



Robots

KR QUANTEC-2 K and KR QUANTEC-2 P

With K-F and P-C Variants
Specification



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Spez KR QUANTEC-2 K+P V4

KUKA Deutschland GmbH

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

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

Subject to technical alterations without an effect on the function.

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1 Introduction

1.1 Target group

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

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



For optimal use of KUKA products, we recommend the training courses offered by KUKA College. Information about the training program can be found at www.kuka.com or can be obtained directly from our subsidiaries.

1.2 Industrial robot documentation

The industrial robot documentation consists of the following parts:

- Documentation for the robot arm
- Documentation for the robot controller
- Documentation for the smartPAD-2 (if used)
- Operating and programming instructions for the System Software
- Instructions for options and accessories
- Spare parts overview in KUKA Xpert

Each of these sets of instructions is a separate document.

1.3 Representation of warnings and notes

Safety

These warnings are provided for safety purposes and **must** be observed.



DANGER

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



WARNING

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



CAUTION

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

NOTICE

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



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

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

SAFETY INSTRUCTION

The following procedure must be followed exactly!

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

Notices

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



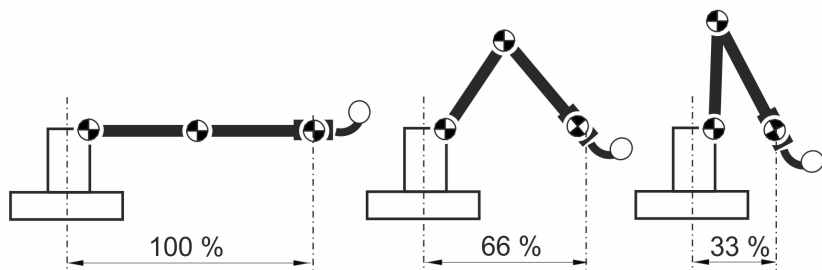
Tip to make your work easier or reference to further information.

1.4 Terms used



The overview may contain terms symbols that are not relevant for this document.

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	Area within which the robot may move. The workspace is derived from the individual axis ranges.
Arctic	Arctic for use in temperature ranges under 0°
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.



C	Ceiling
CR	Clean Room Designation for KUKA products developed for use in cleanrooms.
EDS	Electronic Data Storage (memory card)
EDS cool	Electronic Data Storage cool Memory card with extended temperature range

EMD	Electronic Mastering Device
SPP	Spare parts package
EX	Explosion-proof zone
F	Foundry
F exclusive	Foundry exclusive
Danger zone	The danger zone consists of the workspace and the stopping distances of the manipulator and external axes (optional).
HA	High Accuracy
HM	Hygienic Machine For the primary and secondary foodstuffs industries
HO	Hygienic Oil For the secondary foodstuffs industry
HP	High Protection
HW	Hollow Wrist
K	Shelf-mounted
KCP	KUKA Control Panel Teach pendant for the KR C2/KR C2 edition2005 The KCP has all the operator control and display functions required for operating and programming the industrial robot.
KR	KUKA robot
KR C	KUKA Robot Control Robot controller
KS	Shelf-mounted, small
KUKA smartPAD	see "smartPAD"
KUKA smartPAD-2	see "smartPAD"
Manipulator	The robot arm and the associated electrical installations
MEMD	Micro Electronic Mastering Device
micro RDC	micro Resolver Digital Converter
MT	Machine Tooling
P	Press-to-press robot
PA	Palletizer
Phi	Angle of rotation (°) about the corresponding axis. This value can be entered in the controller via the teach pendant, from which it can be read.

POV	Program override (%) = velocity of the robot motion. This value can be entered in the controller via the teach pendant, from which it can be read.
RDC	Resolver Digital Converter The resolver digital converter is used to acquire motor data (e.g. position data, motor temperatures).
RDC cool	Resolver Digital Converter Resolver Digital Converter with extended temperature range
SC	Special Connection
SE	Second Encoder
SI	Safe Interaction
SL	Washdown
smartPAD	Programming device for the robot controller The smartPAD has all the operator control and display functions required for operating and programming the industrial robot. 2 models exist: <ul style="list-style-type: none"> • smartPAD • smartPAD-2 In turn, for each model there are variants, e.g. with different lengths of connecting cables. For robot controllers of the KR C5 series, only the model “smart-PAD-2” is used. For other robot controllers, the designation “KUKA smartPAD” or “smartPAD” always refers to both models unless an explicit distinction is made.
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. <ul style="list-style-type: none"> • Operating mode T1: the drives are deactivated as soon as the robot has stopped, but no later than after 680 ms. • Operating modes T2, AUT (KR C controller), AUT EXT (KR C controller), EXT (VKR C controller): The drives are switched off after 1.5 s. Note: This stop category is called STOP 1 in this document.

Stop category 1 – Drive Ramp Stop	<p>The manipulator and any external axes (optional) perform path-oriented braking.</p> <ul style="list-style-type: none"> Operating mode T1: the drives are deactivated as soon as the robot has stopped, but no later than after 680 ms. Operating modes T2, AUT (KR C controller), AUT EXT (KR C controller), EXT (VKR C controller): The drives are switched off after 1.5 s. <p>Note: This stop category is called STOP 1 - DRS in this document.</p>
Stop category 2	<p>The drives are not deactivated and the brakes are not applied. The manipulator and any external axes (optional) are braked with a path-maintaining braking ramp.</p> <p>Note: This stop category is called STOP 2 in this document.</p>
T1	Test mode, Manual Reduced Velocity (≤ 250 mm/s)
T2	Test mode, Manual High Velocity (> 250 mm/s permissible)
W	Wall
WP	Waterproof
External axis	Motion axis which is not part of the manipulator but is controlled by the robot controller, e.g. KUKA linear unit, turn-tilt table, positioner.

2 Product description

2.1 Overview of the robot system

A robot system (>>> *Fig. 2-1*) comprises all the assemblies of an industrial robot, including the manipulator (mechanical system and electrical installations), robot controller, connecting cables, tool and other equipment. The product family KR QUANTEC-2 comprises the robot types:

- KR 120 R3500-2 P
- KR 120 R3500-2 P-C
- KR 120 R3900-2 K
- KR 180 R3500-2 K
- KR 180 R3500-2 K-F
- KR 210 R3300-2 K
- KR 210 R3300-2 K-F
- KR 270 R3100-2 K
- KR 270 R3100-2 K-F

An industrial robot of this product family comprises the following components:

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

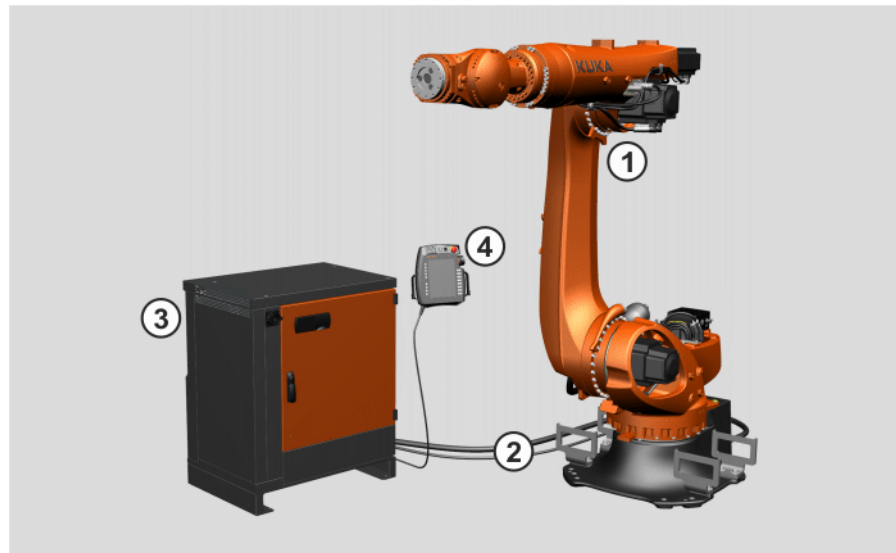


Fig. 2-1: Example of an industrial robot

- | | |
|---------------------|--------------------|
| 1 Manipulator | 3 Robot controller |
| 2 Connecting cables | 4 smartPAD |

2.2 Description of the manipulator

Overview

The manipulators (= robot arm and electrical installations) of the variants are designed as 6-axis jointed-arm kinematic systems. They consist of the following main assemblies:

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

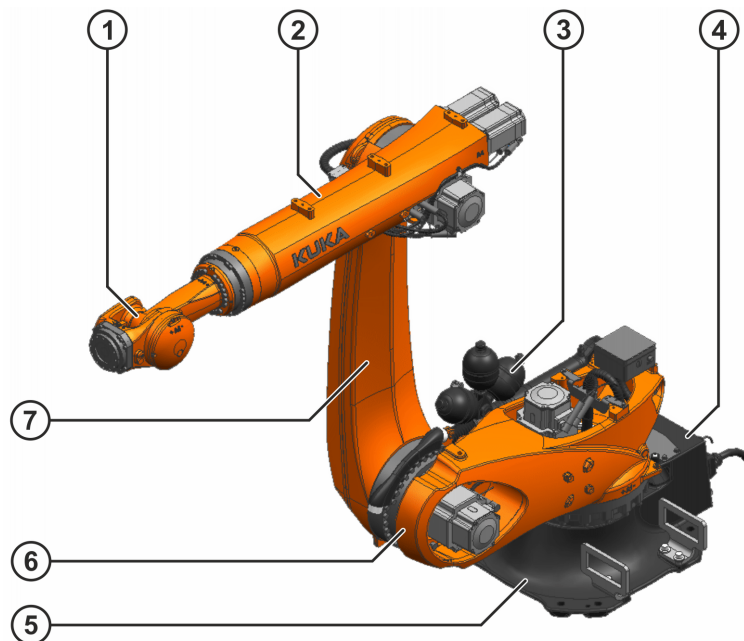


Fig. 2-2: Main assemblies of the manipulator

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



DANGER

Axes 1 to 3 are equipped with end stops. These serve exclusively as machine protection.

The following options are available for personnel protection:

- The Safe Robot functionality of the controller
- The use of mechanical axis limitations for axes 1 to 3 (optional)

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.

Arm

The arm is the link between the in-line wrist and the link arm. It houses the motors of wrist axes 4 and 5. The arm is driven by the motor of axis 3. The maximum permissible swivel angle is mechanically limited by an overrun safeguard for each direction, plus and minus. There is an interface on the arm for fastening supplementary loads.

Link arm

The link arm is the assembly located between the arm and the rotating column. The maximum permissible swivel angle is mechanically limited by an overrun safeguard for each direction, plus and minus. There is an interface on the link arm for fastening supplementary loads.

Rotating column

The rotating column houses the motors of axes 1 and 2. The rotational motion of axis 1 is performed by the rotating column. The rotating column also supports the link arm. The bearings of the counterbalancing system are situated at the rear. There is also an interface for fastening supplementary loads on the rotating column.

Base frame

The base frame is the base of the robot. It is screwed to the mounting base. The electrical installations are fastened in the base frame. Also located on the base frame is the interface for the motor and data 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 three accumulators, a hydraulic cylinder with associated hoses, a pressure gauge and a bursting disc as a safety element to protect against overfilling. The counterbalancing system is classified below category I, fluid group 2, of the Pressure Equipment Directive.

Electrical installations

The electrical installations include all the motor and data 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 split hood housing. The RDC box is located in the rotating column. The split hood housing and the connector for the data cables are mounted on the robot base frame. The connecting cables from the robot controller are connected here by means of connectors. The electrical installations also include a protective circuit.

Options

The robot can, for example, be equipped with the following options. The option is described in separate documentation.

- Axis limitations for axes A1, A2 and A3
- Energy supply systems A1 to A3
- Energy supply systems A3 to A6
- Mounting flange (adapter)

- Mounting flange (adapter) in corrosion-protected design
- Adapter ring KR QUANTEC/KR QUANTEC-2
- Brake release device

The following options are also available:

- Release device
- Purge option A
- Purge option B
- Purge option C
- Purge option D

2.3 Intended use and misuse

Intended use

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

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

Misuse

Any use or application deviating from the intended use is deemed to be misuse and is not allowed. It will result in the loss of warranty and liability claims. KUKA is not liable for any damage resulting from such misuse. This includes e.g.:

- Use as a climbing aid
- Operation outside the specified operating parameters
- Operation without the required safety equipment
- Transportation of persons and animals
- Outdoor operation.
- Use in a potentially explosive area
- Use in radioactive environments
- Operation in underground mining

NOTICE

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



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

3 Safety

3.1 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.

3.1.1 Disclaimer

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, especially those affecting safety, must be rectified immediately.

Safety information

Information about safety may not be construed against the manufacturer. 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 the manufacturer. Unauthorized modifications will result in the loss of warranty and liability claims.

Additional components (tools, software, etc.), not supplied by the manufacturer, 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.

3.1.2 EC declaration of conformity and declaration of incorporation

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

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

EC declaration of conformity

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

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

Declaration of incorporation

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

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

3.1.3 Terms in the “Safety” chapter

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	Area within which the robot may move. The workspace is derived from the individual axis ranges.
User	The user of the industrial robot can be the management, employer or delegated person responsible for use of the industrial robot.

Service life	<p>The service life of a safety-relevant component begins at the time of delivery of the component to the customer.</p> <p>The service life is not affected by whether the component is used or not, as safety-relevant components are also subject to aging during storage.</p>
Danger zone	The danger zone consists of the workspace and the stopping distances of the manipulator and external axes (optional).
KCP	<p>KUKA Control Panel</p> <p>Teach pendant for the KR C2/KR C2 edition2005</p> <p>The KCP has all the operator control and display functions required for operating and programming the industrial robot.</p>
KUKA smartPAD	see "smartPAD"
KUKA smartPAD-2	see "smartPAD"
Manipulator	The robot arm and the associated electrical installations
Safety zone	The safety zone is situated outside the danger zone.
Safety options	<p>Generic term for options which make it possible to configure additional safe monitoring functions in addition to the standard safety functions.</p> <p>Example: SafeOperation</p>
smartPAD	<p>Programming device for the robot controller</p> <p>The smartPAD has all the operator control and display functions required for operating and programming the industrial robot. 2 models exist:</p> <ul style="list-style-type: none"> • smartPAD • smartPAD-2 <p>In turn, for each model there are variants, e.g. with different lengths of connecting cables.</p> <p>For robot controllers of the KR C5 series, only the model "smartPAD-2" is used.</p> <p>For other robot controllers, the designation "KUKA smartPAD" or "smartPAD" always refers to both models unless an explicit distinction is made.</p>
Stop category 0	<p>The drives are deactivated immediately and the brakes are applied. The manipulator and any external axes (optional) perform path-oriented braking.</p> <p>Note: This stop category is called STOP 0 in this document.</p>
Stop category 1	<p>The manipulator and any external axes (optional) perform path-maintaining braking.</p> <ul style="list-style-type: none"> • Operating mode T1: the drives are deactivated as soon as the robot has stopped, but no later than after 680 ms. • Operating modes T2, AUT (KR C controller), AUT EXT (KR C controller), EXT (VKR C controller): The drives are switched off after 1.5 s. <p>Note: This stop category is called STOP 1 in this document.</p>

Stop category 1 – Drive Ramp Stop	<p>The manipulator and any external axes (optional) perform path-oriented braking.</p> <ul style="list-style-type: none"> Operating mode T1: the drives are deactivated as soon as the robot has stopped, but no later than after 680 ms. Operating modes T2, AUT (KR C controller), AUT EXT (KR C controller), EXT (VKR C controller): The drives are switched off after 1.5 s. <p>Note: This stop category is called STOP 1 - DRS in this document.</p>
Stop category 2	<p>The drives are not deactivated and the brakes are not applied. The manipulator and any external axes (optional) are braked with a path-maintaining braking ramp.</p> <p>Note: This stop category is called STOP 2 in this document.</p>
System integrator (plant integrator)	The system integrator is responsible for safely integrating the industrial robot into a complete system and commissioning 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 is controlled by the robot controller, e.g. KUKA linear unit, turn-tilt table, positioner.

