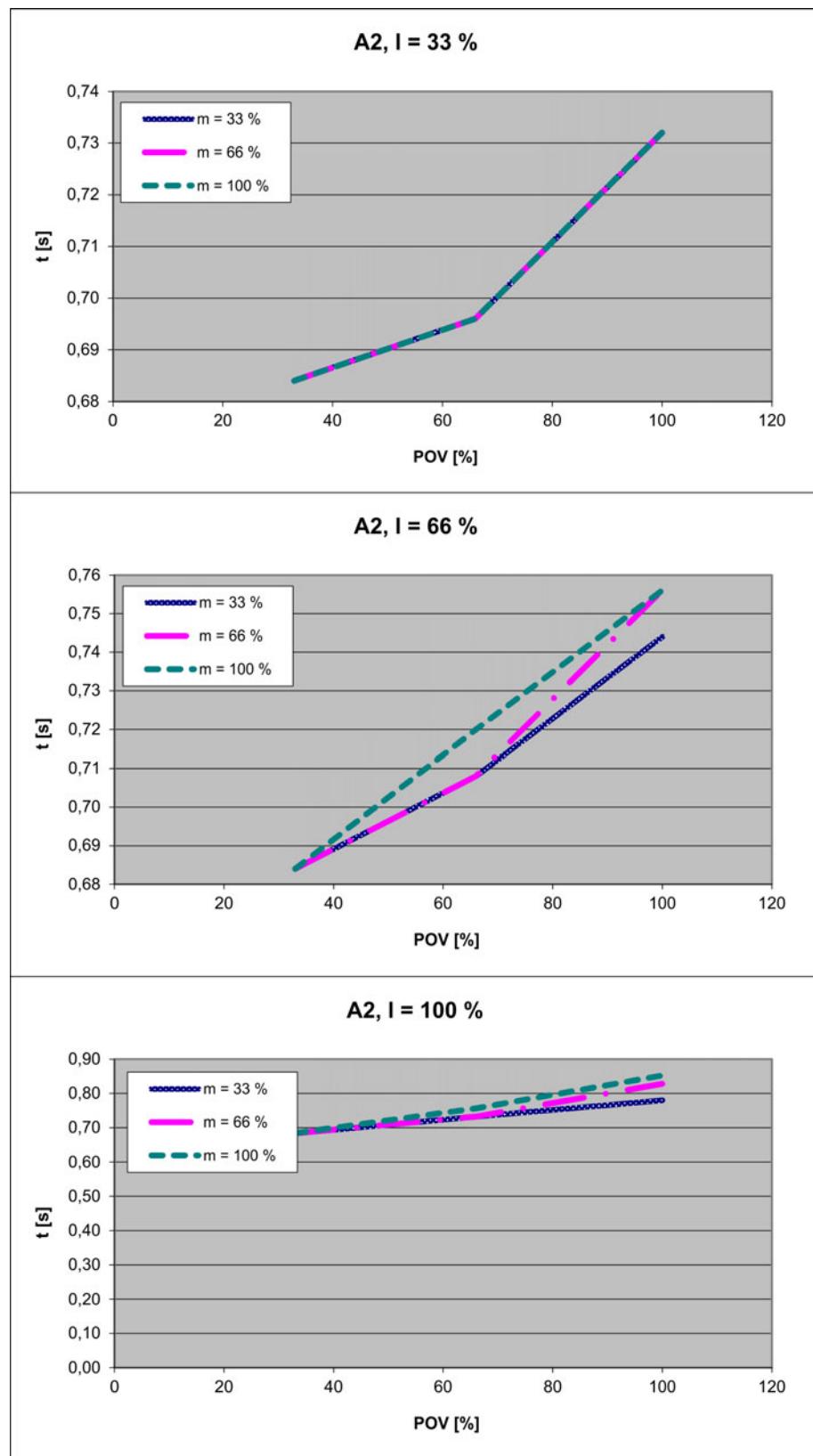


Fig. 4-54: Stopping times for STOP 1, axis 1

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

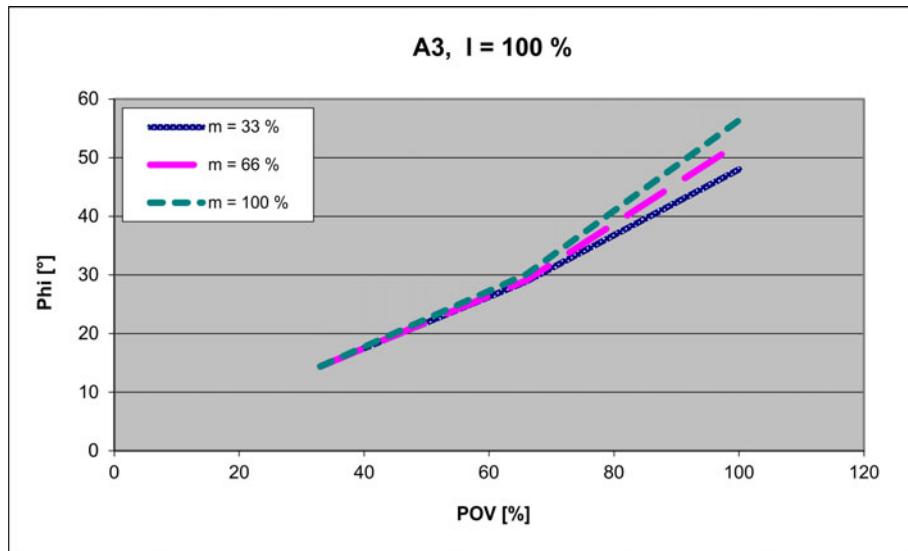


Fig. 4-55: Stopping distances for STOP 1, axis 1

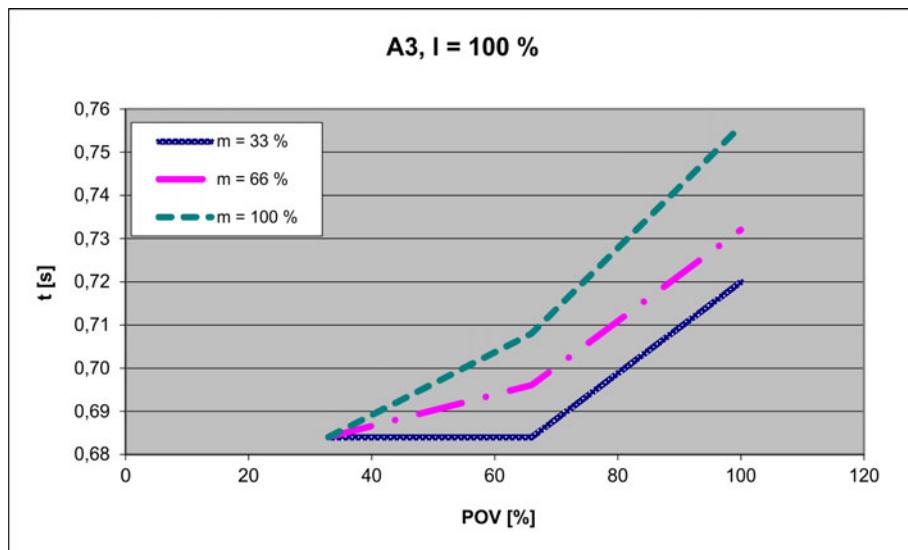


Fig. 4-56: Stopping times for STOP 1, axis 1

#### 4.10.5 Stopping distances and times, KR 6 R900 sixx and KR 6 R900 sixx C

The following values are valid for the following robots:

- KR 6 R900 sixx
- KR 6 R900 sixx C

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

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

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

	<b>Stopping distance (°)</b>	<b>Stopping time (s)</b>
Axis 1	113.59	0.507
Axis 2	126.76	0.684
Axis 3	68.10	0.370

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

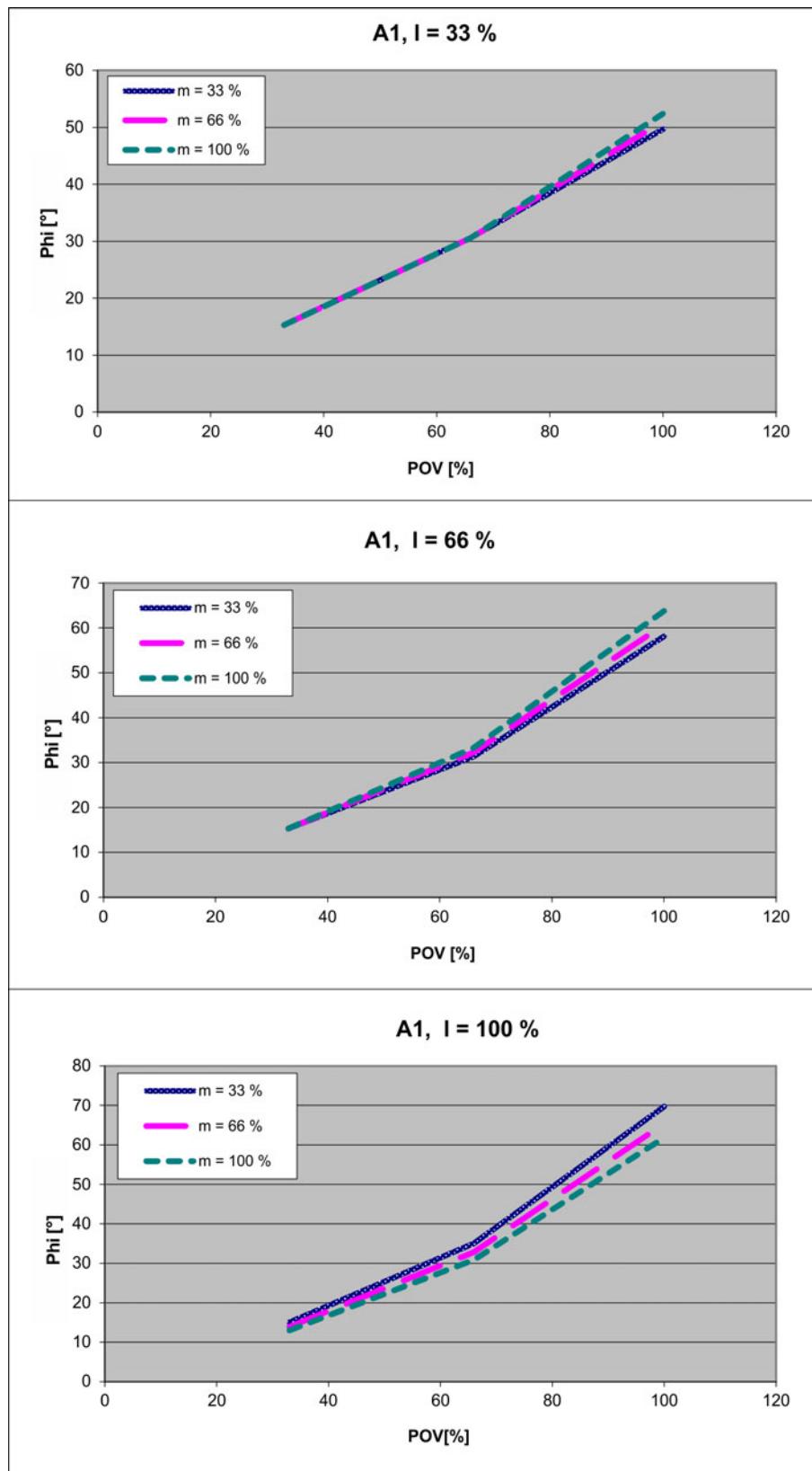


Fig. 4-57: Stopping distances for STOP 1, axis 1

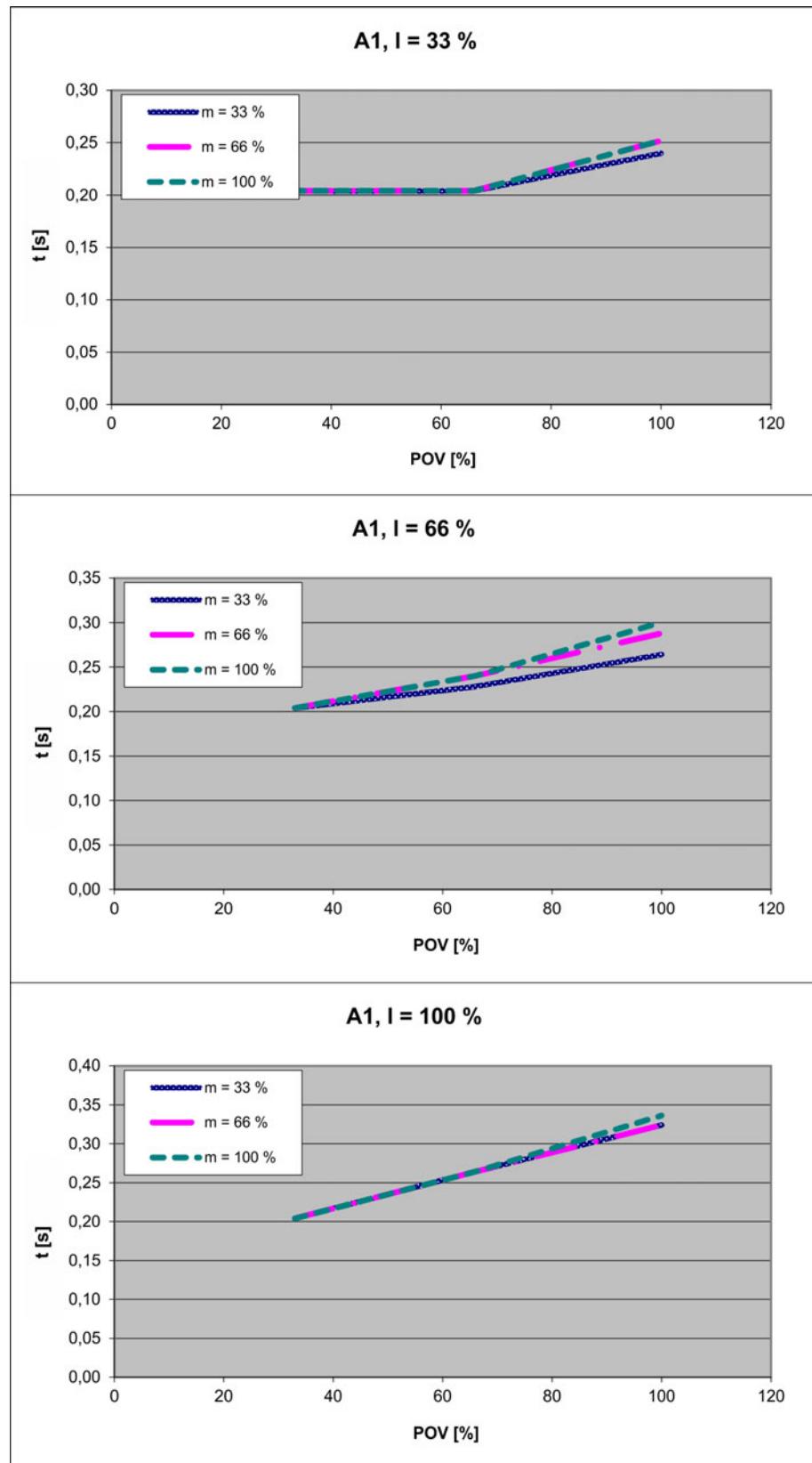
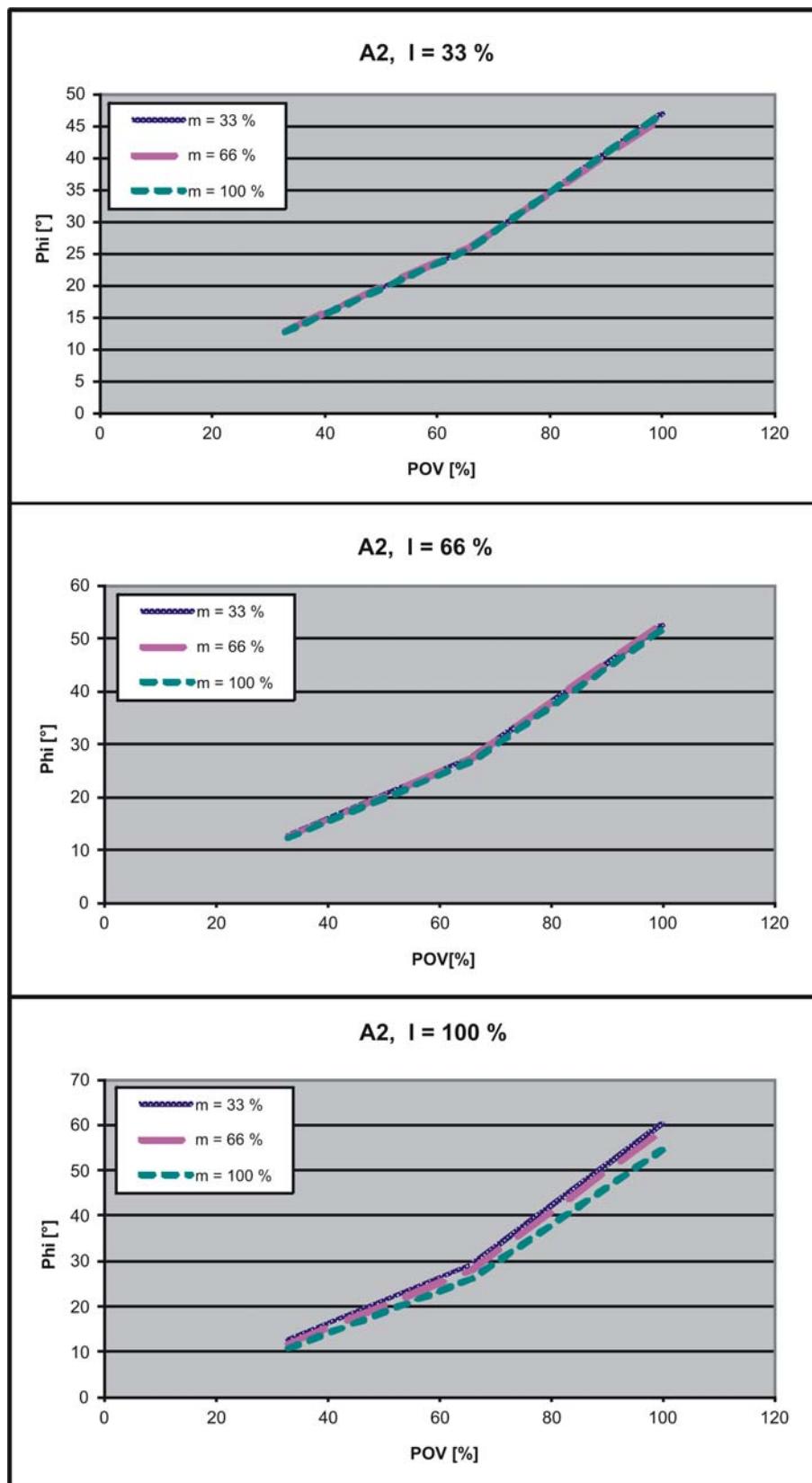


Fig. 4-58: Stopping times for STOP 1, axis 1

**4.10.5.3 Stopping distances and stopping times for STOP 1, axis 2****Fig. 4-59: Stopping distances for STOP 1, axis 2**

