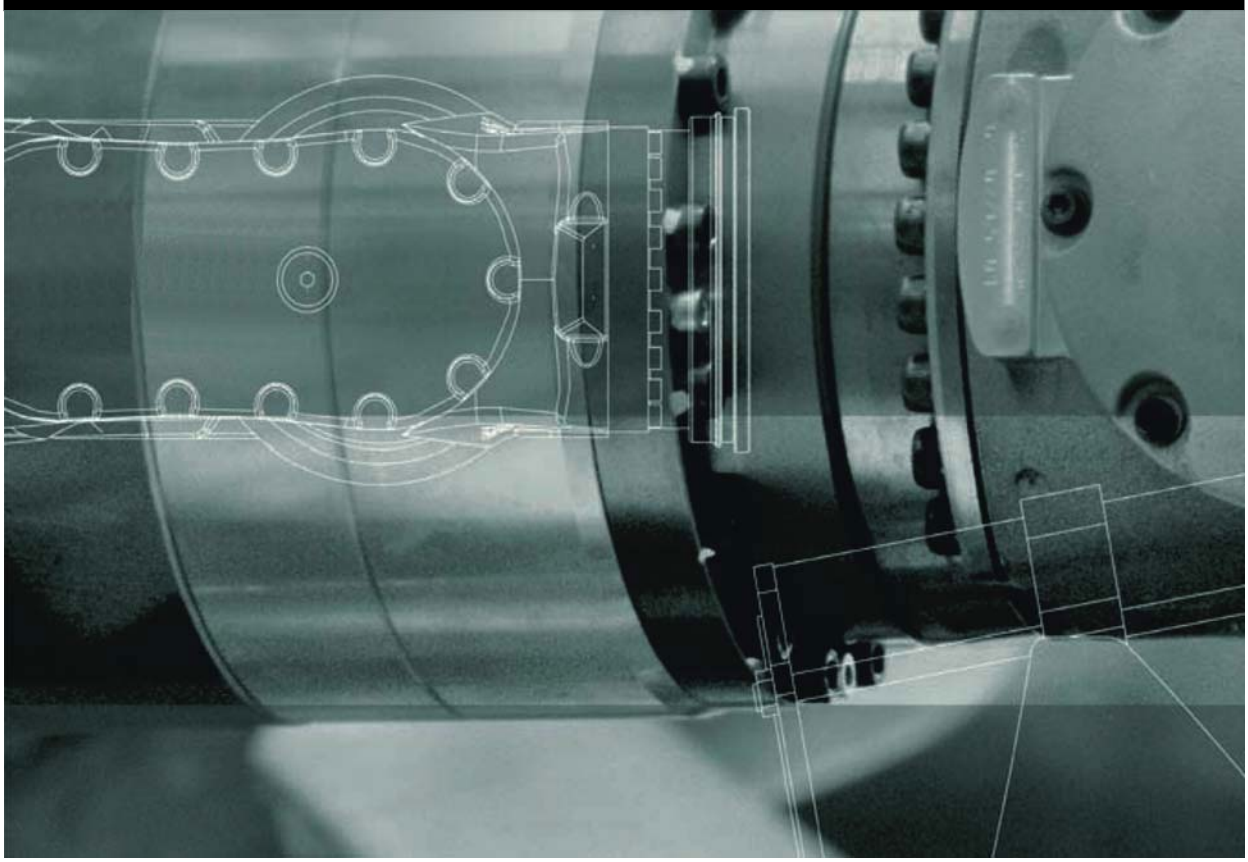
KUKA

Robots

KUKA Roboter GmbH

KR 16 arc HW, KR 16 L8 arc HW

Specification



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Germany

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

Publication:	Pub Spez KR 16 arc HW en
Bookstructure:	Spez KR 16 arc HW V7.1
Version:	Spez KR 16 arc HW V6 en (PDF)

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 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.

Notes

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

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

2 Purpose

2.1 Target group

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

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

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

2.2 Intended use

Use

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

Misuse

Any use or application deviating from the intended use is deemed to be 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
- Use in underground mining

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

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 industrial robots KR 16 arc HW and KR 16 L8 arc HW comprise the following components:

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

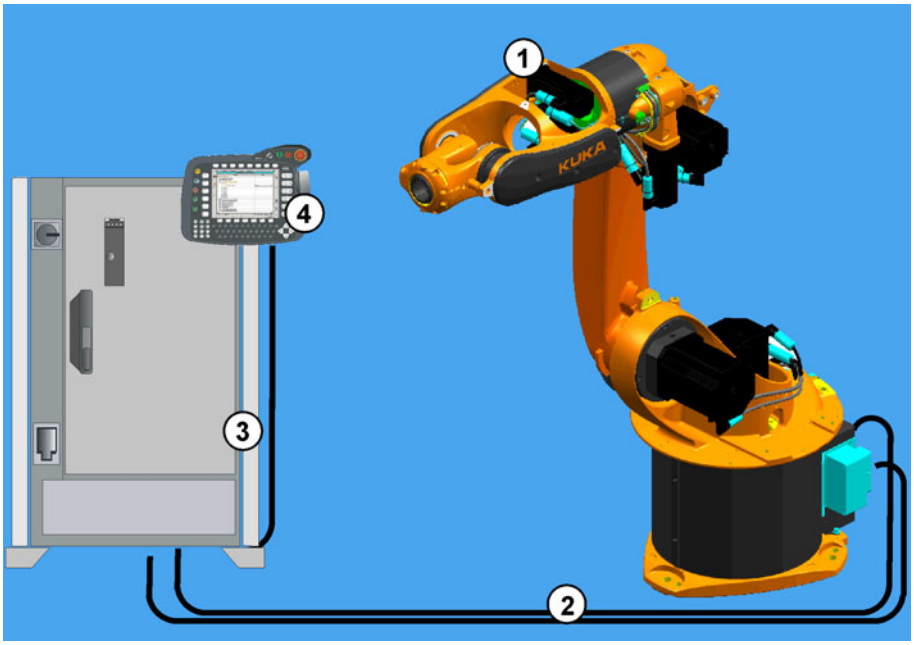


Fig. 3-1: Example of a robot system

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

SafeRobot

The SafeRobot option is available for this robot.

In this case the robot moves within limits that have been configured. The actual position is continuously calculated and monitored by the SafeRDC. If the robot violates a monitoring limit or a safety parameter, it is stopped.

RoboTeam

The RoboTeam option is available for this robot.

RoboTeam allows the operation of cooperating robot systems. In the RoboTeam, up to 15 robots can work together in a group. One robot in the group always takes on the role of “master”, while the remaining robots work as “slaves”.

3.2 Description of the robot

Overview

These manipulators (robots) (>>> Fig. 3-2) are designed as a 6-axis jointed-arm kinematic system. They consist of the following principal components:

- Hollow-shaft wrist
- Arm
- Link arm
- Rotating column
- Base frame
- Electrical installations

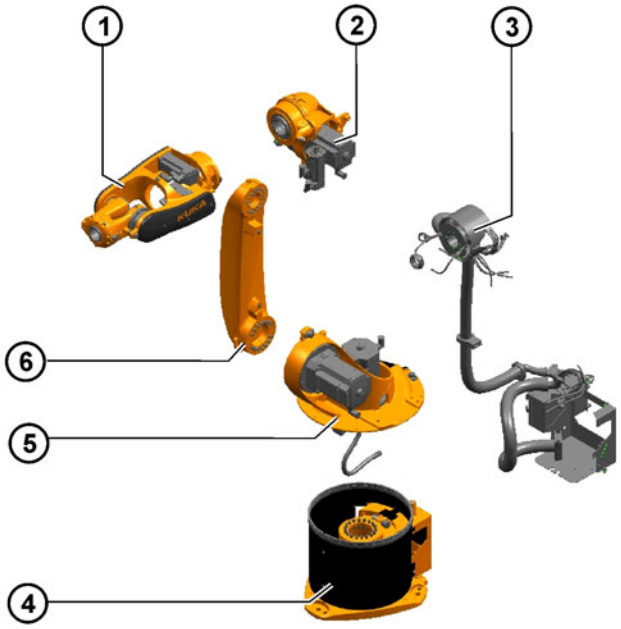


Fig. 3-2: Main assemblies of the manipulator

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

Hollow-shaft wrist

The robot variants KR 16 arc HW and KR 16 L8 arc HW are equipped with a 2-axis hollow-shaft wrist. The wrist contains axes 5 and 6. The motors of axes 5 and 6 are incorporated in this assembly. Both axes are driven via toothed belts and gear units. The design enables the fluid supply to be routed directly through the center of axis 6 to the application.

For attaching end effectors (tools), the in-line wrist has a mounting flange.

Arm

The arm is the link between the hollow-shaft wrist and the link arm. It houses the motors of wrist axes 3 and 4. 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 link arm. The entire drive unit of axis 4 is also integrated inside the arm. In addition, the cable harness for the wrist axes A 5 and A 6 is installed under a cover. Fastening facilities are provided for the welding application equipment on the rear of the arm. The fluid supply to the tool is routed axially through the arm.

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.

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 multi-function housing (MFH) and the data cable junction box.

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), both of which are mounted on the robot base frame. The connecting cables from the robot controller are connected to these junction boxes by means of connectors. The electrical installations also include a protective circuit.

For the supply to the wrist axis drives, an additional cable harness is integrated into the arm, which ensures that the cables are guided without kinking throughout the motion range of axis 4.

4 Technical data

4.1 Basic data

Basic data

Type	KR 16 arc HW KR 16 L8 arc HW
Number of axes	6
Volume of working envelope	KR 16 arc HW: 15.44 m^3 KR 16 L8 arc HW: 29.22 m^3
Pose repeatability (ISO 9283)	KR 16 arc HW: ±0.04 mm KR 16 L8 arc HW: ±0.04 mm
Working envelope reference point	Intersection of axes 4 and 5
Weight	KR 16 arc HW: 245 kg KR 16 L8 arc HW: 240 kg
Principal dynamic loads	See “Loads acting on the mounting base”
Protection classification of the robot	IP 54 ready for operation, with connecting cables plugged in (according to EN 60529)
Protection classification of the in-line wrist	IP 54
Sound level	< 75 dB (A) outside the working envelope
Mounting position	Floor, ceiling
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)
Operation with Safe RDC	283 K to 323 K (+10 °C to +50 °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	DIN EN 60721-3-3, Class 3K3

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	Harting connectors at both ends
Data cable, SafeRobot	X21.1 - X41	Harting connectors at both ends

Cable lengths	
Standard	7 m, 15 m, 25 m, 35 m, 50 m
With RoboTeam*	7 m, 15 m, 25 m, 35 m
With SafeRobot*	7 m, 15 m, 25 m, 35 m

* Only with KR C2.

For detailed specifications of the connecting cables, see “Description of the connecting cables” (>>> 6.4 "Connecting cables and interfaces" Page 61).

4.2 Axis data

Axis data

The following data are valid for the robot KR 16 arc HW:

Axis	Range of motion, software-limited	Speed with rated payload
1	+/-185°	200 °/s
2	+35° to -155°	200 °/s
3	+154° to -120°	195 °/s
4	+/-165°	370 °/s
5	+/-130°	310 °/s
6	Infinitely rotating	610 °/s

The following data are valid for the robot KR 16 L8 arc HW:

Axis	Range of motion, software-limited	Speed with rated payload
1	+/-185°	127 °/s
2	+35° to -155°	130 °/s
3	+154° to -120°	125 °/s
4	+/-165°	315 °/s
5	+/-140°	320 °/s
6	Infinitely rotating	680 °/s

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

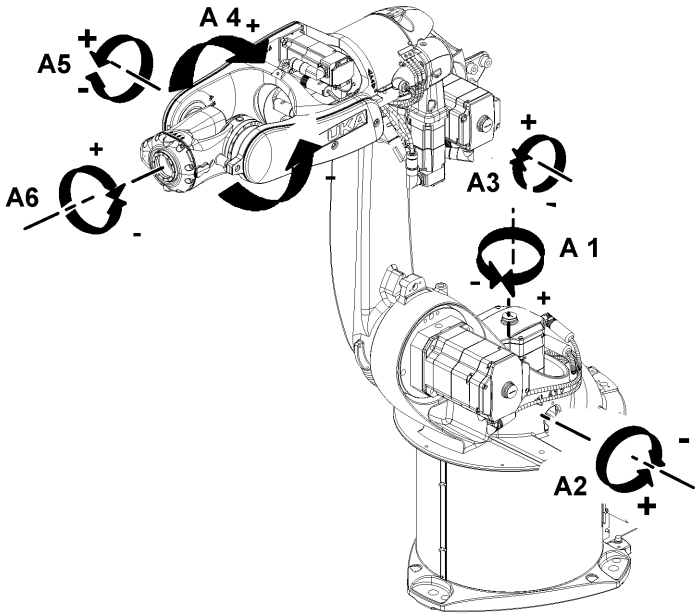


Fig. 4-1: Direction of rotation of the axes

Working envelope

The following diagrams show the shape and size of the working envelopes for the robots KR 16 arc HW (>>> Fig. 4-2) and KR 16 L8 arc HW (>>> Fig. 4-3).