3.2 Personnel

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

- User
- Personnel



Qualification of personnel

Work on the system must only be performed by personnel that is able to assess the tasks to be carried out and detect potential hazards. Death, severe injuries or damage to property may otherwise result. The following qualifications are required:

- Adequate specialist training, knowledge and experience
- Knowledge of the relevant operating or assembly instructions, knowledge of the relevant standards
- All persons working with the industrial robot must have read and understood the industrial robot documentation, including the safety chapter.

User

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

- The user must comply with his monitoring obligations.
- The user must carry out briefing at defined intervals.
- The user must comply with the regulations relating to personal protective equipment (PSA).

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

System integrator

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

The system integrator is responsible for the following tasks:

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

Operators

The operator must meet the following preconditions:

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

3.3 Workspace, safety zone and danger zone

Workspaces are to be restricted to the necessary minimum size.

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

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

There must be no shearing or crushing hazards at the loading and transfer areas.

If there are no physical safeguards present, the requirements for collaborative operation in accordance with EN ISO 10218 must be met.

3.4 Overview of protective equipment

The protective equipment of the mechanical component may include:

- Mechanical end stops

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

Not all equipment is relevant for every mechanical component.

3.4.1 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

Danger to life and limb following collision with obstacle

If the manipulator or an external axis hits an obstruction or a mechanical end stop or mechanical axis limitation, the manipulator can no longer be operated safely. Death, injuries or damage to property may result.

- Put manipulator out of operation.
- KUKA must be consulted before it is put back into operation.

3.4.2 Mechanical axis limitation (optional)

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

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

If this is not possible, the workspace must be limited by means of photoelectric barriers, photoelectric curtains or mechanical limitations 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 the manufacturer.

3.4.3 Options for moving the manipulator without drive energy



Qualification of personnel with regard to behavior in emergency situations

In emergencies or other exceptional situations, it may be necessary to move the manipulator without drive energy.

- Personnel must be trained in how to move the manipulator without drive energy.

Description

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

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



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

NOTICE

Damage to property due to moving the manipulator without drive energy

Moving the manipulator without drive energy can damage the motor brakes of the axes concerned.

- Only move the manipulator without drive energy in emergencies, e.g. for rescuing persons.
- Perform brake test.
- The motor must be replaced if the brake has been damaged.

3.4.4 Labeling on the industrial robot

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

Labeling on the industrial robot consists of:

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



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

3.5 Safety measures

3.5.1 General safety measures

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

It is important to be prepared for possible movements of the industrial robot even after the robot controller has been switched off and locked out. Incorrect installation (e.g. overload) or mechanical defects (e.g. brake defect) can cause the manipulator or external axes to sag. If work is to be carried out on a switched-off industrial robot, the manipulator and external

axes must first be moved into a position in which they are unable to move on their own, whether the payload is mounted or not. If this is not possible, the manipulator and external axes must be secured by appropriate means.



DANGER

Risk of fatal injury due to non-operational safety functions or external safeguards

In the absence of operational safety functions or safeguards, the industrial robot can cause death, severe injuries or damage to property.

- If safety functions or safeguards are dismantled or deactivated, do not operate the industrial robot.



DANGER

Danger to life and limb of persons under the robot arm

Sagging or falling parts can cause death or serious injuries. This applies at all times, e.g. also for assembly tasks or with the controller switched off.

- Never loiter under the robot arm.



CAUTION

Risk of burns from hot motors

The motors reach temperatures during operation which can cause burns.

- Avoid contact.
- Take appropriate safety precautions, e.g. wear protective gloves.

Implants



WARNING

Danger to life due to malfunction of implants due to motors

Electric motors generate electric and magnetic fields. The fields can cause malfunctions in active implants, e.g. pacemakers.

- Affected persons must maintain a minimum distance of 300 mm from the motors. This applies to both energized and deenergized motors.

KCP/smartPAD

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

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



WARNING

Danger to life due to disconnected smartPAD/KCP

If a smartPAD/KCP is disconnected, its EMERGENCY STOP device is not operational. There is a risk of connected and disconnected smartPADs/KCPs being interchanged. Death, injuries or damage to property may result.

- Remove the disconnected smartPAD/KCP from the system immediately.
- Store the disconnected smartPAD/KCP out of sight and reach of personnel working on the industrial robot.

External keyboard, external mouse

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

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

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

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

Modifications

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

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

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

Faults

In the case of faults on the industrial robot, the following safety measures must be implemented immediately:

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

Carry out a functional test after the fault has been rectified.

3.5.2 Transportation

Manipulator

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

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

Robot controller

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

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

External axis (optional)

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

3.5.3 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.

**Changing default passwords**

The KUKA System Software is supplied with default passwords for the user groups. If the passwords are not changed, this enables unauthorized persons to log on.

- Before start-up, change the passwords for the user groups.
- Only communicate the passwords to authorized personnel.

**WARNING****Danger to life and limb due to incorrectly assigned cables**

The robot controller is preconfigured for the specific industrial robot. The manipulator and other components can receive incorrect data if they are connected to a different robot controller. Death, severe injuries or damage to property may result.

- Only connect the manipulator to the corresponding robot controller.

**Do not impair safety functions**

Additional components (e.g. cables and hoses) not supplied by KUKA may be integrated into the industrial robot. If the safety functions are not taken into consideration, this may result in death, severe injuries or damage to property.

- Additional components must not impair or disable safety functions.

NOTICE**Damage to property due to condensation**

If the internal cabinet temperature of the robot controller differs greatly from the ambient temperature, condensation can form. This may result in damage to property.

- Wait until the internal cabinet temperature has adapted to the ambient temperature in order to avoid condensation.

Function test

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

It must be ensured that:

- The industrial robot is correctly installed and fastened in accordance with the specifications in the documentation.



- There is no damage to the robot that could be attributed to external forces. Example: Dents or abrasion that could be caused by an impact or collision.

WARNING

Danger to life and limb resulting from external forces

External forces, such as an impact or a collision, can cause non-visible damage. For example, it can lead to a gradual loss of drive power from the motor, resulting in unintended movements of the manipulator.

Death, severe injuries or damage to property may result from non-visible damage.

- Check the robot for damage that could have been caused by external forces, e.g. dents or abrasion of paintwork.

Check the motor and counterbalancing system particularly carefully.

(Motor inspection not relevant for robots with internal motors.)

- In the case of damage, the affected components must be exchanged.

- There are no foreign bodies or defective 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.

3.5.4 Manual mode

General

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:

- 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.

Setup work in T1

If it is necessary to carry out setup work from inside the safeguarded area, the following must be taken into consideration in the operating mode **Manual Reduced Velocity (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 zone and get out of harm's way.
- Unexpected motions of the manipulator cannot be ruled out, e.g. in the event of a fault. For this reason, an appropriate clearance must be maintained between persons and the manipulator (including tool). Guide value: 50 cm.

The minimum clearance may vary depending on local circumstances, the motion program and other factors. The minimum clearance that is to apply for the specific application must be decided by the user on the basis of a risk assessment.

Setup work in T2

If it is necessary to carry out setup work from inside the safeguarded area, the following must be taken into consideration in the operating mode **Manual High Velocity (T2)**:

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

3.5.5 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 or the requirements for collaborative operation in accordance with EN ISO 10218 have been met.
- 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.

3.5.6 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 regula-

tions must be observed for this check. The correct functioning of all safety functions must also be tested.

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

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

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



DANGER

Danger to life and limb due to live parts

The robot system must be disconnected from the mains power supply prior to work on live parts. It is not sufficient to trigger an EMERGENCY STOP or safety stop, because parts remain live. Death or severe injuries may result.

- Before commencing work on live parts, turn off the main switch and secure it against being switched on again.
If the controller variant in question does not have a main switch (e.g. KR C5 micro), turn off the device switch then disconnect the power cable and secure it so it cannot be reconnected.
- Then check to ensure that the system is deenergized.
- Inform the individuals involved that the robot controller is switched off. (e.g. by affixing a warning sign)

Faulty components must be replaced using new components with the same article numbers or equivalent components approved by the manufacturer 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 780 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.

On robot controllers with transformers, the transformers must be disconnected before working on components in the robot controller.

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.

- **Counterbalancing system classified below category I:** Is subject to the Pressure Equipment Directive but exempt from application of the Pressure Equipment Directive according to Art. 4, para. 3 and therefore not CE marked.
- **Counterbalancing system classified as category I or higher:** Is subject to the Pressure Equipment Directive and CE marked as a component (see rating plate of the counterbalancing system). The pressure equipment is placed on the market in conjunction with partly completed machinery. Conformity is expressed on the declaration of incorporation according to the Machinery Directive.

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

- In Germany, the counterbalancing system is work equipment according to the German Ordinance on Industrial Safety and Health (BetrSichV). Inspection intervals in Germany in accordance with the Ordinance on Industrial Safety and Health, Sections 14 and 15. Inspection by the user before commissioning at the installation site.
- Inspection intervals in all other countries must be researched and observed. As a rule, however, at least the maintenance intervals specified by KUKA must be observed. These must not be exceeded.

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

- The 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.



Use current safety data sheets

Knowledge of the safety data sheets of the substances and mixtures used is a prerequisite for the safe use of KUKA products. Death, injuries or damage to property may otherwise result.

- Request up-to-date safety data sheets from the manufacturers of hazardous substances regularly.

3.5.7 Decommissioning, storage and disposal

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

4 Technical data

4.1 Basic data overview

Basic data

	Kinematic type	Number of axes	Rated payload	Maximum pay-load		
KR 120 R3500-2 P	Articulated robot	6	120 kg	180 kg		
KR 120 R3500-2 P-C						
KR 120 R3900-2 K				146 kg		
KR 180 R3500-2 K				180 kg	228 kg	
KR 180 R3500-2 K-F						
KR 210 R3300-2 K				210 kg	273 kg	
KR 210 R3300-2 K-F						
KR 270 R3100-2 K				270 kg	344 kg	
KR 270 R3100-2 K-F						
	Maximum reach	Volume of working envelope	Pose repeatability (ISO 9283)	Footprint		
KR 120 R3500-2 P	3505 mm	150.5 m³	± 0.05 mm	754 mm x 754 mm		
KR 120 R3500-2 P-C		116.2 m³				
KR 120 R3900-2 K	3904 mm	211.3 m³				
KR 180 R3500-2 K	3505 mm	150.5 m³				
KR 180 R3500-2 K-F						
KR 210 R3300-2 K	3305 mm	123.9 m³				
KR 210 R3300-2 K-F						
KR 270 R3100-2 K	3105 mm	100.7 m³				
KR 270 R3100-2 K-F						

	Weight	Protection rating (IEC 60529)	Protection rating, robot wrist (IEC 60529)	Sound level
KR 120 R3500-2 P	approx. 1281 kg	IP65	IP65 / IP67	< 75 dB (A)
KR 120 R3500-2 P-C	approx. 1283 kg			
KR 120 R3900-2 K	approx. 1280 kg			
KR 180 R3500-2 K	approx. 1256 kg	IP65 / IP67		
KR 180 R3500-2 K-F				
KR 210 R3300-2 K	approx. 1266 kg	IP65		
KR 210 R3300-2 K-F		IP65 / IP67		
KR 270 R3100-2 K	approx. 1260 kg	IP65		
KR 270 R3100-2 K-F		IP65 / IP67		

Foundry robots

Overpressure in the arm	0.03 MPa (0.3 bar) $\pm 10\%$
Compressed air	Free of oil and water in accordance with ISO 8573-1:2010 (7:4:4)
Compressed air supply line	Air line in the cable set
Operating pressure (PURGE)	max. 0.03 MPa (0.3 bar) $\pm 10\%$
Air consumption	0.1 m ³ /h
Air line connection	Push-in fitting for hose, 6 mm
Thermal load of the wrist	10 s/min at 180 °C (453 K)
Resistance	Increased resistance to dust, lubricants, coolants and water vapor.
Special paint finish on the robot	Special paint finish on the entire robot, and an additional protective clear coat.
Other ambient conditions	KUKA Deutschland GmbH must be consulted if the robot is to be used under other ambient conditions.

Ambient conditions

	Ambient temperature during operation	Ambient temperature during storage/transportation	Humidity class (EN 60204)	Classification of environmental conditions (EN 60721-3-3)
KR 120 R3500-2 P	0 °C to 40 °C (273 K to 313 K)	-40 °C to 60 °C (233 K to 333 K)	-	-
KR 120 R3500-2 P-C				
KR 120 R3900-2 K	0 °C to 55 °C (273 K to 328 K)			
KR 180 R3500-2 K				
KR 180 R3500-2 K-F				
KR 210 R3300-2 K				
KR 210 R3300-2 K-F				
KR 270 R3100-2 K				
KR 270 R3100-2 K-F				



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



During operation in the low-temperature range, frost and condensation must be avoided, as damage to property may otherwise arise.

pH value for F variants

pH value	7.0 to 9.0
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Connecting cables, KR C4

Cable designation	Connector designation robot controller - robot	Interface with robot
Motor cable	X20 - X30	Han® 16HP
Data cable	X21 - X31	Han® 3A Q12
Ground conductor / equipotential bonding (optional)		M8 ring cable lug at both ends
Cable lengths	7 m, 10 m, 15 m, 20 m, 25 m, 30 m, 35 m, 50 m	
Max. cable length	50 m	
Number of extensions	1	

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

4.2 Axis data overview

Motion range					
A1	A2	A3	A4	A5	A6
KR 120 R3500-2 P					
±185 °	-120 ° / 70 °	-120 ° / 168 °	±350 °	±122.5 °	±350 °
KR 120 R3500-2 P-C					
±185 °	-120 ° / 0 °	-120 ° / 168 °	±350 °	±122.5 °	±350 °
KR 120 R3900-2 K					
±185 °	-120 ° / 70 °	-120 ° / 168 °	±350 °	±125 °	±350 °
KR 180 R3500-2 K					
±185 °	-120 ° / 70 °	-120 ° / 168 °	±350 °	±125 °	±350 °
KR 180 R3500-2 K-F					
±185 °	-120 ° / 70 °	-120 ° / 168 °	±350 °	±125 °	±350 °
KR 210 R3300-2 K					
±185 °	-120 ° / 70 °	-120 ° / 168 °	±350 °	±122.5 °	±350 °
KR 210 R3300-2 K-F					
±185 °	-120 ° / 70 °	-120 ° / 168 °	±350 °	±122.5 °	±350 °
KR 270 R3100-2 K					
±185 °	-120 ° / 70 °	-120 ° / 168 °	±350 °	±122.5 °	±350 °
KR 270 R3100-2 K-F					
±185 °	-120 ° / 70 °	-120 ° / 168 °	±350 °	±122.5 °	±350 °
Speed with rated payload					
A1	A2	A3	A4	A5	A6
KR 120 R3500-2 P					
112 °/s	107 °/s	114 °/s	150 °/s	129 °/s	219 °/s
KR 120 R3500-2 P-C					
112 °/s	107 °/s	114 °/s	150 °/s	129 °/s	219 °/s
KR 120 R3900-2 K					
105 °/s	101 °/s	110 °/s	190 °/s	180 °/s	260 °/s
KR 180 R3500-2 K					
105 °/s	101 °/s	110 °/s	150 °/s	180 °/s	260 °/s
KR 180 R3500-2 K-F					
105 °/s	101 °/s	110 °/s	150 °/s	180 °/s	260 °/s
KR 210 R3300-2 K					
105 °/s	101 °/s	110 °/s	140 °/s	140 °/s	219 °/s
KR 210 R3300-2 K-F					
105 °/s	101 °/s	110 °/s	140 °/s	140 °/s	219 °/s
KR 270 R3100-2 K					
105 °/s	101 °/s	110 °/s	140 °/s	113 °/s	180 °/s
KR 270 R3100-2 K-F					
105 °/s	101 °/s	110 °/s	140 °/s	113 °/s	180 °/s