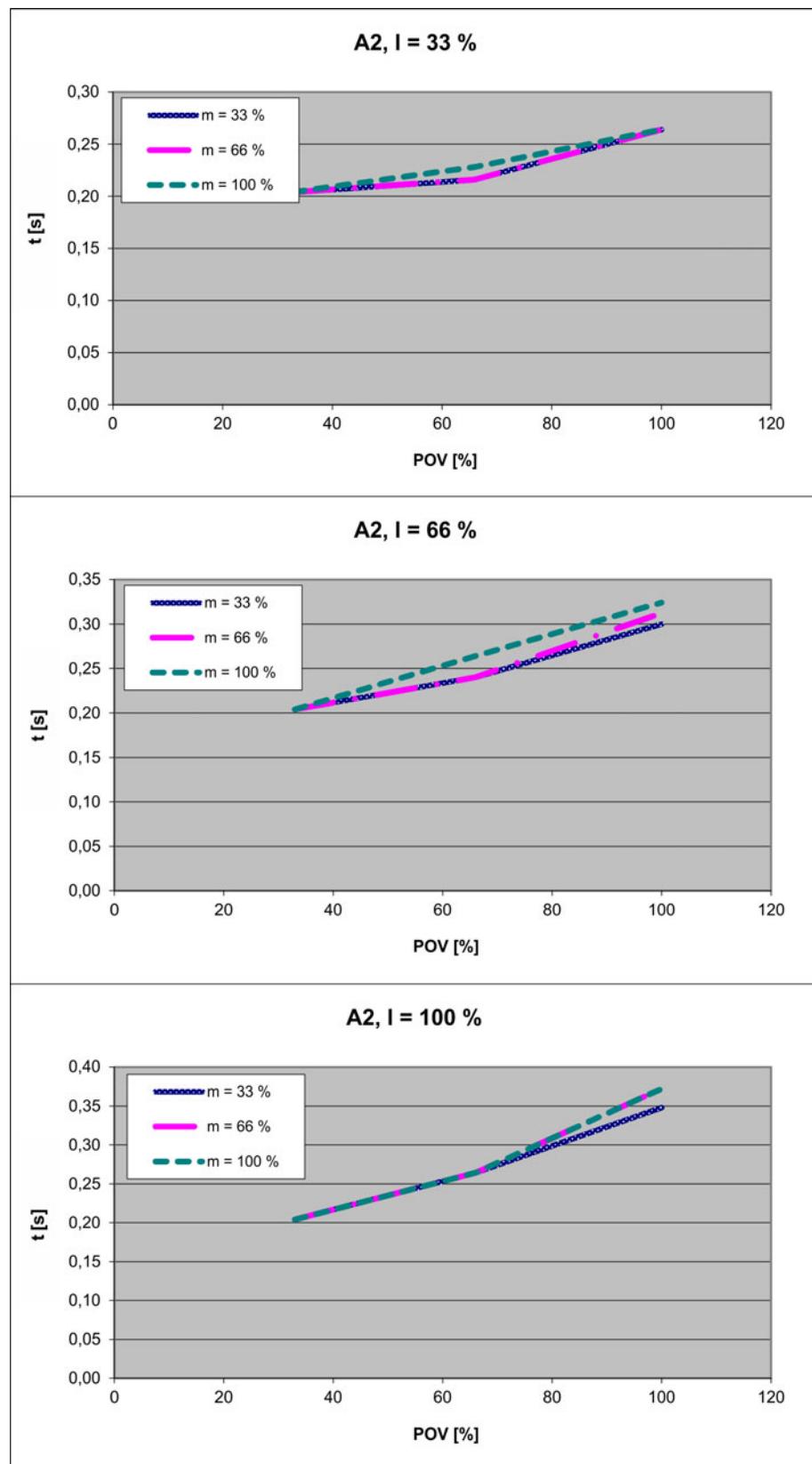


Fig. 4-60: Stopping times for STOP 1, axis 2

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

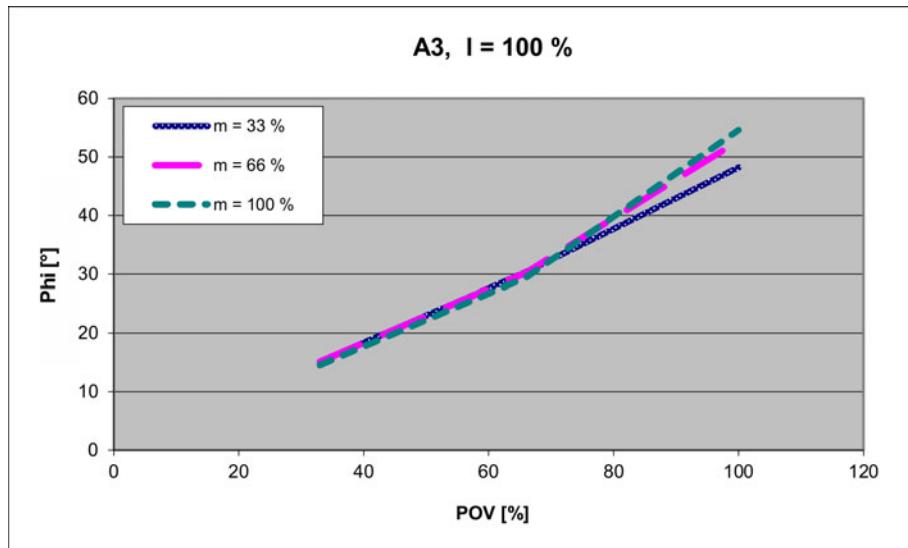


Fig. 4-61: Stopping distances for STOP 1, axis 3

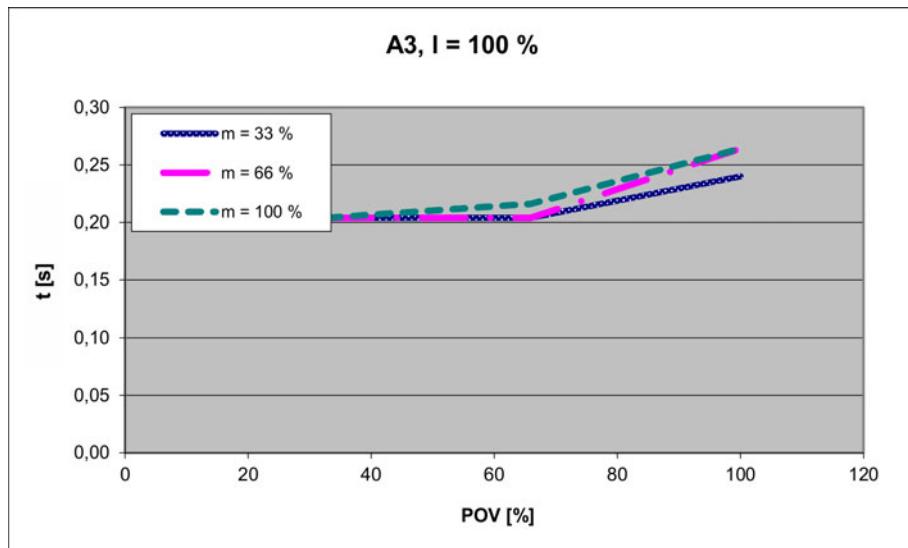


Fig. 4-62: Stopping times for STOP 1, axis 3

#### 4.10.6 Stopping distances and times, KR 6 R900 sixx W

The following values are valid for the following robots:

- KR 6 R900 sixx W

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

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

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

	<b>Stopping distance (°)</b>	<b>Stopping time (s)</b>
Axis 1	163.11	0.745
Axis 2	67.78	0.404
Axis 3	60.96	0.387

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

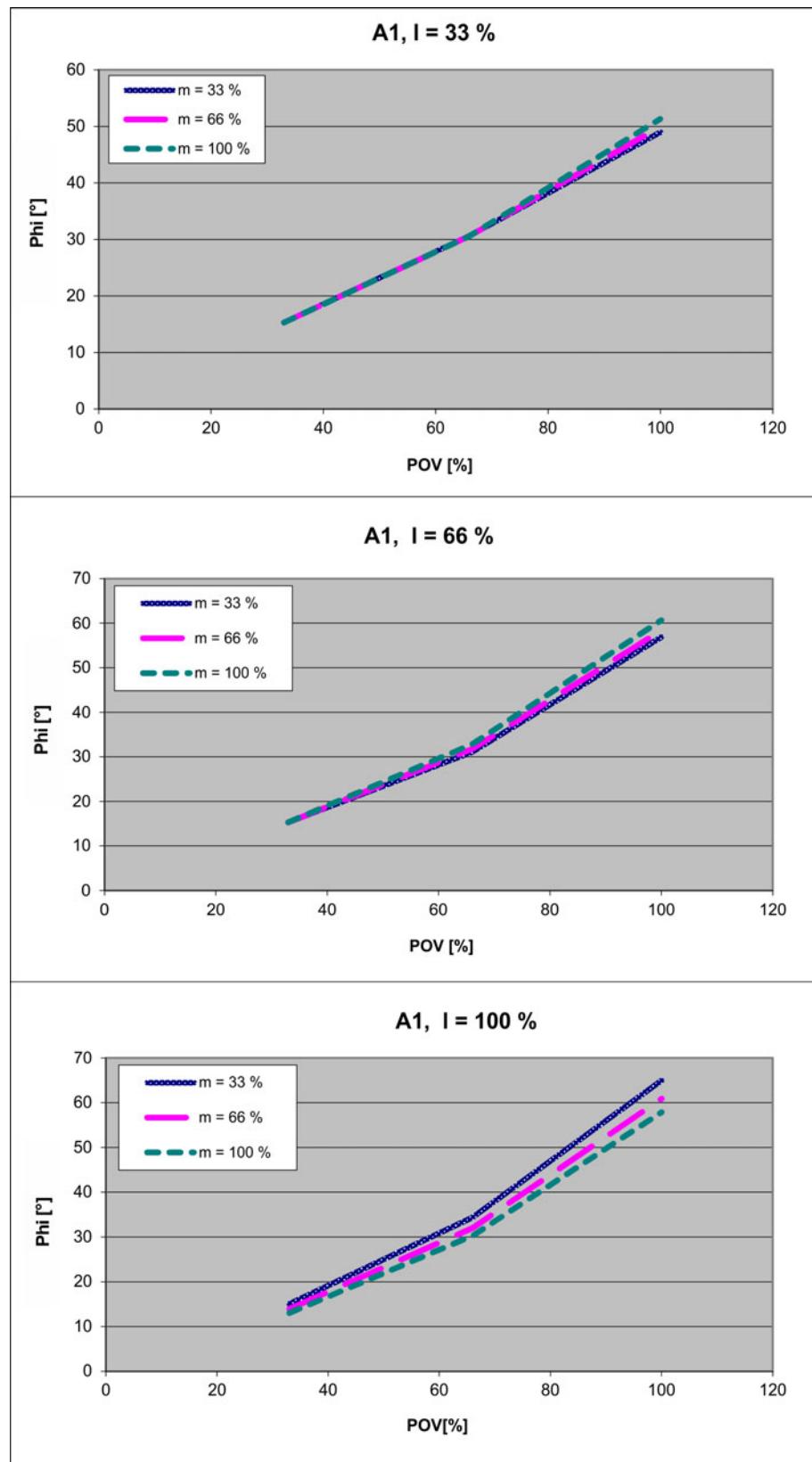


Fig. 4-63: Stopping distances for STOP 1, axis 1

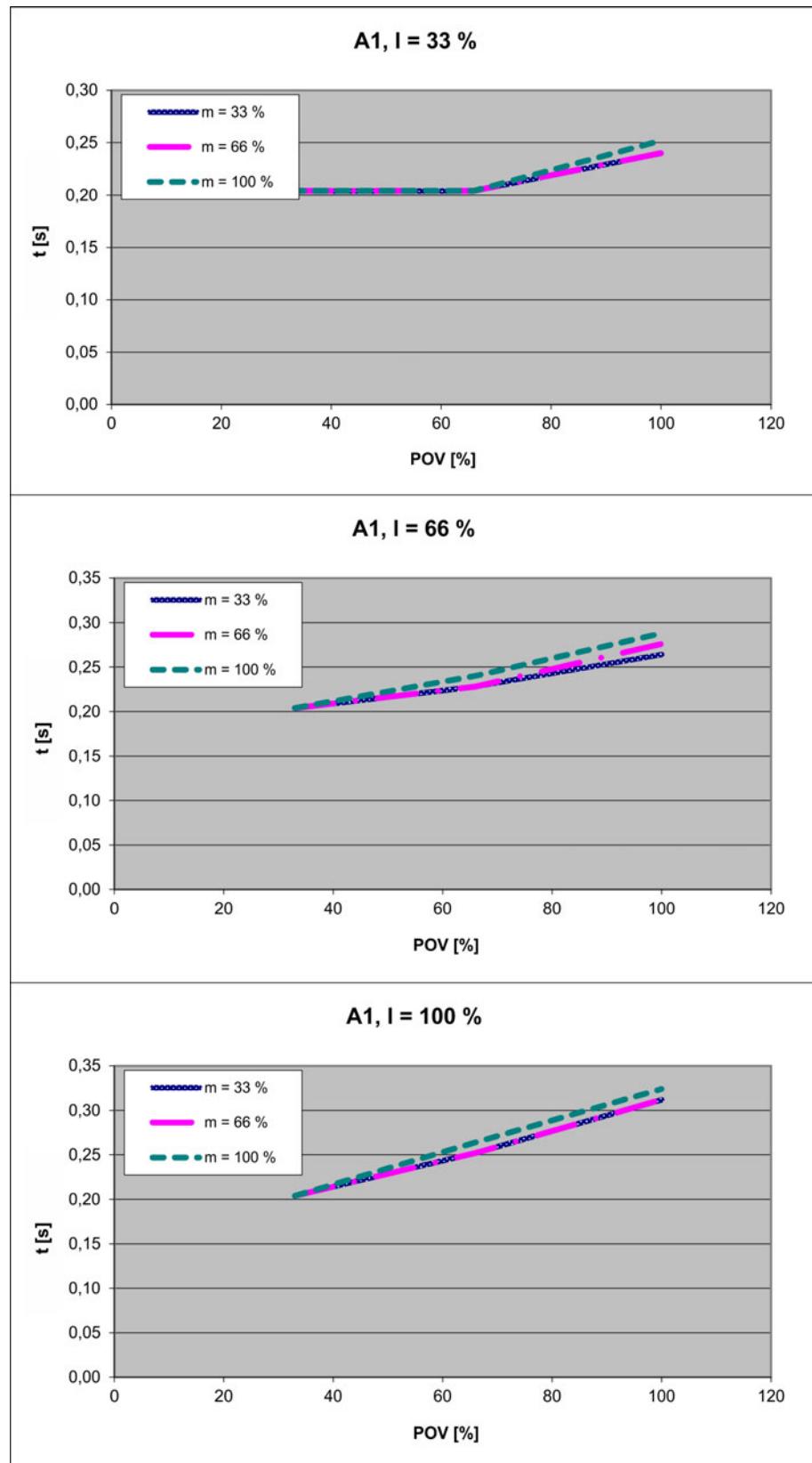
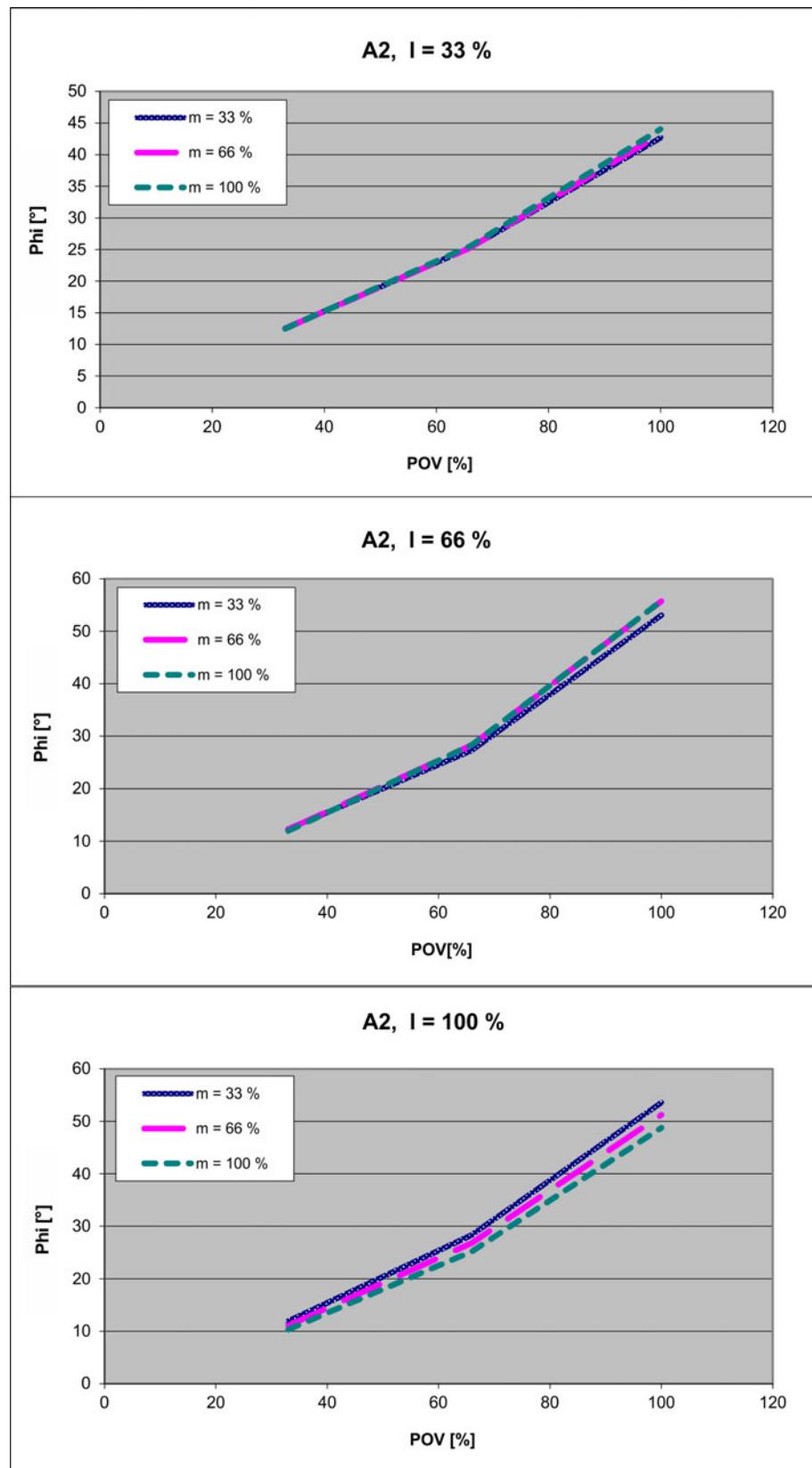


Fig. 4-64: Stopping times for STOP 1, axis 1

**4.10.6.3 Stopping distances and stopping times for STOP 1, axis 2****Fig. 4-65: Stopping distances for STOP 1, axis 2**

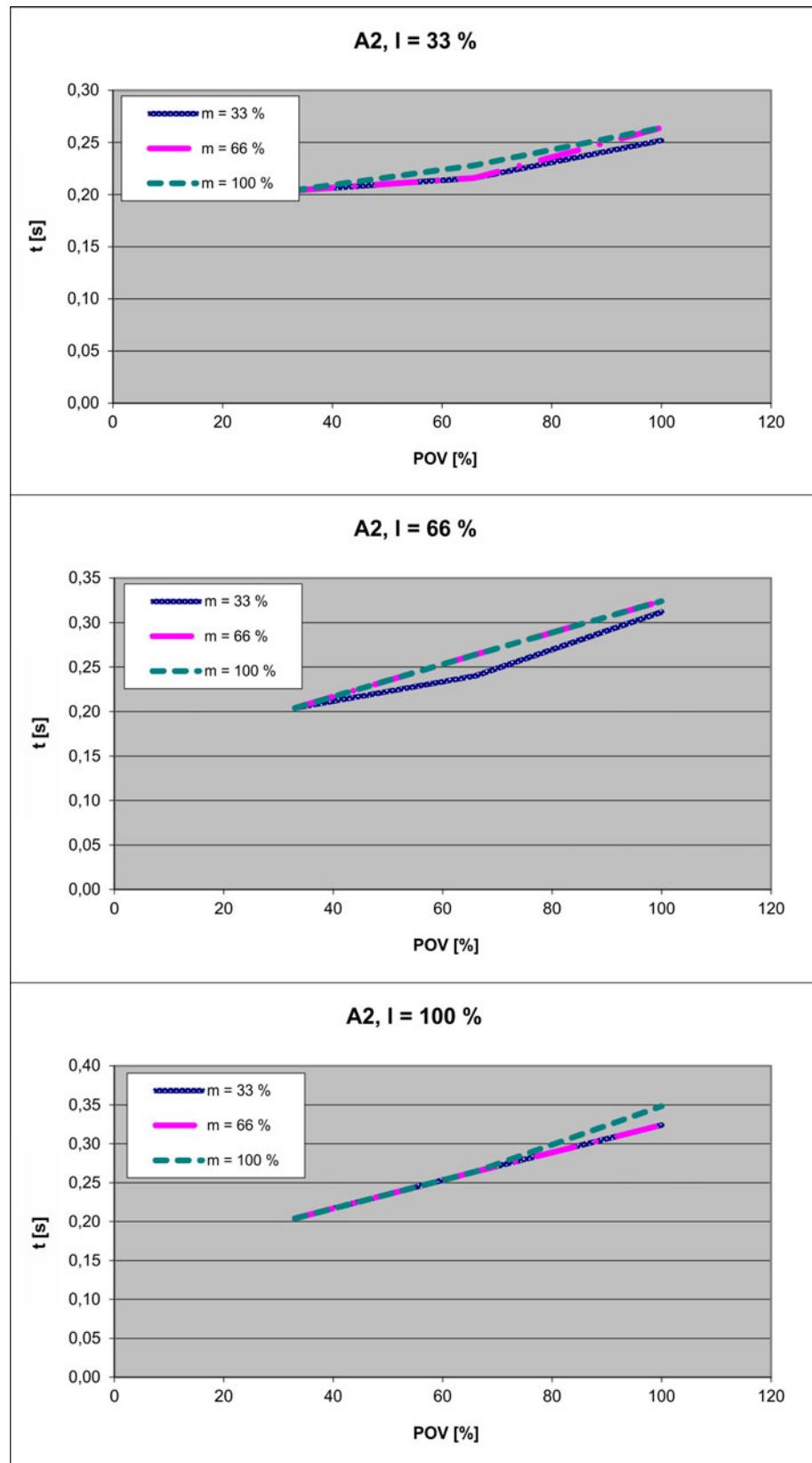


Fig. 4-66: Stopping times for STOP 1, axis 2

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

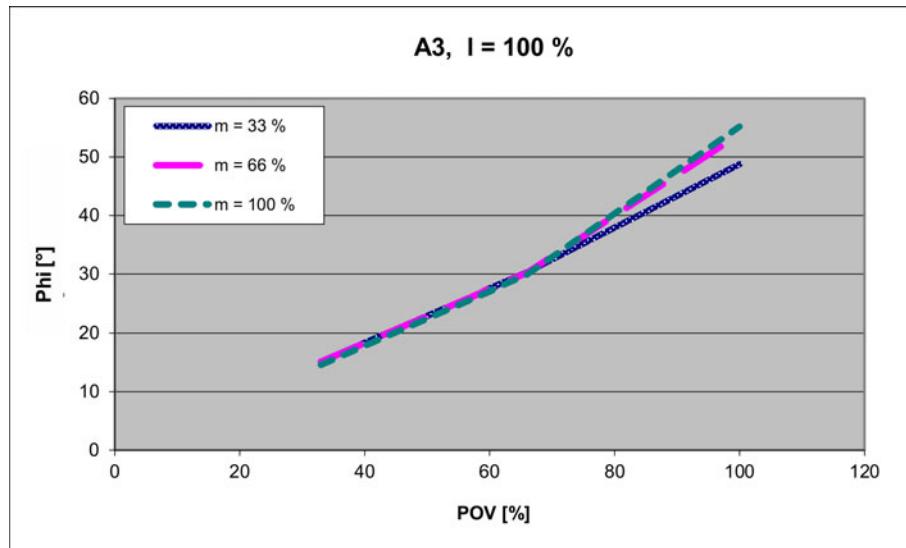


Fig. 4-67: Stopping distances for STOP 1, axis 3

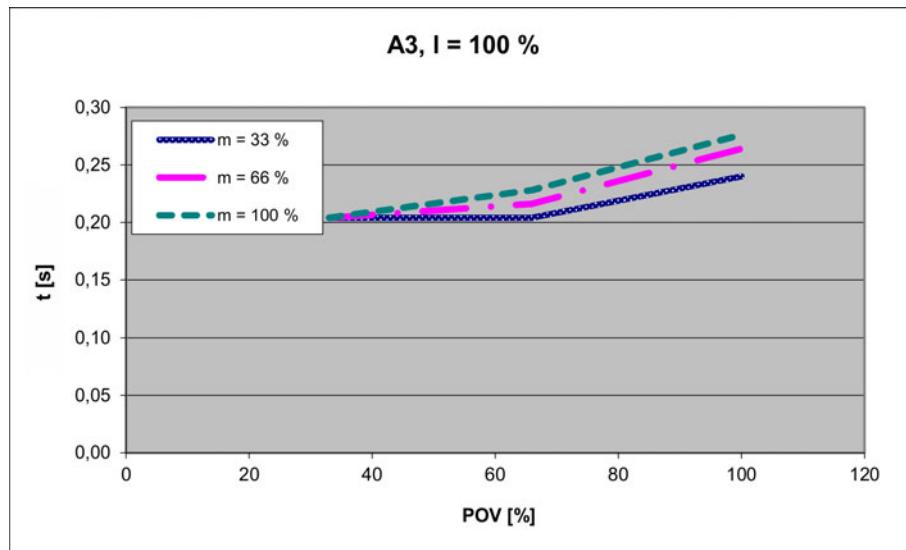


Fig. 4-68: Stopping times for STOP 1, axis 3

#### 4.10.7 Stopping distances and times, KR 10 R900 sixx and KR 10 R1100 sixx

The following values are preliminary values and are valid for the following robots.

