KUKA

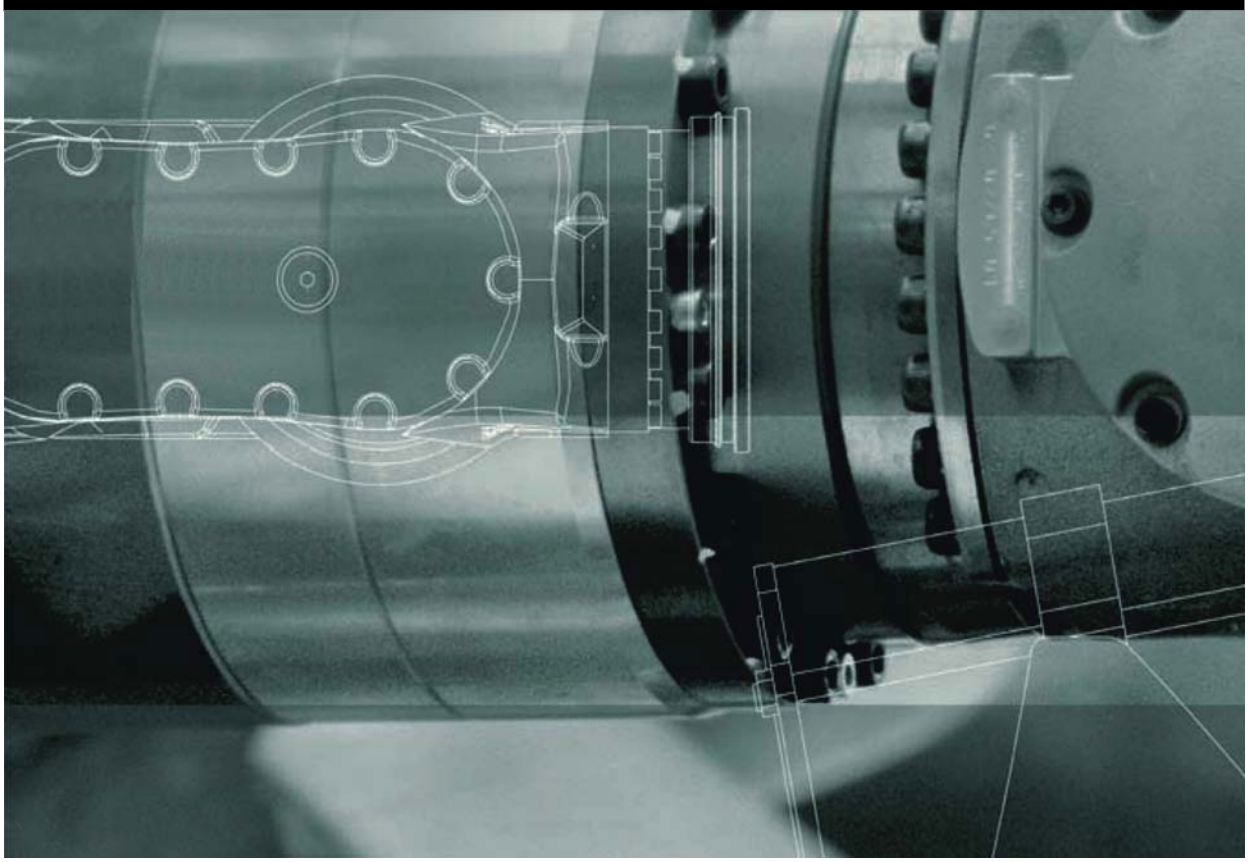
Robots

KUKA Roboter GmbH

KR QUANTEC prime

With F and C Variants

Specification



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Contents

1 Introduction

1.1 Industrial robot documentation

The industrial robot documentation consists of the following parts:

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

Each of these sets of instructions is a separate document.

1.2 Representation of warnings and notes

Safety

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

DANGER	These warnings mean that it is certain or highly probable that death or severe injuries **will** occur, if no precautions are taken.
WARNING	These warnings mean that death or severe injuries **may** occur, if no precautions are taken.
CAUTION	These warnings mean that minor injuries **may** occur, if no precautions are taken.
NOTICE	These warnings mean that damage to property **may** occur, if no precautions are taken.
	These warnings contain references to safety-relevant information or general safety measures. These warnings do not refer to individual hazards or individual precautionary measures.

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

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

Notices

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

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

2 Purpose

2.1 Target group

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

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

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

2.2 Intended use

Use

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

Misuse

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

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

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

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

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

3 Product description

3.1 Overview of the robot system

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

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

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

An industrial robot of this type comprises the following components:

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

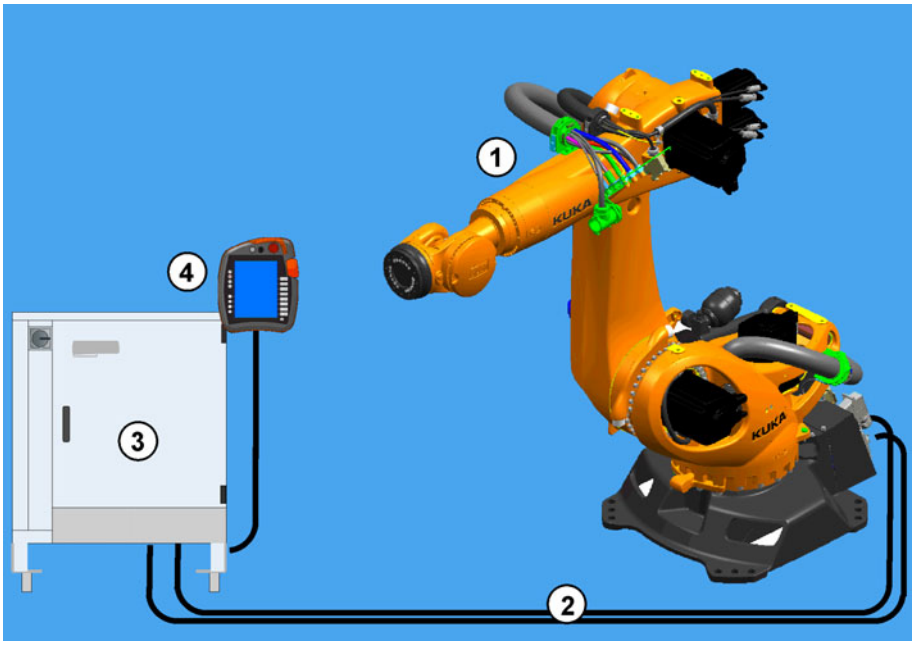


Fig. 3-1: Example of a robot system

1	Manipulator	3	Robot controller
2	Connecting cables	4	Control panel

3.2 Description of the manipulator

Overview

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

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

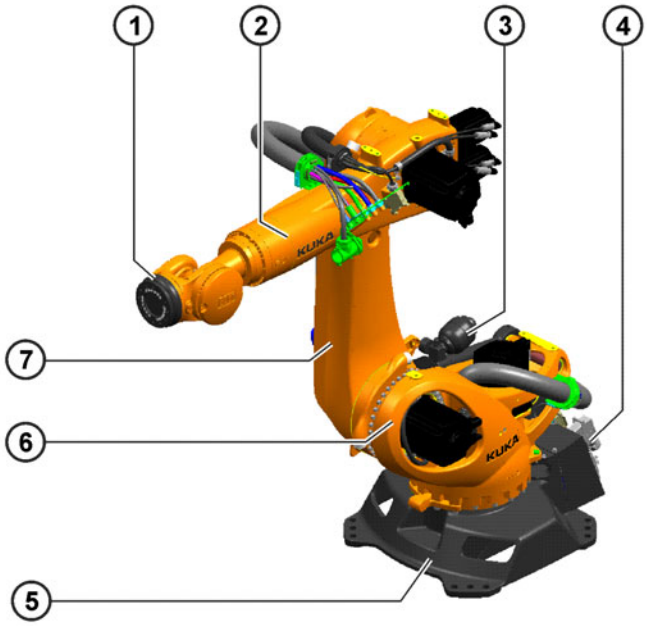


Fig. 3-2: Main assemblies of the manipulator

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

In-line wrist

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

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

Arm

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

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

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

Link arm

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

Rotating column

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

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

Base frame

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

Counterbalancing system

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

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

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

Electrical installations

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

Options

The robot can be fitted and operated with various options, such as energy supply systems for axes 1 to 3, energy supply systems for axes 3 to 6, range limitation systems for A1 and A3, a mounting flange (adapter) or a control cable for single axis (>>> 8 "Options" Page 143). The options are described in separate documentation.

4 Technical data

4.1 Technical data, overview

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

Robot	Technical data
KR 240 R2700 prime	■ Technical data (>>> 4.2 "Technical data, KR 240 R2700 prime" Page 17) ■ Supplementary loads (>>> 4.11 "Supplementary load" Page 80) ■ Plates and labels (>>> 4.12 "Plates and labels" Page 81) ■ Stopping distances and times (>>> 4.14.4 "Stopping distances and times, KR 240 R2700 prime" Page 92)
KR 240 R2500 prime	■ Technical data (>>> 4.3 "Technical data, KR 240 R2500 prime" Page 24) ■ Supplementary loads (>>> 4.11 "Supplementary load" Page 80) ■ Plates and labels (>>> 4.12 "Plates and labels" Page 81) ■ Stopping distances and times (>>> 4.14.3 "Stopping distances and stopping times for KR 240 R2500 prime" Page 87)
KR 210 R2700 prime	■ Technical data (>>> 4.4 "Technical data, KR 210 R2700 prime" Page 31) ■ Supplementary loads (>>> 4.11 "Supplementary load" Page 80) ■ Plates and labels (>>> 4.12 "Plates and labels" Page 81) ■ Stopping distances and times (>>> 4.14.5 "Stopping distances and stopping times for KR 210 R2700 prime" Page 97)
KR 210 R2700 prime F	■ Technical data (>>> 4.5 "Technical data, KR 210 R2700 prime F" Page 38) ■ Supplementary loads (>>> 4.11 "Supplementary load" Page 80) ■ Plates and labels (>>> 4.12 "Plates and labels" Page 81) ■ Stopping distances and times (>>> 4.14.5 "Stopping distances and stopping times for KR 210 R2700 prime" Page 97)

Robot	Technical data
KR 210 R2700 prime CR	■ Technical data (>>> 4.6 "Technical data, KR 210 R2700 prime CR" Page 45) ■ Supplementary loads (>>> 4.11 "Supplementary load" Page 80) ■ Plates and labels (>>> 4.12 "Plates and labels" Page 81) ■ Stopping distances and times (>>> 4.14.5 "Stopping distances and stopping times for KR 210 R2700 prime" Page 97)
KR 210 R2700 prime C	■ Technical data (>>> 4.7 "Technical data, KR 210 R2700 prime C" Page 52) ■ Supplementary loads (>>> 4.11 "Supplementary load" Page 80) ■ Plates and labels (>>> 4.12 "Plates and labels" Page 81) ■ Stopping distances and times (>>> 4.14.6 "Stopping distances and times, KR 210 R2700 prime C" Page 102)
KR 210 R2700 prime C-F	■ Technical data (>>> 4.8 "Technical data, KR 210 R2700 prime C-F" Page 59) ■ Supplementary loads (>>> 4.11 "Supplementary load" Page 80) ■ Plates and labels (>>> 4.12 "Plates and labels" Page 81) ■ Stopping distances and times (>>> 4.14.6 "Stopping distances and times, KR 210 R2700 prime C" Page 102)
KR 180 R2900 prime	■ Technical data (>>> 4.9 "Technical data, KR 180 R2900 prime" Page 66) ■ Supplementary loads (>>> 4.11 "Supplementary load" Page 80) ■ Plates and labels (>>> 4.12 "Plates and labels" Page 81) ■ Stopping distances and times (>>> 4.14.7 "Stopping distances and stopping times for KR 180 R2900 prime" Page 107)
KR 150 R3100 prime	■ Technical data (>>> 4.10 "Technical data, KR 150 R3100 prime" Page 73) ■ Supplementary loads (>>> 4.11 "Supplementary load" Page 80) ■ Plates and labels (>>> 4.12 "Plates and labels" Page 81) ■ Stopping distances and times (>>> 4.14.8 "Stopping distances and stopping times for KR 150 R3100 prime" Page 112)

4.2 Technical data, KR 240 R2700 prime

4.2.1 Basic data, KR 240 R2700 prime

Basic data

	KR 240 R2700 prime
Number of axes	6
Number of controlled axes	6
Volume of working envelope	55 m³
Pose repeatability (ISO 9283)	± 0.06 mm
Weight	approx. 1111 kg
Rated payload	240 kg
Maximum reach	2696 mm
Protection rating	IP65
Protection rating, in-line wrist	IP65
Sound level	< 75 dB (A)
Mounting position	Floor
Footprint	830 mm x 830 mm
Permissible angle of inclination	≤ 5 °
Default color	Base frame: black (RAL 9005); Moving parts: KUKA orange 2567
Controller	KR C4
Transformation name	KR C4: KR240R2700 PRIME C4 FLR

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

Ambient conditions

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

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

Connecting cables

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

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

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

Minimum bending radius	5x D

For detailed specifications of the connecting cables, see “Description of the connecting cables”.

4.2.2 Axis data, KR 240 R2700 prime

Axis data

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

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

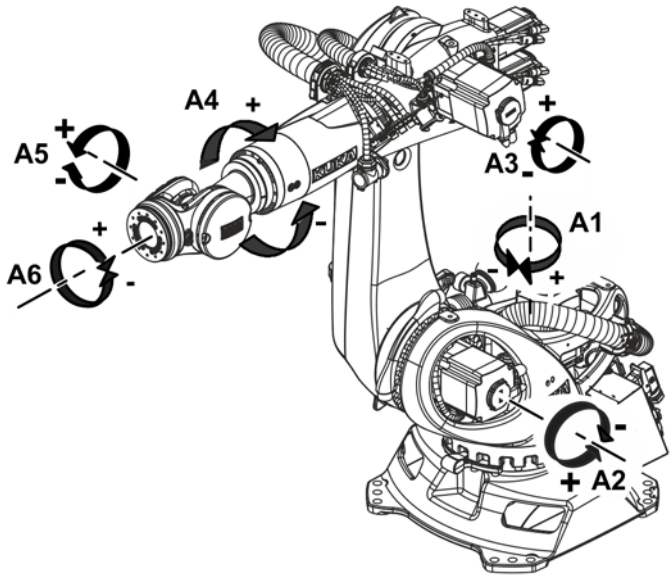


Fig. 4-1: Direction of rotation of the axes

Mastering position

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

Working envelope

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

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

Dimensions: mm

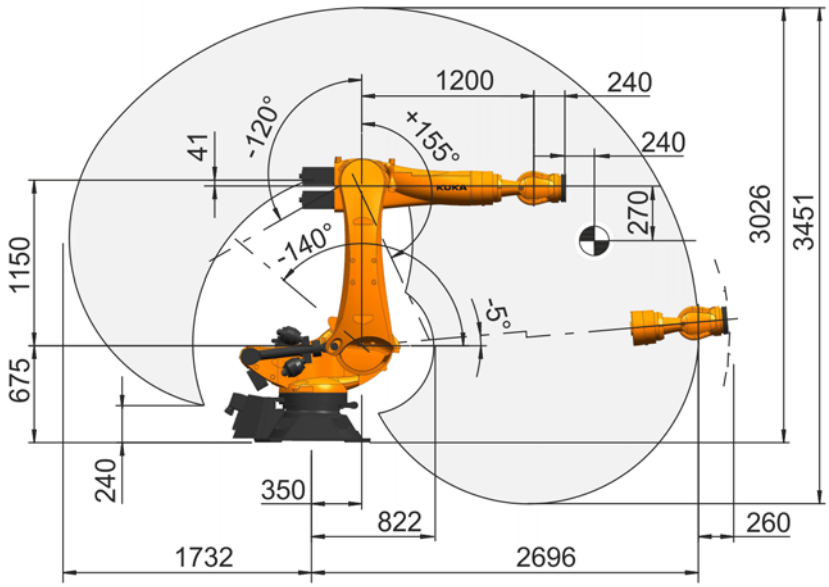


Fig. 4-2: KR 240 R2700 prime, working envelope, side view

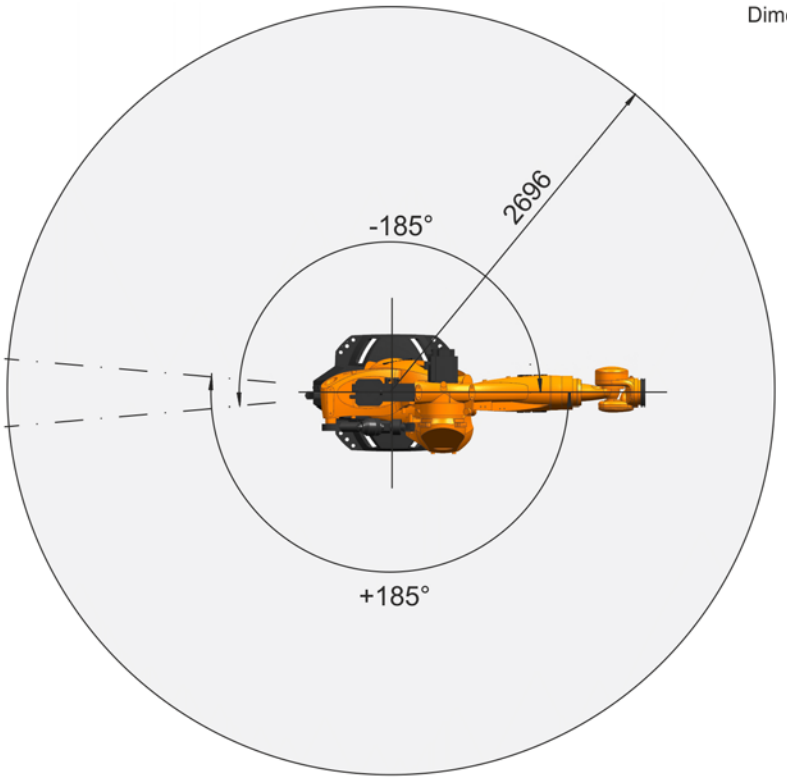


Fig. 4-3: KR 240 R2700 prime, working envelope, top view

4.2.3 Payloads, KR 240 R2700 prime

Payloads

Rated payload	240 kg
Rated mass moment of inertia	120 kgm²
Rated total load	-
Rated supplementary load, base frame	-
Maximum supplementary load, base frame	-
Rated supplementary load, rotating column	-
Maximum supplementary load, rotating column	300 kg
Rated supplementary load, link arm	-
Maximum supplementary load, link arm	130 kg
Rated supplementary load, arm	50 kg
Maximum supplementary load, arm	150 kg
Nominal distance to load center of gravity	
Lxy	270 mm
Lz	240 mm

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

Load center of gravity

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

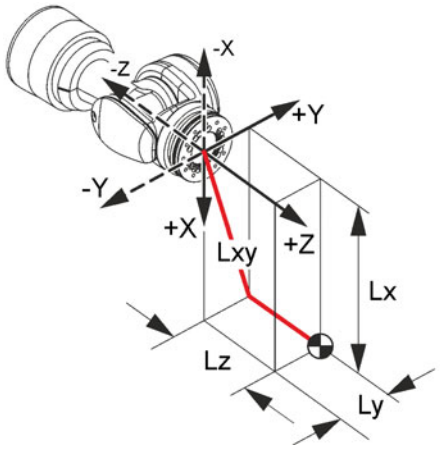


Fig. 4-4: Load center of gravity

Payload diagram

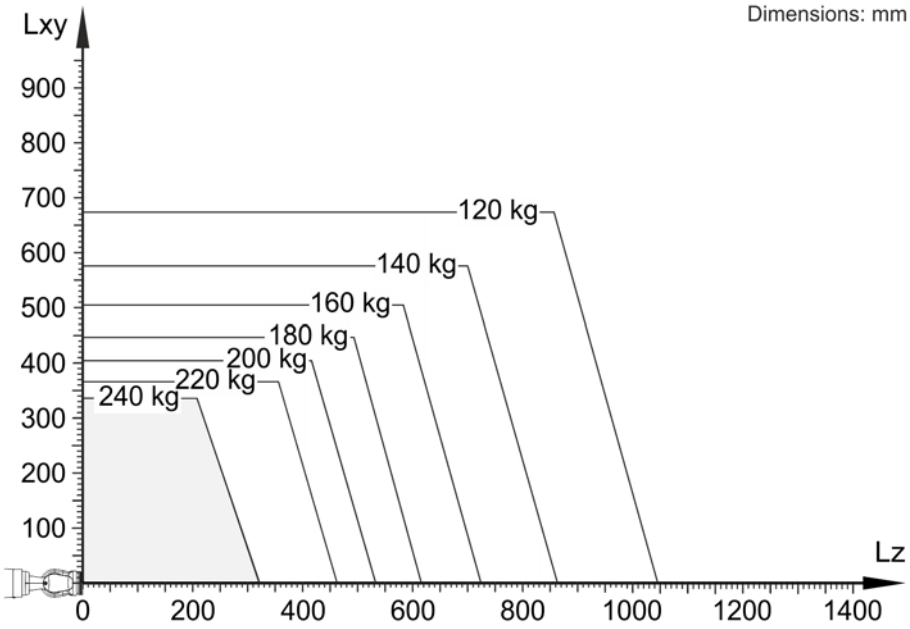


Fig. 4-5: KR QUANTEC prime payload diagram, payload 240 kg

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

In-line wrist

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

Mounting flange

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

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

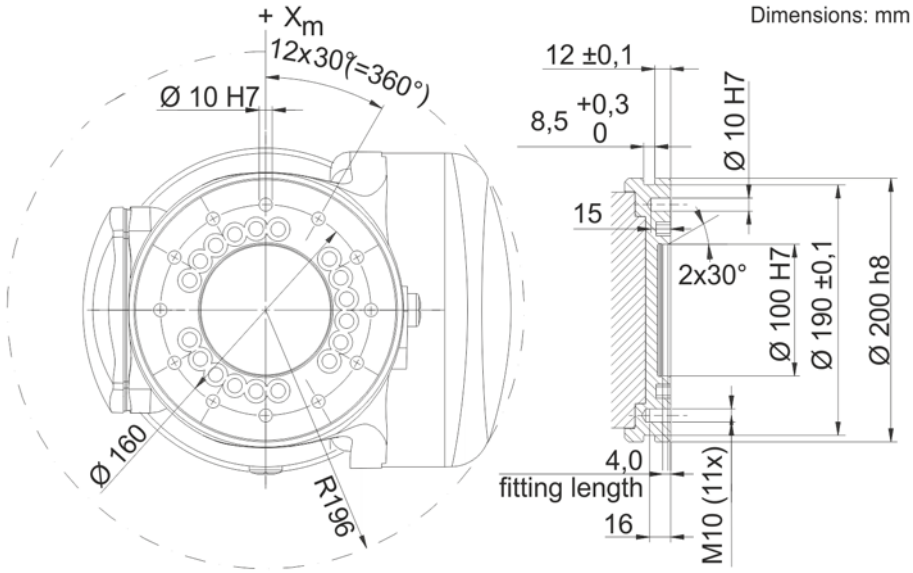


Fig. 4-6: Mounting fange D=160

4.2.4 Loads acting on the foundation, KR 240 R2700 prime

Foundation loads

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

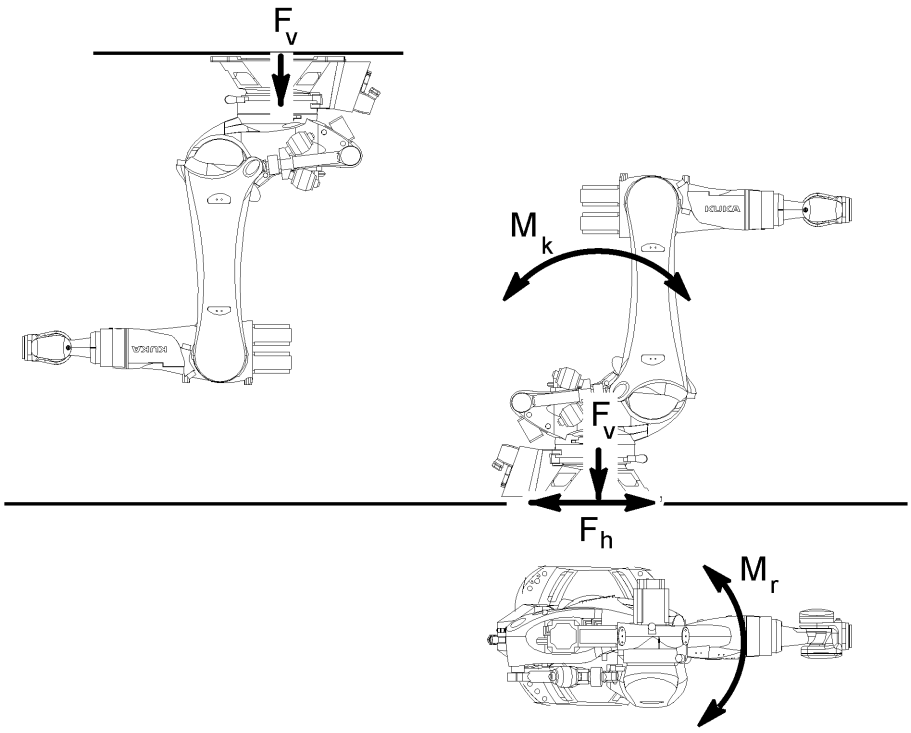


Fig. 4-7: Loads acting on the mounting base

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

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

⚠ WARNING Normal loads and maximum loads for the foundations are specified in the table.
The maximum loads must be referred to when dimensioning the foundations and must be adhered to for safety reasons. Failure to observe this can result in personal injury and damage to property.
The normal loads are average expected foundation loads. The actual loads are dependent on the program and on the robot loads and may therefore be greater or less than the normal loads.
The supplementary loads (A1, A2 and A3) are not taken into consideration in the calculation of the foundation load. These supplementary loads must be taken into consideration for F_v.

4.3 Technical data, KR 240 R2500 prime

4.3.1 Basic data, KR 240 R2500 prime

Basic data

	KR 240 R2500 prime
Number of axes	6
Number of controlled axes	6
Volume of working envelope	41 m³
Pose repeatability (ISO 9283)	± 0.06 mm
Weight	approx. 1102 kg
Rated payload	240 kg
Maximum reach	2496 mm
Protection rating	IP65
Protection rating, in-line wrist	IP65
Sound level	< 75 dB (A)
Mounting position	Floor
Footprint	830 mm x 830 mm
Permissible angle of inclination	≤ 5 °
Default color	Base frame: black (RAL 9005); Moving parts: KUKA orange 2567
Controller	KR C4
Transformation name	KR C4: KR240R2500 PRIME C4 FLR

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

Ambient conditions

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

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

Connecting cables

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

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

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

Minimum bending radius	5x D

For detailed specifications of the connecting cables, see “Description of the connecting cables”.

4.3.2 Axis data, KR 240 R2500 prime

Axis data

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

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

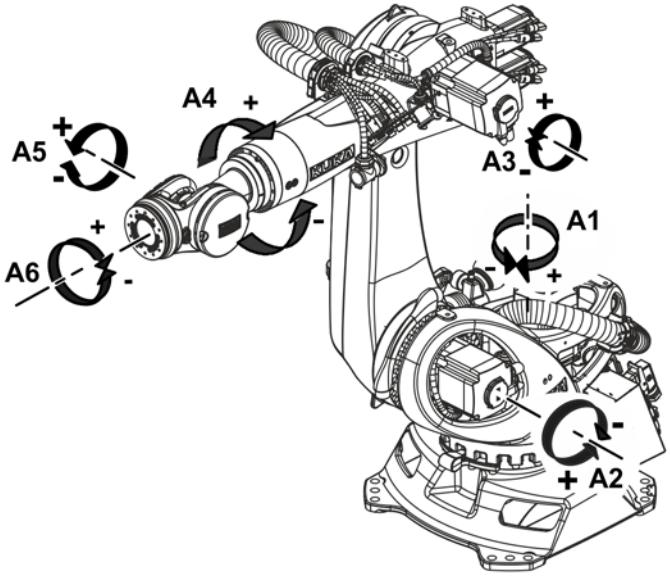


Fig. 4-8: Direction of rotation of the axes

Mastering position

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

Working envelope

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

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

Dimensions: mm

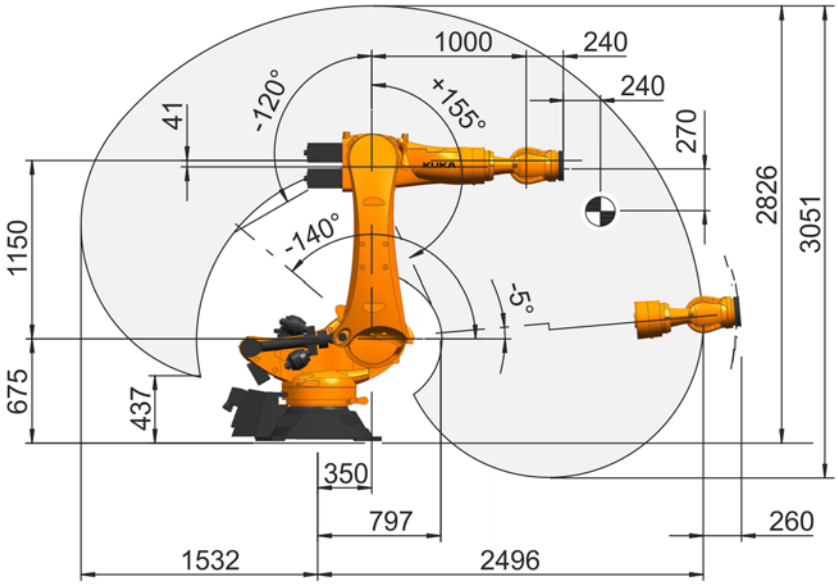


Fig. 4-9: KR 240 R2500 prime, working envelope, side view

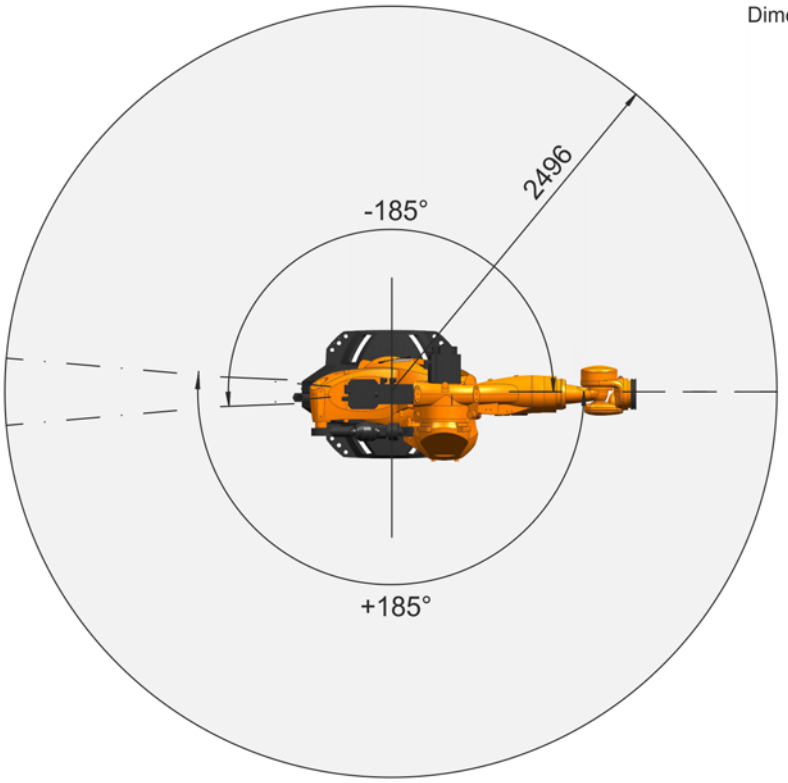


Fig. 4-10: KR 240 R2500 prime, working envelope, top view

4.3.3 Payloads, KR 240 R2500 prime

Payloads

Rated payload	240 kg
Rated mass moment of inertia	120 kgm²
Rated total load	-
Rated supplementary load, base frame	-
Maximum supplementary load, base frame	-
Rated supplementary load, rotating column	-
Maximum supplementary load, rotating column	300 kg
Rated supplementary load, link arm	-
Maximum supplementary load, link arm	130 kg
Rated supplementary load, arm	50 kg
Maximum supplementary load, arm	150 kg
Nominal distance to load center of gravity	
Lxy	270 mm
Lz	240 mm

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

Load center of gravity

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

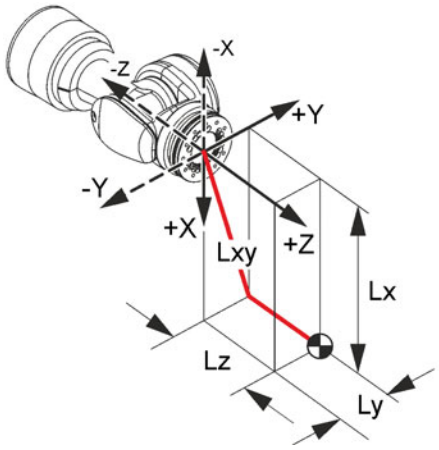


Fig. 4-11: Load center of gravity

Payload diagram

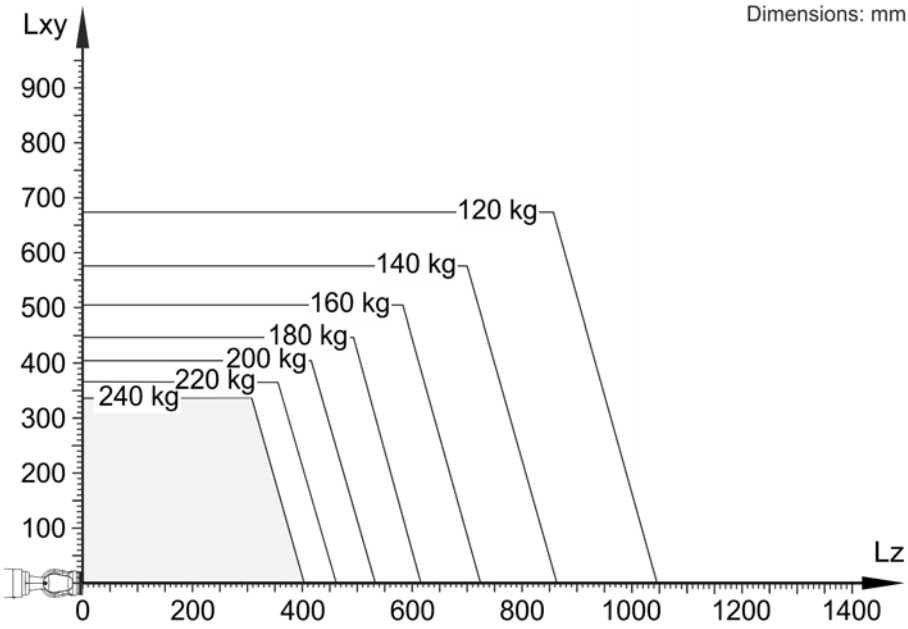


Fig. 4-12: KR QUANTEC prime payload diagram, payload 240 kg

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

In-line wrist

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

Mounting flange

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

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

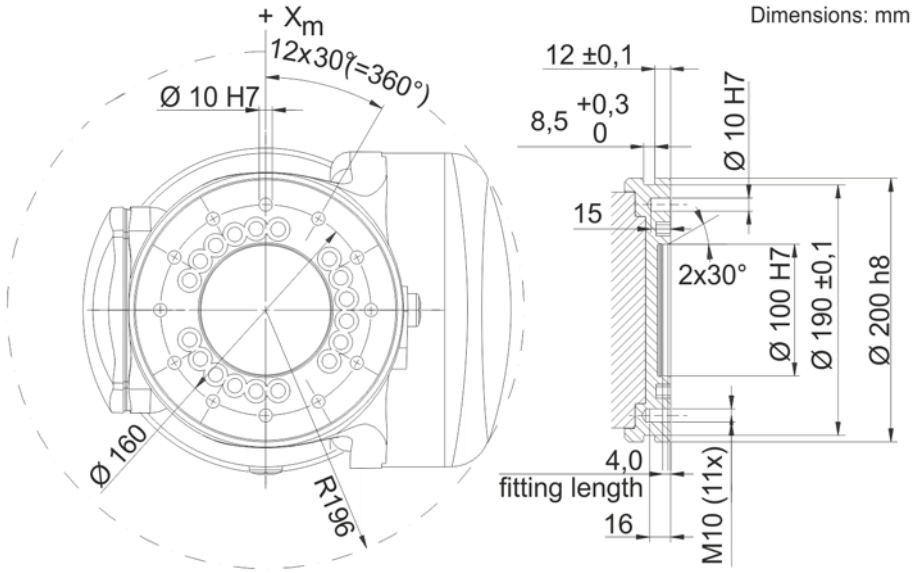


Fig. 4-13: Mounting fange D=160

4.3.4 Loads acting on the foundation, KR 240 R2500 prime

Foundation loads

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

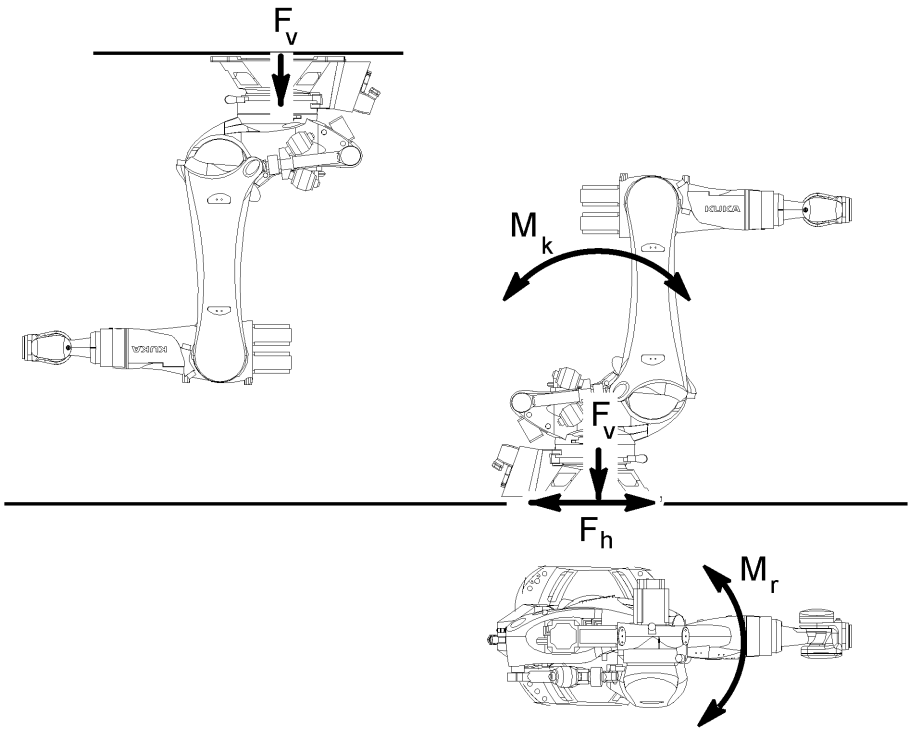


Fig. 4-14: Loads acting on the mounting base

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

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

⚠ WARNING Normal loads and maximum loads for the foundations are specified in the table.
The maximum loads must be referred to when dimensioning the foundations and must be adhered to for safety reasons. Failure to observe this can result in personal injury and damage to property.
The normal loads are average expected foundation loads. The actual loads are dependent on the program and on the robot loads and may therefore be greater or less than the normal loads.
The supplementary loads (A1, A2 and A3) are not taken into consideration in the calculation of the foundation load. These supplementary loads must be taken into consideration for F_v.