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

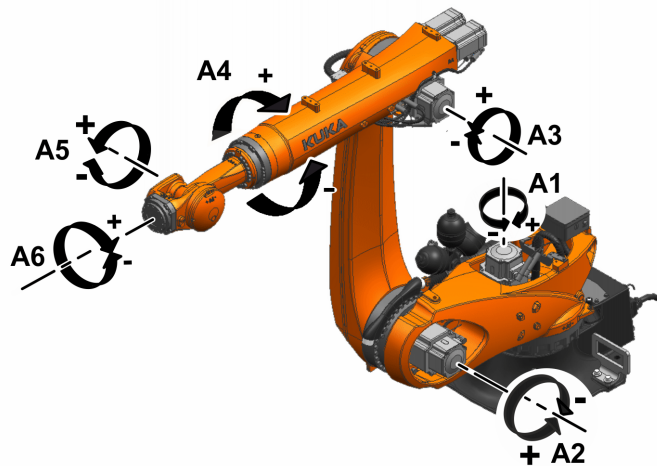
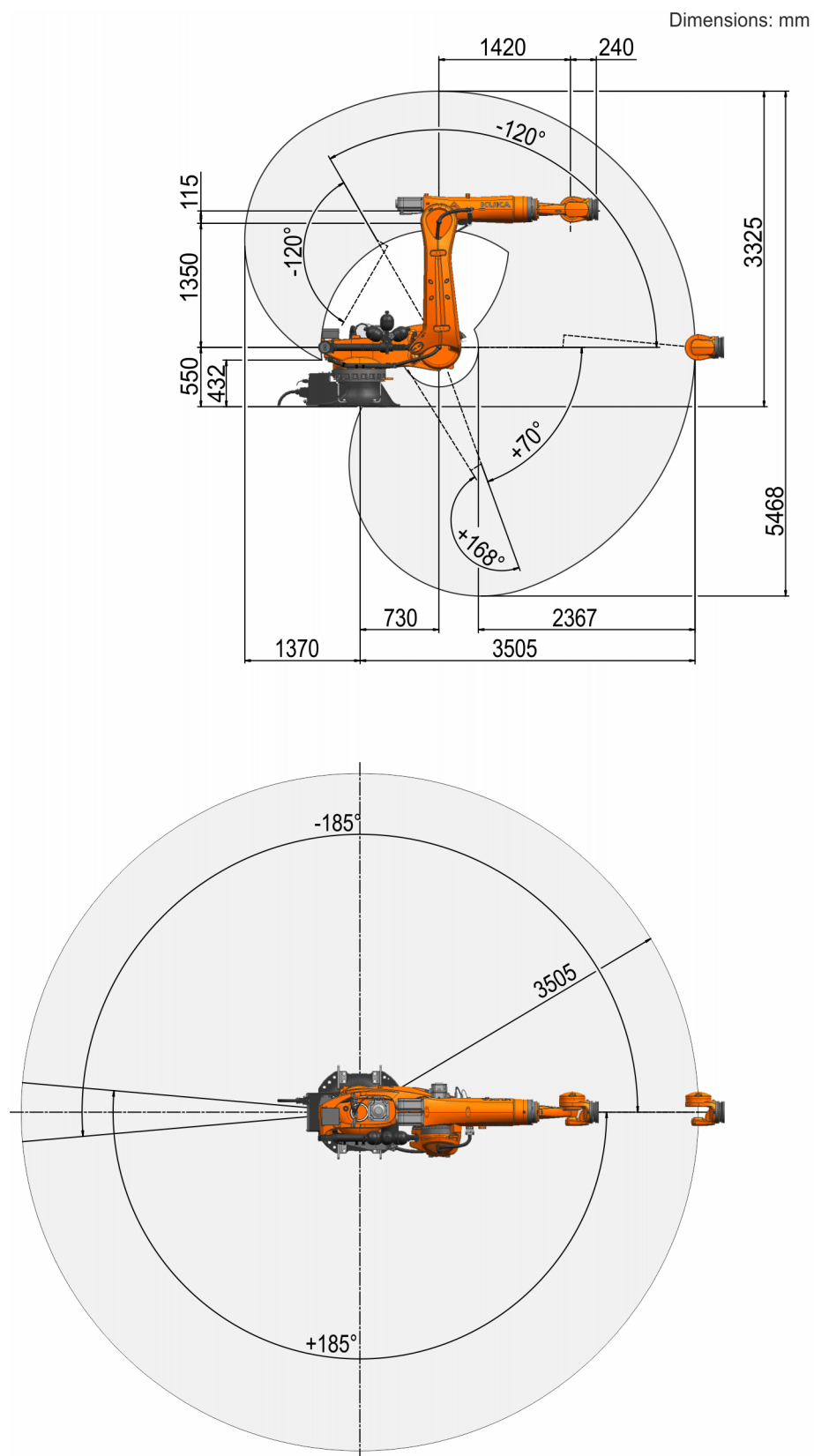


Fig. 4-1: Direction of rotation of the axes

Working envelope

The following diagrams show the shape and size of the working envelope for these variants of this product family.

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

Working envelope, KR 120 R3500-2 P**Fig. 4-2: KR 120 R3500-2 P, working envelope, overall**

Working envelope, KR 120 R3500-2 P-C

Dimensions: mm

Technical data

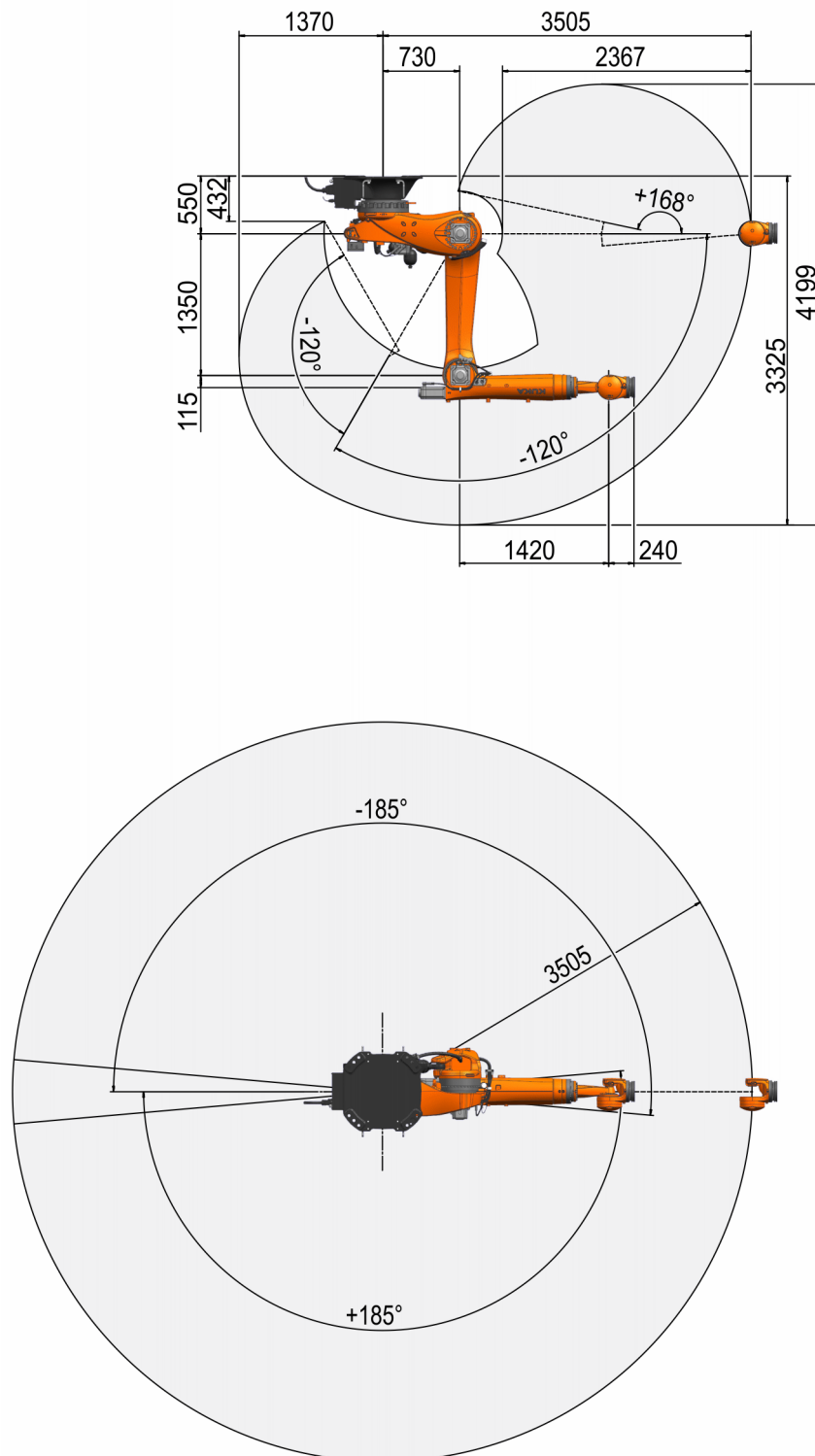
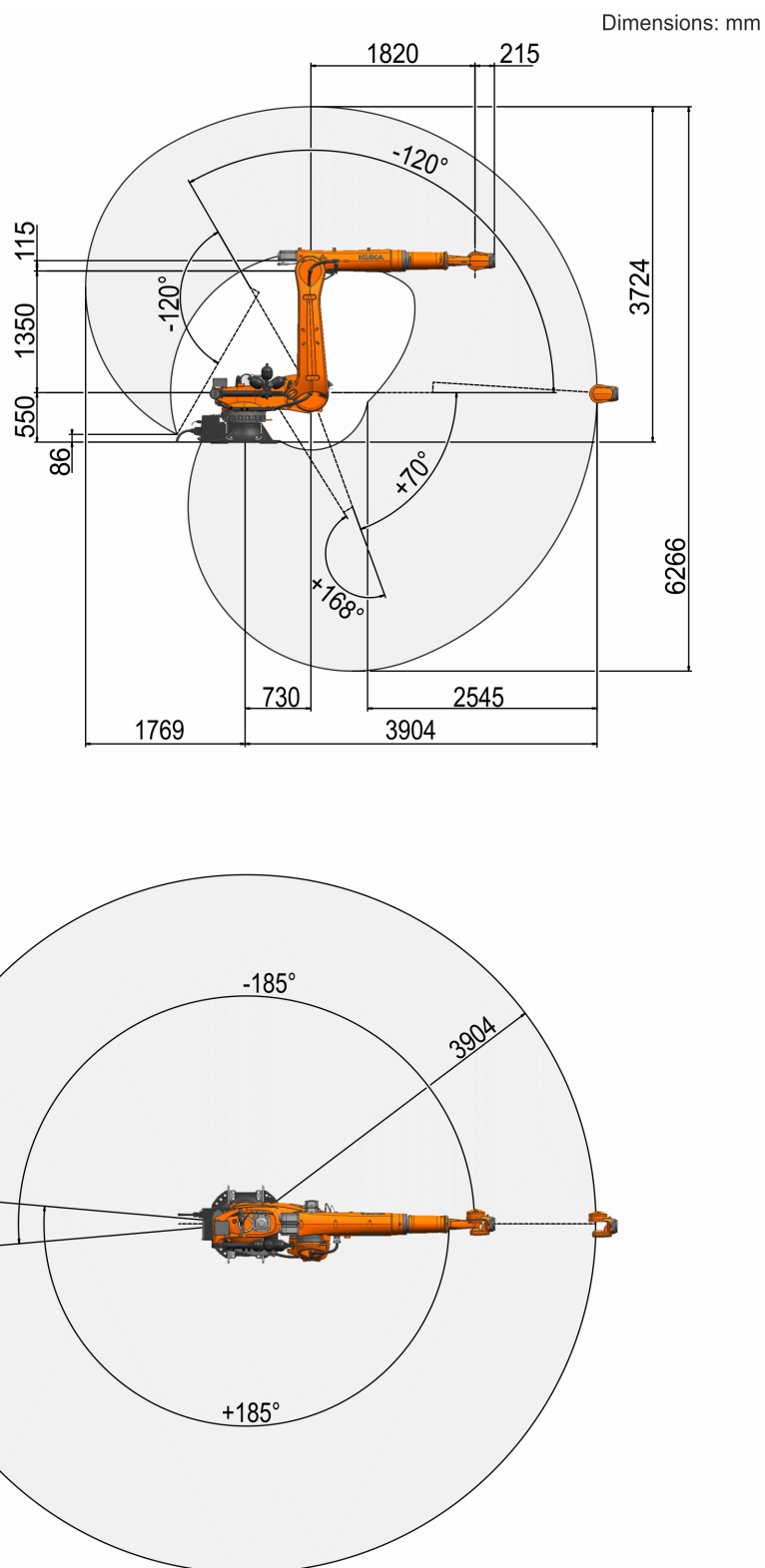
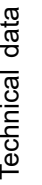


Fig. 4-3: KR 120 R3500-2 P-C, working envelope, overall

Working envelope, KR 120 R3900-2 K**Fig. 4-4: KR 120 R3900-2 K, working envelope, overall**