- KR 10 R900 sixx
- KR 10 R900 sixx C
- KR 10 R1100 sixx
- KR 10 R1100 sixx C

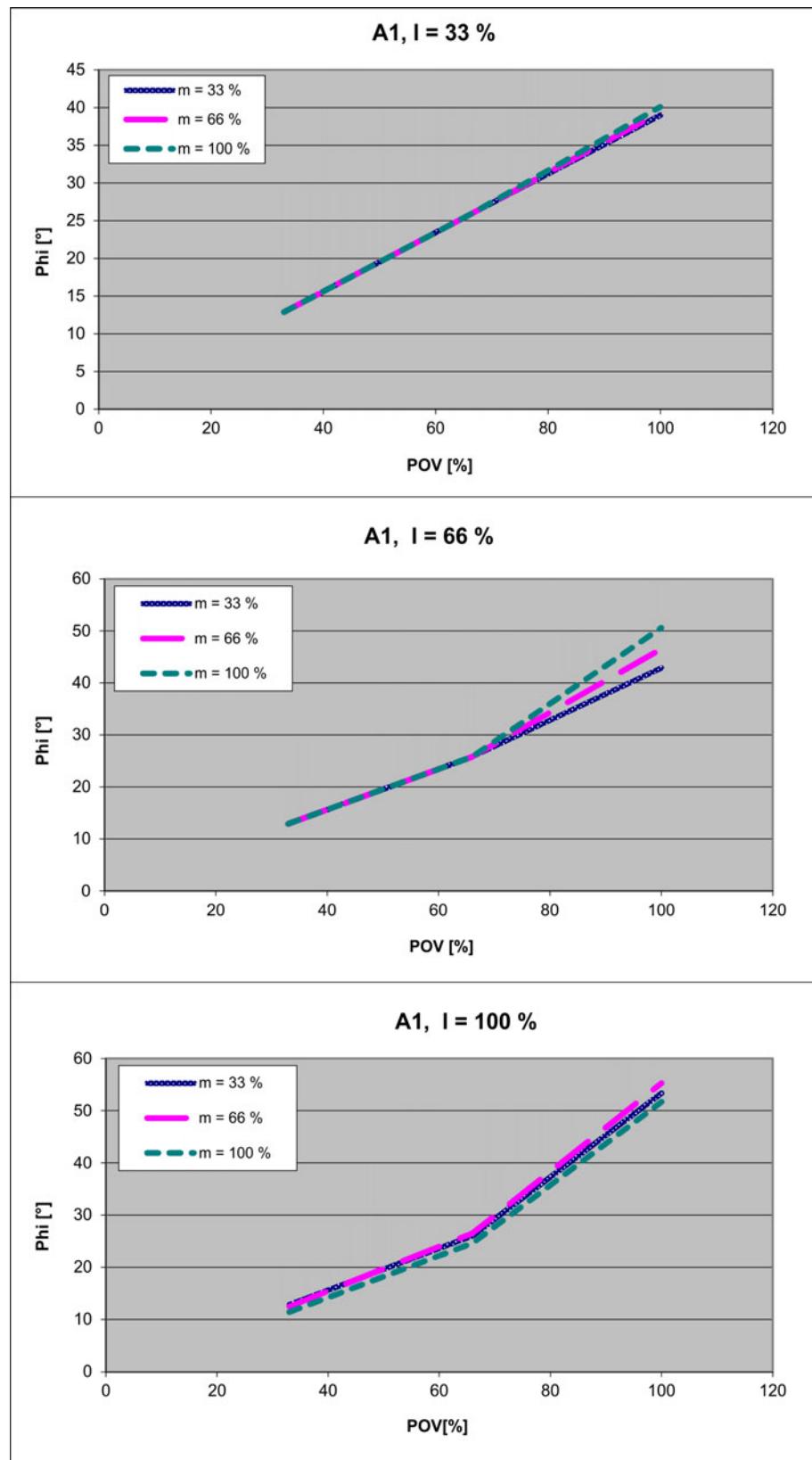
##### 4.10.7.1 Stopping distances and stopping times for STOP 0, axis 1 to axis 3

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

- Extension I = 100 %
- Program override POV = 100 %

- Mass m = maximum load (rated load + supplementary load on arm)

	<b>Stopping distance (°)</b>	<b>Stopping time (s)</b>
Axis 1	106.21	0.536
Axis 2	96.06	0.647
Axis 3	46.99	0.373

**4.10.7.2 Stopping distances and stopping times for STOP 1, axis 1****Fig. 4-69: Stopping distances for STOP 1, axis 1**

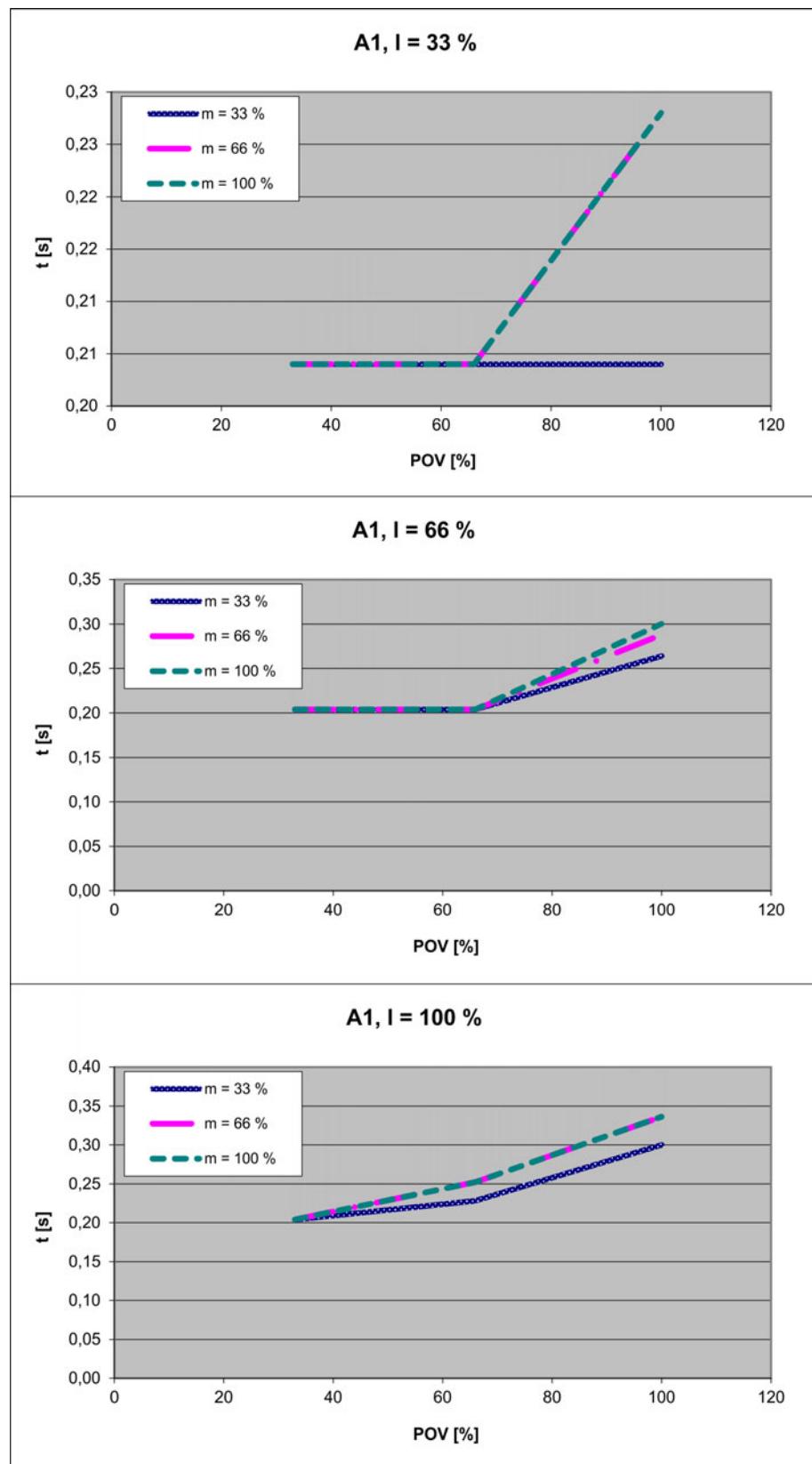
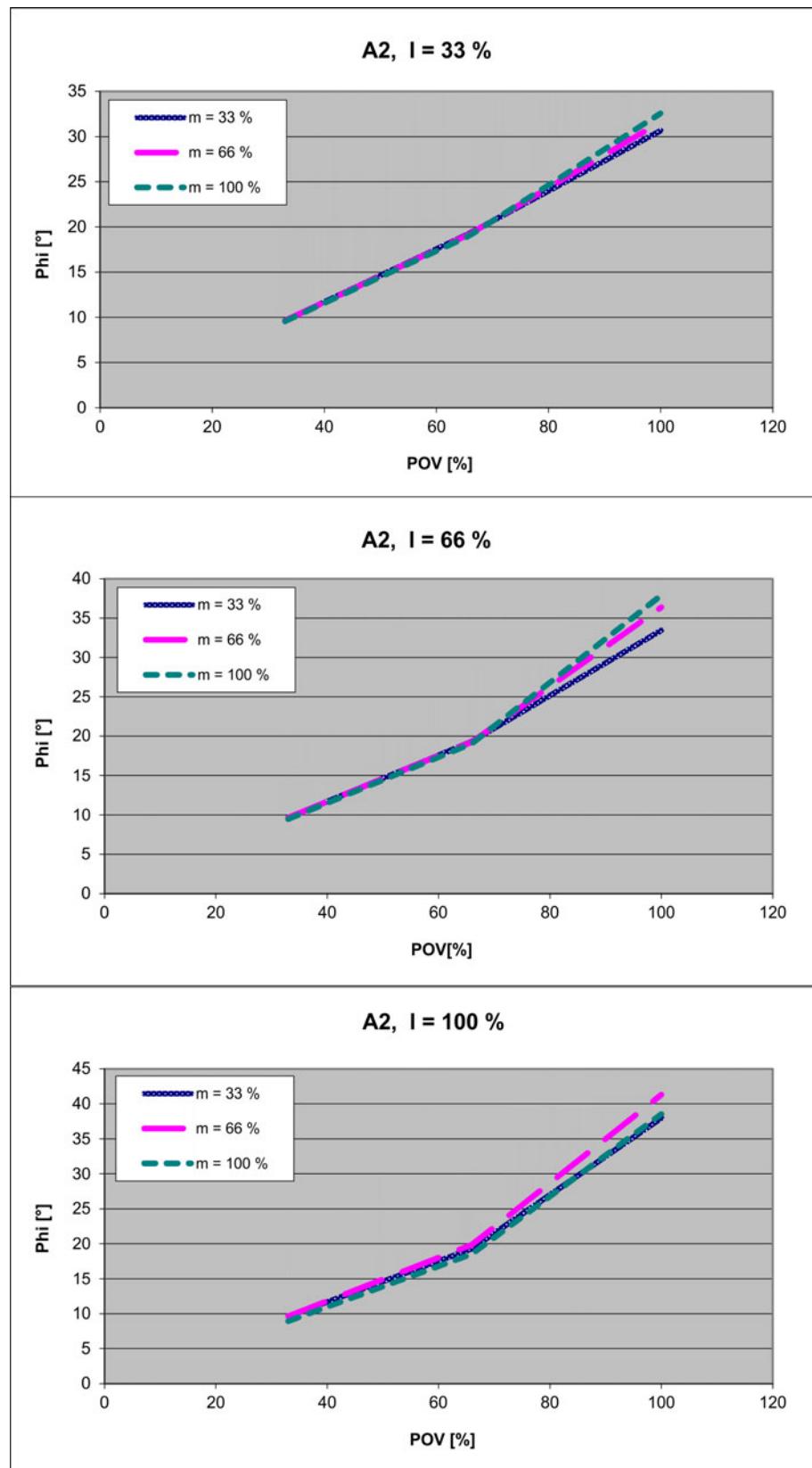


Fig. 4-70: Stopping times for STOP 1, axis 1

**4.10.7.3 Stopping distances and stopping times for STOP 1, axis 2****Fig. 4-71: Stopping distances for STOP 1, axis 2**

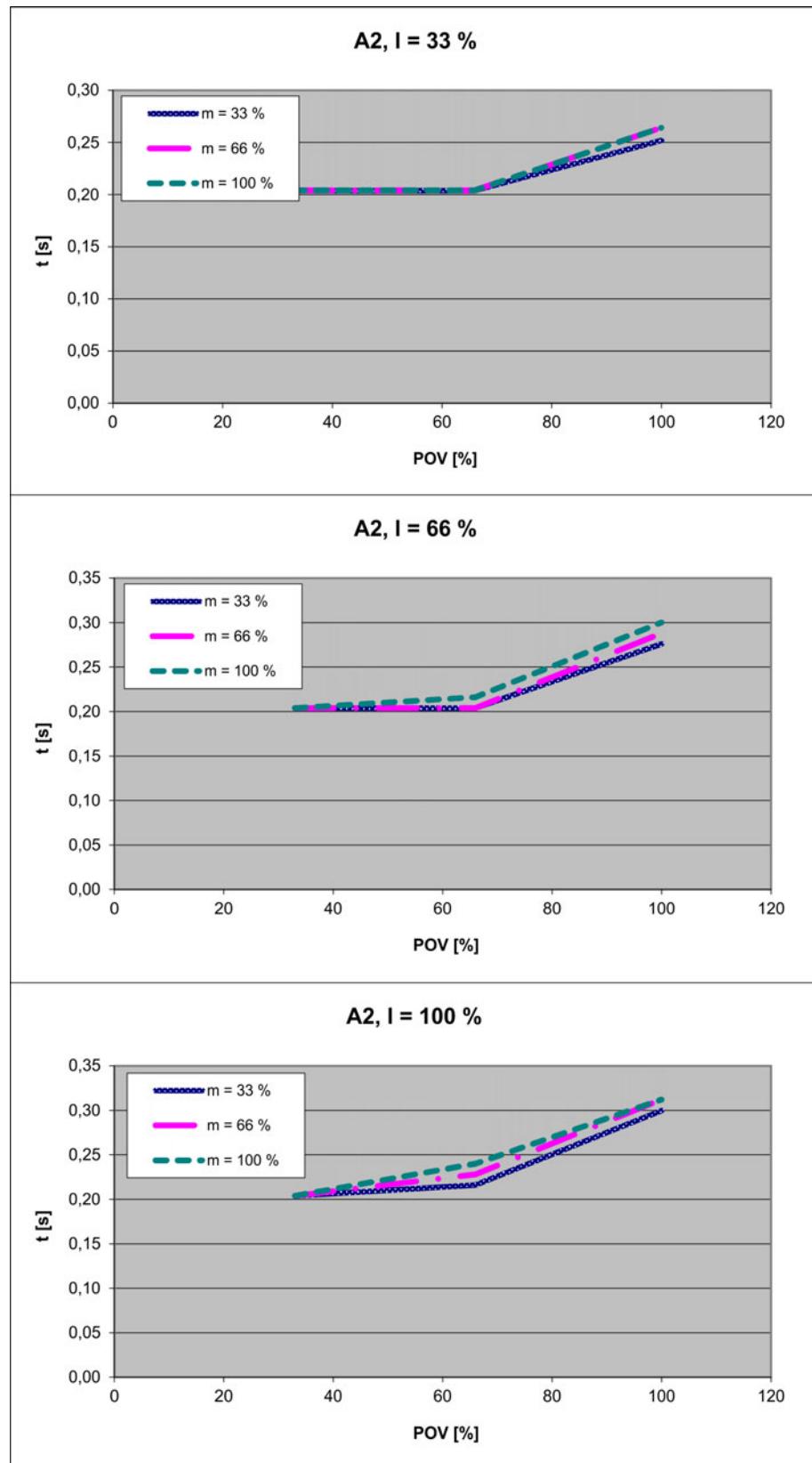


Fig. 4-72: Stopping times for STOP 1, axis 2

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

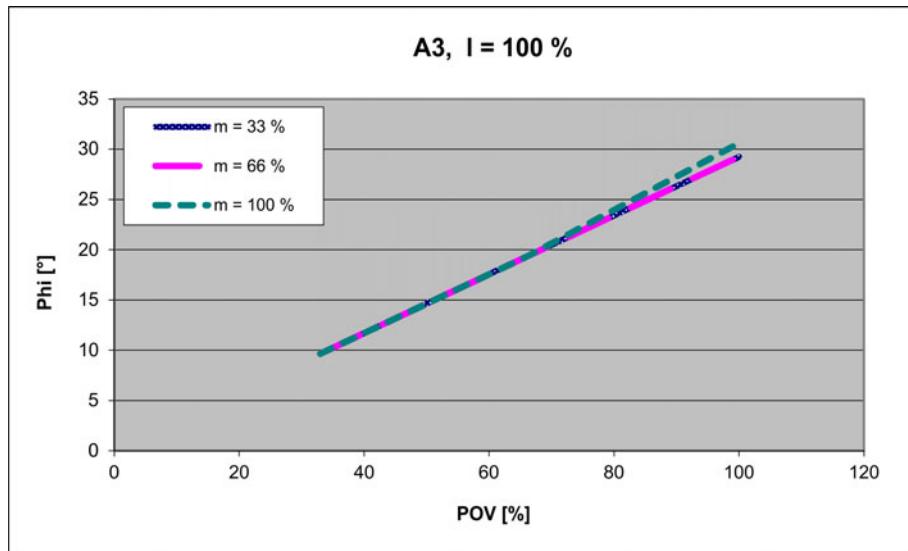


Fig. 4-73: Stopping distances for STOP 1, axis 3

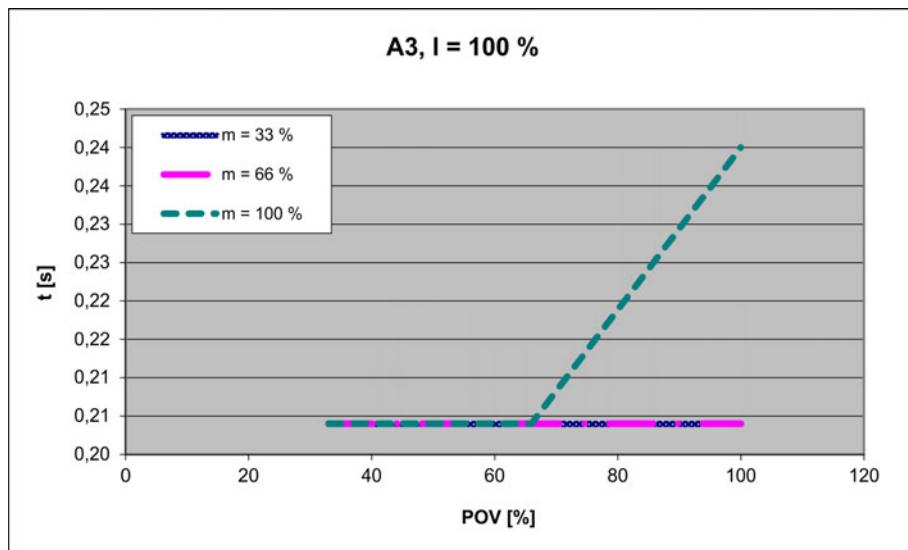


Fig. 4-74: Stopping times for STOP 1, axis 3

#### 4.10.8 Stopping distances and times, KR 10 R900 sixx W and KR 10 R1100 sixx W

The following values are preliminary values and are valid for the following robots.

