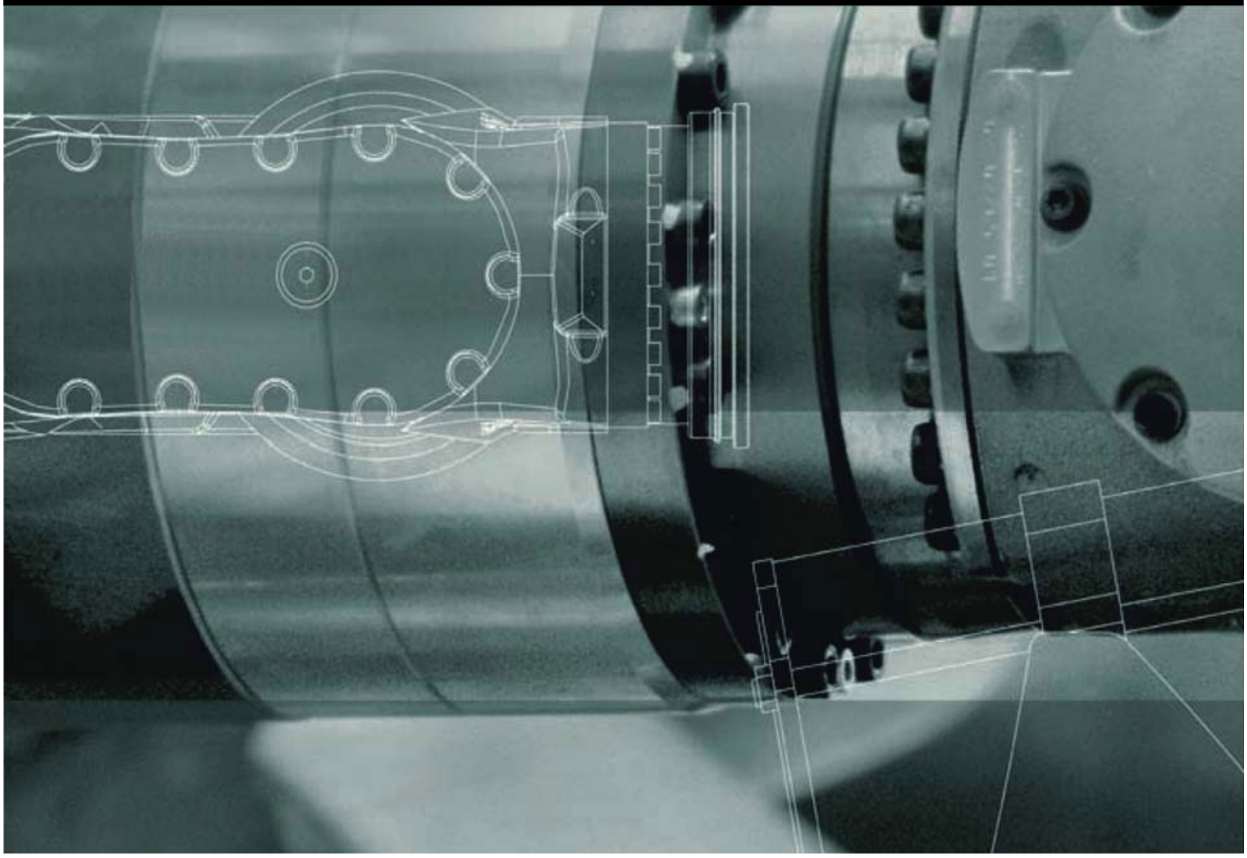
KUKA Roboter GmbH

Robots

QUANTEC pro

Specification



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Series product documentation

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

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

Subject to technical alterations without an effect on the function.

Translation of the original documentation

KIM-PS5-DOC

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Bookstructure:	Spez KR QUANTEC pro V3.1
Version:	Spez KR QUANTEC pro V3 en

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 KUKA System Software
- Documentation relating to 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 physical injury **will** occur, if no precautions are taken.

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

⚠ **CAUTION** These warnings mean that minor physical 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.

Hints

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

i 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

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

Misuse

Any use or application deviating from the intended use is deemed to be impermissible misuse; examples of such misuse include:

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

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.

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 QUANTEC pro product family comprises the types:

- KR 120 R2500 pro
- KR 90 R2700 pro

An industrial robot of this type comprises the following components:

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

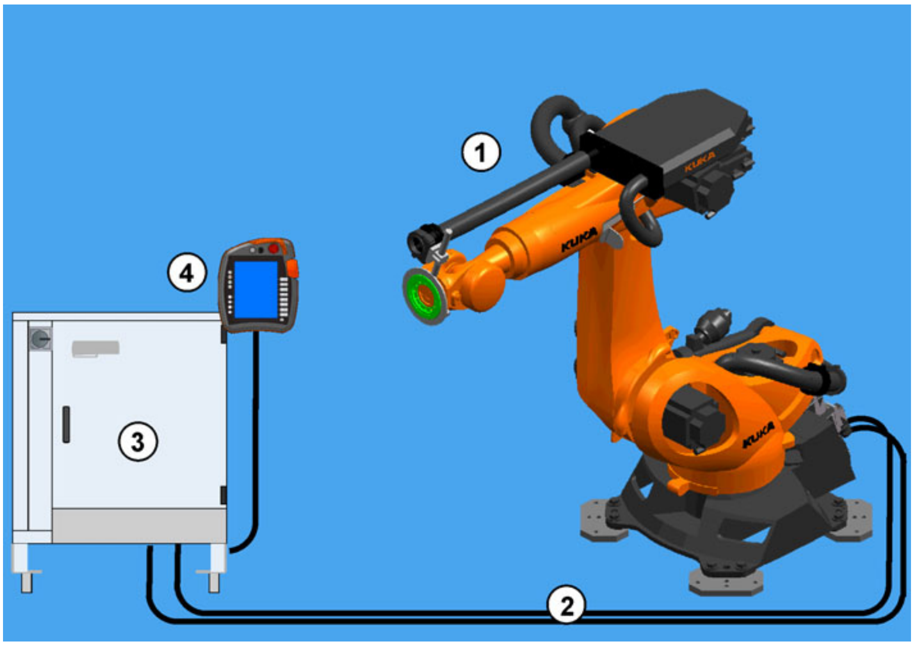


Fig. 3-1: Example of a robot system

1	Manipulator	3	Robot controller
2	Connecting cables	4	Teach pendant (KCP)

3.2 Description of the manipulator

Overview

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

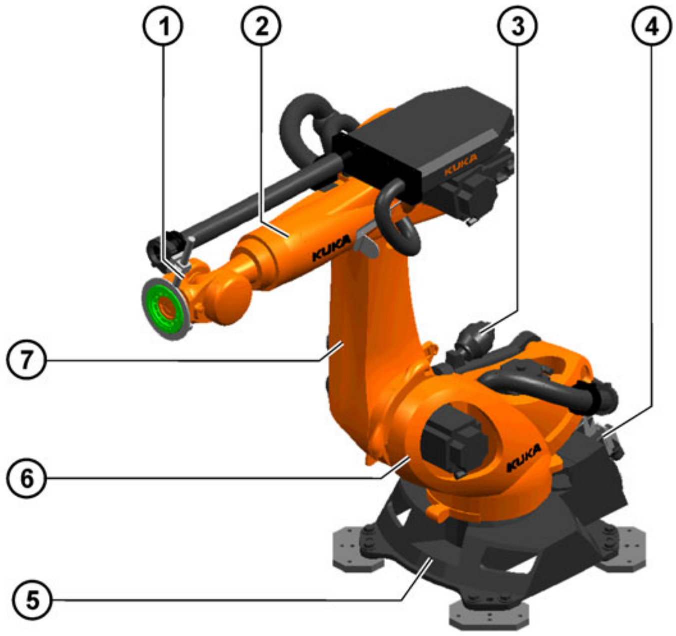


Fig. 3-2: Main assemblies of the manipulator

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. The mounting flange conforms, with minimal deviations, to DIN/ISO9409-1-A and meets the requirements of IP65.

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 IP 65.

Arm

The arm is the link between the in-line wrist and the link arm. It houses the motors of the wrist axes A 4 and A 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.

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 three different lengths of link arm available to obtain the specified reach.

Rotating column

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

Base frame

The base frame is the base of the robot. It is screwed to the mounting base. The flexible tube for the electrical installations is fastened to 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 correspond to category 0, 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. 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, or working range limitation systems for A1. The options are described in separate documentation.

4 Technical data

4.1 Basic data

Basic data

Type	KR 120 R2500 pro KR 90 R2700 pro
Number of axes	6
Volume of working envelope	KR 120 R2500 pro 41.00 m^3 KR 90 R2700 pro 55.00 m^3
Pose repeatability (ISO 9283)	±0.06 mm
Working envelope reference point	Intersection of axes 4 and 5
Weight	KR 120 R2500 pro approx. 1049 kg KR 90 R2700 pro approx. 1058 kg
Principal dynamic loads	See “Loads acting on the mounting base”
Protection classification of the robot	IP 65 ready for operation, with connecting cables plugged in (according to EN 60529)
Protection classification of the in-line wrist	IP 65
Protection classification of the “F” in-line wrist	IP 65
Sound level	< 75 dB (A) outside the working envelope
Mounting position	Floor, permissible angle of inclination ≤ 5º
Surface finish, paintwork	Base frame, covers on hollow-shaft wrist and arm: black (RAL 9005); moving parts: KUKA orange 2567

Ambient temperature

Operation	283 K to 328 K (+10 °C to +55 °C)
Storage and transportation	233 K to 333 K (-40 °C to +60 °C)
Start-up	283 K to 288 K (+10 °C to +15 °C) At these temperatures the robot may have to be warmed up before normal operation. Other temperature limits available on request.
Humidity rating	Humidity class EN 60204/4.4.4 F

The maintenance intervals and the specified service life are based on typical gear unit temperatures and axis motions. If special functions or applications result in atypical gear unit temperatures or axis motions, this can lead to increased wear. In this case, the maintenance intervals or service life may be shortened. If you have any questions, please contact KUKA Customer Support.

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	HAN 3A EMC at both ends
Ground conductor, optional		M8 ring cable lug at both ends

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

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

4.2 Axis data

Axis data, KR 120 R2500 pro

Axis	Range of motion, software-limited	Speed with rated payload
1	+/-185°	136 °/s
2	-5° to -140°	130 °/s
3	+155° to -120°	120 °/s
4	+/-350°	292 °/s
5	+/-125°	258 °/s
6	+/-350°	284 °/s

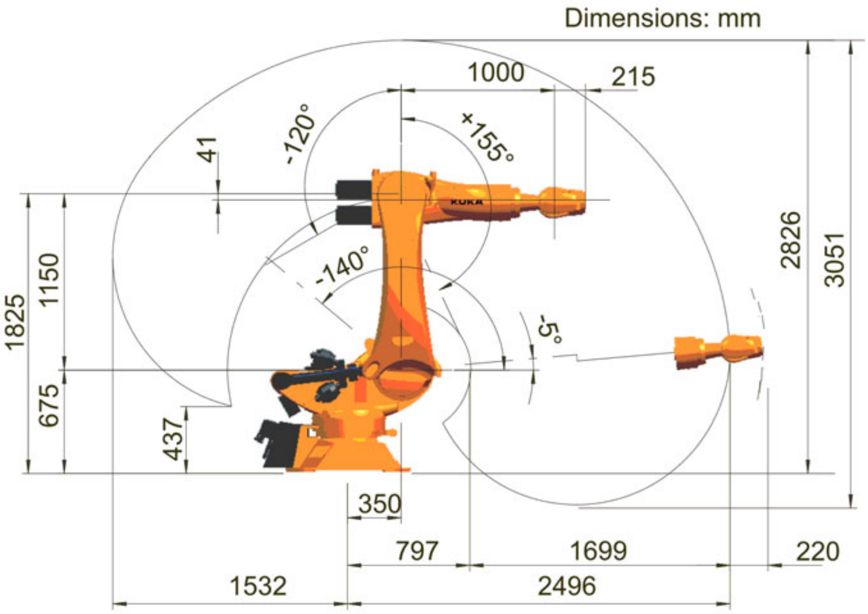
Axis data, KR 90 R2700 pro

Axis	Range of motion, software-limited	Speed with rated payload
1	+/-185°	136 °/s
2	-5° to -140°	130 °/s
3	+155° to -120°	120 °/s
4	+/-350°	292 °/s
5	+/-125°	258 °/s
6	+/-350°	284 °/s

Working envelope

The following diagrams show the shape and size of the working envelopes for the “pro” variants.