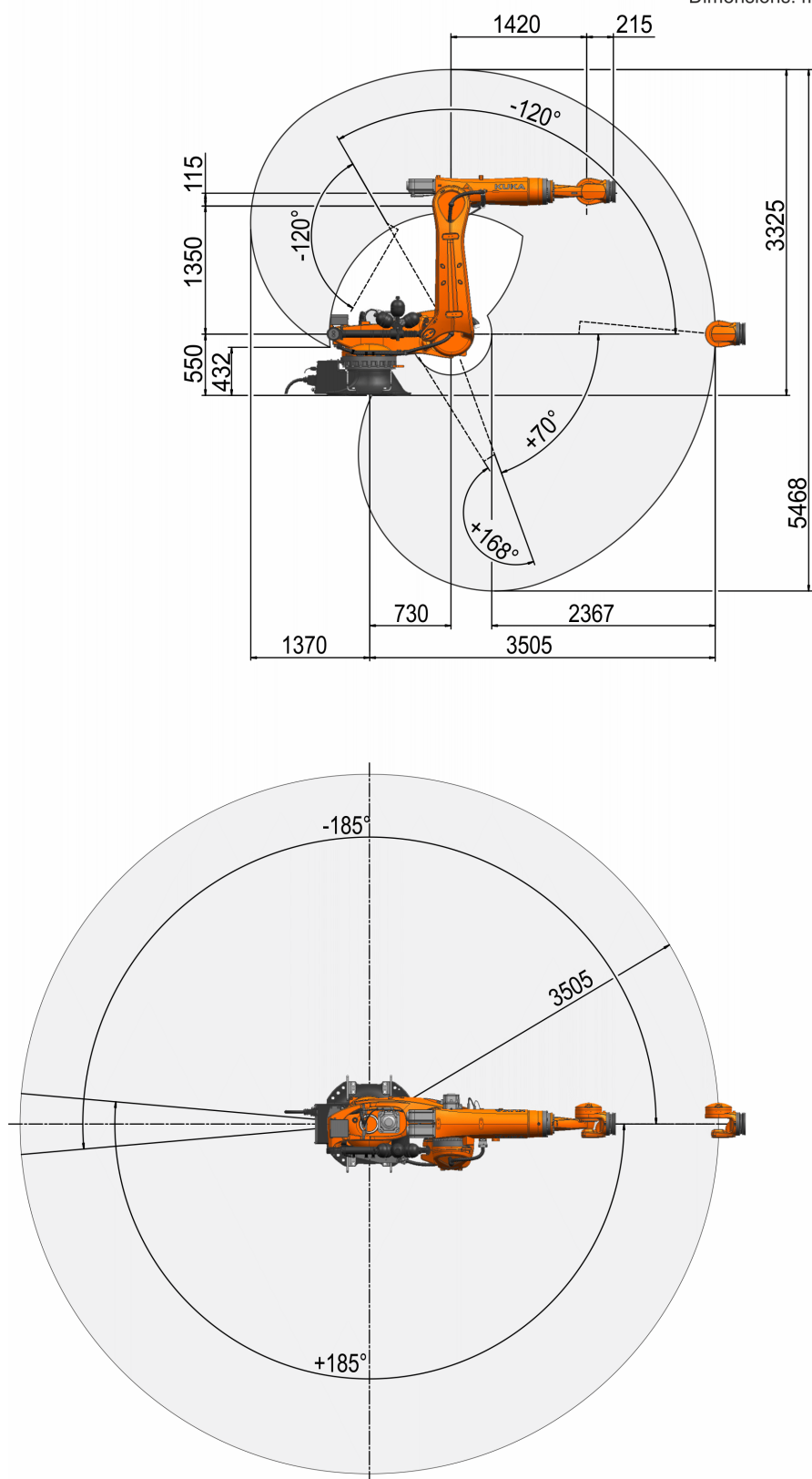
Technical data



Technical data

Working envelope, KR 180 R3500-2 K-F

Dimensions: mm

**Fig. 4-6: KR 180 R3500-2 K-F, working envelope, overall**

Working envelope, KR 210 R3300-2 K

Technical data

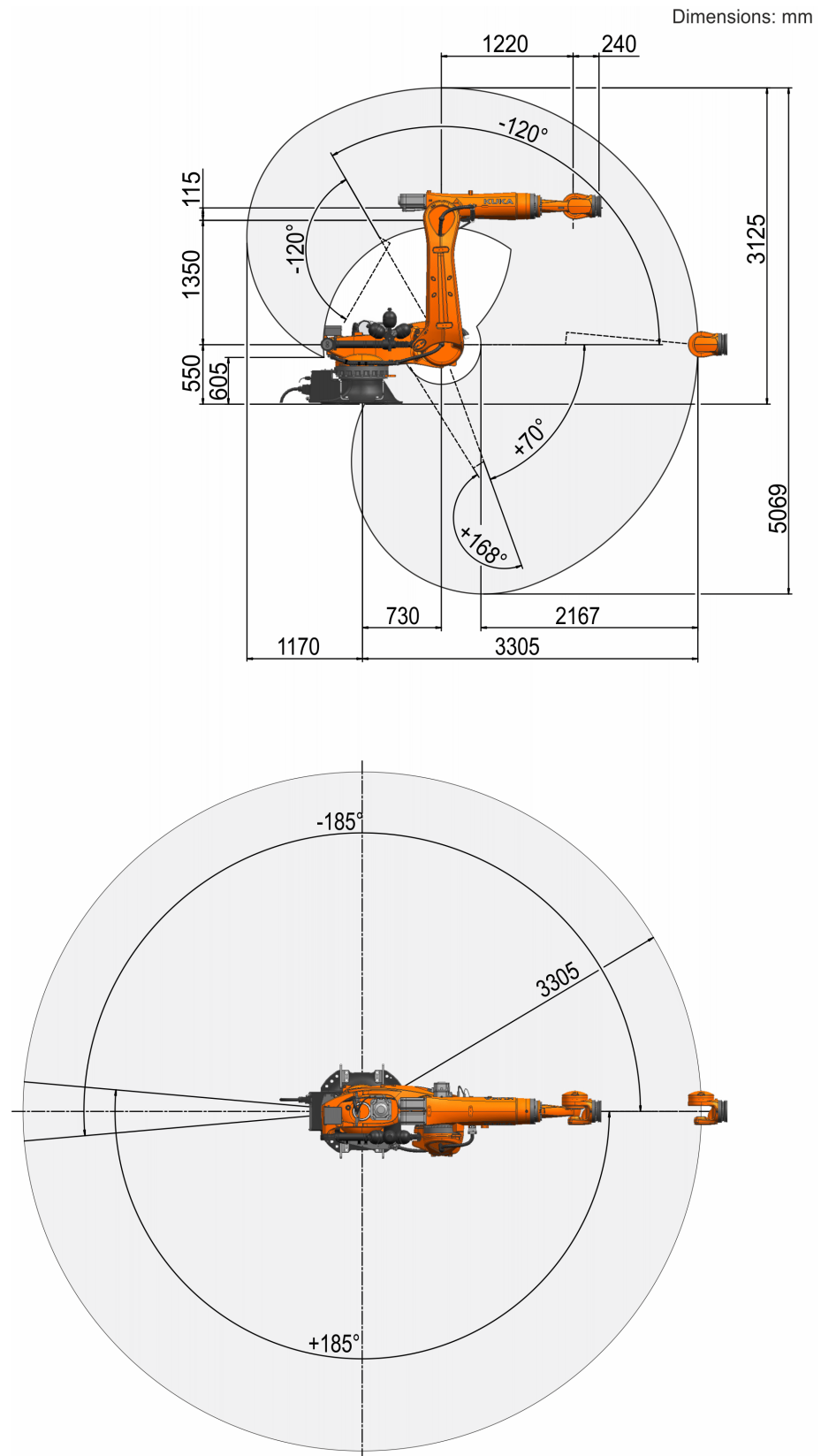
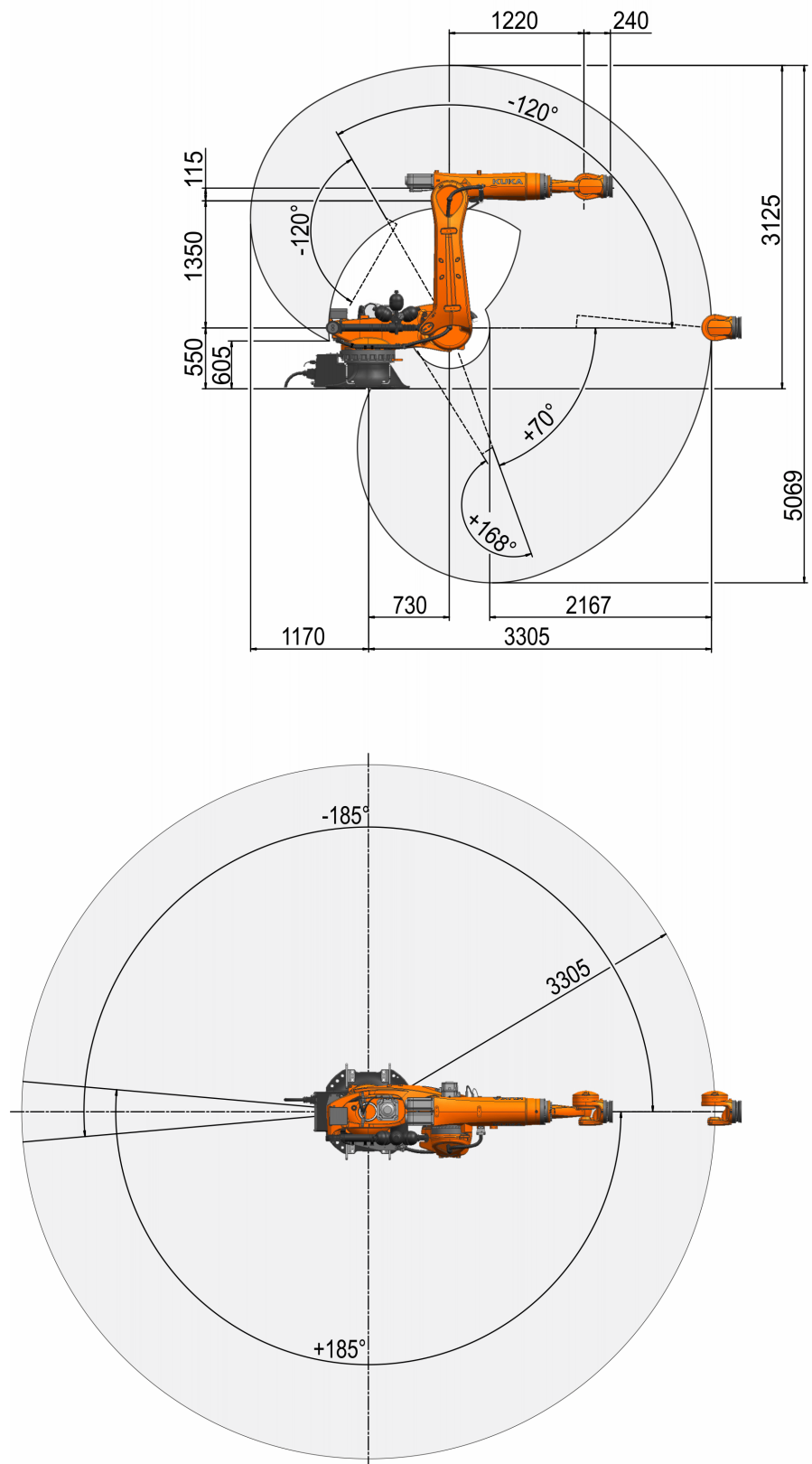


Fig. 4-7: KR 210 R3300-2 K, working envelope, overall

Working envelope, KR 210 R3300-2 K-F

Dimensions: mm

**Fig. 4-8: KR 210 R3300-2 K-F, working envelope, overall**

Working envelope, KR 270 R3100-2 K

Technical data

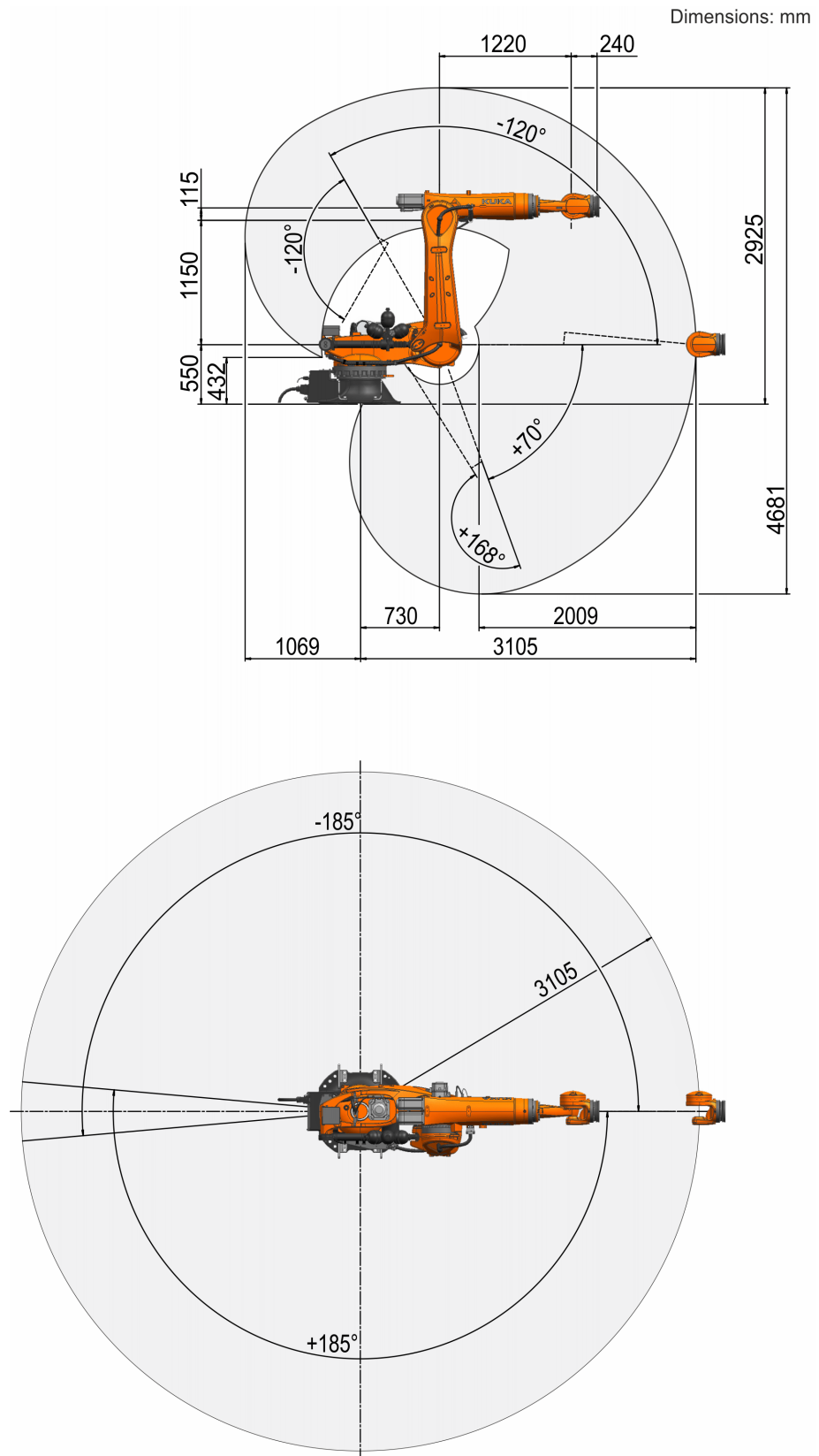
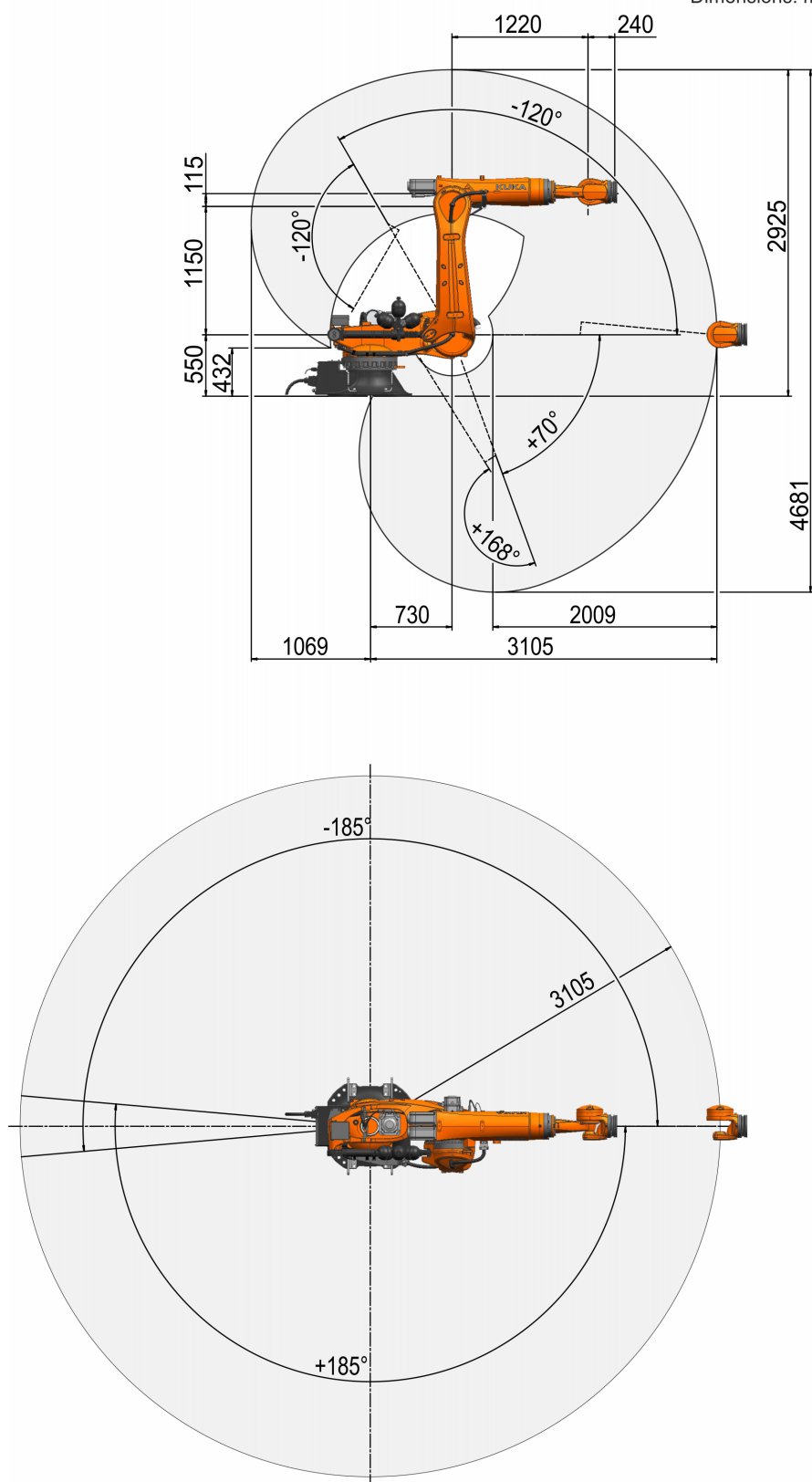