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

Maße / Dimensions: mm

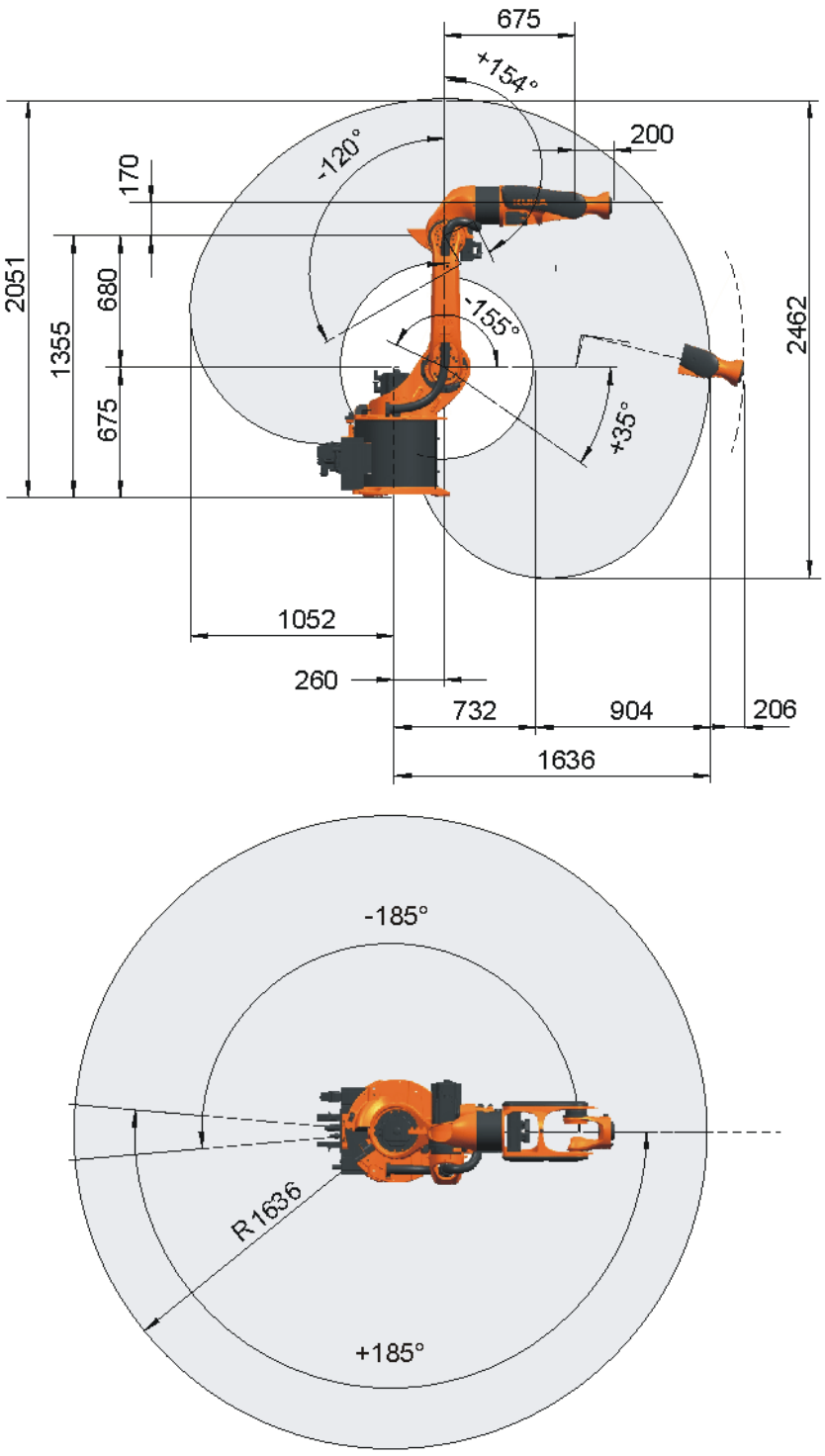


Fig. 4-2: Working envelope, KR 16 arc HW

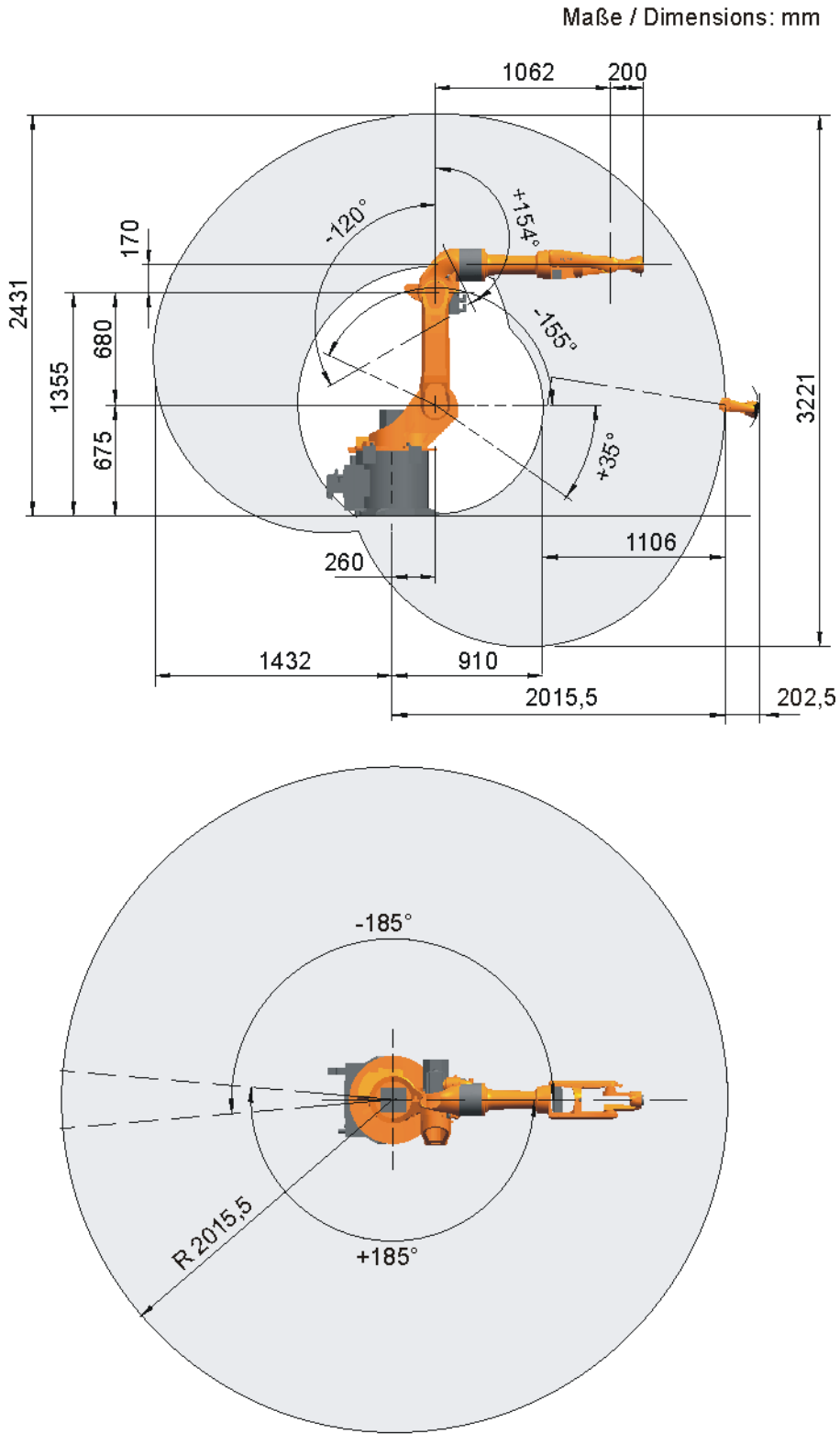


Fig. 4-3: Working envelope for KR 16 L8 arc HW

4.3 Payloads

Payloads KR 16 arc HW

Robot	KR 16 arc HW
In-line wrist	IW 16 arc HW
Rated payload	16 kg
Distance of the load center of gravity L_z (horizontal)	120 mm

Robot	KR 16 arc HW
Distance of the load center of gravity L_{xy} (vertical)	80 mm
Permissible mass moment of inertia	0.36 kgm^2
Max. total load	48 kg
Supplementary load, arm	12 kg
Supplementary load, link arm	None
Supplementary load, rotating column	20 kg
Supplementary load, base frame	None

Payloads KR 16 L8 arc HW

Robot	KR 16 L8 arc HW
In-line wrist	IW 5 arc HW
Rated payload	8 kg
Distance of the load center of gravity L_z (horizontal)	70 mm
Distance of the load center of gravity L_{xy} (vertical)	50 mm
Permissible mass moment of inertia	0.10 kgm^2
Max. total load	40 kg
Supplementary load, arm	12 kg
Supplementary load, link arm	None
Supplementary load, rotating column	20 kg
Supplementary load, base frame	None

Load center of gravity P

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

Payload diagram

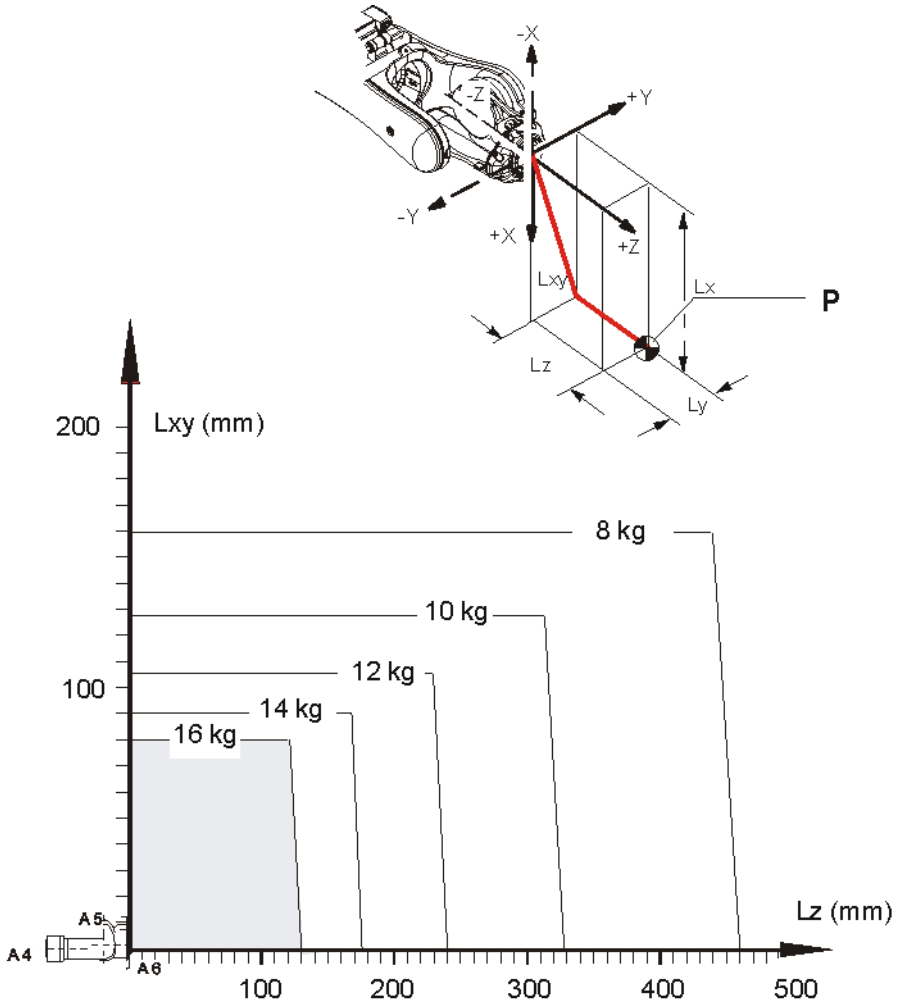


Fig. 4-4: Payload diagram, KR 16 arc HW

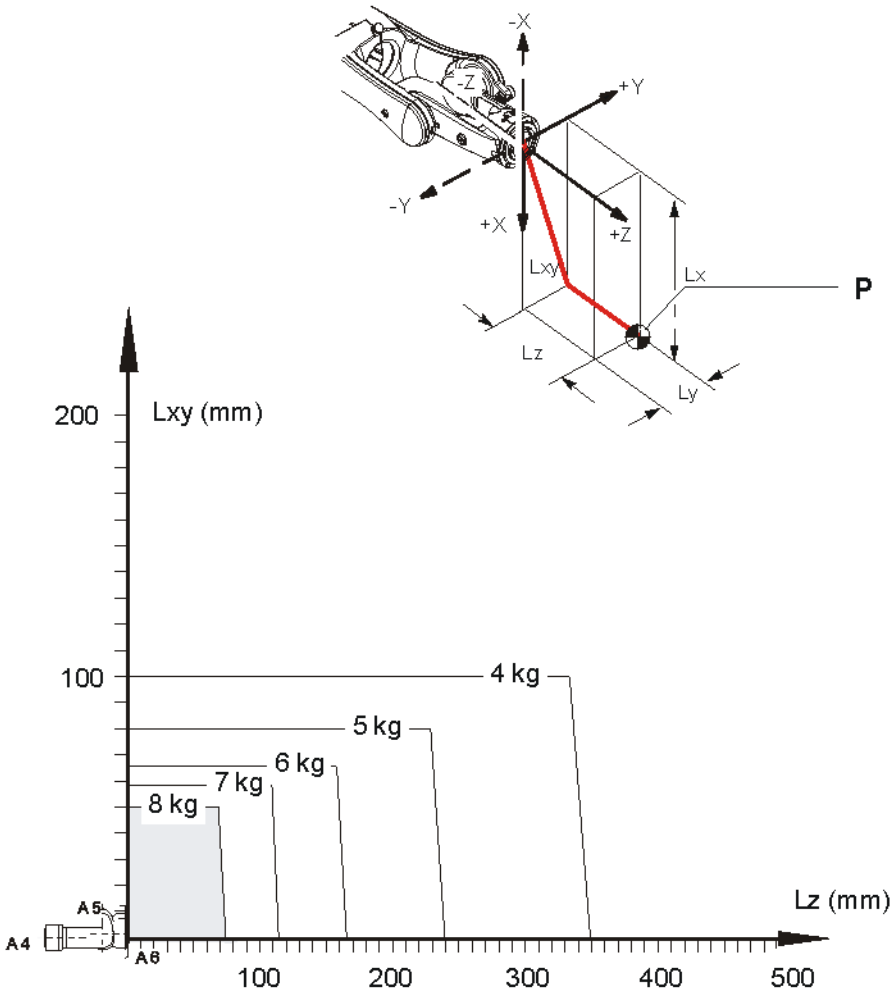


Fig. 4-5: Payload diagram, KR 16 L8 arc HW

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!

Mounting flange

Robot	KR 16 arc HW	KR 16 L8 arc HW
Wrist	IW 16 arc HW	IW 5 arc HW
Mounting flange (hole circle)	66 mm	58 mm
Screw grade	10.9	10.9
Screw size	M5	M4
Grip length	1.5 x nominal diameter	1.5 x nominal diameter
Depth of engagement	min. 7 mm, max. 8 mm	min. 6 mm, max. 7 mm
Locating element	5 ^{H7}	4 ^{H7}

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

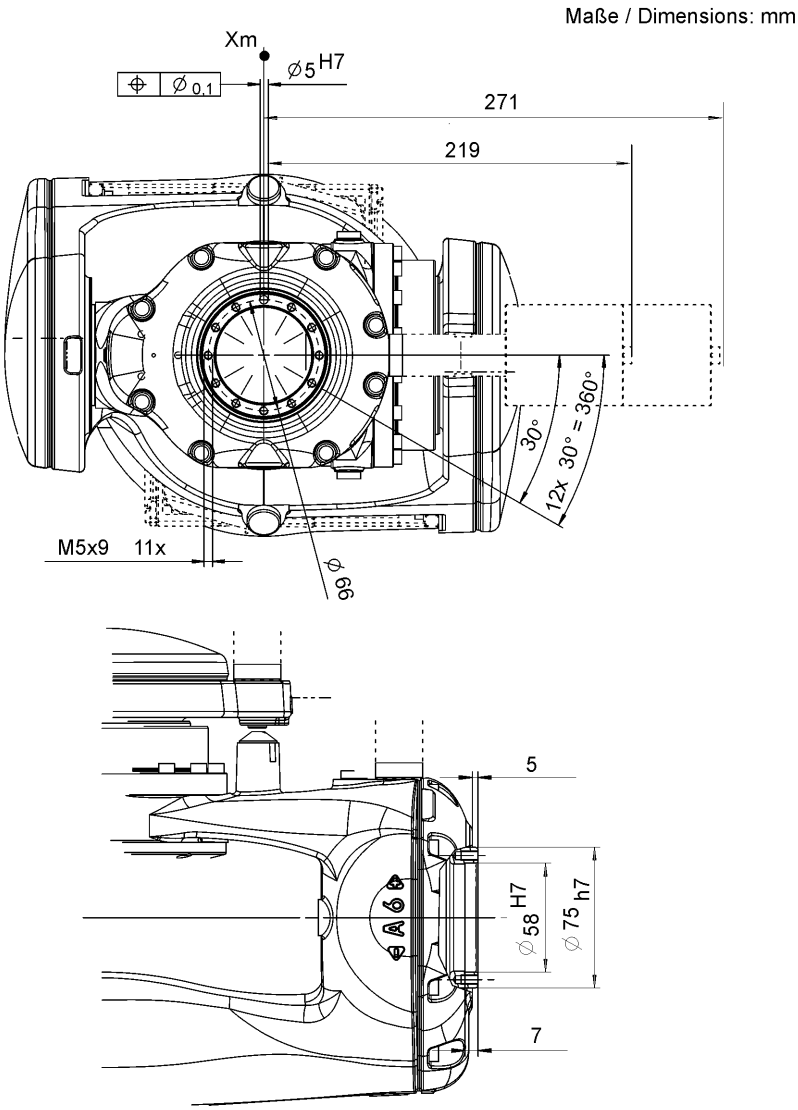


Fig. 4-6: Mounting flange, KR 16 arc HW

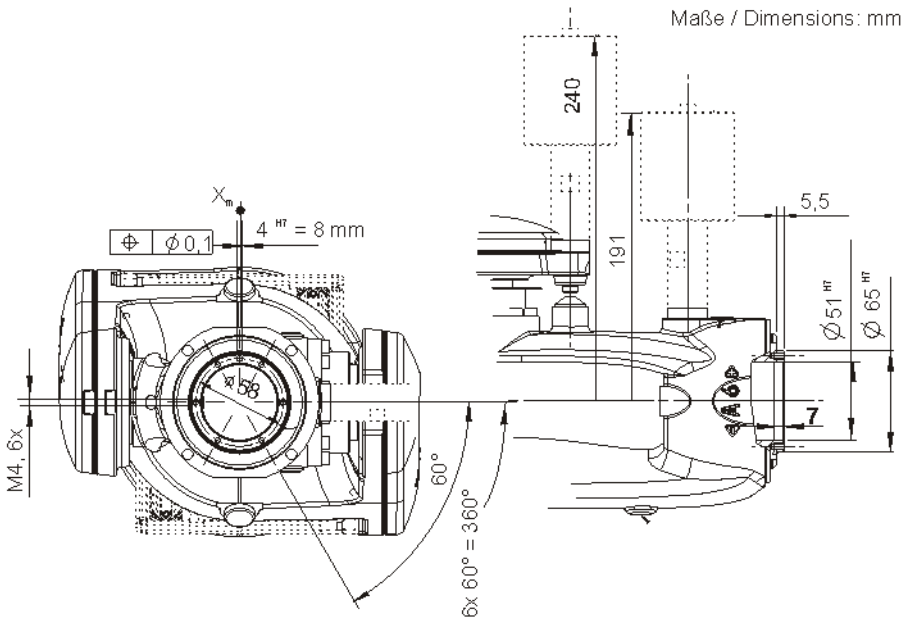


Fig. 4-7: Mounting flange, KR 16 L8 arc HW

Interface A6

The hollow-shaft wrists are provided with a special interface, interface A6, which allows welding equipment to be connected to the swivel housing. The dimensions and designs of this interface can be seen in the following illustrations.