4.4 Technical data, KR 210 R2700 prime

4.4.1 Basic data, KR 210 R2700 prime

Basic data

	KR 210 R2700 prime
Number of axes	6
Number of controlled axes	6
Volume of working envelope	55 m³
Pose repeatability (ISO 9283)	± 0.06 mm
Weight	approx. 1111 kg
Rated payload	210 kg
Maximum reach	2696 mm
Protection rating	IP65
Protection rating, in-line wrist	IP65
Sound level	< 75 dB (A)
Mounting position	Floor
Footprint	830 mm x 830 mm
Permissible angle of inclination	≤ 5 °
Default color	Base frame: black (RAL 9005); Moving parts: KUKA orange 2567
Controller	KR C4
Transformation name	KR C4: KR210R2700 PRIME C4 FLR

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

Ambient conditions

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

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

Connecting cables

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

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

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

Minimum bending radius	5x D

For detailed specifications of the connecting cables, see “Description of the connecting cables”.

4.4.2 Axis data, KR 210 R2700 prime

Axis data

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

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

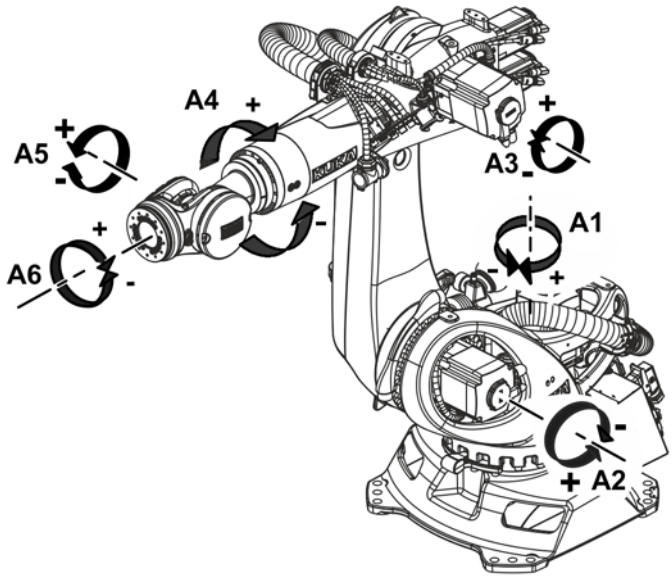


Fig. 4-15: Direction of rotation of the axes

Mastering position

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

Working envelope

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

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

Dimensions: mm

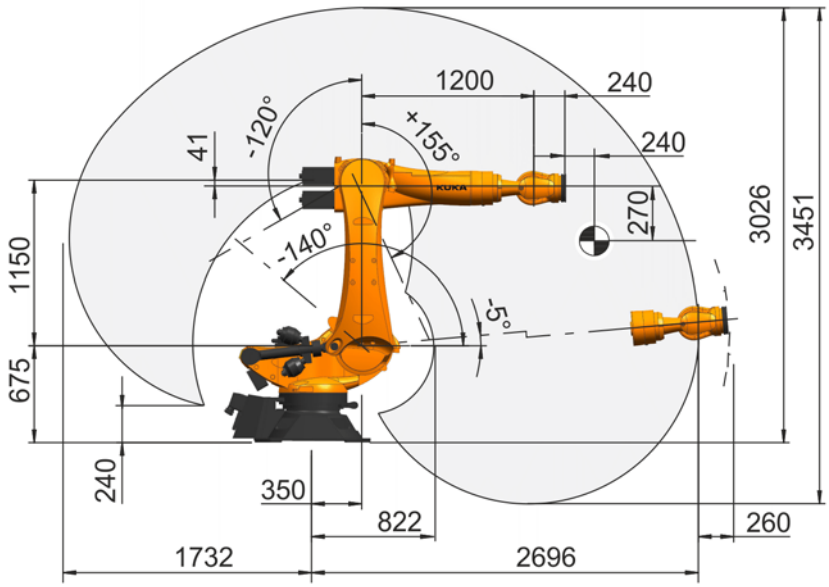


Fig. 4-16: KR 210 R2700 prime, working envelope, side view

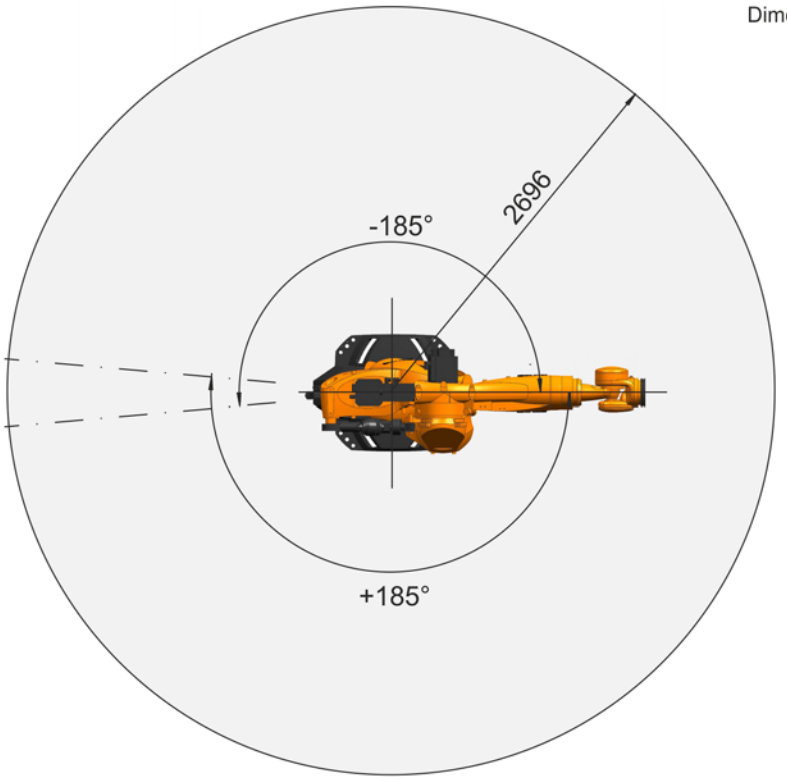


Fig. 4-17: KR 210 R2700 prime, working envelope, top view

4.4.3 Payloads, KR 210 R2700 prime

Payloads

Rated payload	210 kg
Rated mass moment of inertia	105 kgm²
Rated total load	-
Rated supplementary load, base frame	-
Maximum supplementary load, base frame	-
Rated supplementary load, rotating column	-
Maximum supplementary load, rotating column	300 kg
Rated supplementary load, link arm	-
Maximum supplementary load, link arm	130 kg
Rated supplementary load, arm	50 kg
Maximum supplementary load, arm	150 kg
Nominal distance to load center of gravity	
Lxy	270 mm
Lz	240 mm

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

Load center of gravity

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

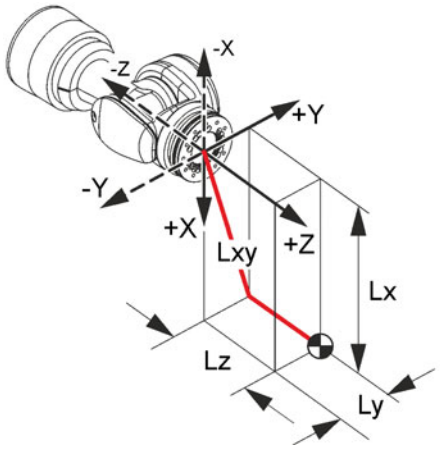


Fig. 4-18: Load center of gravity

Payload diagram

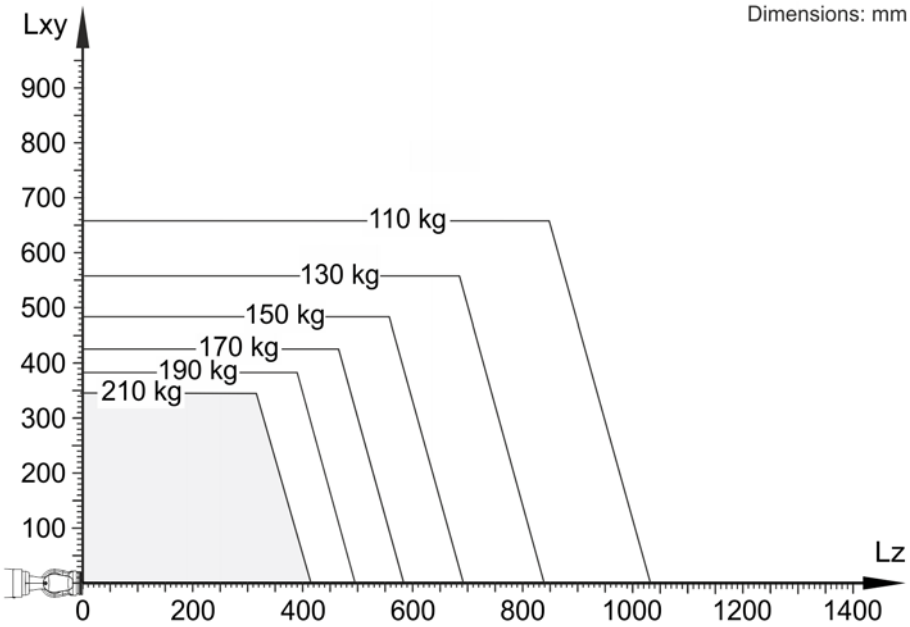


Fig. 4-19: KR QUANTEC prime payload diagram, payload 210 kg

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

In-line wrist

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

Mounting flange

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

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

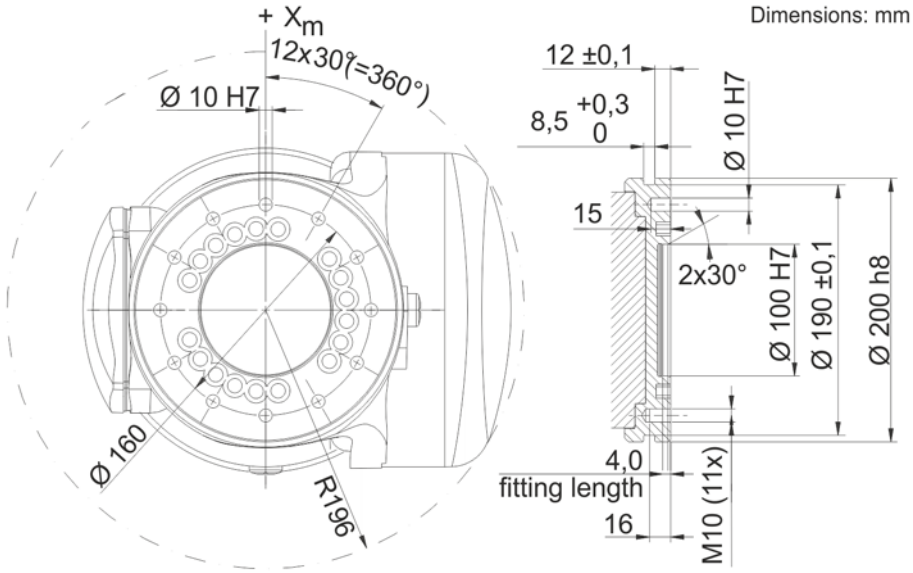


Fig. 4-20: Mounting fange D=160

4.4.4 Loads acting on the foundation, KR 210 R2700 prime

Foundation loads

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

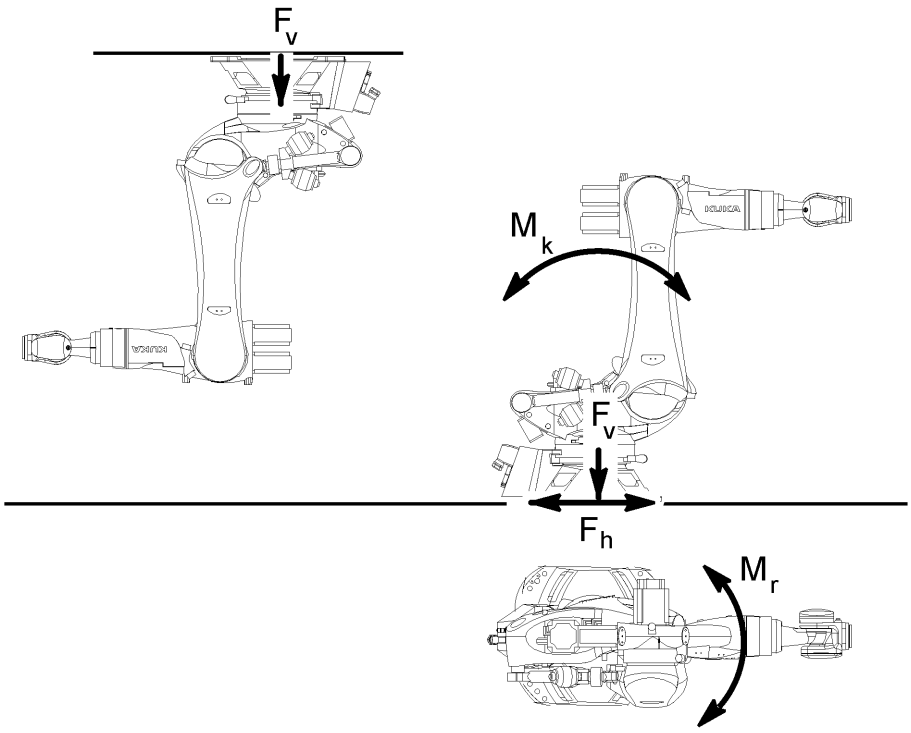


Fig. 4-21: Loads acting on the mounting base

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

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

⚠ WARNING Normal loads and maximum loads for the foundations are specified in the table.
The maximum loads must be referred to when dimensioning the foundations and must be adhered to for safety reasons. Failure to observe this can result in personal injury and damage to property.
The normal loads are average expected foundation loads. The actual loads are dependent on the program and on the robot loads and may therefore be greater or less than the normal loads.
The supplementary loads (A1, A2 and A3) are not taken into consideration in the calculation of the foundation load. These supplementary loads must be taken into consideration for F_v.

4.5 Technical data, KR 210 R2700 prime F

4.5.1 Basic data, KR 210 R2700 prime F

Basic data

	KR 210 R2700 prime F
Number of axes	6
Number of controlled axes	6
Volume of working envelope	55 m³
Pose repeatability (ISO 9283)	± 0.06 mm
Weight	approx. 1111 kg
Rated payload	210 kg
Maximum reach	2696 mm
Protection rating	IP65
Protection rating, in-line wrist	IP67
Sound level	< 75 dB (A)
Mounting position	Floor
Footprint	830 mm x 830 mm
Permissible angle of inclination	≤ 5 °
Default color	Base frame: black (RAL 9005); Moving parts: KUKA orange 2567
Controller	KR C4
Transformation name	KR C4: KR210R2700 PRIME C4 FLR

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

Foundry robots

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

Ambient conditions

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

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

Connecting cables

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

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

Minimum bending radius	5x D

For detailed specifications of the connecting cables, see “Description of the connecting cables”.

4.5.2 Axis data, KR 210 R2700 prime F

Axis data

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

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

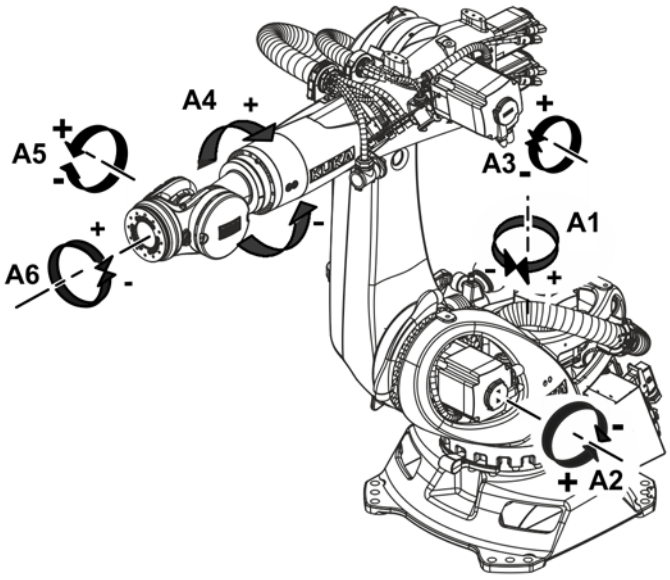


Fig. 4-22: Direction of rotation of the axes

Mastering position

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

Working envelope

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

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

Dimensions: mm

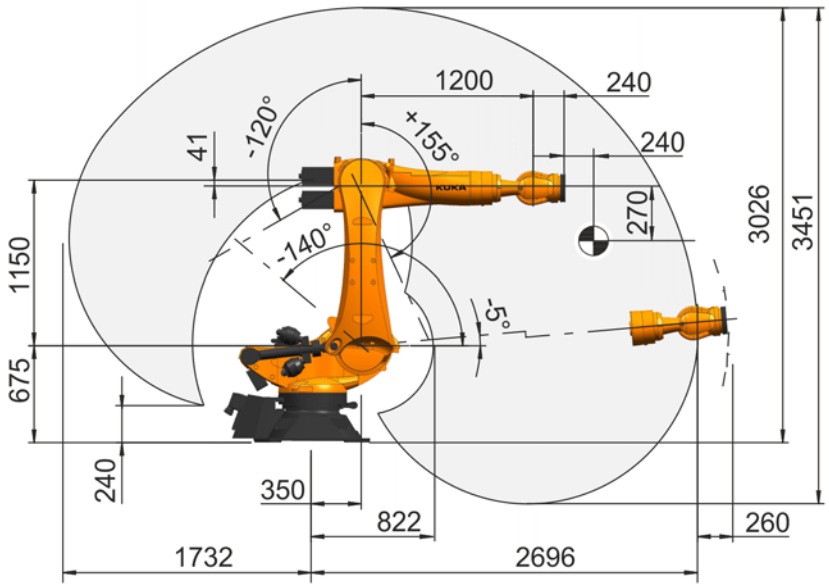


Fig. 4-23: KR 210 R2700 prime, working envelope, side view

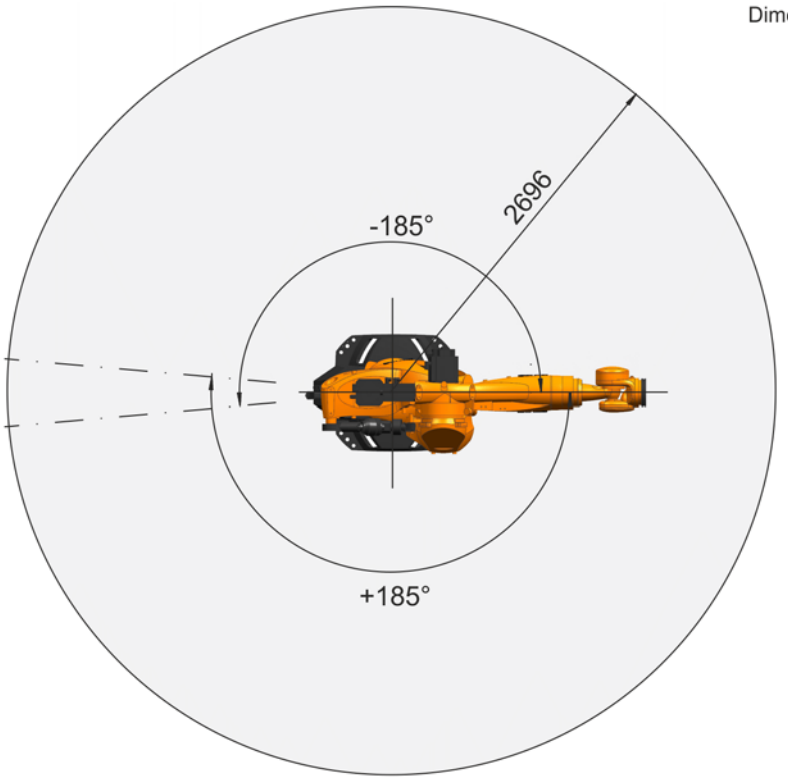


Fig. 4-24: KR 210 R2700 prime, working envelope, top view

4.5.3 Payloads, KR 210 R2700 prime F

Payloads

Rated payload	210 kg
Rated mass moment of inertia	105 kgm²
Rated total load	-
Rated supplementary load, base frame	-
Maximum supplementary load, base frame	-
Rated supplementary load, rotating column	-
Maximum supplementary load, rotating column	300 kg
Rated supplementary load, link arm	-
Maximum supplementary load, link arm	130 kg
Rated supplementary load, arm	50 kg
Maximum supplementary load, arm	150 kg
Nominal distance to load center of gravity	
Lxy	270 mm
Lz	240 mm

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

Load center of gravity

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

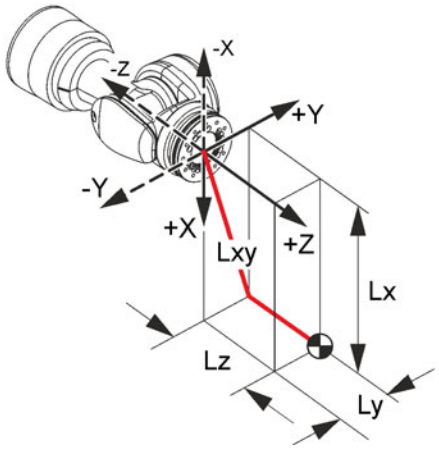


Fig. 4-25: Load center of gravity

Payload diagram

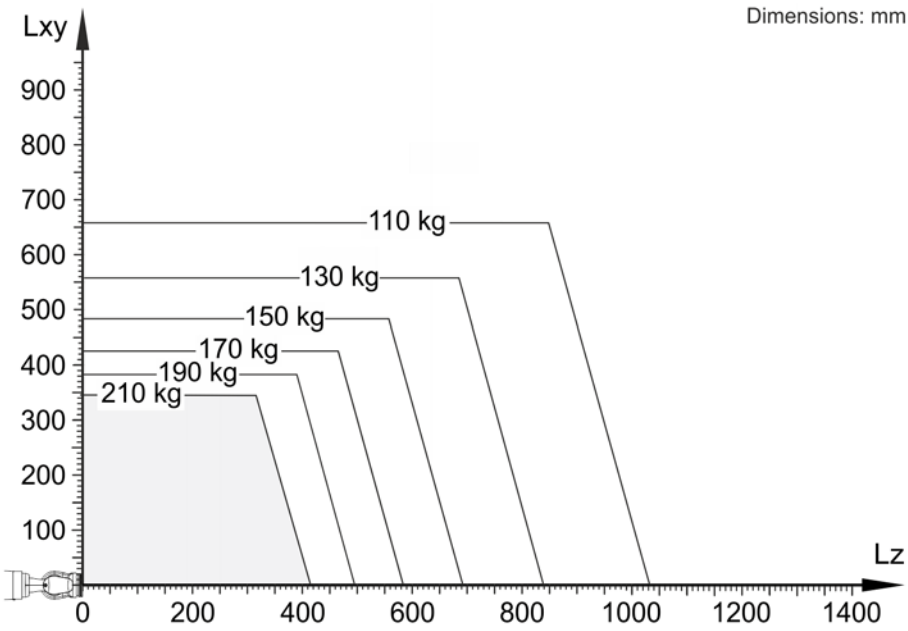


Fig. 4-26: KR QUANTEC prime payload diagram, payload 210 kg

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

In-line wrist

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

Mounting flange

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

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

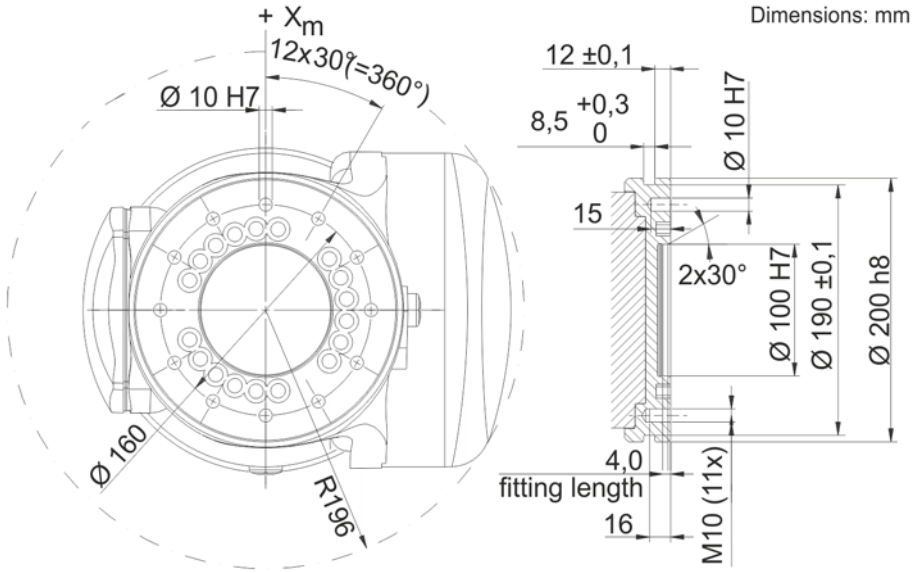


Fig. 4-27: Mounting fange D=160

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

Foundation loads

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

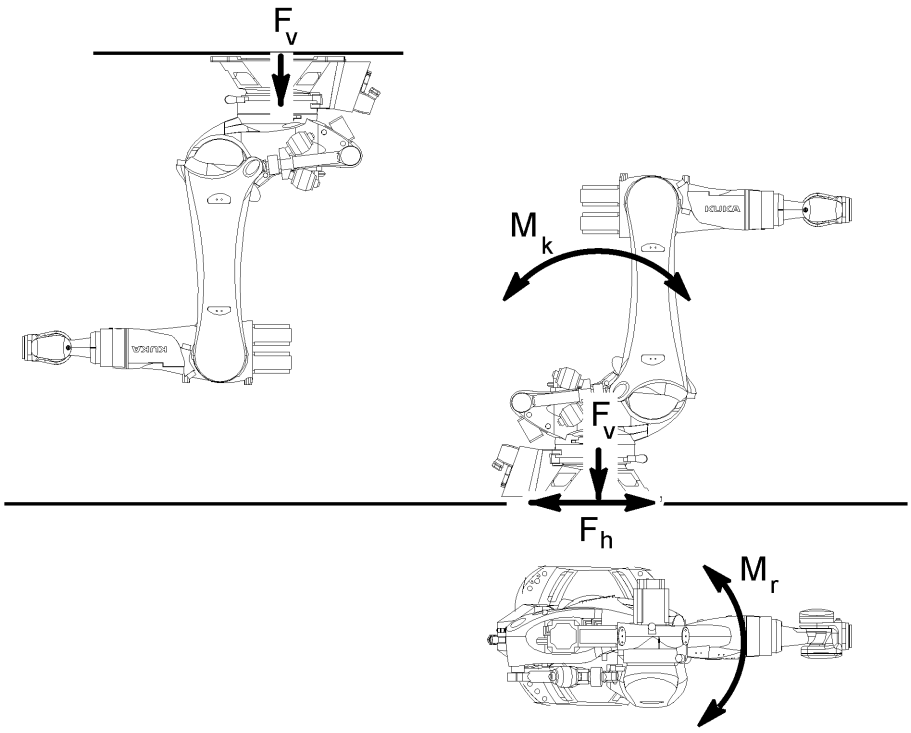


Fig. 4-28: Loads acting on the mounting base

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

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

⚠ WARNING Normal loads and maximum loads for the foundations are specified in the table.
The maximum loads must be referred to when dimensioning the foundations and must be adhered to for safety reasons. Failure to observe this can result in personal injury and damage to property.
The normal loads are average expected foundation loads. The actual loads are dependent on the program and on the robot loads and may therefore be greater or less than the normal loads.
The supplementary loads (A1, A2 and A3) are not taken into consideration in the calculation of the foundation load. These supplementary loads must be taken into consideration for F_v.

4.6 Technical data, KR 210 R2700 prime CR

4.6.1 Basic data, KR 210 R2700 prime CR

Basic data

	KR 210 R2700 prime CR
Number of axes	6
Number of controlled axes	6
Volume of working envelope	51 m³
Pose repeatability (ISO 9283)	± 0.06 mm
Weight	approx. 1116 kg
Rated payload	210 kg
Maximum reach	2696 mm
Protection rating	IP65
Protection rating, in-line wrist	IP65
Sound level	< 75 dB (A)
Mounting position	Floor
Footprint	830 mm x 830 mm
Permissible angle of inclination	≤ 5 °
Default color	Base frame: traffic white (RAL 9016); Moving parts: traffic white (RAL 9016); Protective cover: traffic white (RAL 9016)
Controller	KR C4
Transformation name	KR C4: KR210R2700 PRIME CR C4 FLR

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

Cleanroom robots

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

Ambient conditions

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

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

Connecting cables

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

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

Minimum bending radius	5x D

For detailed specifications of the connecting cables, see “Description of the connecting cables”.

4.6.2 Axis data, KR 210 R2700 prime CR

Axis data

Motion range	
A1	±165 °
A2	-140 ° / -5 °
A3	-120 ° / 155 °
A4	±350 °
A5	±122.5 °
A6	±350 °
Speed with rated payload	
A1	105 °/s
A2	107 °/s
A3	114 °/s
A4	136 °/s
A5	129 °/s
A6	206 °/s

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

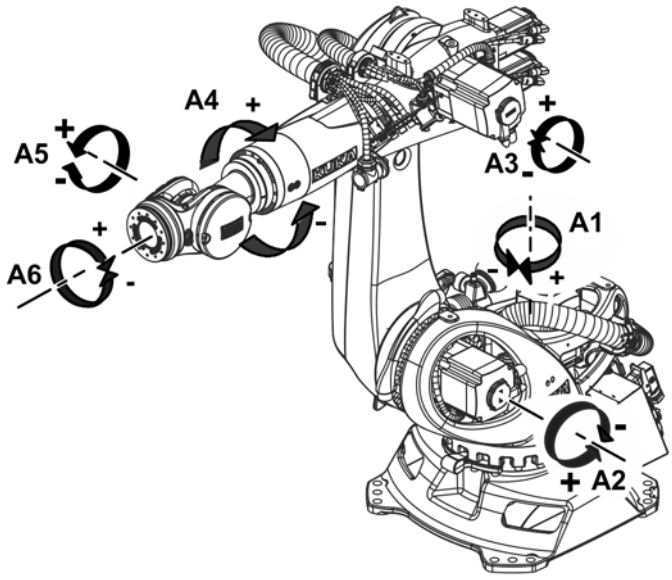


Fig. 4-29: Direction of rotation of the axes

Mastering position

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

Working envelope

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

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

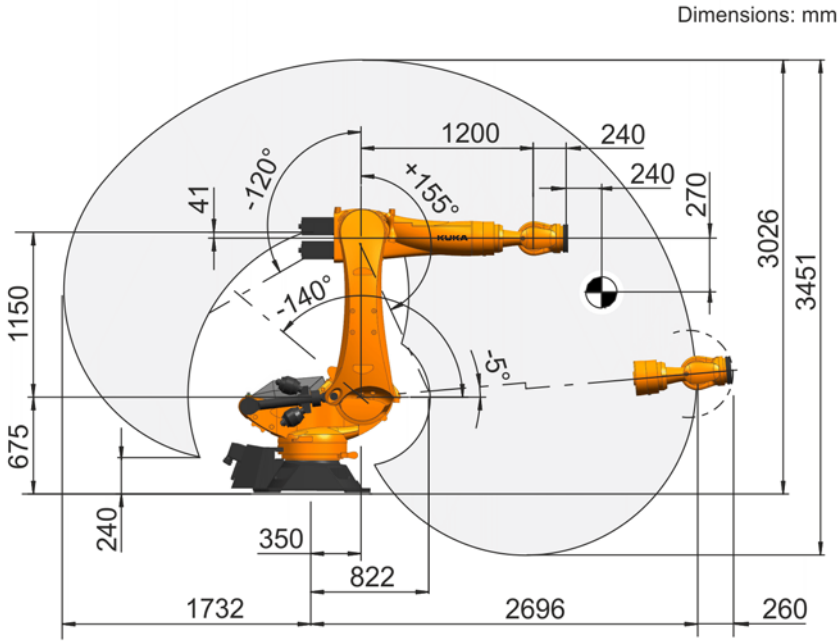


Fig. 4-30: KR 210 R2700 prime CR, working envelope, side view

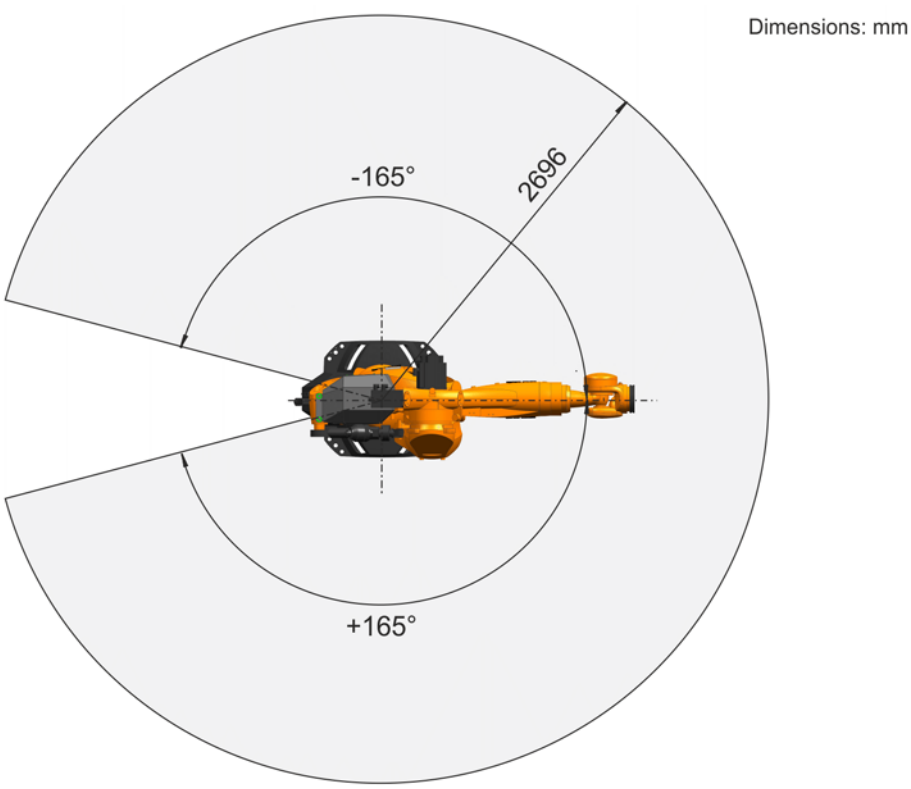


Fig. 4-31: KR 210 R2700 prime CR, working envelope, top view

4.6.3 Payloads, KR 210 R2700 prime CR

Payloads

Rated payload	210 kg
Rated mass moment of inertia	105 kgm²
Rated total load	-
Rated supplementary load, base frame	-
Maximum supplementary load, base frame	-
Rated supplementary load, rotating column	-
Maximum supplementary load, rotating column	-
Rated supplementary load, link arm	-
Maximum supplementary load, link arm	-
Rated supplementary load, arm	50 kg
Maximum supplementary load, arm	-
Nominal distance to load center of gravity	
Lxy	270 mm
Lz	240 mm