Fig. 4-9: KR 270 R3100-2 K, working envelope, overall

Working envelope, KR 270 R3100-2 K-F

Dimensions: mm

**Fig. 4-10: KR 270 R3100-2 K-F, working envelope, overall**

4.3 Payloads overview

Payloads

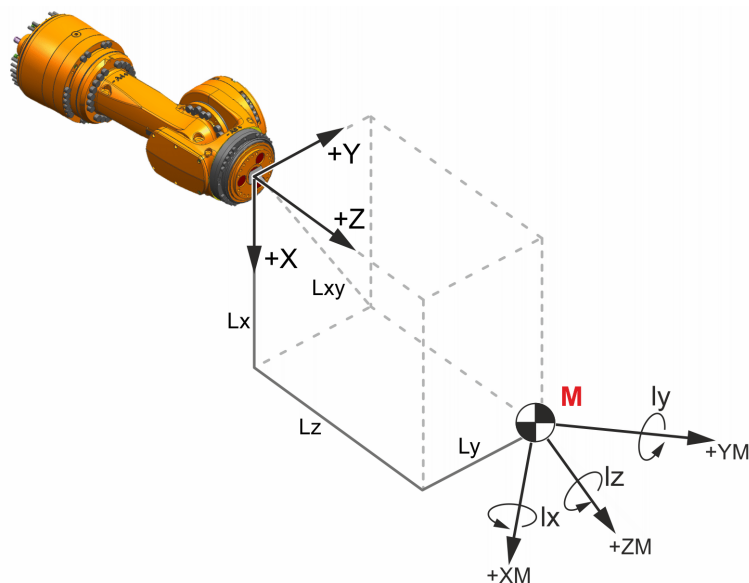
	Rated payload	Maximum payload	Rated total load
KR 120 R3500-2 P	120 kg	180 kg	170 kg
KR 120 R3500-2 P-C			
KR 120 R3900-2 K		146 kg	
KR 180 R3500-2 K	180 kg	228 kg	230 kg
KR 180 R3500-2 K-F			
KR 210 R3300-2 K	210 kg	273 kg	260 kg
KR 210 R3300-2 K-F			
KR 270 R3100-2 K	270 kg	344 kg	320 kg
KR 270 R3100-2 K-F			

Rated supplementary loads

	Base frame	Rotating column	Link arm	Arm
KR 120 R3500-2 P	0 kg	0 kg	0 kg	50 kg
KR 120 R3500-2 P-C				
KR 120 R3900-2 K				
KR 180 R3500-2 K				
KR 180 R3500-2 K-F				
KR 210 R3300-2 K				
KR 210 R3300-2 K-F				
KR 270 R3100-2 K				
KR 270 R3100-2 K-F				

Maximum supplementary loads

	Base frame	Rotating column	Link arm	Arm
KR 120 R3500-2 P	0 kg	300 kg	130 kg	150 kg
KR 120 R3500-2 P-C				
KR 120 R3900-2 K				
KR 180 R3500-2 K				
KR 180 R3500-2 K-F				
KR 210 R3300-2 K				
KR 210 R3300-2 K-F				
KR 270 R3100-2 K				
KR 270 R3100-2 K-F				

Load center of gravity and mass moment of inertia**Fig. 4-11: Load center of gravity and mass moment of inertia****Parameter**

Parameter/unit		Description
Mass	kg	Payload mass
L_x, L_y, L_z	mm	Position of the center of mass in the reference system

Parameter/unit		Description
A, B, C	Degrees	Orientation of the principal inertia axes
		<ul style="list-style-type: none">• A: Rotation about the Z axis of the reference system The result is a coordinate system named CS'.• B: Rotation about the Y axis of CS' Result: CS''• C: Rotation about the X axis of CS'' <p>Note: A, B and C are not shown in the diagram.</p>
Mass moments of inertia:		
I_x	kgm^2	Inertia about the X axis of the main axis system
I_y	kgm^2	Inertia about the Y axis of the main axis system
I_z	kgm^2	Inertia about the Z axis of the main axis system

L_x , L_y , L_z and A, B, C unambiguously define the main axis system:

- The origin of the main axis system is the center of mass.
- A characteristic feature of the main axis system is that, among other things, the maximum possible inertia occurs about one of the 3 coordinate axes.



More information is contained in the **KUKA.Load** documentation.

Payload diagram, KR 120 R3500-2 P

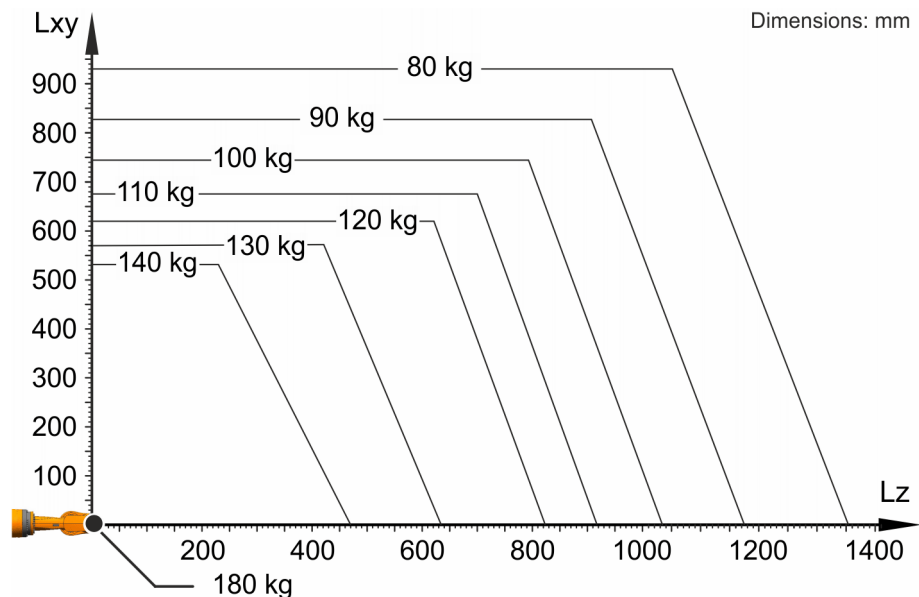
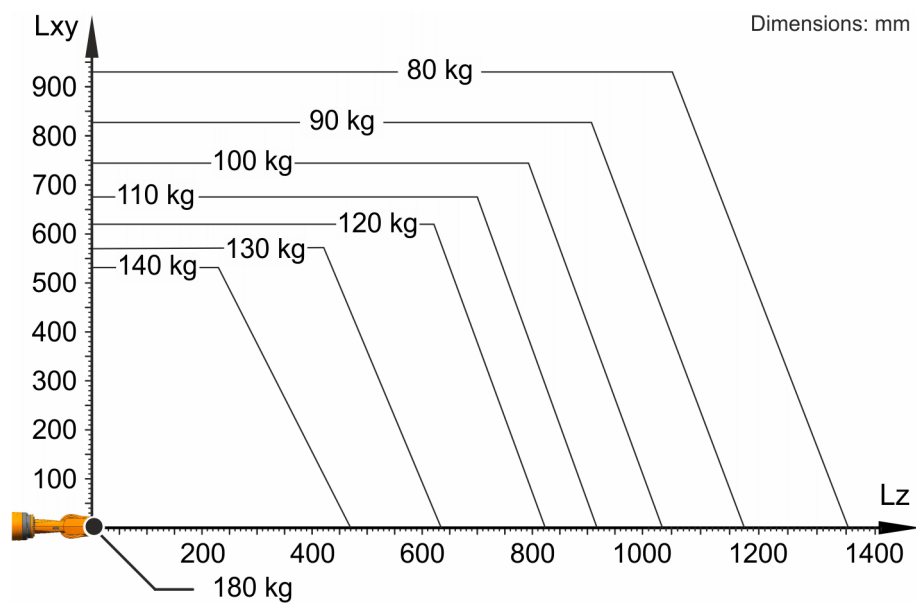
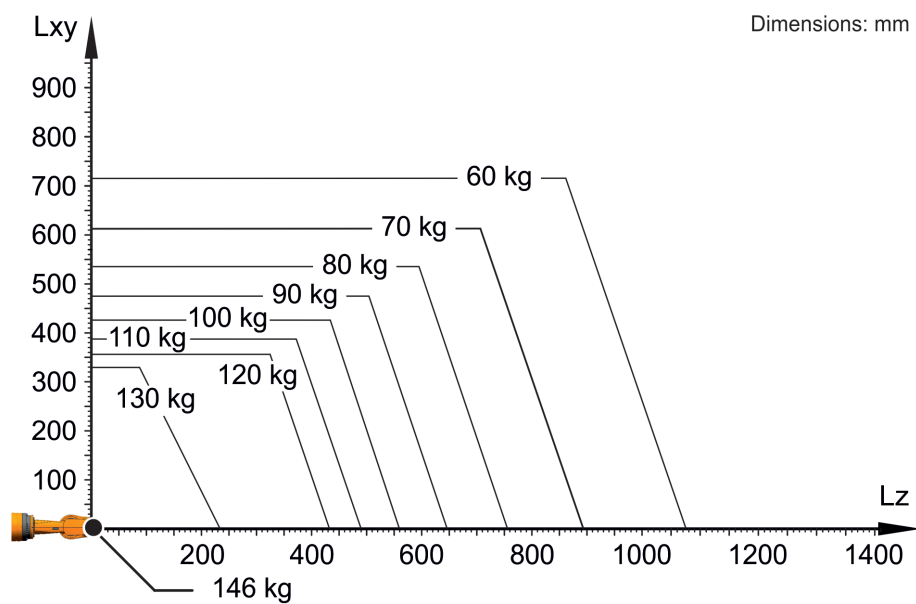
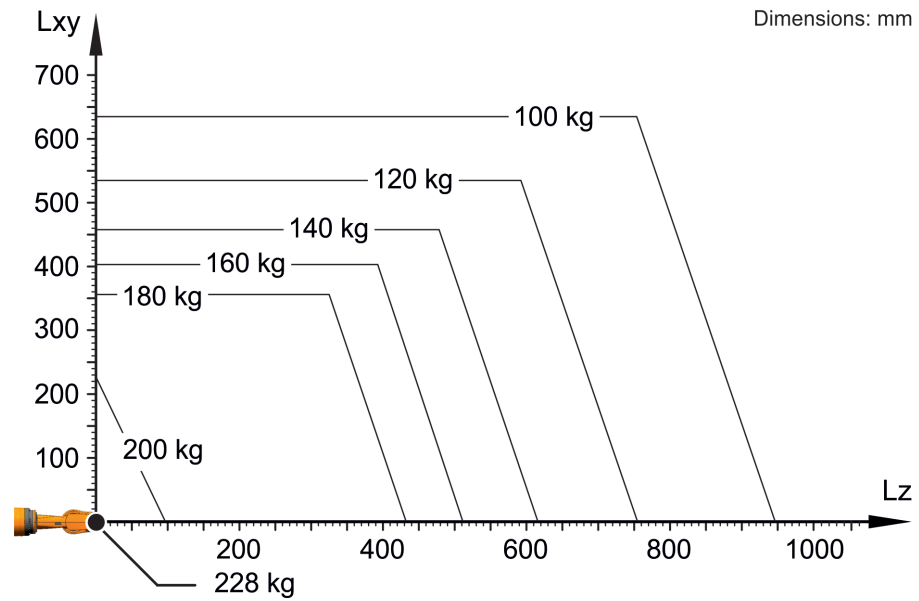
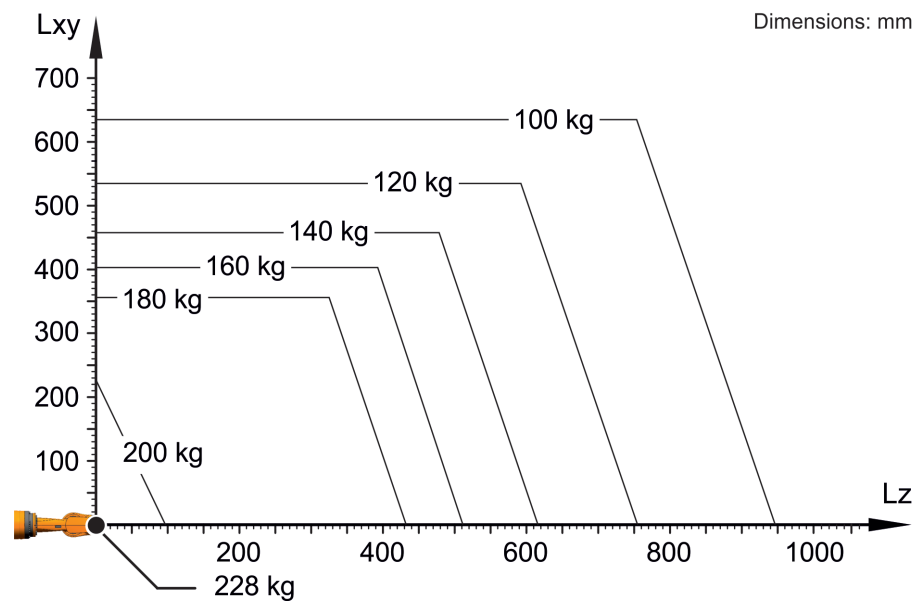
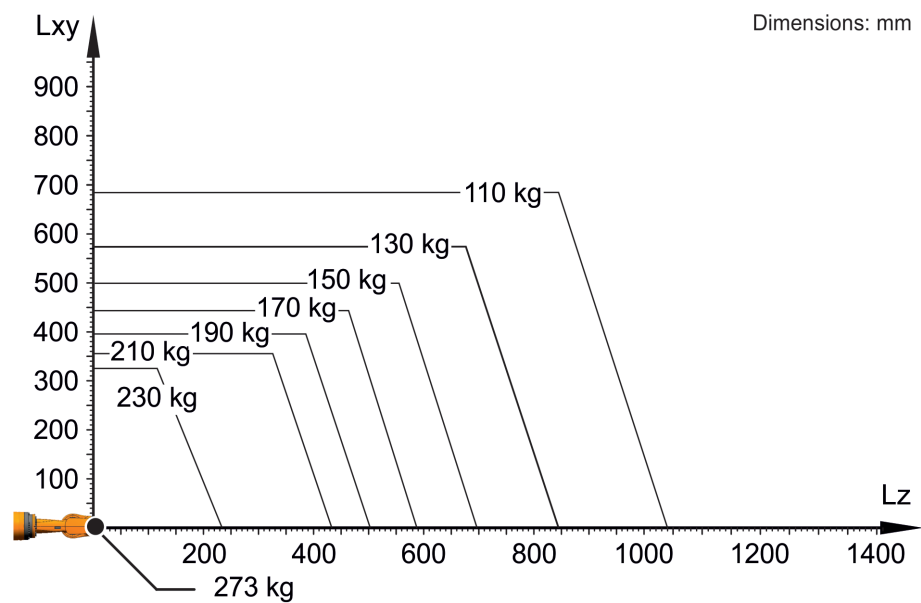
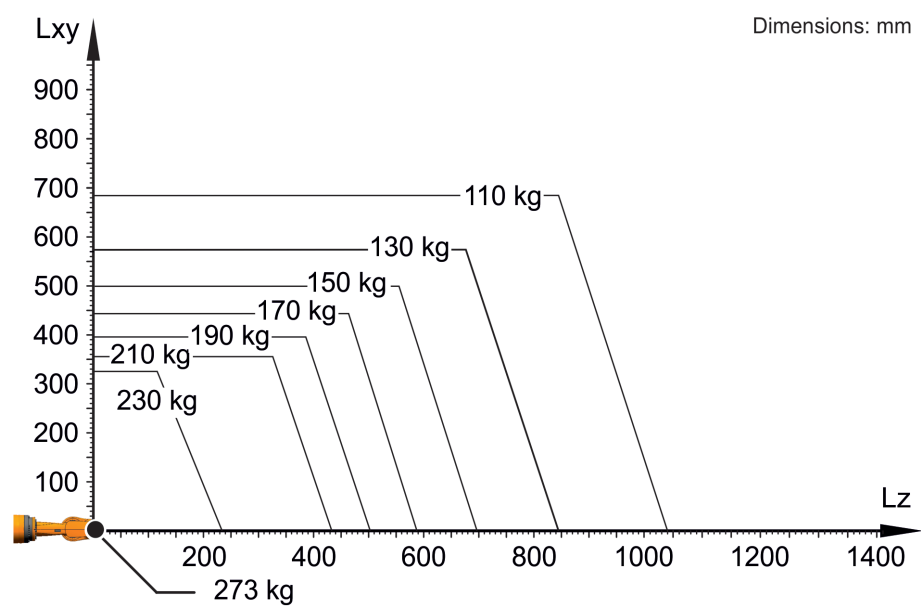