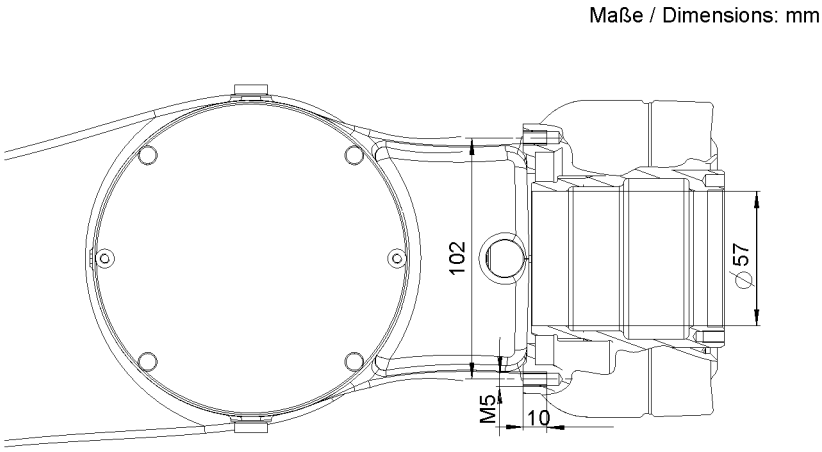


Fig. 4-8: Interface A6, IW 16 arc HW

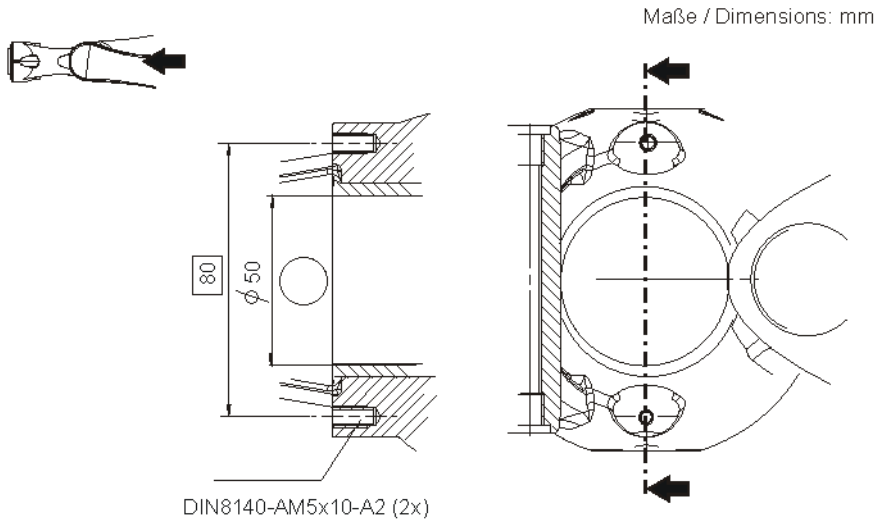


Fig. 4-9: Interface A6, IW 5 (8 kg) arc HW

Supplementary load

The robot can carry supplementary loads on the arm. When mounting the supplementary loads, be careful to observe the maximum permissible total load. The dimensions and positions of the installation options can be seen in the following diagram. These dimensions and positions are valid for KR 16 arc HW and KR 16 L8 arc HW.

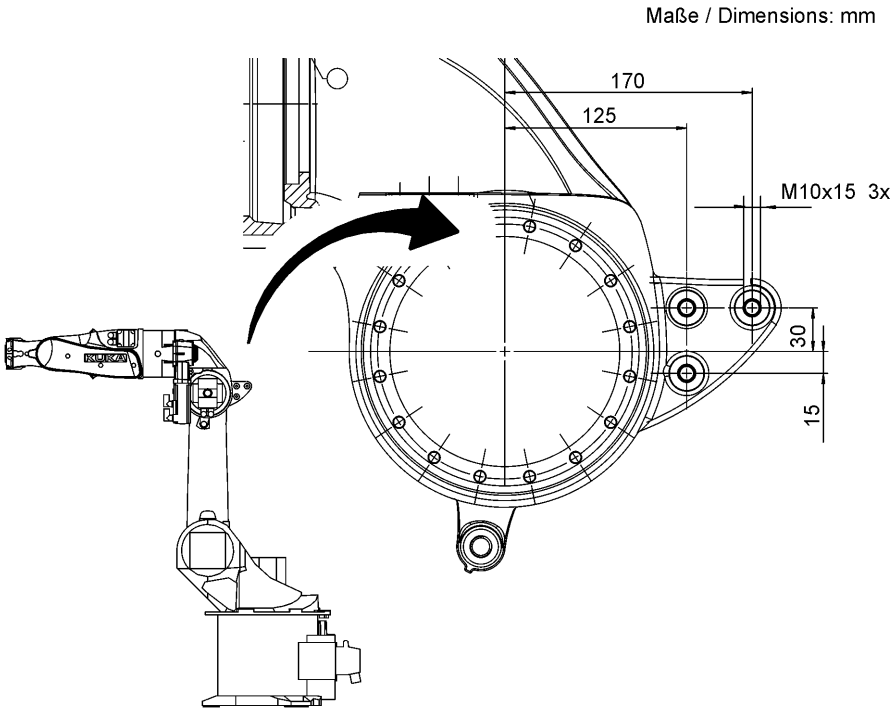


Fig. 4-10: Supplementary load on arm (example: KR 16 arc HW)

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.

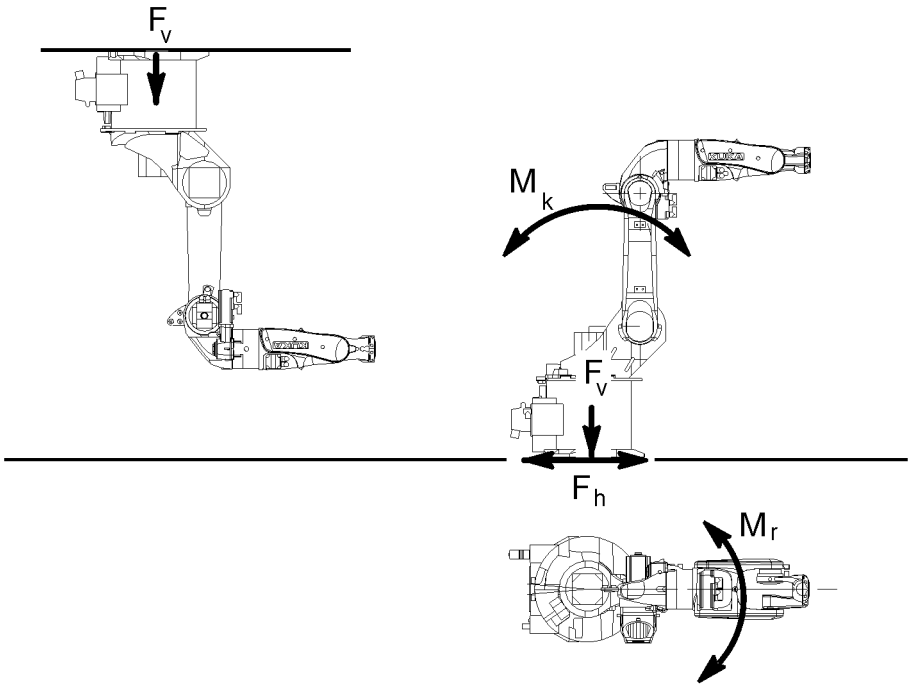


Fig. 4-11: Loads acting on the mounting base

Type of load	Force/torque/mass
F_v = vertical force	F_{vmax} = 4,600 N
F_h = horizontal force	F_{hmax} = 5,000 N
M_k = tilting moment	M_{kmax} = 5,200 Nm
M_r = torque	M_{rmax} = 4,200 Nm
Total mass for load acting on the mounting base	KR 16 arc HW: 273 kg KR 16 L8 arc HW: 258 kg
Robot	KR 16 arc HW: 245 kg KR 16 L8 arc HW: 240 kg
Total load (suppl. load on arm + rated payload)	KR 16 arc HW: 28 kg KR 16 L8 arc HW: 20 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. 4-12) for the robot can be noted from the following diagram. The position of the center of mass 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.

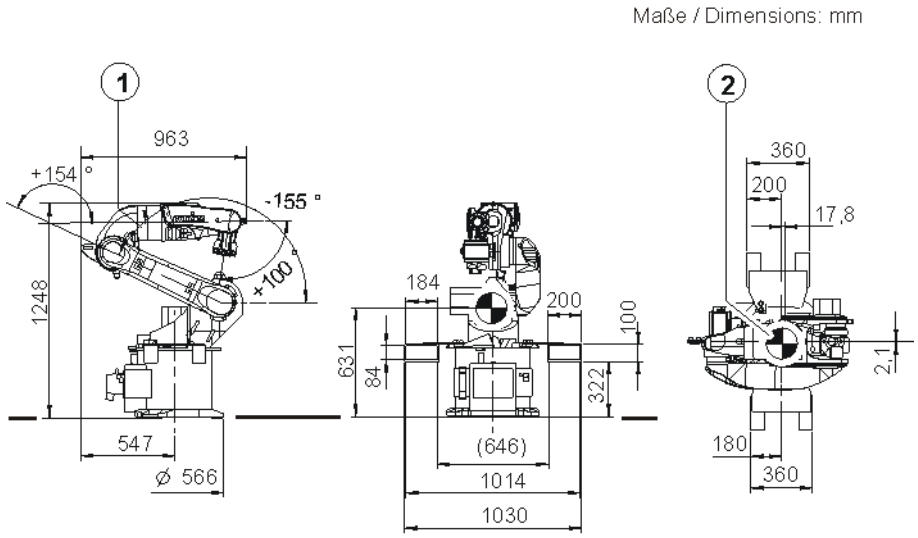


Fig. 4-12: Transport dimensions, floor-mounted robot KR 16 arc HW

1 Robot 2 Center of gravity

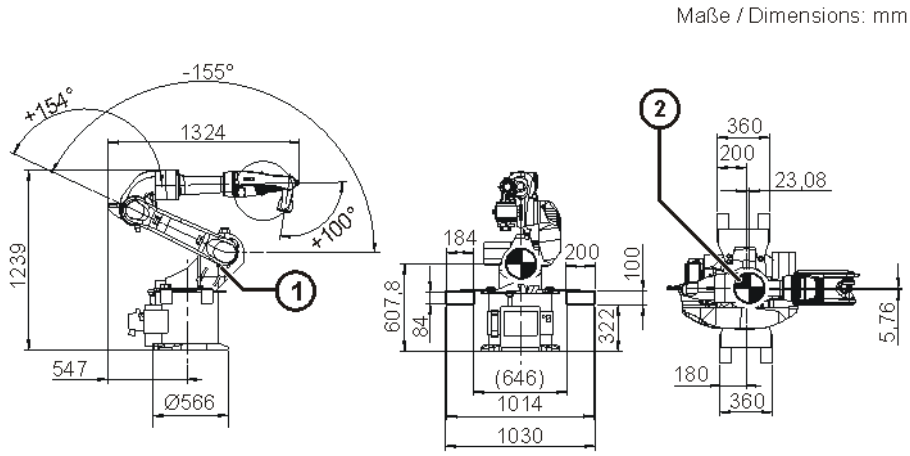


Fig. 4-13: Transport dimensions, floor-mounted robot KR 16 L8 arc HW

1 Robot 2 Center of gravity

For transporting ceiling-mounted robots in the mounting position, a transport frame is provided (>>> Fig. 4-14), which can be picked up using a crane attached to 4 eyebolts, or with a fork lift truck.

Maße / Dimensions: mm

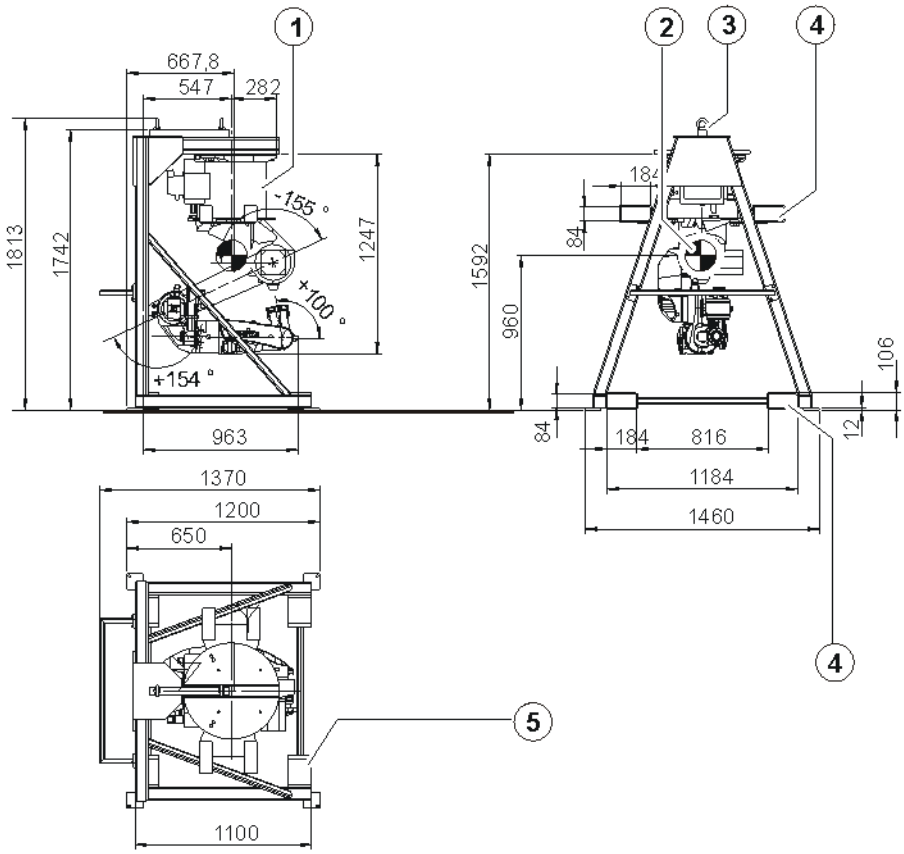


Fig. 4-14: Transport dimensions, ceiling-mounted robot KR 16 arc HW

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

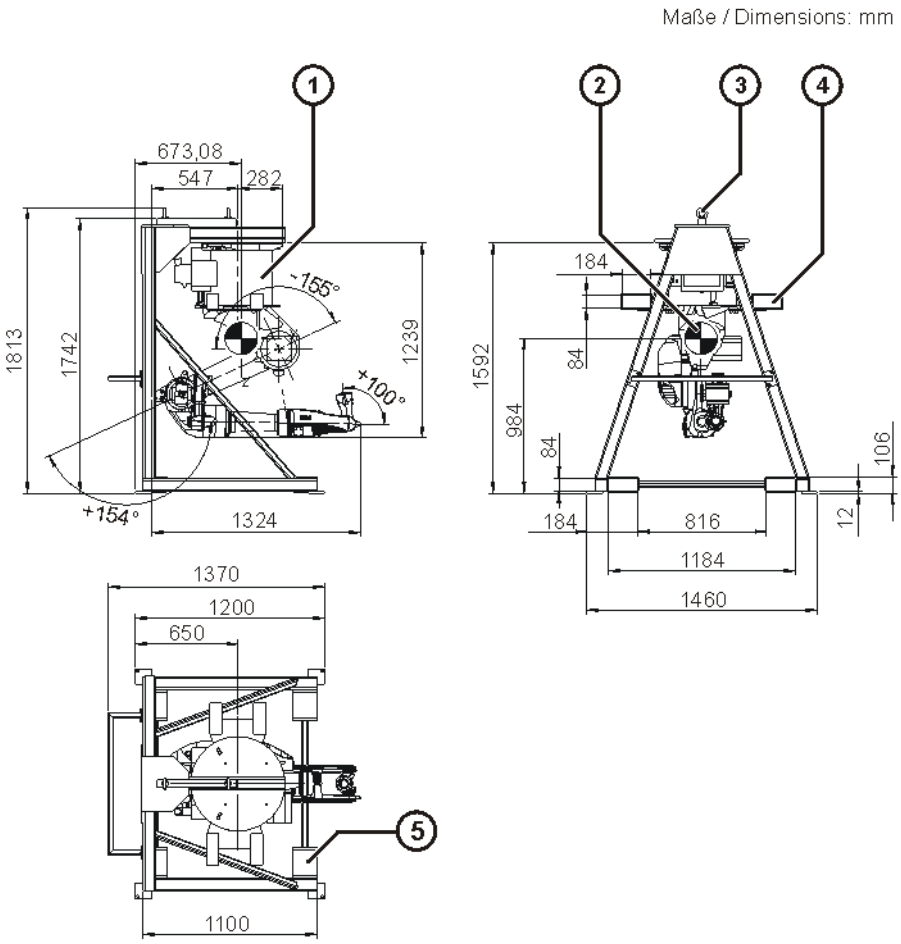


Fig. 4-15: Transport dimensions, ceiling-mounted robot KR 16 L8 arc HW

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

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.