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

Load center of gravity

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

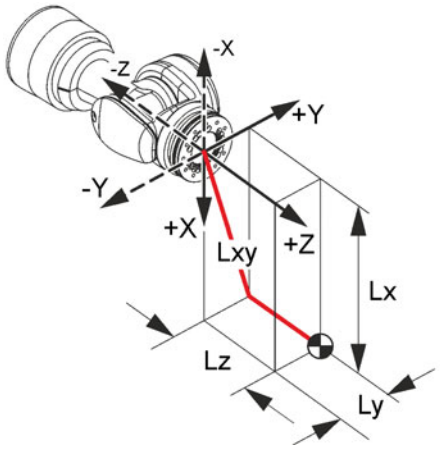


Fig. 4-32: Load center of gravity

Payload diagram

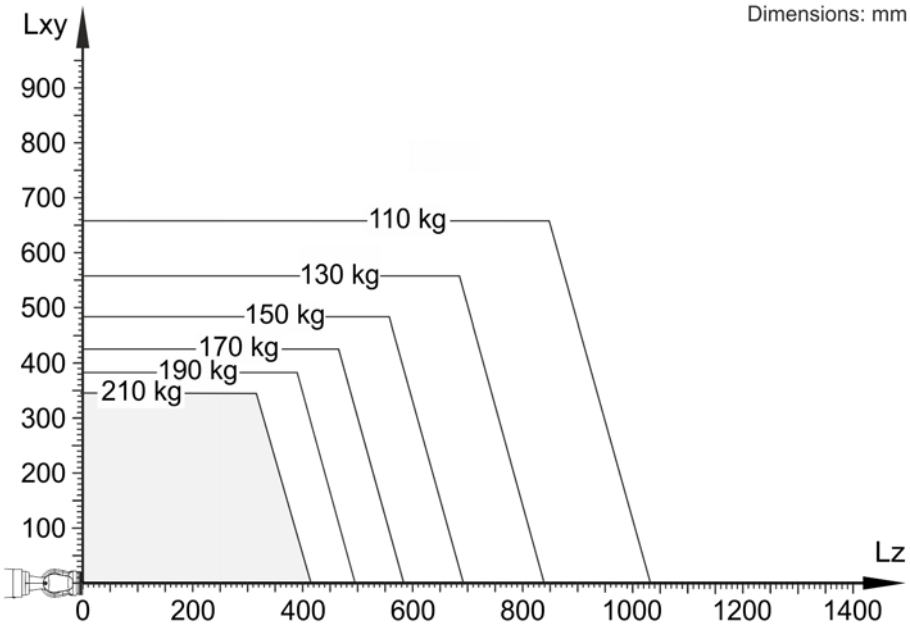


Fig. 4-33: KR QUANTEC prime payload diagram, payload 210 kg

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

In-line wrist

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

Mounting flange

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

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

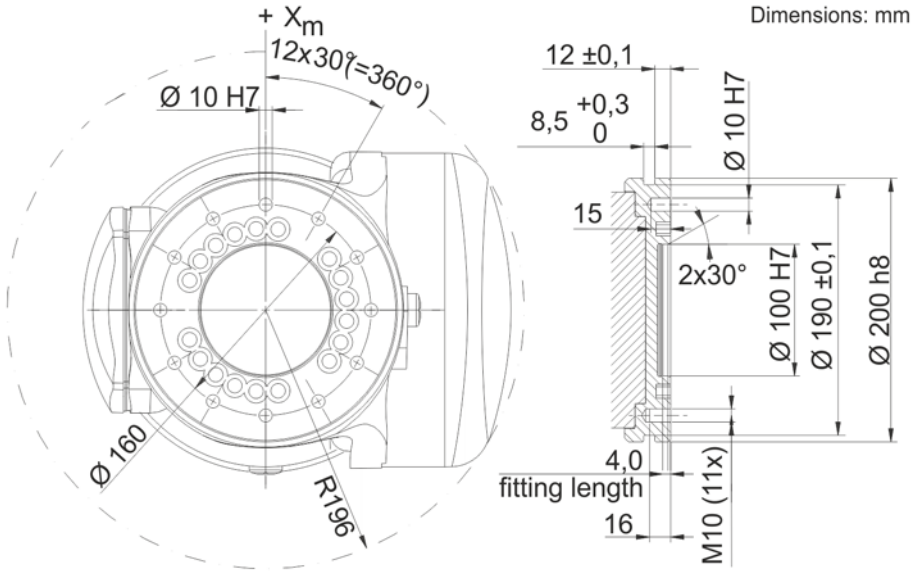


Fig. 4-34: Mounting fange D=160

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

Mounting base loads

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

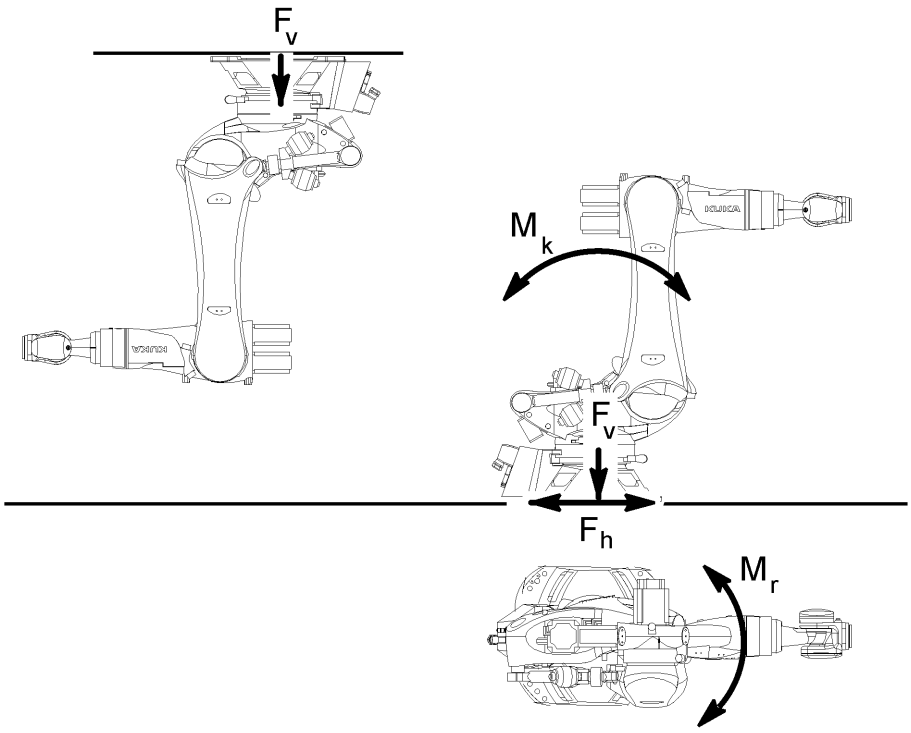


Fig. 4-35: Loads acting on the mounting base

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

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

⚠ 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.

4.7 Technical data, KR 210 R2700 prime C

4.7.1 Basic data, KR 210 R2700 prime C

Basic data

	KR 210 R2700 prime C
Number of axes	6
Number of controlled axes	6
Volume of working envelope	42.33 m³
Pose repeatability (ISO 9283)	± 0.06 mm
Weight	approx. 1111 kg
Rated payload	210 kg
Maximum reach	2556 mm
Protection rating	IP65
Protection rating, in-line wrist	IP65
Sound level	< 75 dB (A)
Mounting position	Ceiling
Footprint	830 mm x 830 mm
Permissible angle of inclination	≤ 0 °
Default color	Base frame: black (RAL 9005); Moving parts: KUKA orange 2567
Controller	KR C4
Transformation name	KR C4: KR210R2700 PRIME C4 CLG

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

Ambient conditions

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

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

Connecting cables

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

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

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

Minimum bending radius	5x D

For detailed specifications of the connecting cables, see “Description of the connecting cables”.

4.7.2 Axis data, KR 210 R2700 prime C

Axis data

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

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

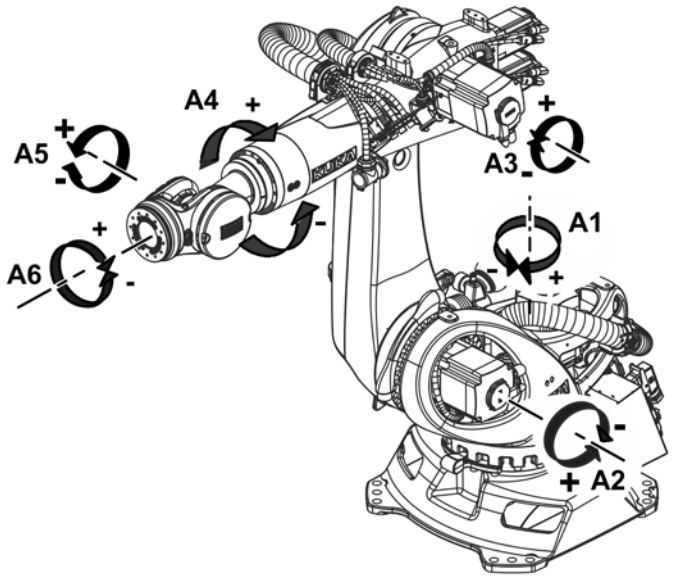


Fig. 4-36: Direction of rotation of the axes

Mastering position

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

Working envelope

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

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

Dimensions: mm

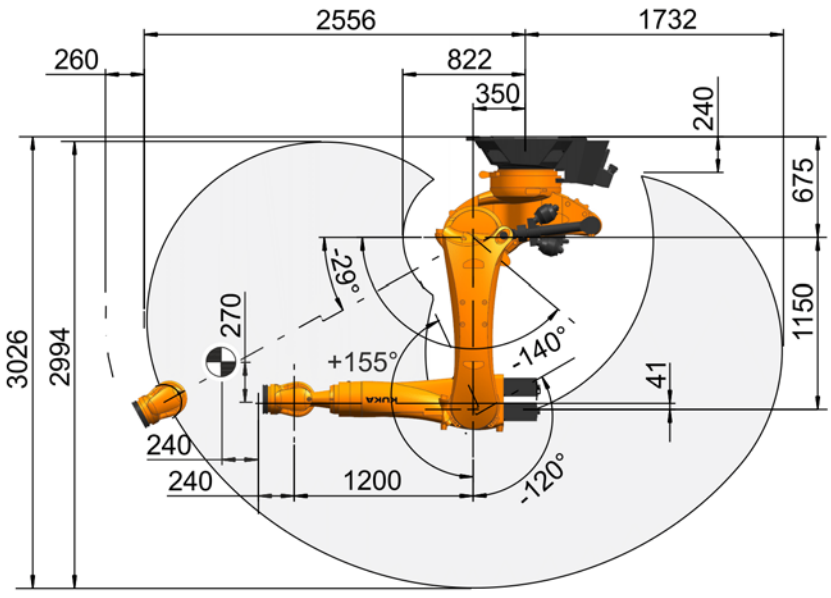


Fig. 4-37: KR 210 R2700 prime C, working envelope, side view

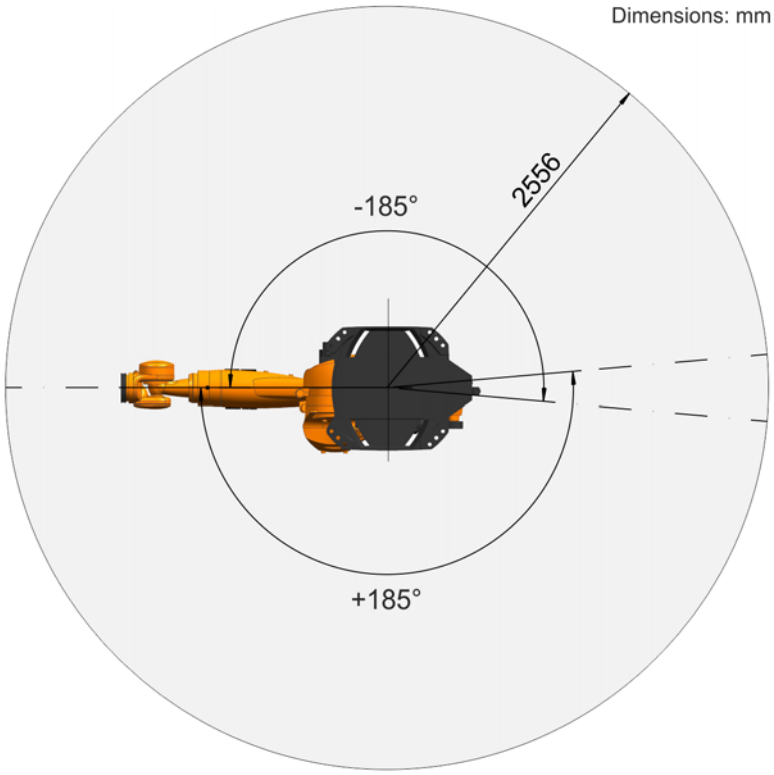


Fig. 4-38: KR 210 R2700 prime C, working envelope, top view

4.7.3 Payloads, KR 210 R2700 prime C

Payloads

Rated payload	210 kg
Reduced payload	-
Rated mass moment of inertia	105 kgm²
Rated total load	-
Rated supplementary load, base frame	-
Maximum supplementary load, base frame	-
Rated supplementary load, rotating column	-
Maximum supplementary load, rotating column	300 kg
Rated supplementary load, link arm	-
Maximum supplementary load, link arm	130 kg
Rated supplementary load, arm	50 kg
Maximum supplementary load, arm	150 kg
Nominal distance to load center of gravity	
Lxy	270 mm
Lz	240 mm

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

Load center of gravity

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

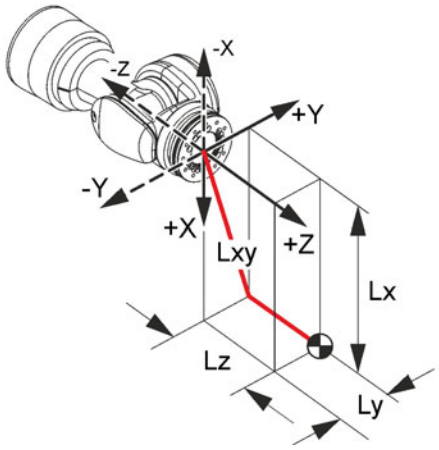


Fig. 4-39: Load center of gravity

Payload diagram

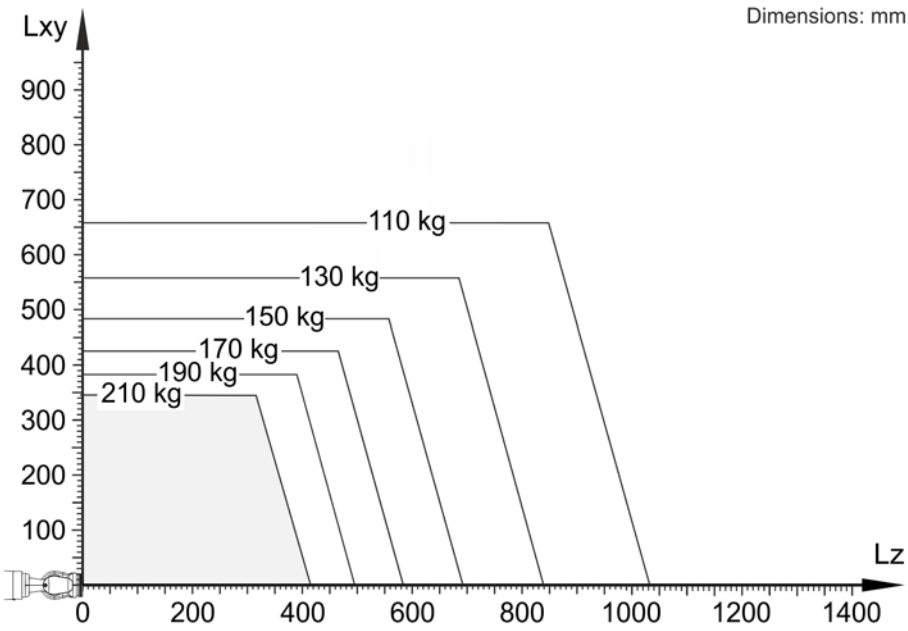


Fig. 4-40: KR QUANTEC prime payload diagram, payload 210 kg

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

In-line wrist

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

Mounting flange

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

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

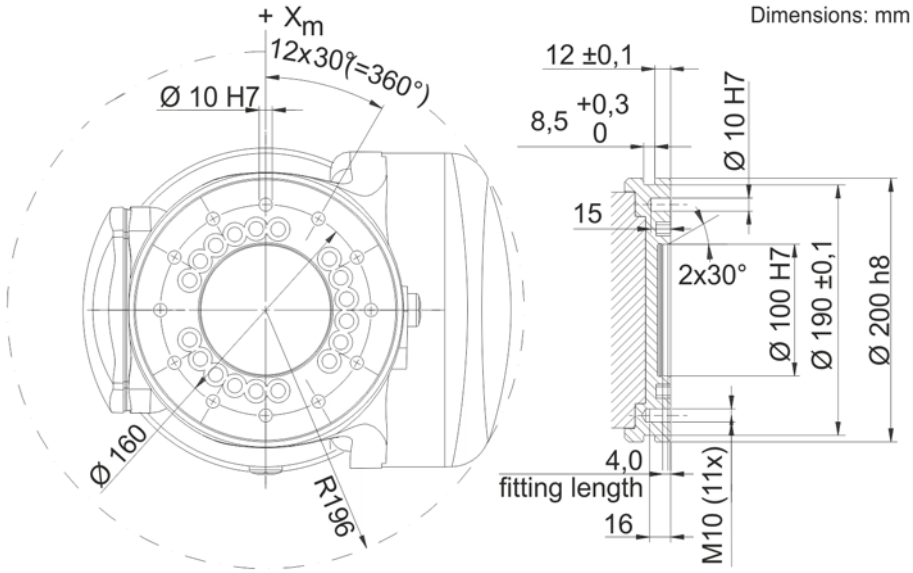


Fig. 4-41: Mounting fange D=160

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

Foundation loads

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

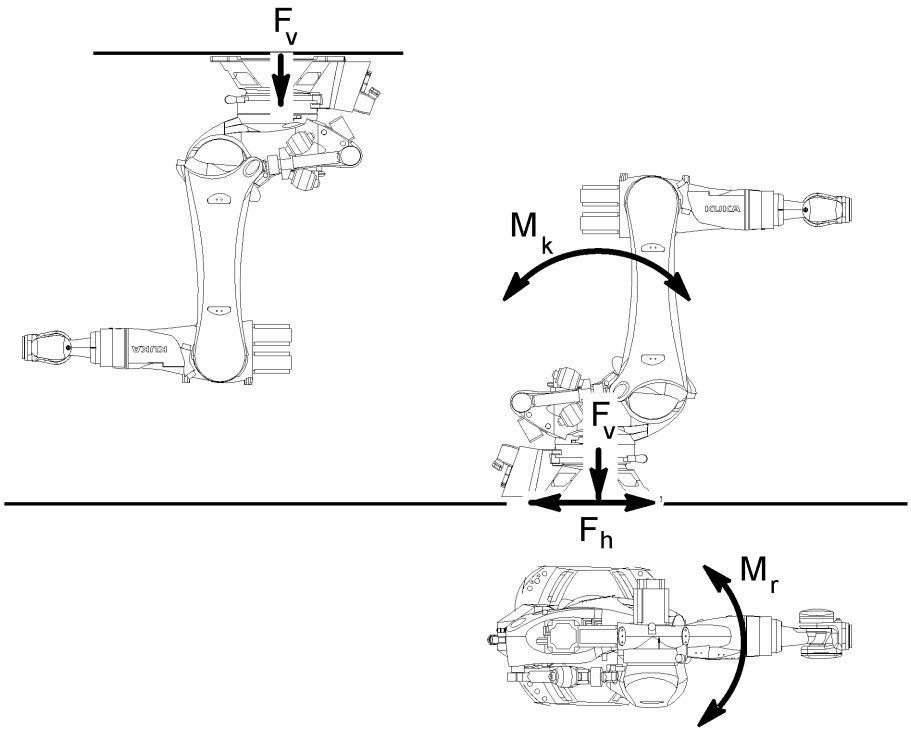


Fig. 4-42: Loads acting on the mounting base

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

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

⚠ WARNING Normal loads and maximum loads for the foundations are specified in the table.
The maximum loads must be referred to when dimensioning the foundations and must be adhered to for safety reasons. Failure to observe this can result in personal injury and damage to property.
The normal loads are average expected foundation loads. The actual loads are dependent on the program and on the robot loads and may therefore be greater or less than the normal loads.
The supplementary loads (A1, A2 and A3) are not taken into consideration in the calculation of the foundation load. These supplementary loads must be taken into consideration for F_v.

4.8 Technical data, KR 210 R2700 prime C-F

4.8.1 Basic data, KR 210 R2700 prime C-F

Basic data

	KR 210 R2700 prime C-F
Number of axes	6
Number of controlled axes	6
Volume of working envelope	42.33 m³
Pose repeatability (ISO 9283)	± 0.06 mm
Weight	approx. 1111 kg
Rated payload	210 kg
Maximum reach	2556 mm
Protection rating	IP65
Protection rating, in-line wrist	IP67
Sound level	< 75 dB (A)
Mounting position	Ceiling
Footprint	830 mm x 830 mm
Permissible angle of inclination	≤ 0 °
Default color	Base frame: black (RAL 9005); Moving parts: KUKA orange 2567
Controller	KR C4
Transformation name	KR C4: KR210R2700 PRIME C4 CLG

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

Foundry robots

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

Ambient conditions

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

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

Connecting cables

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

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

Minimum bending radius	5x D

For detailed specifications of the connecting cables, see “Description of the connecting cables”.

4.8.2 Axis data, KR 210 R2700 prime C-F

Axis data

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

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

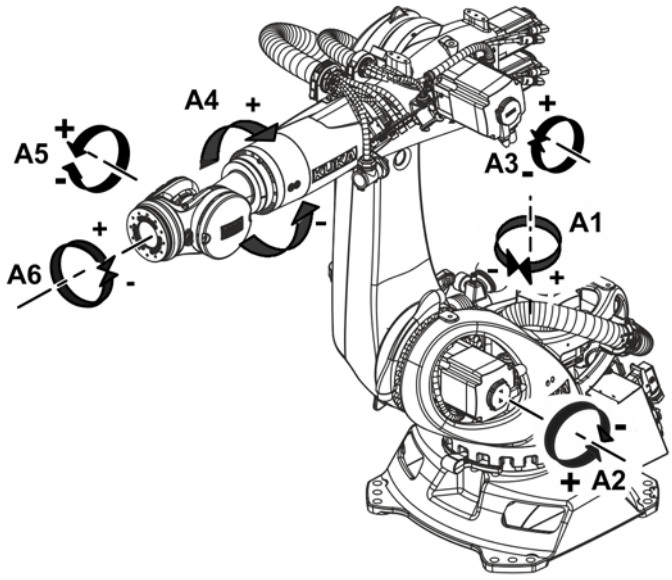


Fig. 4-43: Direction of rotation of the axes

Mastering position

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

Working envelope

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

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

Dimensions: mm

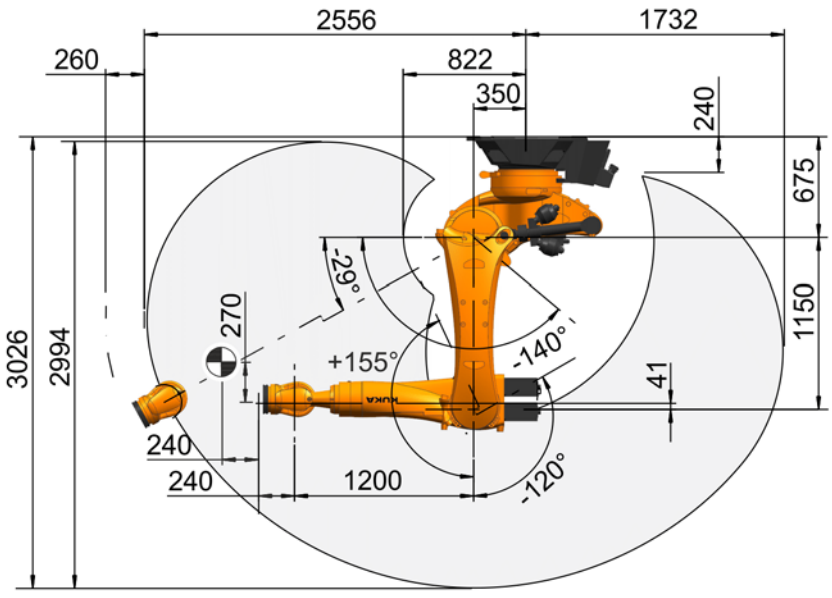


Fig. 4-44: KR 210 R2700 prime C, working envelope, side view

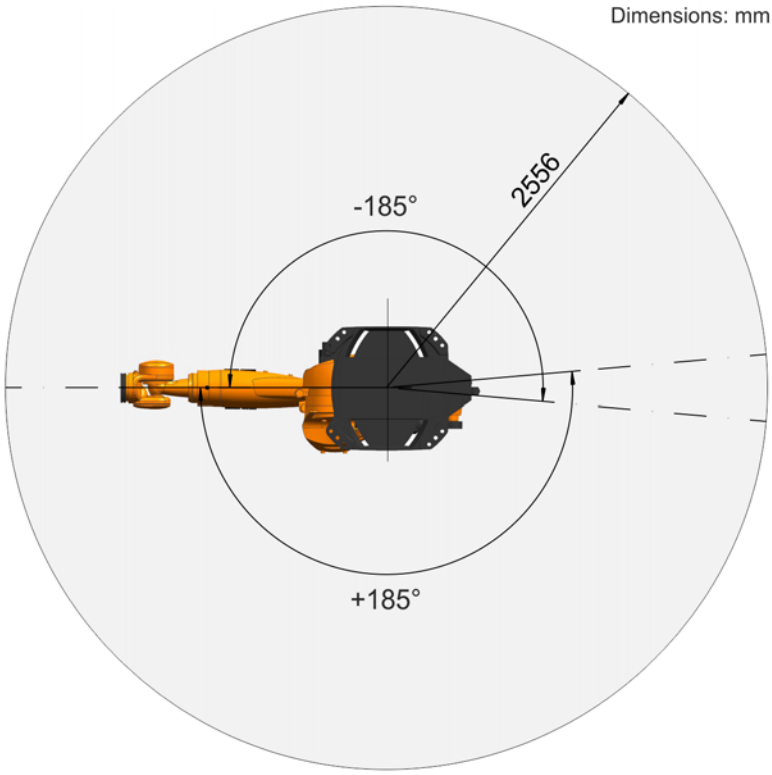


Fig. 4-45: KR 210 R2700 prime C, working envelope, top view

4.8.3 Payloads, KR 210 R2700 prime C-F

Payloads

Rated payload	210 kg
Reduced payload	-
Rated mass moment of inertia	105 kgm²
Rated total load	-
Rated supplementary load, base frame	-
Maximum supplementary load, base frame	-
Rated supplementary load, rotating column	-
Maximum supplementary load, rotating column	300 kg
Rated supplementary load, link arm	-
Maximum supplementary load, link arm	130 kg
Rated supplementary load, arm	50 kg
Maximum supplementary load, arm	150 kg
Nominal distance to load center of gravity	
Lxy	270 mm
Lz	240 mm

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

Load center of gravity

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

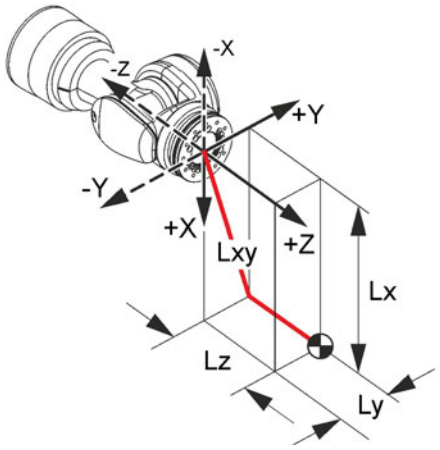


Fig. 4-46: Load center of gravity

Payload diagram

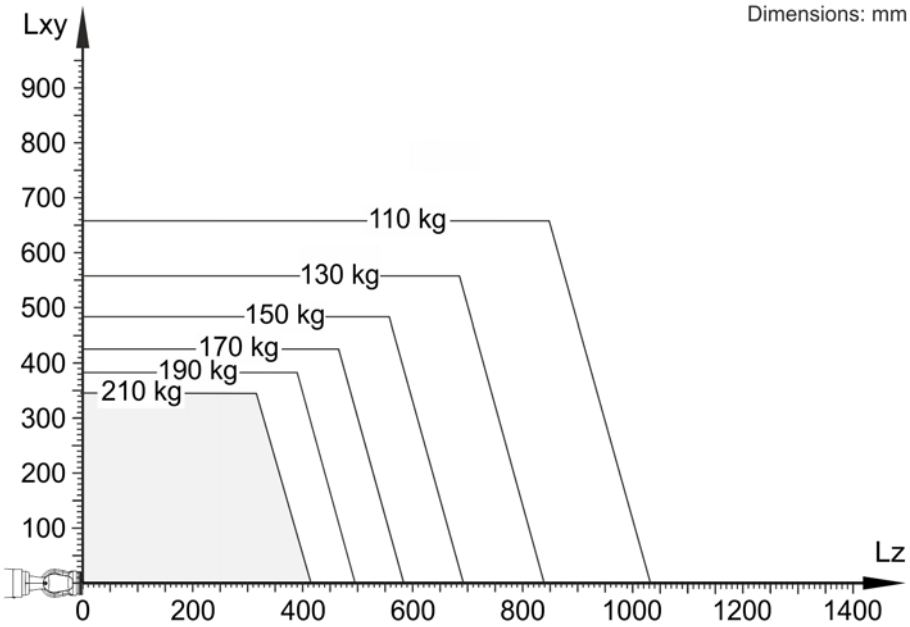


Fig. 4-47: KR QUANTEC prime payload diagram, payload 210 kg

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

In-line wrist

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

Mounting flange

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

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

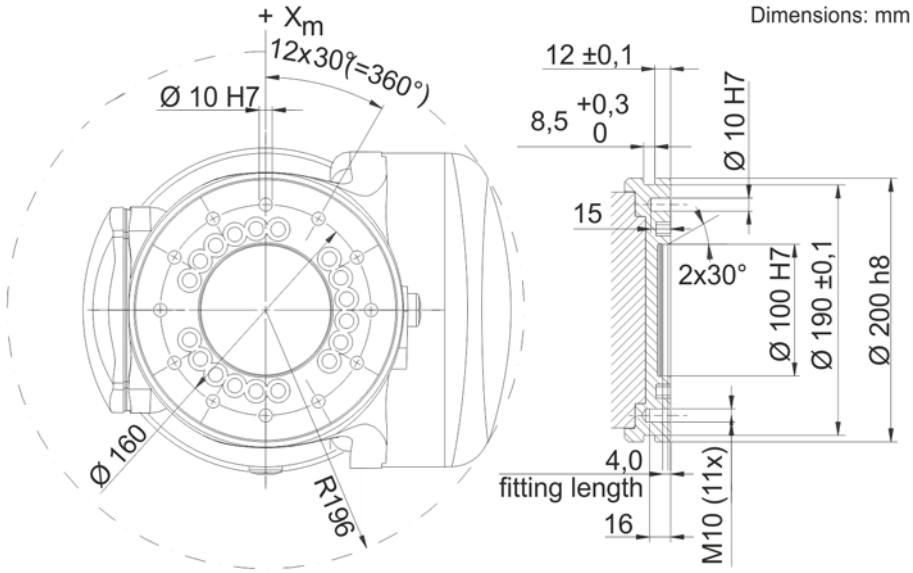


Fig. 4-48: Mounting fange D=160

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

Foundation loads

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

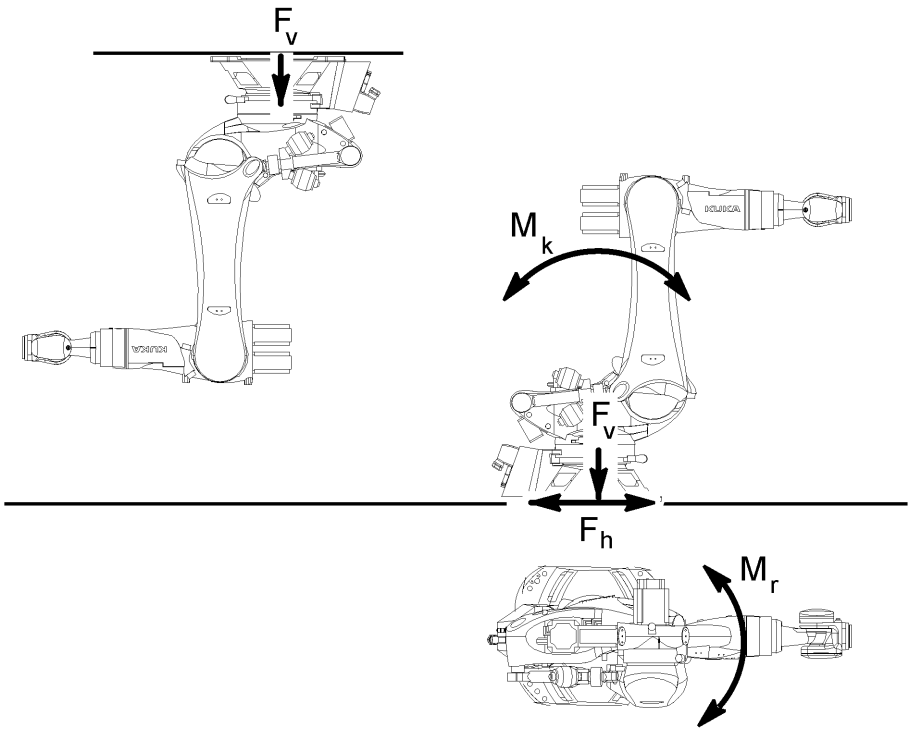


Fig. 4-49: Loads acting on the mounting base

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

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

⚠ WARNING Normal loads and maximum loads for the foundations are specified in the table.
The maximum loads must be referred to when dimensioning the foundations and must be adhered to for safety reasons. Failure to observe this can result in personal injury and damage to property.
The normal loads are average expected foundation loads. The actual loads are dependent on the program and on the robot loads and may therefore be greater or less than the normal loads.
The supplementary loads (A1, A2 and A3) are not taken into consideration in the calculation of the foundation load. These supplementary loads must be taken into consideration for F_v.

4.9 Technical data, KR 180 R2900 prime

4.9.1 Basic data, KR 180 R2900 prime

Basic data

	KR 180 R2900 prime
Number of axes	6
Number of controlled axes	6
Volume of working envelope	66 m³
Pose repeatability (ISO 9283)	± 0.06 mm
Weight	approx. 1106 kg
Rated payload	180 kg
Maximum reach	2896 mm
Protection rating	IP65
Protection rating, in-line wrist	IP65
Sound level	< 75 dB (A)
Mounting position	Floor
Footprint	830 mm x 830 mm
Permissible angle of inclination	≤ 5 °
Default color	Base frame: black (RAL 9005); Moving parts: KUKA orange 2567
Controller	KR C4
Transformation name	KR C4: KR180R2900 PRIME C4 FLR

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

Ambient conditions

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

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

Connecting cables

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

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

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

Minimum bending radius	5x D

For detailed specifications of the connecting cables, see “Description of the connecting cables”.