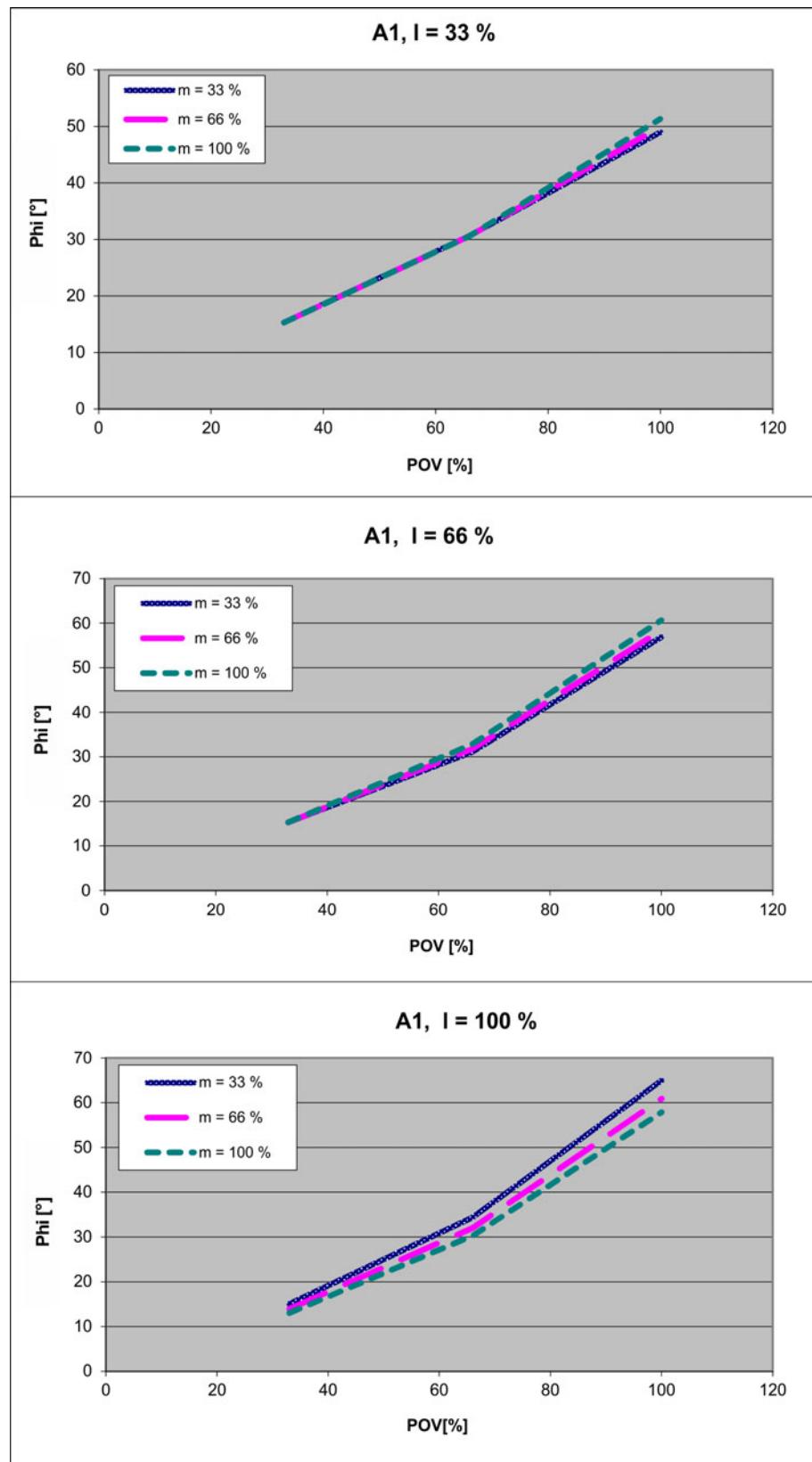
- KR 10 R900 sixx W
- KR 10 R1100 sixx W

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

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

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

	<b>Stopping distance (°)</b>	<b>Stopping time (s)</b>
Axis 1	163.11	0.745
Axis 2	67.78	0.404
Axis 3	60.96	0.387

**4.10.8.2 Stopping distances and stopping times for STOP 1, axis 1****Fig. 4-75: Stopping distances for STOP 1, axis 1**

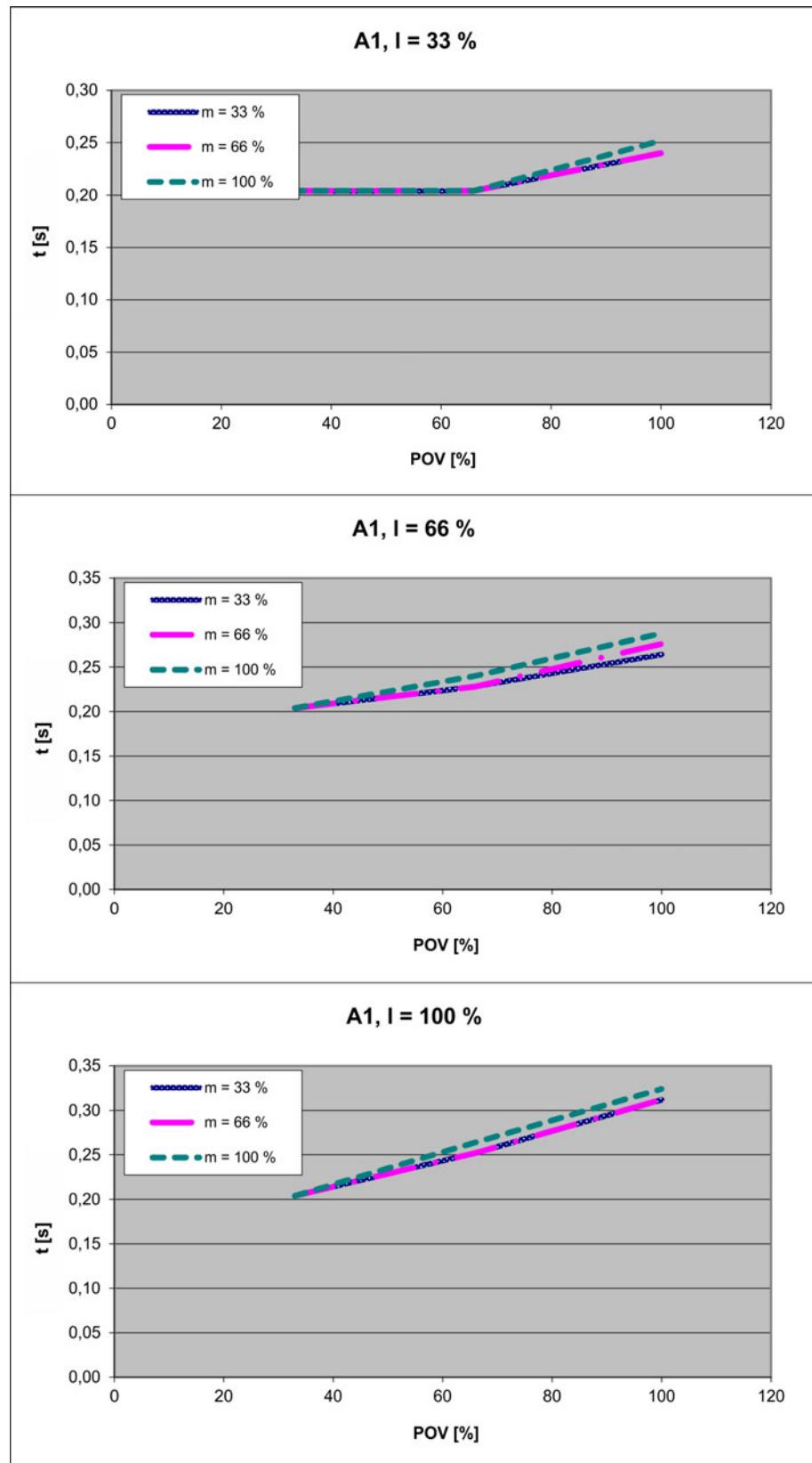
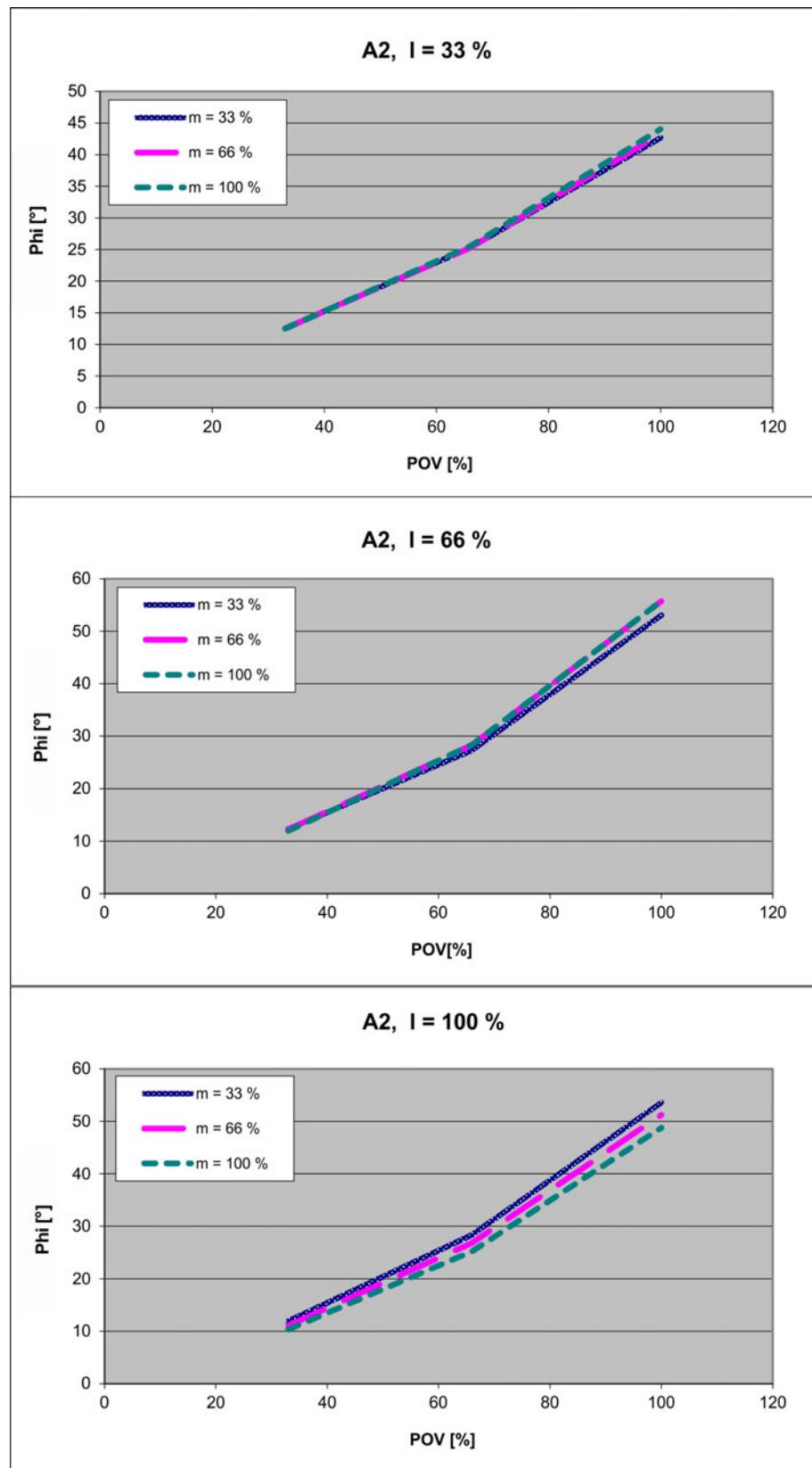


Fig. 4-76: Stopping times for STOP 1, axis 1

**4.10.8.3 Stopping distances and stopping times for STOP 1, axis 2****Fig. 4-77: Stopping distances for STOP 1, axis 2**

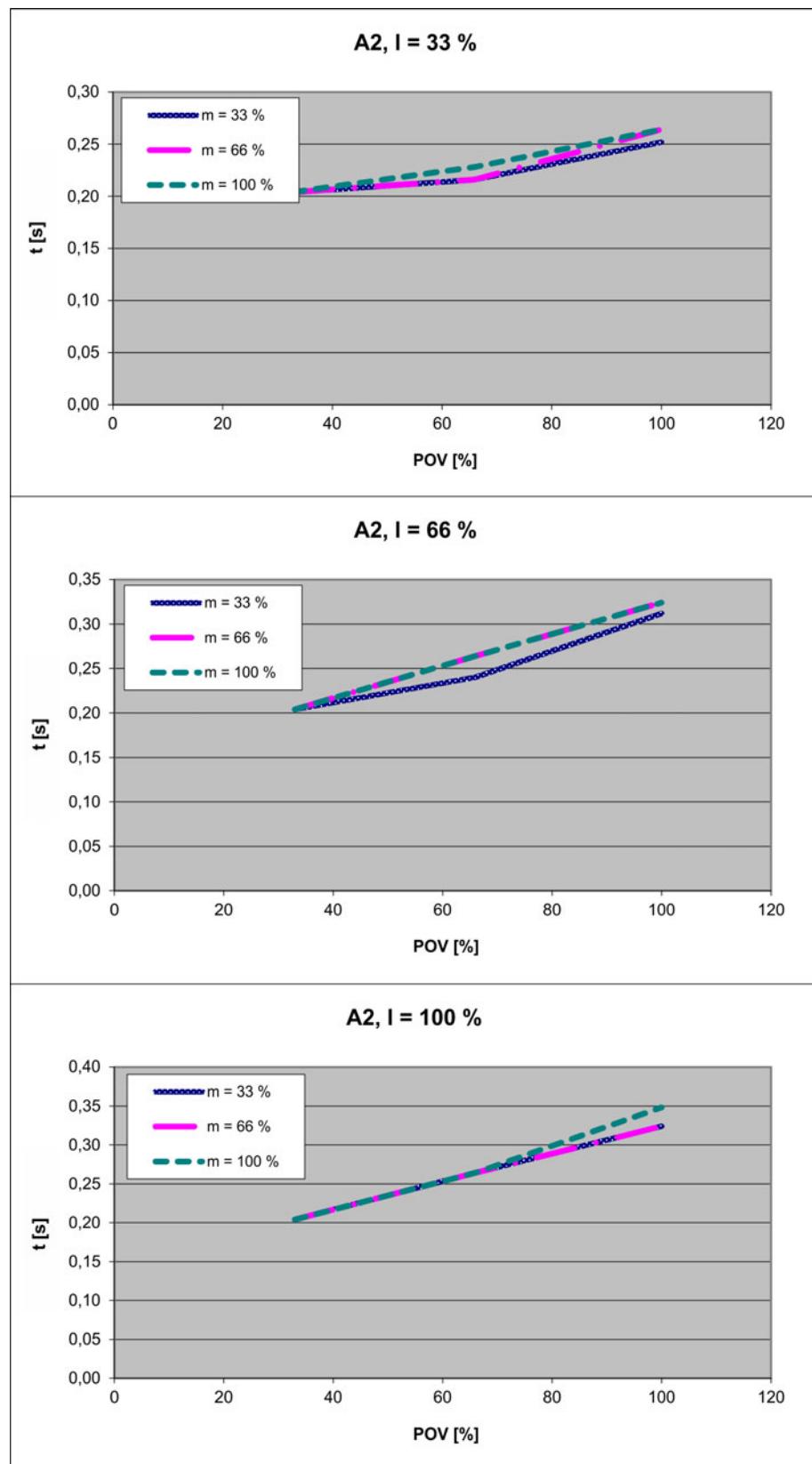
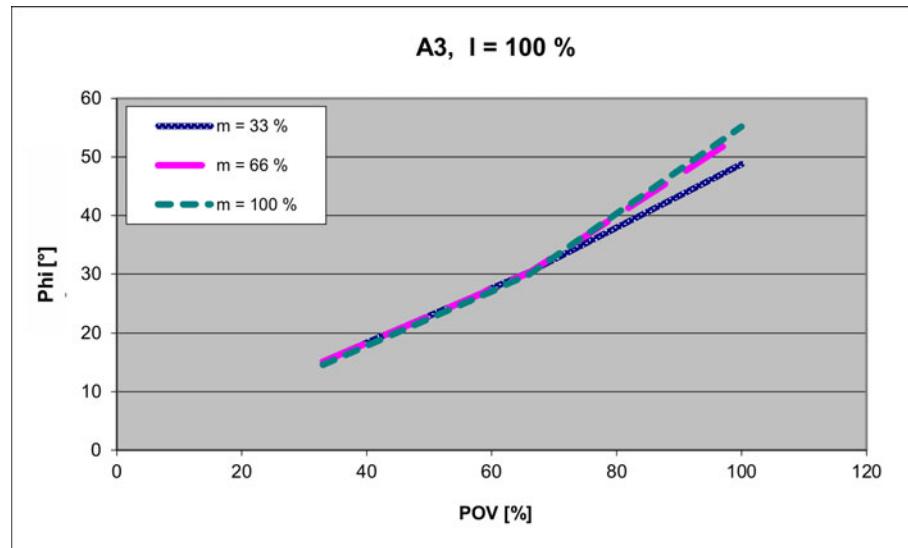
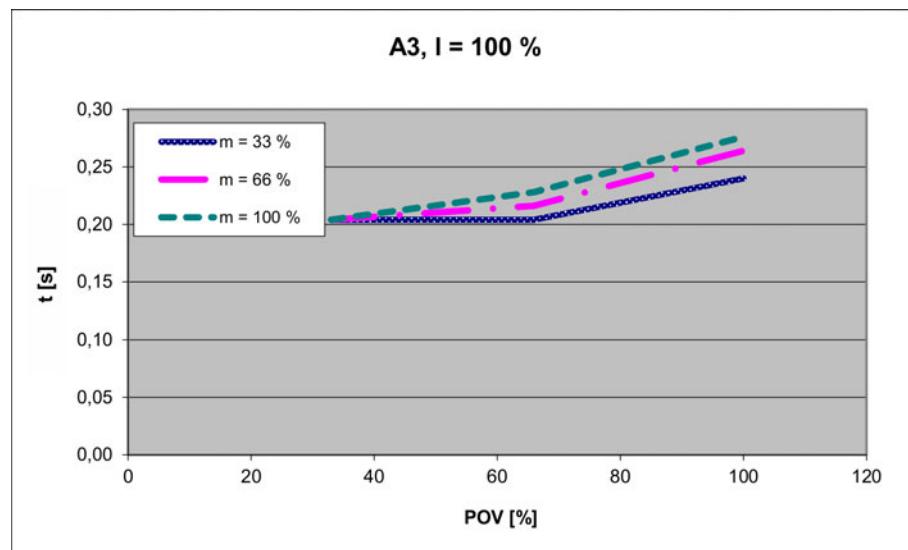


Fig. 4-78: Stopping times for STOP 1, axis 2

**4.10.8.4 Stopping distances and stopping times for STOP 1, axis 3****Fig. 4-79: Stopping distances for STOP 1, axis 3****Fig. 4-80: Stopping times for STOP 1, axis 3**



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

## 5.2 Personnel

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

- User
- Personnel



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

### User

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

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

### Personnel

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

Personnel includes:

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



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

### System integrator

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

The system integrator is responsible for the following tasks:

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

### Operators

The operator must meet the following preconditions:

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



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

## 5.3 Workspace, safety zone and danger zone

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

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

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

## 5.4 Overview of protective equipment

The protective equipment of the mechanical component may include:

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

Not all equipment is relevant for every mechanical component.

### 5.4.1 Mechanical end stops

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

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



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

### 5.4.2 Mechanical axis limitation (optional)

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

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

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



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

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



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

#### Description

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

- Release device (optional)

The release device can be used for the main axis drive motors and, depending on the robot variant, also for the wrist axis drive motors.

- Brake release device (option)

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

- Moving the wrist axes directly by hand

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



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

**NOTICE**

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

### 5.4.4 Labeling on the industrial robot

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

Labeling on the industrial robot consists of:

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



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

## 5.5 Safety measures

### 5.5.1 General safety measures

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

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



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



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



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

#### KCP/smartPAD

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

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



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

#### External keyboard, external mouse

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

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

The KCP/smartPAD must not be used as long as an external keyboard and/or external mouse are connected to the control cabinet.

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

<b>Modifications</b>	<p>After modifications to the industrial robot, checks must be carried out to ensure the required safety level. The valid national or regional work safety regulations must be observed for this check. The correct functioning of all safety functions must also be tested.</p> <p>New or modified programs must always be tested first in Manual Reduced Velocity mode (T1).</p> <p>After modifications to the industrial robot, existing programs must always be tested first in Manual Reduced Velocity mode (T1). This applies to all components of the industrial robot and includes e.g. modifications of the external axes or to the software and configuration settings.</p>
<b>Faults</b>	<p>The following tasks must be carried out in the case of faults in the industrial robot:</p> <ul style="list-style-type: none"><li>■ Switch off the robot controller and secure it (e.g. with a padlock) to prevent unauthorized persons from switching it on again.</li><li>■ Indicate the fault by means of a label with a corresponding warning (tag-out).</li><li>■ Keep a record of the faults.</li><li>■ Eliminate the fault and carry out a function test.</li></ul>

### 5.5.2 Transportation

<b>Manipulator</b>	<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>
<b>Robot controller</b>	<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>
<b>External axis (optional)</b>	<p>The prescribed transport position of the external axis (e.g. KUKA linear unit, turn-tilt table, positioner) must be observed. Transportation must be carried out in accordance with the operating instructions or assembly instructions of the external axis.</p>

### 5.5.3 Start-up and recommissioning

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

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



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

**WARNING**

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



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

**NOTICE**

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

**Function test**

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

It must be ensured that:

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

**WARNING**

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

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

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

**5.5.4 Manual mode**

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

- Jog mode
- Teaching
- Programming
- Program verification

The following must be taken into consideration in manual mode:

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

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

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

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

- If it can be avoided, there must be no other persons inside the safeguarded area.
- If it is necessary for there to be several persons inside the safeguarded area, the following must be observed:
- Each person must have an enabling device.
  - All persons must have an unimpeded view of the industrial robot.
  - Eye-contact between all persons must be possible at all times.
- The operator must be so positioned that he can see into the danger area and get out of harm's way.

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

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

### 5.5.5 Automatic mode

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

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

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

### 5.5.6 Maintenance and repair

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

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

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

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



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

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

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

#### Robot controller

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

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

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

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

#### Counterbalancing system

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

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

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

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

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

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

#### Hazardous substances

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

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



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

#### 5.5.7 Decommissioning, storage and disposal

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

#### 5.6 Applied norms and regulations

Name/Edition	Definition
<b>2006/42/EU:2006</b>	<b>Machinery Directive:</b> 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)
<b>2014/68/EU:2014</b>	<b>Pressure Equipment Directive:</b> Directive 2014/68/EU of the European Parliament and of the Council dated 15 May 2014 on the approximation of the laws of the Member States concerning pressure equipment  (Only applicable for robots with hydropneumatic counterbalancing system.)
<b>EN ISO 13850:2015</b>	<b>Safety of machinery:</b> Emergency stop - Principles for design
<b>EN ISO 13849-1:2015</b>	<b>Safety of machinery:</b> Safety-related parts of control systems - Part 1: General principles of design
<b>EN ISO 13849-2:2012</b>	<b>Safety of machinery:</b> Safety-related parts of control systems - Part 2: Validation
<b>EN ISO 12100:2010</b>	<b>Safety of machinery:</b> General principles of design, risk assessment and risk reduction
<b>EN ISO 10218-1:2011</b>	<b>Industrial robots – Safety requirements:</b> Part 1: Robots  <b>Note:</b> Content equivalent to <b>ANSI/RIA R.15.06-2012, Part 1</b>

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

#### Description

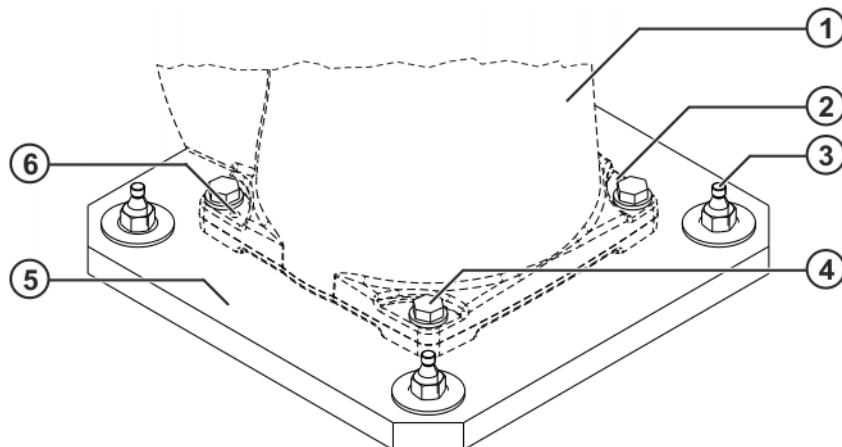
The mounting base with centering is used when the robot is fastened to the floor, i.e. directly on a concrete foundation.