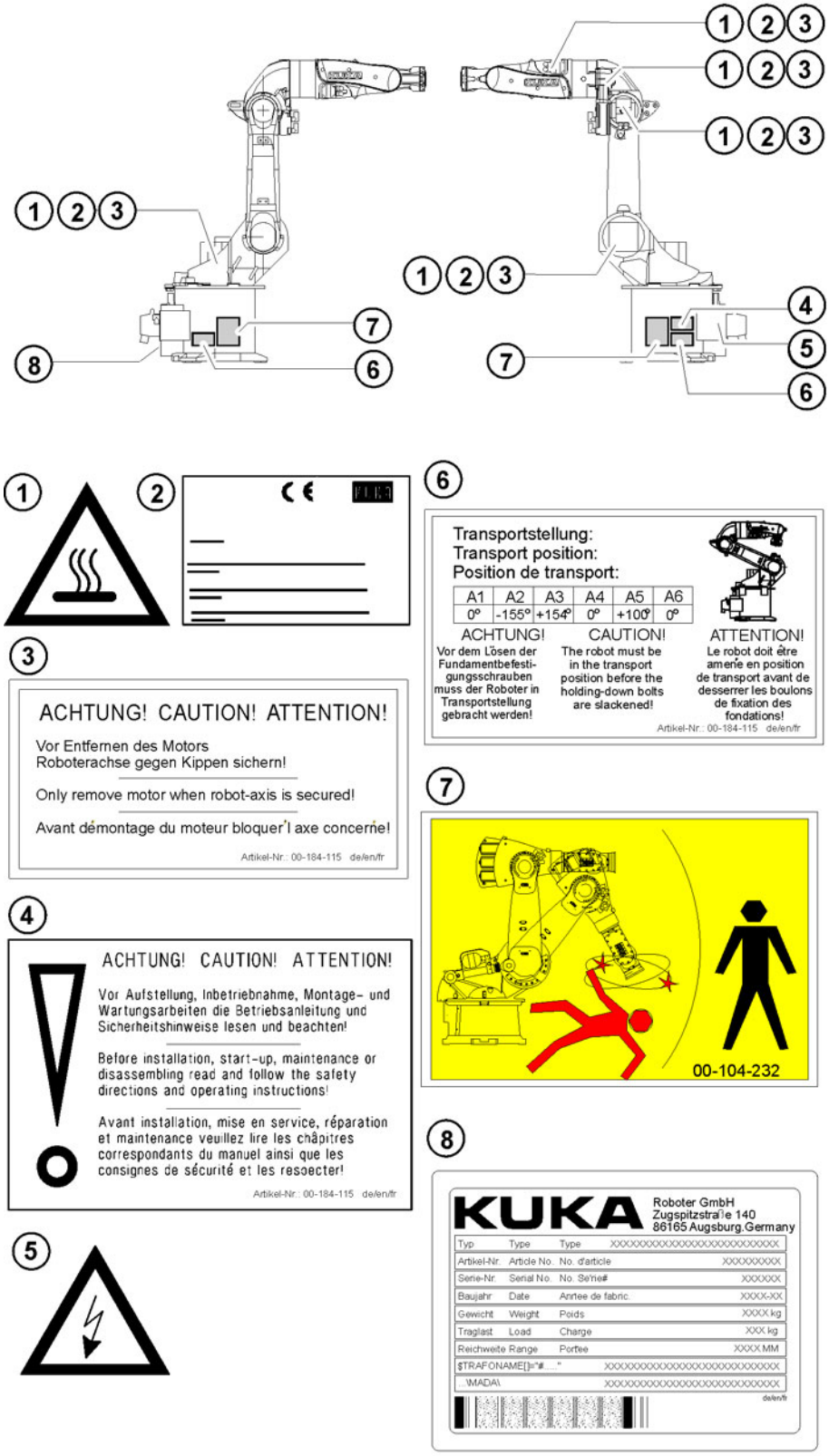


Fig. 4-16: Plates and labels

4.7 Stopping distances and times, KR 16 arc HW

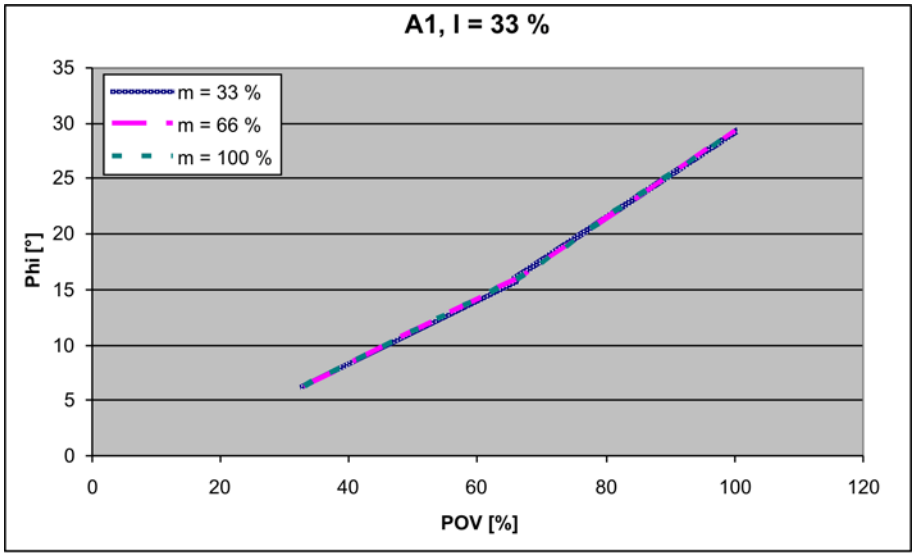
4.7.1 Stopping distances and stopping times for STOP 0, axis 1 to axis 3

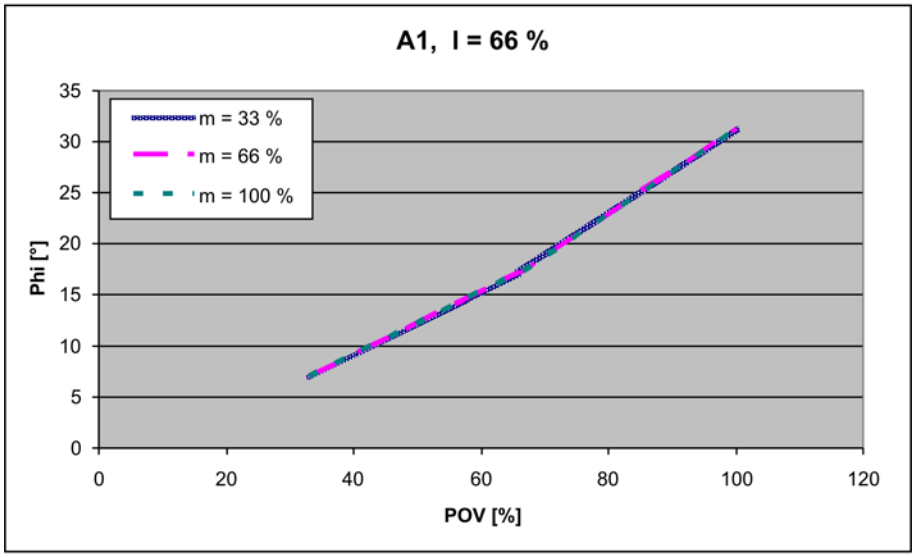
The table shows the stopping distances and stopping times after a STOP 0 (category 0 stop) is triggered. The values refer to the following configuration:

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

	Stopping distance (°)	Stopping time (s)
Axis 1	42.16	0.387
Axis 2	41.35	0.385
Axis 3	33.51	0.266