4.9.2 Axis data, KR 180 R2900 prime

Axis data

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

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

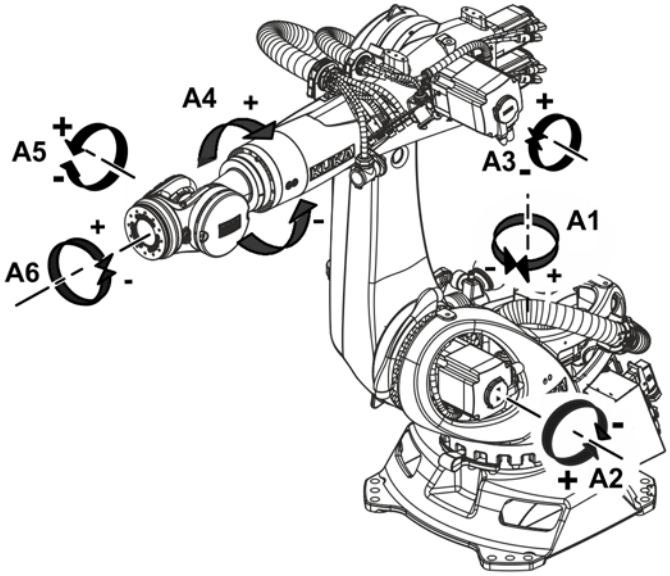


Fig. 4-50: Direction of rotation of the axes

Mastering position

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

Working envelope

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

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

Dimensions: mm

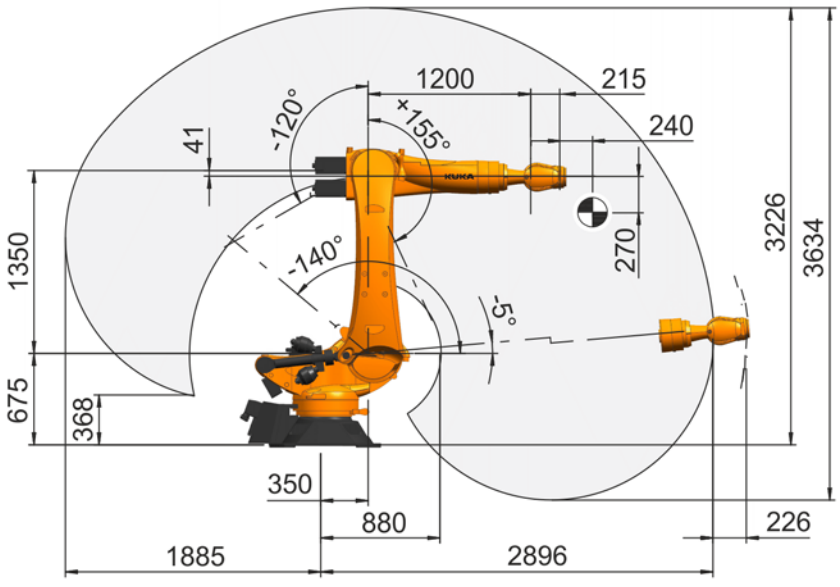


Fig. 4-51: KR 180 R2900 prime, working envelope, side view

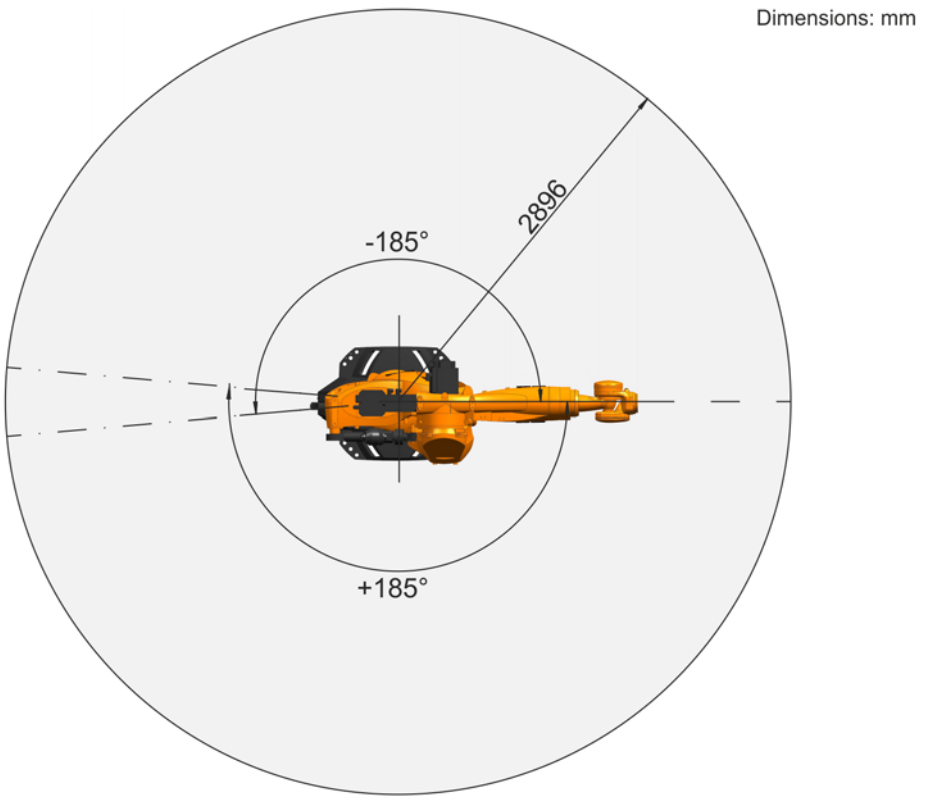


Fig. 4-52: KR 180 R2900 prime, working envelope, top view

4.9.3 Payloads, KR 180 R2900 prime

Payloads

Rated payload	180 kg
Rated mass moment of inertia	90 kgm²
Rated total load	-
Rated supplementary load, base frame	-
Maximum supplementary load, base frame	-
Rated supplementary load, rotating column	-
Maximum supplementary load, rotating column	300 kg
Rated supplementary load, link arm	-
Maximum supplementary load, link arm	130 kg
Rated supplementary load, arm	50 kg
Maximum supplementary load, arm	150 kg
Nominal distance to load center of gravity	
Lxy	270 mm
Lz	240 mm

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

Load center of gravity

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

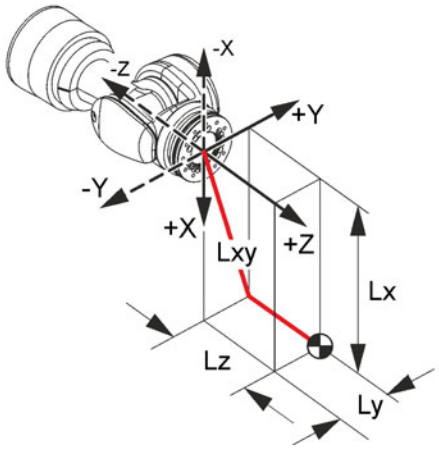


Fig. 4-53: Load center of gravity

Payload diagram

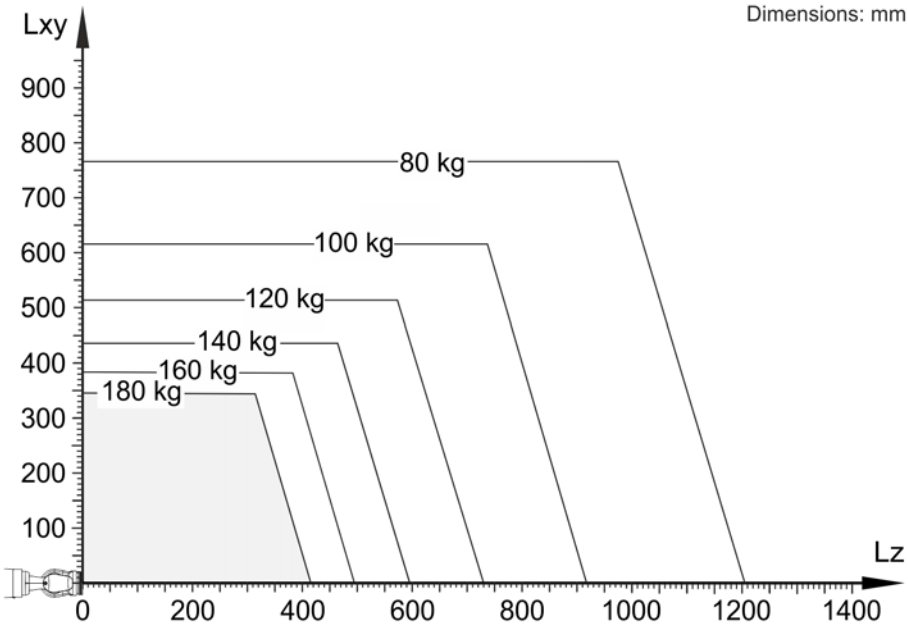


Fig. 4-54: KR QUANTEC prime payload diagram, payload 180 kg

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

In-line wrist

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

Mounting flange

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

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

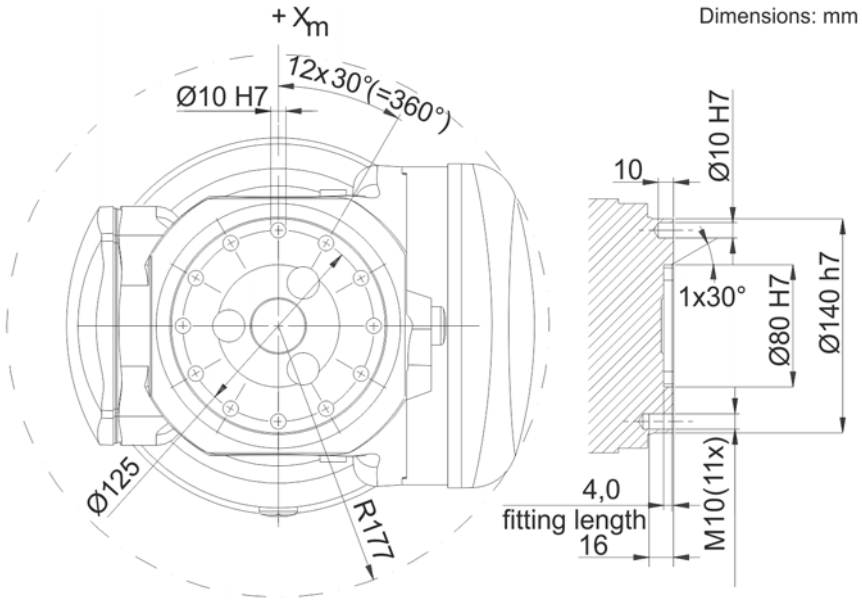


Fig. 4-55: Mounting flange D=125

NOTICE An optional adapter is available for the mounting flange. Further information about this option may be found in the chapter “Options” (>>> 8 "Options" Page 143).

4.9.4 Loads acting on the foundation, KR 180 R2900 prime

Foundation loads

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

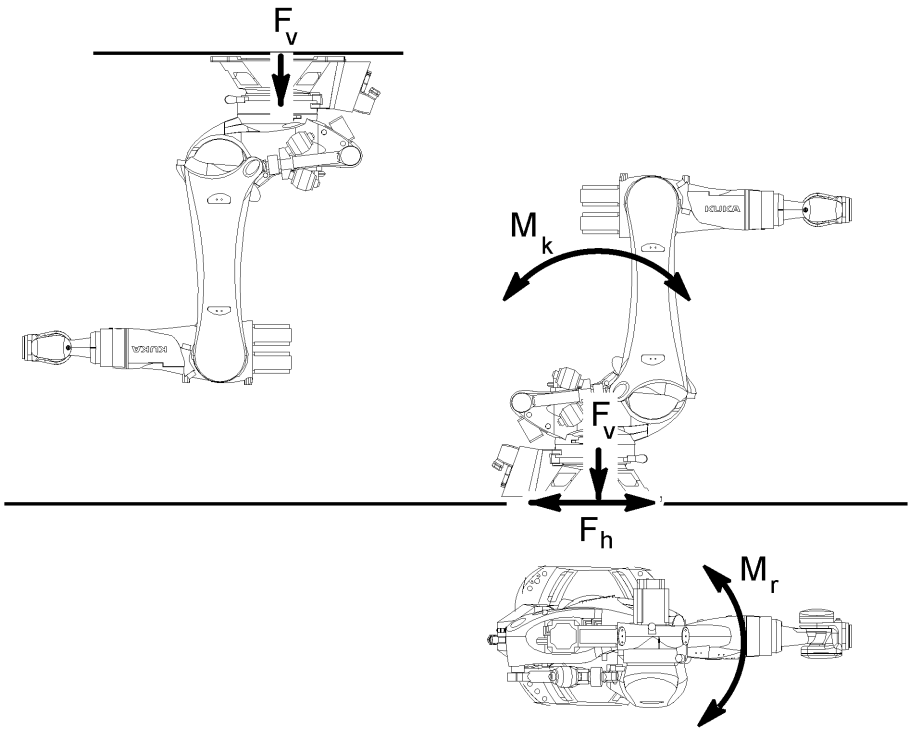


Fig. 4-56: Loads acting on the mounting base

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

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

⚠ WARNING Normal loads and maximum loads for the foundations are specified in the table.
The maximum loads must be referred to when dimensioning the foundations and must be adhered to for safety reasons. Failure to observe this can result in personal injury and damage to property.
The normal loads are average expected foundation loads. The actual loads are dependent on the program and on the robot loads and may therefore be greater or less than the normal loads.
The supplementary loads (A1, A2 and A3) are not taken into consideration in the calculation of the foundation load. These supplementary loads must be taken into consideration for F_v.

4.10 Technical data, KR 150 R3100 prime

4.10.1 Basic data, KR 150 R3100 prime

Basic data

	KR 150 R3100 prime
Number of axes	6
Number of controlled axes	6
Volume of working envelope	84 m³
Pose repeatability (ISO 9283)	± 0.06 mm
Weight	approx. 1114 kg
Rated payload	150 kg
Maximum reach	3095 mm
Protection rating	IP65
Protection rating, in-line wrist	IP65
Sound level	< 75 dB (A)
Mounting position	Floor
Footprint	830 mm x 830 mm
Permissible angle of inclination	≤ 5 °
Default color	Base frame: black (RAL 9005); Moving parts: KUKA orange 2567
Controller	KR C4
Transformation name	KR C4: KR150R3100 PRIME C4 FLR

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

Ambient conditions

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

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

Connecting cables

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

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

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

Minimum bending radius	5x D

For detailed specifications of the connecting cables, see “Description of the connecting cables”.

4.10.2 Axis data, KR 150 R3100 prime

Axis data

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

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

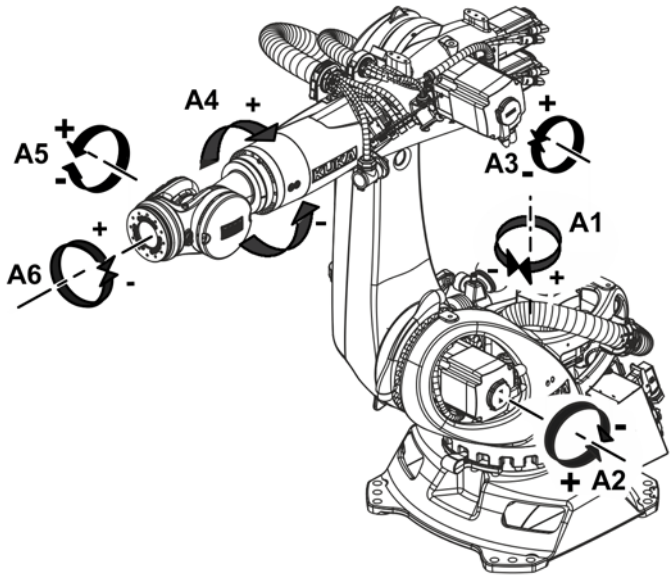


Fig. 4-57: Direction of rotation of the axes

Mastering position

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

Working envelope

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

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

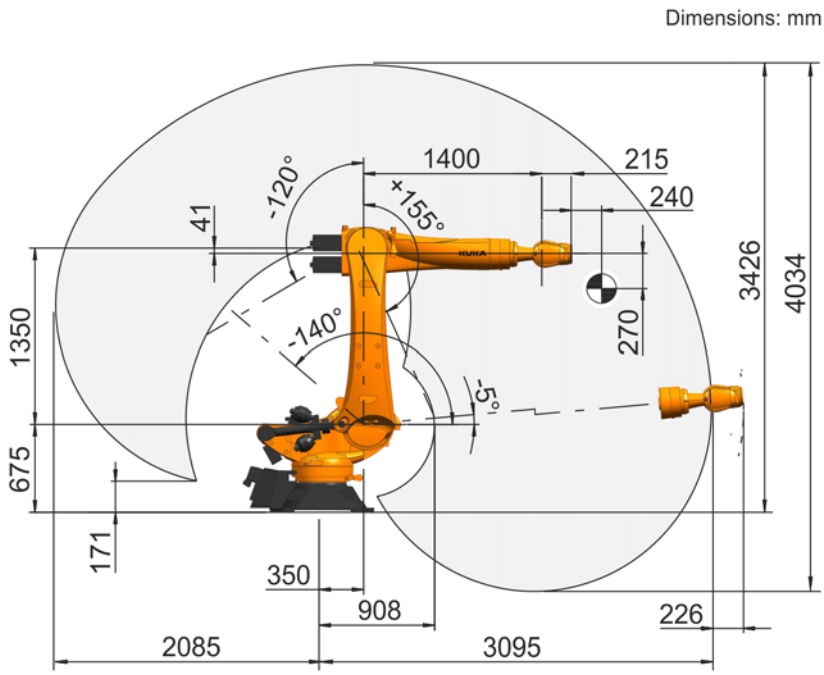


Fig. 4-58: KR 150 R3100 prime, working envelope, side view

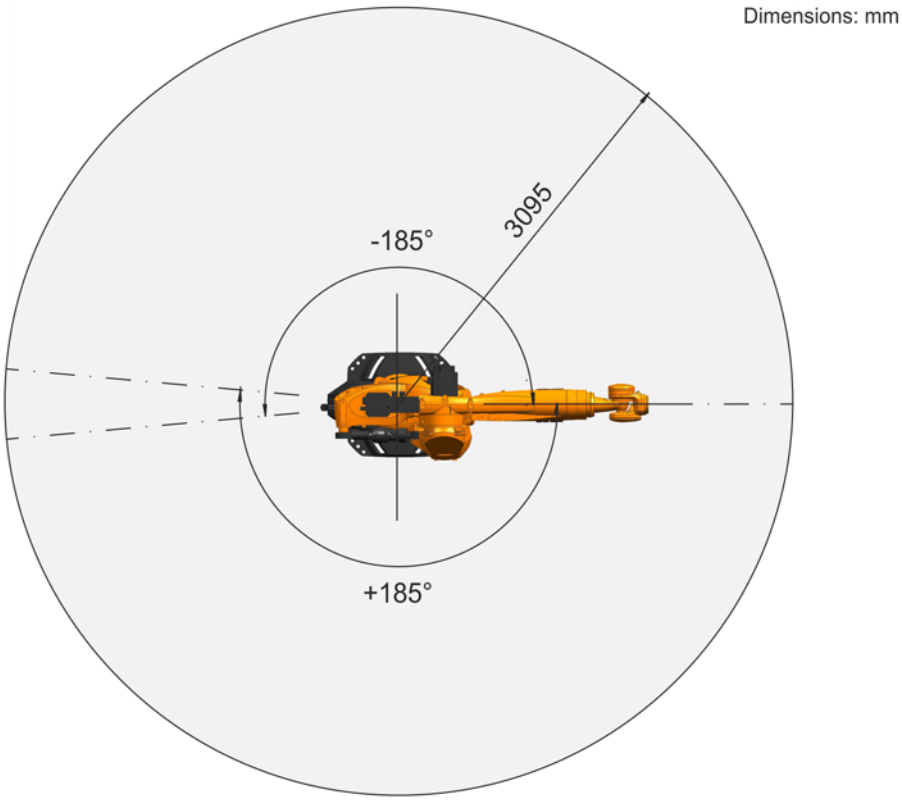


Fig. 4-59: KR 150 R3100 prime, working envelope, top view

4.10.3 Payloads, KR 150 R3100 prime

Payloads

Rated payload	150 kg
Rated mass moment of inertia	75 kgm²
Rated total load	-

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

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

Load center of gravity

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

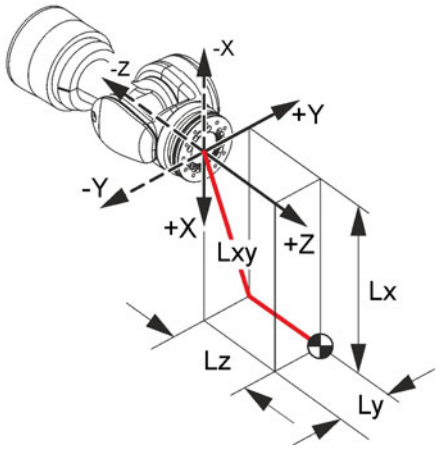


Fig. 4-60: Load center of gravity

Payload diagram

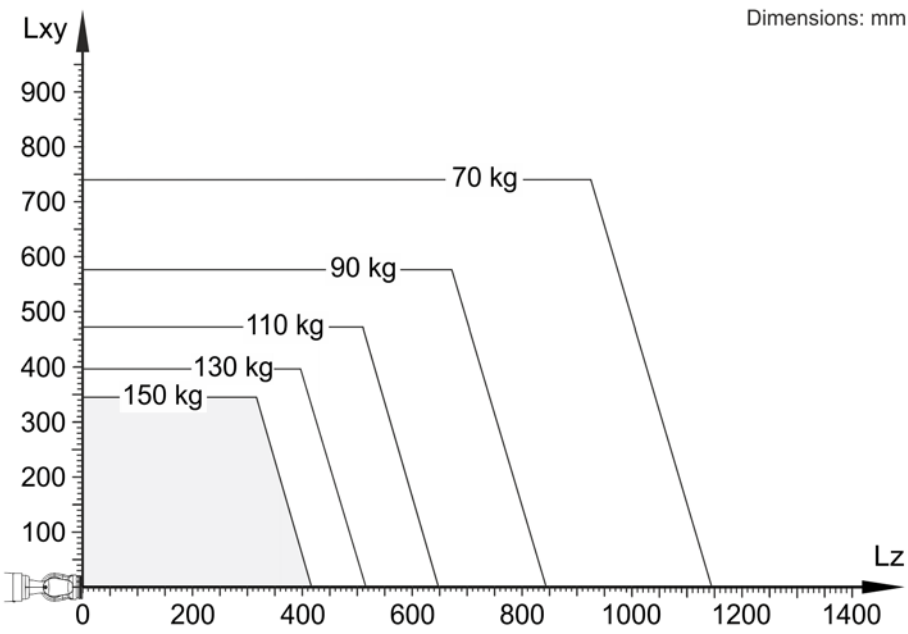


Fig. 4-61: KR QUANTEC prime payload diagram, payload 150 kg

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

In-line wrist

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

Mounting flange

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

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

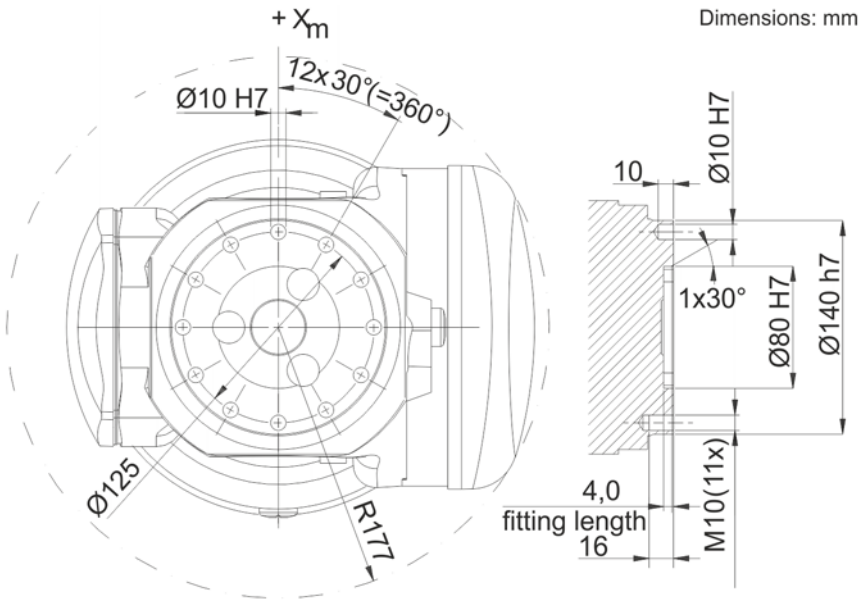


Fig. 4-62: Mounting flange D=125

NOTICE An optional adapter is available for the mounting flange. Further information about this option may be found in the chapter “Options” (>>> 8 "Options" Page 143).

4.10.4 Loads acting on the foundation, KR 150 R3100 prime

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

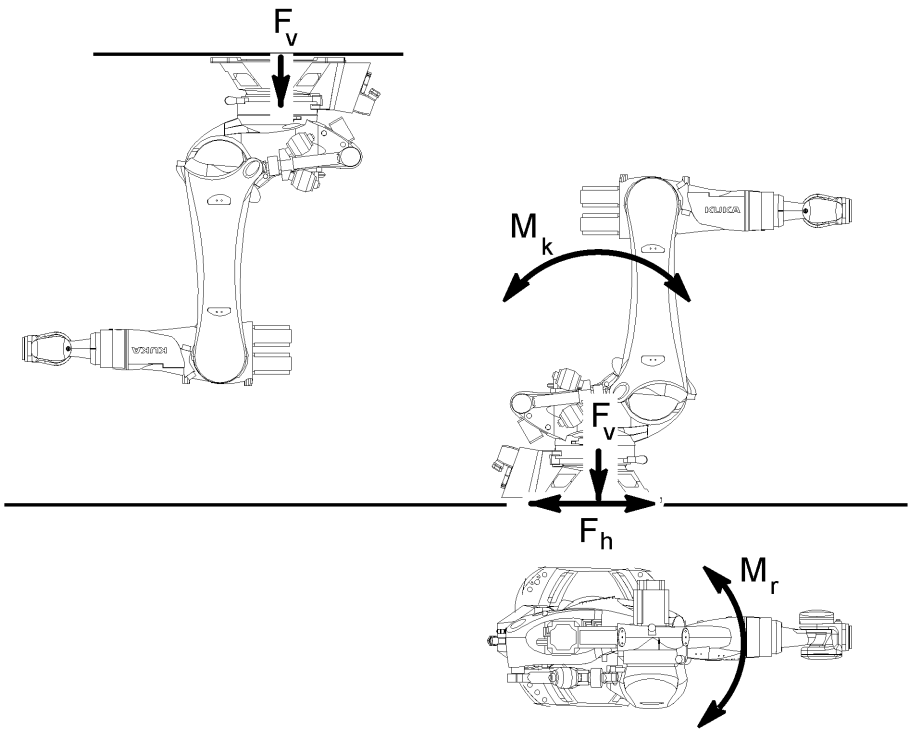


Fig. 4-63: Loads acting on the mounting base

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

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

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

⚠ WARNING Normal loads and maximum loads for the foundations are specified in the table.
The maximum loads must be referred to when dimensioning the foundations and must be adhered to for safety reasons. Failure to observe this can result in personal injury and damage to property.
The normal loads are average expected foundation loads. The actual loads are dependent on the program and on the robot loads and may therefore be greater or less than the normal loads.
The supplementary loads (A1, A2 and A3) are not taken into consideration in the calculation of the foundation load. These supplementary loads must be taken into consideration for F_V.

4.11 Supplementary load

Description

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

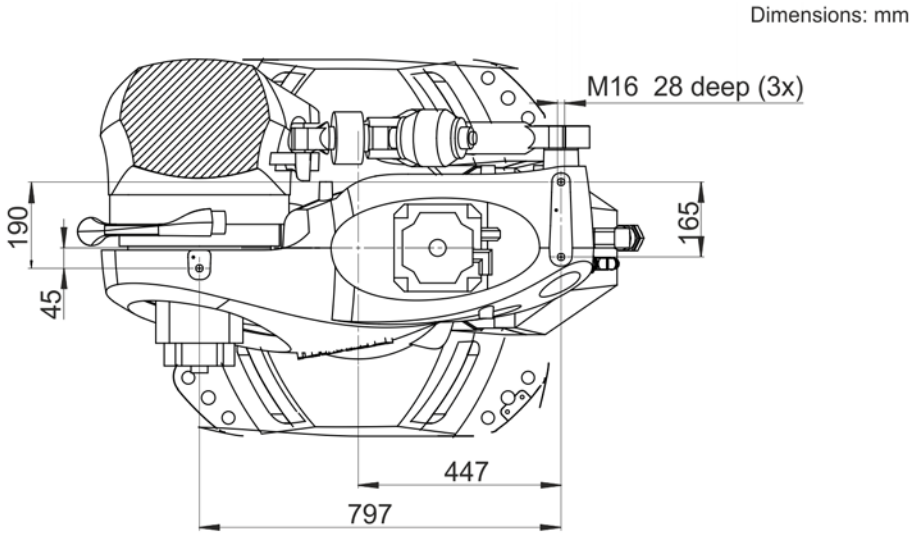


Fig. 4-64: Supplementary load, rotating column

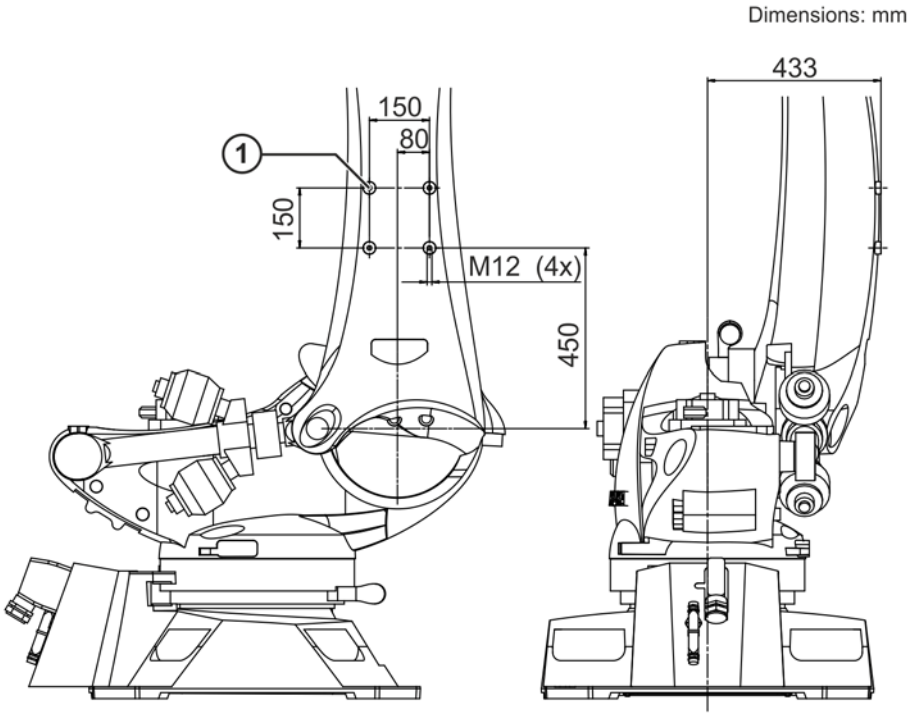


Fig. 4-65: Supplementary load, link arm

1 Mounting surface

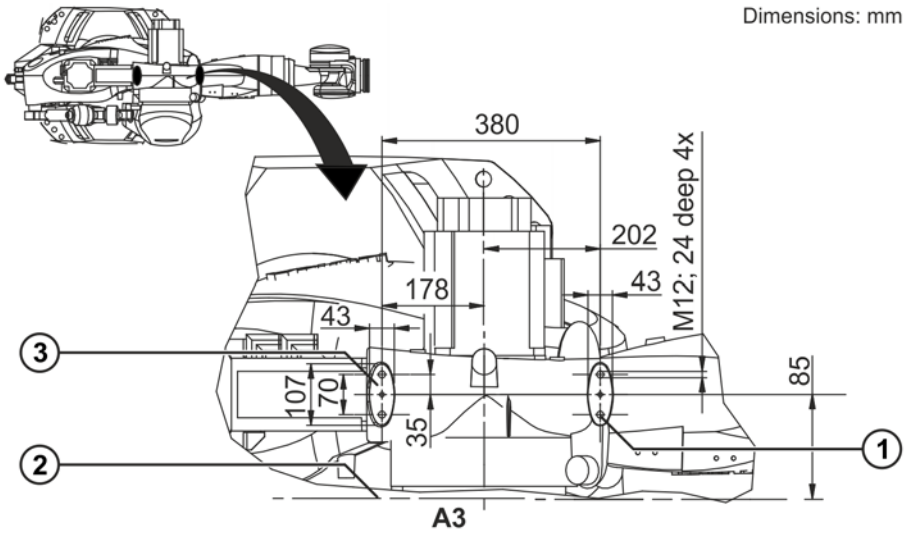


Fig. 4-66: Supplementary load, arm

1 Fastening thread
2 Interference contour, arm
3 Mounting surface

4.12 Plates and labels

Plates and labels

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

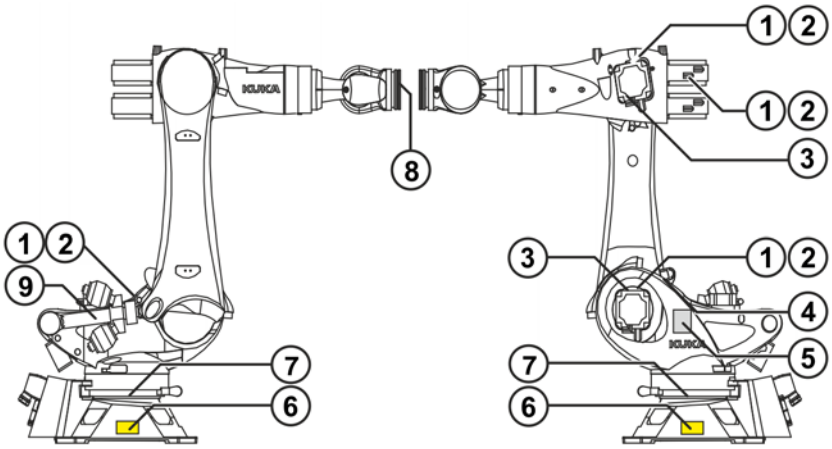
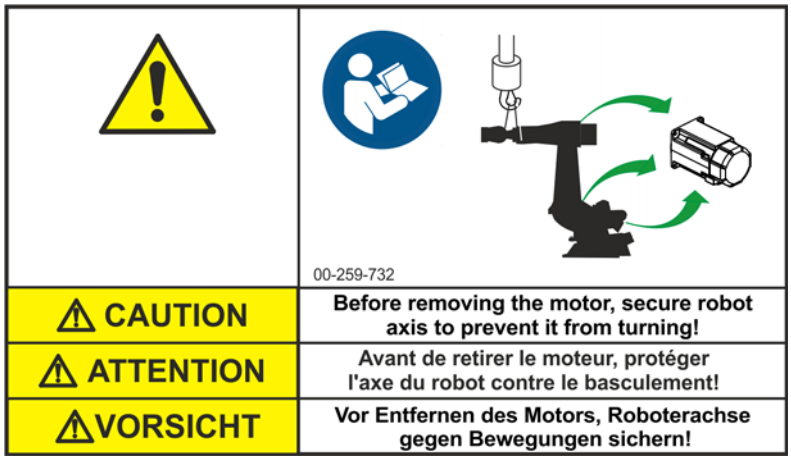
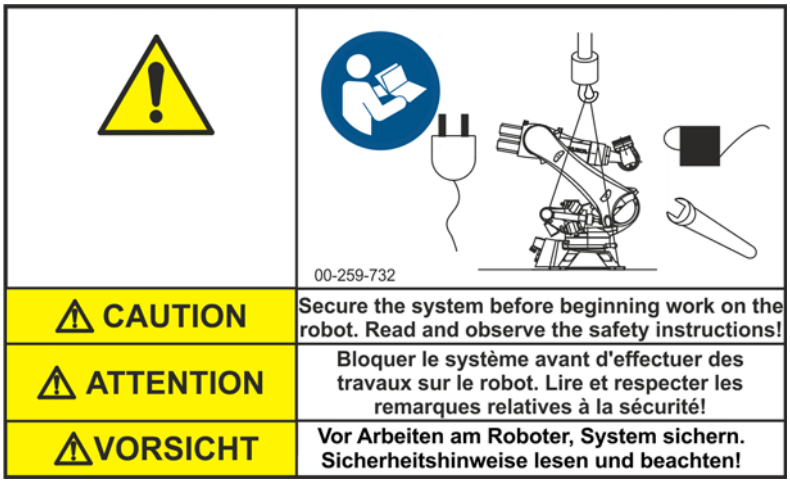
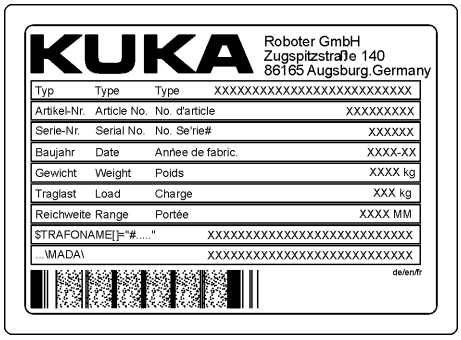
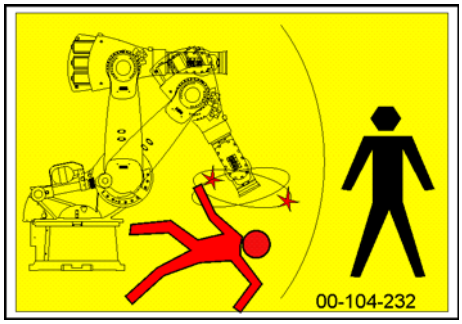
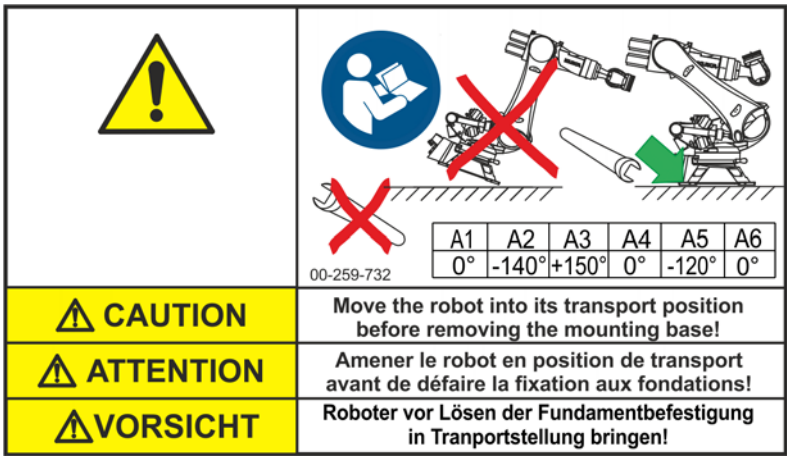
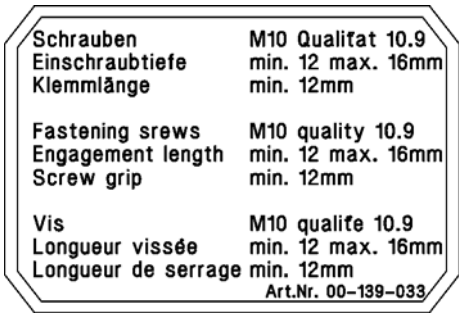
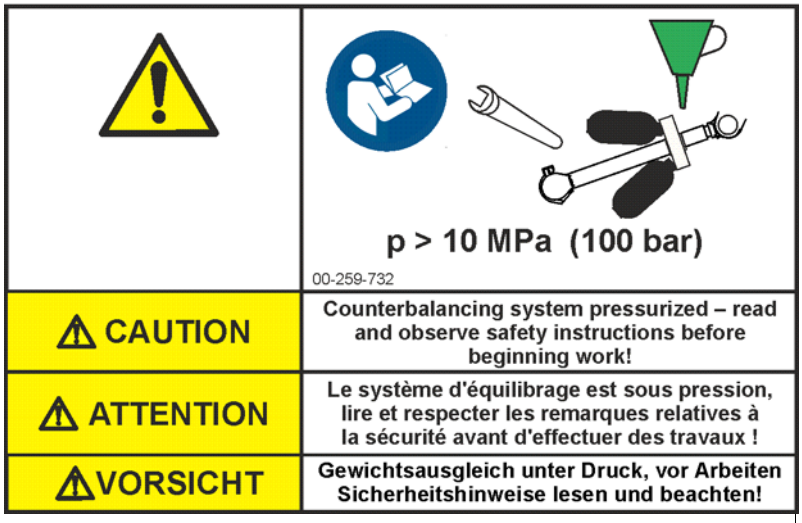


Fig. 4-67: Location of plates and labels

Item	Description
1	 **High voltage** Any improper handling can lead to contact with current-carrying components. Electric shock hazard!
2	 **Hot surface** During operation of the robot, surface temperatures may be reached that could result in burn injuries. Protective gloves must be worn!
3	 **Secure the axes** Before exchanging any motor, secure the corresponding axis through safeguarding by suitable means/devices to protect against possible movement. The axis can move. Risk of crushing!