The mounting base with centering consists of:

- 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 bedplate and the concrete foundation.

The minimum dimensions must be observed.



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

- |                             |                            |
|-----------------------------|----------------------------|
| 1 Robot base frame          | 4 Hexagon bolt             |
| 2 Locating pin, cylindrical | 5 Bedplate                 |
| 3 Resin-bonded anchor       | 6 Locating pin, flat-sided |

**Grade of concrete  
for foundations**

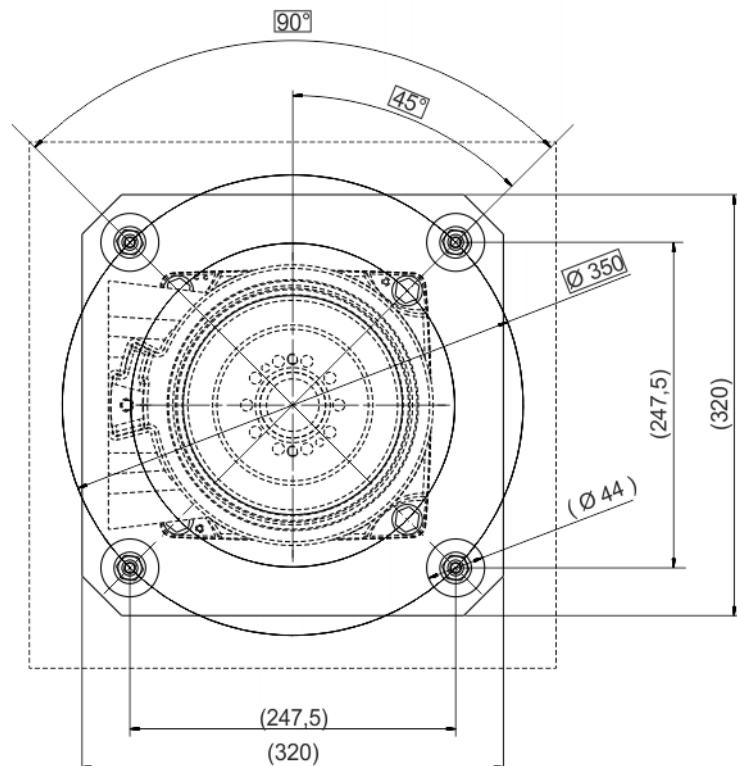
When producing foundations from concrete, observe the load-bearing capacity of the ground and the country-specific construction regulations. There must be no layers of insulation or screed between the bedplate/bedplates and the concrete foundation. The quality of the concrete must meet the requirements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

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

**Dimensioned  
drawing**

The following illustration ([>>> Fig. 6-2](#)) provides all the necessary information on the mounting base, together with the required foundation data. The specified foundation dimensions refer to the safe transmission of the foundation loads into the foundation and not to the stability of the foundation.

Dimensions: mm



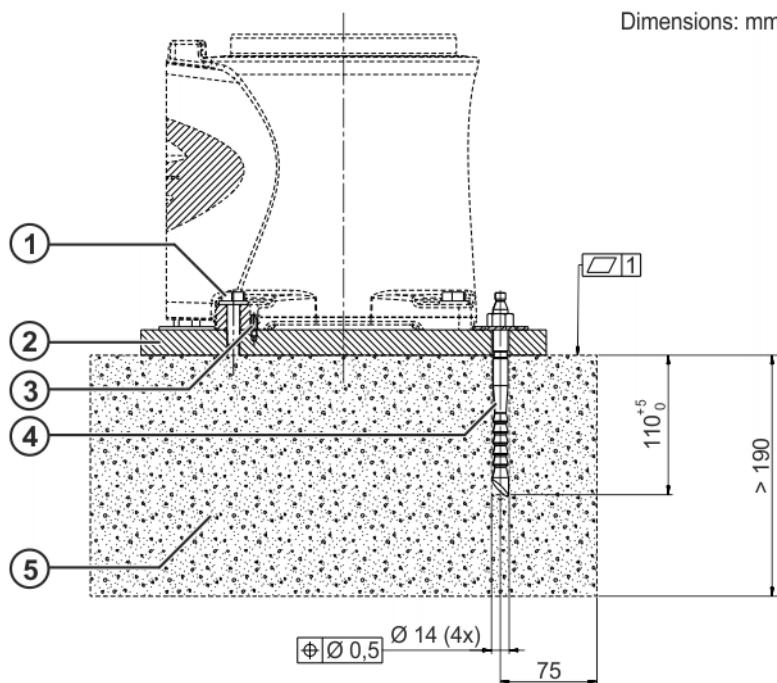
**Fig. 6-2: Mounting base, dimensioned drawing**

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](#)).

**NOTICE**

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

Dimensions: mm

**Fig. 6-3: Cross-section of foundations**

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

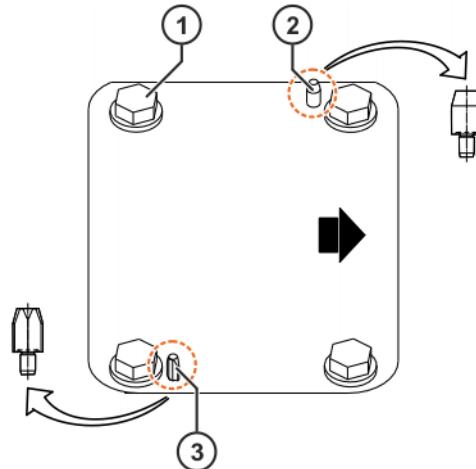
### 6.3 Machine frame mounting

#### Description

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

The machine frame mounting assembly consists of:

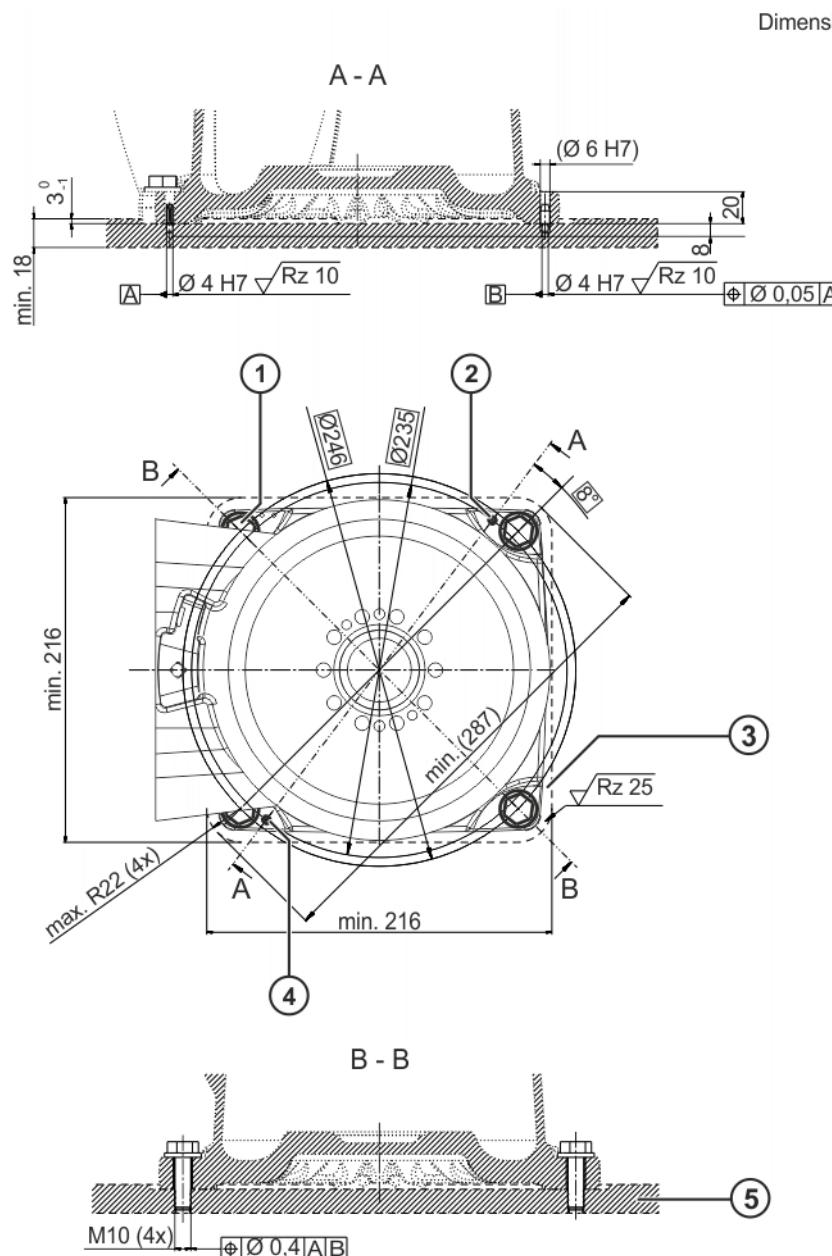
- Locating pin
- Hexagon bolts with conical spring washers

**Fig. 6-4: Machine frame mounting**

- 1 Hexagon bolt
- 2 Locating pin, cylindrical
- 3 Locating pin, flat-sided

### Dimensioned drawing

The following illustration ([>>> Fig. 6-5](#)) provides all the necessary information on machine frame mounting, together with the required foundation data.



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

- |                             |                            |
|-----------------------------|----------------------------|
| 1 Hexagon bolt (4x)         | 4 Locating pin, flat-sided |
| 2 Locating pin, cylindrical | 5 Steel structure          |
| 3 Mounting surface          |                            |

## 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
- Data cable
- CAT5 data cable (optional)
- Connecting cable, external axes A7 and A8 (optional)
- Ground conductor (optional)

Depending on the specification of the robot, various connecting cables are used. The standard cable length is 4 m. Cable lengths of 1 m, 7 m, 15 m and 25 m are available as an option. The maximum length of the connecting cables must not exceed 25 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, 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.

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

- The bending radius for fixed routing must not be less than 50 mm for motor cables and 30 mm for control cables.
- Protect cables against exposure to mechanical stress.
- Route the cables without mechanical stress – no tensile forces on the connectors
- Cables are only to be installed indoors.
- Observe the permissible temperature range (fixed installation) of 263 K (-10 °C) to 343 K (+70 °C).
- Route the motor cables and the data cables separately in metal ducts; if necessary, additional measures must be taken to ensure electromagnetic compatibility (EMC).

#### Interface A1

Interface A1 is located at the rear of the base frame. The connections for the motor and data cables are shown in the following illustration.

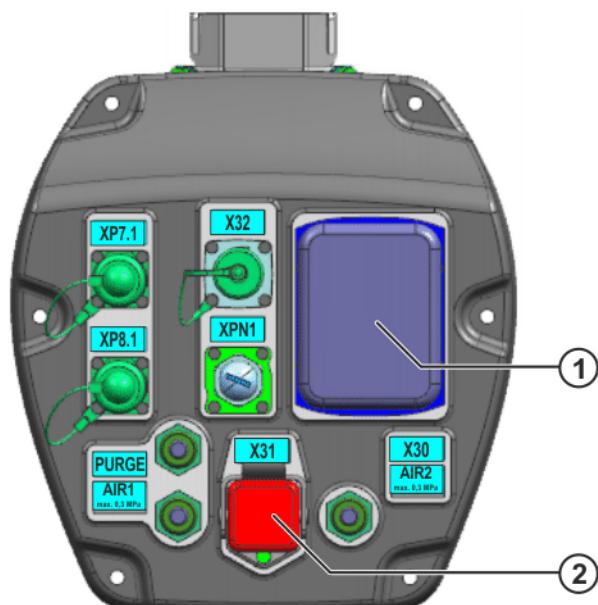
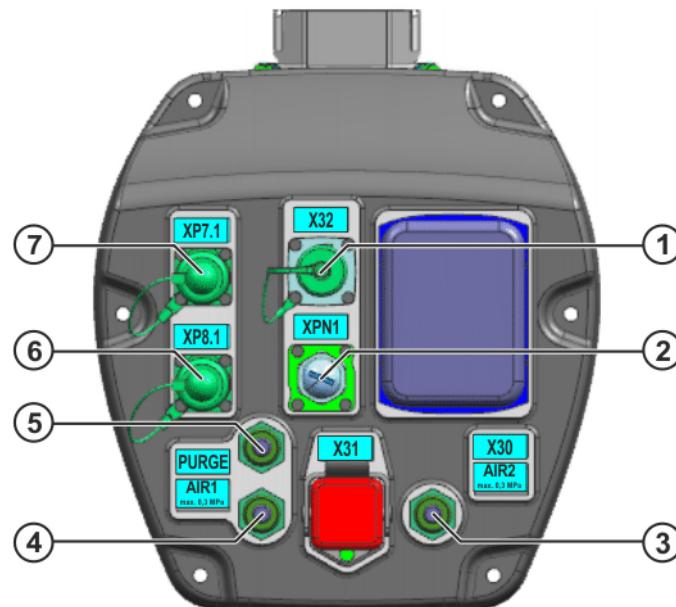


Fig. 6-6: Interface A1

- 1 Motor cable connection X30
- 2 Data cable connection X31

## 6.5 Customer interfaces

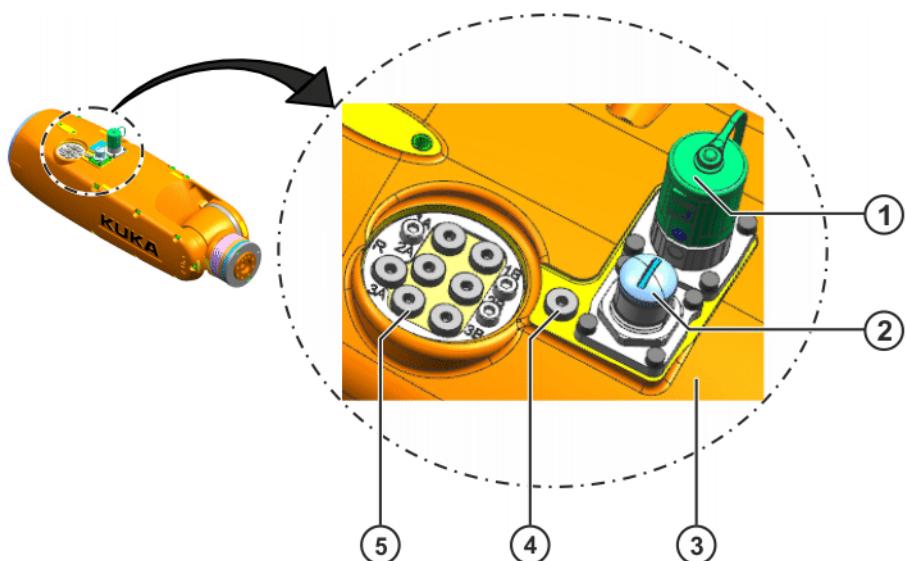
**Interface A1** Interface A1 is located at the rear of the base frame.



**Fig. 6-7: Customer interface A1**

- 1 MEMD connection X32
- 2 CAT5 data cable connection XPN1
- 3 Air line connection AIR2  
Outside diameter: 6 mm
- 4 Air line connection AIR1  
Outside diameter: 6 mm
- 5 Pressurization connection (optional)  
Max. pressure: 0.3 bar  
Air, oil-free, dry, filtered  
according to: ISO 8573.1-1, 1.2 to 16.2
- 6 Connection for external axis A8 (XP8.1)
- 7 Connection for external axis A7 (XP7.1)

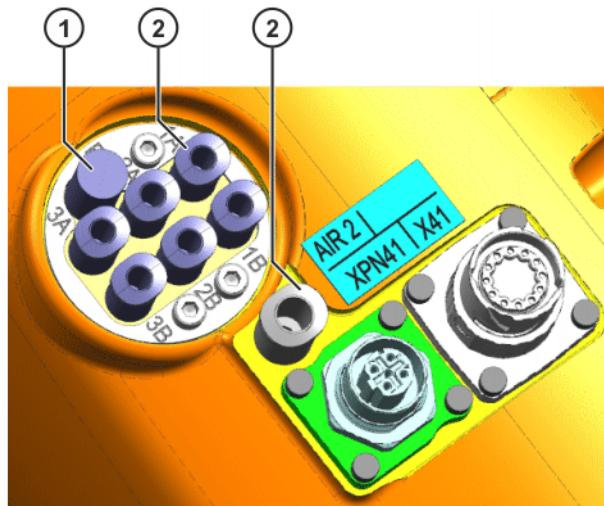
**Interface A4** Interface A4 is located on top of the in-line wrist.



**Fig. 6-8: Interface A4, example**

- |                    |                   |
|--------------------|-------------------|
| 1 Connection X41   | 4 Air line AIR2   |
| 2 Connection XPN41 | 5 Air connections |
| 3 In-line wrist    |                   |

The optional connector bypass is required for use of the air connections. This option contains a silencer and several plug-in couplings (=> Fig. 6-9 ).



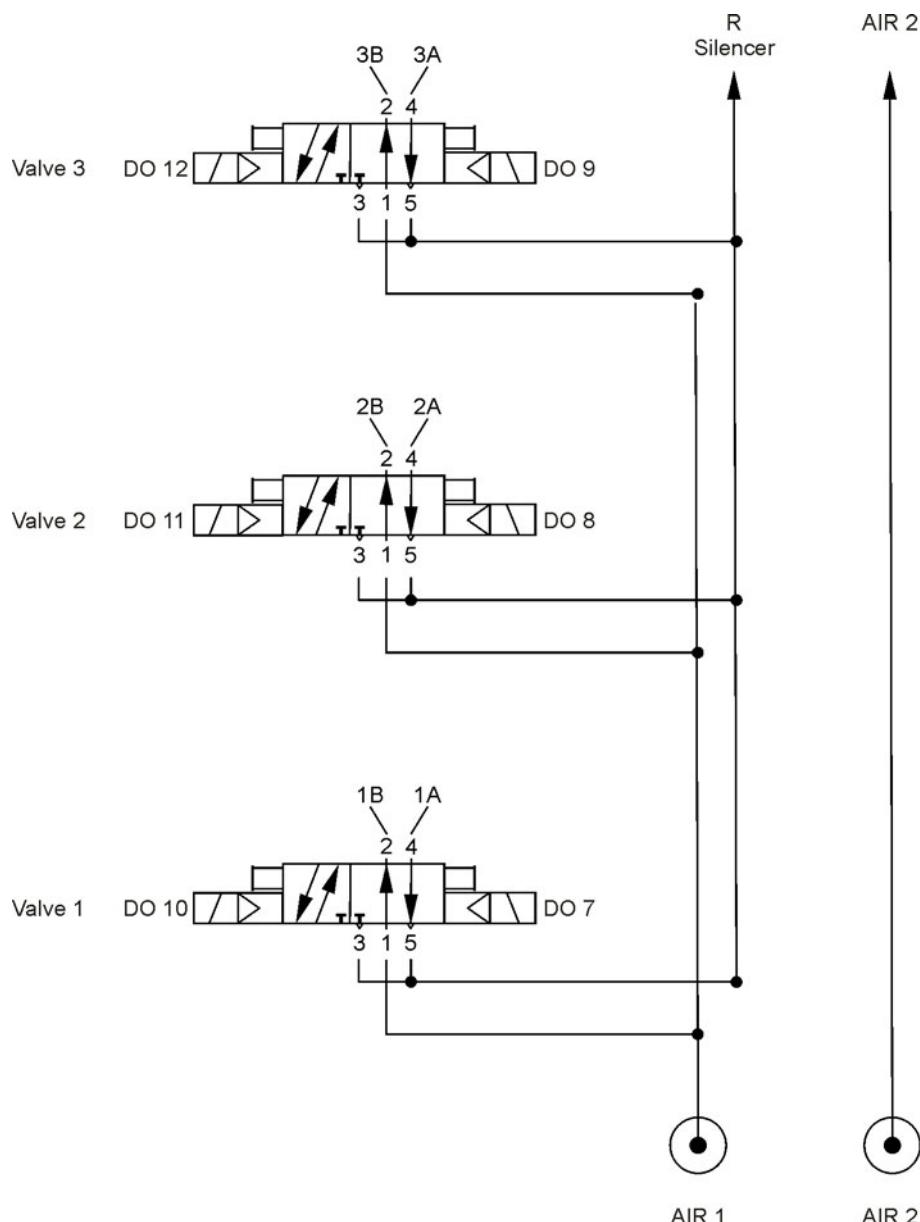
**Fig. 6-9: Connections for connector bypass option**

- |            |                   |
|------------|-------------------|
| 1 Silencer | 2 Push-in fitting |
|------------|-------------------|

The robot has three bistable 5/2-way solenoid valves integrated into the in-line wrist. The valve unit is activated via the internal energy supply system:

Designation	Limit values
Valve type	5/2-way solenoid valve
Max. pressure	7 bar
Switching frequency	10 Hz
Operating temperature	+5 °C to +45 °C (278 K to 318 K) Free from condensation
Threaded union	M5

Designation	Limit values
Medium	Air, oil-free, dry, filtered according to: ISO 8573.1-1, 1.2 to 16.2 Degree of filtration: max. 5 µm
Operating voltage	24 V DC
Current	25 mA



**Fig. 6-10: Valve diagram**

#### Valve activation

Designation	Values
Digital outputs (for valve activation)	6 (DO7 to DO12): <ul style="list-style-type: none"> <li>■ Valve 1: DO7/DO10</li> <li>■ Valve 2: DO8/DO11</li> <li>■ Valve 3: DO9/DO12</li> </ul> not short-circuit proof
	Rated voltage
	Output current



The inputs and outputs are not preconfigured and must be configured in WorkVisual.  
Further information about mapping inputs and outputs can be found in the **WorkVisual** documentation.