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



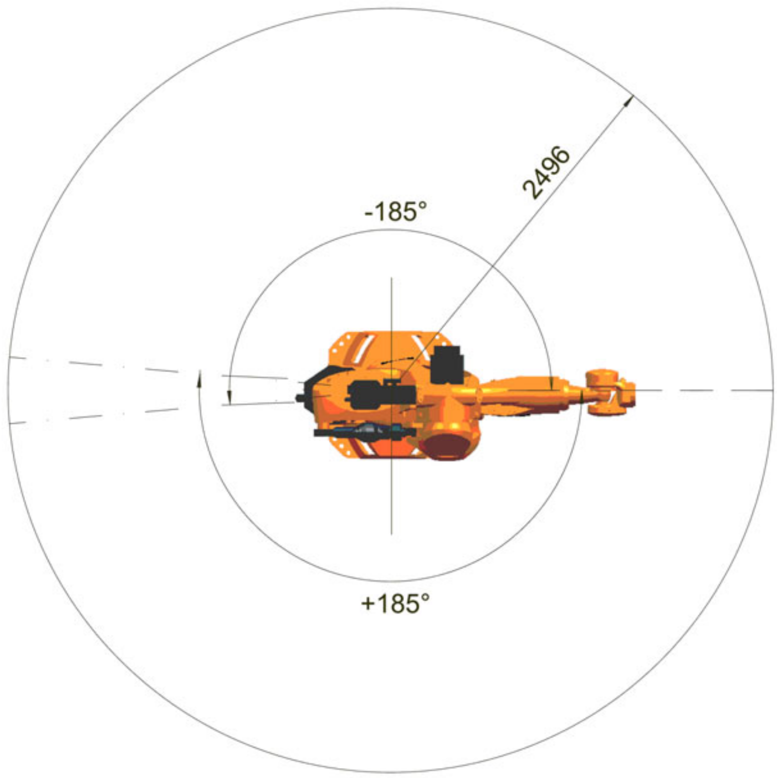


Fig. 4-1: Working envelope, KR 120 R2500 pro

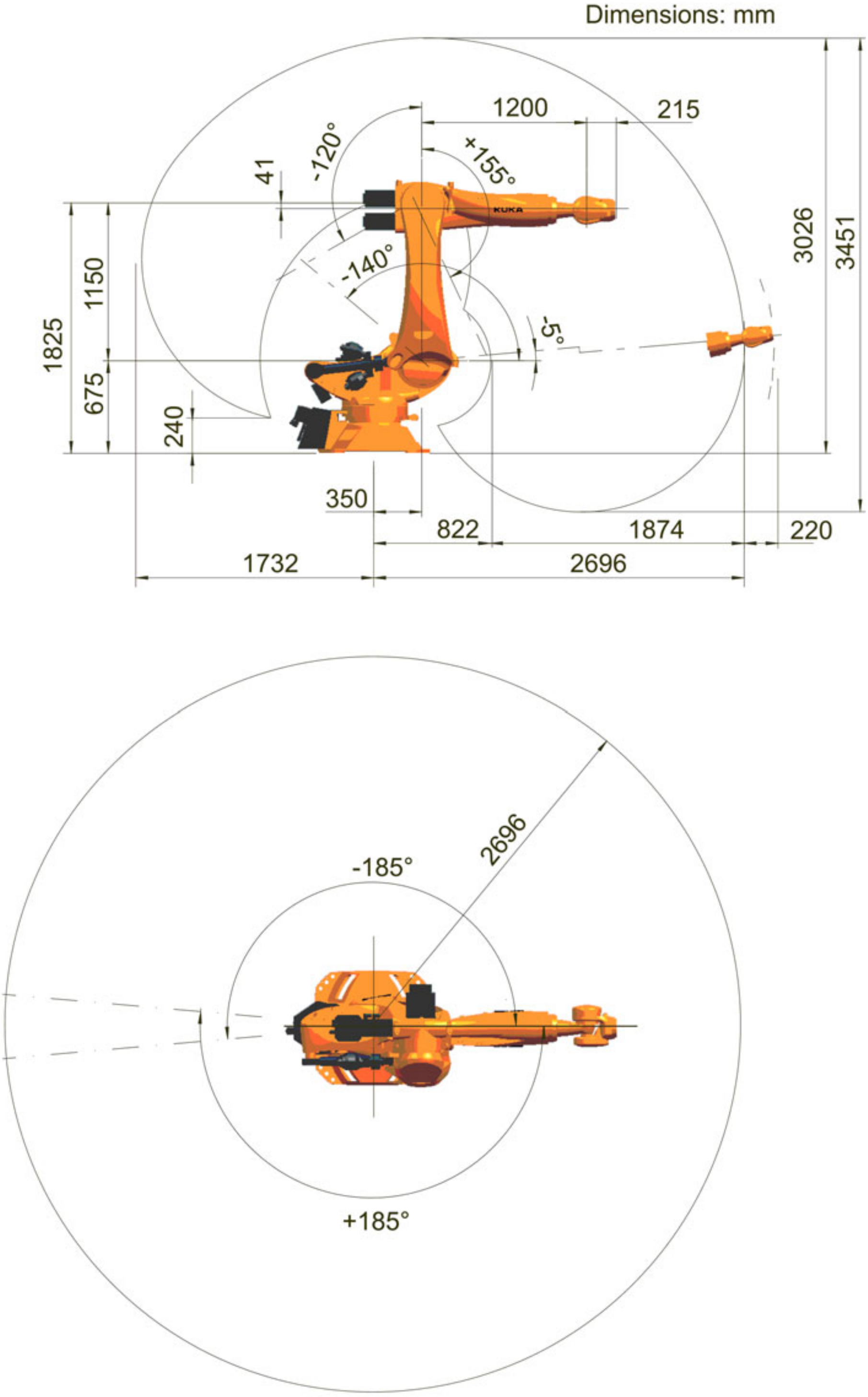


Fig. 4-2: Working envelope, KR 90 R2700 pro

4.3 Payloads

Payloads, KR 120 R2500 pro

Robot	KR 120 R2500 pro
In-line wrist	IW 90/120
Rated payload	120 kg
Distance of the load center of gravity L_z (horizontal)	240 mm
Distance of the load center of gravity L_{xy} (vertical)	270 mm

Permissible mass moment of inertia	60 kgm^2
Max. total load	170 kg
Supplementary load, arm	50 kg
Supplementary load, link arm	On request
Supplementary load, rotating column	On request
Supplementary load, base frame	On request

Payloads, KR 90 R2700 pro

Robot	KR 90 R2700 pro
In-line wrist	IW 90/120
Rated payload	90 kg
Distance of the load center of gravity L_z (horizontal)	240 mm
Distance of the load center of gravity L_{xy} (vertical)	270 mm
Permissible mass moment of inertia	45 kgm^2
Max. total load	140 kg
Supplementary load, arm	50 kg
Supplementary load, link arm	On request
Supplementary load, rotating column	On request
Supplementary load, base frame	On request

Load center of gravity P

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

Payload diagram

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 operating and programming instructions of the KUKA System Software.
The mass inertia must be verified using KUKA.Load. It is imperative for the load data to be entered in the robot controller!

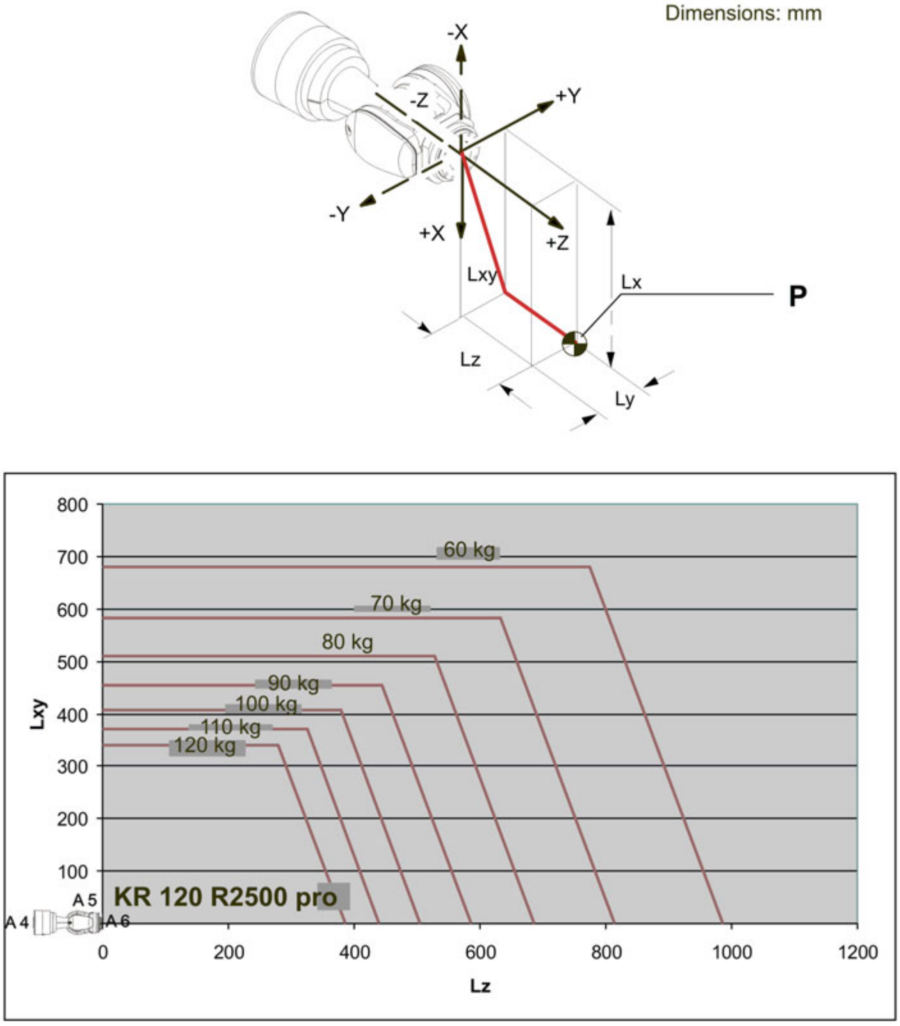
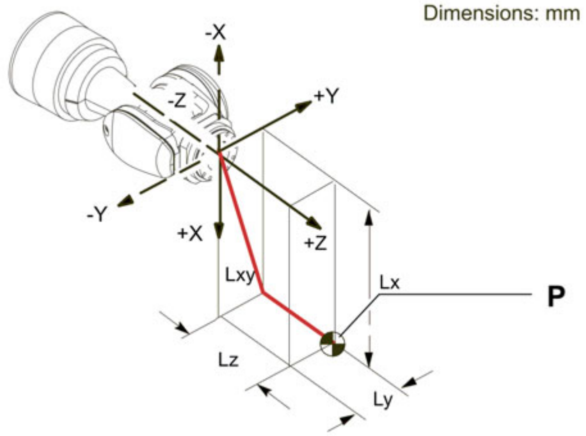


Fig. 4-3: Payload diagram



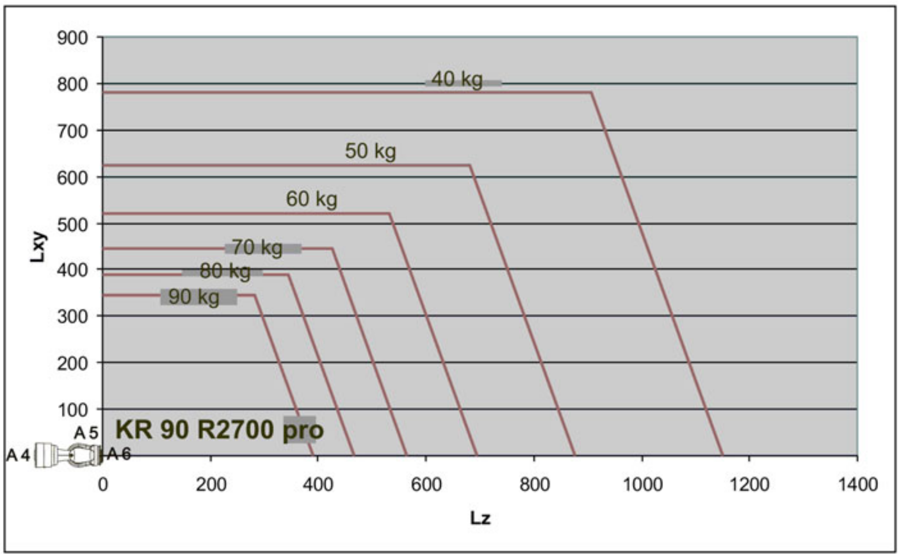


Fig. 4-4: Payload diagram

Mounting flange D=125 mm

In-line wrist type	IW 90/120
Mounting flange (hole circle)	125 mm
Screw grade	10.9
Screw size	M10
Number of fastening screws	11
Grip length	1.5 x nominal diameter
Depth of engagement	min. 12 mm, max. 16 mm
Locating element	10^{H7}
Standard	similar to DIN/ISO 9409-1-A

The mounting flange is depicted (>>> Fig. 4-5) with axes 4 and 6 in the zero position. The symbol X_m indicates the position of the locating element (bushing) in the zero position.

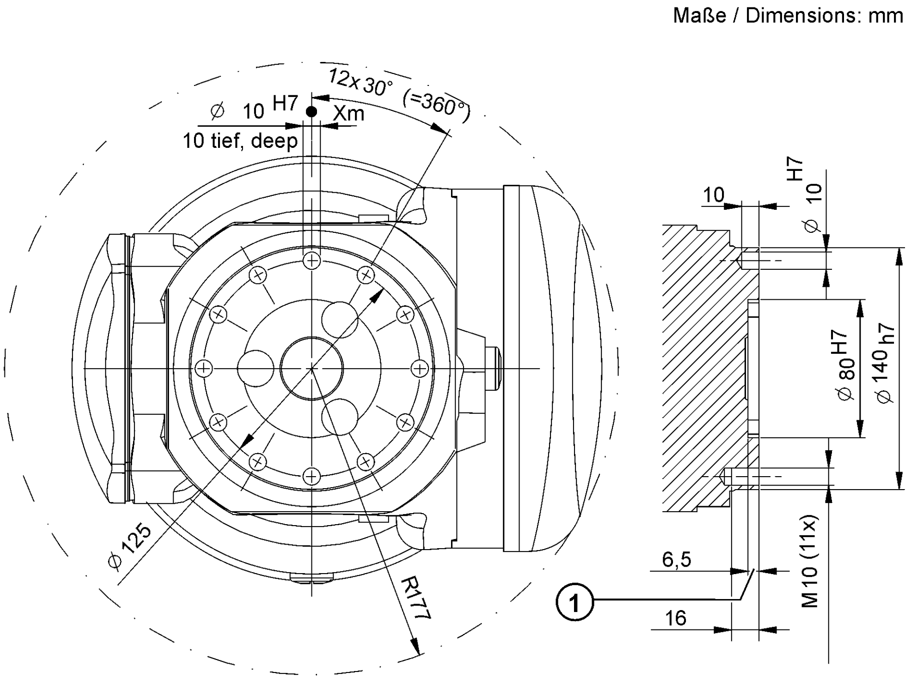


Fig. 4-5: Mounting flange D=125

1 Fitting length

Mounting flange, adapter (optional)

The mounting flange is depicted (>>> Fig. 4-6) 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. This adapter can be fitted on the 150/180/210 kg in-line wrist to convert it to a mounting flange with D=160. The reference point for the load center of gravity remains unchanged, i.e. the same as for the mounting flange of the in-line wrist. The design of the adapter is similar to DIN/ISO 9409-1-A.