Item	Description
4	 **Work on the robot** Before start-up, transportation or maintenance, read and follow the assembly and operating instructions.
5	 **Identification plate** Content according to Machinery Directive.
6	 **Danger zone** Entering the danger zone of the robot is prohibited if the robot is in operation or ready for operation. Risk of injury!

Item	Description
7	 **Transport position** Before loosening the bolts of the mounting base, the robot must be in the transport position as indicated in the table. Risk of toppling!
8	 **Mounting flange on in-line wrist** The values specified on this plate apply for the installation of tools on the mounting flange of the wrist and must be observed.

Item	Description
9	(8)  **Counterbalancing system** The system is pressurized with oil and nitrogen. Read and follow the assembly and operating instructions before commencing work on the counterbalancing system. Risk of injury!
10	Only for CR robot on each oil filler plug  **FoodProof** Appying on gear unit. Unlike the standard gear unit, this gear unit must be filled with “FoodProof 1800” oil. Please observe the particularities!

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

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

4.14 Stopping distances and times

4.14.1 General information

Information concerning the data:

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

- Stopping distances and stopping times in accordance with DIN EN ISO 10218-1, Annex B.
- Stop categories:
  - Stop category 0 » STOP 0
  - Stop category 1 » STOP 1

  according to IEC 60204-1
- The values specified for Stop 0 are guide values determined by means of tests and simulation. They are average values which conform to the requirements of DIN EN ISO 10218-1. The actual stopping distances and stopping times may differ due to internal and external influences on the braking torque. It is therefore advisable to determine the exact stopping distances and stopping times where necessary under the real conditions of the actual robot application.
- Measuring technique

  The stopping distances were measured using the robot-internal measuring technique.
- The wear on the brakes varies depending on the operating mode, robot application and the number of STOP 0 stops triggered. It is therefore advisable to check the stopping distance at least once a year.