### Connection X41

Designation	Values
Digital outputs (for customer interface X41)	2 (DO13, DO14) short-circuit proof
Rated voltage	24 V DC (-15%/+20%)
Output current	max. 0.5 A
Short-circuit current	max. 2 A
Load type	Ohmic, inductive Lamp load
Digital inputs (for customer interface X41)	6 (DI1 to DI6)
Signal voltage "0"	-3 V ... +5 V EN 61131-2, type 3
Signal voltage "1"	15 V ... 30 V EN 61131-2, type 3
Input current	typically 3 mA EN 61131-2, type 3
Input filter	typically 0.3 ms
Power supply	24 V / 3 A

A 615springtec® connector, 12-pole EMC enclosure E-part from Intercontec is required for connection X41.

When using the power supply, the customer must protect this against overload and short-circuit with a 3 A fuse downstream of connector X41.

For the connector bypack option, the pin assignments on the connector insert are to be noted.

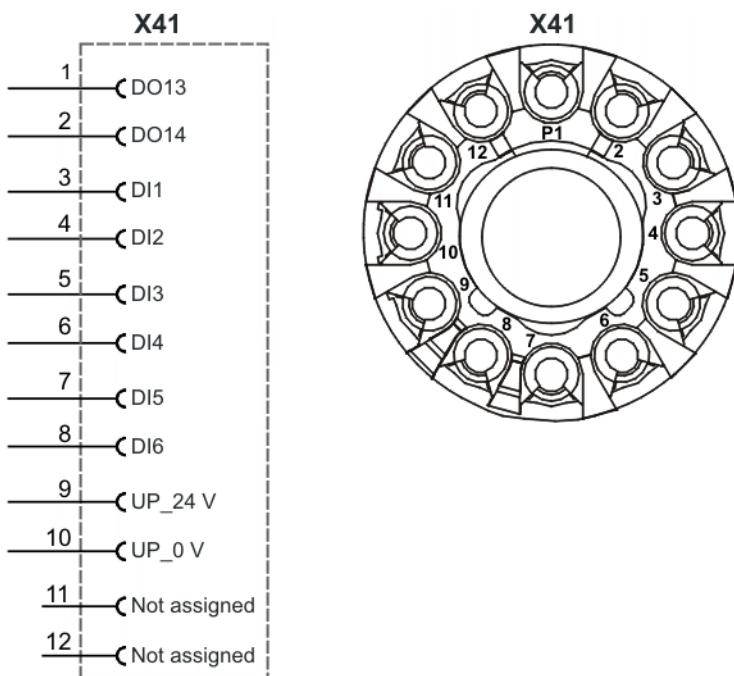
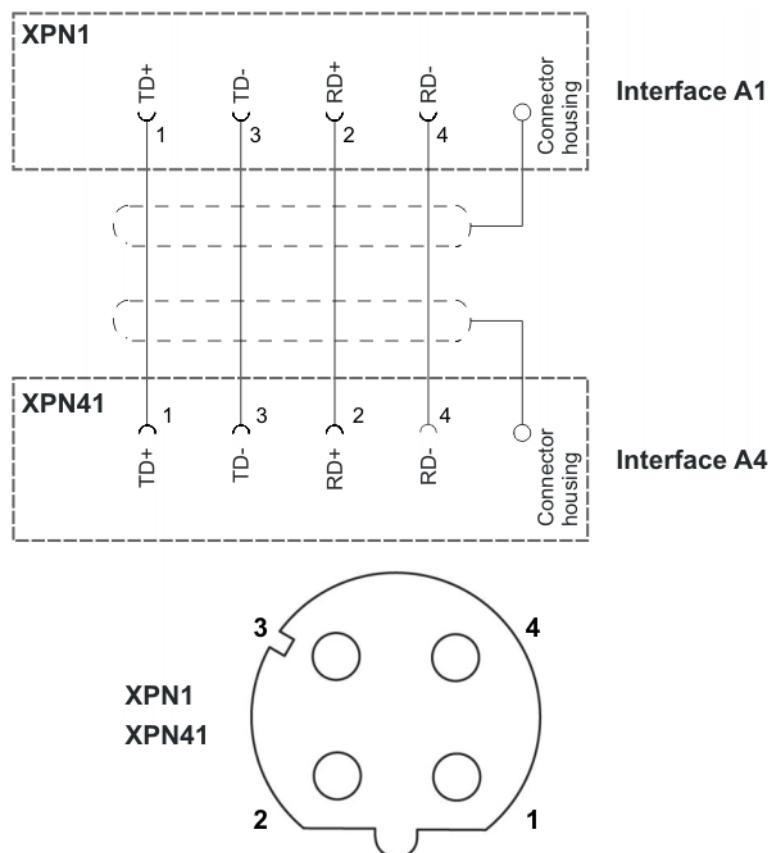


Fig. 6-11: Wiring diagram, connection X41

**Connection  
XPN41**

**Fig. 6-12: Wiring diagram, connection XPN41**

A SAISM-4/8S-M12 4P D-ZF connector from Weidmüller is required for connection XPN41.

**Connection AIR2**

Customer-specific air connection with the following values:

Designation	Limit values
Max. pressure	7 bar
Vacuum	Atmospheric pressure minus 0.95 bar



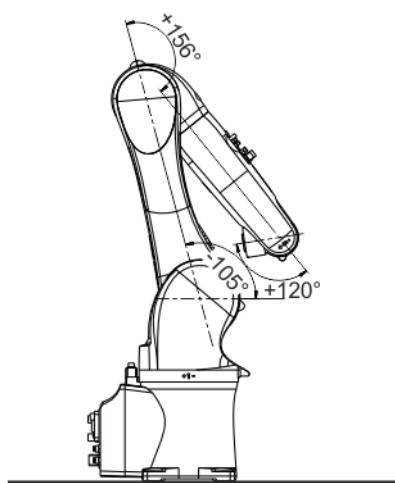
## 7 Transportation

### 7.1 Transporting the manipulator

**Description** Move the robot into its transport position 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 to the foundation. 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 corrosion or glue on contact surfaces.

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

Axis	A1	A2	A3	A4	A5	A6
Angle	0°	-105°	+156°	0°	+120°	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.

The following transport dimensions ([>>> Fig. 7-2](#)) are valid for the robots:

- KR 6 R700 sixx
- KR 6 R700 sixx W
- KR 6 R700 sixx C

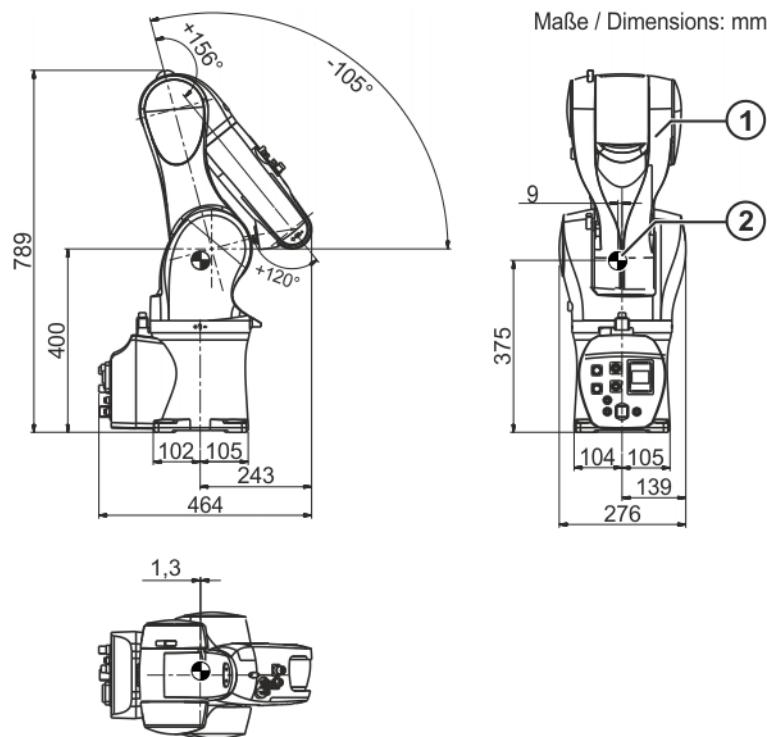


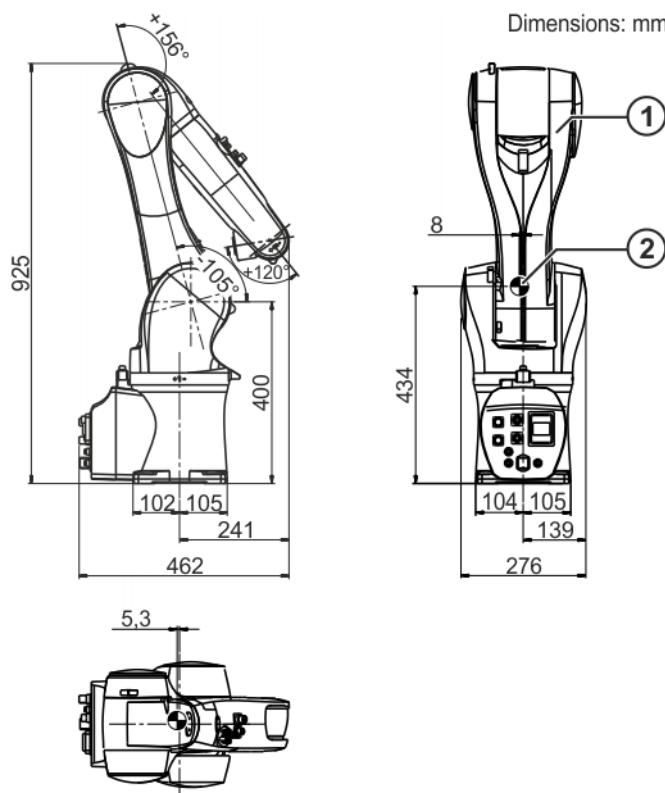
Fig. 7-2: Transport dimensions, R700

1 Robot

2 Center of gravity

The following transport dimensions (>>> Fig. 7-3 ) are valid for the robots:

- KR 6 R900 sixx
- KR 6 R900 sixx W
- KR 6 R900 sixx C
- KR 10 R900 sixx
- KR 10 R900 sixx W
- KR 10 R900 sixx C



**Fig. 7-3: Transport dimensions, R900**

1 Robot

2 Center of gravity

The following transport dimensions ([>>> Fig. 7-4](#)) are valid for the robots:

- KR 10 R1100 sixx
- KR 10 R1100 sixx W
- KR 10 R1100 sixx C

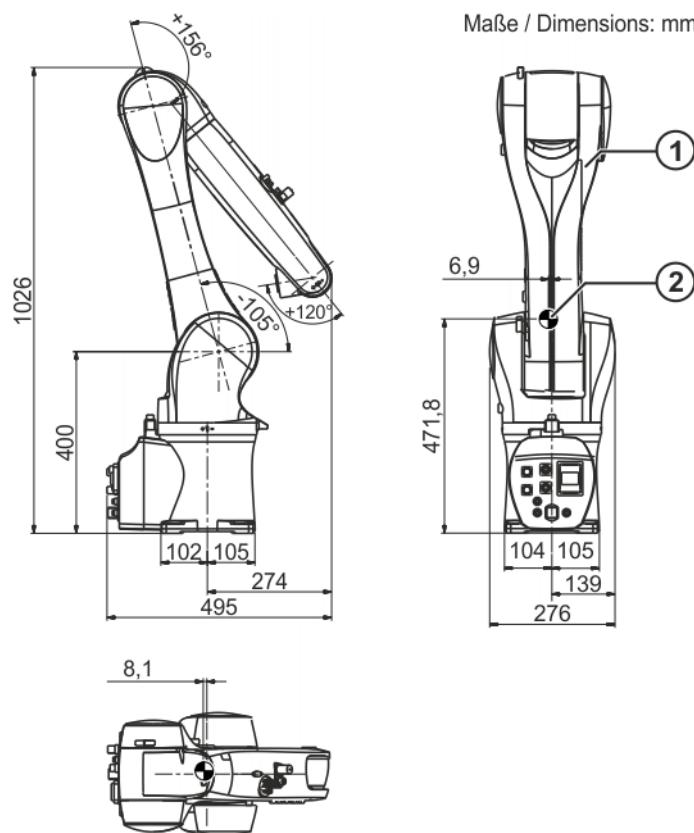


Fig. 7-4: Transport dimensions, R1100

1 Robot

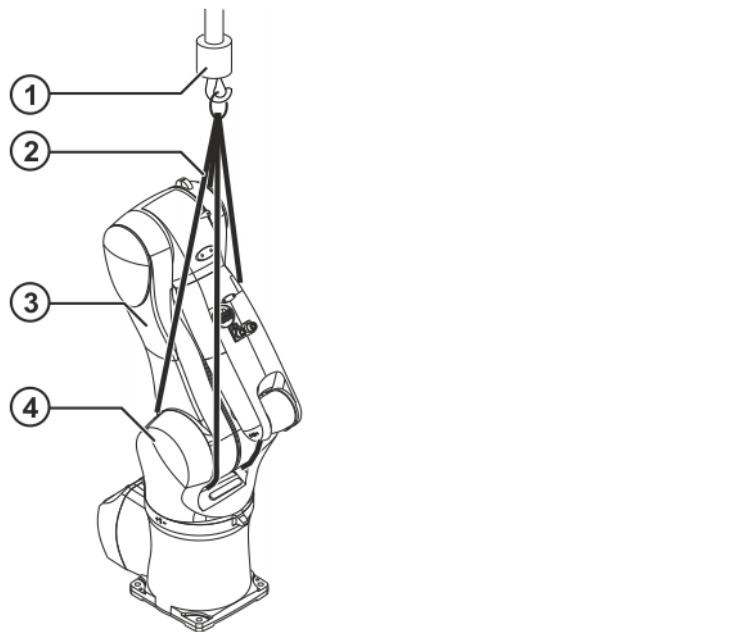
2 Center of gravity

### Transportation 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.

The robot is transported using lifting tackle (>>> Fig. 7-5). The robot must be in the transport position. The loops of the lifting tackle are passed around the link arm and rotating column. 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. 7-5: Transportation using lifting tackle**

- |   |                |   |                 |
|---|----------------|---|-----------------|
| 1 | Crane          | 3 | Link arm        |
| 2 | Lifting tackle | 4 | Rotating column |



## 8 Start-up and recommissioning

**CAUTION** For screwed connections, the fastening screws (standard, strength class 8.8) are to be tightened with the tightening torques specified in the appendix ([>>> 9 "Appendix" Page 135](#)). Tightening torques deviating from these values are specified directly. The specified screw sizes and strength classes are those valid at the copy deadline. The specifications contained in the Parts Catalog are, however, always to be taken as the most up-to-date information. Screws of strength class 10.9 and higher may only be tightened once with the rated tightening torque. When the screws are first slackened they must be replaced with new ones.

### 8.1 Installing the mounting base

<b>Description</b>	<p>These instructions apply to the variant “mounting base with centering (resin cartridge)”. The robot is fastened to an appropriate concrete foundation using one or more bedplates and resin-bonded anchors.</p> <p>If the surface of the concrete foundation is not sufficiently smooth and even, the differences must be evened out with a suitable leveling compound.</p> <p>When using resin-bonded anchors, use only resin cartridges and anchors from the same manufacturer. No diamond tools or core drills may be used for drilling the anchor holes; for preference, drilling tools supplied by the anchor manufacturer are to be used. The manufacturer’s instructions for the use of resin-bonded anchors must also be observed.</p>
<b>Precondition</b>	<ul style="list-style-type: none"> <li>■ The concrete foundation must have the required dimensions and cross-section.</li> <li>■ The surface of the foundation must be smooth and even.</li> <li>■ The mounting base assembly must be complete.</li> <li>■ Have the leveling compound readily at hand.</li> </ul>
<b>Special tools</b>	<p>The following special tools are required:</p> <ul style="list-style-type: none"> <li>■ Drill with a Ø 14 mm bit</li> <li>■ Setting tool approved by the anchor manufacturer</li> </ul>
<b>Procedure</b>	<ol style="list-style-type: none"> <li>1. Determine the position of the plate on the foundation in relation to the working envelope.</li> <li>2. Set the bedplate down on the foundation in its installation position.</li> </ol> <p><b>NOTICE</b> If the bedplate is not fully seated on the concrete ceiling, this can cause strain or result in loosening of the mounting base. Fill the gap with leveling compound. To do this, lift the bedplate again and apply sufficient leveling compound to the underside (toothed spatula). Then set the bedplate down again and align it, removing any excess leveling compound. The maximum height of the leveling compound must not be exceeded.</p> <p>The area under the hexagon bolt for robot fastening must be kept free from leveling compound.</p> <p>Allow the leveling compound to cure for about 3 hours. The curing time is longer at temperatures below 293 K (20 °C).</p> <ol style="list-style-type: none"> <li>3. Check that the bedplate is horizontal. The maximum permissible deviation is 3°.</li> <li>4. Drill 4 anchor holes in accordance with the manufacturer’s specifications and fit the anchors as specified in the instructions for use.</li> </ol>

The instructions for use are enclosed with the anchors and must be followed precisely.

5. Allow the resin to cure. See table provided by manufacturer.

## 8.2 Installing the machine frame mounting assembly

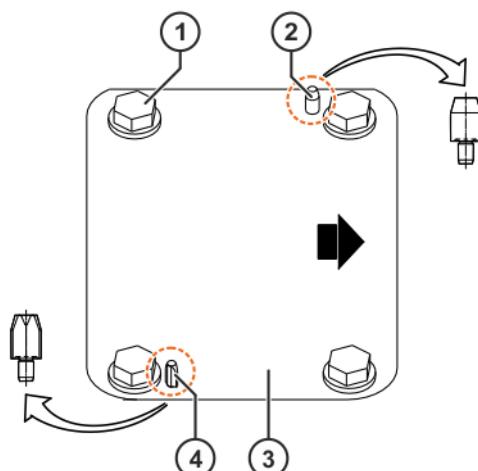
**Description** The machine frame mounting is used for installing robots on a steel structure prepared by the customer.

**Precondition**

- The mounting surface has been prepared as shown in the diagram ([>>> Fig. 6-5](#) ).
- The substructure has been checked for sufficient safety.
- The machine frame mounting assembly is complete.

**Procedure**

1. Clean the mounting surface of the robot ([>>> Fig. 8-1](#) ).
2. Check the hole pattern.
3. Insert 2 locating pins into the hole pattern.
4. Prepare 4 M10x35 hexagon bolts together with conical spring washers.



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

- 1 M10x35-8.8 hexagon bolt (4x)
- 2 Locating pin, cylindrical
- 3 Mounting surface
- 4 Locating pin, flat-sided

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

## 8.3 Installing a floor-mounted robot

**Description** This description is valid for the installation of floor-mounted robots.

4 hexagon bolts with conical spring washers are used for fastening to the bed-plate or to a machine frame. A cylindrical pin and a flat-sided pin are provided to ensure correct positioning.

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

**Precondition**

- The mounting base is installed.
- The installation site is accessible with a crane.
- 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.

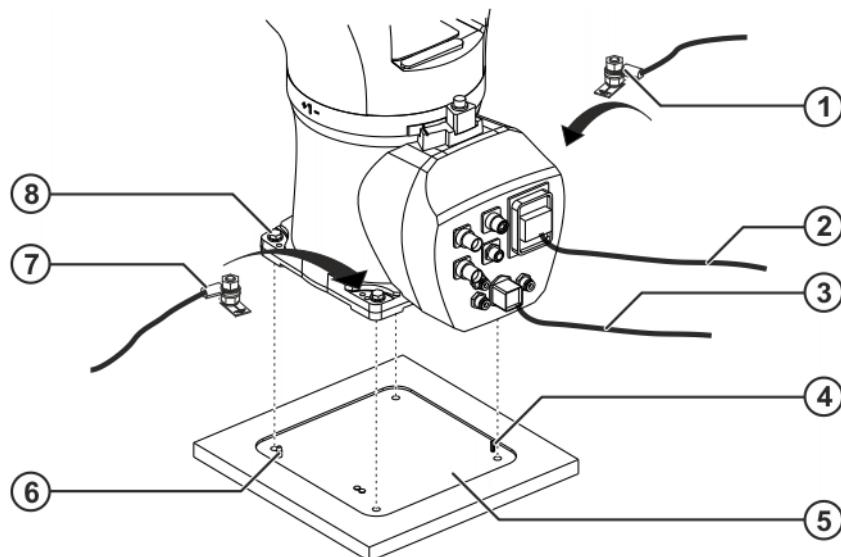
**Procedure**

1. Check that the pins are undamaged and fitted securely (**>>>** Fig. 8-2 ).
  2. Bring the robot to the installation site with the crane.
  3. Carefully lower the robot vertically onto the mounting surface. Ensure that an entirely vertical position is maintained in order to prevent damage to the pins.
  4. Insert 4 M10x35 hexagon bolts together with conical spring washers.
  5. Tighten 4 M10x35 hexagon bolts with a torque wrench in diagonally opposite sequence. Gradually increase the tightening torque to 45.0 Nm.
  6. Remove the lifting tackle.
  7. Connect motor cable X30 and data cable X31.
- When connecting the motor cable connectors, it must be ensured that the connectors on the controller and on the robot are locked correctly. Correct locking is indicated by an audible click. It is indicated optically by the fact that the red rings on each of the locking buttons are not visible and are pushed in completely.
8. Connect the ground conductor between the robot controller and the robot to the ground conductor connection.
  9. Connect the ground conductor between the system component and the robot to the ground conductor connection.
  10. Check the equipotential bonding in accordance with VDE 0100 and EN 60204-1.



Further information is contained in the operating and assembly instructions of the robot controller.

11. Mount tooling, if present.
12. Retighten the 4 M10x35 hexagon bolts with a torque wrench after 100 hours of operation.



**Fig. 8-2: Installing a floor-mounted robot**

- |                              |                             |
|------------------------------|-----------------------------|
| 1 Ground conductor, external | 5 Mounting surface          |
| 2 Motor cable                | 6 Locating pin, cylindrical |

- |                            |                         |
|----------------------------|-------------------------|
| 3 Data cable               | 7 Ground conductor, KRC |
| 4 Locating pin, flat-sided | 8 Hexagon bolt          |
| Locating pin, cylindrical  |                         |

Put the robot system into operation in accordance with the "Start-up" chapter of the operating and programming instructions for the KUKA System Software (KSS) and the "Start-up" chapter of the operating instructions for the robot controller.