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





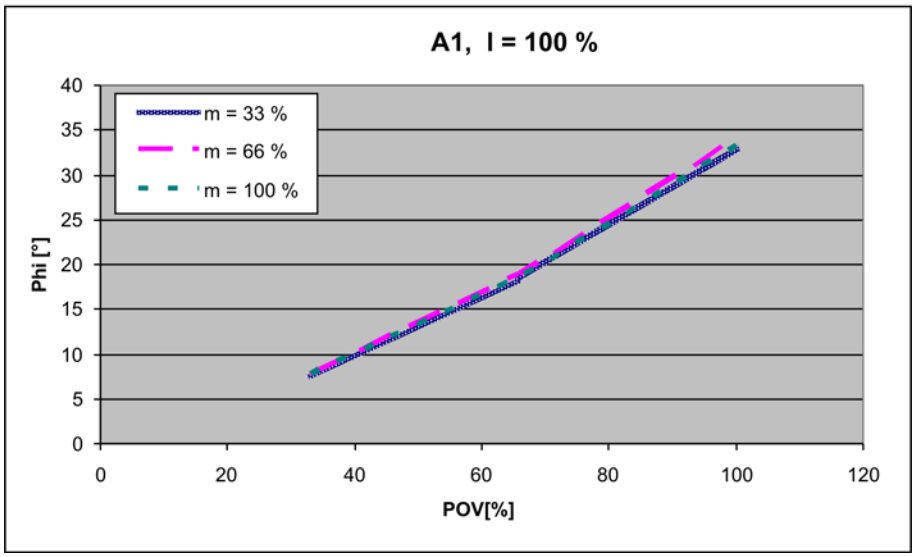


Fig. 4-17: Stopping distances for STOP 1, axis 1

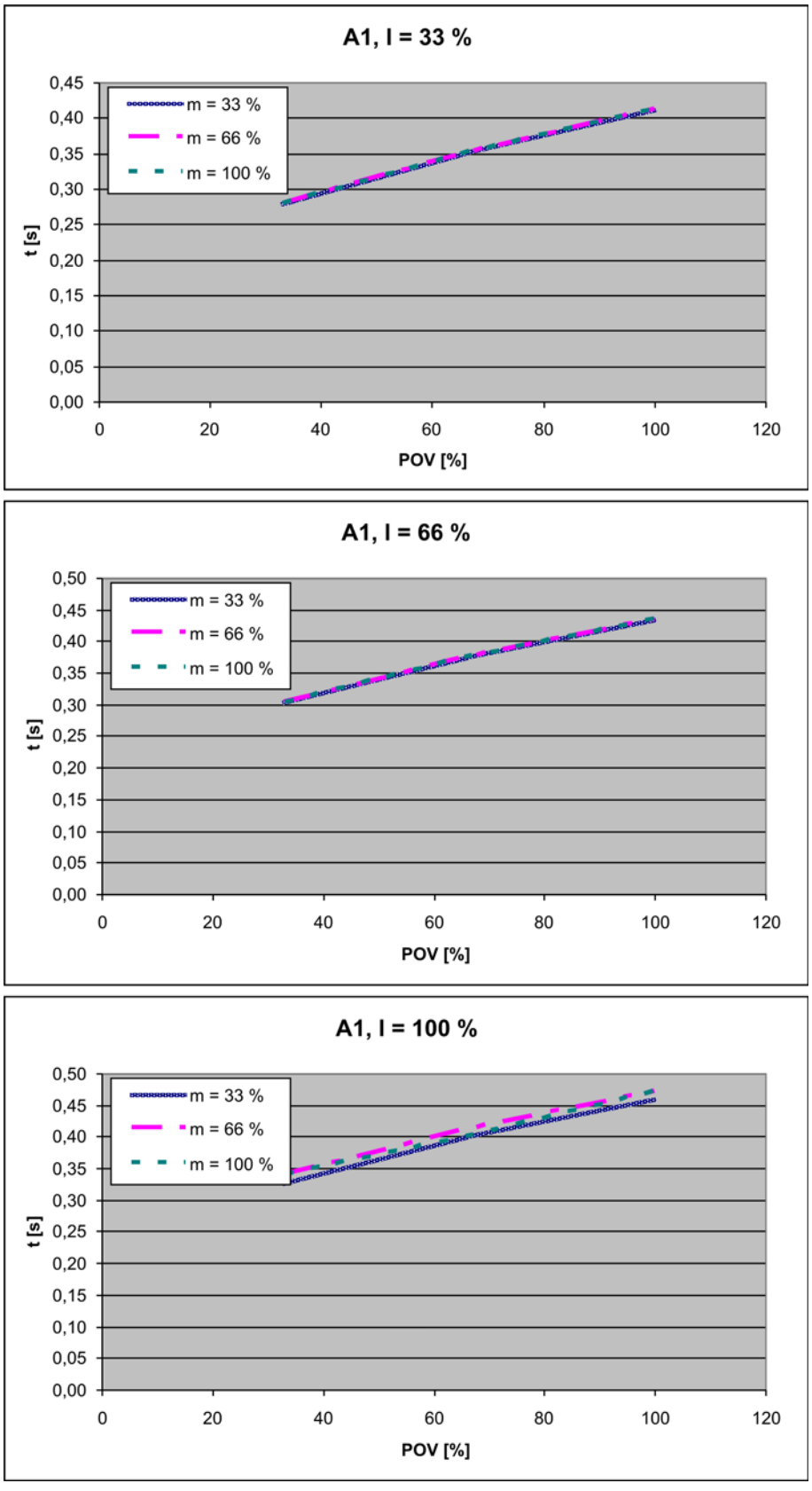


Fig. 4-18: Stopping times for STOP 1, axis 1

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

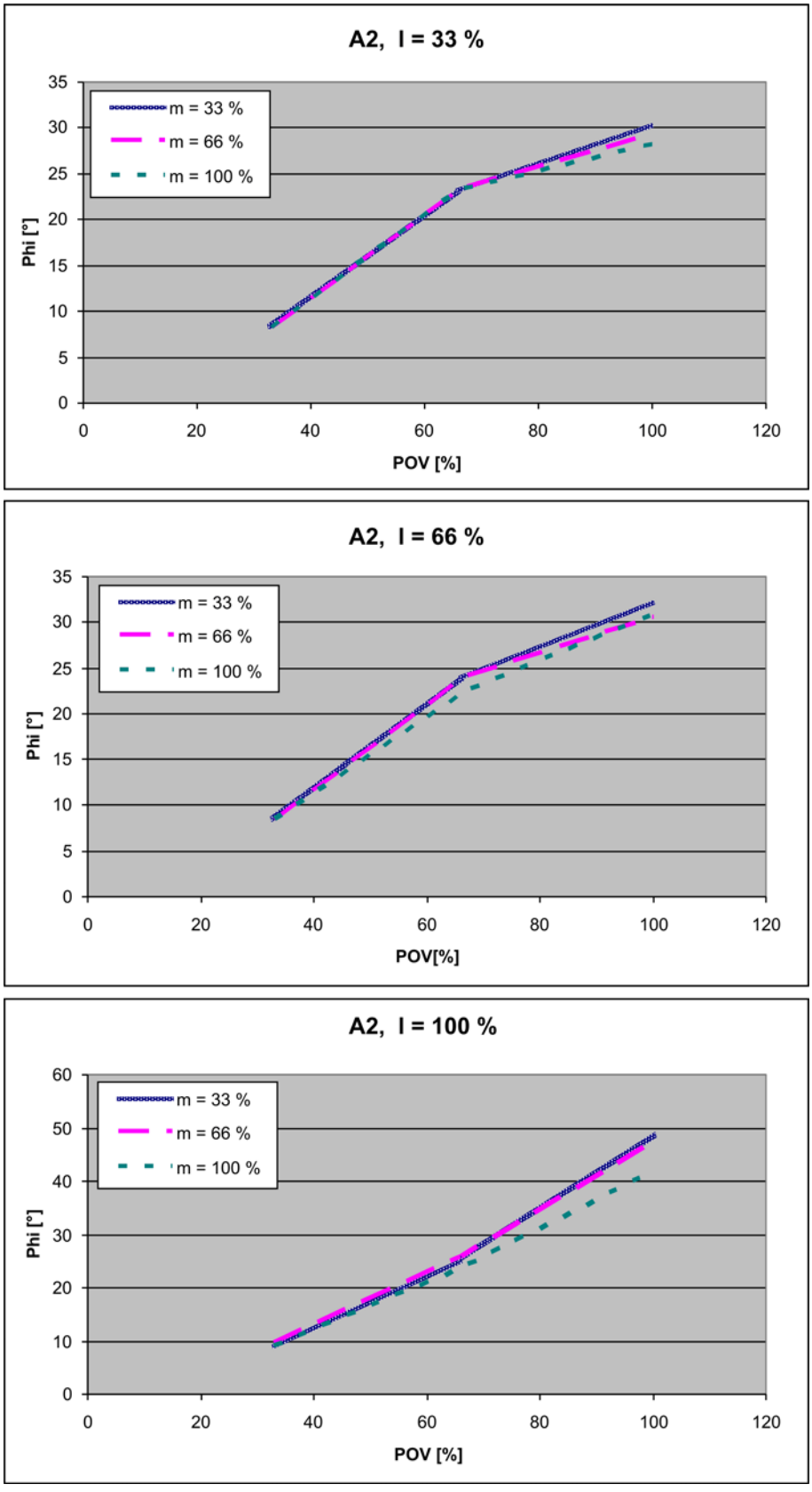


Fig. 4-19: Stopping distances for STOP 1, axis 2

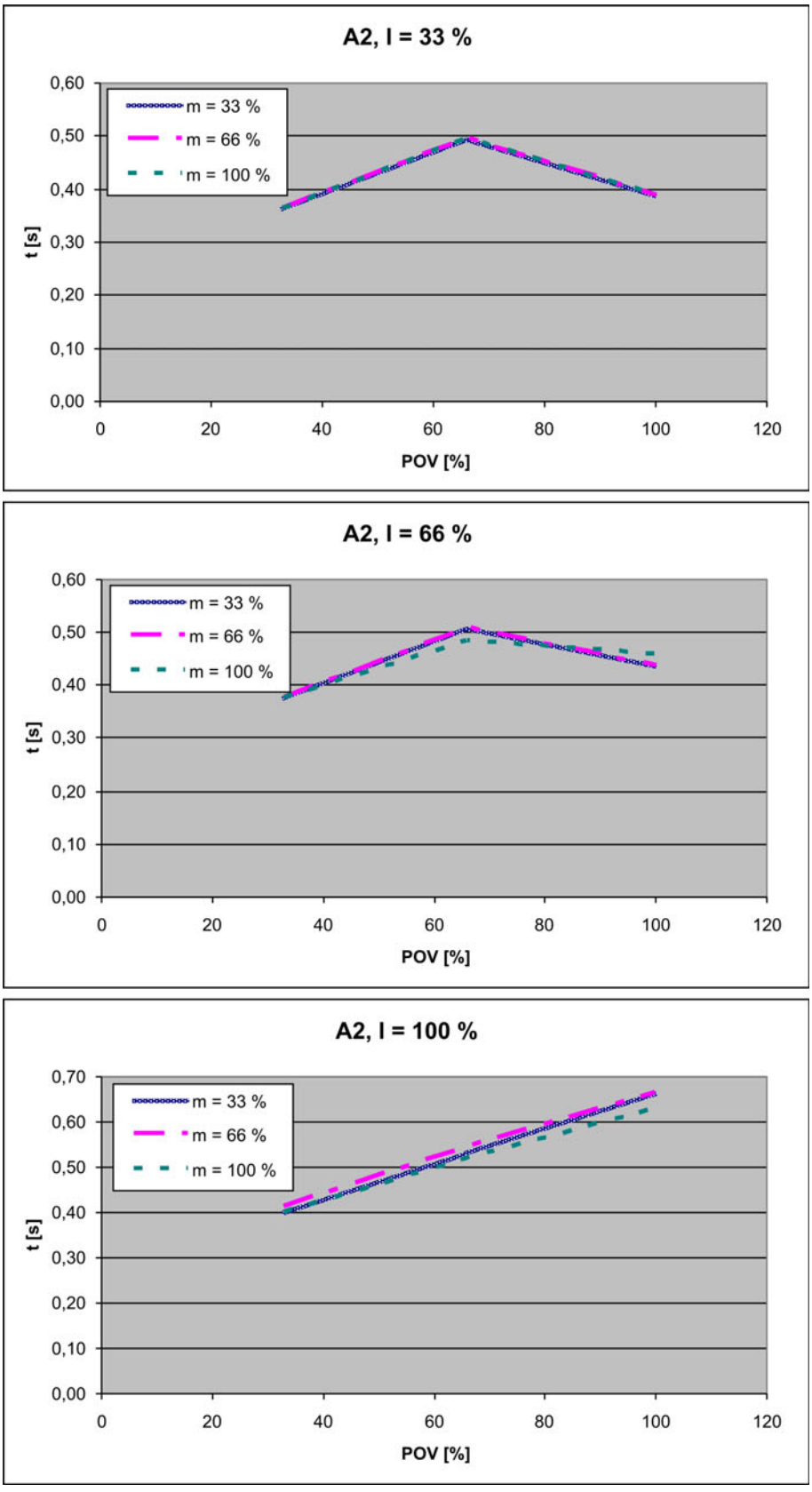


Fig. 4-20: Stopping times for STOP 1, axis 2

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

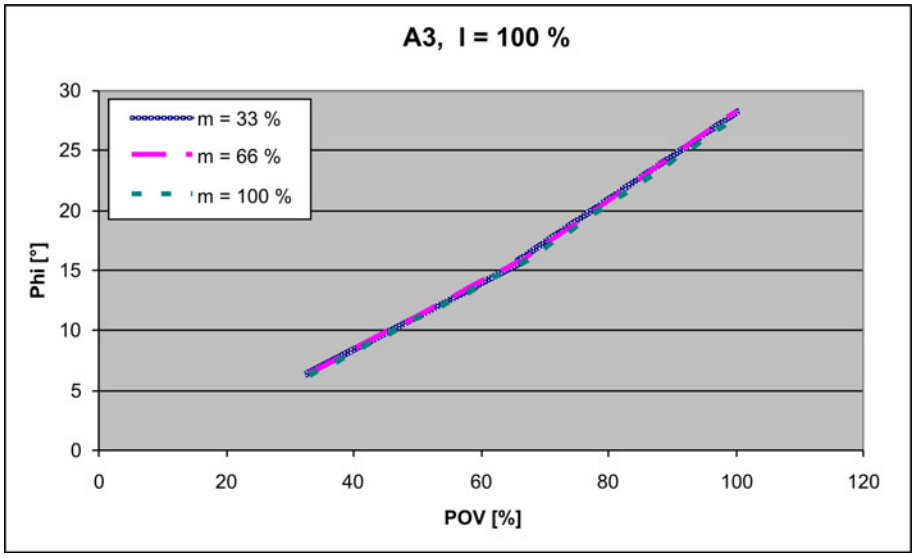


Fig. 4-21: Stopping distances for STOP 1, axis 3

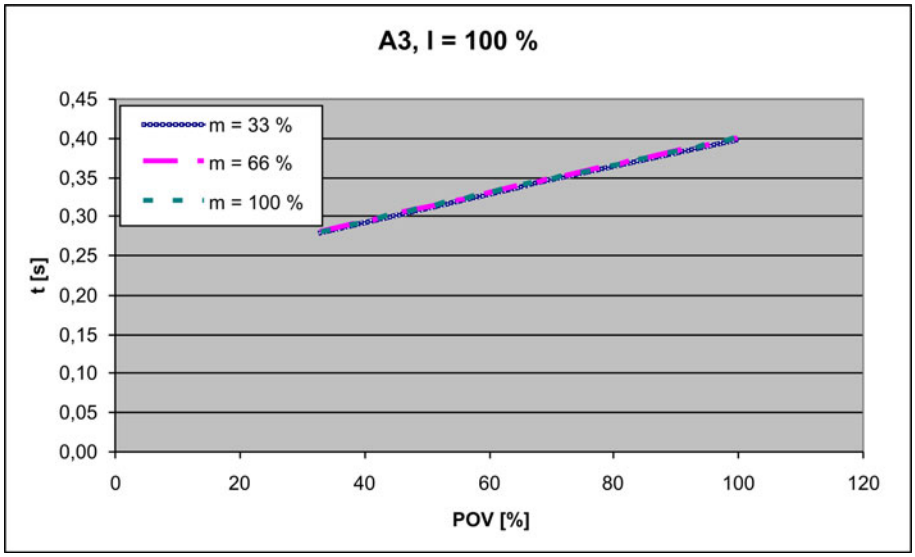


Fig. 4-22: Stopping times for STOP 1, axis 3

4.8 Stopping distances and times, KR 16 L8 arc HW

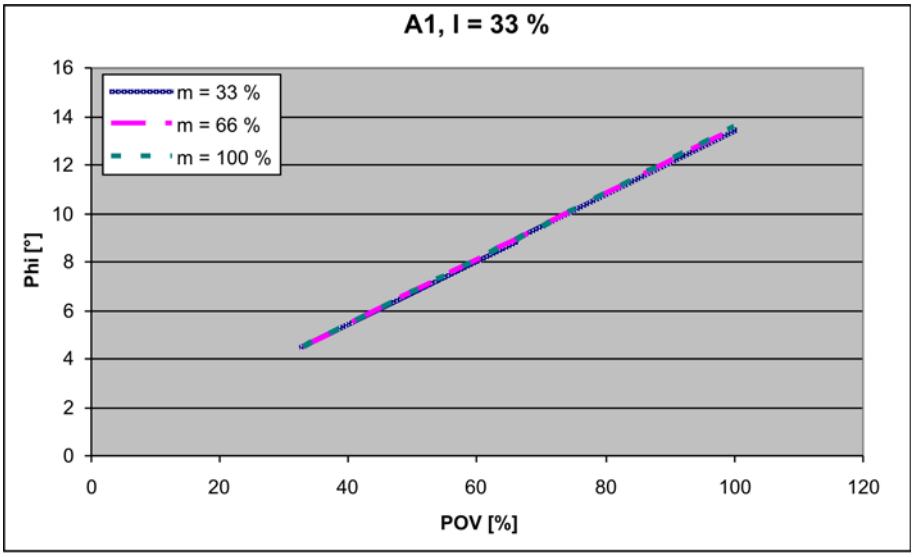
4.8.1 Stopping distances and stopping times for STOP 0, axis 1 to axis 3

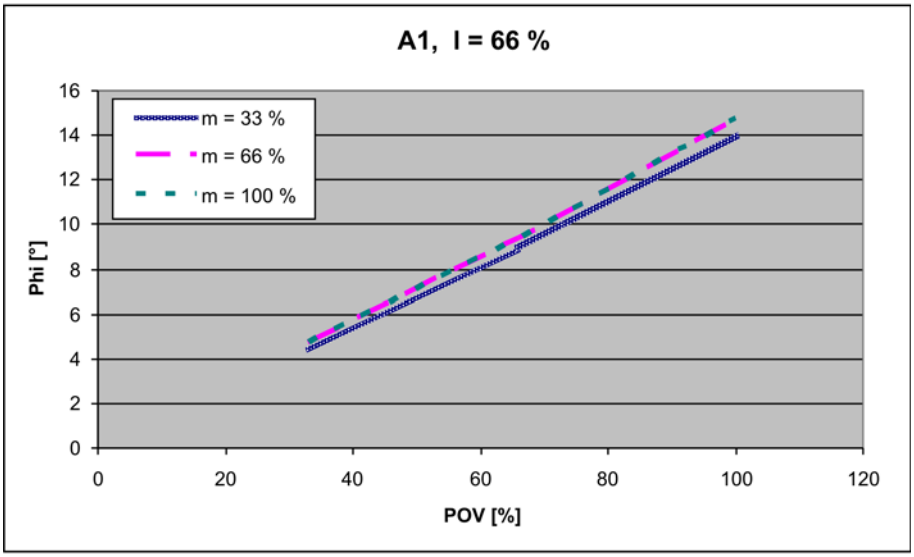
The table shows the stopping distances and stopping times after a STOP 0 (category 0 stop) is triggered. The values refer to the following configuration:

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

	Stopping distance (°)	Stopping time (s)
Axis 1	30.49	0.343
Axis 2	31.00	0.324
Axis 3	23.70	0.271