4.14.2 Terms used

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

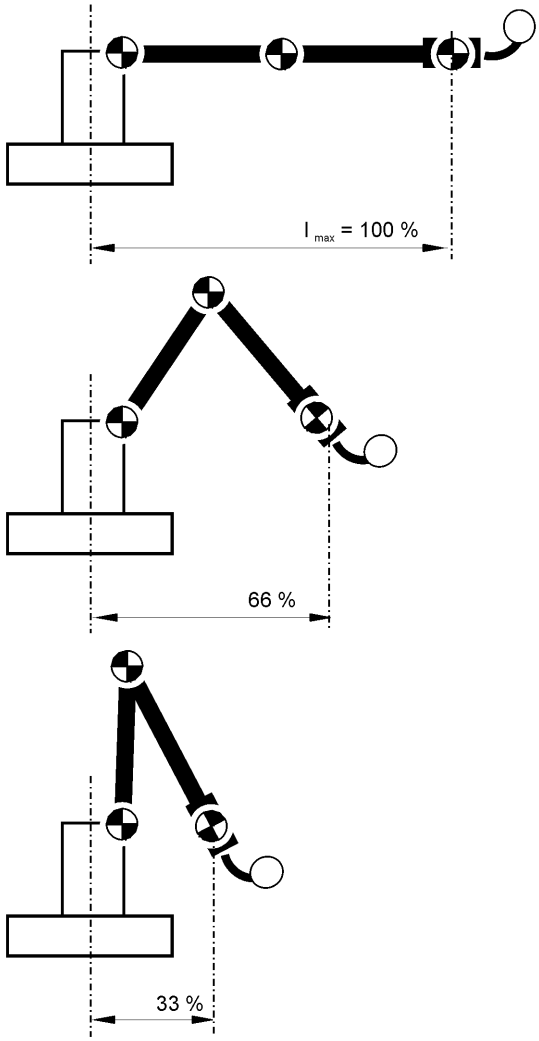


Fig. 4-68: Extension

4.14.3 Stopping distances and stopping times for KR 240 R2500 prime

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

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

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

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

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

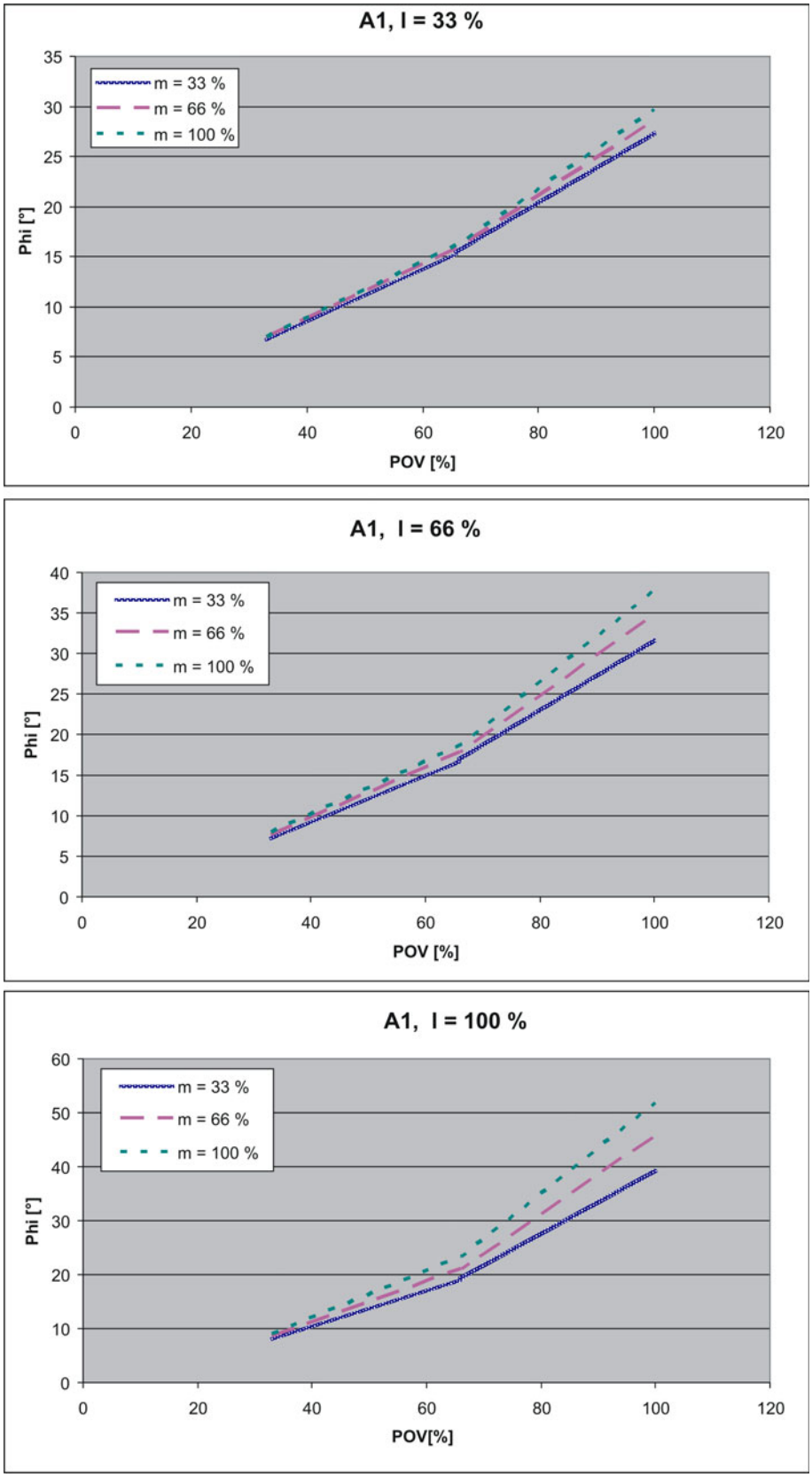


Fig. 4-69: Stopping distances for STOP 1, axis 1

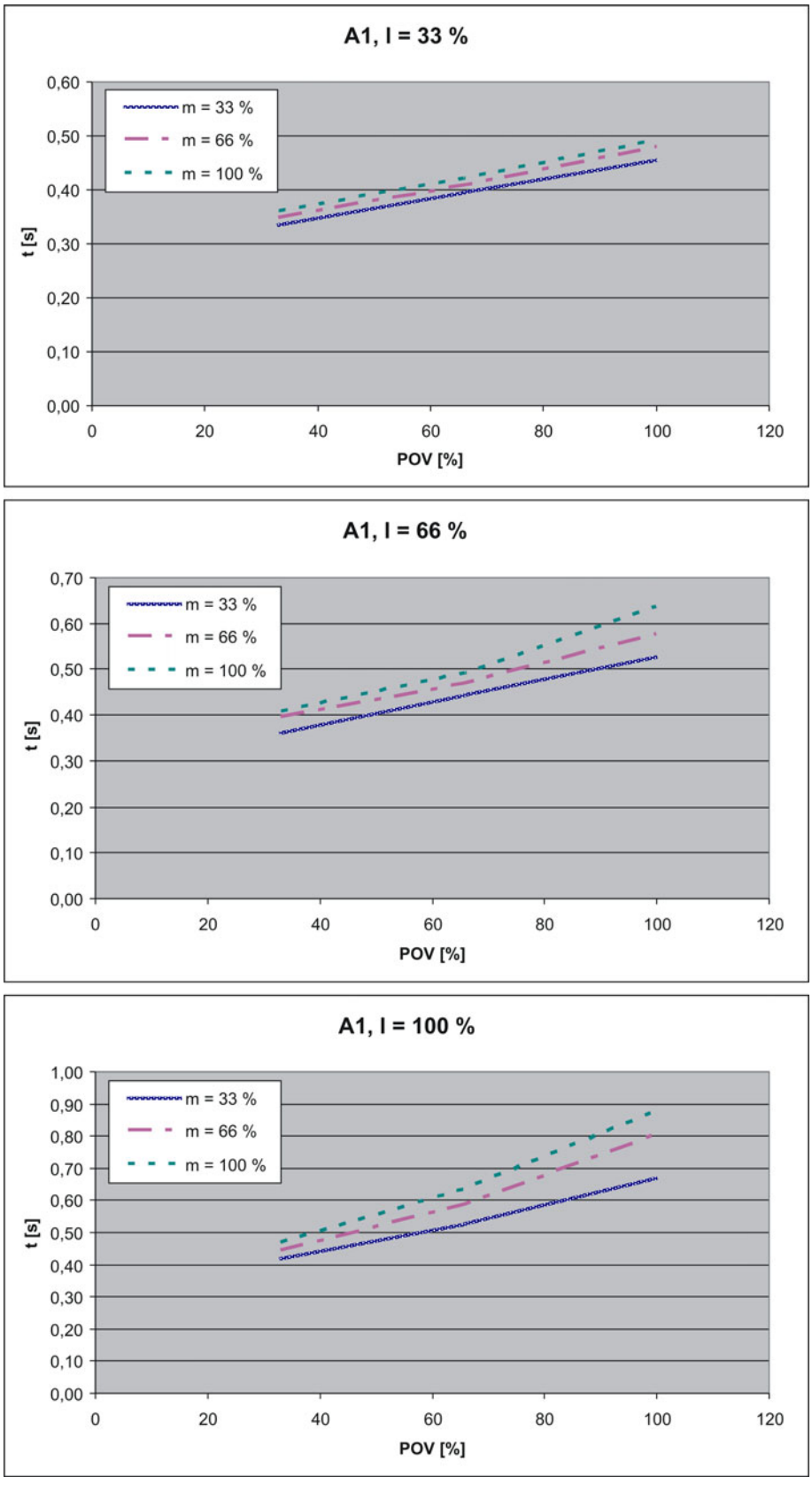


Fig. 4-70: Stopping times for STOP 1, axis 1

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

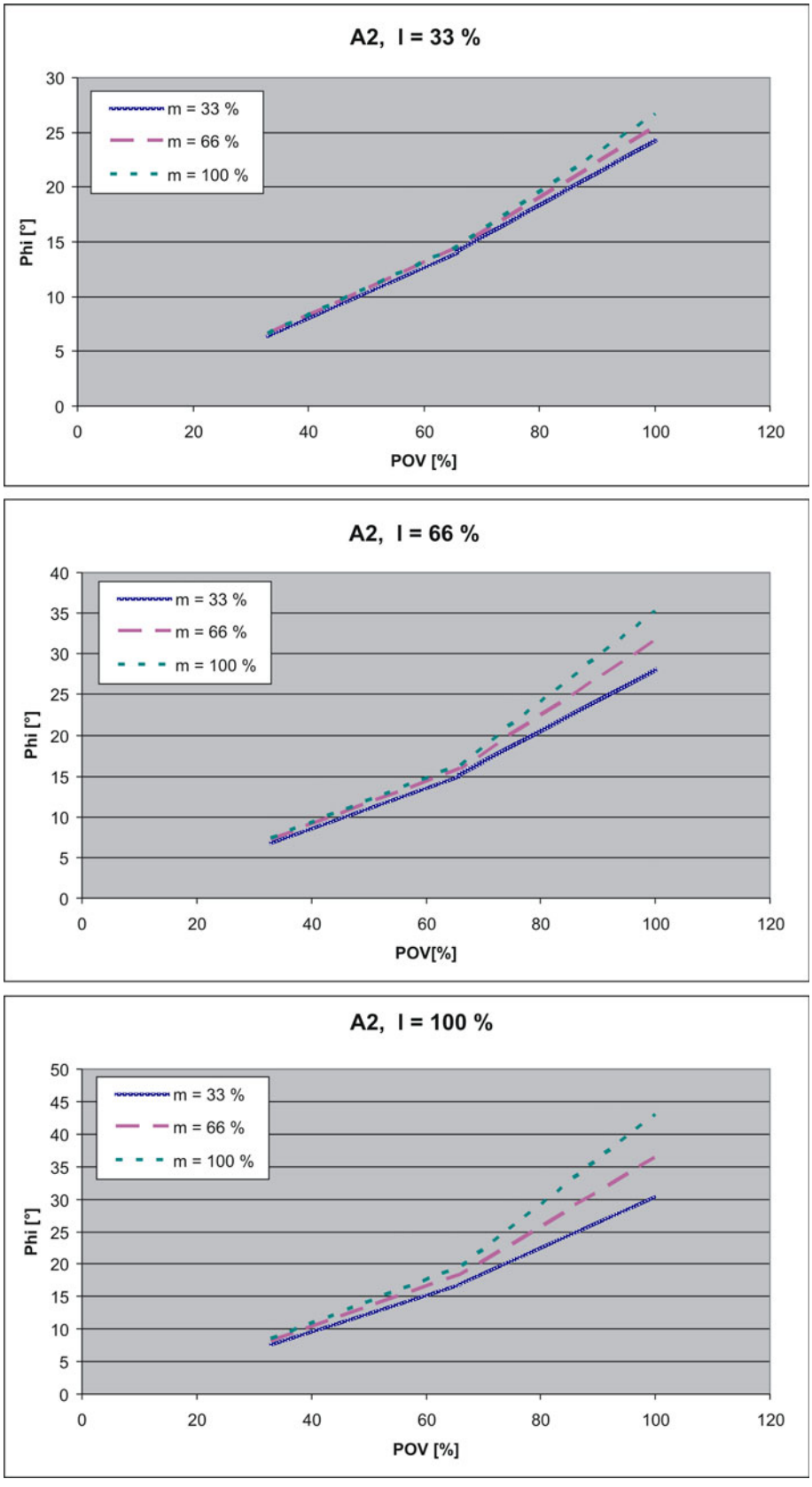


Fig. 4-71: Stopping distances for STOP 1, axis 2

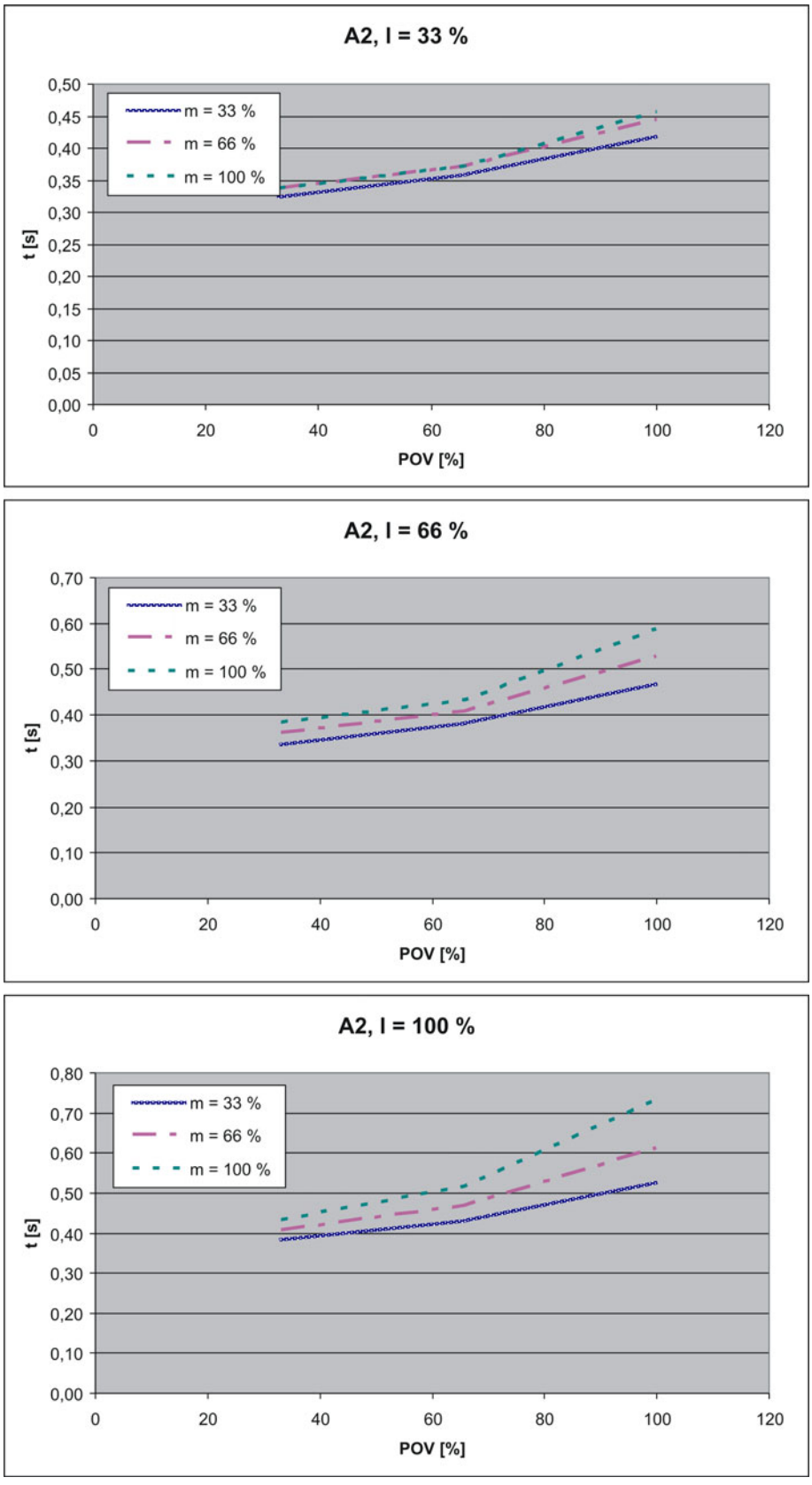


Fig. 4-72: Stopping times for STOP 1, axis 2

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

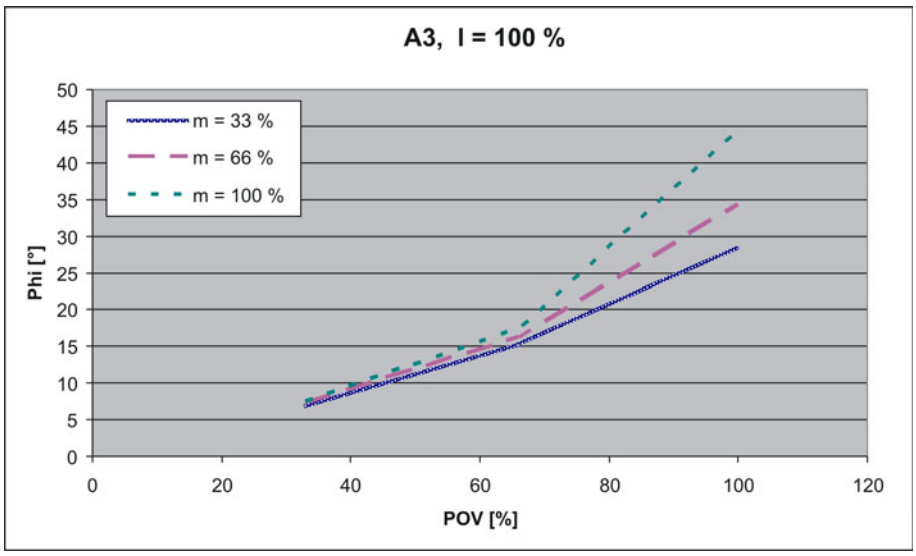


Fig. 4-73: Stopping distances for STOP 1, axis 3

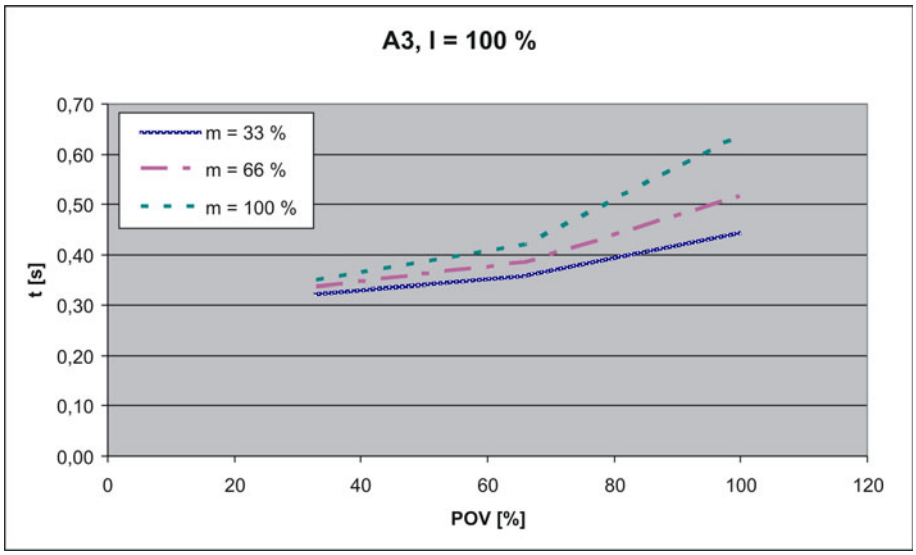


Fig. 4-74: Stopping times for STOP 1, axis 3

4.14.4 Stopping distances and times, KR 240 R2700 prime

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

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

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

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

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

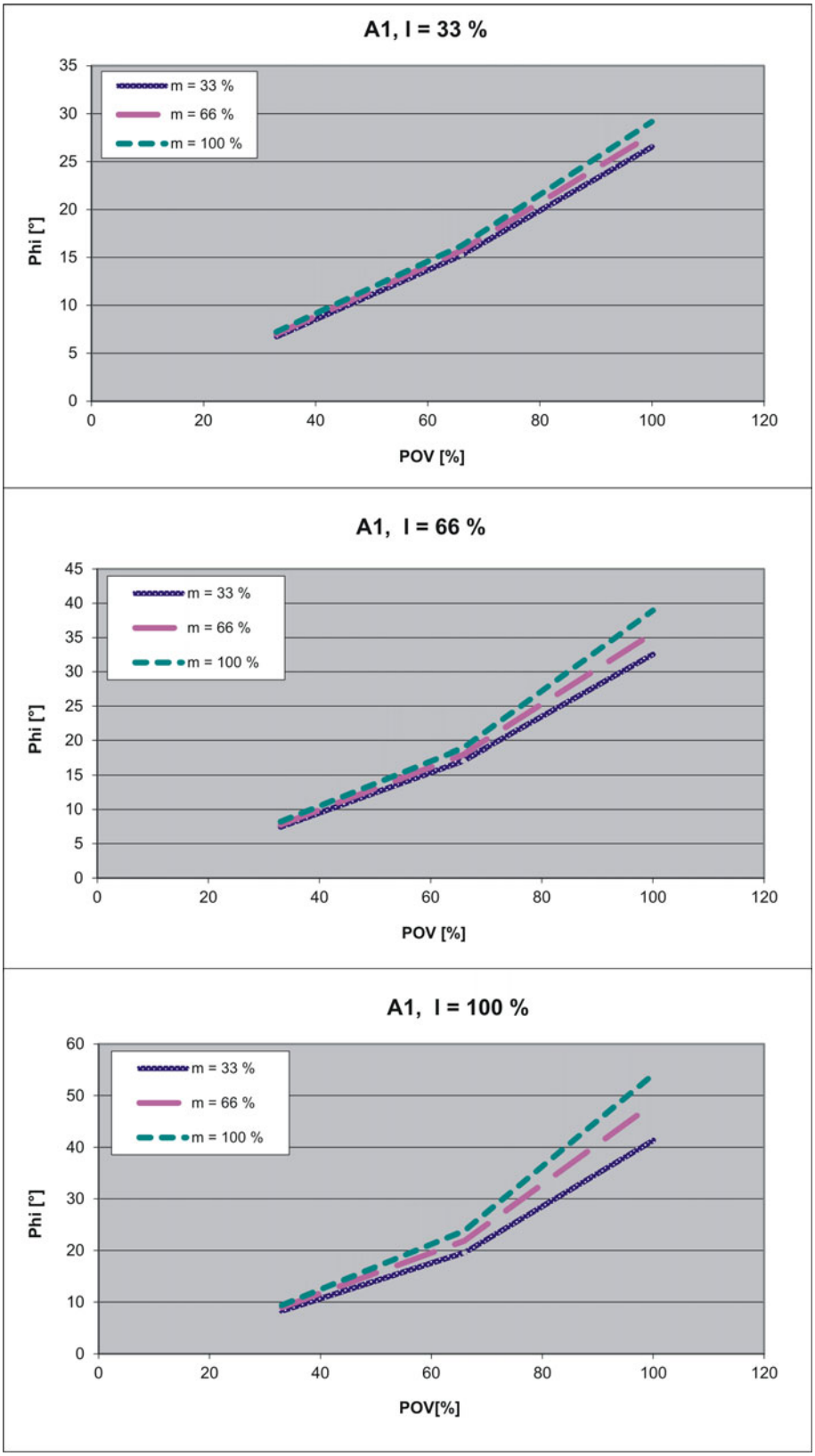


Fig. 4-75: Stopping distances for STOP 1, axis 1

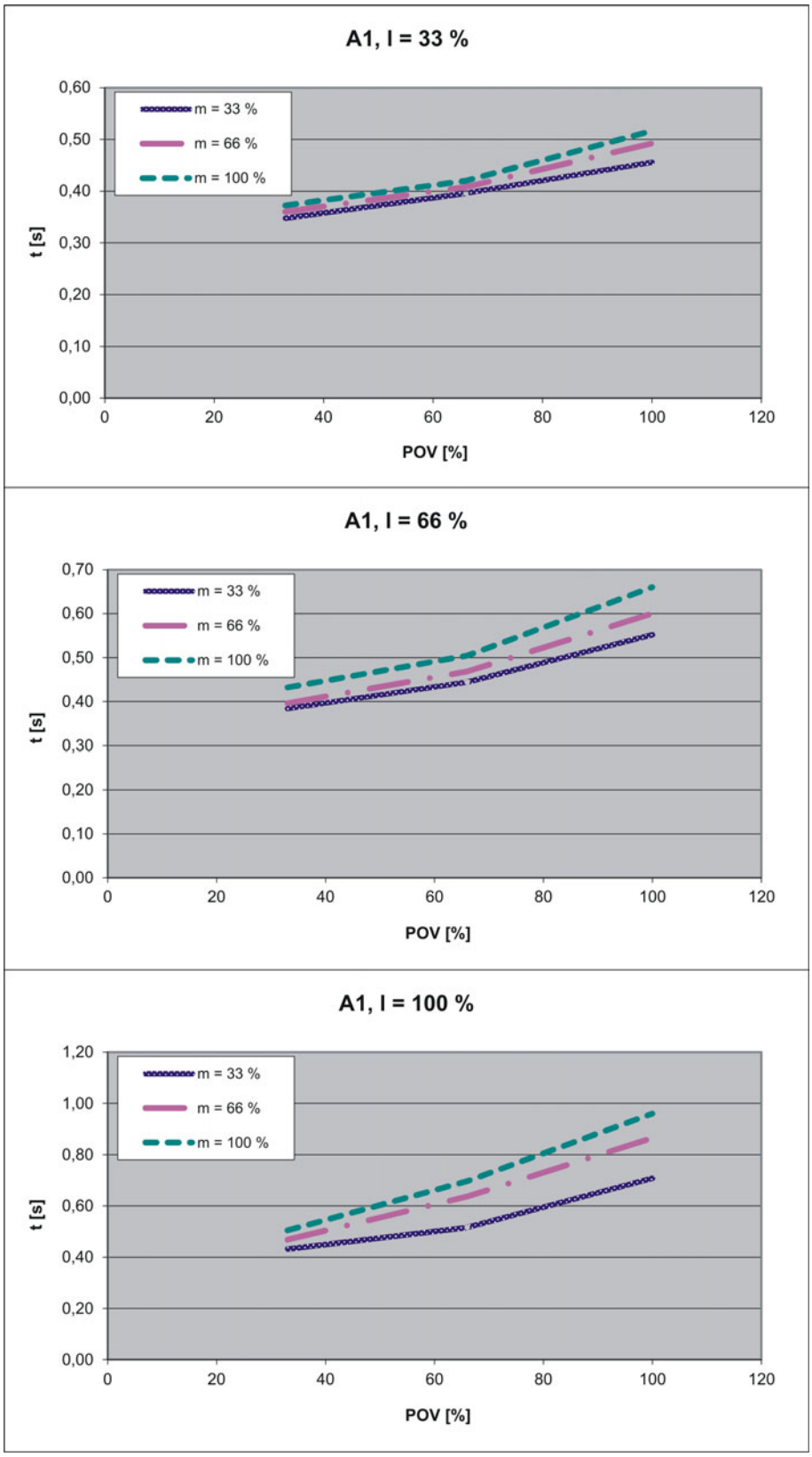


Fig. 4-76: Stopping times for STOP 1, axis 1

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

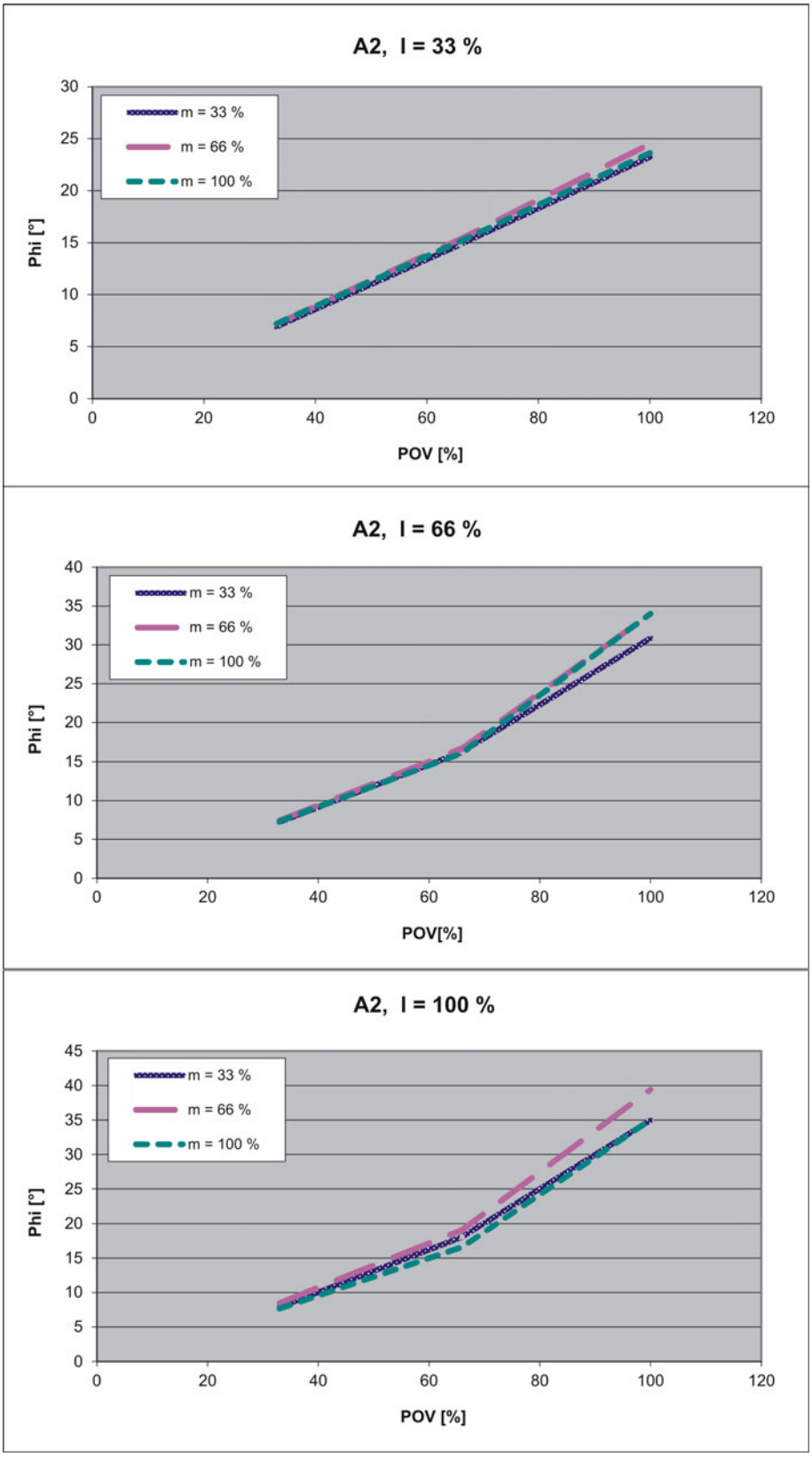


Fig. 4-77: Stopping distances for STOP 1, axis 2

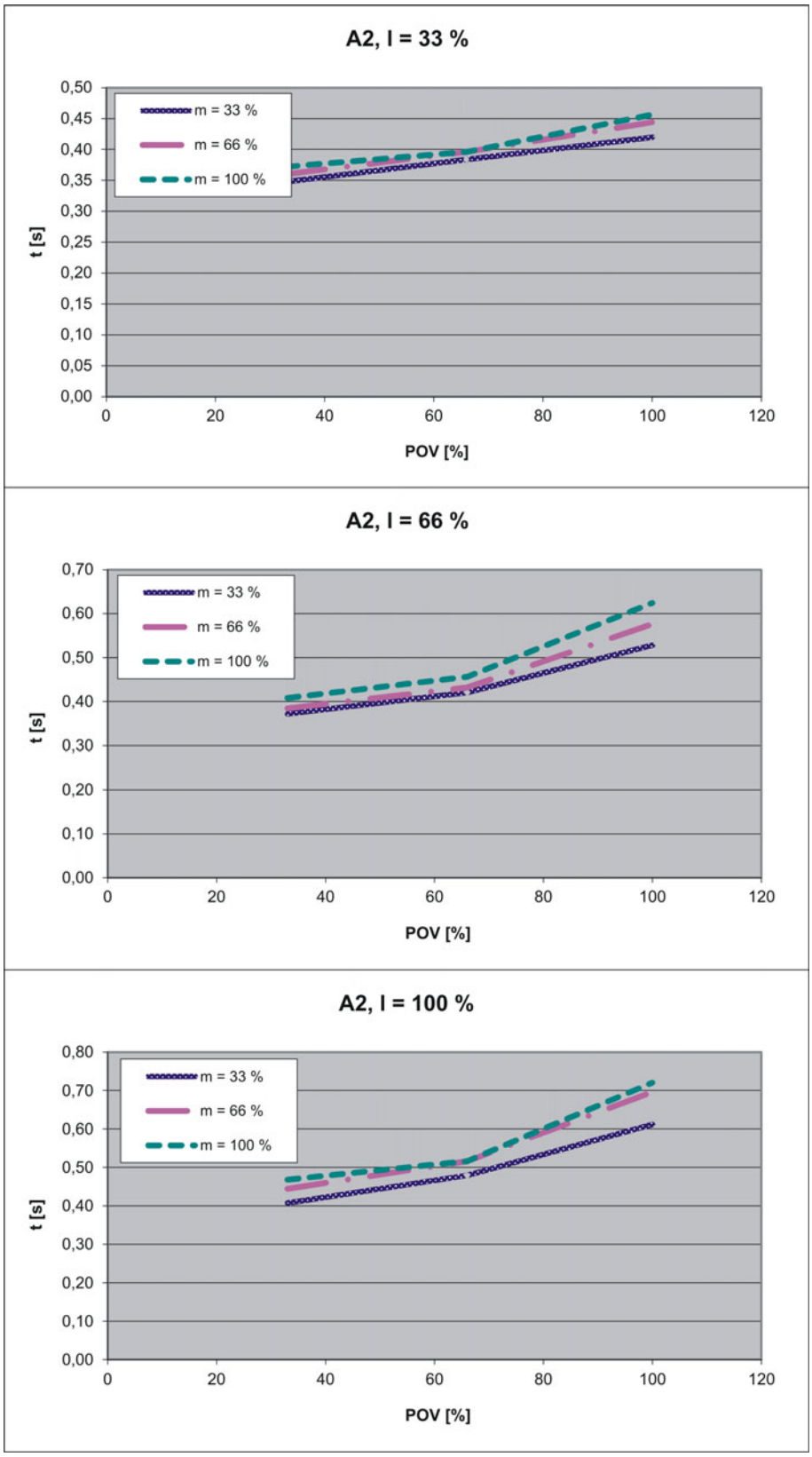


Fig. 4-78: Stopping times for STOP 1, axis 2

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

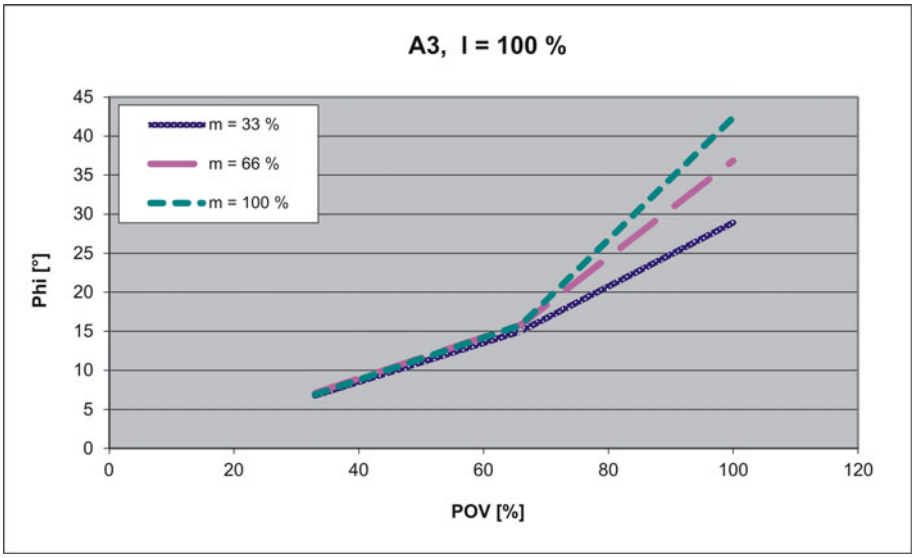


Fig. 4-79: Stopping distances for STOP 1, axis 3

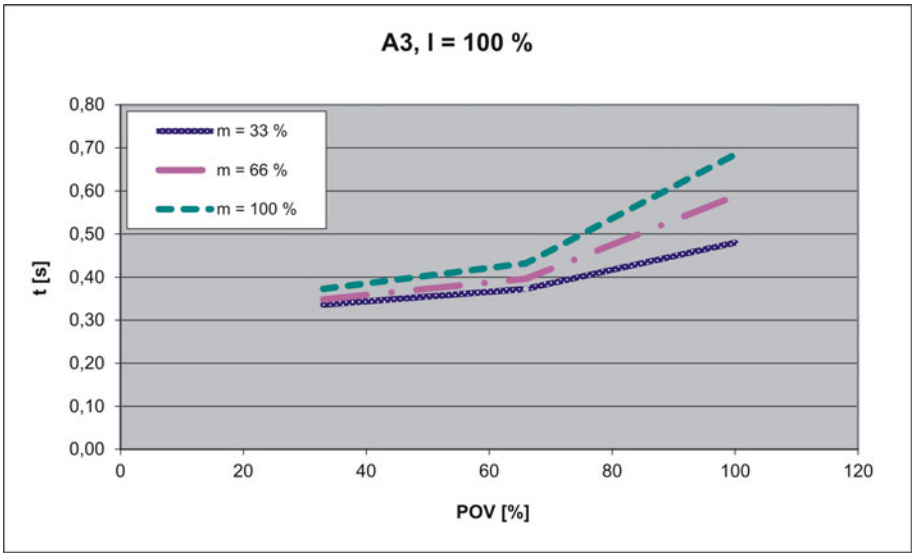


Fig. 4-80: Stopping times for STOP 1, axis 3

4.14.5 Stopping distances and stopping times for KR 210 R2700 prime

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

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

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

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

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

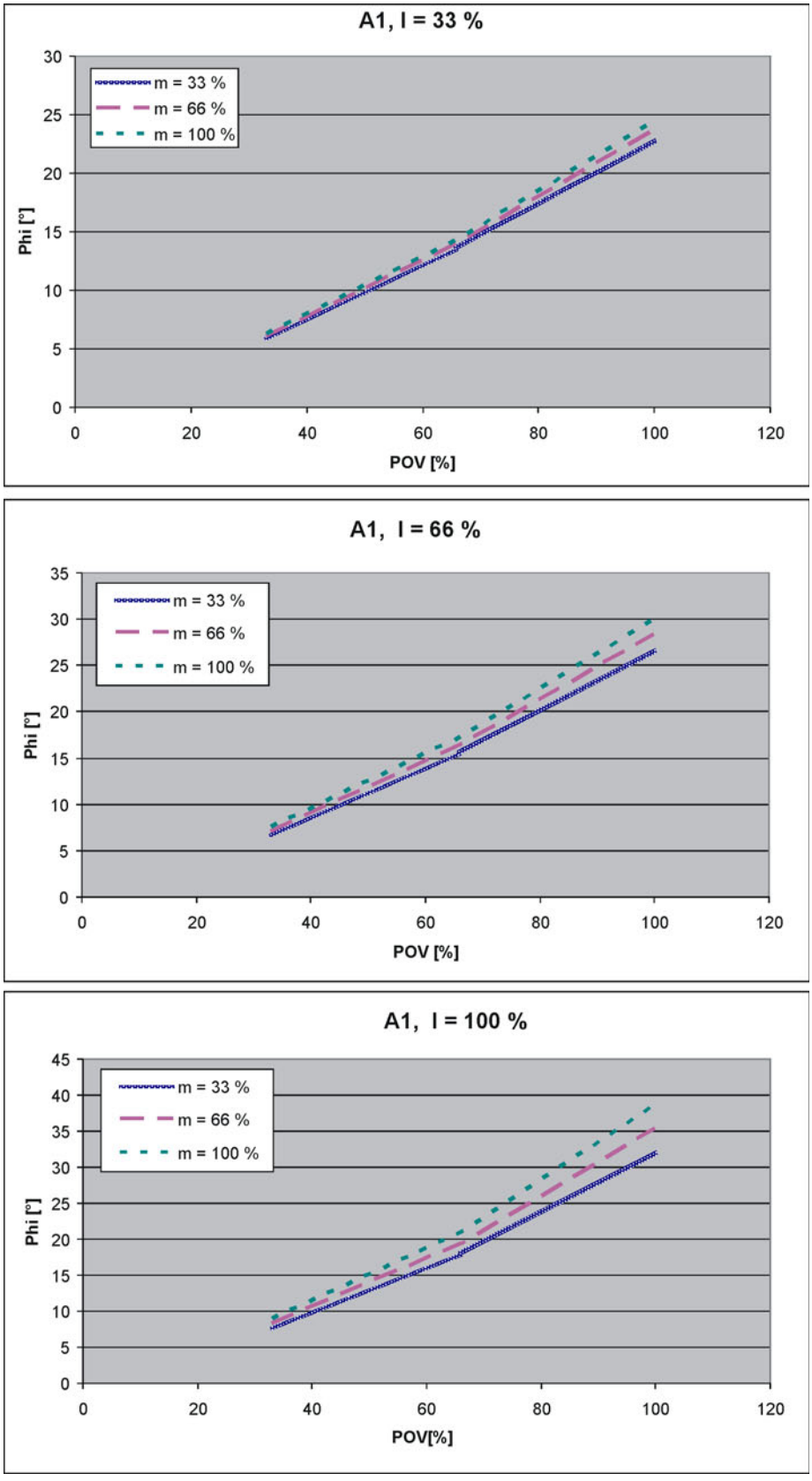


Fig. 4-81: Stopping distances for STOP 1, axis 1

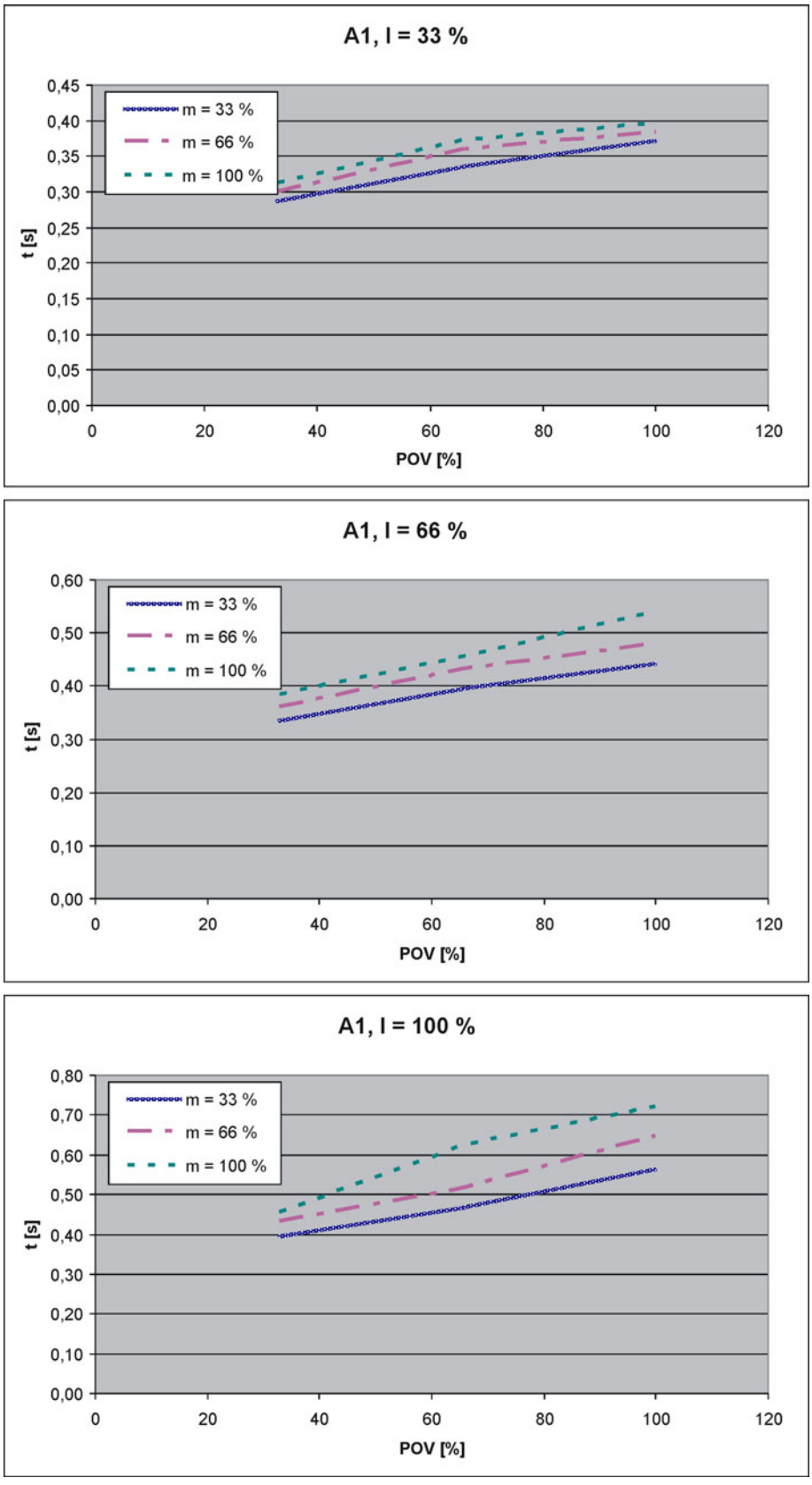


Fig. 4-82: Stopping times for STOP 1, axis 1

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

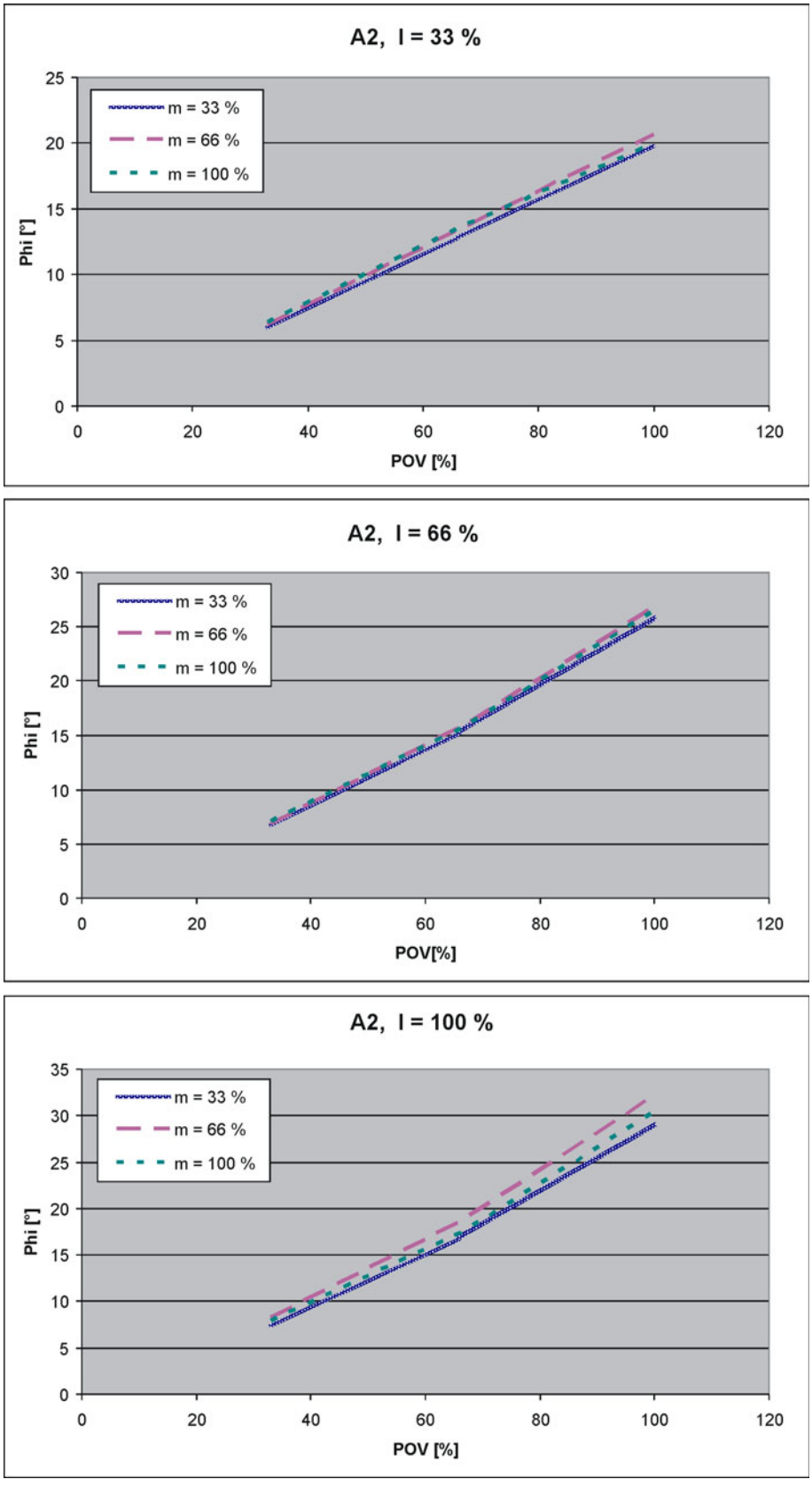