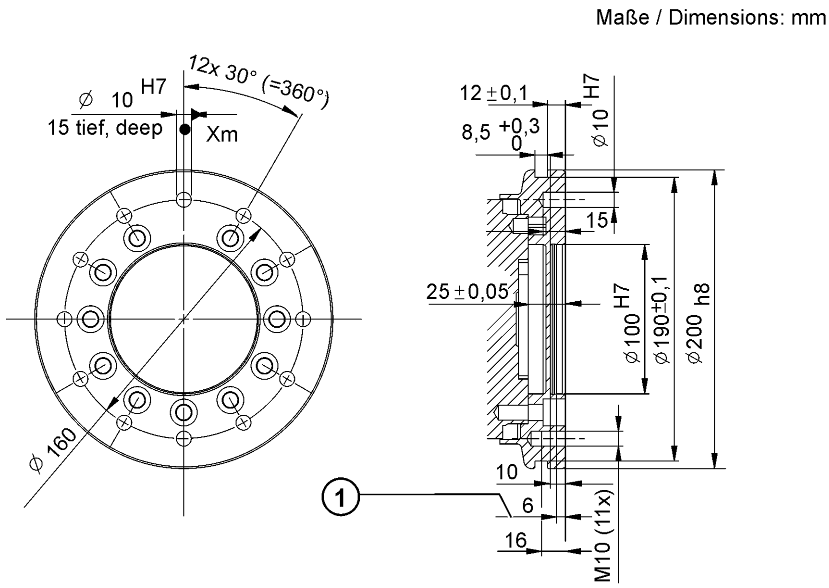


Fig. 4-6: Mounting flange, adapter

1 Fitting length

Supplementary load

The robot can carry supplementary loads (>>> Fig. 4-7) on the arm. When mounting the supplementary loads, be careful to observe the maximum permissible total load. The dimensions and positions of the installation options can be seen in the following diagram.

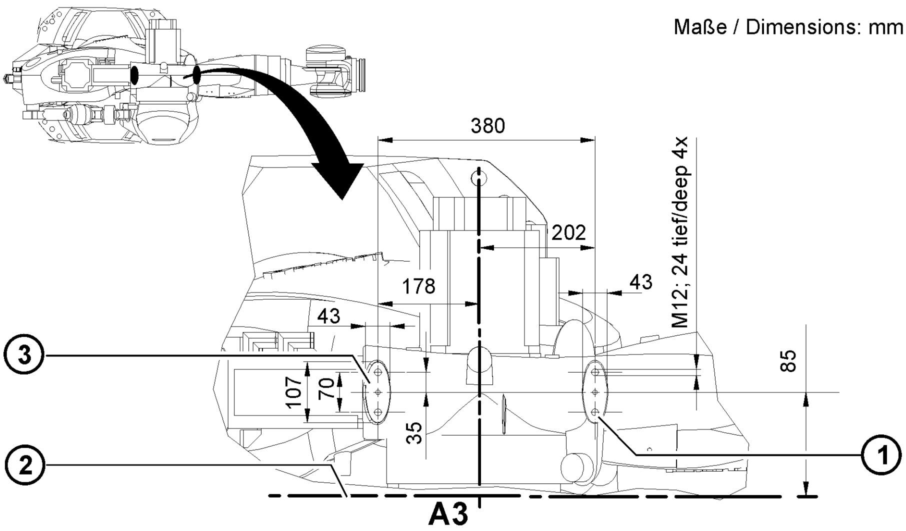


Fig. 4-7: Supplementary load on arm

1	Fastening threads	3	Mounting surface
2	Interference contour, arm		

4.4 Loads acting on the mounting base

Loads acting on the mounting base

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

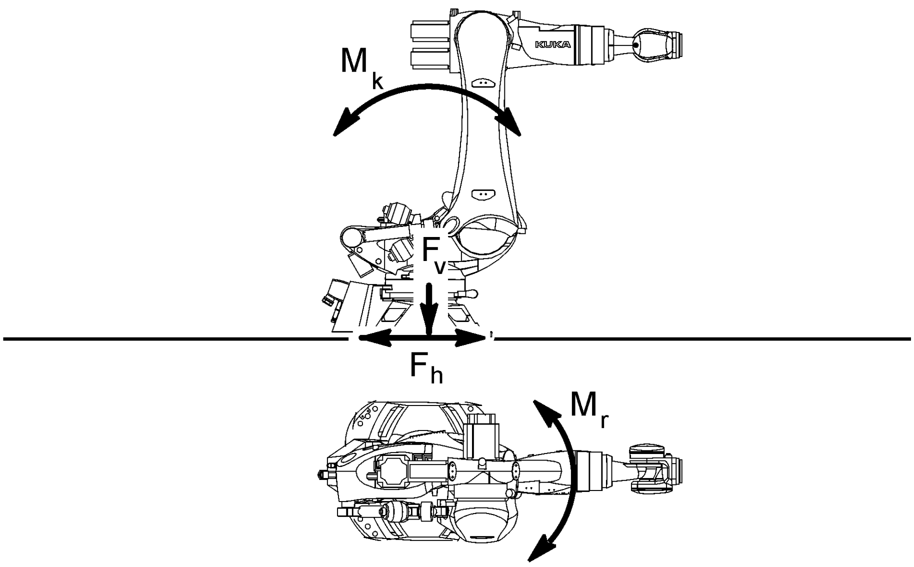


Fig. 4-8: Loads acting on the mounting base

All variants	Force/torque/mass
F_v = vertical force	F_{vmax} = 24,000 N
F_h = horizontal force	F_{hmax} = 16,000 N
M_k = tilting moment	M_{kmax} = 49,000 Nm
M_r = torque	M_{rmax} = 35,000 Nm
Total mass for load acting on the mounting base	KR 120 R2500 pro = 1,219 kg KR 90 R2700 pro = 1,198 kg
Robot	KR 120 R2500 pro = 1,049 kg KR 90 R2700 pro = 1,058 kg
Total load (suppl. load on arm + rated payload)	KR 120 R2500 pro = 170 kg KR 90 R2700 pro = 140 kg

The supplementary loads on the base frame and rotating column are not taken into consideration in the calculation of the mounting base load. These supplementary loads must be taken into consideration for F_v.

4.5 Transport dimensions

The transport dimensions (>>> Fig. 4-9) for the robot (1) can be noted from the following diagram. The position of the center of gravity (2) and the weight vary according to the specific configuration. The specified dimensions refer to the robot without equipment. The following diagram shows the dimensions of the robot when it stands on the floor without wooden transport blocks.

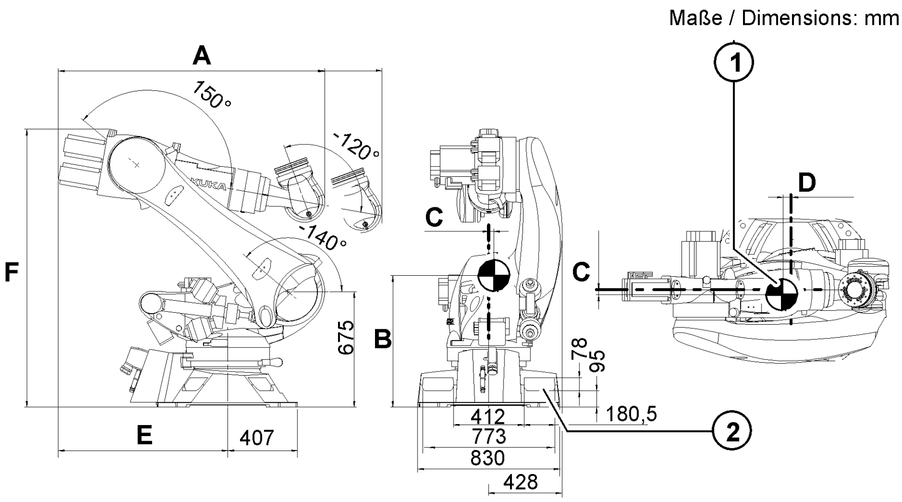


Fig. 4-9: Transport dimensions

1 Robot
2 Center of gravity

Transport dimensions and centers of gravity

Robot with reach	A	B	C	D	E	F
R2500	1582	741	48	56	997	1625
R2700	1747	742	47	35	997	1625

4.6 Plates and labels

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

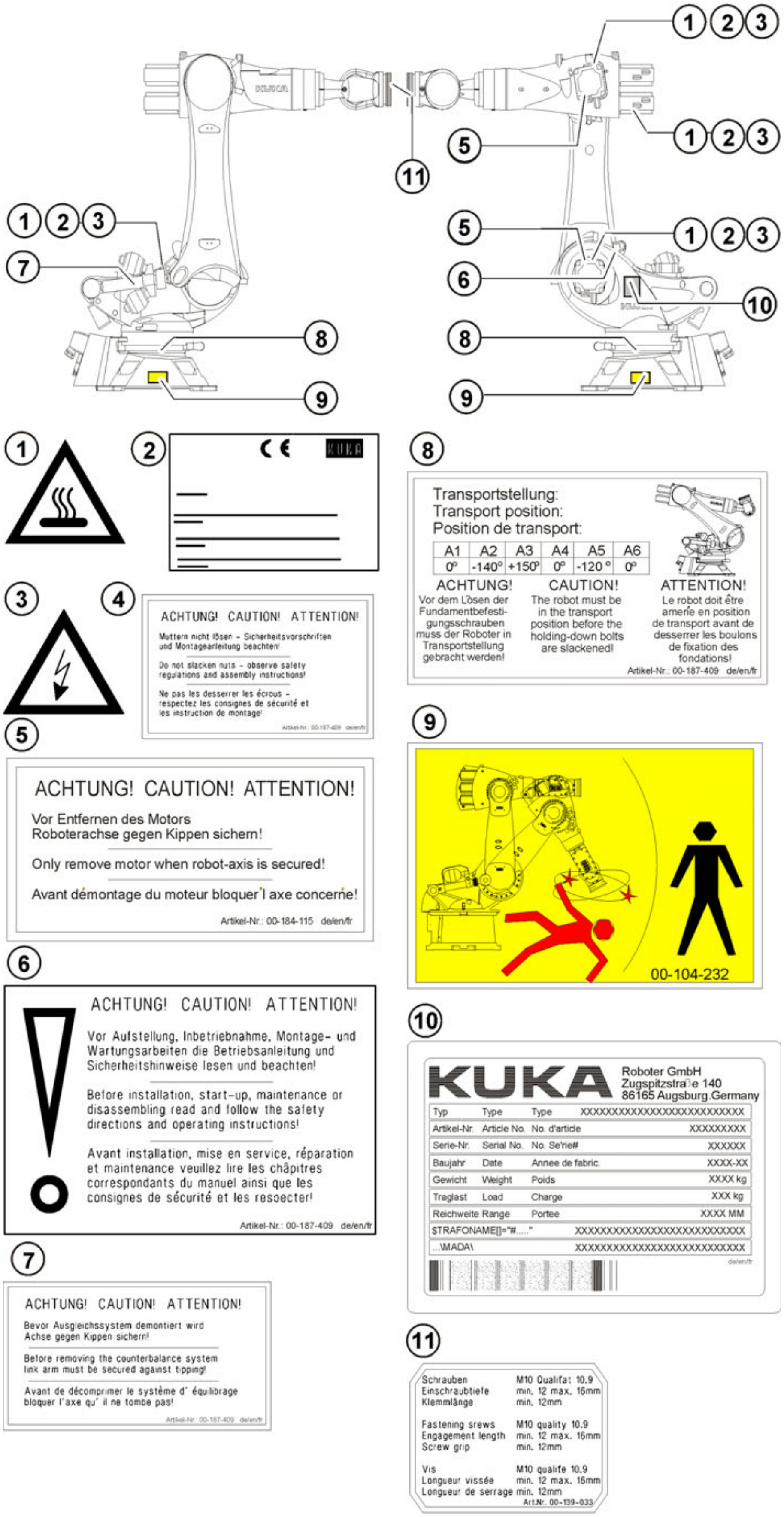


Fig. 4-10: Plates and labels

4.7 Stopping distances and times

4.7.1 General information

Information concerning the data:

- The stopping distance is the angle traveled by the robot from the moment the stop signal is triggered until the robot comes to a complete standstill.
- The stopping time is the time that elapses from the moment the stop signal is triggered until the robot comes to a complete standstill.
- The data are given for the main axes A1, A2 and A3. The main axes are the axes with the greatest deflection.
- Superposed axis motions can result in longer stopping distances.
- Stopping distances and stopping times in accordance with DIN EN ISO 10218-1, Annex B.
- Stop categories:
  - Stop category 0 » STOP 0
  - Stop category 1 » STOP 1

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

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

4.7.2 Terms used

Term	Description
m	Mass of the rated load and the supplementary load on the arm.
Phi	Angle of rotation (°) about the corresponding axis. This value can be entered in the controller via the KCP and is displayed on the KCP.
POV	Program override (%) = velocity of the robot motion. This value can be entered in the controller via the KCP and is displayed on the KCP.
Extension	Distance (l in %) between axis 1 and the intersection of axes 4 and 5. With parallelogram robots, the distance between axis 1 and the intersection of axis 6 and the mounting flange.
KCP	The KCP teach pendant has all the operator control and display functions required for operating and programming the robot system.