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





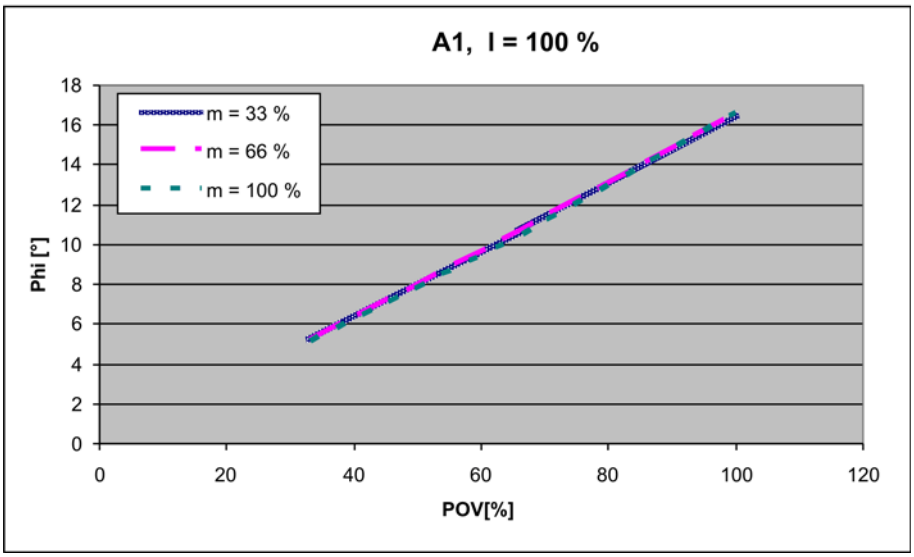


Fig. 4-23: Stopping distances for STOP 1, axis 1

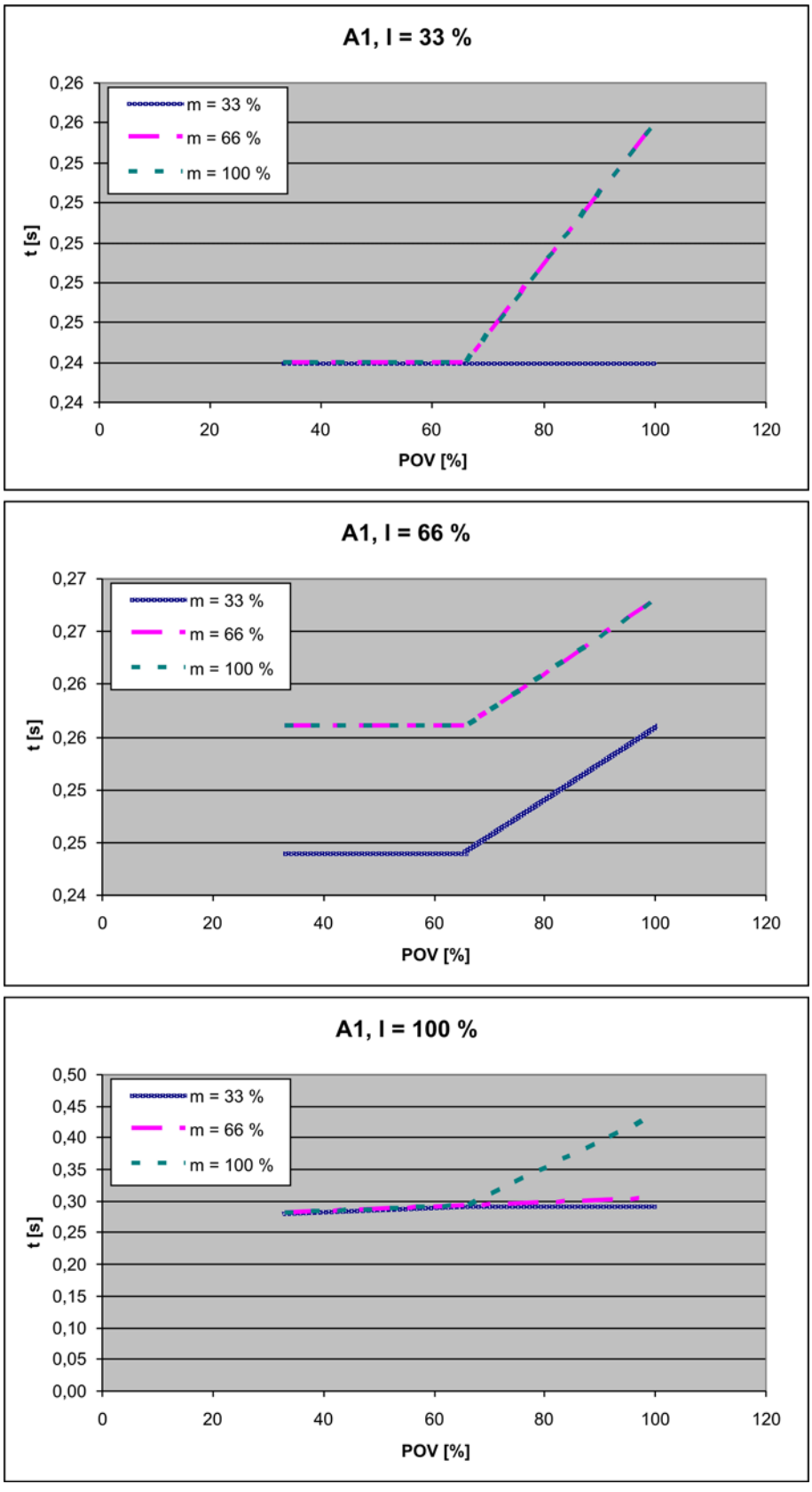


Fig. 4-24: Stopping times for STOP 1, axis 1

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

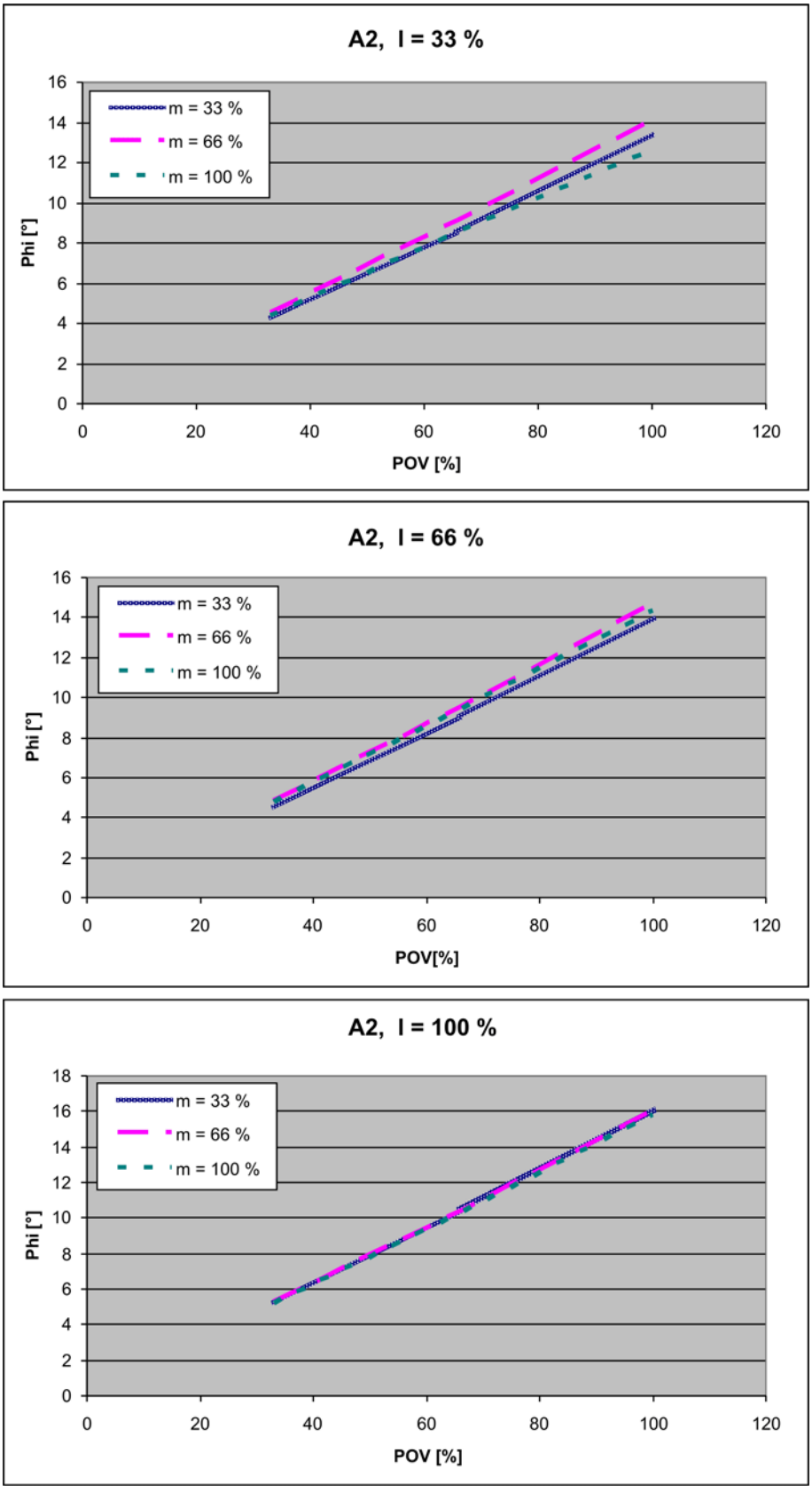


Fig. 4-25: Stopping distances for STOP 1, axis 2

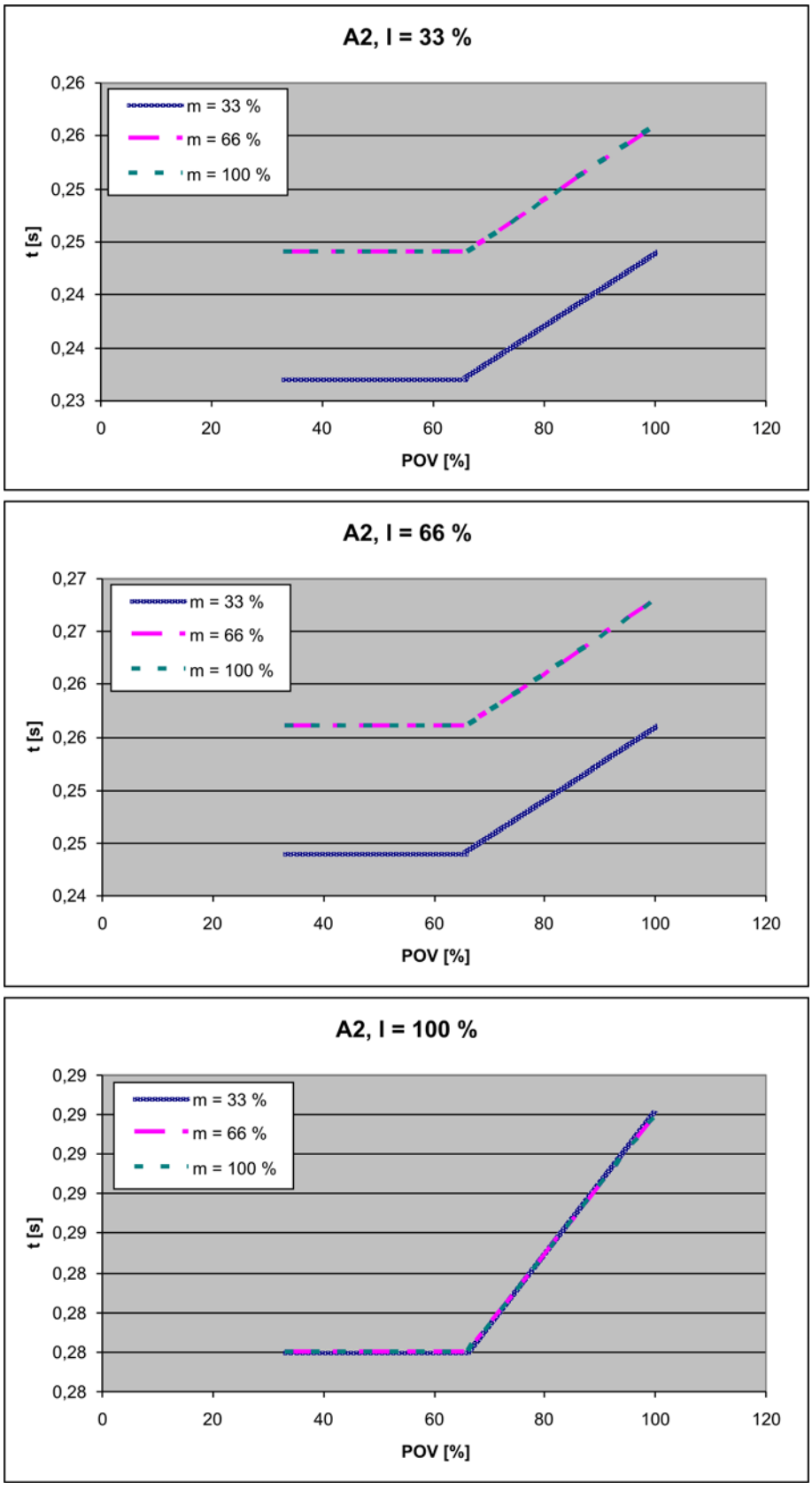


Fig. 4-26: Stopping times for STOP 1, axis 2

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

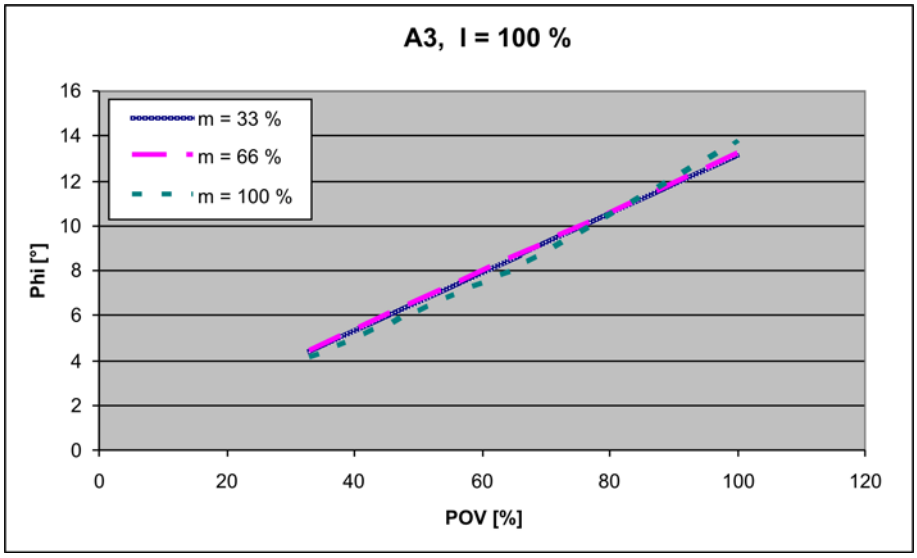


Fig. 4-27: Stopping distances for STOP 1, axis 3

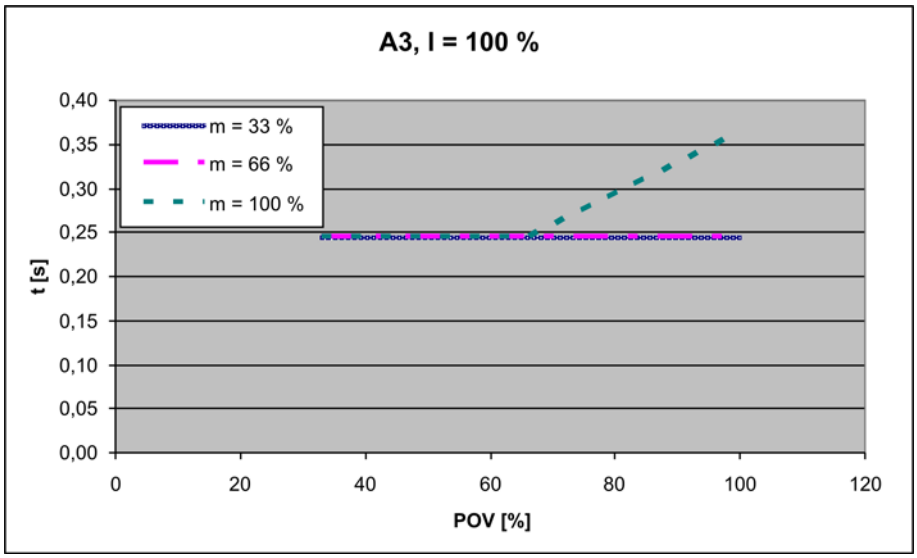


Fig. 4-28: Stopping times for STOP 1, axis 3

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.

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
- Underground 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.
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 ageing during storage.
KCP	The KCP (KUKA Control Panel) teach pendant has all the operator control and display functions required for operating and programming the industrial robot. The KCP variant for the KR C4 is called KUKA smartPAD. The general term “KCP”, however, is generally used in this documentation.
KUKA smartPAD	See KCP
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
Maintenance			x
Repair			x
Shutting down			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.