Fig. 4-83: Stopping distances for STOP 1, axis 2

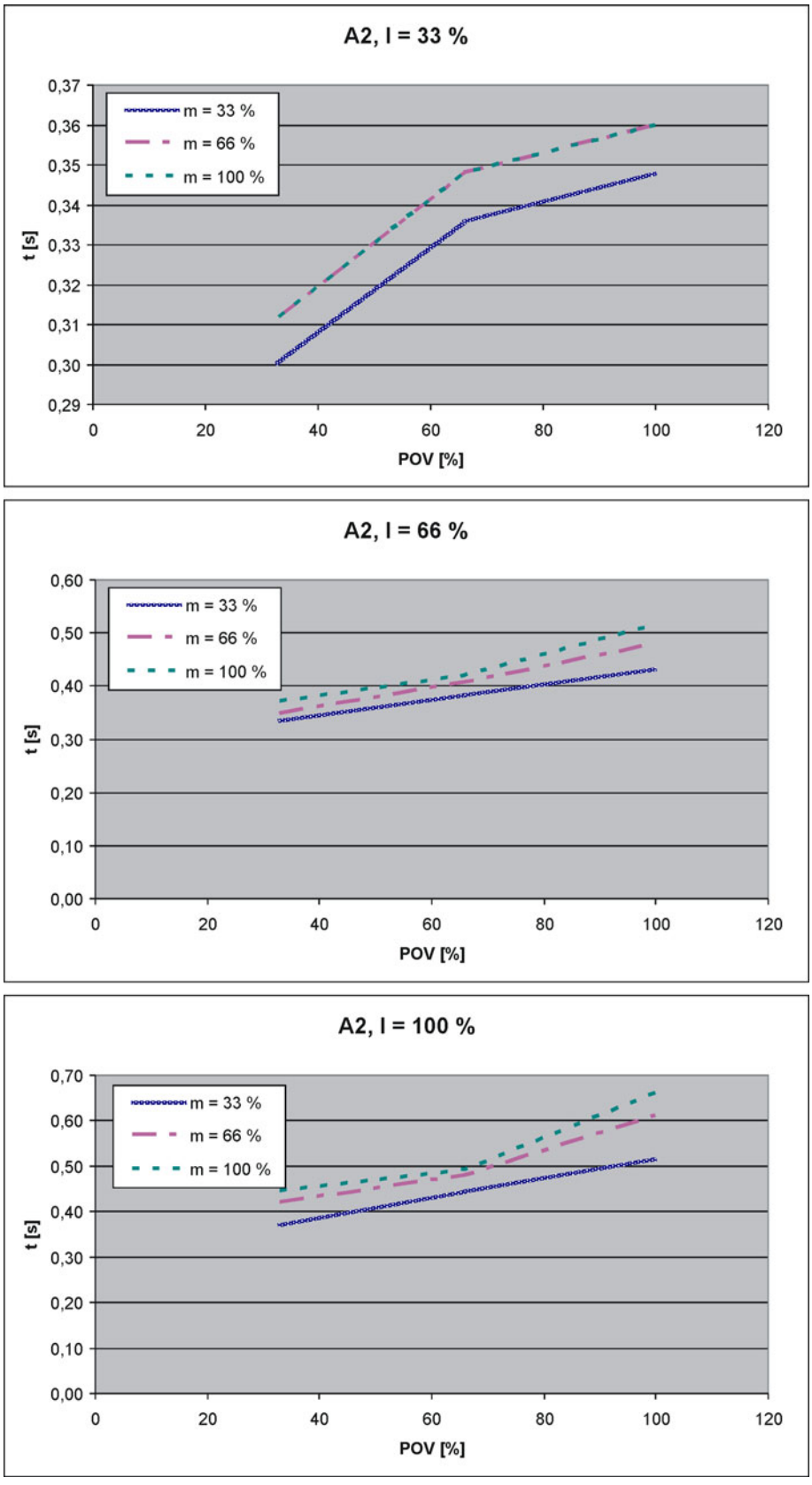


Fig. 4-84: Stopping times for STOP 1, axis 2

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

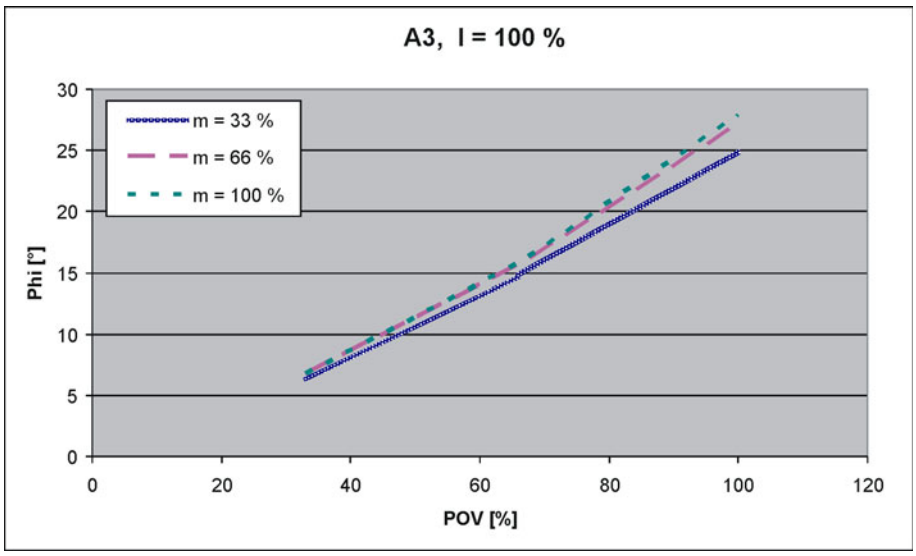


Fig. 4-85: Stopping distances for STOP 1, axis 3

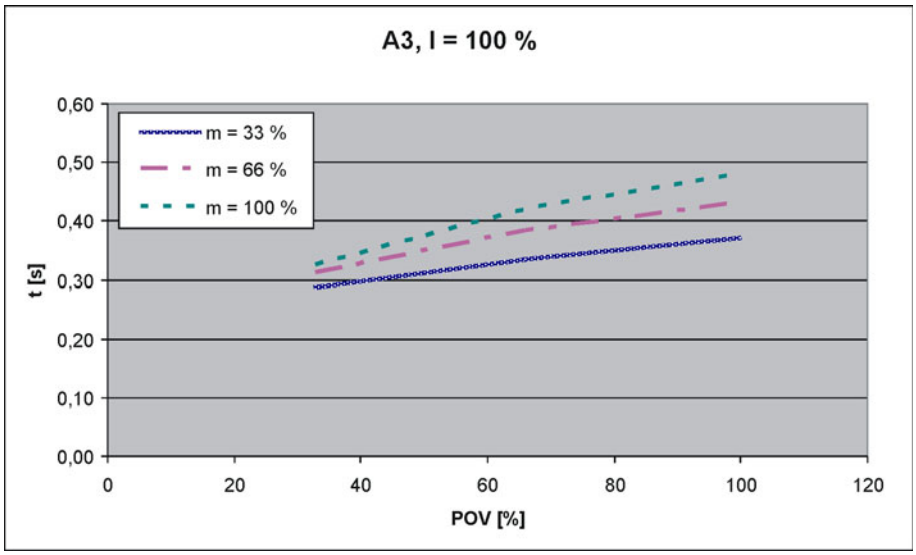


Fig. 4-86: Stopping times for STOP 1, axis 3

4.14.6 Stopping distances and times, KR 210 R2700 prime C

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

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

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

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

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

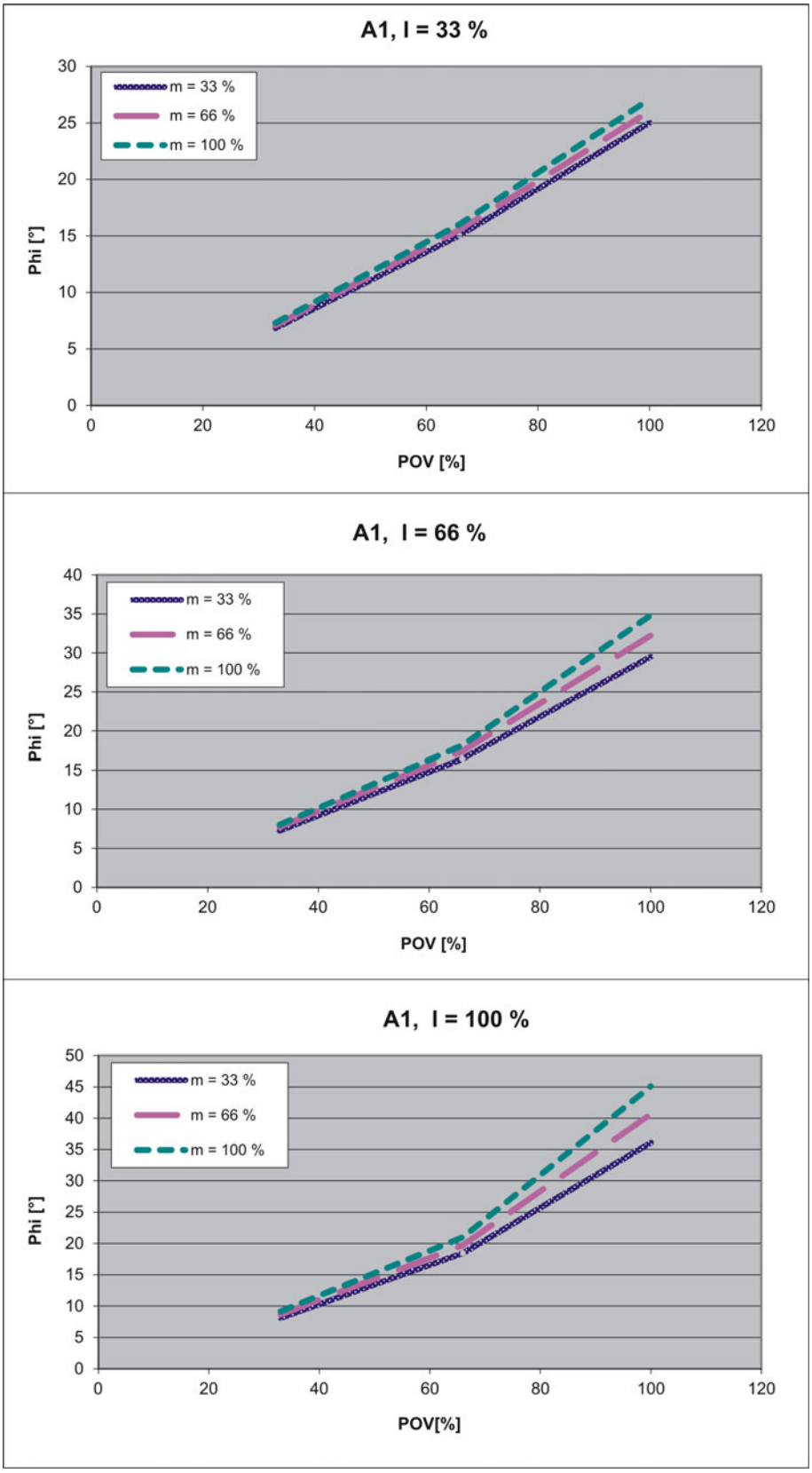


Fig. 4-87: Stopping distances for STOP 1, axis 1

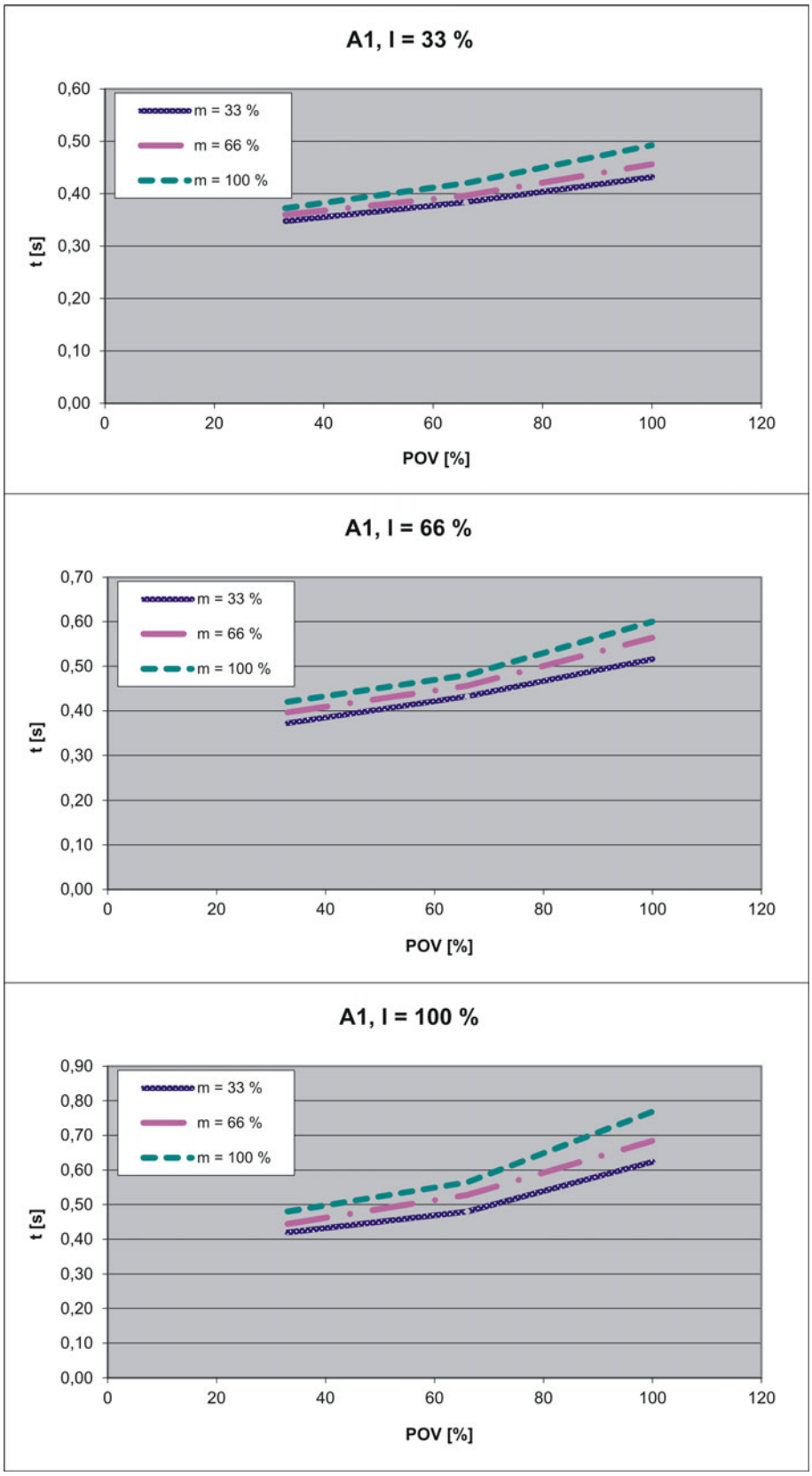


Fig. 4-88: Stopping times for STOP 1, axis 1

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

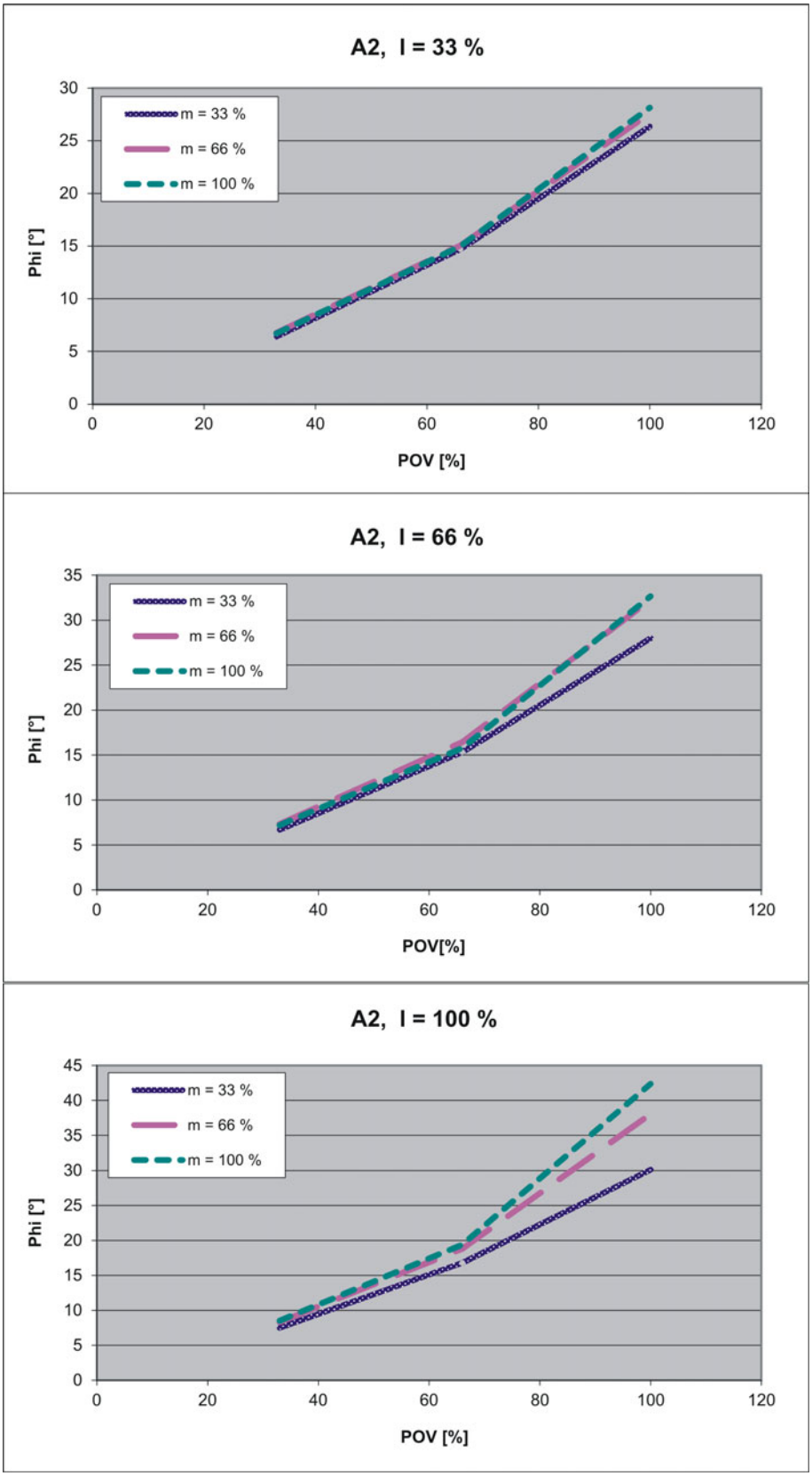


Fig. 4-89: Stopping distances for STOP 1, axis 2

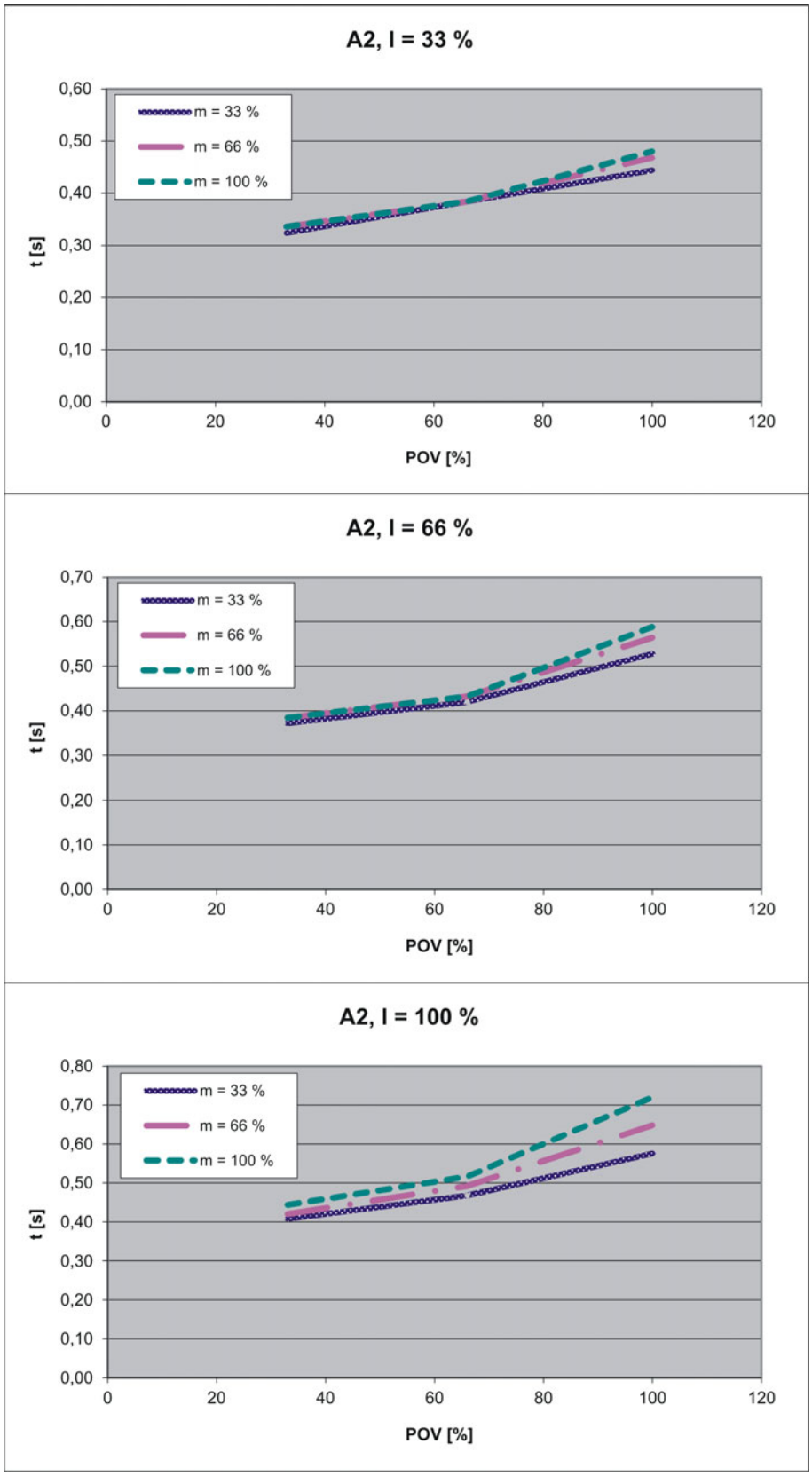


Fig. 4-90: Stopping times for STOP 1, axis 2

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

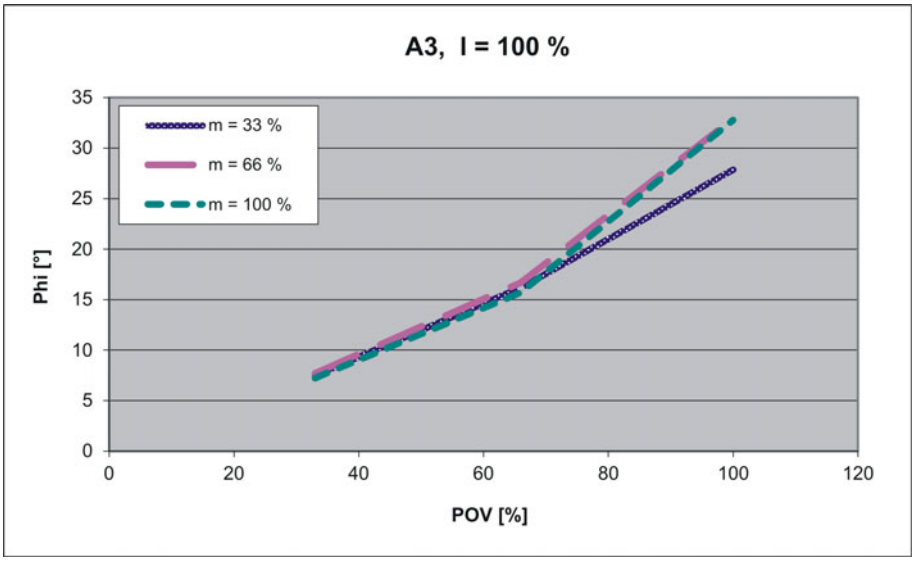


Fig. 4-91: Stopping distances for STOP 1, axis 3

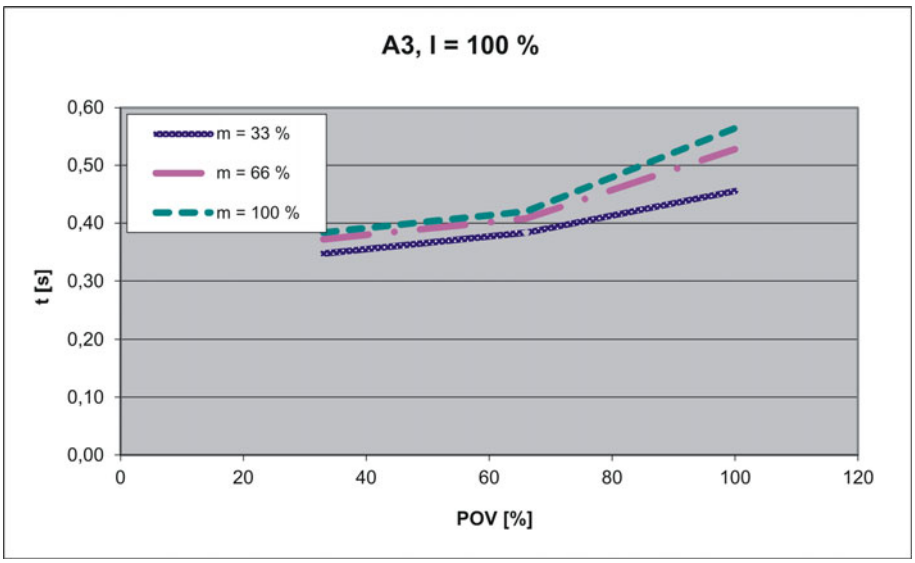


Fig. 4-92: Stopping times for STOP 1, axis 3

4.14.7 Stopping distances and stopping times for KR 180 R2900 prime

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

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

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

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

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

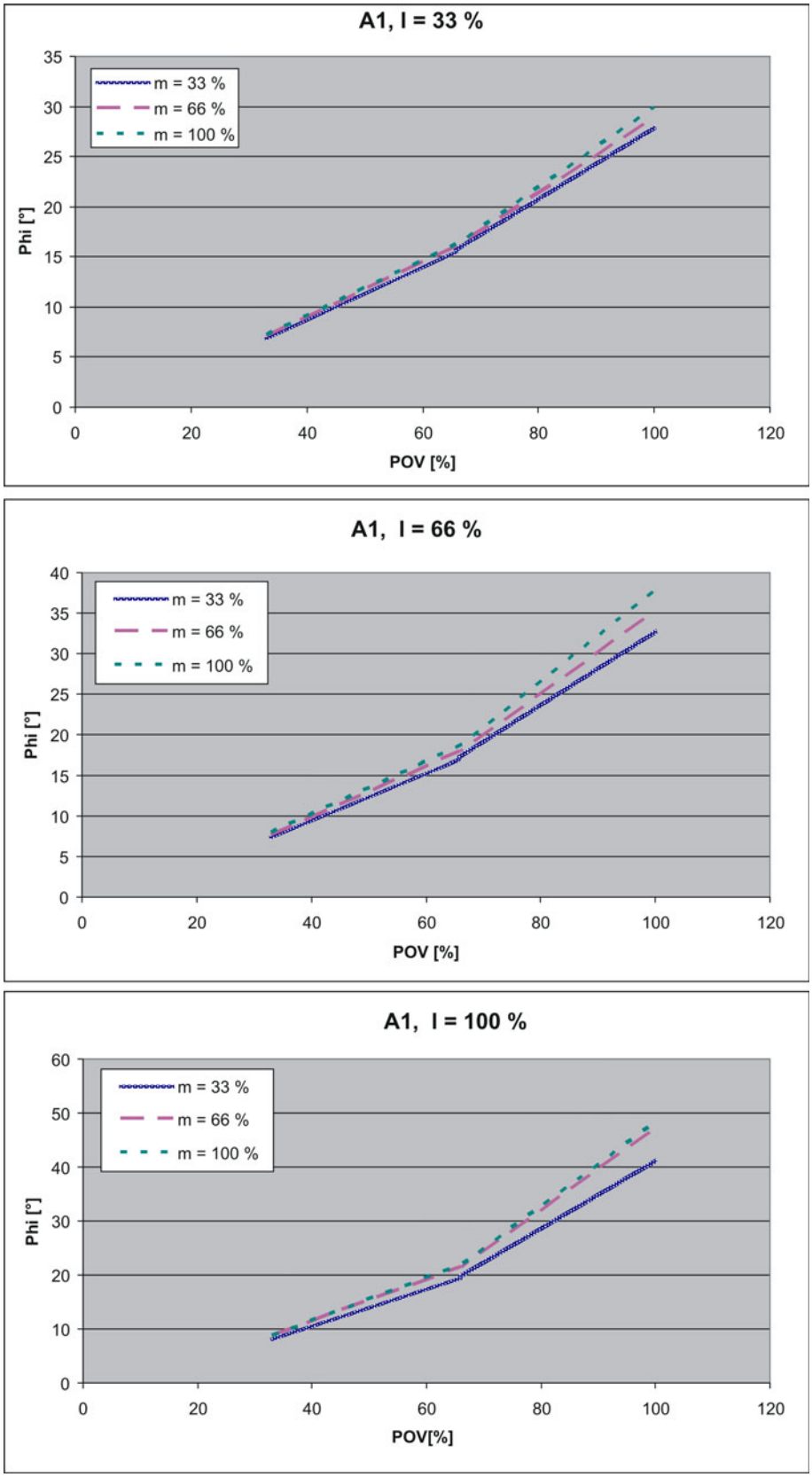


Fig. 4-93: Stopping distances for STOP 1, axis 1

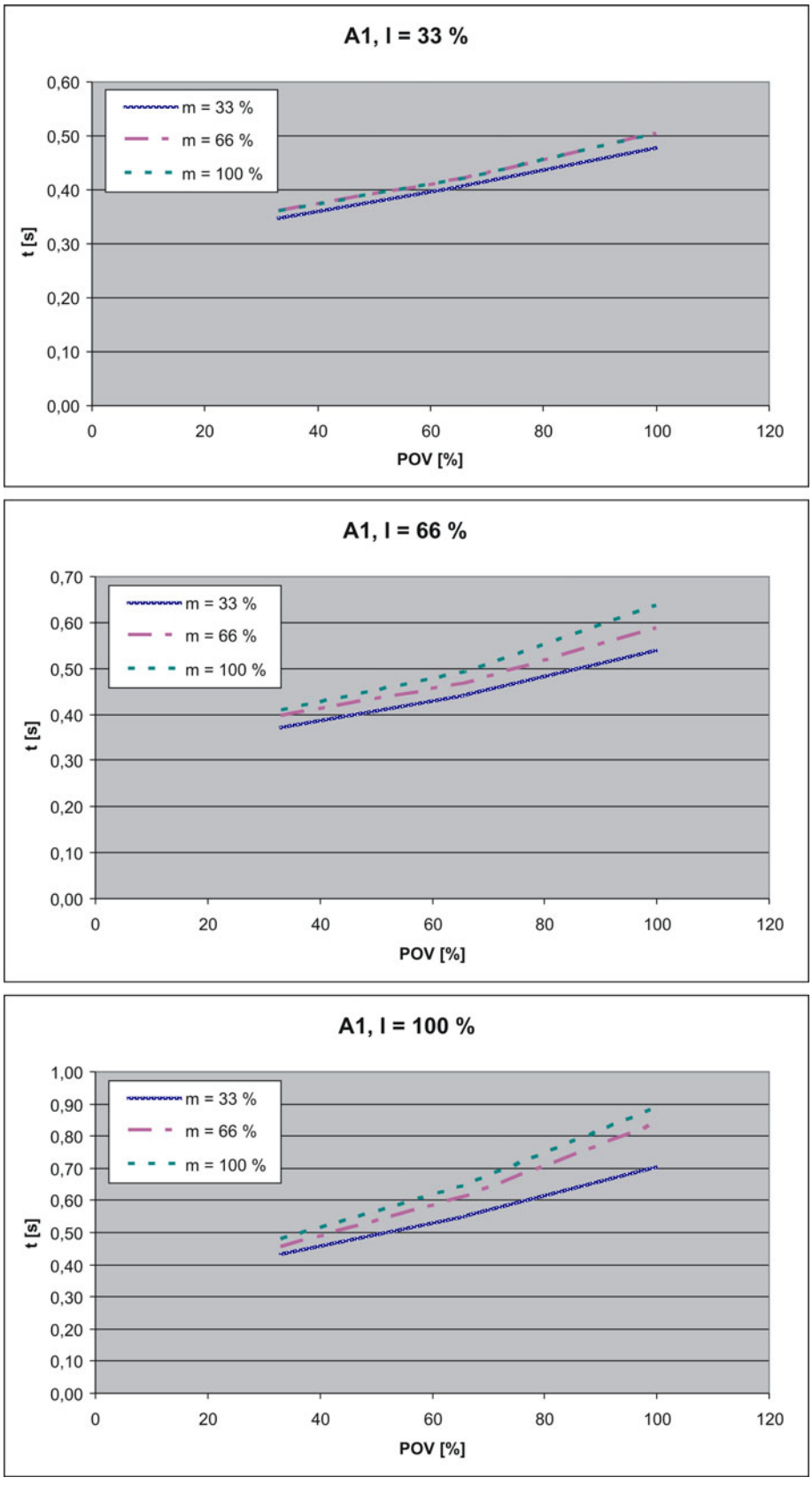


Fig. 4-94: Stopping times for STOP 1, axis 1

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

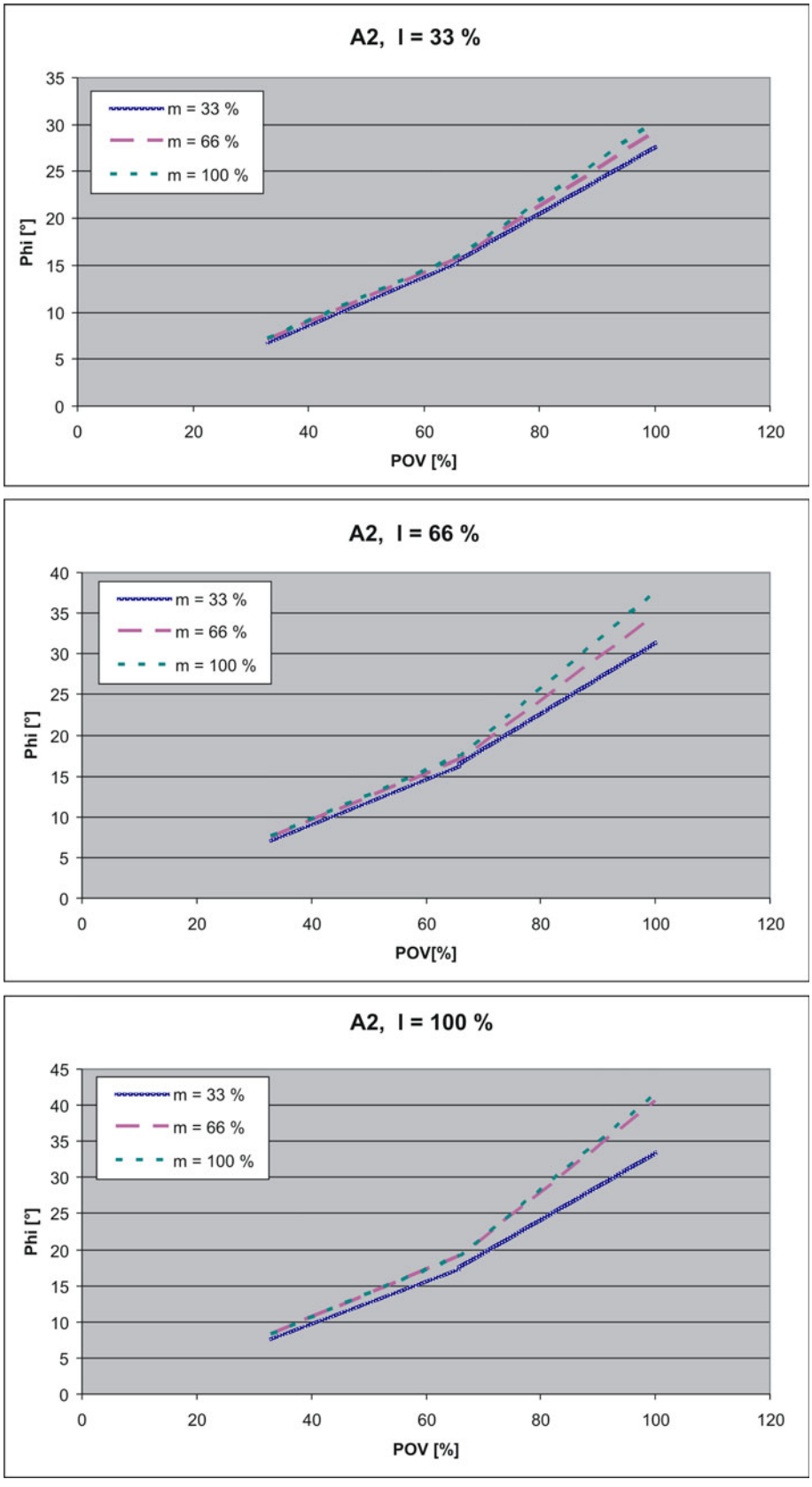


Fig. 4-95: Stopping distances for STOP 1, axis 2

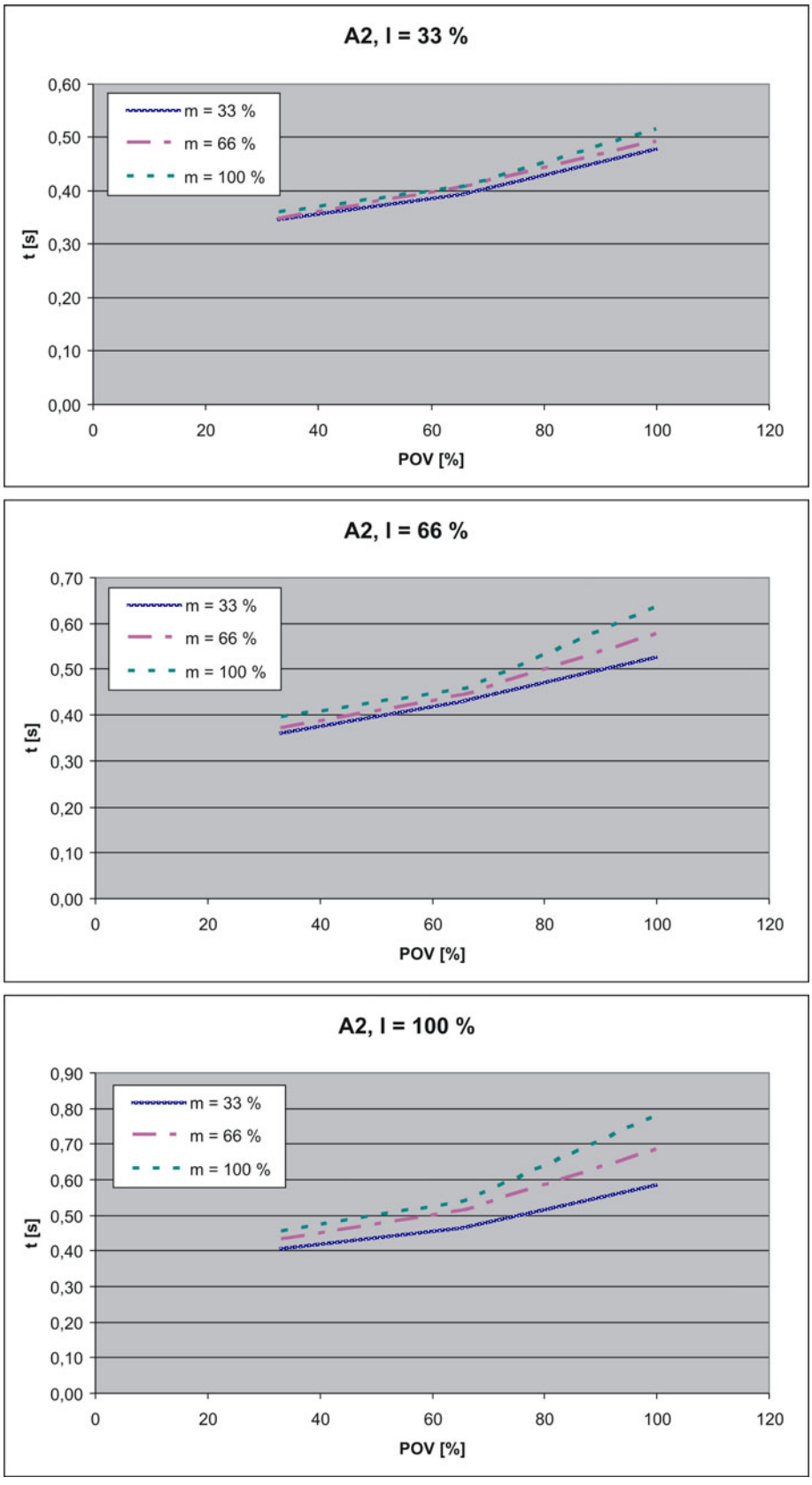


Fig. 4-96: Stopping times for STOP 1, axis 2

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

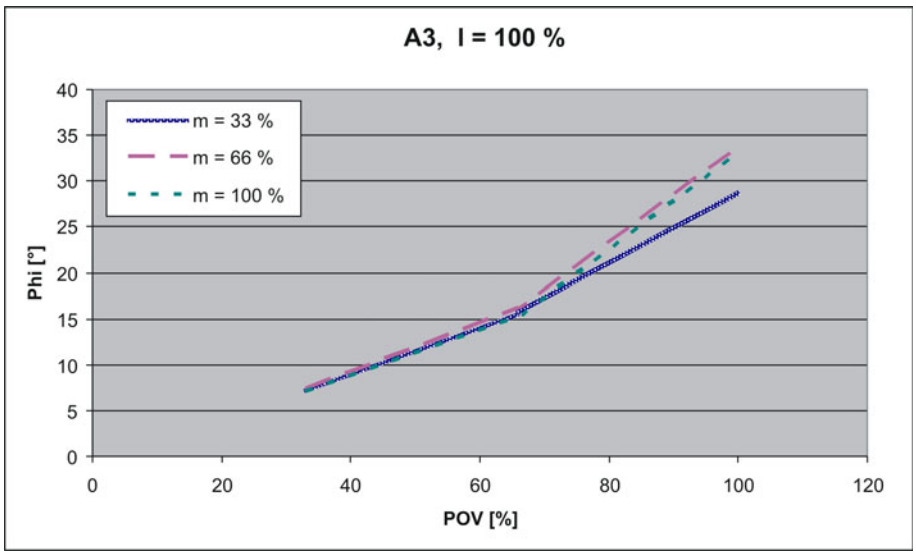


Fig. 4-97: Stopping distances for STOP 1, axis 3

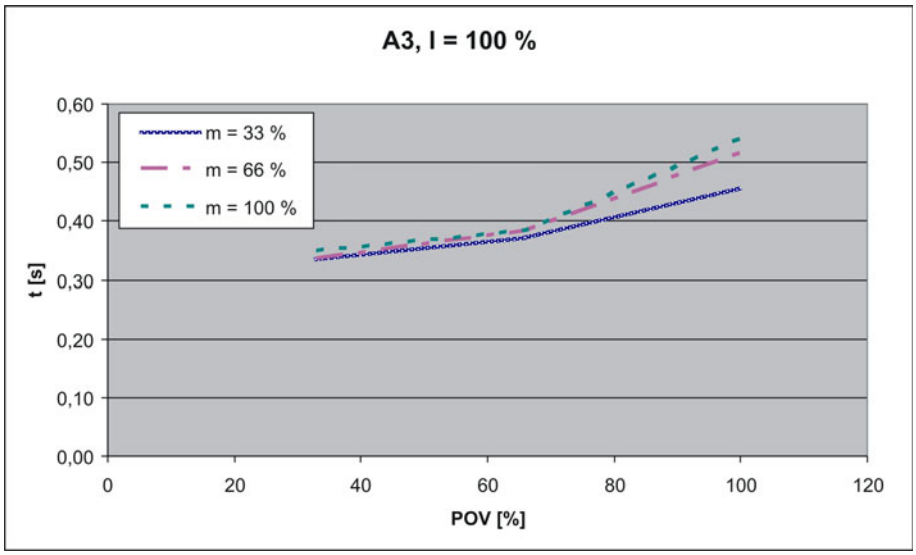


Fig. 4-98: Stopping times for STOP 1, axis 3

4.14.8 Stopping distances and stopping times for KR 150 R3100 prime

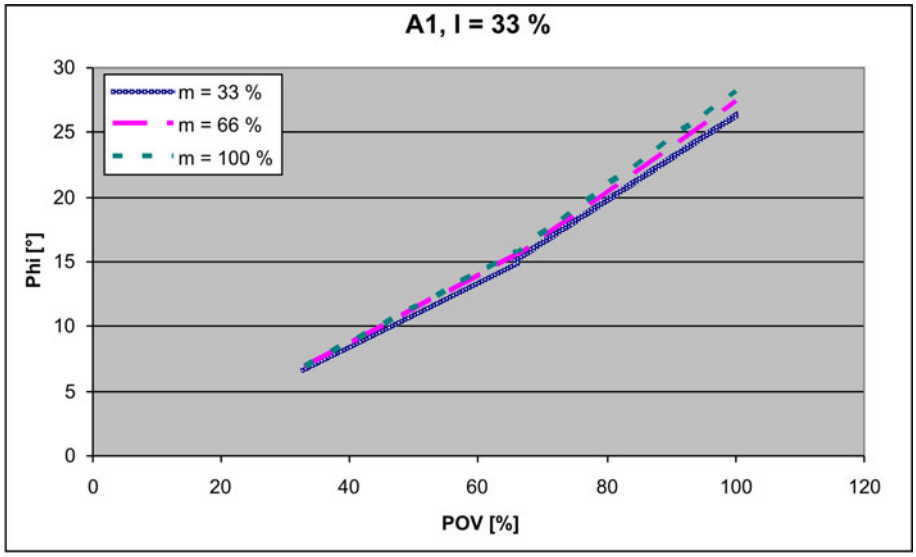
4.14.8.1 Stopping distances and stopping times for STOP 0, axis 1 to axis 3

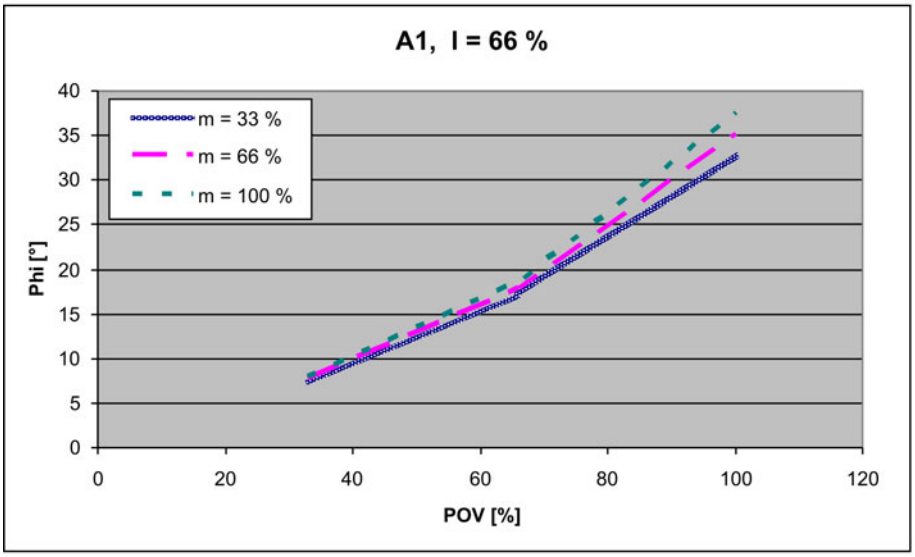
The table shows the stopping distances and stopping times after a STOP 0 (category 0 stop) is triggered. The values refer to the following configuration:

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

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

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





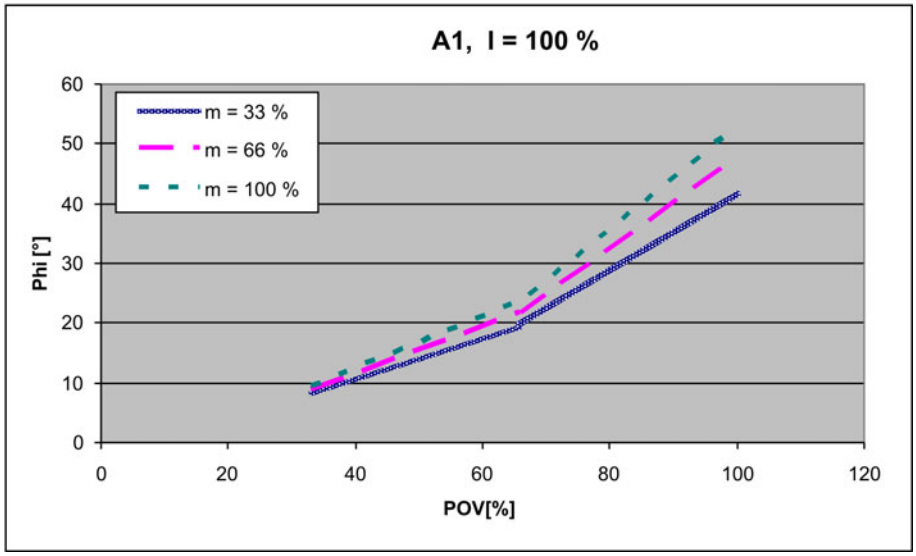


Fig. 4-99: Stopping distances for STOP 1, axis 1

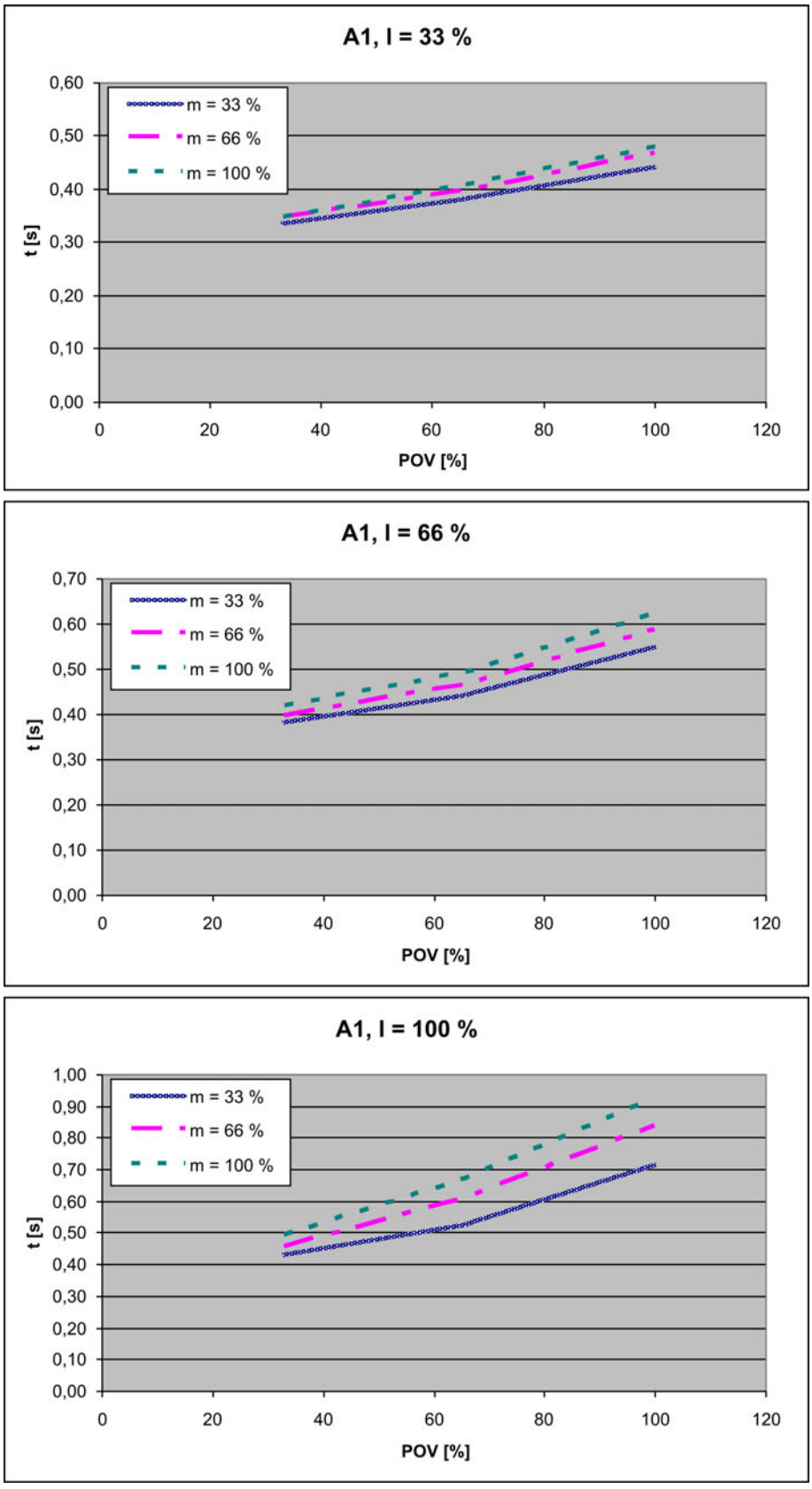


Fig. 4-100: Stopping times for STOP 1, axis 1

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

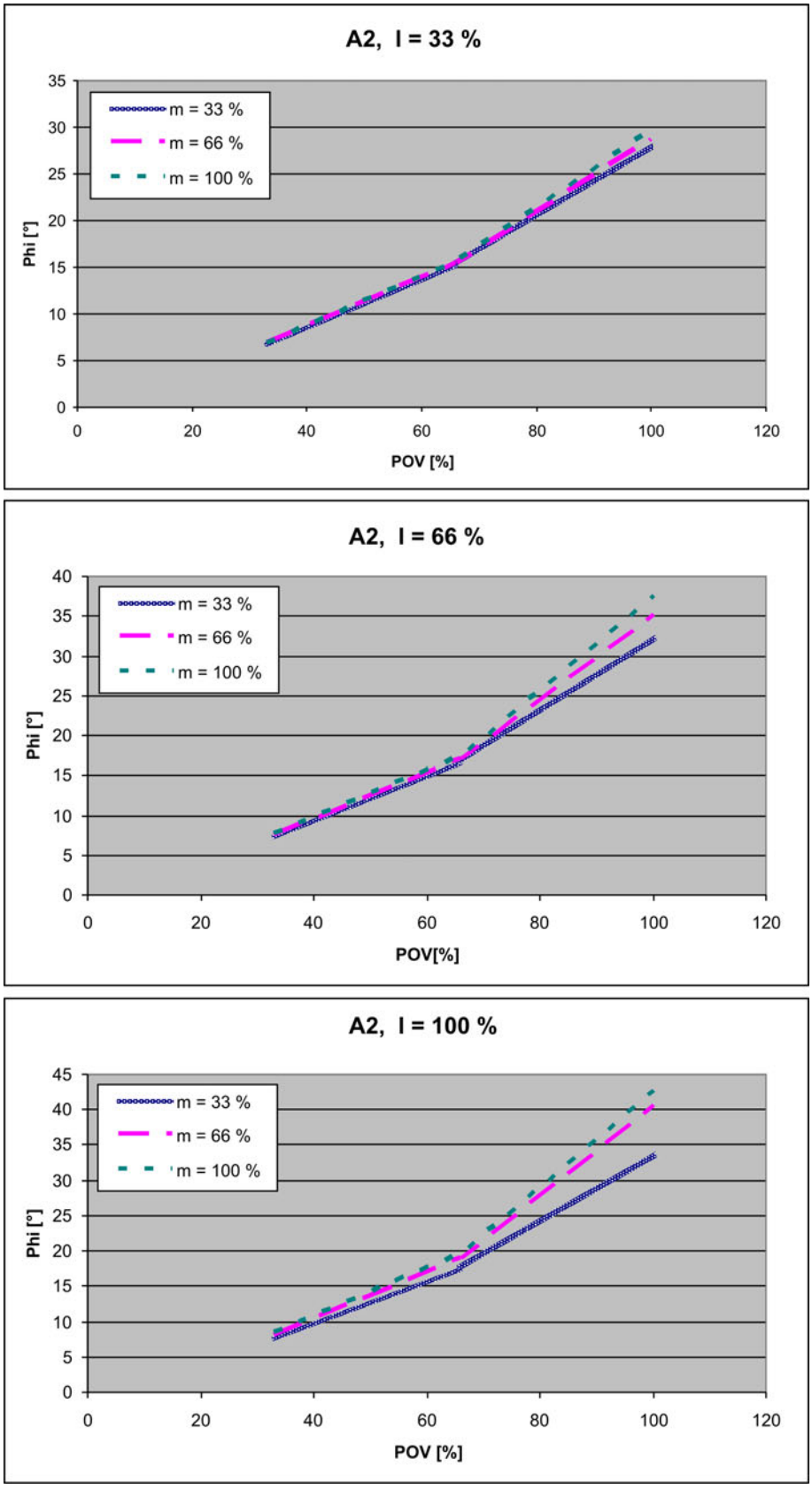


Fig. 4-101: Stopping distances for STOP 1, axis 2

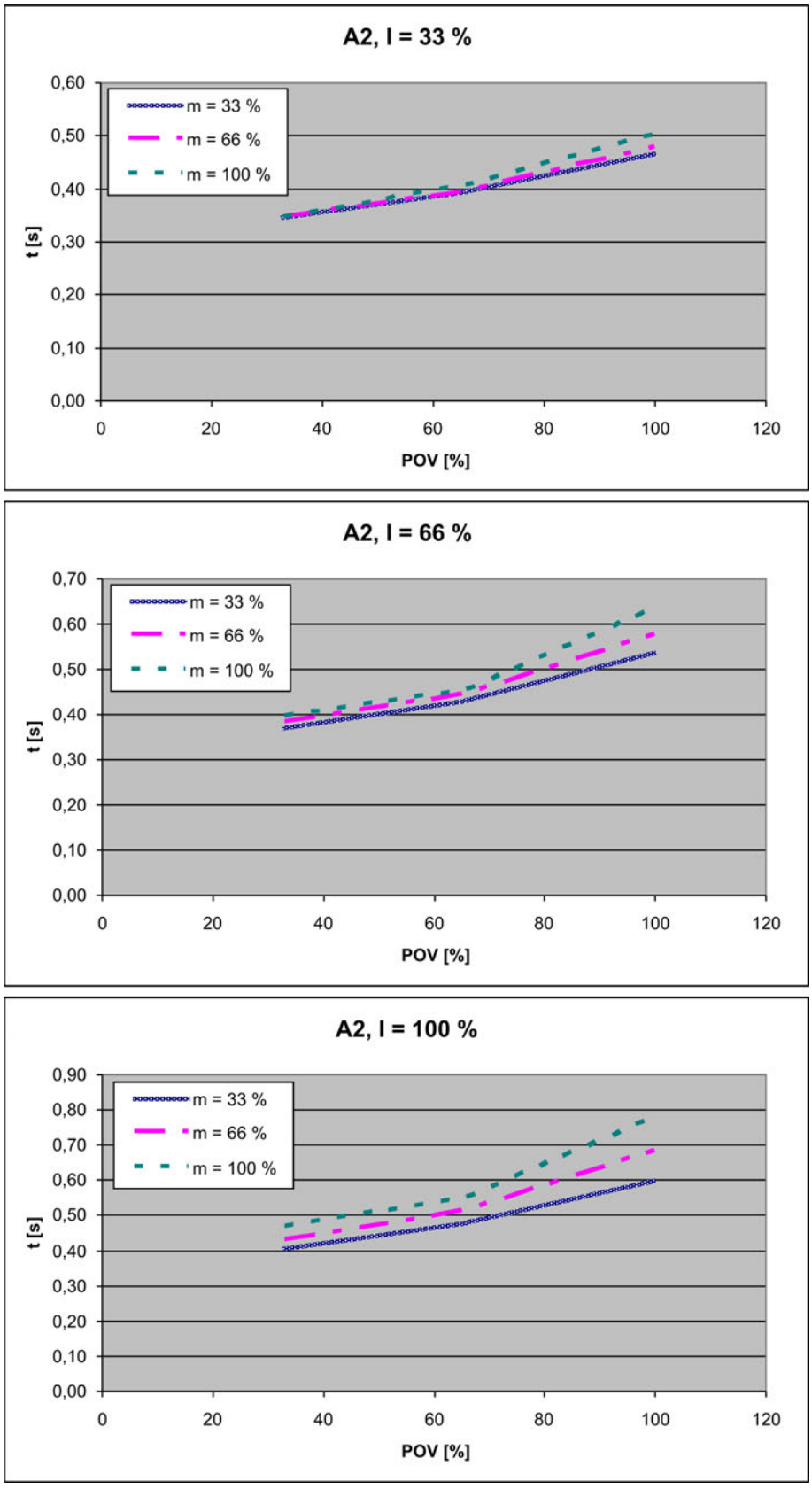


Fig. 4-102: Stopping times for STOP 1, axis 2

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

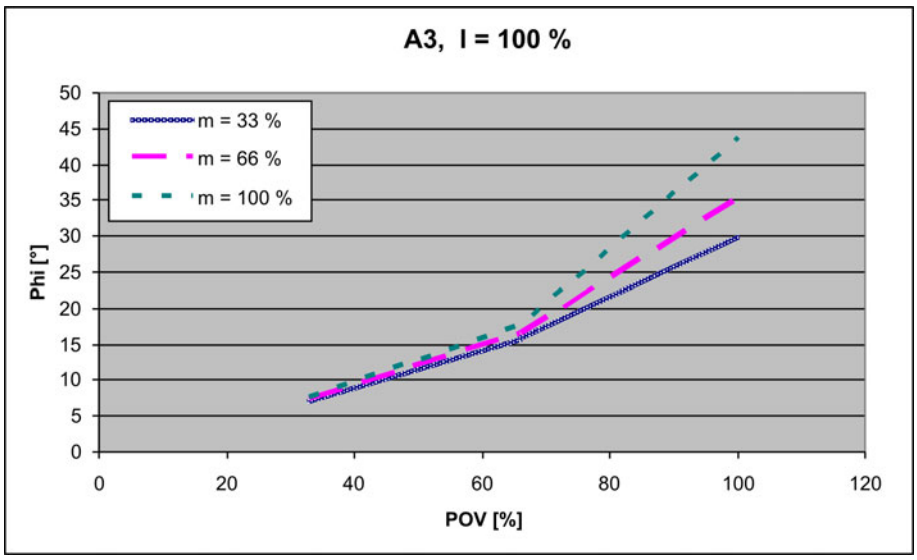


Fig. 4-103: Stopping distances for STOP 1, axis 3

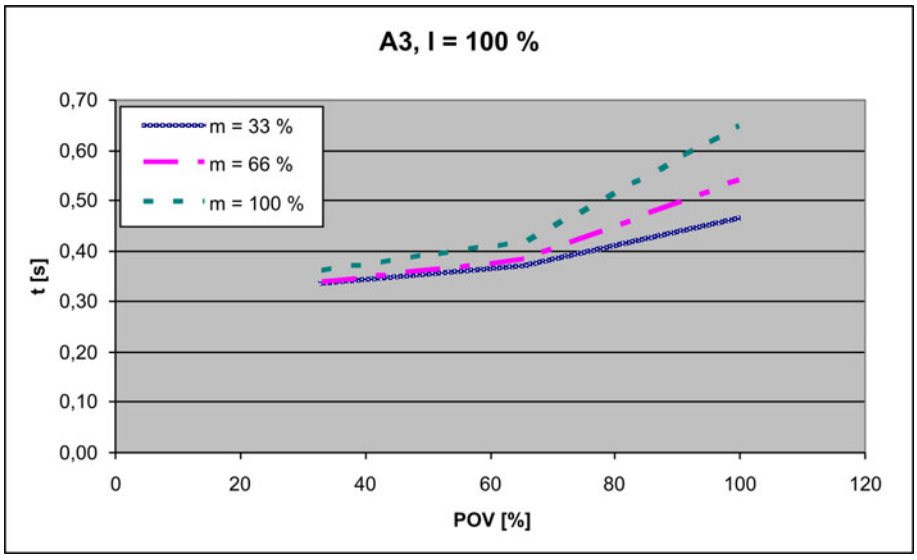


Fig. 4-104: Stopping times for STOP 1, axis 3

5 Safety

5.1 General

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

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

5.1.1 Liability

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

Components of the industrial robot:

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

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

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

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

Safety information

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

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

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

5.1.2 Intended use of the industrial robot

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

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

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

Misuse

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

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

5.1.3 EC declaration of conformity and declaration of incorporation

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

- The industrial robot is integrated into a complete system.

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

  or: All safety functions and safeguards required for operation in the complete machine as defined by the EC Machinery Directive have been added to the industrial robot.
- The complete system complies with the EC Machinery Directive. This has been confirmed by means of 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 robot controller or elsewhere or not, as safety-relevant components are also subject to aging during storage.
KCP	KUKA Control Panel Teach pendant for the KR C2/KR C2 edition2005 The KCP has all the operator control and display functions required for operating and programming the industrial robot.
KUKA smartPAD	see “smartPAD”
Manipulator	The robot arm and the associated electrical installations
Safety zone	The safety zone is situated outside the danger zone.
smartPAD	Teach pendant for the KR C4 The smartPAD has all the operator control and display functions required for operating and programming the industrial robot.
Stop category 0	The drives are deactivated immediately and the brakes are applied. The manipulator and any external axes (optional) perform path-oriented braking. **Note:** This stop category is called STOP 0 in this document.
Stop category 1	The manipulator and any external axes (optional) perform path-maintaining braking. The drives are deactivated after 1 s and the brakes are applied. **Note:** This stop category is called STOP 1 in this document.
Stop category 2	The drives are not deactivated and the brakes are not applied. The manipulator and any external axes (optional) are braked with a normal braking ramp. **Note:** This stop category is called STOP 2 in this document.
System integrator (plant integrator)	System integrators are people who safely integrate the industrial robot into a complete system and commission it.
T1	Test mode, Manual Reduced Velocity (<= 250 mm/s)
T2	Test mode, Manual High Velocity (> 250 mm/s permissible)
External axis	Motion axis which is not part of the manipulator but which is controlled using the robot controller, e.g. KUKA linear unit, turn-tilt table, Posiflex.

5.2 Personnel

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

- User

- Personnel

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

User

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

- The user must comply with his monitoring obligations.
- The user must carry out 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

Operator

The operator must meet the following preconditions:

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

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

5.3 Workspace, safety zone and danger zone

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

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

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

5.4 Overview of protective equipment

The protective equipment of the mechanical component may include:

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

Not all equipment is relevant for every mechanical component.

5.4.1 Mechanical end stops

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

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

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

5.4.2 Mechanical axis range limitation (optional)

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

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

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

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

5.4.3 Axis range monitoring (optional)

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

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

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

5.4.4 Options for moving the manipulator without drive energy

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

Description

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

- Release device (optional)

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

  The brake release device is designed for robot variants whose motors are not freely accessible.
- Moving the wrist axes directly by hand

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

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

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

5.4.5 Labeling on the industrial robot

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

Labeling on the industrial robot consists of:

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

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

5.5 Safety measures

5.5.1 General safety measures

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

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

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

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

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

KCP/smartPAD

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

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

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

External keyboard, external mouse

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

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

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

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

Modifications

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

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

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

Faults

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

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

5.5.2 Transportation

Manipulator

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

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

Robot controller

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

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

External axis (optional)

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

5.5.3 Start-up and recommissioning

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

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

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

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

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

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

Function test

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

It must be ensured that:

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

⚠ WARNING In the case of such damage, the affected components must be exchanged. In particular, the motor and counterbalancing system must be checked carefully.
External forces can cause non-visible damage. For example, it can lead to a gradual loss of drive power from the motor, resulting in unintended movements of the manipulator. Death, injuries or considerable damage to property may otherwise result.

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

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 Roboter GmbH for this purpose.

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

Robot controller

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

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

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

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

Counterbalancing system

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

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

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

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

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

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

Hazardous substances

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

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

To ensure safe use of our products, we recommend 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	Definition	Edition
2006/42/EC	**Machinery Directive:** Directive 2006/42/EC of the European Parliament and of the Council of 17 May 2006 on machinery, and amending Directive 95/16/EC (recast)	2006
2014/30/EU	**EMC Directive:** Directive 2014/30/EC of the European Parliament and of the Council of 26 February 2014 on the approximation of the laws of the Member States concerning electromagnetic compatibility	2014
2014/68/EU	**Pressure Equipment Directive**: Directive 2014/68/EU of the European Parliament and of the Council of 15 May 2014 on the approximation of the laws of the Member States concerning pressure equipment (Only applicable for robots with hydropneumatic counterbalancing system.)	2014
EN ISO 13850	**Safety of machinery:** Emergency stop - Principles for design	2015
EN ISO 13849-1	**Safety of machinery:** Safety-related parts of control systems - Part 1: General principles of design	2015
EN ISO 13849-2	**Safety of machinery:** Safety-related parts of control systems - Part 2: Validation	2012

EN ISO 12100	**Safety of machinery:** General principles of design, risk assessment and risk reduction	2010
EN ISO 10218-1	**Industrial robots – Safety requirements** Part 1: Robots **Note:** Content equivalent to **ANSI/RIA R.15.06-2012, Part 1**	2011
EN 614-1 + A1	**Safety of machinery:** Ergonomic design principles - Part 1: Terms and general principles	2009
EN 61000-6-2	**Electromagnetic compatibility (EMC):** Part 6-2: Generic standards; Immunity for industrial environments	2005
EN 61000-6-4 + A1	**Electromagnetic compatibility (EMC):** Part 6-4: Generic standards; Emission standard for industrial environments	2011
EN 60204-1 + A1	**Safety of machinery:** Electrical equipment of machines - Part 1: General requirements	2009

6 Planning

6.1 Information for planning

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

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

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

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

6.2 Mounting base with centering

Description

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

The mounting base with centering consists of:

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

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

The minimum dimensions must be observed.

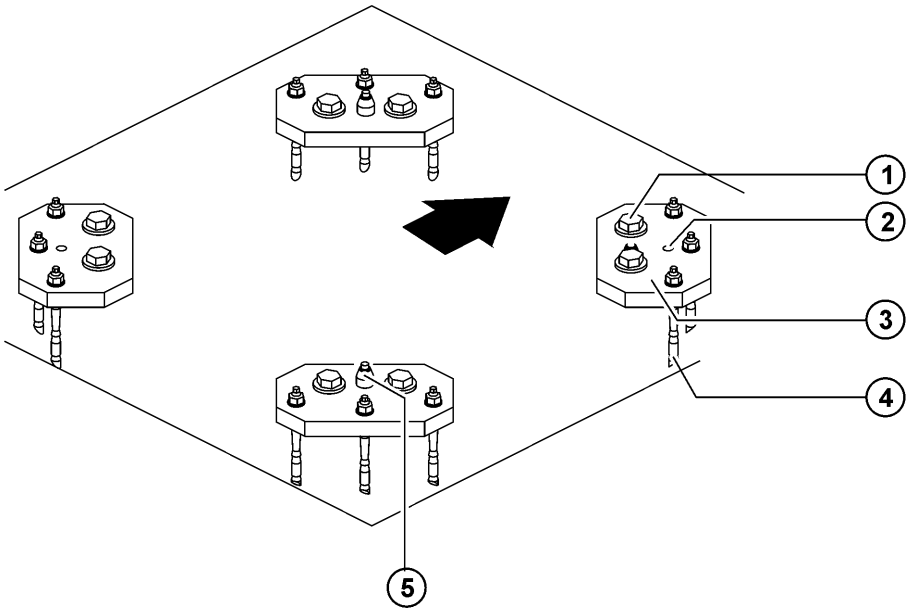


Fig. 6-1: Mounting base

1	Hexagon bolt	4	Resin-bonded anchors with Dynamic Set
2	M20 thread for mastering screw	5	Pin with Allen screw
3	Bedplate		

Grade of concrete for foundations

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

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

Dimensioned drawing

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

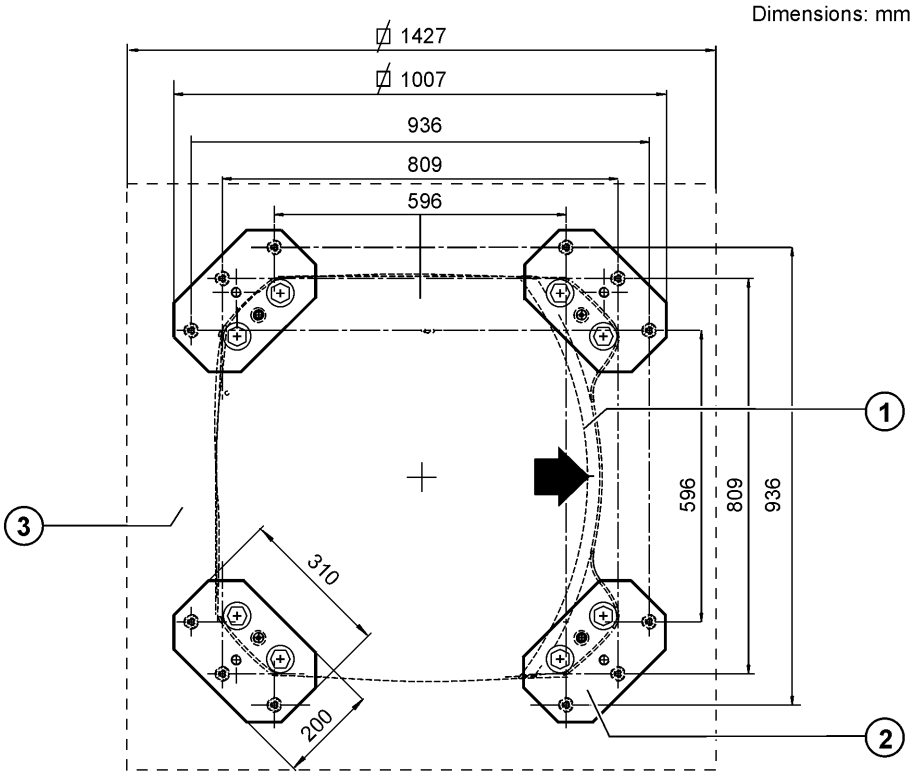


Fig. 6-2: Mounting base, dimensioned drawing

1 Robot
2 Bedplate
3 Concrete foundation

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

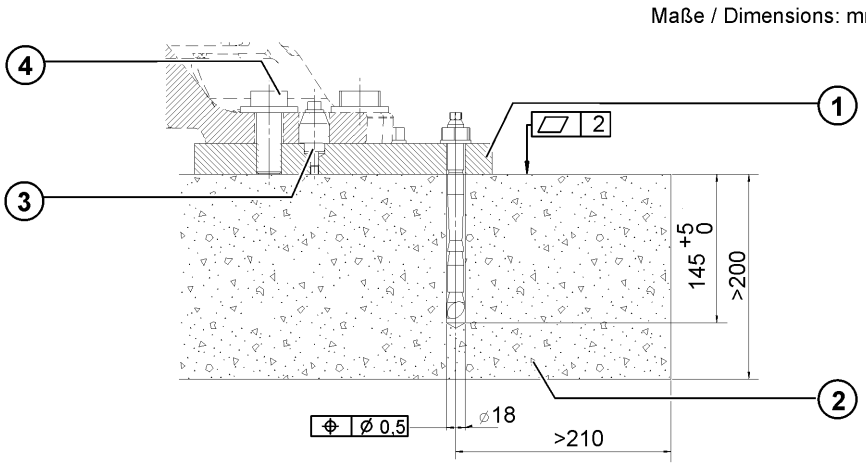


Fig. 6-3: Cross-section of foundations

1 Bedplate
2 Concrete foundation
3 Pin
4 Hexagon bolt

6.3 Machine frame mounting

Description

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

The machine frame mounting assembly consists of:

- Pins with fasteners
- Hexagon bolts with conical spring washers

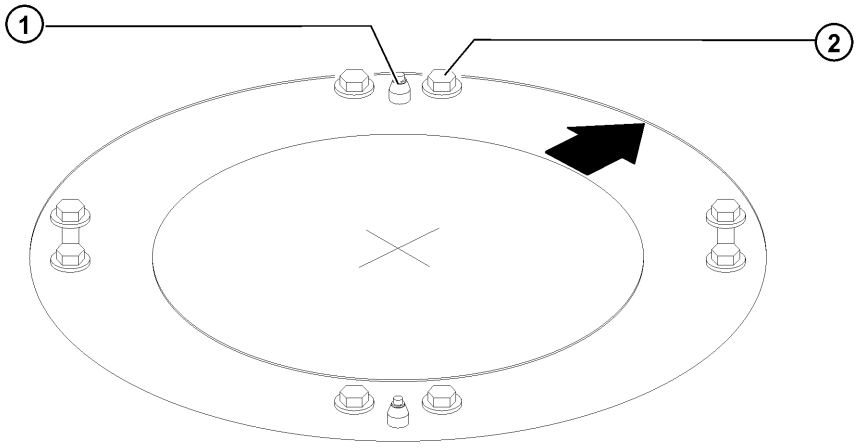


Fig. 6-4: Machine frame mounting

1 Pin
2 Hexagon bolt

Dimensioned drawing

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

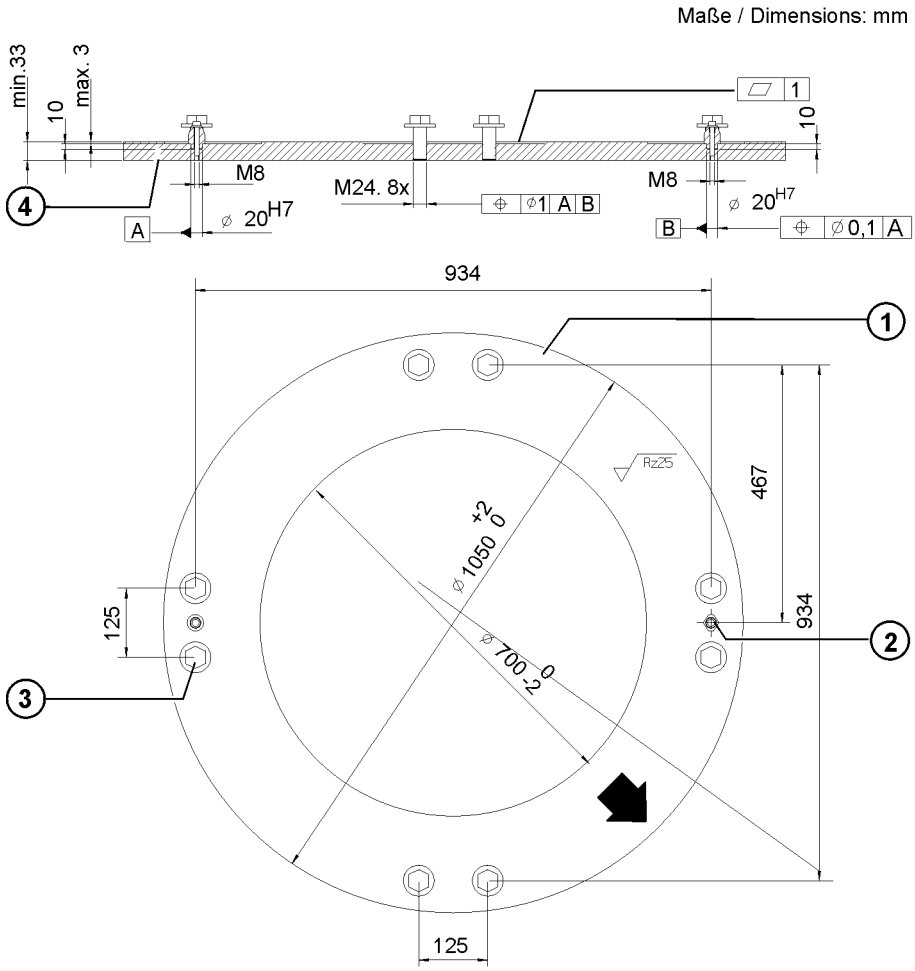


Fig. 6-5: Machine frame mounting, dimensioned drawing

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

6.4 Connecting cables and interfaces

Connecting cables

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

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

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

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

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

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

Interface for energy supply systems

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

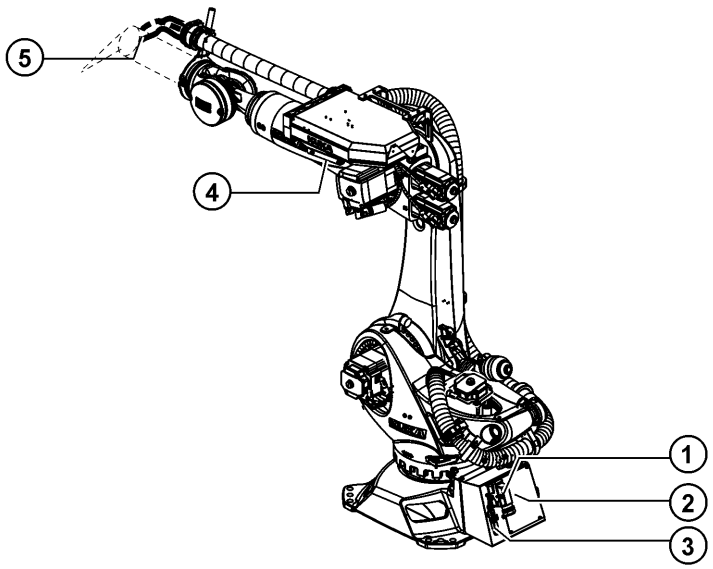


Fig. 6-6: Interfaces on the robot

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

7 Transportation

7.1 Transporting the robot

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

Transport position

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

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

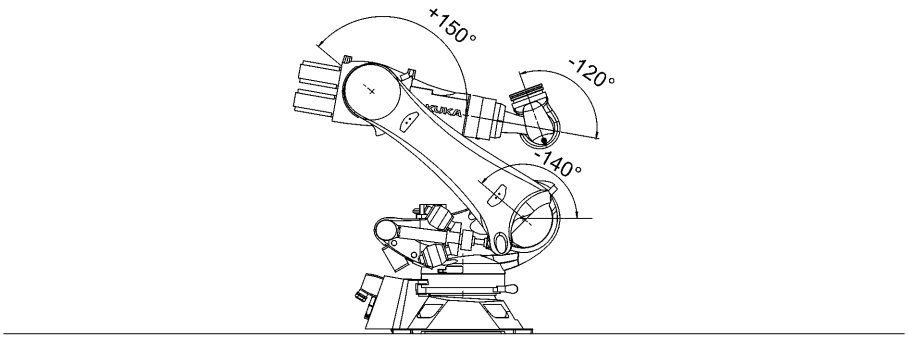


Fig. 7-1: Transport position

Transport dimensions

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

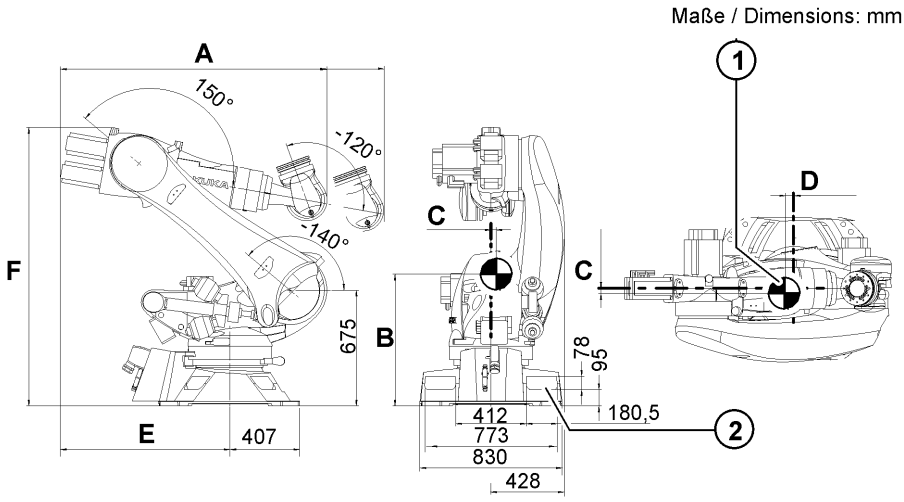


Fig. 7-2: Transport dimensions

1 Center of gravity
2 Fork slots

Transport dimensions and centers of gravity

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

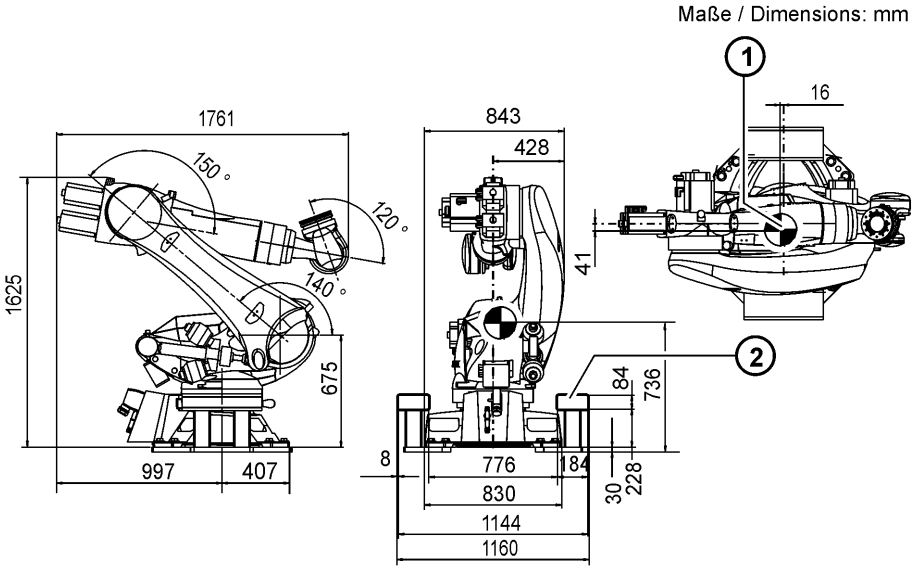


Fig. 7-3: Transport dimensions, CR robots

1 Center of gravity
2 Fork slots

Transportation

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

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

Transportation by fork lift truck

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

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

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

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

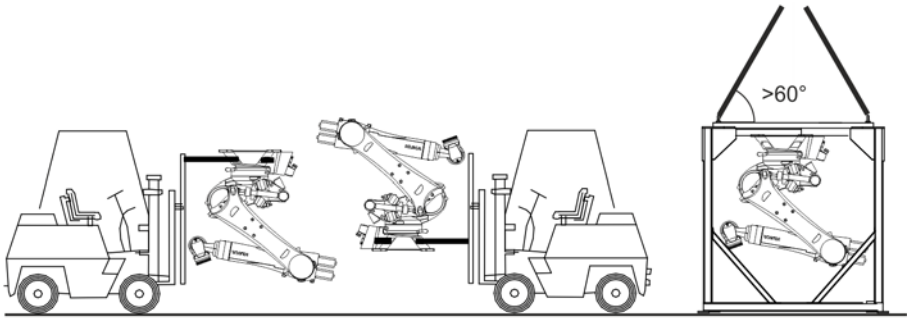


Fig. 7-4: Transportation by fork lift truck

Transportation by fork lift truck, CR robots

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

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

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

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

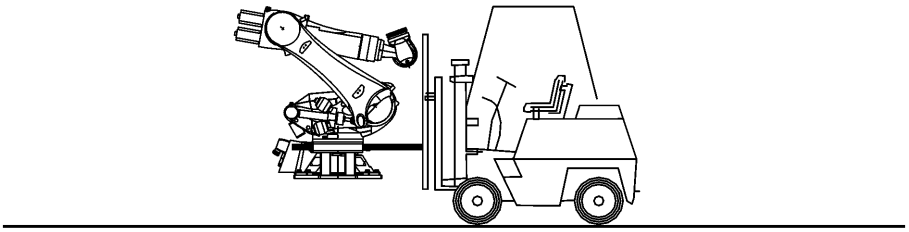


Fig. 7-5: Transportation of CR robots by fork lift truck

Transportation with lifting tackle

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

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

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

⚠ 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!

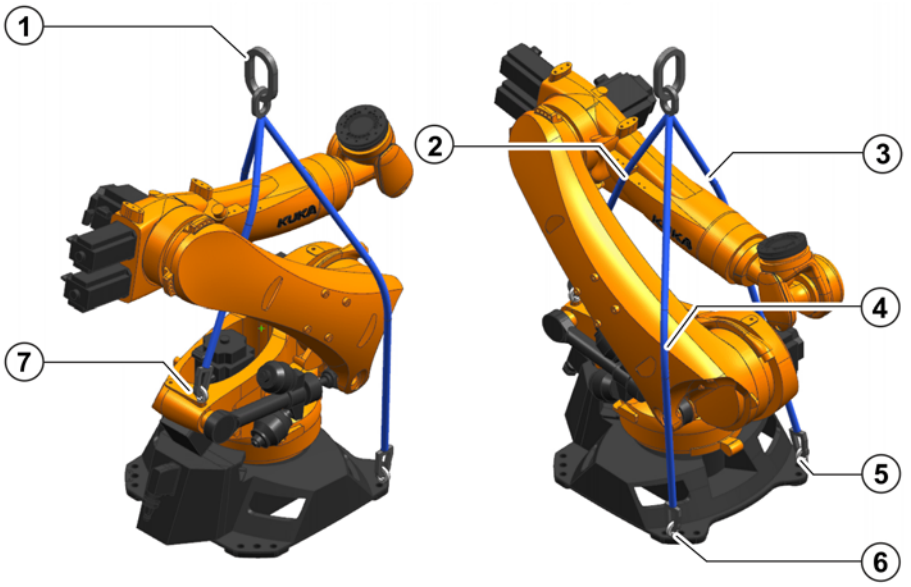


Fig. 7-6: Transportation using lifting tackle

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

8 Options

8.1 Mounting flange, adapter (optional)

Description

This mounting flange (adapter) (>>> Fig. 8-1) can be fitted on the 150/180/210 kg in-line wrist to convert it to a mounting flange with D=160. This enables e.g. tools to be used which are dimensioned for the in-line wrist with the D=160 mounting flange. The design of the flange also allows mounting of the holder A6 of the energy supply systems A3-A6.

When this adapter is mounted, the distance between the intersection of A4/A5 and the face of the mounting flange is offset forward by 25 mm.

The reference point for the load center of gravity remains unchanged and thus corresponds to the values for the in-line wrist IW 150/180/210. The design of the adapter is similar to DIN/ISO 9409-1-A.

The mounting flange is depicted (>>> Fig. 8-1) with axes 4 and 6 in the zero position. The symbol X_m indicates the position of the locating element (bushing) in the zero position.

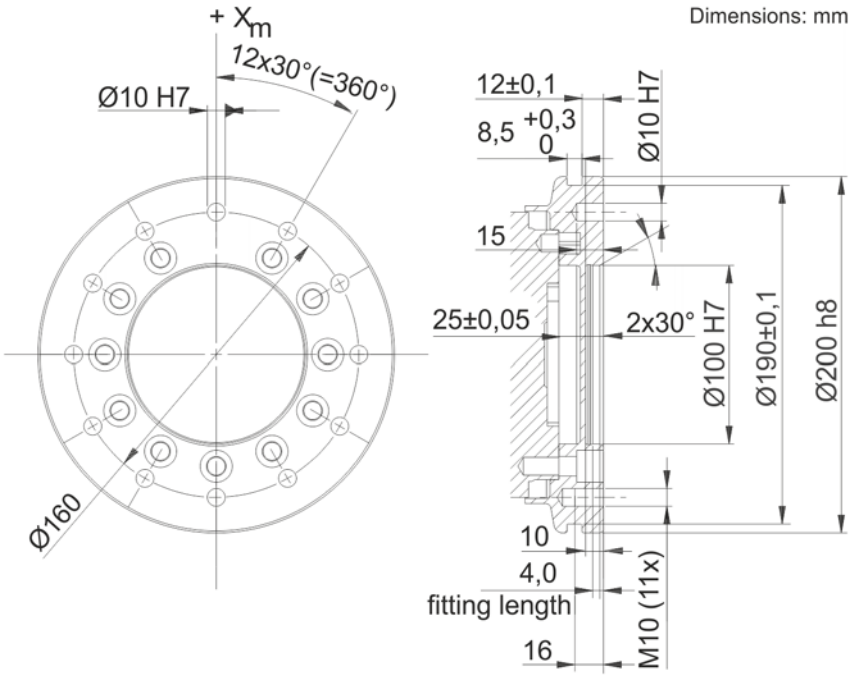


Fig. 8-1: Mounting flange, adapter

1 Fitting length

Mounting flange, adapter	IW 150/180/210 to IW 210/240
Hole circle	160 mm
Screw grade	10.9
Screw size	M10
Number of fastening threads	11
Clamping length	1.5 x nominal diameter
Depth of engagement	min. 12 mm, max. 16 mm
Locating element	10 ^{H7}

8.2 Control cable for single axis (optional)

Description

The control cable for single axis is used when additional axes (e.g. KUKA linear unit or turntables) are controlled via the robot. In this case, the control cable is guided from the RDC box through the hollow shaft of axis 1 to a connector interface on the push-in module.

8.3 Release device (optional)

Description

The release device can be used to move the manipulator manually after an accident or malfunction. The release device can be used for the motors of axes 1 to 5. It cannot be used for axis 6, as this motor is not accessible. It is only for use in exceptional circumstances and emergencies (e.g. for freeing people).

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

9 KUKA Service

9.1 Requesting support

Introduction

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

Information

The following information is required for processing a support request:

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

  The following list gives an indication of the information which is relevant in many cases:
  - Model and serial number of the kinematic system, e.g. the manipulator
  - Model and serial number of the controller
  - Model and serial number of the energy supply system
  - Designation and version of the system software
  - Designations and versions of other software components or modifications
  - Diagnostic package KRCDiag

    Additionally for KUKA Sunrise: Existing projects including applications

    For versions of KUKA System Software older than V8: Archive of the software (KRCDiag is not yet available here.)
  - Application used
  - External axes used

9.2 KUKA Customer Support

Availability

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

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