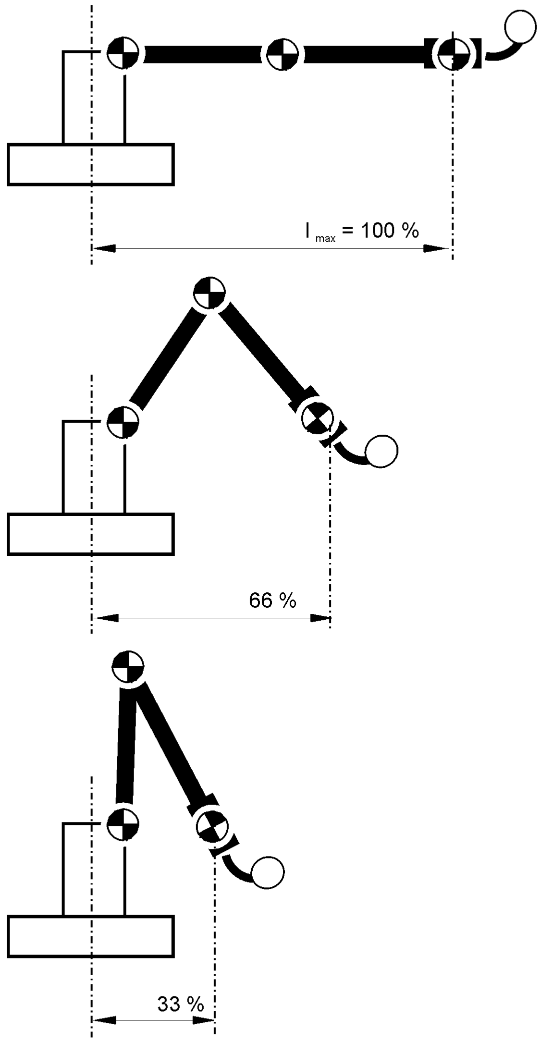


Fig. 4-11: Extension

4.7.3 Stopping distances and times, KR 120 R2500 pro

4.7.3.1 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	86.67	1.186
Axis 2	88.75	1.388
Axis 3	49.49	0.595