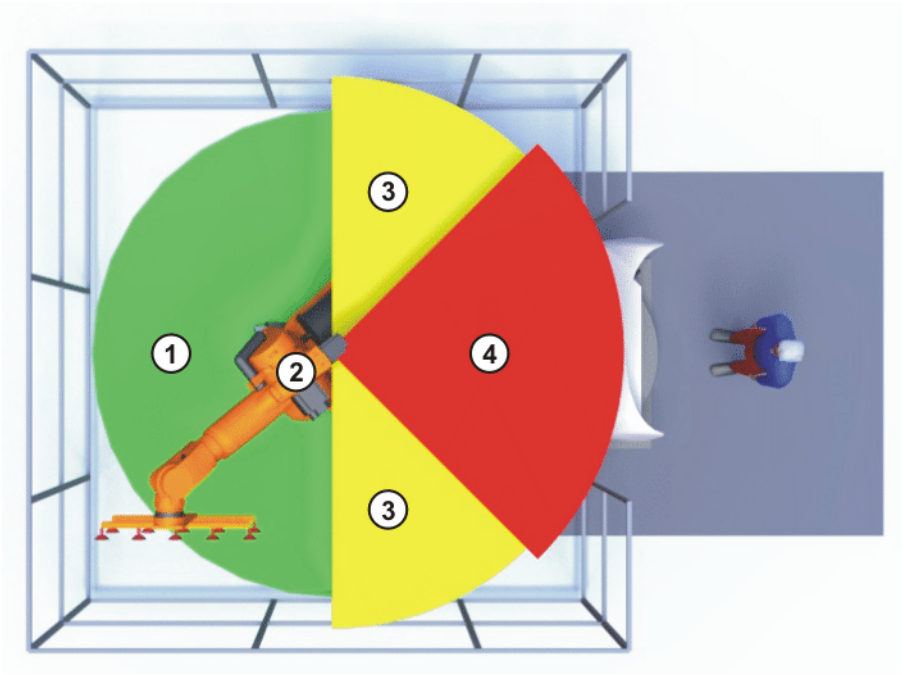


Fig. 5-1: Example of axis range A1

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

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, this can result in material damage to the industrial robot. The manipulator must be taken out of operation and KUKA Roboter GmbH must be consulted before it is put back into operation (>>> 8 "KUKA Service" Page 69).

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 Options for moving the manipulator without the robot controller

Description

The following options are available for moving the manipulator 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

  In the case of the low payload category, no release device for the wrist axes is available. A release device is not necessary, as the wrist axes can be moved directly by hand.

The options are only for use in exceptional circumstances and emergencies, e.g. for freeing people.

Information on the availability of options for specific robot models can be obtained from KUKA Roboter GmbH.

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

Moving the manipulator with the release device:

SAFETY INSTRUCTIONS The following procedure must be followed exactly!

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 motor must be exchanged.

⚠ WARNING If a robot axis has been moved by the release device, all robot axes must be remastered. Serious infuries or damage to property may otherwise result.

Procedure **Moving the manipulator with the brake release device:**

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

SAFETY INSTRUCTIONS The following procedure must be followed exactly!

1. Switch off the robot controller and secure it (e.g. with a padlock) to prevent unauthorized persons from switching it on again.
2. Connect the brake release device to the base frame of the robot:

   Unplug connector X30 from interface A1. Plug connector X20 of the brake release device into interface A1.
3. Select the brakes to be released (main axes, wrist axes) via the selection switch on the brake release device.
4. Press the button on the hand-held device.

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

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

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

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.

⚠ DANGER Standing underneath the robot arm can cause death or serious 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 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 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 robot.

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.

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.

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

5.5.4 Manual mode

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

- Jog mode
- Teach
- Programming
- Program verification

The following must be taken into consideration in manual mode:

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

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

- All setup work must be carried out, where possible, from outside the safeguarded area.

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

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

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

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

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

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

5.5.5 Automatic mode

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

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

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

5.5.6 Maintenance and repair

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

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

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

- Carry out work outside the danger zone. If work inside the danger zone is necessary, the user must define additional safety measures to ensure the safe protection of personnel.

- Switch off the industrial robot and secure it (e.g. with a padlock) to prevent it from being switched on again. If it is necessary to carry out work with the robot controller switched on, the user must define additional safety measures to ensure the safe protection of personnel.
- If it is necessary to carry out work with the robot controller switched on, this may only be done in operating mode T1.
- Label the system with a sign indicating that work is in progress. This sign must remain in place, even during temporary interruptions to the work.
- The EMERGENCY STOP 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 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	Safety of machinery: General principles of design, risk assessment and risk reduction	2010
EN ISO 10218-1	Industrial robots: Safety	2011

Name	Definition	Edition
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
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. There are two variants available, which differ in their construction and method of installation. The installation dimensions on the concrete foundation and the interface dimensions for the robot are identical, however.

- Variant 1: Mounting base with centering (resin capsule)
- Variant 2: Mounting base with centering (resin cartridge)

Both mounting base variants consist of:

- Bedplates
- Resin-bonded anchors
- Fasteners

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

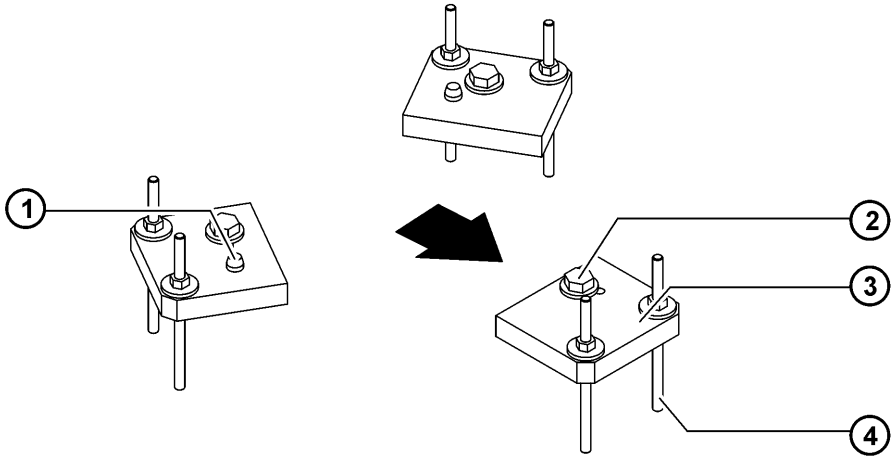


Fig. 6-1: Mounting base with centering

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

Grade of concrete for foundations

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

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

Dimensioned drawing

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

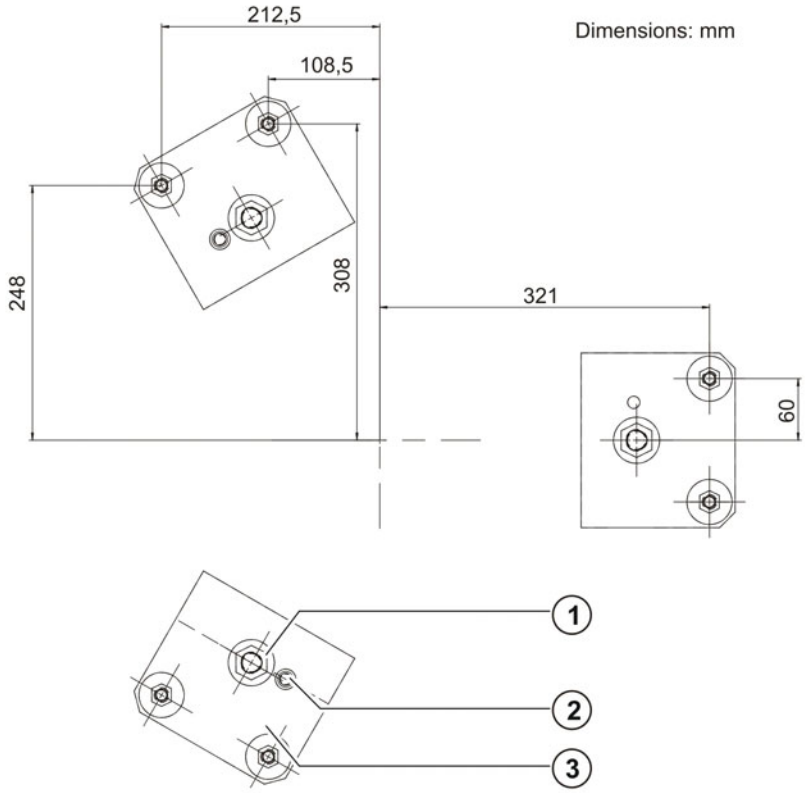


Fig. 6-2: Mounting base with centering, dimensioned drawing

1 Hexagon bolts
2 Locating pin
3 Bedplate

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

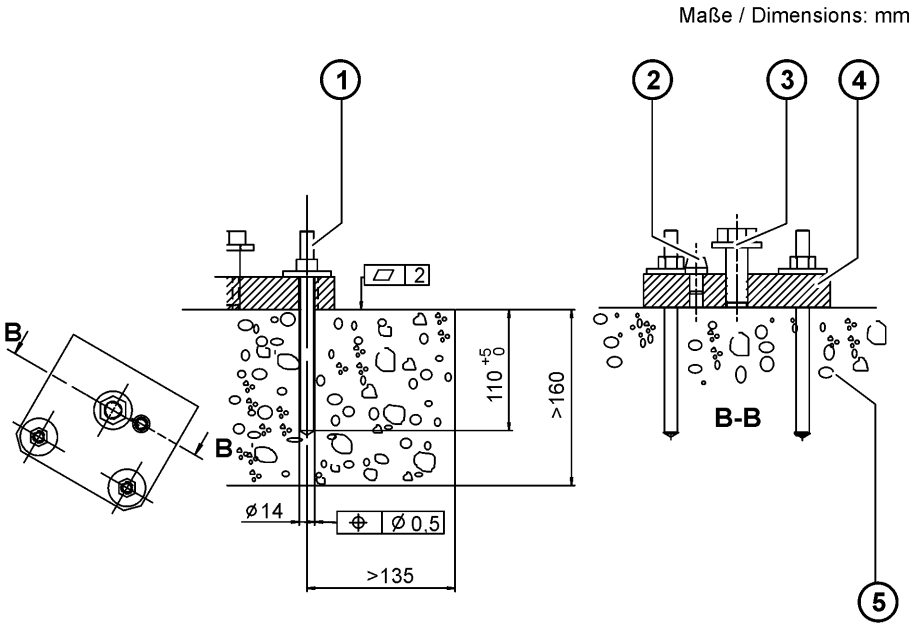


Fig. 6-3: Cross-section of foundations

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

6.2 Machine frame mounting with centering

Description

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

The machine frame mounting assembly consists of:

- Locating pins
- Hexagon bolts with conical spring washers

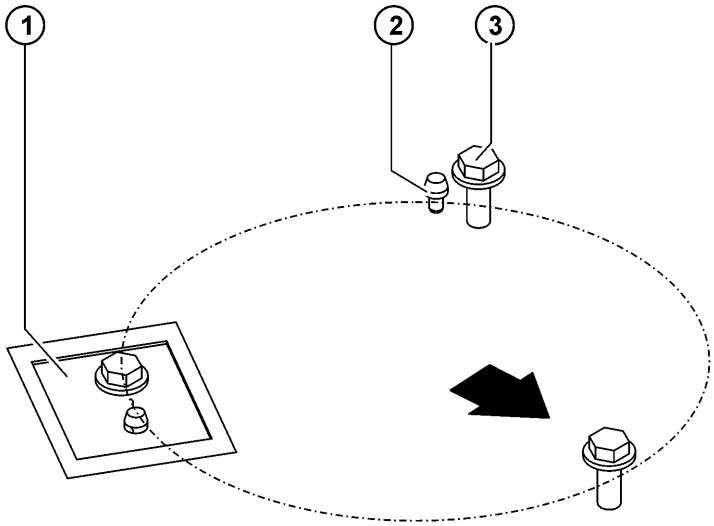


Fig. 6-4: Machine frame mounting

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

Dimensioned drawing

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

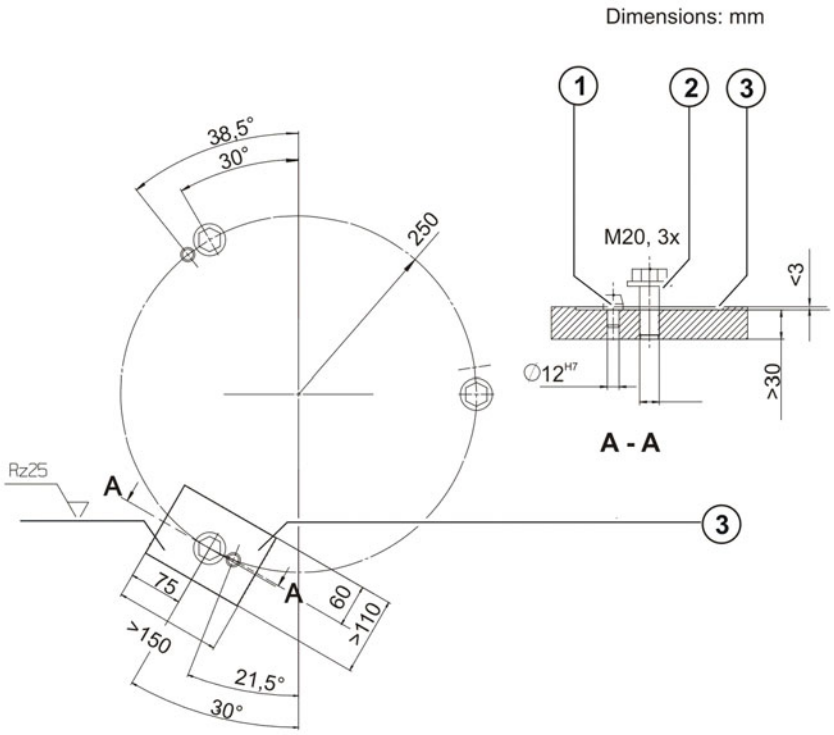


Fig. 6-5: Machine frame mounting, dimensioned drawing

1 Locating pin
2 Hexagon bolt
3 Mounting surface, machined

6.3 Adapter plate

Description

The adapter plate enables the robot to be fastened to

- mounting bases
- steel structures
- carriages of KUKA linear units

which are already equipped with the hole pattern for the KR 6.

The mounting surface for the adapter plate (>>> Fig. 6-6) must be machined and of an appropriate quality. The adapter plate is fastened to the mounting base with the KR 6 hole pattern with 3 Allen screws. 2 pins are used for centering. For fastening the robot to the adapter platte, the “machine frame mounting” assembly with 3 hexagon bolts is required, together with 2 locating pins for centering.

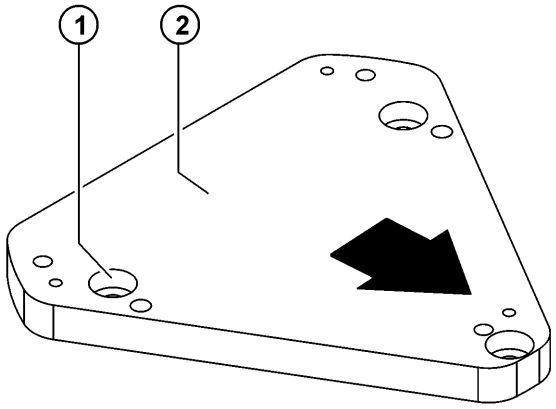


Fig. 6-6: Adapter plate

1 Fastening hole
2 Adapter plate

The size and dimensions of the adapter plate (>>> Fig. 6-7) are given in the following diagram.

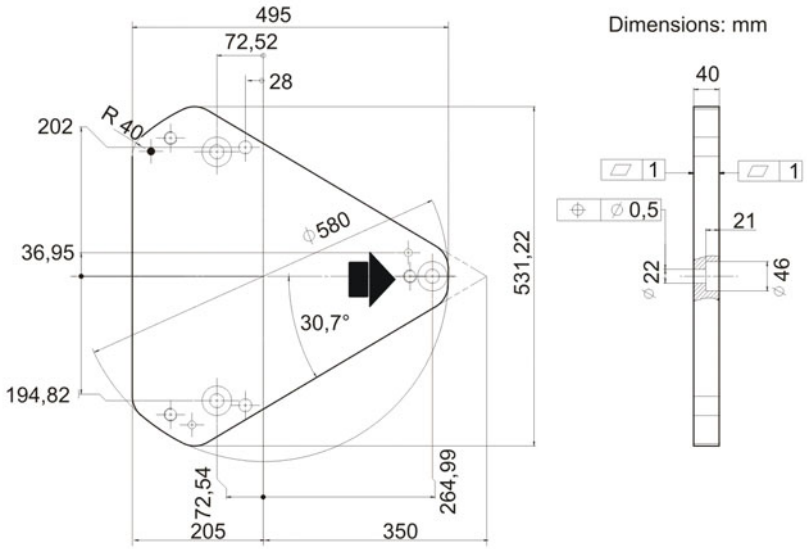


Fig. 6-7: Adapter plate

6.4 Connecting cables and interfaces

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

- The bending radius for fixed routing must not be less than 150 mm for motor cables and 60 mm for control cables.
- Protect cables against exposure to mechanical stress.
- Route the cables without mechanical stress – no tensile forces on the connectors
- Cables are only to be installed indoors.