Fig. 4-12: Payload diagram, KR 120 R3500-2 P

Payload diagram, KR 120 R3500-2 P-C**Fig. 4-13: Payload diagram, KR 120 R3500-2 P-C****Payload diagram, KR 120 R3900-2 K****Fig. 4-14: Payload diagram, KR 120 R3900-2 K**

Payload diagram, KR 180 R3500-2 K**Fig. 4-15: Payload diagram, KR 180 R3500-2 K****Payload diagram, KR 180 R3500-2 K-F****Fig. 4-16: Payload diagram, KR 180 R3500-2 K-F**

Payload diagram, KR 210 R3300-2 K**Fig. 4-17: Payload diagram, KR 210 R3300-2 K****Payload diagram, KR 210 R3300-2 K-F****Fig. 4-18: Payload diagram, KR 210 R3300-2 K-F**

Payload diagram, KR 270 R3100-2 K

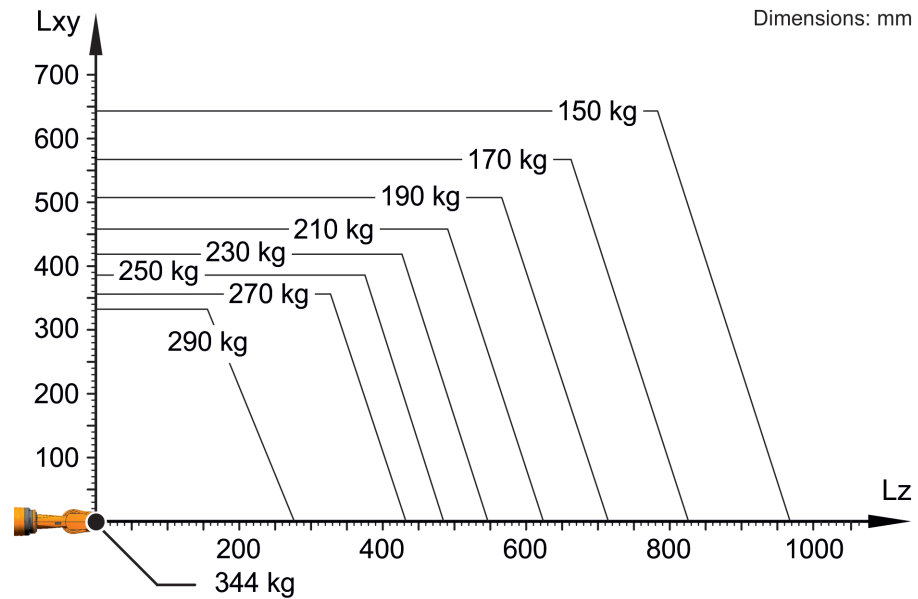


Fig. 4-19: Payload diagram, KR 270 R3100-2 K

Payload diagram, KR 270 R3100-2 K-F

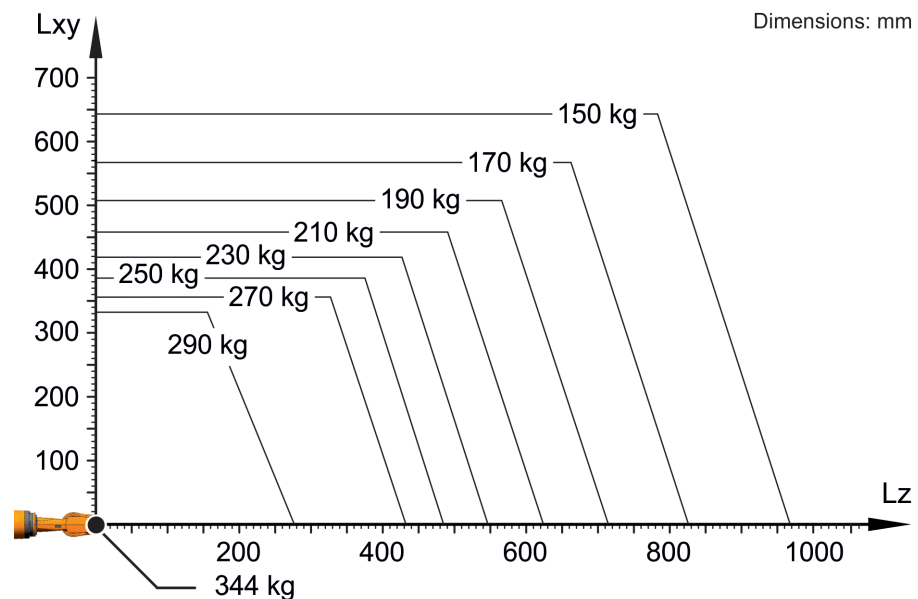


Fig. 4-20: Payload diagram, KR 270 R3100-2 K-F

NOTICE

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

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

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

The manipulator is designed for its respective rated payload in order to optimize the dynamic performance of the robot. With reduced load center

distances, higher loads up to the maximum payload may be used. The specific load case must be verified using KUKA.Load. For further consultation, please contact KUKA Support.

Mounting flange D=125

Designation	Robot wrist type	Mounting flange
KR 120 R3900-2 K	ZH120 HV400	see drawing
KR 180 R3500-2 K	ZH210	
KR 180 R3500-2 K-F	ZH210 F	

Mounting flange (hole circle)	125 mm
Screw grade	10.9
Screw size	M10
Number of fastening threads	11
Depth of engagement	min. 11.5 mm, max. 16 mm
Locating element	10 H7
Standard	See diagram (>>> Fig. 4-21)

The mounting flange is depicted (>>> Fig. 4-21) 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.

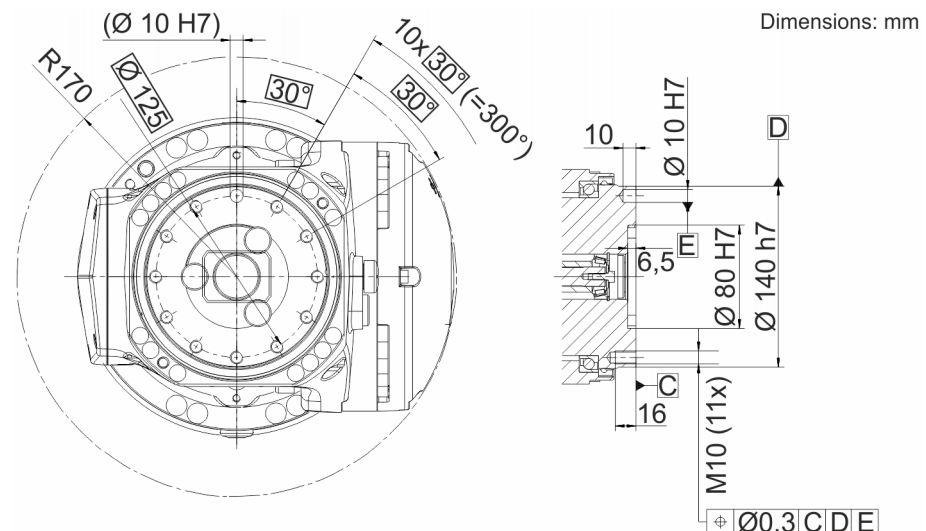


Fig. 4-21: Mounting flange D=125

Mounting flange D=160

Designation	Robot wrist type	Mounting flange
KR 120 R3500-2 P	ZH300	see drawing
KR 120 R3500-2 P-C		
KR 270 R3100-2 K		
KR 270 R3100-2 K-F	ZH300 F	
KR 210 R3300-2 K	ZH300	
KR 210 R3300-2 K-F	ZH300 F	

Mounting flange (hole circle)	160 mm
Screw grade	10.9

Screw size	M10
Number of fastening threads	11
Depth of engagement	min. 15 mm, max. 19 mm
Locating element	10 H7
Standard	See diagram (>>> Fig. 4-22)

The mounting flange is depicted (>>> [Fig. 4-22](#)) 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.

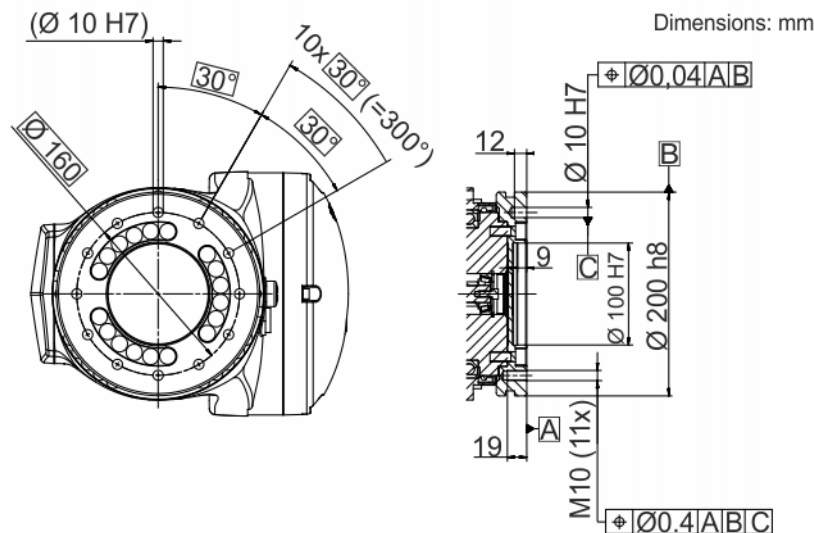


Fig. 4-22: Mounting flange D=160

Flange loads

Due to the motion of the payload (e.g. tool) mounted on the robot, forces and torques act on the mounting flange. These forces and torques depend on the motion profile as well as the mass, load center of gravity and mass moment of inertia of the payload.

The specified values refer to nominal payloads and do not include safety factors. It is imperative for the load data to be entered in the robot controller. The robot controller takes the payload into consideration during path planning. A reduced payload does not necessarily result in lower forces and torques.

The values are guide values determined by means of trial and simulation and refer to the most heavily loaded machine in the robot family. The actual forces and torques may differ due to internal and external influences on the mounting flange or a different point of application. It is therefore advisable to determine the exact forces and torques where necessary on site under the real conditions of the actual robot application.

The operating values may occur permanently in the normal motion profile. It is advisable to rate the tool for its fatigue strength.

The EMERGENCY STOP values may arise in the event of an Emergency Stop situation of the robot. As these should only occur very rarely during the service life of the robot, a static strength verification is usually sufficient.

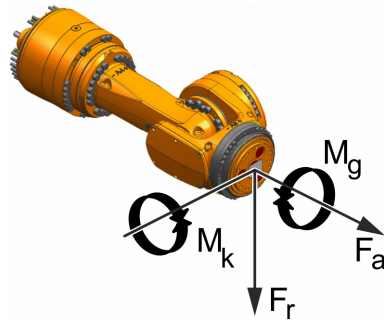


Fig. 4-23: Flange loads

Axial force $F(a)$, radial force $F(r)$

Flange loads during operation		Flange loads in the case of EMERGENCY STOP	
$F(a)$	$F(r)$	$F(a)$	$F(r)$
KR 120 R3500-2 P			
2550 N	2550 N	4700 N	6200 N
KR 120 R3500-2 P-C			
2550 N	2550 N	4700 N	6200 N
KR 120 R3900-2 K			
3900 N	3300 N	5400 N	8300 N
KR 180 R3500-2 K			
3900 N	3300 N	5400 N	8300 N
KR 180 R3500-2 K-F			
3900 N	3300 N	5400 N	8300 N
KR 210 R3300-2 K			
5500 N	5000 N	8000 N	10800 N
KR 210 R3300-2 K-F			
5500 N	5000 N	8000 N	10800 N
KR 270 R3100-2 K			
5500 N	5000 N	8000 N	10800 N
KR 270 R3100-2 K-F			
5500 N	5000 N	8000 N	10800 N

Tilting torque $M(k)$, torque about mounting flange $M(g)$

Flange loads during operation		Flange loads in the case of EMERGENCY STOP	
$M(k)$	$M(g)$	$M(k)$	$M(g)$
KR 120 R3500-2 P			
2900 Nm	1600 Nm	7150 Nm	5550 Nm
KR 120 R3500-2 P-C			
2900 Nm	1600 Nm	7150 Nm	5550 Nm
KR 120 R3900-2 K			
2200 Nm	1000 Nm	5300 Nm	4300 Nm
KR 180 R3500-2 K			

Flange loads during operation		Flange loads in the case of EMERGENCY STOP	
M(k)	M(g)	M(k)	M(g)
2200 Nm	1000 Nm	5300 Nm	4300 Nm
KR 180 R3500-2 K-F			
2200 Nm	1000 Nm	5300 Nm	4300 Nm
KR 210 R3300-2 K			
2800 Nm	1700 Nm	6200 Nm	5300 Nm
KR 210 R3300-2 K-F			
2800 Nm	1700 Nm	6200 Nm	5300 Nm
KR 270 R3100-2 K			
2800 Nm	1700 Nm	6200 Nm	5300 Nm
KR 270 R3100-2 K-F			
2800 Nm	1700 Nm	6200 Nm	5300 Nm

Supplementary load

The robot can carry supplementary loads on the rotating column, link arm, arm and in-line wrist. 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 diagrams.