## 8.4 Installing a wall-mounted robot

### Description

This description is valid for the installation of wall-mounted robots with the mounting variant "Machine frame mounting". For installation on the wall, the robot must be fastened to the Load Lifting Attachment. The robot is fastened to the wall using the Load Lifting Attachment. The Load Lifting Attachment must then be removed.

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

### Precondition

- The machine frame mounting assembly is installed.
- The installation site is accessible with a crane and fork lift truck.
- Any tools or other system components which would hinder the work have been removed.
- The robot is in the transport position.
- 2 instructed persons are required for performing this task.

### Procedure

1. Bring the robot to the installation site with the crane and set it down.
2. Carefully push the Load Lifting Attachment onto the base frame of the robot from the front ([>>> Fig. 8-3](#) ).
3. Remove the lifting tackle.
4. Fasten the robot to the front of the Load Lifting Attachment with 2 M12x30 Allen screws and washers;  $M_A = 40 \text{ Nm}$ .

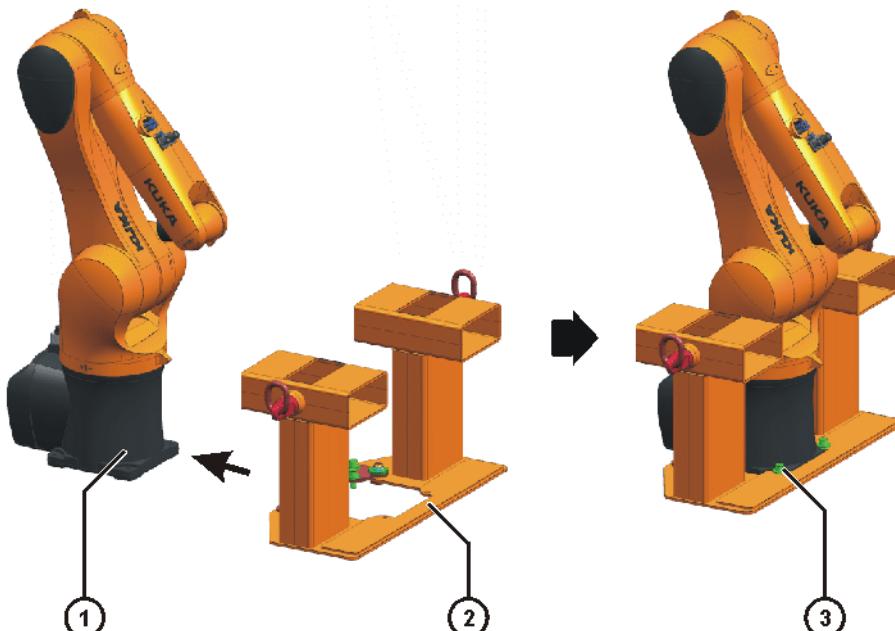


Fig. 8-3: Pushing on the Load Lifting Attachment and fastening it at the front

- 1 Base frame
- 2 Load lifting attachment
- 3 M12x30 Allen screw (front)
5. Position swivel holders on base frame (**>>> Fig. 8-4** ).
6. Fasten the swivel holders to the rear of the base frame with 2 M12x30 Allen screws and washers;  $M_A = 40 \text{ Nm}$ .
7. Lock the swivel holders to the Load Lifting Attachment with 2 M12x30 Allen screws and washers.



**Fig. 8-4: Positioning and fastening the swivel holders**

- 1 Swivel holder
- 2 M12x30 Allen screw (rear)
- 3 M12x30 Allen screw (locking screw)
8. Attach lifting tackle to the 2 rotating swivel eyebolts on the Load Lifting Attachment and to the crane.
9. Person 1:  
Slowly and carefully lift the robot with the crane.  
Person 2:  
Secure the robot against toppling during the lifting operation.

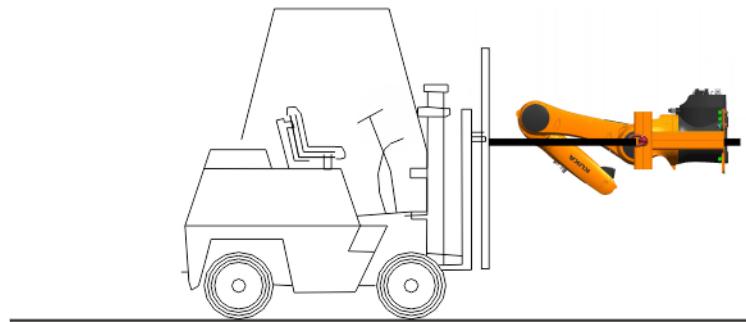
**WARNING**

Ensure that the robot does not topple during the lifting operation. Serious injuries and damage to property may otherwise result.

10. Slowly rotate the robot through 90°. The arm must point downward.
11. Lift the Load Lifting Attachment with a fork lift truck (**>>> Fig. 8-5** ).  
The fork lift truck must remain in the fork slots of the Load Lifting Attachment during installation in order to prevent slipping.

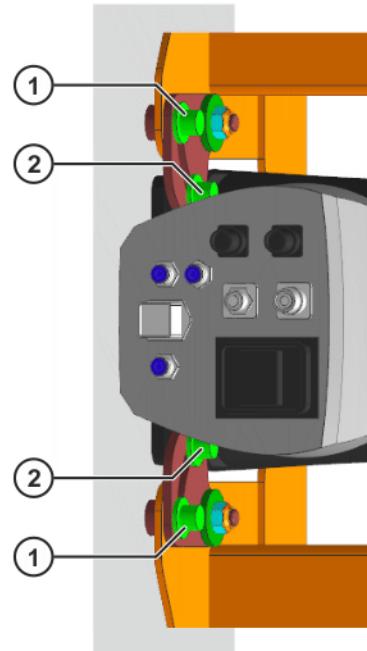
**NOTICE**

When picking up the Load Lifting Attachment with the fork lift truck, the width of the fork slots (140 mm) must be taken into consideration. Damage to property may otherwise result.



**Fig. 8-5: Lifting the Load Lifting Attachment with a fork lift truck**

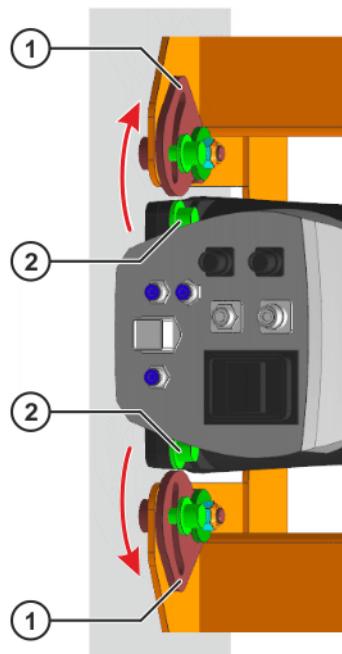
12. Position the robot on the wall using the fork lift truck. Ensure that an entirely horizontal position is maintained in order to prevent damage to the pins.
13. Unscrew 2 M12x30 Allen screws (top Allen screws) and washers from the top of the base frame (**>>> Fig. 8-6** ).
14. Unscrew 2 M12x30 Allen screws (locking screws) and washers from the Load Lifting Attachment.



**Fig. 8-6: Removing the top screws**

- 1 M12x30 Allen screw (top)
- 2 M12x30 Allen screw (locking screw)

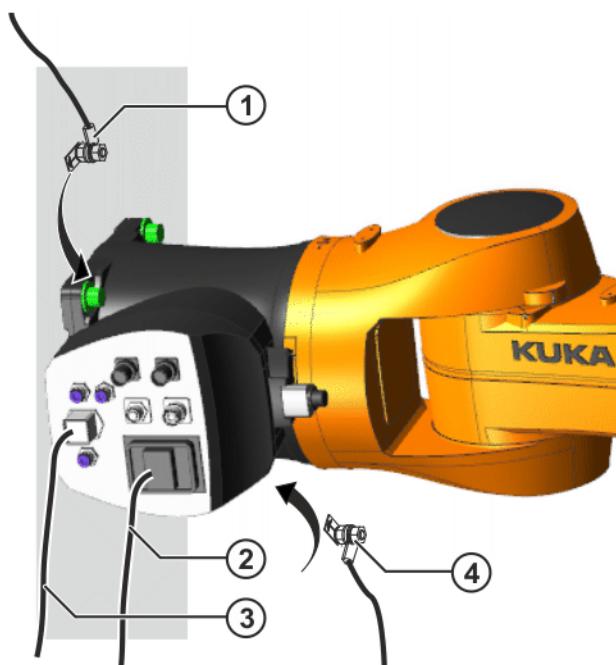
15. Rotate the swivel holders outwards (**>>> Fig. 8-7** ).
16. Fasten the robot to the wall with 2 M10x35 hexagon bolts (top hexagon bolts) and washers at the top.  
Tighten the hexagon bolts alternately with the torque wrench. Gradually increase the tightening torque to 45 Nm.



**Fig. 8-7: Rotating the swivel holders outwards**

- 1 Swivel holder
- 2 M10x35 hexagon bolt (top)

17. Unscrew 2 M12x30 Allen screws (bottom Allen screws) and washers from the bottom of the base frame.
18. Carefully separate the Load Lifting Attachment from the bottom of the base frame with the fork lift truck.
19. Fasten the robot to the wall with 2 M10x35 hexagon bolts and washers on the bottom of the base frame.  
Tighten the hexagon bolts alternately with the torque wrench. Gradually increase the tightening torque to 45 Nm.
20. Connect motor cable X30 and data cable X31 (**>>> Fig. 8-8** ).  
When connecting the motor cable connectors, it must be ensured that the connectors on the controller and on the robot are locked correctly. Correct locking is indicated by an audible click. It is indicated optically by the fact that the red rings on each of the locking buttons are not visible and are pushed in completely.
21. Connect the ground conductor between the robot controller and the robot to the ground conductor connection.



**Fig. 8-8: Connecting the supply lines**

- |   |                       |   |                            |
|---|-----------------------|---|----------------------------|
| 1 | Ground conductor, KRC | 3 | Data cable                 |
| 2 | Motor cable           | 4 | Ground conductor, external |

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

**i** Further information is contained in the operating and assembly instructions of the robot controller.

23. Connect the ground conductor between the system component and the robot to the ground conductor connection.

24. Mount tooling, if present.

25. Retighten the 4 hexagon bolts with a torque wrench after 100 hours of operation.

Put the robot system into operation in accordance with the “Start-up” chapter of the operating and programming instructions for the KUKA System Software (KSS) and the “Start-up” chapter of the operating instructions for the robot controller.

## 8.5 Installing a ceiling-mounted robot

### Description

This description is valid for the installation of ceiling-mounted robots. The mounting base or machine frame mounting assembly is used for this purpose. For installation on the ceiling, the robot must be fastened to the Load Lifting Attachment. The robot is fastened to the ceiling using the Load Lifting Attachment. The Load Lifting Attachment must then be removed.

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

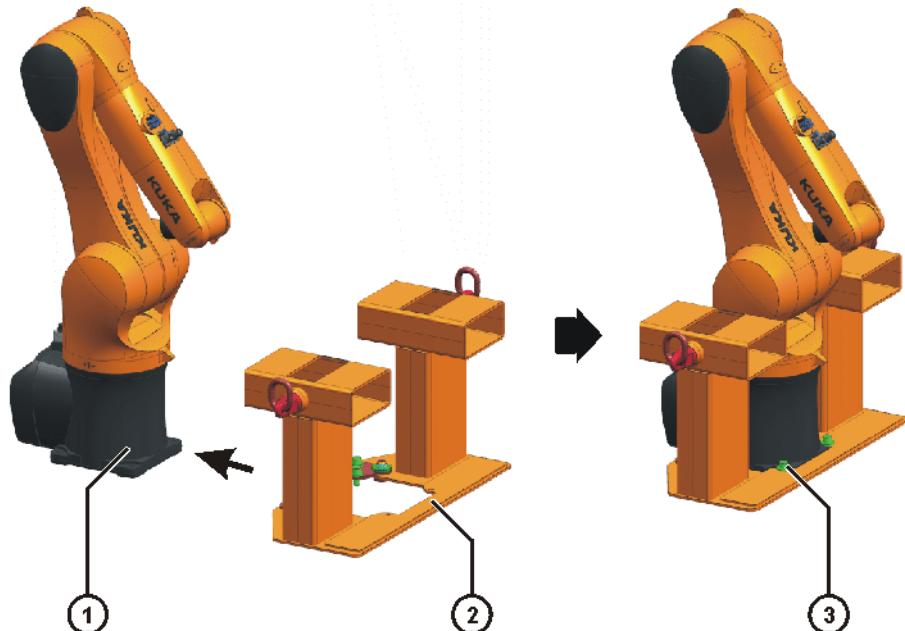
### Precondition

- The machine frame mounting assembly is installed.
- The installation site is accessible with a crane and fork lift truck.
- Any tools or other system components which would hinder the work have been removed.
- The robot is in the transport position.

- 2 instructed persons are required for performing this task.

### Procedure

1. Bring the robot to the installation site with the crane and set it down.
2. Carefully push the Load Lifting Attachment onto the base frame of the robot from the front (**>>> Fig. 8-9** ).
3. Remove the lifting tackle.
4. Fasten the robot to the front of the Load Lifting Attachment with 2 M12x30 Allen screws and washers;  $M_A = 40.0 \text{ Nm}$ .



**Fig. 8-9: Pushing on the Load Lifting Attachment and fastening it at the front**

- 1 Base frame
- 2 Load lifting attachment
- 3 M12x30 Allen screw (front)
- 5 Position swivel holders on base frame (**>>> Fig. 8-10** ).
- 6 Fasten the swivel holders to the rear of the base frame with 2 M12x30 Allen screws and washers;  $M_A = 40.0 \text{ Nm}$ .
- 7 Lock the swivel holders to the Load Lifting Attachment with 2 M12x30 Allen screws and washers.



**Fig. 8-10: Positioning and fastening the swivel holders**

- 1 Swivel holder
- 2 M12x30 Allen screw (rear)
- 3 M12x30 Allen screw (locking screw)
8. Attach lifting tackle to the 2 rotating swivel eyebolts on the Load Lifting Attachment and to the crane.
9. Person 1:  
Slowly and carefully lift the robot with the crane.  
Person 2:  
Secure the robot against toppling during the lifting operation.

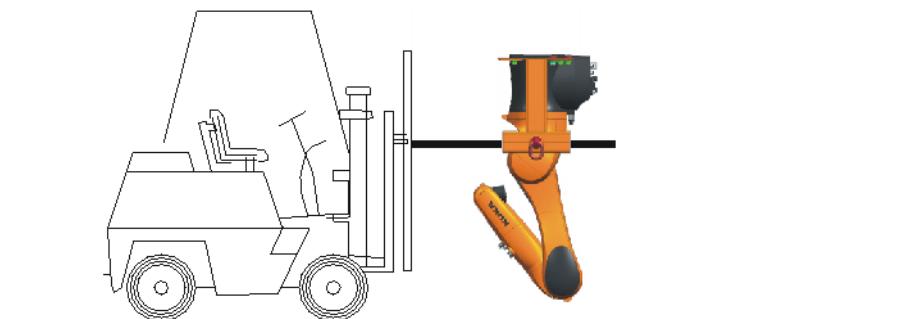


**WARNING** Ensure that the robot does not topple during the lifting operation. Serious injuries and damage to property may otherwise result.

10. Slowly rotate the robot through 180° and lower it.
11. Lift the Load Lifting Attachment with a fork lift truck (**>>> Fig. 8-11**).  
The fork lift truck must remain in the fork slots of the Load Lifting Attachment during installation in order to prevent slipping.

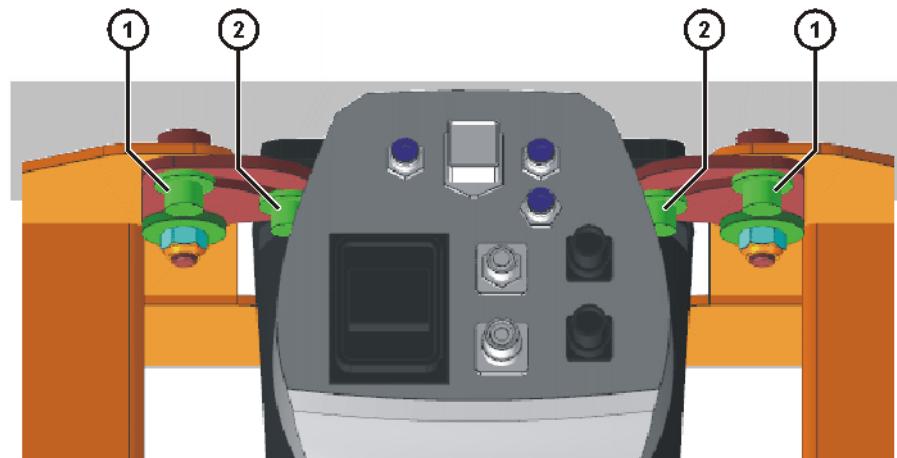


**NOTICE** When picking up the Load Lifting Attachment with the fork lift truck, the width of the fork slots (140 mm) must be taken into consideration. Damage to property may otherwise result.



**Fig. 8-11: Lifting the Load Lifting Attachment with a fork lift truck**

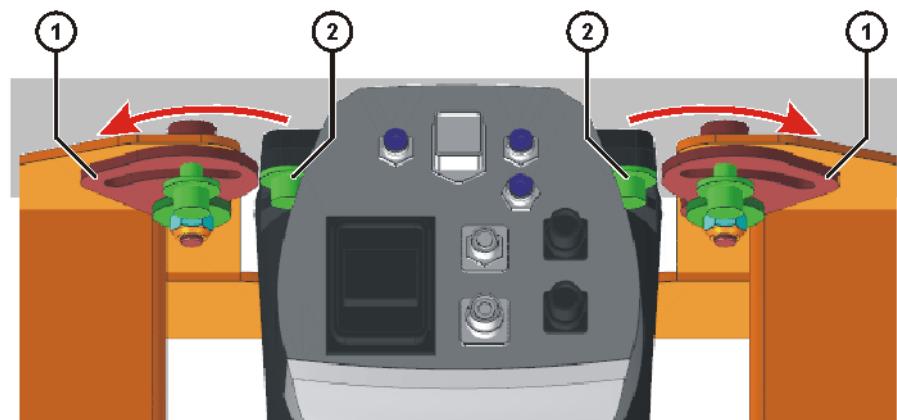
12. Position the robot on the ceiling using the fork lift truck. Ensure that an entirely vertical position is maintained in order to prevent damage to the pins.
13. Unscrew 2 M12x30 Allen screws (rear Allen screws) and washers from the rear of the base frame (**>>> Fig. 8-12**).
14. Unscrew 2 M12x30 Allen screws (locking screws) and washers from the Load Lifting Attachment.



**Fig. 8-12: Removing screws from the rear**

- 1 M12x30 Allen screw (rear)
- 2 M12x30 Allen screw (locking screw)

15. Rotate the swivel holders outwards ([>>> Fig. 8-13](#) ).
  16. Fasten the robot to the ceiling with 2 M10x35 hexagon bolts (rear hexagon bolts) and washers at the rear.
- Tighten the hexagon bolts alternately with the torque wrench. Gradually increase the tightening torque to 45.0 Nm.



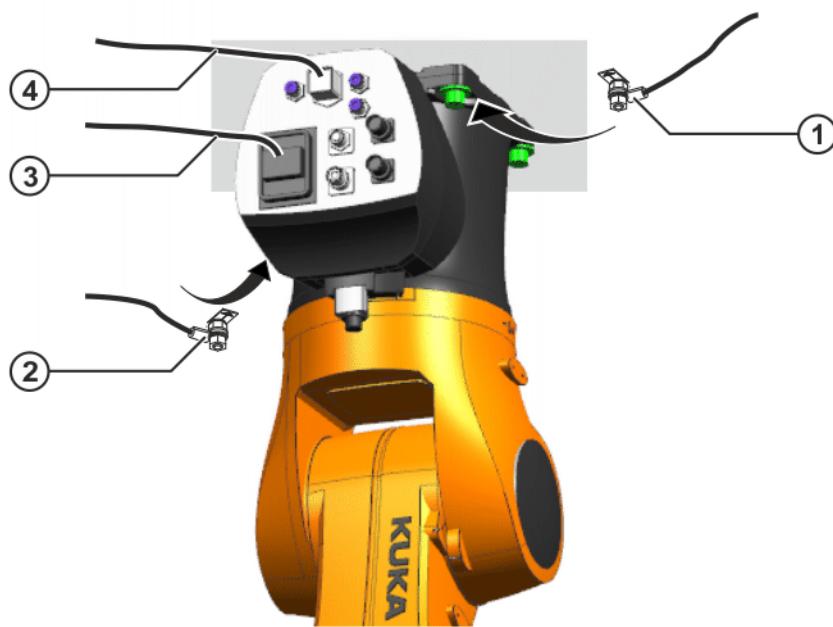
**Fig. 8-13: Rotating the swivel holders outwards**

- 1 Swivel holder
- 2 M10x35 hexagon bolt (rear)

17. Unscrew 2 M12x30 Allen screws (front Allen screws) and washers from the front of the base frame.
  18. Carefully push the Load Lifting Attachment down from the rear of the base frame with the fork lift truck.
  19. Fasten the robot to the ceiling with 2 M10x35 hexagon bolts and washers at the front of the base frame.
- Tighten the hexagon bolts alternately with the torque wrench. Gradually increase the tightening torque to 45.0 Nm.
20. Connect motor cable X30 and data cable X31 ([>>> Fig. 8-14](#) ).

When connecting the motor cable connectors, it must be ensured that the connectors on the controller and on the robot are locked correctly. Correct locking is indicated by an audible click. It is indicated optically by the fact that the red rings on each of the locking buttons are not visible and are pushed in completely.

21. Connect the ground conductor between the robot controller and the robot to the ground conductor connection.



**Fig. 8-14: Connecting the supply lines**

- |   |                            |   |             |
|---|----------------------------|---|-------------|
| 1 | Ground conductor, KRC      | 3 | Motor cable |
| 2 | Ground conductor, external | 4 | Data cable  |
22. Check the equipotential bonding in accordance with VDE 0100 and EN 60204-1.



Further information is contained in the operating and assembly instructions of the robot controller.

23. Connect the ground conductor between the system component and the robot to the ground conductor connection.
24. Mount tooling, if present.
25. Retighten the 4 M10x35 hexagon bolts with a torque wrench after 100 hours of operation.