- Observe permissible temperature range (fixed installation) of 263 K (-10 °C) to 343 K (+70 °C).
- Route the motor cables and the data cables separately in metal ducts; if necessary, additional measures must be taken to ensure electromagnetic compatibility (EMC).

Interface for energy supply systems

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

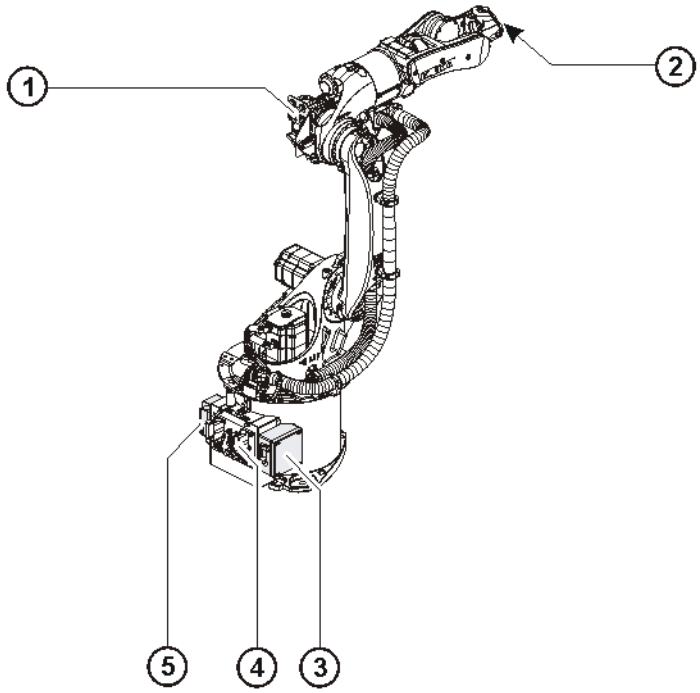


Fig. 6-8: Connecting cables and interfaces

1 Interface A3, arm
2 Interface A6, tool
3 Junction box, control cable X31
2nd control cable X41 (for SafeRobot only)
4 Interface A1, energy supply system
5 Connection, motor cable X30

7 Transportation

7.1 Transporting the robot

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

Transport position

The transport position is the same for both floor-mounted and ceiling-mounted robots. The robot is in the transport position when the axes are in the following positions:

Axis	A1	A2	A3	A4	A5	A6
Angle	0°	-155°	+154°	0°	+100°	0°

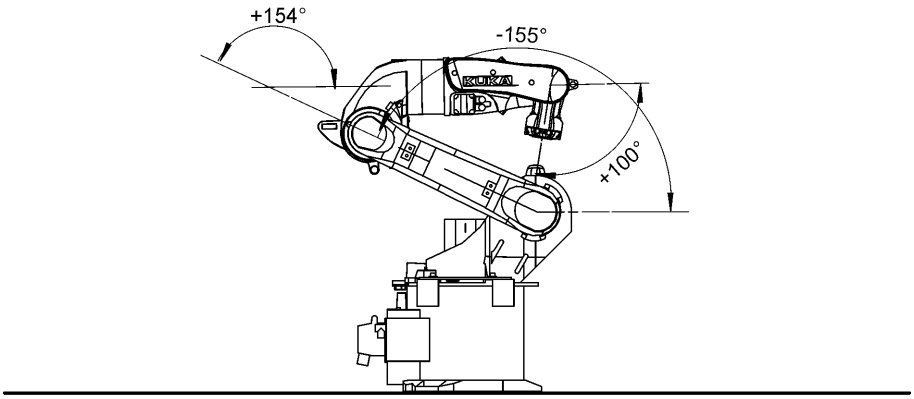


Fig. 7-1: Transport position

Transport dimensions

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

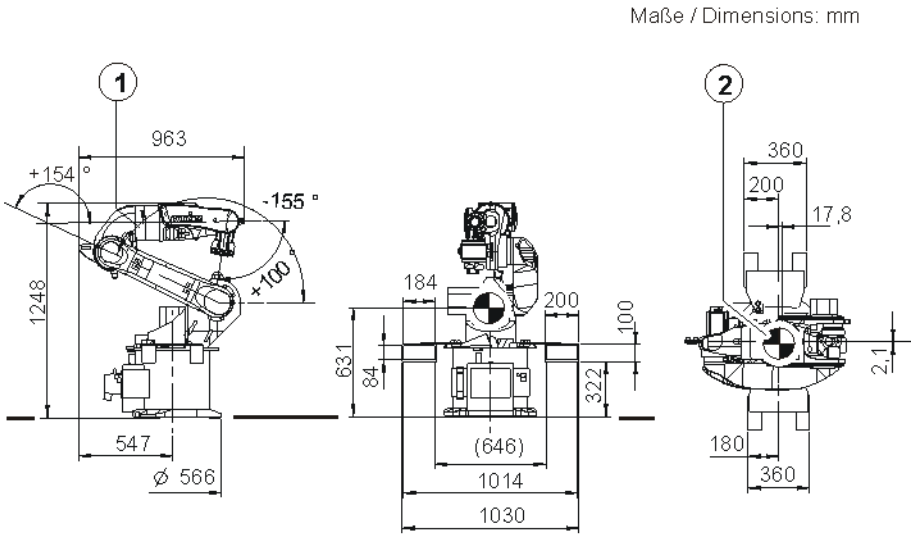


Fig. 7-2: Transport dimensions, floor-mounted robot KR 16 arc HW

1 Robot 2 Center of gravity

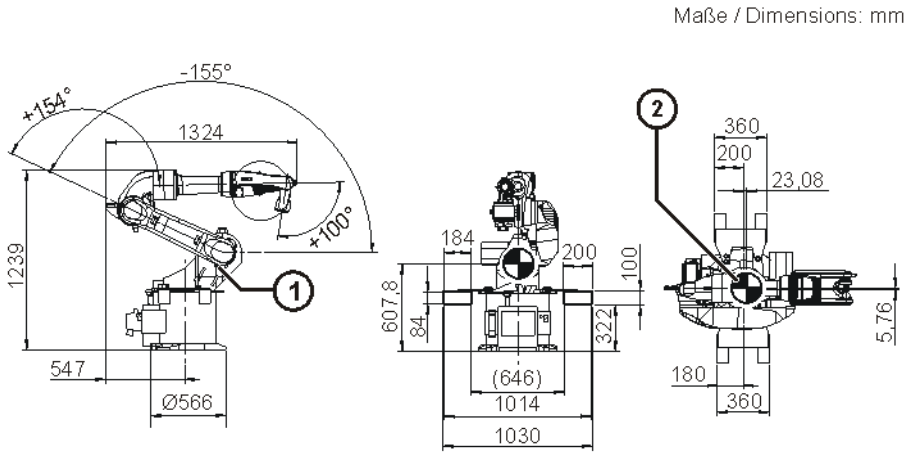


Fig. 7-3: Transport dimensions, floor-mounted robot KR 16 L8 arc HW

1 Robot 2 Center of gravity

Ceiling-mounted robots can also be transported in a transport frame, already in the correct orientation. The transport frame can be picked up with a fork lift truck via the fork slots, or with a crane via eyebolts.

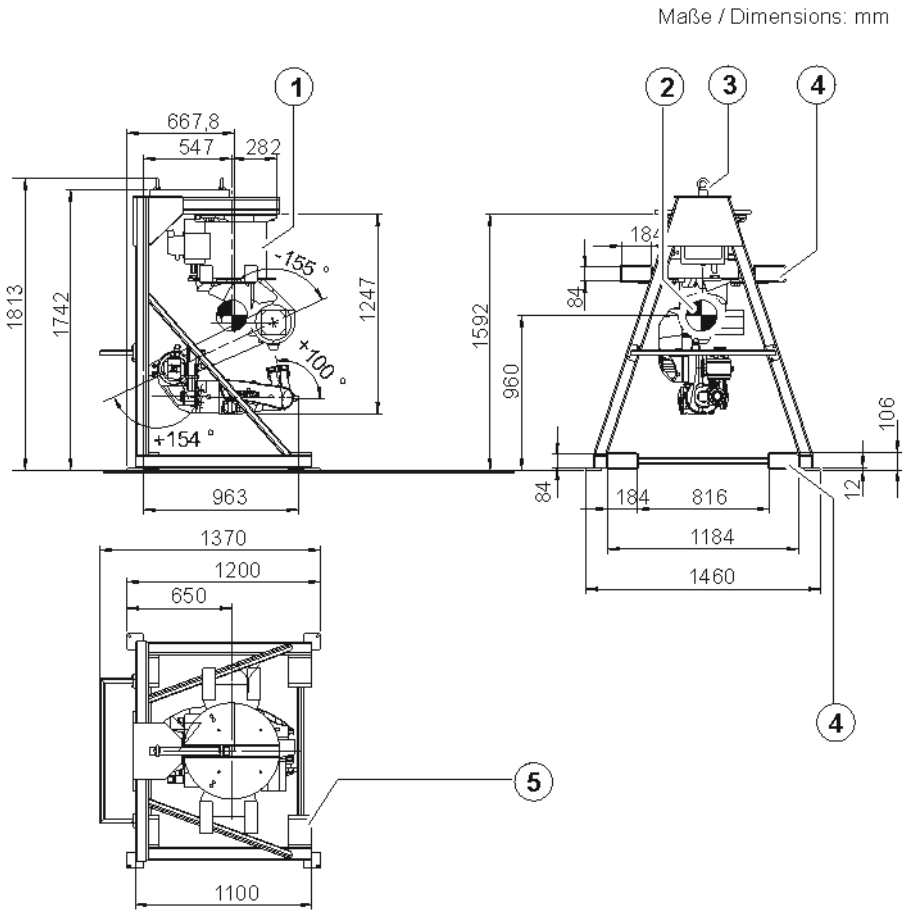


Fig. 7-4: Transport dimensions, ceiling-mounted robot KR 16 arc HW

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

Maße / Dimensions: mm

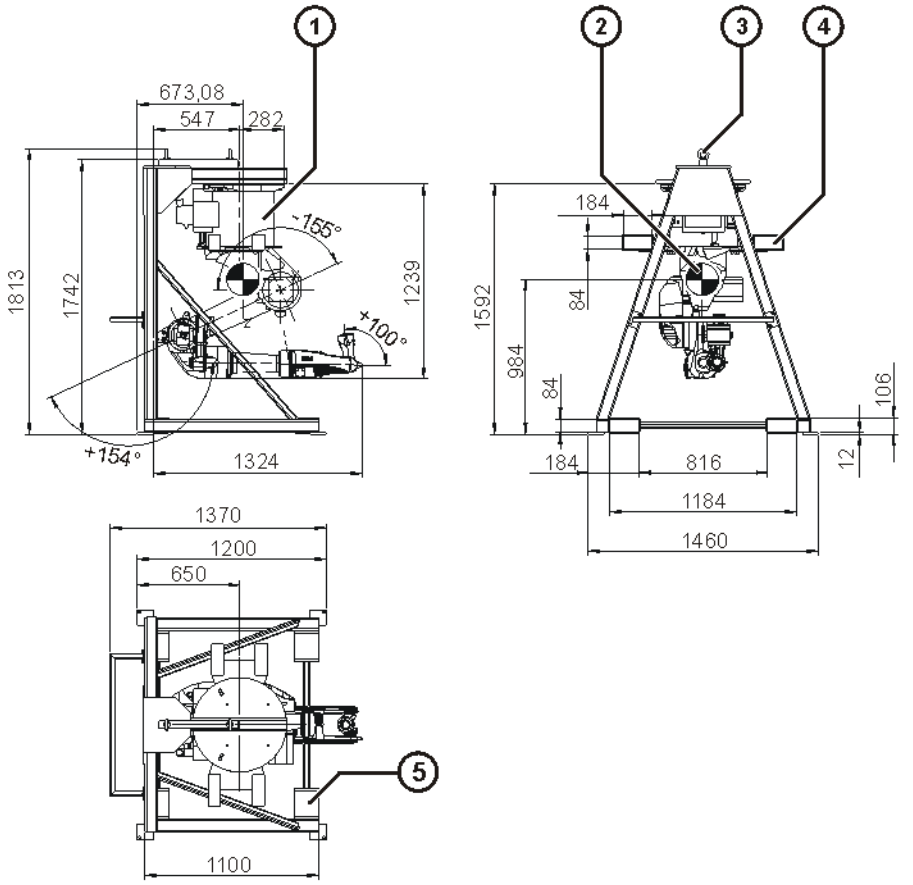


Fig. 7-5: Transport dimensions, ceiling-mounted robot KR 16 L8 arc HW

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

Transportation

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

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

Transportation by fork lift truck

The ceiling-mounted robot is transported using a fork lift truck (>>> Fig. 7-6). For transport by fork lift truck, the fork slots must be installed. The robot must be in the transport position for ceiling installation.

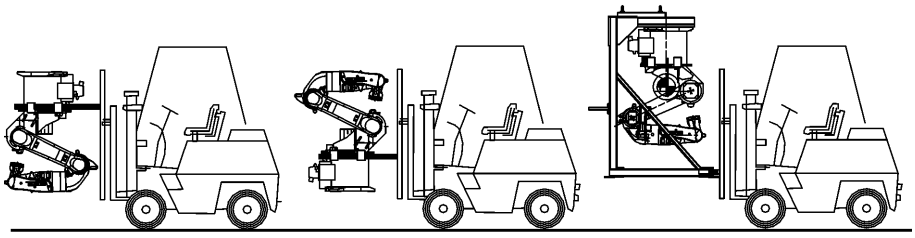


Fig. 7-6: Transportation by fork lift truck

Transportation using lifting tackle

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

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

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

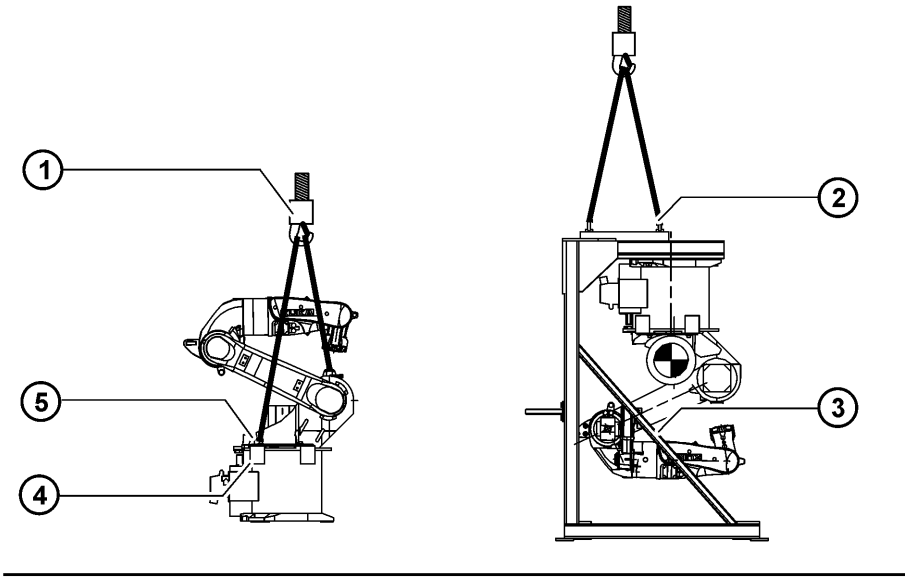


Fig. 7-7: Lifting tackle

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

8 KUKA Service

8.1 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)
- Model and serial number of the energy supply system (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

8.2 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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