Supplementary load, KR 120 R3500-2 P

Dimensions: mm

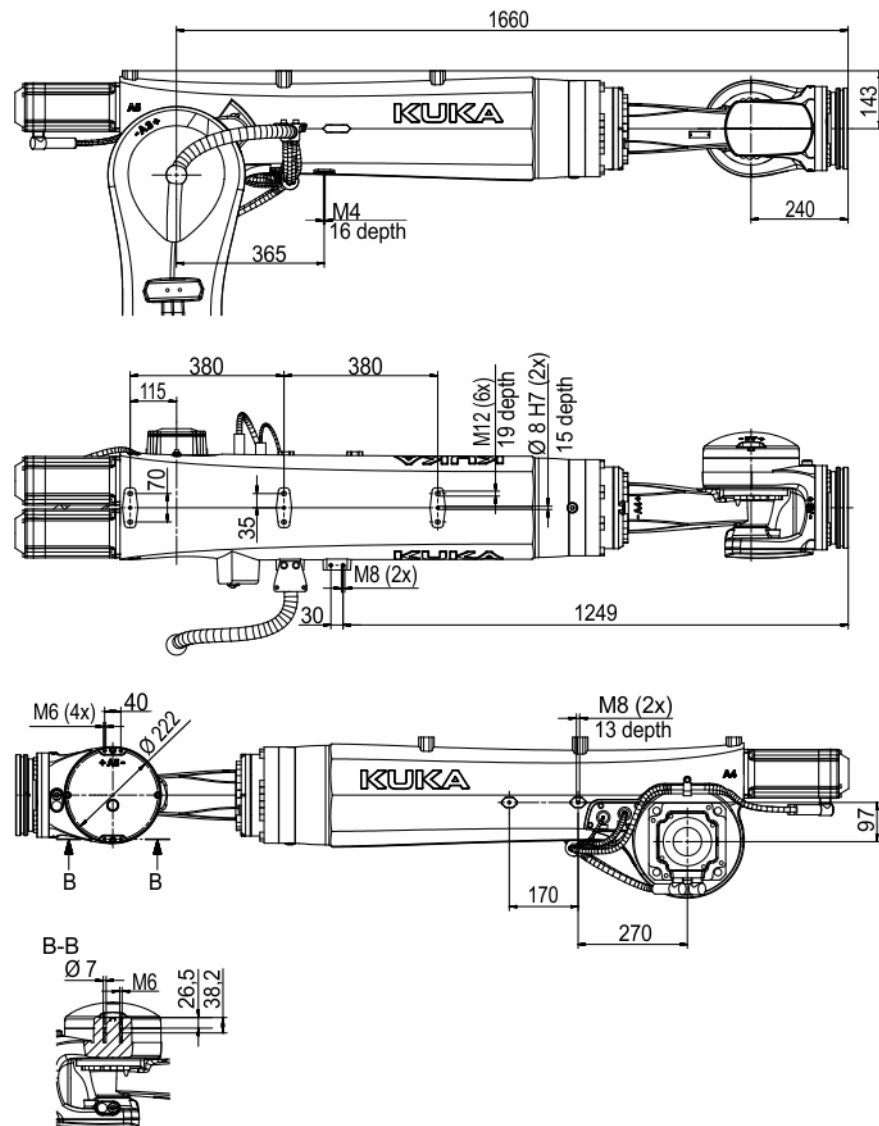


Fig. 4-24: Fastening of supplementary load, arm/in-line wrist, KR 120 R3500-2 P

Dimensions: mm

Technical data

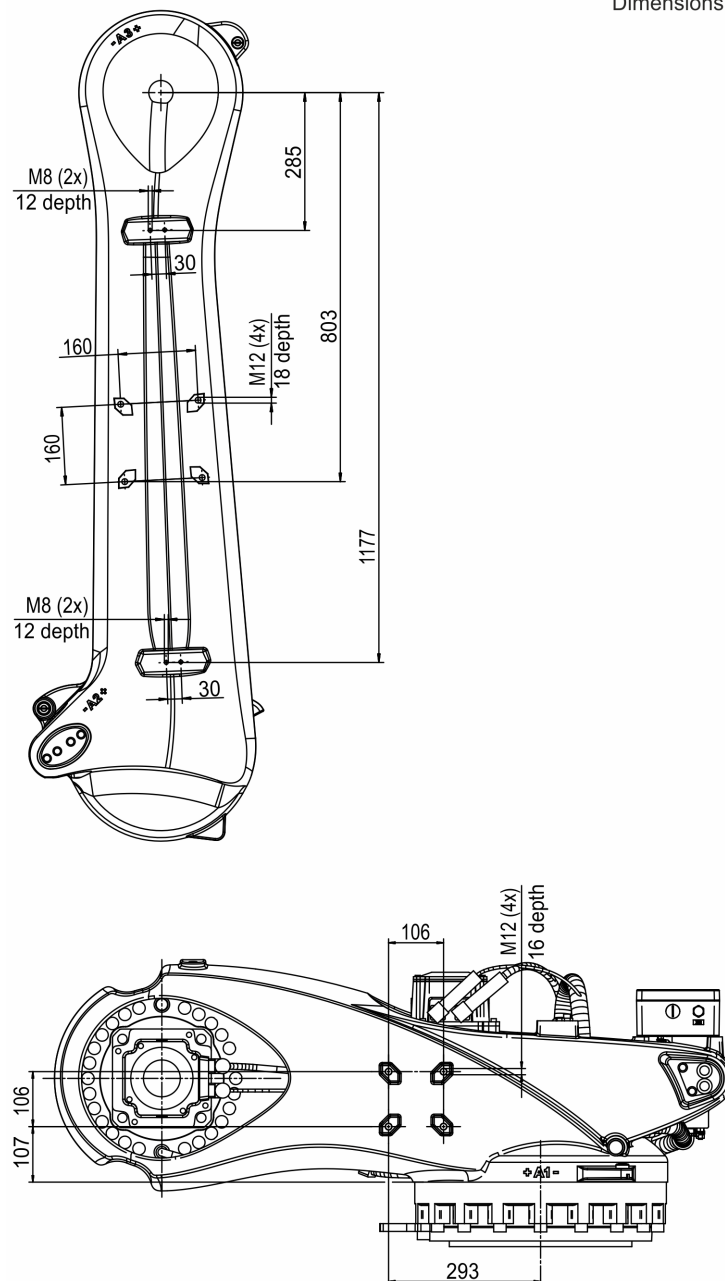


Fig. 4-25: Fastening of supplementary load on rotating column/link arm, KR 120 R3500-2 P

Supplementary load, KR 120 R3500-2 P-C

Dimensions: mm

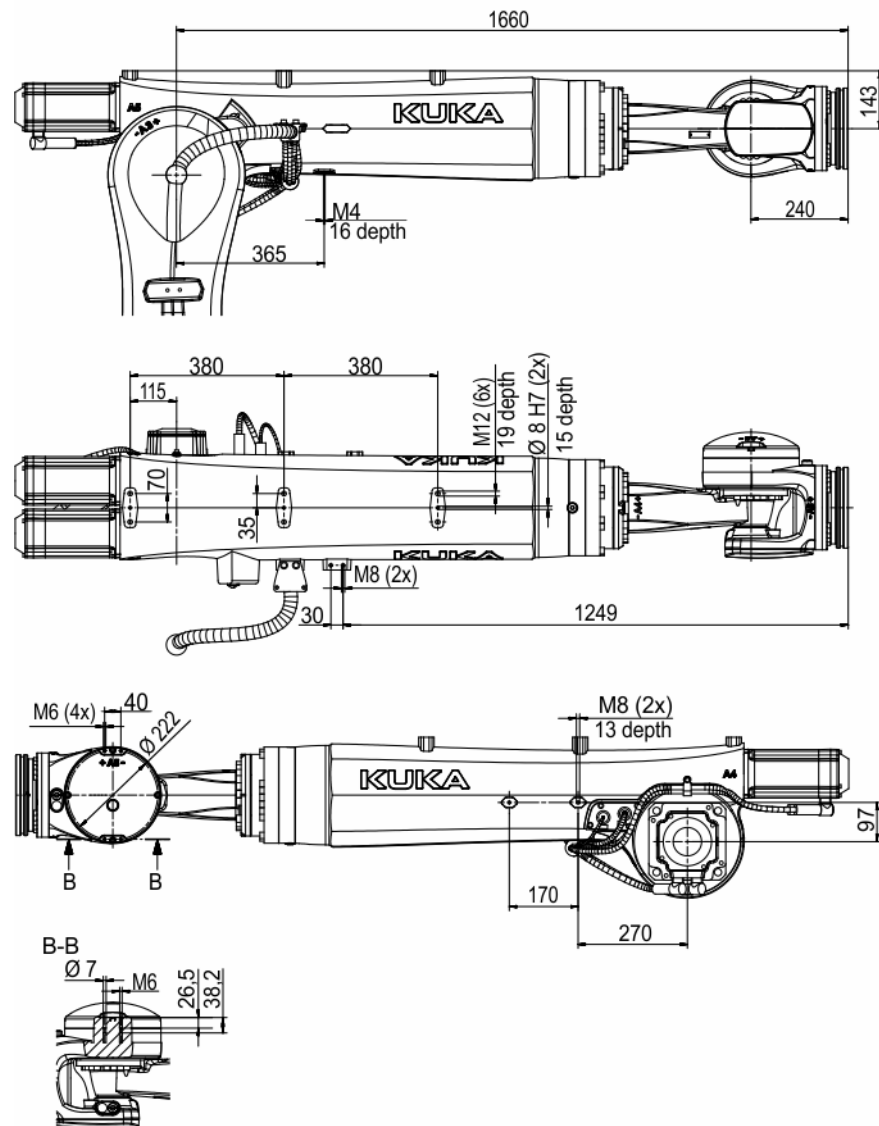


Fig. 4-26: Fastening of supplementary load, arm/in-line wrist, KR 120 R3500-2 P-C

Dimensions: mm

Technical data

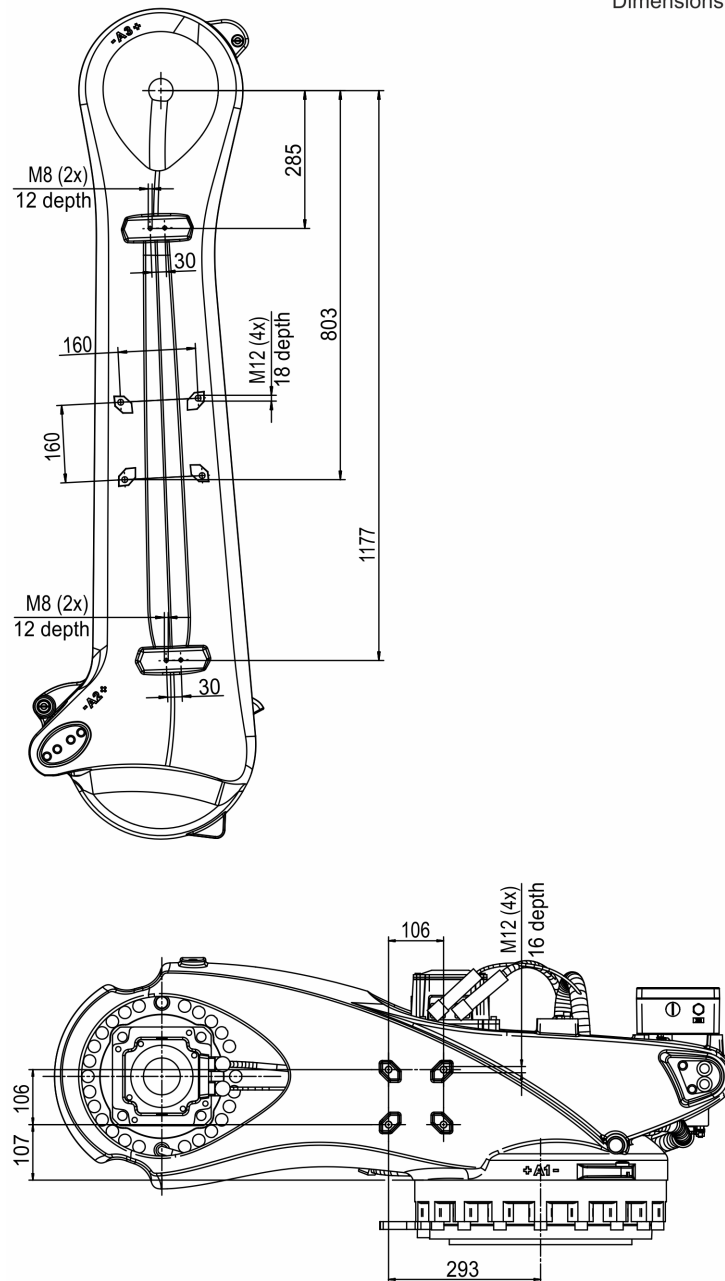


Fig. 4-27: Fastening of supplementary load on rotating column/link arm, KR 120 R3500-2 P-C

Supplementary load, KR 120 R3900-2 K

Dimensions: mm

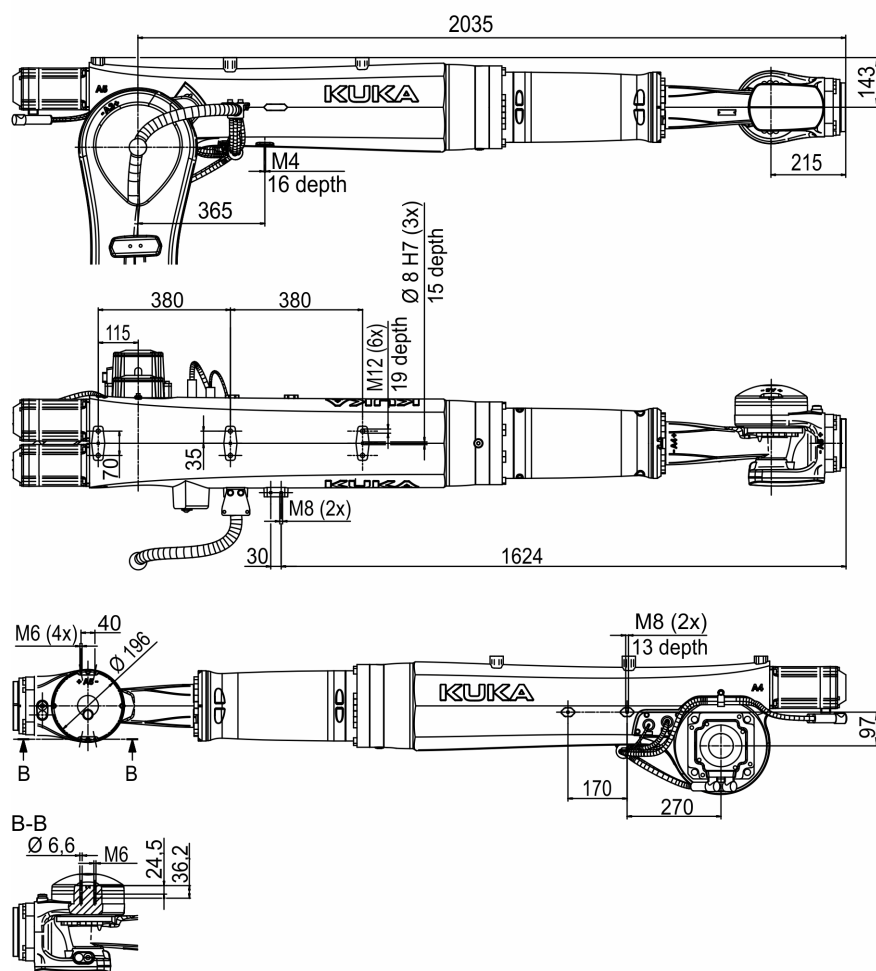


Fig. 4-28: Fastening of supplementary load, arm/in-line wrist, KR 120 R3900-2 K

Dimensions: mm

Technical data

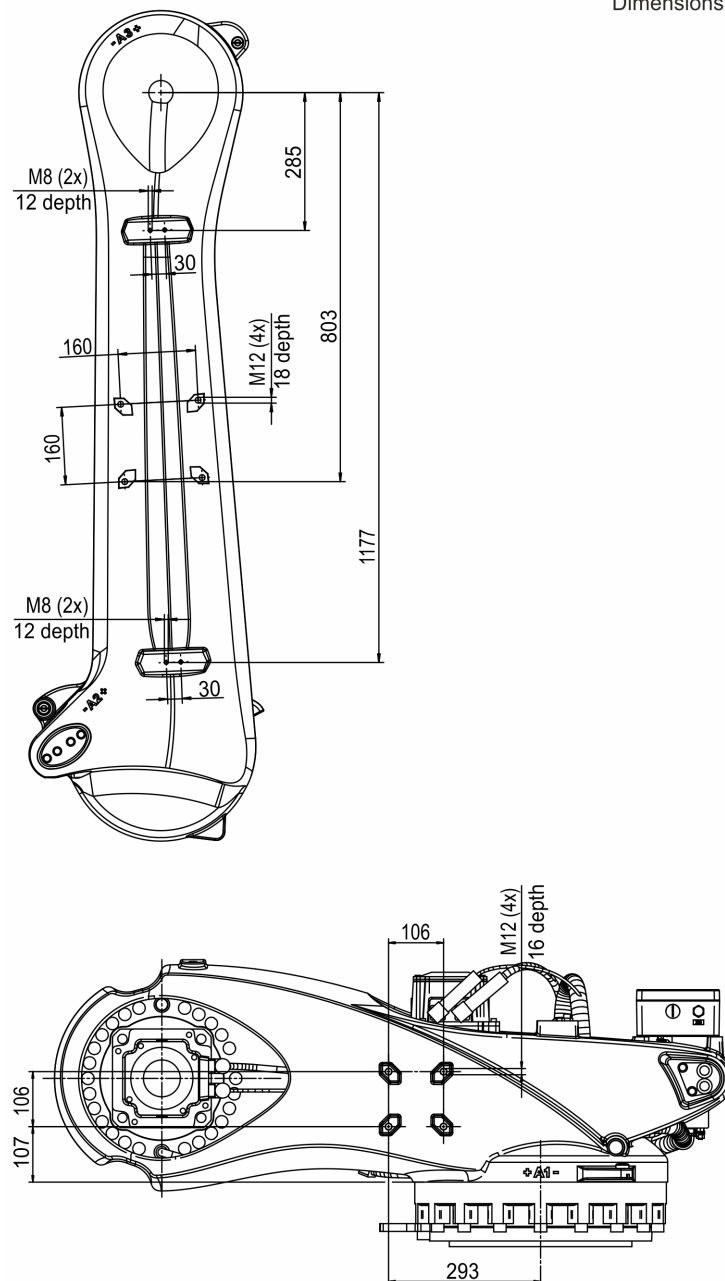


Fig. 4-29: Fastening of supplementary load on rotating column/link arm, KR 120 R3900-2 K