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

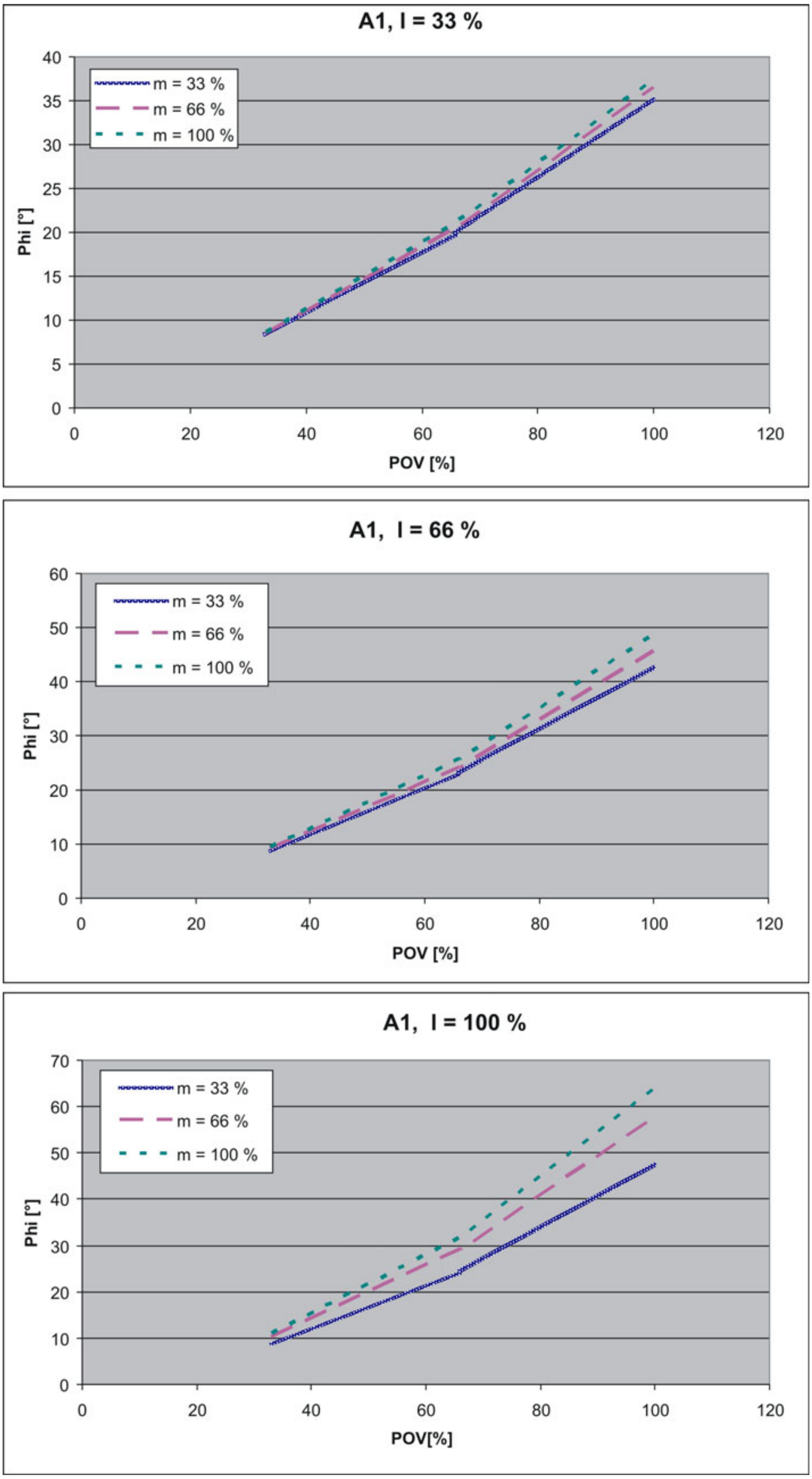


Fig. 4-12: Stopping distances for STOP 1, axis 1

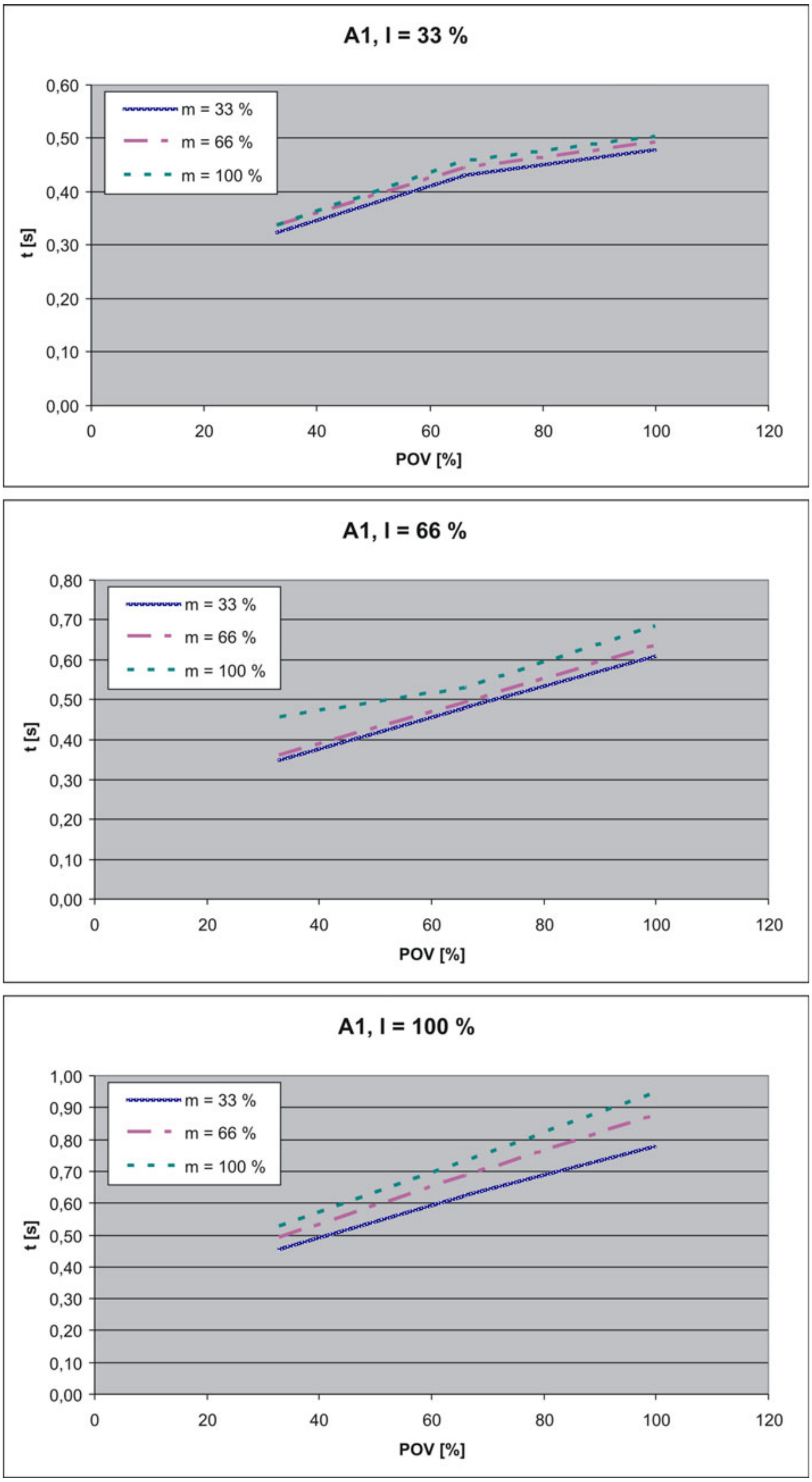


Fig. 4-13: Stopping times for STOP 1, axis 1

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

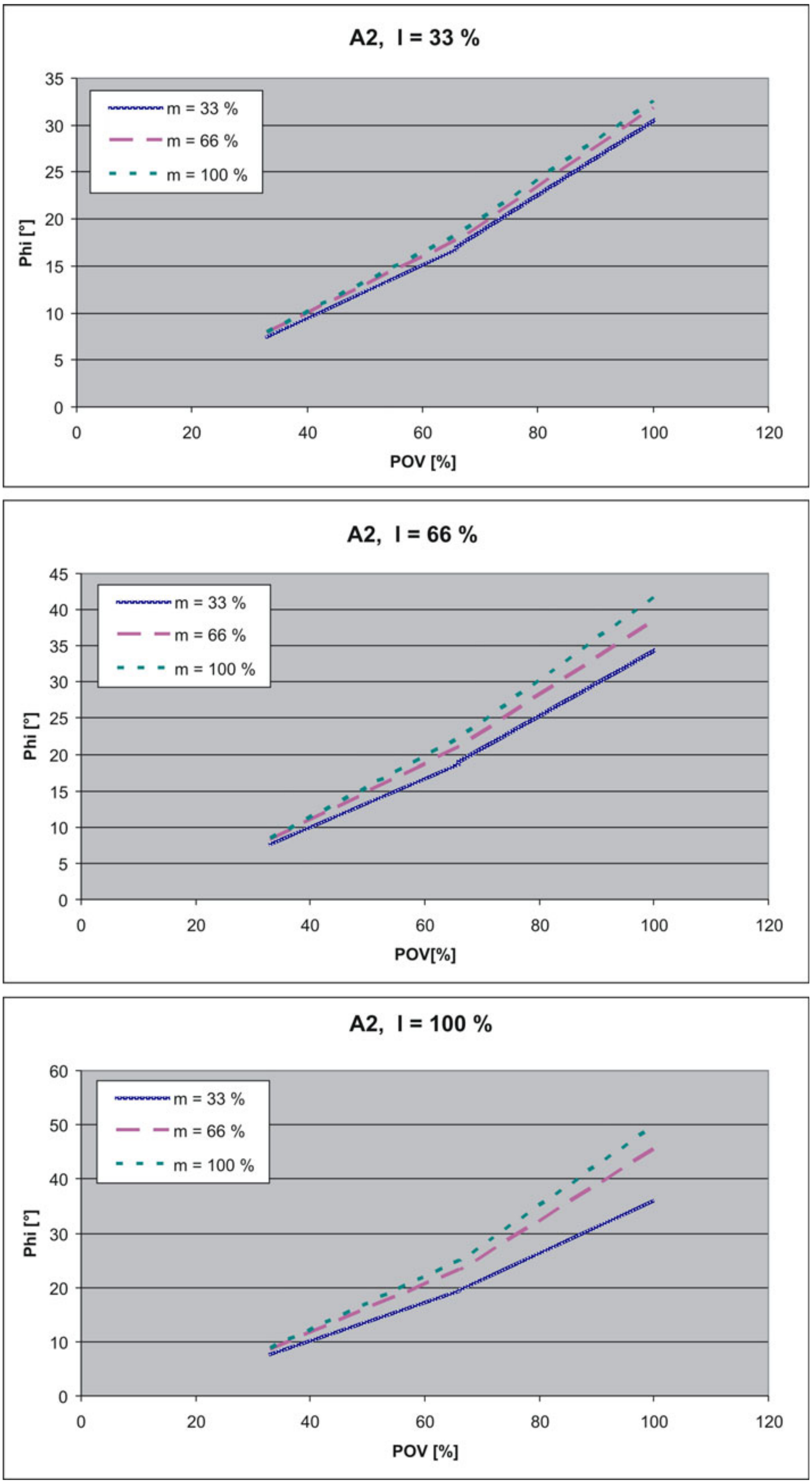


Fig. 4-14: Stopping distances for STOP 1, axis 2

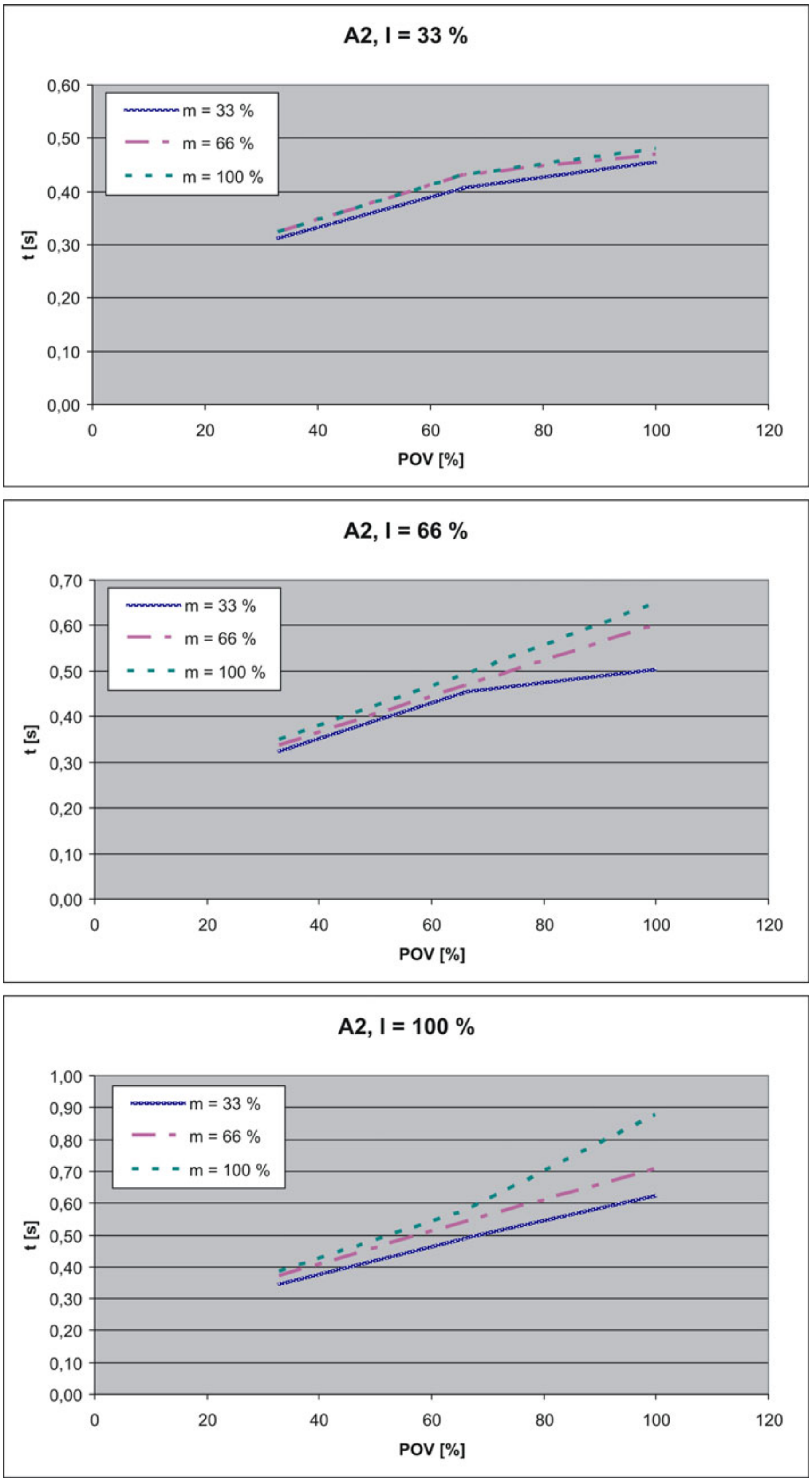


Fig. 4-15: Stopping times for STOP 1, axis 2

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

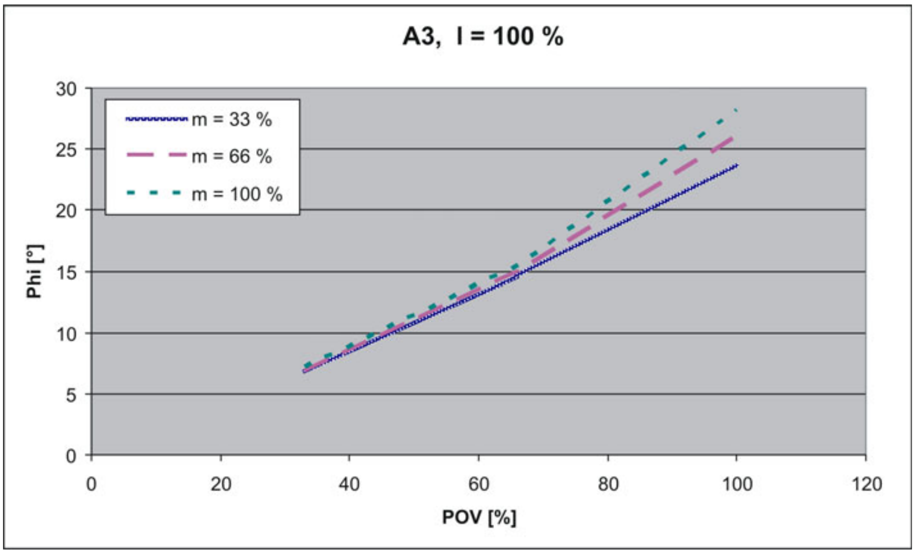


Fig. 4-16: Stopping distances for STOP 1, axis 3

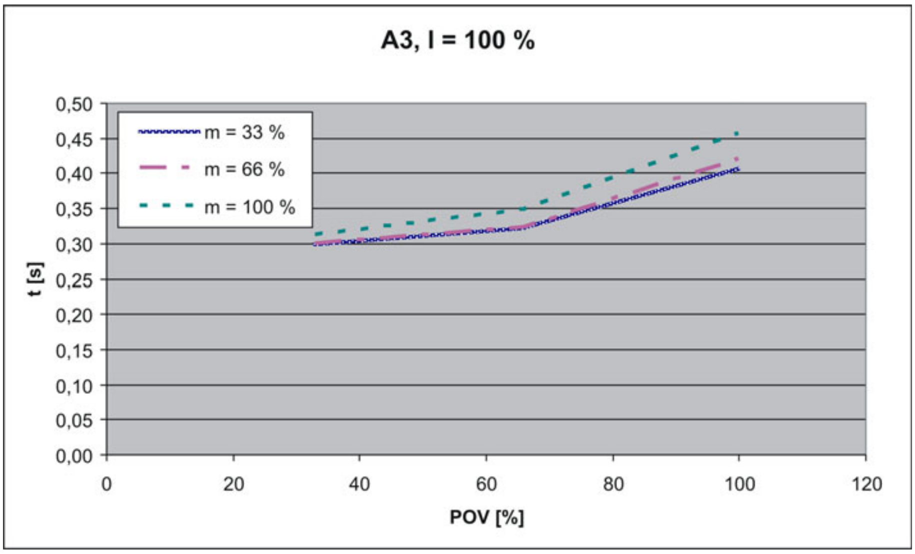


Fig. 4-17: Stopping times for STOP 1, axis 3

4.7.4 Stopping distances and times, KR 90 R2700 pro

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

	Stopping distance (°)	Stopping time (s)
Axis 1	86.11	1.177
Axis 2	83.33	1.289
Axis 3	50.10	0.605