Put the robot system into operation in accordance with the “Start-up” chapter of the operating and programming instructions for the KUKA System Software (KSS) and the “Start-up” chapter of the operating instructions for the robot controller.

## 8.6 Description of the connecting cables

### Setup

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
- CAT5 data cable (optional)
- Connecting cable, external axes A7 and A8 (optional)
- Ground conductor (optional)

### Interface

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

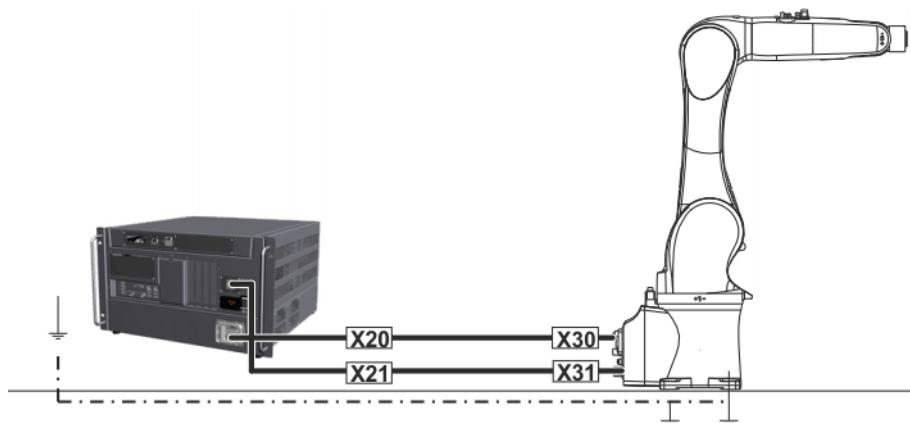
Cable designation	Connector designation robot controller - robot	Interface with robot
Motor cable	X20 - X30	Han Yellock 30
Data cable	X21 - X31	Han Q12
Data cable CAT5 (can be ordered as an option)	X65/X66 - XPN1	M12 connector
Connecting cable, external axes A7 and A8 (can be ordered as an option)	XP7 - XP7.1 XP8 - XP8.1	Connector M17 in each case
Ground conductor, equi- potential bonding (can be ordered as an option)		M4 ring cable lug

Only resolvers can be connected to the connections XP7.1 and XP8.1.

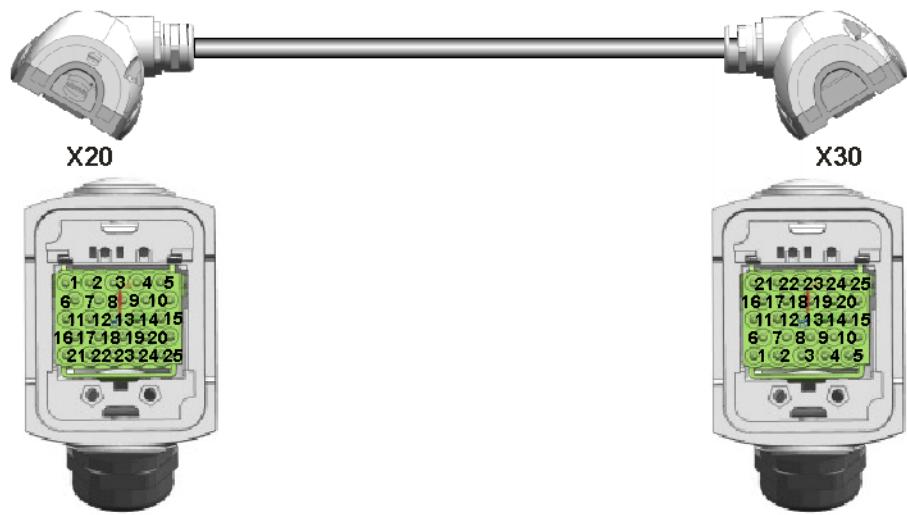


For the connecting cables, a ground conductor is always required to provide a low-resistance connection between the robot and the control cabinet in accordance with DIN EN 60204. The ground conductor is not part of the scope of supply and can be ordered as an option. The connection must be made by the customer. The tapped holes for connecting the ground conductor are located on the base frame of the robot.

#### Standard connecting cable



**Fig. 8-15: Connecting cables, overview**



Wiring diagram

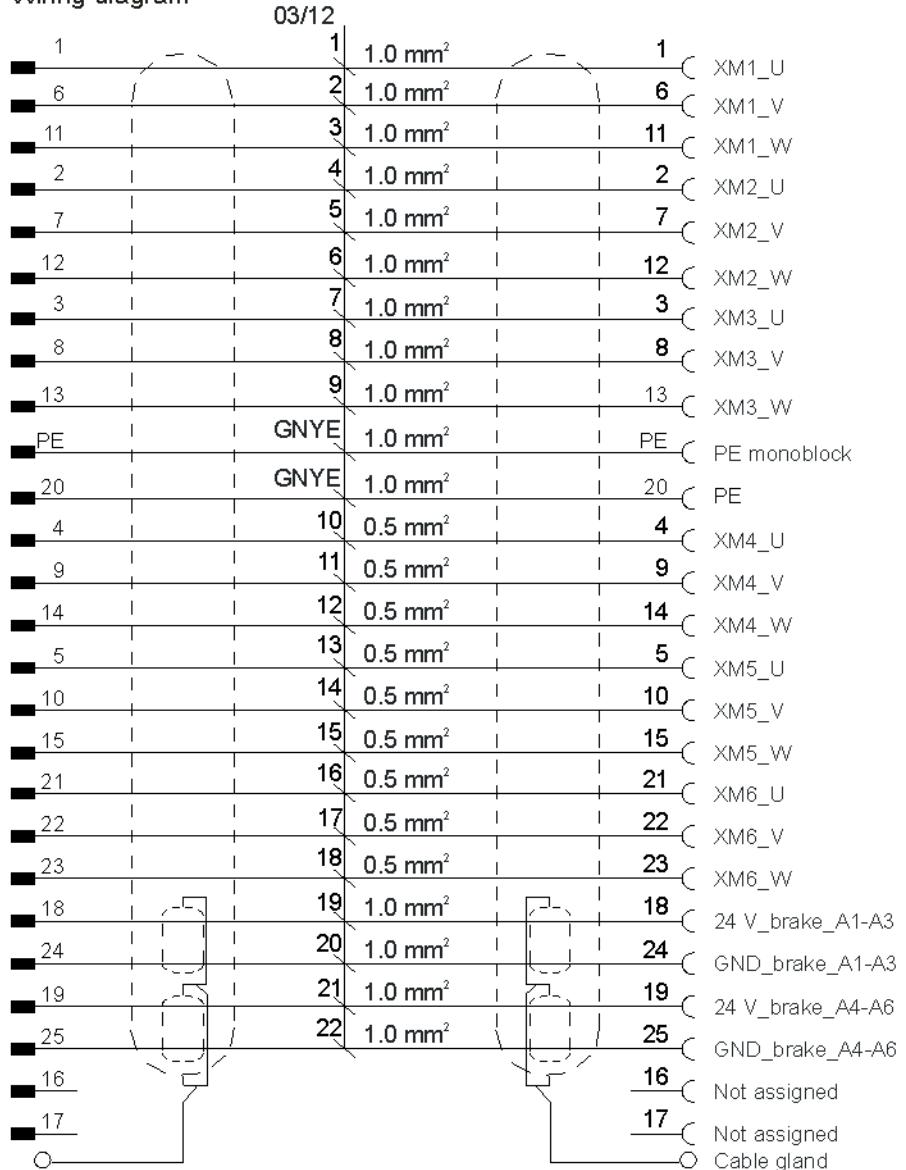
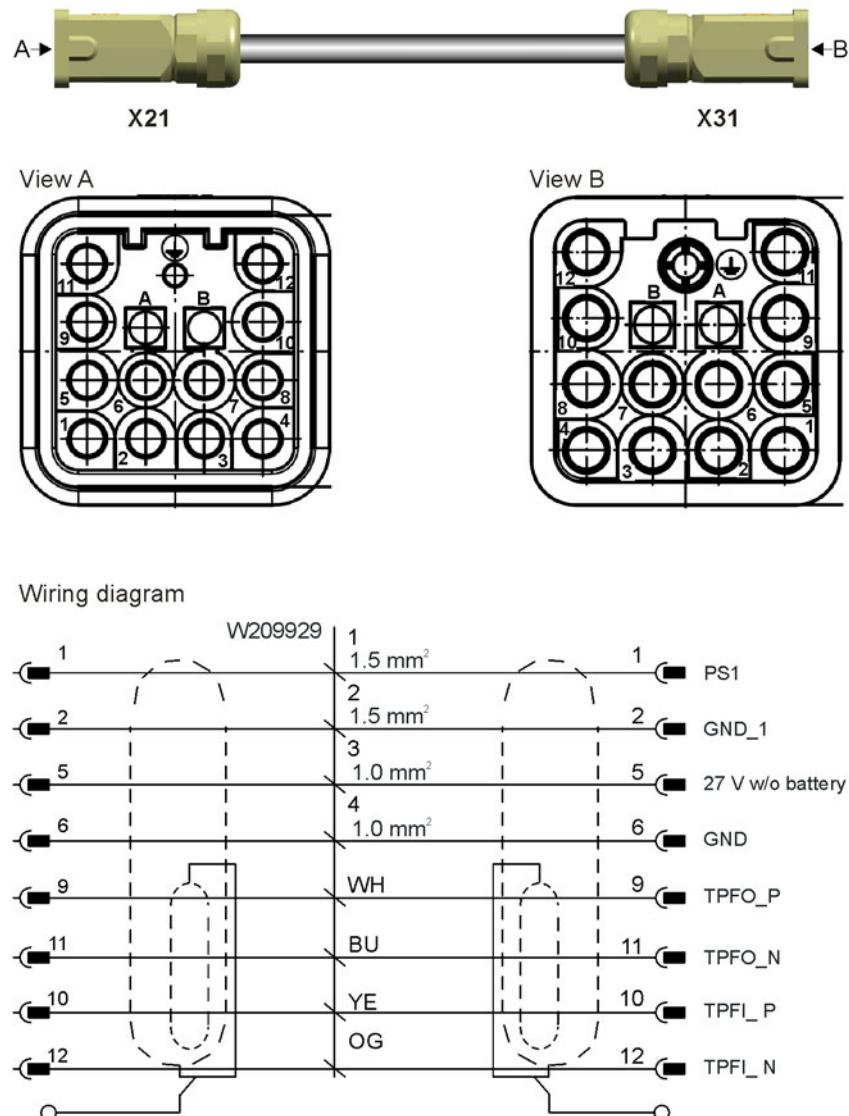


Fig. 8-16: Connecting cable, motor cable, X20 - X30



**Fig. 8-17: Connecting cable, data cable X21 - X31**

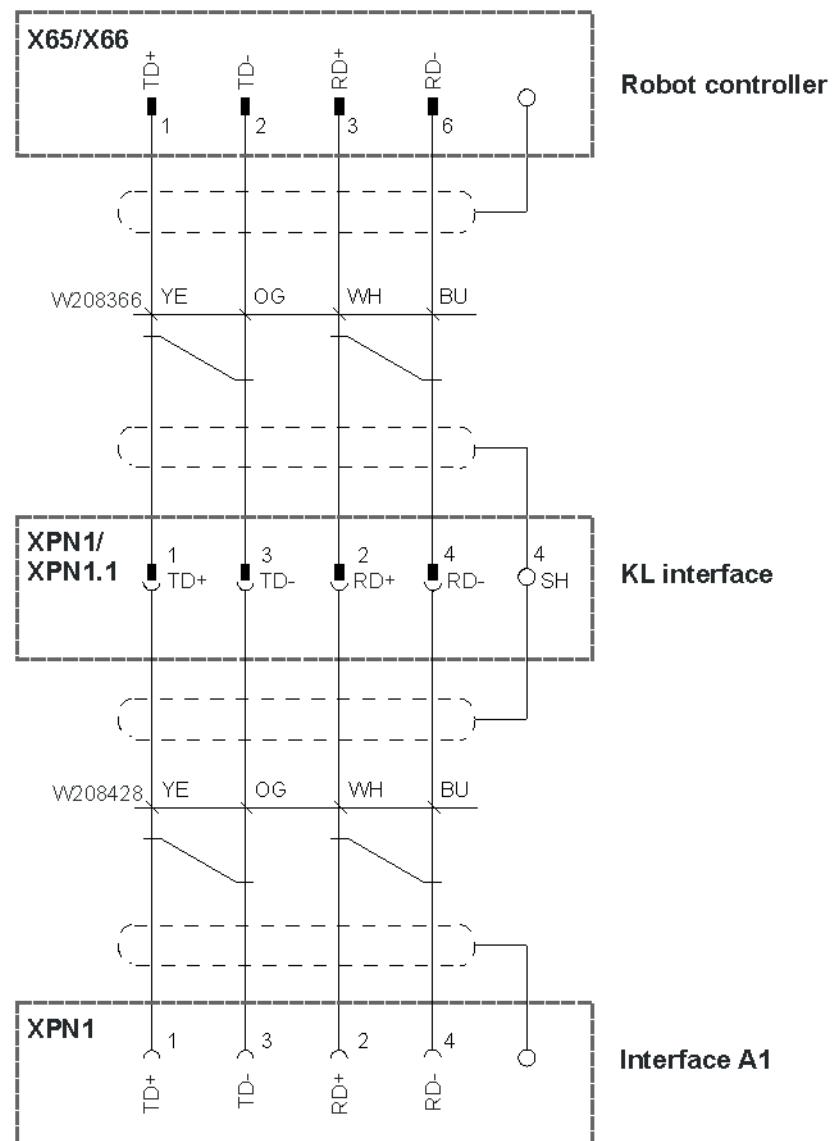


Fig. 8-18: Connecting cable, data cable CAT5 X65/X66 - XPN1

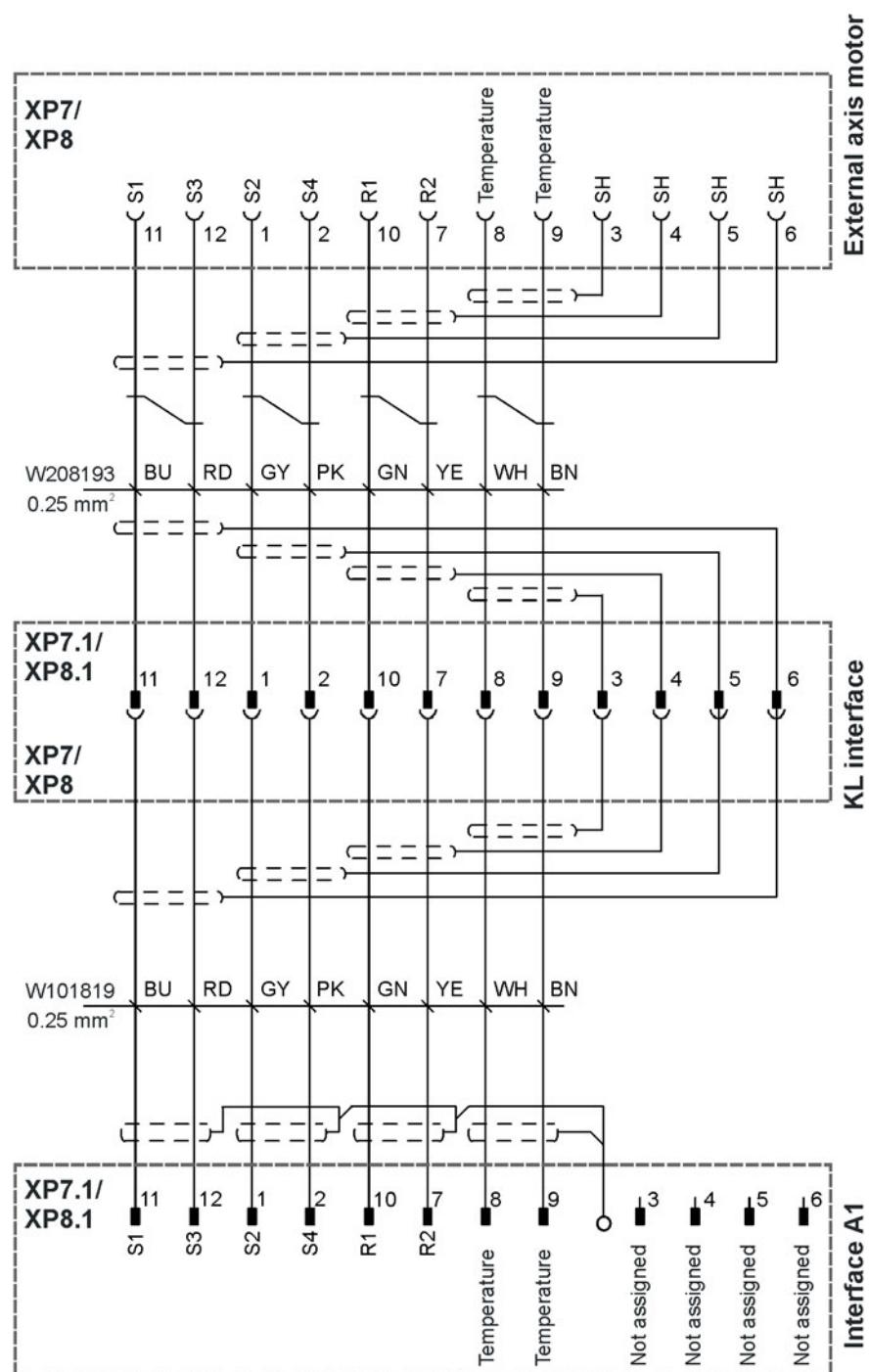


Fig. 8-19: Connecting cable, external axes A7 and A8

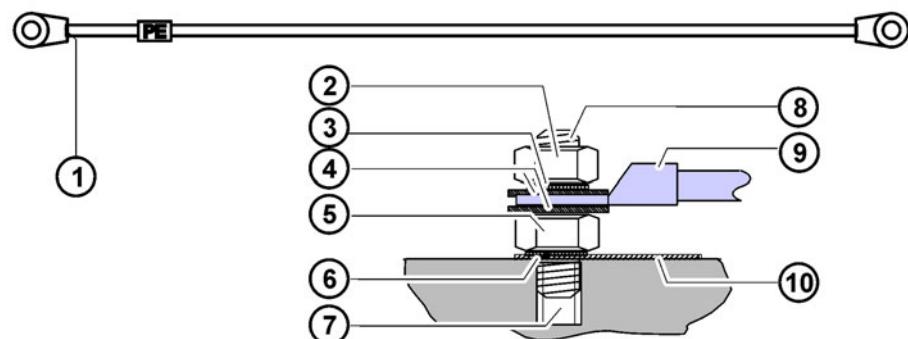


Fig. 8-20: Connecting cable, ground conductor

1	Ground conductor	6	Conical spring washer
2	Hexagon nut	7	Robot
3	Conical spring washer	8	Setscrew, M4
4	Plain washer 2x	9	Ground conductor connection, M4 ring cable lug
5	Hexagon nut	10	Ground sign

## 8.7 Moving the manipulator without drive energy

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

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

**Precondition** ■ The robot controller must be switched off and secured (e.g. with a padlock) to prevent unauthorized persons from switching it on again.

**Procedure**

**⚠ WARNING** Use of the brake release device may result in unexpected robot motions, especially sagging of the axes. During use of the brake release device, attention must be paid to motion of this kind in order to be able to prevent physical injuries or damage to property. Standing under moving axes is not permitted.

**SAFETY INSTRUCTIONS** The following procedure must be followed exactly!

1. Unplug motor cable X30 on the robot.
2. Plug connector X20 into the brake release device and connector X30 into the robot.
3. Plug connector X1 of the hand-held device into the brake release device.
4. Select the brakes to be released (main axes, wrist axes) via the selection switch on the brake release device.
5. Press the button on the hand-held device.

The brakes of the main axes or wrist axes are released and the robot can be moved manually.



Further information about the brake release device can be found in the documentation for the brake release device.

## 9 Appendix

### 9.1 Tightening torques

#### Tightening torques

The following tightening torques (Nm) are valid for screws and nuts where no other specifications are given.

The specified values apply to lightly oiled black (e.g. phosphated) and coated (e.g. mech. galv., zinc flake plating) screws and nuts.

Thread	Strength class		
	8.8	10.9	12.9
M1.6	0.17 Nm	0.24 Nm	0.28 Nm
	0.35 Nm	0.48 Nm	0.56 Nm
M2.5	0.68 Nm	0.93 Nm	1.10 Nm
M3	1.2 Nm	1.6 Nm	2.0 Nm
M4	2.8 Nm	3.8 Nm	4.4 Nm
M5	5.6 Nm	7.5 Nm	9.0 Nm
M6	9.5 Nm	12.5 Nm	15.0 Nm
M8	23.0 Nm	31.0 Nm	36.0 Nm
M10	45.0 Nm	60.0 Nm	70.0 Nm
M12	78.0 Nm	104.0 Nm	125.0 Nm
M14	125.0 Nm	165.0 Nm	195.0 Nm
M16	195.0 Nm	250.0 Nm	305.0 Nm
M20	370.0 Nm	500.0 Nm	600.0 Nm
M24	640.0 Nm	860.0 Nm	1030.0 Nm
M30	1330.0 Nm	1700.0 Nm	2000.0 Nm

Thread	Strength class	
	8.8 ISO7991 Allen screw	10.9 ISO7380, ISO07381 Fillister head screw
M3	0.8 Nm	0.8 Nm
M4	1.9 Nm	1.9 Nm
M5	3.8 Nm	3.8 Nm

Thread	Strength class	
	10.9 DIN7984 pan head screws	
M4	2.8 Nm	

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

### 9.2 Auxiliary and operating materials used

Product designation	Use	Manufacturer designation/Address

**Optitemp RB 2**

Lubricating grease

**Deutsche BP Aktiengesellschaft - Industrial Lubricants & Services**  
Erkelenzer Straße 20  
D-41179  
Mönchengladbach  
Germany

**Flexolub®-A1**Lubricant for Harmonic  
Drive gear units

**Harmonic Drive AG**  
Hoengenstrasse 14  
D-65555  
Limburg a. d. Lahn  
Germany



To ensure safe use of our products, we recommend regularly requesting up-to-date safety data sheets from the manufacturers of auxiliary and operating materials.

## 10 KUKA Service

### 10.1 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

### 10.2 KUKA Customer Support

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

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