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

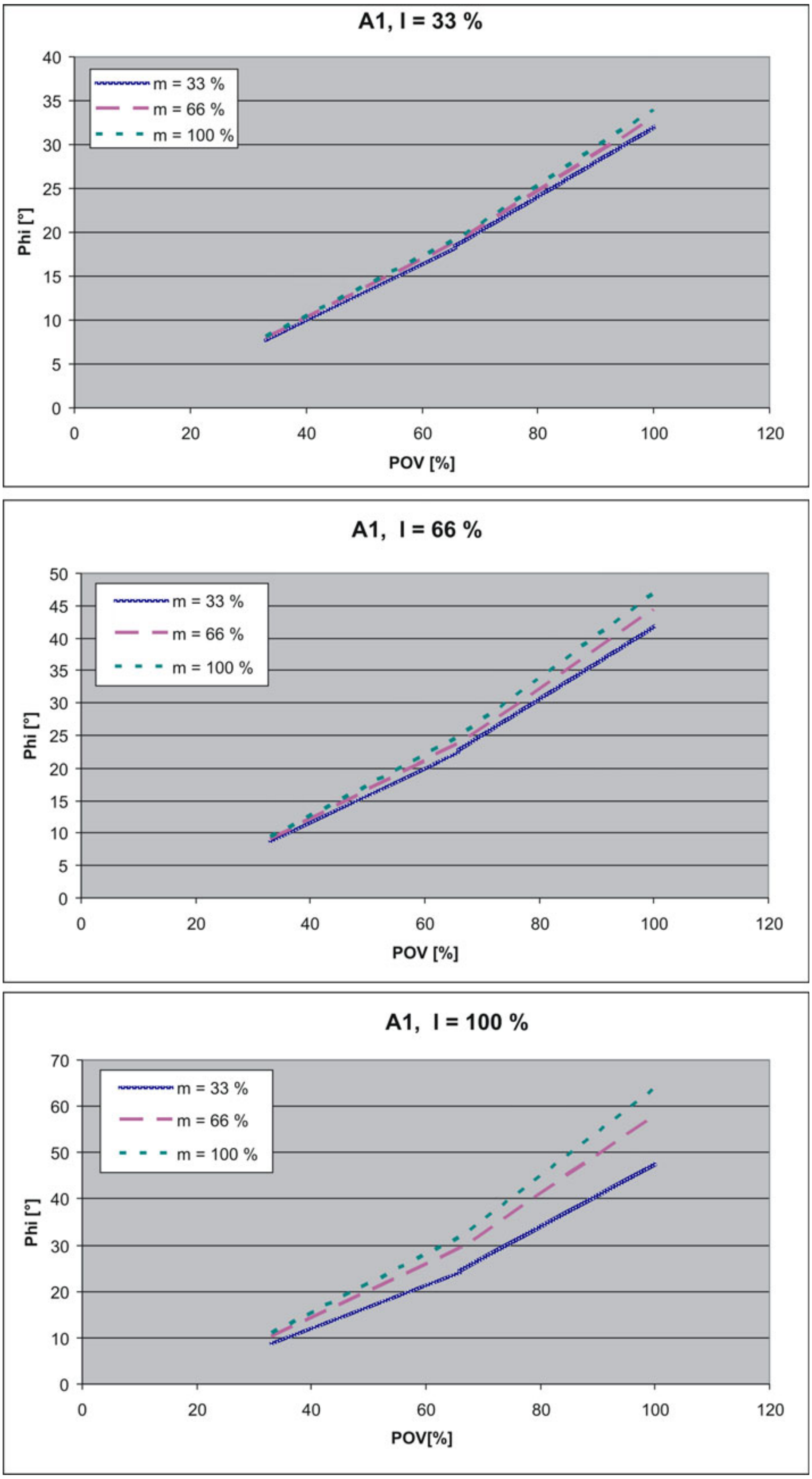


Fig. 4-18: Stopping distances for STOP 1, axis 1

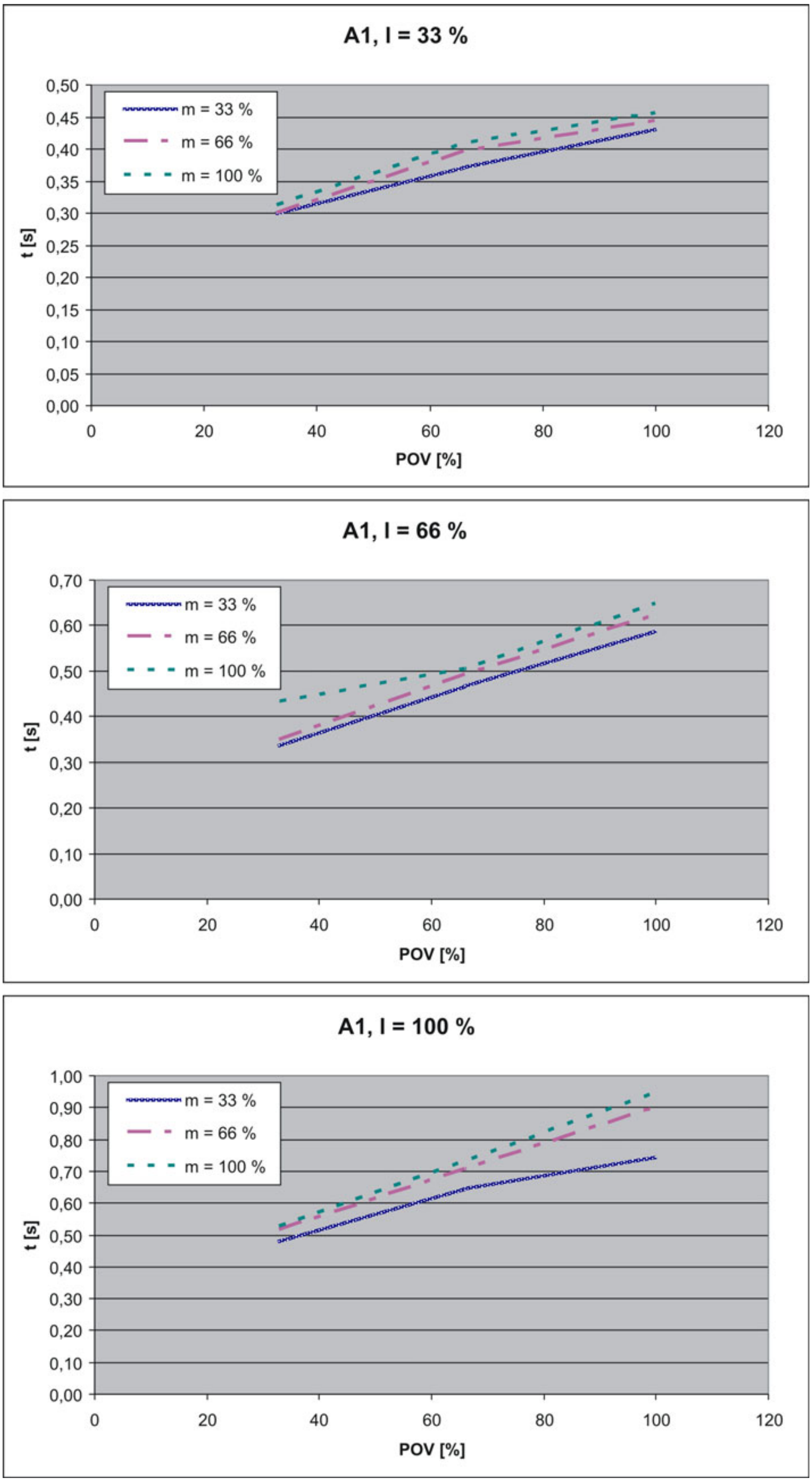


Fig. 4-19: Stopping times for STOP 1, axis 1

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

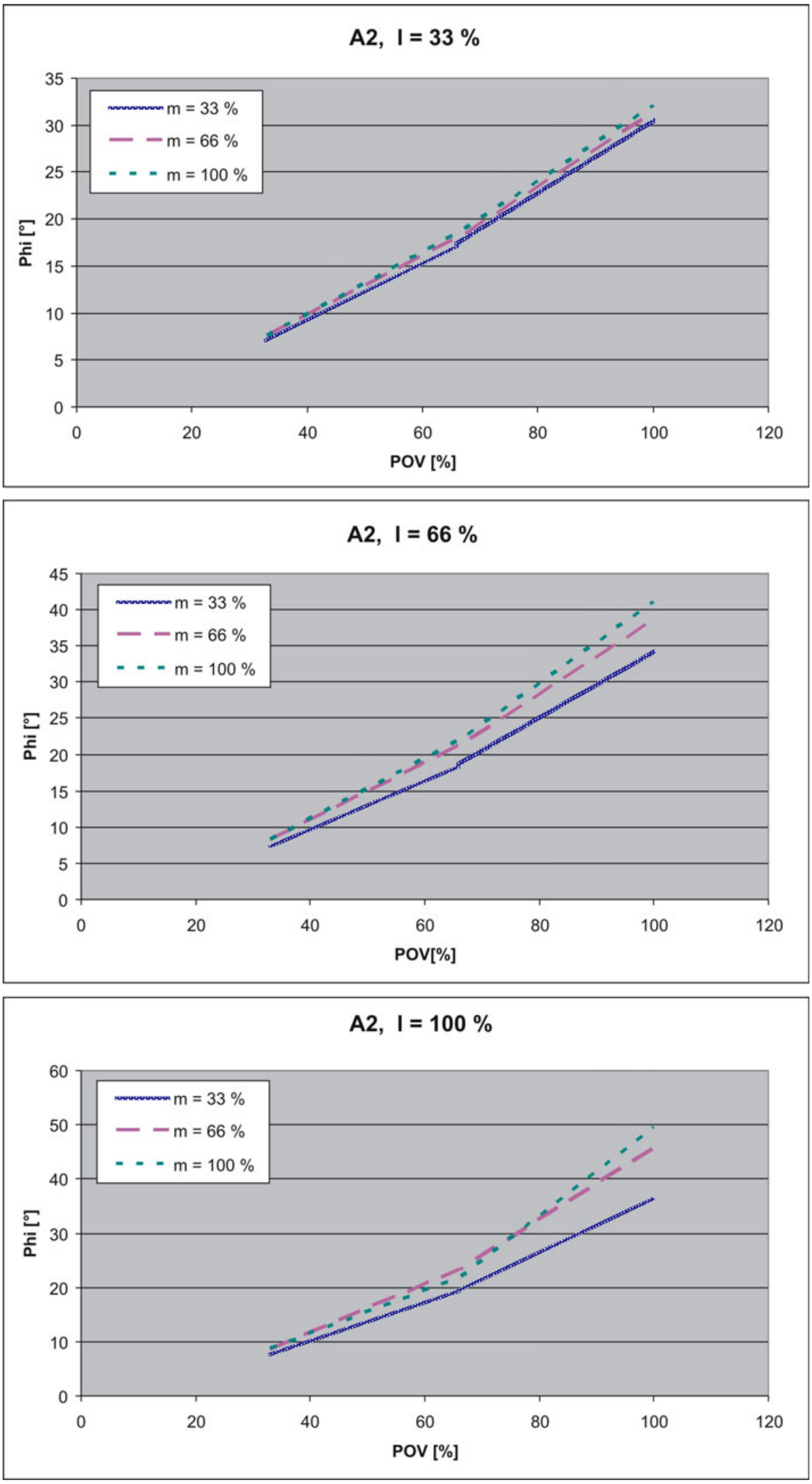


Fig. 4-20: Stopping distances for STOP 1, axis 2

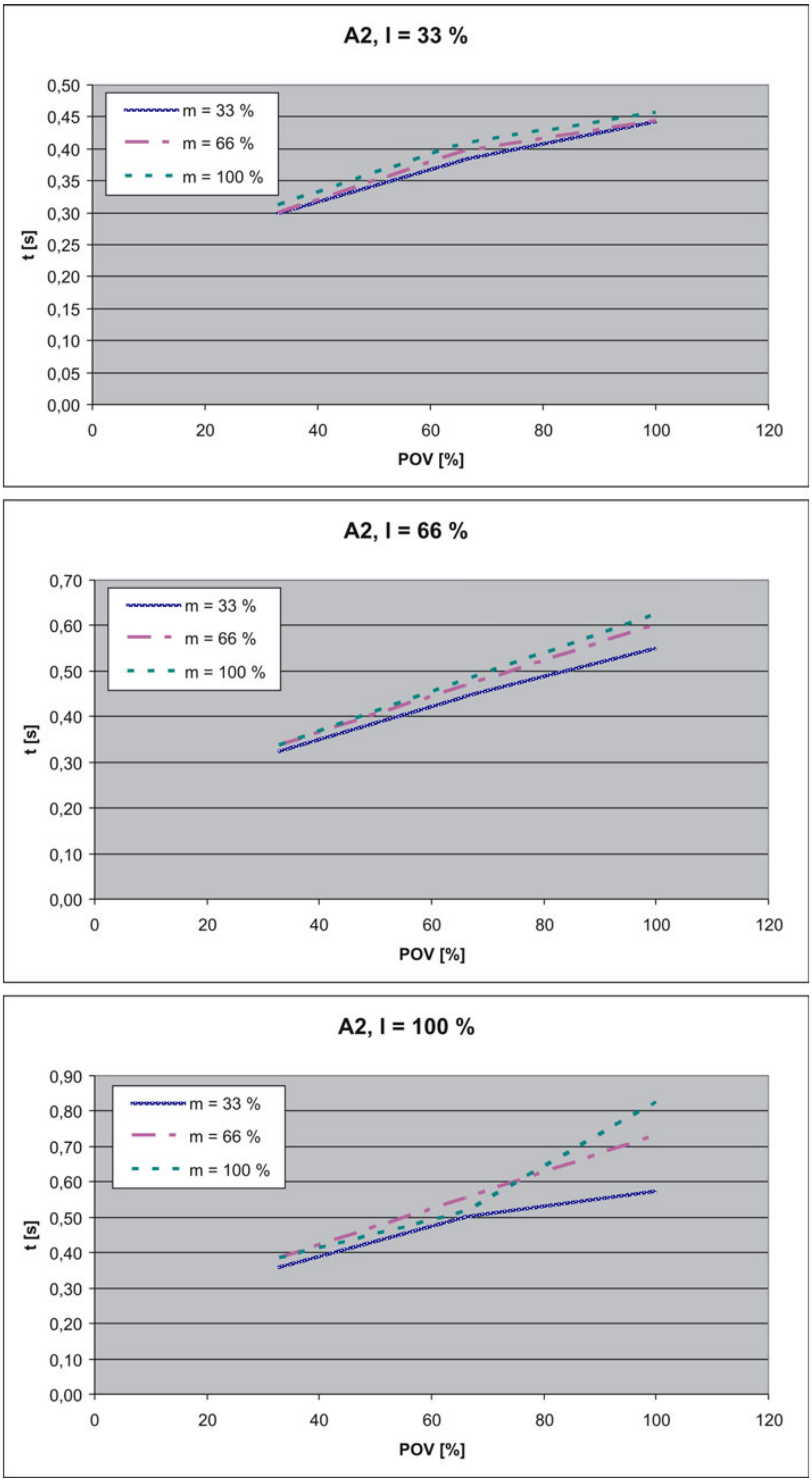


Fig. 4-21: Stopping times for STOP 1, axis 2

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

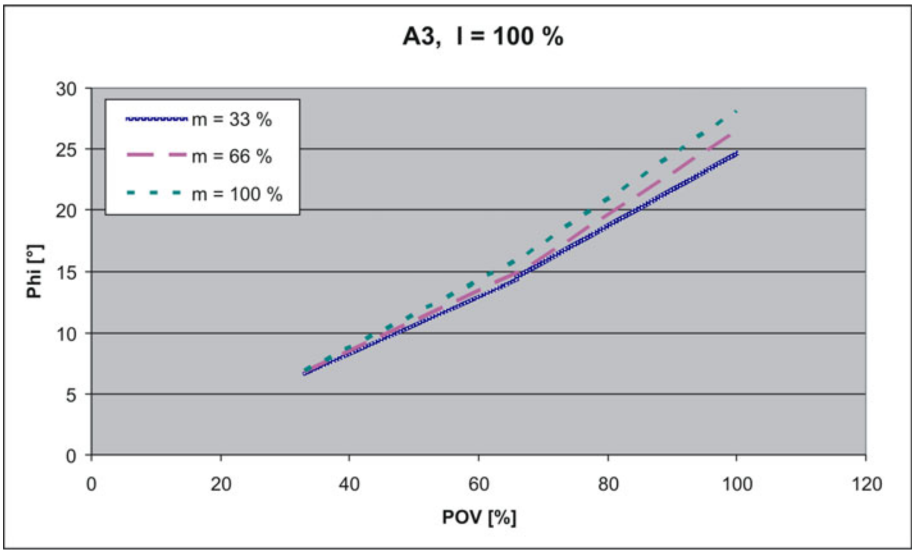


Fig. 4-22: Stopping distances for STOP 1, axis 3

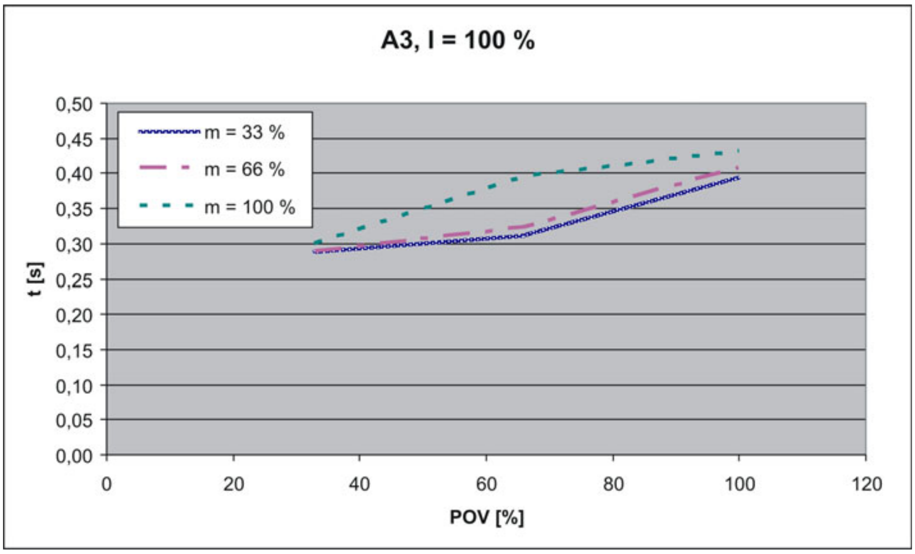


Fig. 4-23: Stopping times for STOP 1, axis 3

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 intended 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 the safety of the industrial robot 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.

> Further information is contained in the "Purpose" chapter of the operating instructions or assembly instructions of the industrial robot.

Using the industrial robot for any other or additional purpose is considered impermissible misuse. The manufacturer cannot be held liable for any damage resulting from such use. The risk lies entirely with the user.

Operating the industrial robot and its options within the limits of its intended use also involves observance of 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 impermissible misuse. This includes e.g.:

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

5.1.3 EC declaration of conformity and declaration of incorporation

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

- The industrial robot is integrated into a complete system.

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

  Or: All safety functions and safeguards required for operation in the complete machine as defined by the EC Machinery Directive have been added to the industrial robot.
- The complete system complies with the EC Machinery Directive. This has been confirmed by means of an assessment of conformity.

Declaration of conformity

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

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

Declaration of incorporation

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

The declaration of incorporation declares that the start-up of the partly completed machinery remains impermissible 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.

The declaration of incorporation, together with its annexes, remains with the system integrator as an integral part of the technical documentation of the complete machinery.

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.
KCP	The KCP (KUKA Control Panel) teach pendant has all the operator control and display functions required for operating and programming the industrial robot.
Manipulator	The robot arm and the associated electrical installations
Safety zone	The safety zone is situated outside the danger zone.
Stop category 0	The drives are deactivated immediately and the brakes are applied. The manipulator and any external axes (optional) perform path-oriented braking. **Note:** This stop category is called STOP 0 in this document.
Stop category 1	The manipulator and any external axes (optional) perform path-maintaining braking. The drives are deactivated after 1 s and the brakes are applied. **Note:** This stop category is called STOP 1 in this document.
Stop category 2	The drives are not deactivated and the brakes are not applied. The manipulator and any external axes (optional) are braked with a normal braking ramp. **Note:** This stop category is called STOP 2 in this document.
System integrator (plant integrator)	System integrators are people who safely integrate the industrial robot into a complete system and commission it.
T1	Test mode, Manual Reduced Velocity (<= 250 mm/s)
T2	Test mode, Manual High Velocity (> 250 mm/s permissible)
External axis	Motion axis which is not part of the manipulator but which is controlled using the robot controller, e.g. KUKA linear unit, turn-tilt table, Posiflex.

5.2 Personnel

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

- User
- Personnel

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

User

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

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

Personnel

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

Personnel includes:

- System integrator
- Operators, subdivided into:
  - Start-up, maintenance and service personnel
  - 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 declaration of conformity
- Attaching the CE mark
- Creating the operating instructions for the complete system

Operator

The operator must meet the following preconditions:

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

Example

The tasks can be distributed as shown in the following table.

Tasks	Operator	Programmer	System integrator
Switch robot controller on/off	x	x	x
Start program	x	x	x
Select program	x	x	x
Select operating mode	x	x	x
Calibration (tool, base)		x	x
Master the manipulator		x	x
Configuration		x	x
Programming		x	x
Start-up			x

Tasks	Operator	Programmer	System integrator
Maintenance			x
Repair			x
Decommissioning			x
Transportation			x

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.

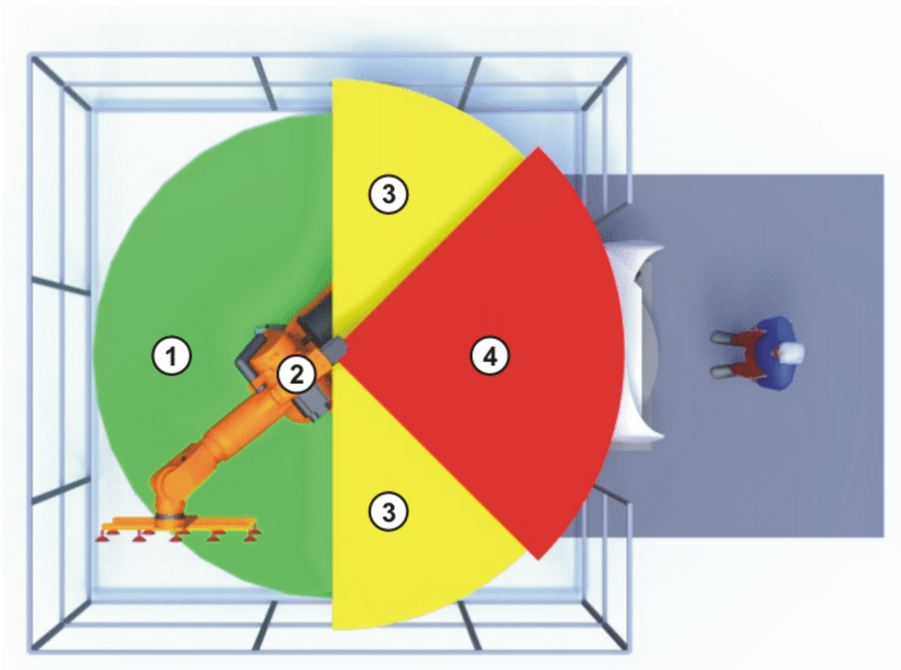


Fig. 5-1: Example of axis range A1

1	Workspace	3	Stopping distance
2	Manipulator	4	Safety zone

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

The axis ranges of main axes A1 to A3 and wrist axis A5 of the manipulator are limited by means of mechanical end stops with buffers.

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

> **NOTICE** If the manipulator or an external axis hits an obstruction or a buffer on the mechanical end stop or axis range limitation, this can result in material damage to the industrial robot. KUKA Roboter GmbH must be consulted before the industrial robot is put back into operation. (>>> 9 "KUKA Service" Page 63)
> The affected buffer must be replaced with a new one before operation of the industrial robot is resumed. If a manipulator (or external axis) collides with a buffer at more than 250 mm/s, the manipulator (or external axis) must be exchanged or recommissioning must be carried out by KUKA Roboter GmbH.

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 all robot models. Information on specific robot models can be obtained from KUKA Roboter GmbH.

5.4.4 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 main axis drive motors and, depending on the robot variant, also for the wrist axis drive motors. It is only for use in exceptional circumstances and emergencies (e.g. for freeing people).

> **⚠ 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.

Procedure

1. Switch off the robot controller and secure it (e.g. with a padlock) to prevent unauthorized persons from switching it on again.
2. Remove the protective cap from the motor.
3. Push the release device onto the corresponding motor and move the axis in the desired direction.

   The directions are indicated with arrows on the motors. It is necessary to overcome the resistance of the mechanical motor brake and any other loads acting on the axis.

> **⚠ WARNING** Moving an axis with the release device can damage the motor brake. This can result in personal injury and material damage. After using the release device, the affected motor must be exchanged.

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 labels
- Safety symbols
- Designation labels
- Cable markings
- Rating plates

> **i** 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. 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.

⚠ WARNING Standing underneath the robot arm can cause death or serious physical 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

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

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

⚠ WARNING The operator must ensure that decoupled KCPs 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 facilities from becoming interchanged.
Failure to observe this precaution may result in death, severe physical 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 must not be used as long as an external keyboard and/or external mouse are connected.

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

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.

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 circuits 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.

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 manipulator.

Robot controller

The robot controller must be transported and installed in an upright position. Avoid vibrations and impacts during transportation in order to prevent damage to the robot controller.

Transportation must be carried out in accordance with the operating instructions or assembly instructions of the robot controller.

External axis (optional)

The prescribed transport position of the external axis (e.g. KUKA linear unit, turn-tilt table, etc.) 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.

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

Machine data

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

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

5.5.4 Manual mode

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

- Jog mode
- Teaching
- Programming
- Program verification

The following must be taken into consideration in manual mode:

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

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

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

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

- If it can be avoided, there must be no other persons inside the safeguarded area.

  If it is necessary for there to be several persons inside the safeguarded area, the following must be observed:
  - Each person must have an enabling device.
  - All persons must have an unimpeded view of the industrial robot.
  - Eye-contact between all persons must be possible at all times.
- The operator must be so positioned that he can see into the danger area and get out of harm’s way.

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

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

5.5.5 Automatic mode

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

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

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

5.5.6 Maintenance and repair

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

WARNING 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 by unauthorized personnel. The incoming power cable must be deenergized. The robot controller and mains supply lead must then be checked to ensure that it is deenergized.
If the KR C4 or VKR C4 robot controller is used:
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 in the case of the drives of the new generation. Parts remain energized. Death or severe physical 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. Depending on the robot variant, the counterbalancing systems correspond to category 0, II or III, fluid group 2, of the Pressure Equipment Directive.

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

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

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

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

Hazardous substances

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

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

To ensure safe use of our products, we recommend that our customers regularly request up-to-date safety data sheets from the manufacturers of hazardous substances.

5.5.7 Decommissioning, storage and disposal

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

5.6 Applied norms and regulations

Name	Definition	Edition
2006/42/EC	Machinery Directive: Directive 2006/42/EC of the European Parliament and of the Council of 17 May 2006 on machinery, and amending Directive 95/16/EC (recast)	2006
2004/108/EC	EMC Directive: Directive 2004/108/EC of the European Parliament and of the Council of 15 December 2004 on the approximation of the laws of the Member States relating to electromagnetic compatibility and repealing Directive 89/336/EEC	2004
97/23/EC	Pressure Equipment Directive: Directive 97/23/EC of the European Parliament and of the Council of 29 May 1997 on the approximation of the laws of the Member States concerning pressure equipment (Only applicable for robots with hydropneumatic counterbalancing system.)	1997
EN ISO 13850	Safety of machinery: Emergency stop - Principles for design	2008
EN ISO 13849-1	Safety of machinery: Safety-related parts of control systems - Part 1: General principles of design	2008
EN ISO 13849-2	Safety of machinery: Safety-related parts of control systems - Part 2: Validation	2008
EN ISO 12100-1	Safety of machinery: Basic concepts, general principles for design - Part 1: Basic terminology, methodology	2003
EN ISO 12100-2	Safety of machinery: Basic concepts, general principles for design - Part 2: Technical principles	2003
EN ISO 10218-1	Industrial robots: Safety	2008
EN 614-1	Safety of machinery: Ergonomic design principles - Part 1: Terms and general principles	2006
EN 61000-6-2	Electromagnetic compatibility (EMC): Part 6-2: Generic standards; Immunity for industrial environments	2005

Name	Definition	Edition
EN 61000-6-4	Electromagnetic compatibility (EMC): Part 6-4: Generic standards; Emission standard for industrial environments	2007
EN 60204-1	Safety of machinery: Electrical equipment of machines - Part 1: General requirements	2006

6 Planning

6.1 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
- 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.

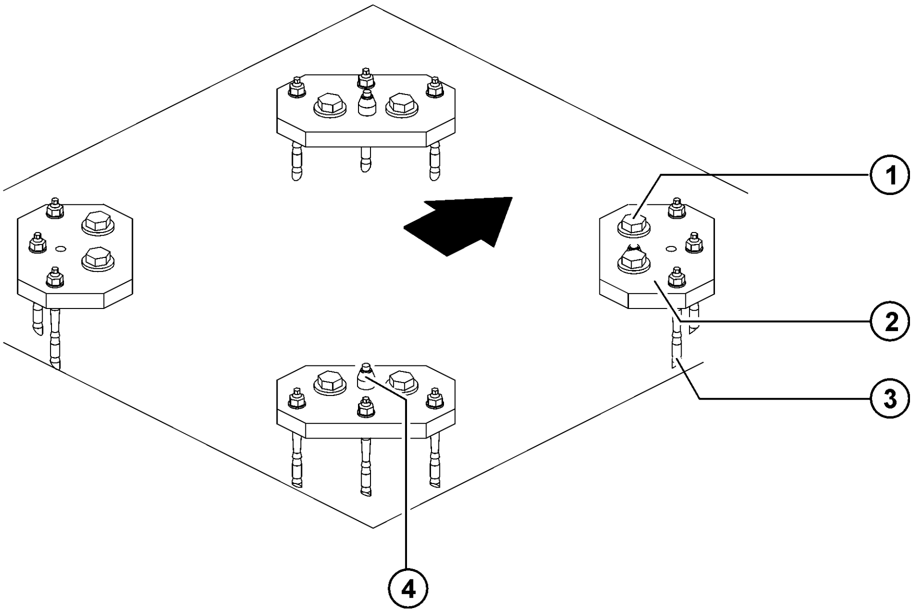


Fig. 6-1: Mounting base

1	Hexagon bolt	3	Resin-bonded anchors with Dynamic Set
2	Bedplate	4	Pin with Allen screw

Grade of concrete for foundations

When producing foundations from concrete, observe the load-bearing capacity of the ground and the country-specific construction regulations. The concrete must have no cracks and fulfill the following norms for quality:

- B25 according to DIN 1045:1988
- C20/25 according to DIN EN 206-1:2001/DIN 1045-2:2001

Dimensioned drawing

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

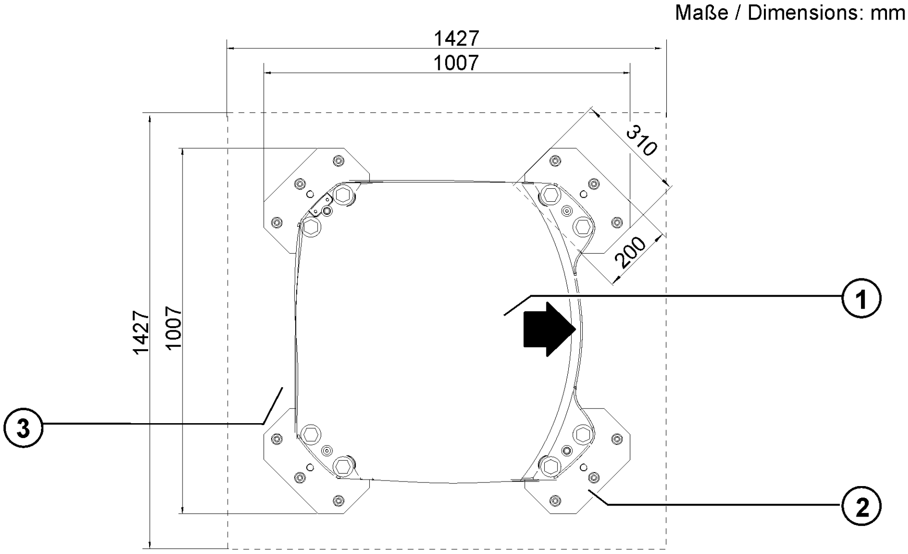


Fig. 6-2: Mounting base, dimensioned drawing

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.

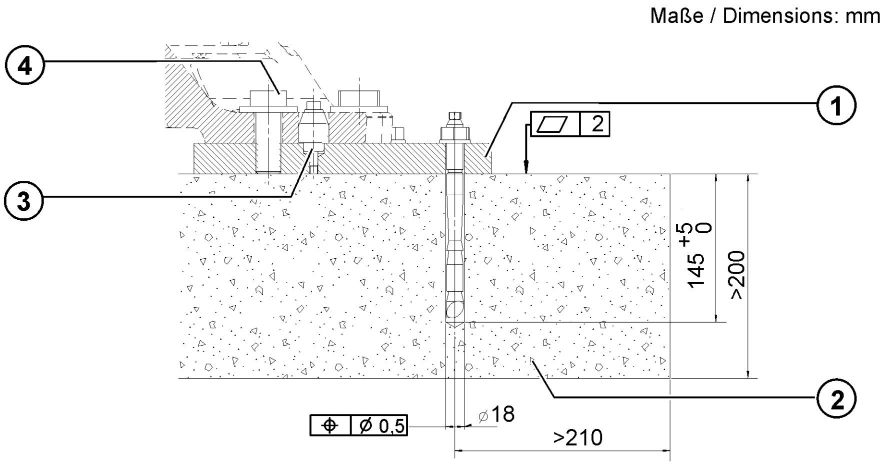


Fig. 6-3: Cross-section of foundations

1	Bedplate	3	Pin
2	Concrete foundation	4	Hexagon bolt

6.2 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:

- Pin with fasteners
- Hexagon bolts with conical spring washers

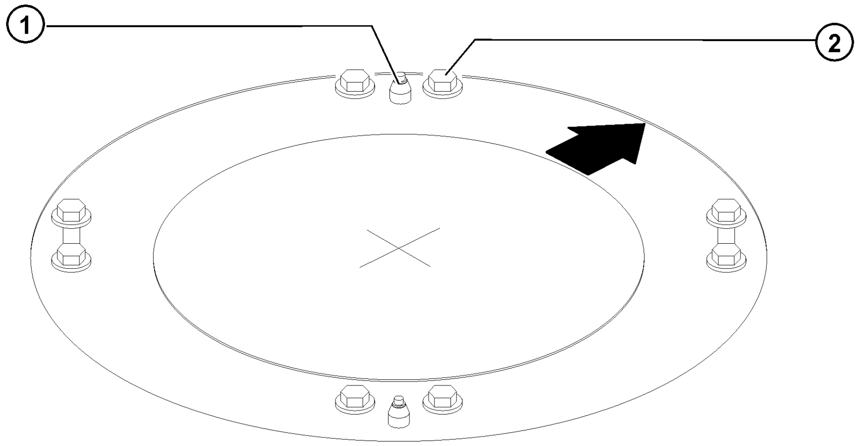


Fig. 6-4: Machine frame mounting

1 Pin
2 Hexagon bolt

Dimensioned drawing

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

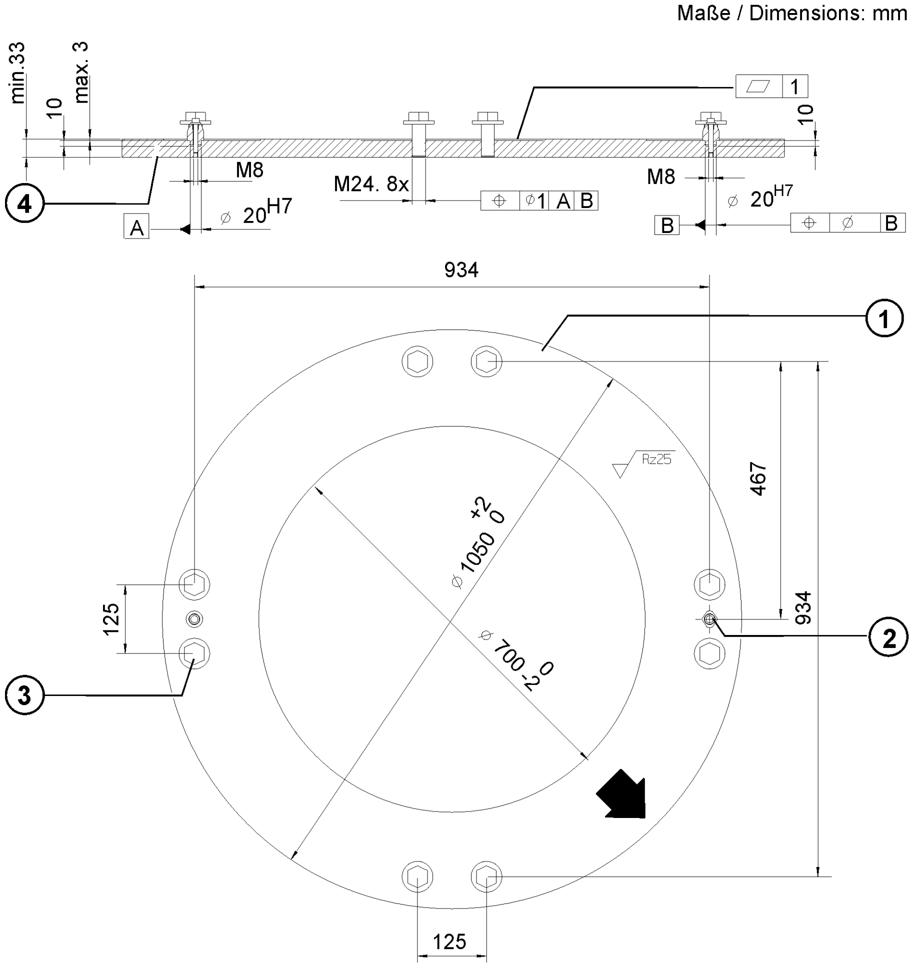


Fig. 6-5: Machine frame mounting, dimensioned drawing

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

6.3 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
- Control 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.

Wiring diagrams, connector pin allocations and connector designations can be found in the section “Electrical installations” .

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

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

Interface for energy supply systems

The robot can be equipped with an energy supply system between axis 1 and axis 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.

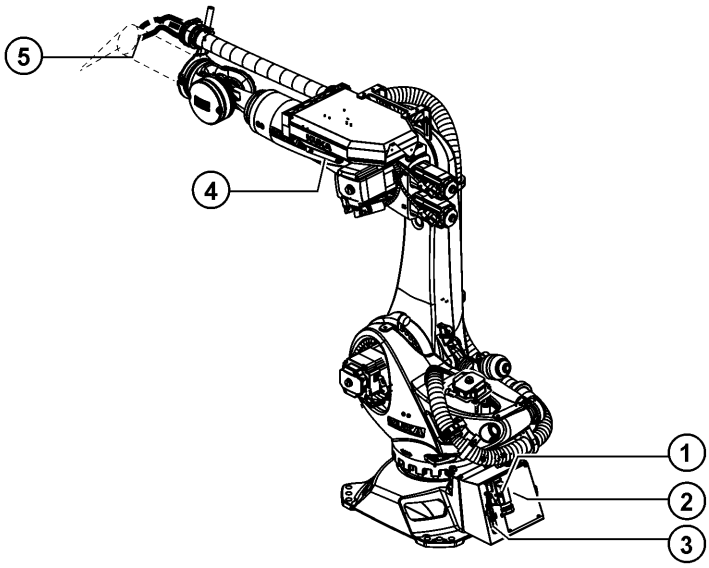


Fig. 6-6: Interfaces on the robot

1	Connection, motor cable X30	4	Interface, axis 3, arm
2	Interface, axis 1, base frame	5	Interface, axis 6, tool
3	Connection, control 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 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°	0º	-120º	0º

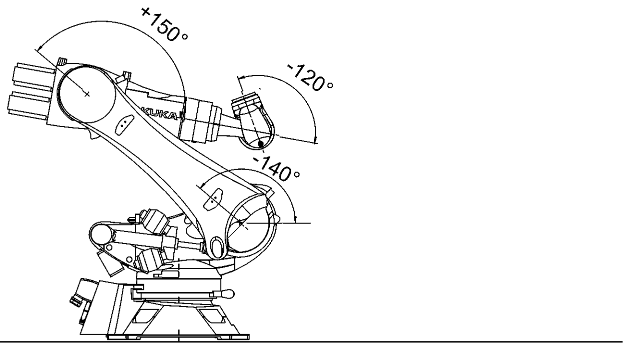


Fig. 7-1: Transport position

Transport dimensions

The transport dimensions for the robot can be noted from the following diagram. The position of the center of gravity and the weight vary according to the specific configuration and the position of axes 2 and 3. The specified dimensions refer to the robot without equipment.

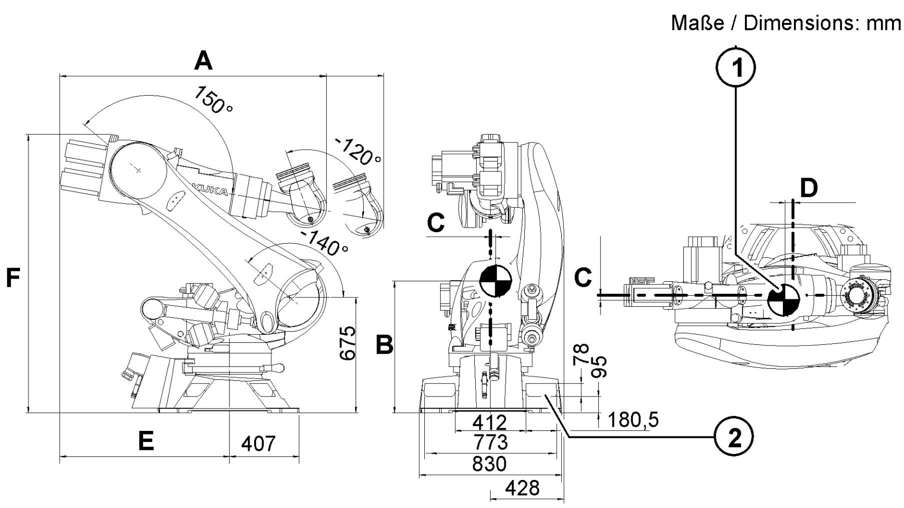


Fig. 7-2: Transport dimensions

1 Center of gravity
2 Fork slots

Transport dimensions and centers of gravity

Robot with reach	A	B	C	D	E	F
R2500	1582	741	48	56	997	1625
R2700	1747	742	47	35	997	1625

Transportation

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

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

Transportation by fork lift truck

For transport by fork lift truck (>>> Fig. 7-3), two fork slots are provided in the base frame. The robot can be picked up by the fork lift truck from the front and rear. The 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 2.0 t 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.

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

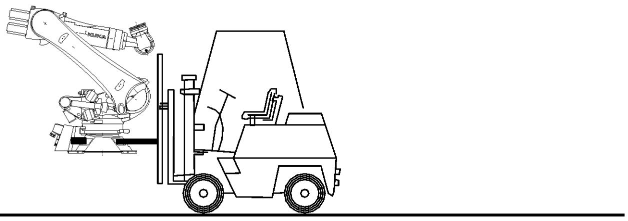


Fig. 7-3: Transportation by fork lift truck

Transportation with lifting tackle

The robot can also be transported using lifting tackle (>>> Fig. 7-4). The robot must be in the transport position. The lifting tackle is attached at 4 points to M20 DIN 580 eyebolts. All ropes must be long enough and must be routed in such a way that the robot is not damaged. Installed tools and pieces of equipment can cause undesirable shifts in the center of gravity.

> **⚠ WARNING** The robot may tip during transportation. Risk of personal injury and damage to property.
> If the robot is being transported using lifting tackle, special care must be excercised to prevent it from tipping. Additional safeguarding measures must be taken. It is forbidden to pick up the robot in any other way using a crane!

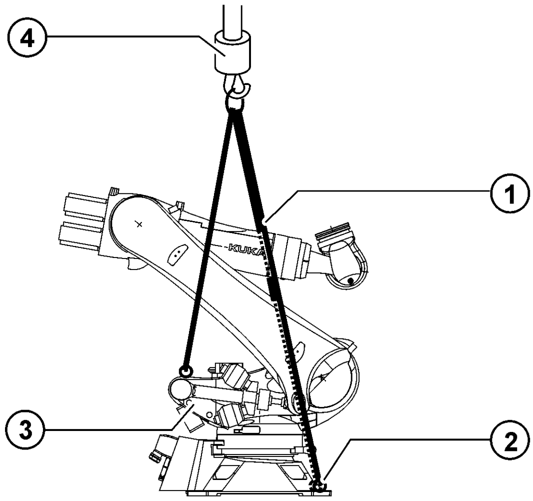


Fig. 7-4: Transportation using lifting tackle

1	Lifting tackle	3	Rotating column
2	M20 eyebolt	4	Crane

8 Options

8.1 Mounting flange, adapter (optional)

Description

This mounting flange (adapter) (>>> 8.1 "Mounting flange, adapter (optional)" Page 61) 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 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.

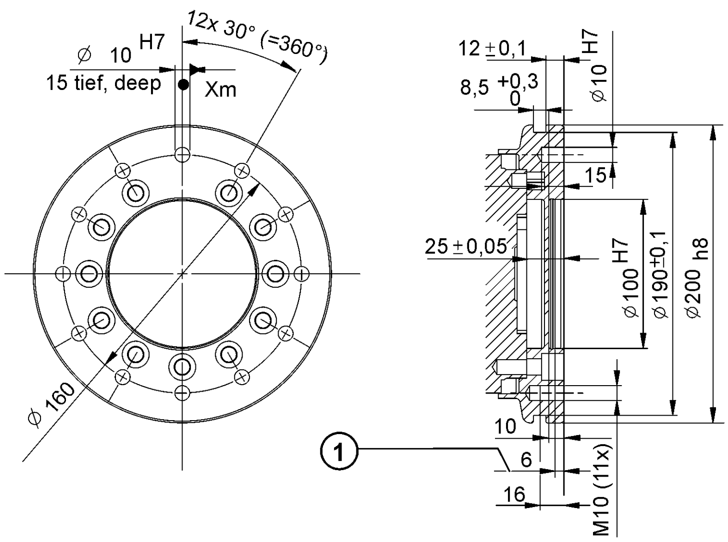


Fig. 8-1: Mounting flange, adapter

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
Grip length	1.5 x nominal diameter
Depth of engagement	min. 12 mm, max. 16 mm
Locating element	10^{H7}

8.2 Working range limitation, supplementary stop (optional)

Description

The working range limitation (>>> Fig. 8-2) can be used to restrict the available working range about axis 1 in 20° steps in both the plus and minus directions. The assembly consists of two stops with the relevant fastening screws.

Depending on the mounting position of the stops, the available range can be set from min. +/-5° to max. +/-105°. Due to the trailing stop, there is always a residual range of 90°, which cannot be limited.

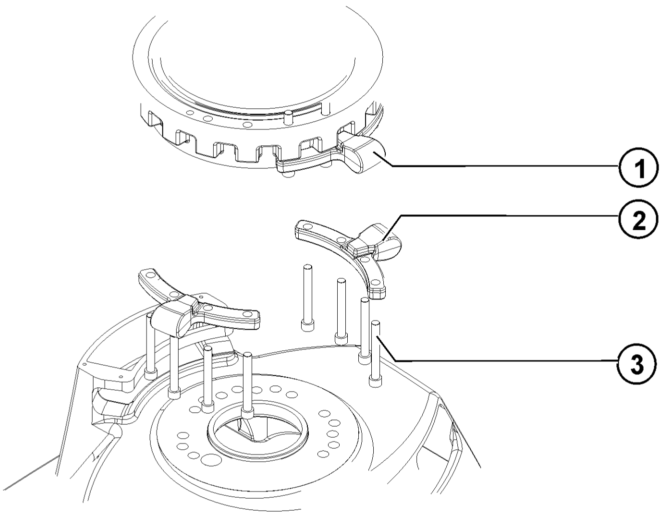


Fig. 8-2: Working range limitation A1 (optional)

1 Standard stop
2 Supplementary stops
3 Fastening screws

8.3 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.

9 KUKA Service

9.1 Requesting support

Introduction

The KUKA Roboter GmbH documentation offers information on operation 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:

- Model and serial number of the robot
- Model and serial number of the controller
- Model and serial number of the linear unit (if applicable)
- Version of the KUKA System Software
- Optional software or modifications
- Archive of the software

  For KUKA System Software V8: instead of a conventional archive, generate the special data package for fault analysis (via **KrcDiag**).
- Application used
- Any external axes used
- Description of the problem, duration and frequency of the fault

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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