Supplementary load, KR 180 R3500-2 K

Dimensions: mm

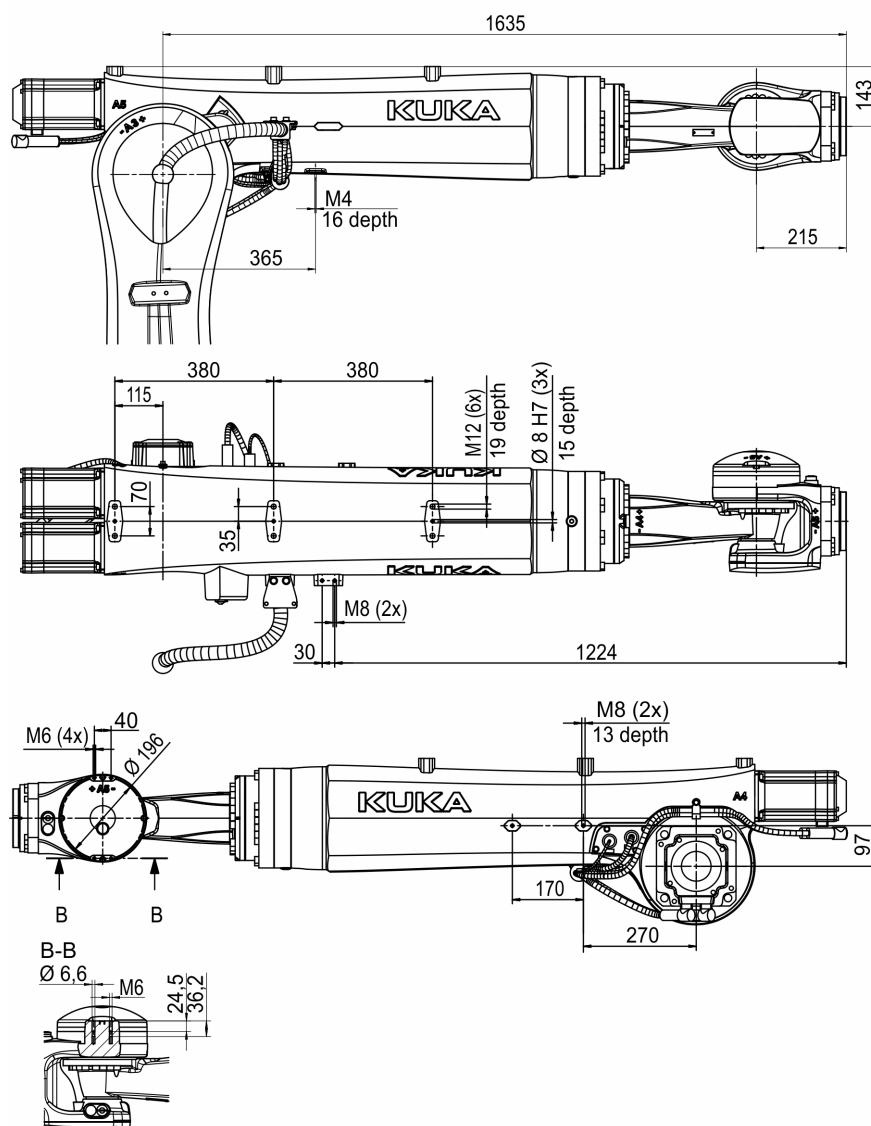


Fig. 4-30: Fastening of supplementary load, arm/in-line wrist, KR 180 R3500-2 K

Dimensions: mm

Technical data

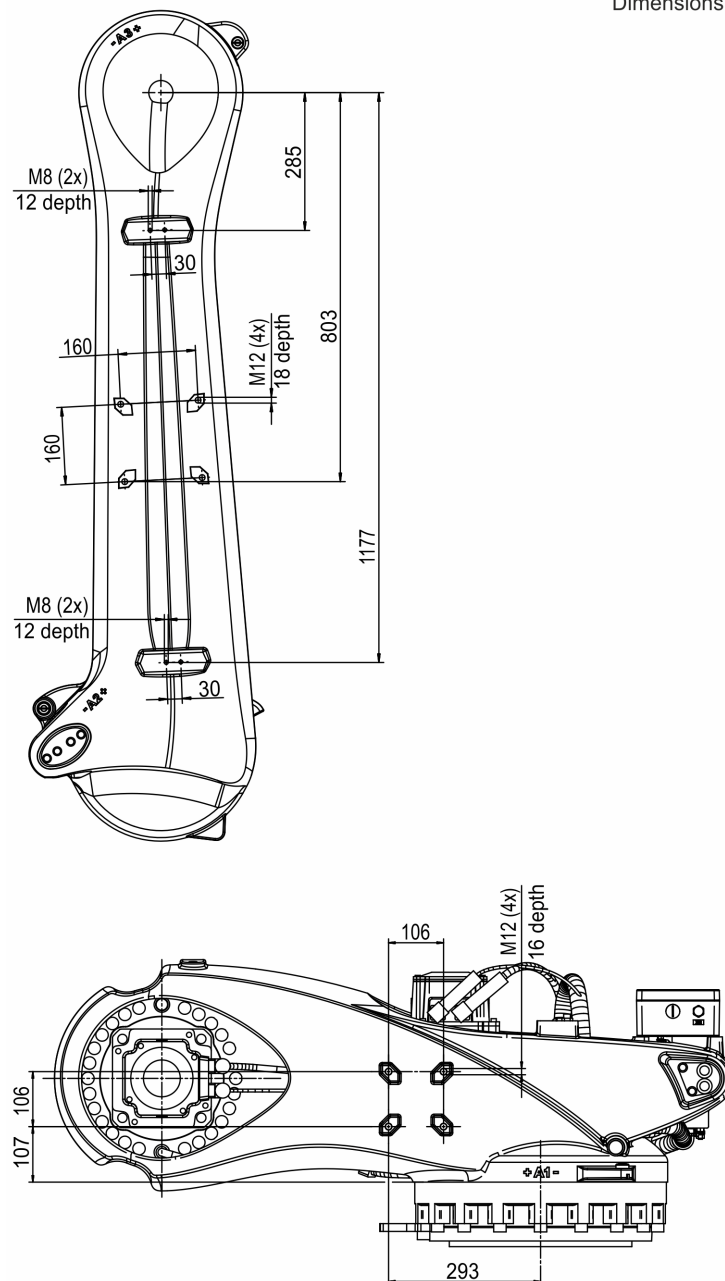


Fig. 4-31: Fastening of supplementary load on rotating column/link arm, KR 180 R3500-2 K

Supplementary load, KR 180 R3500-2 K-F

Dimensions: mm

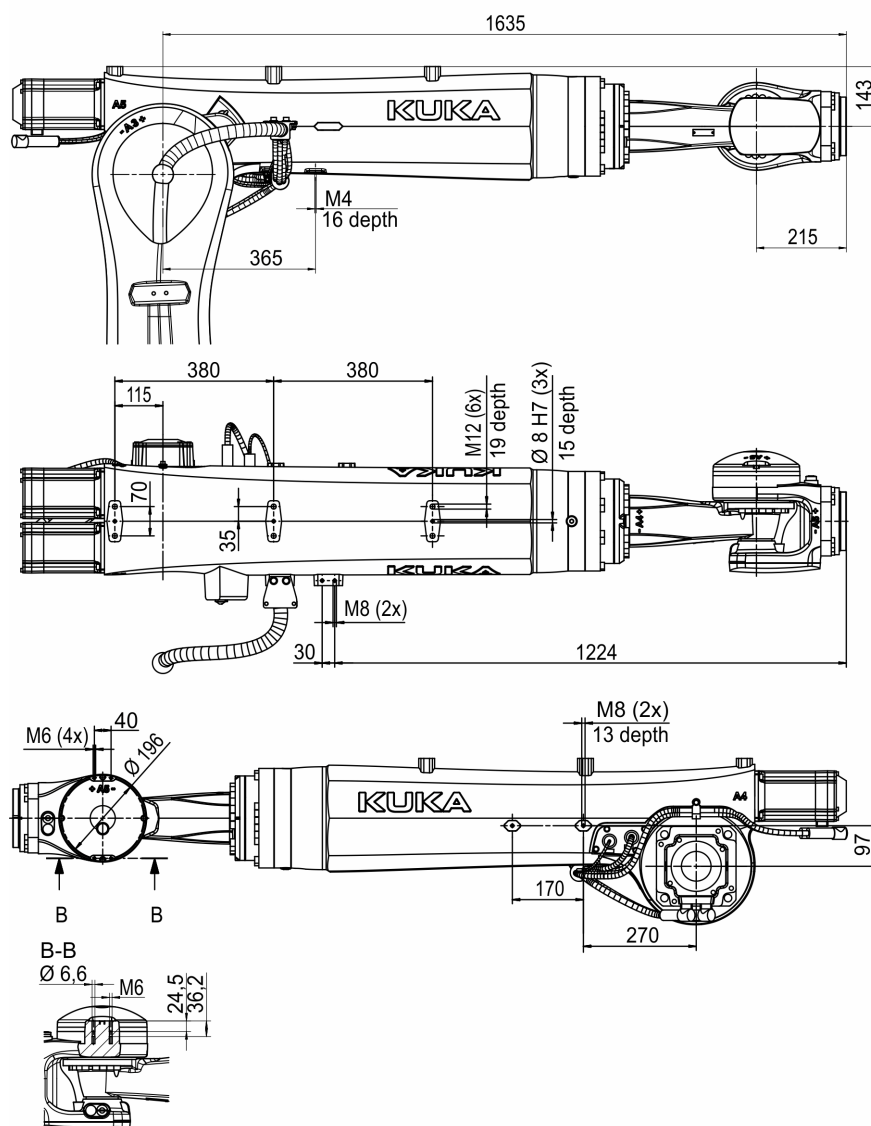


Fig. 4-32: Fastening of supplementary load, arm/in-line wrist, KR 180 R3500-2 K-F

Dimensions: mm

Technical data

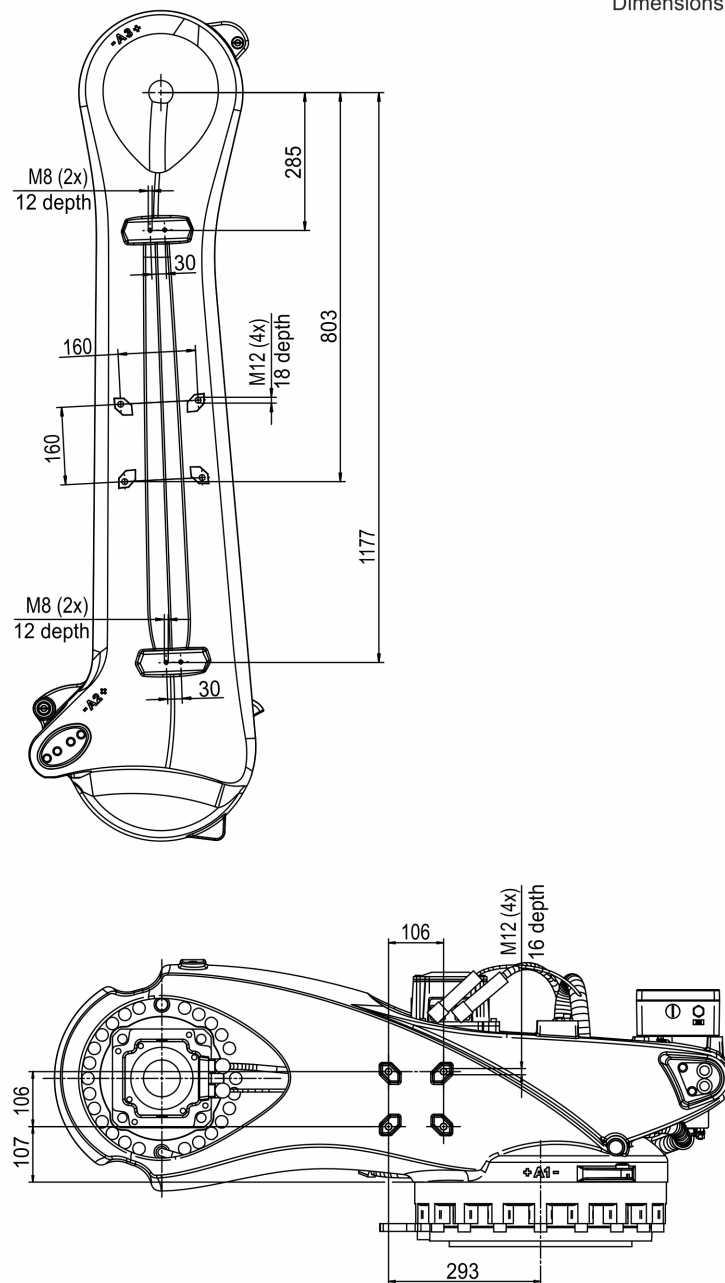


Fig. 4-33: Fastening of supplementary load on rotating column/link arm, KR 180 R3500-2 K-F

Supplementary load, KR 210 R3300-2 K

Dimensions: mm

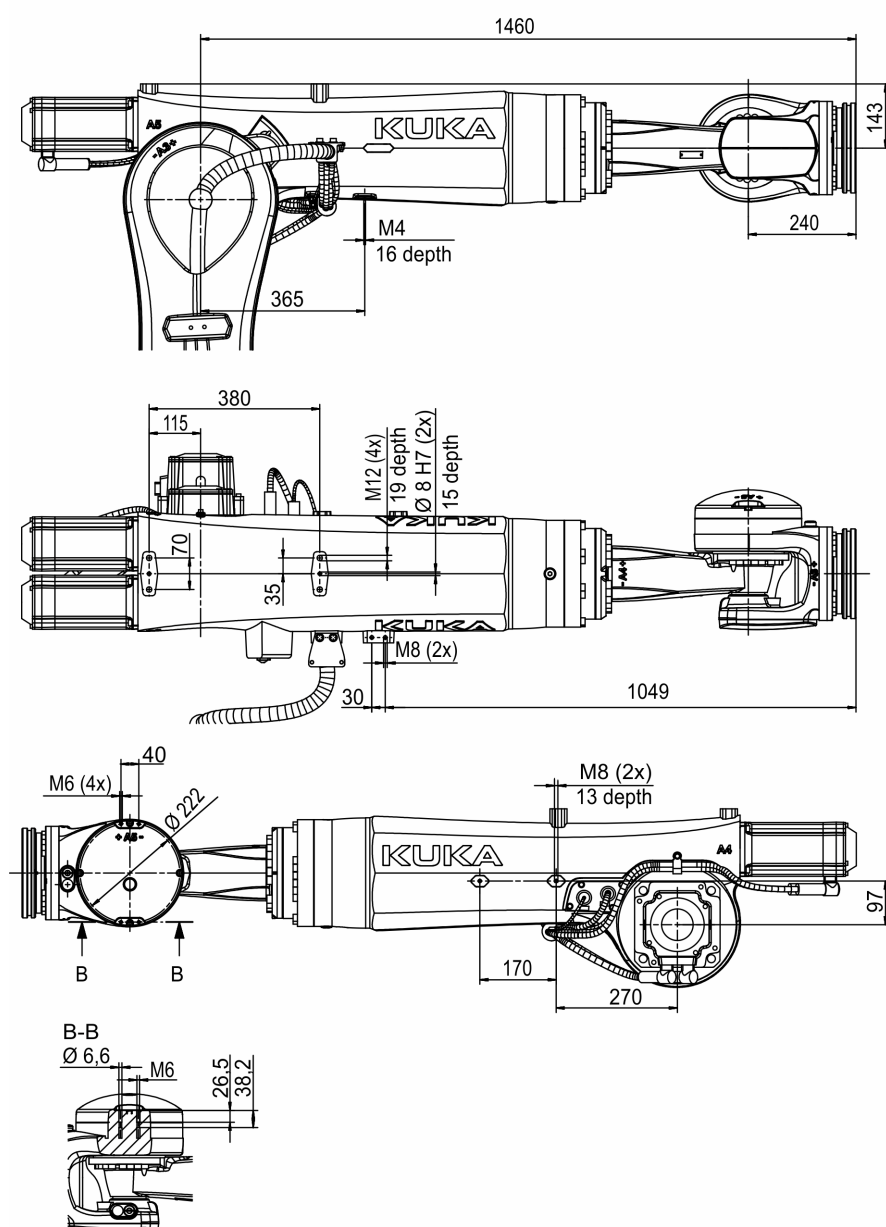


Fig. 4-34: Fastening of supplementary load, arm/in-line wrist, KR 210 R3300-2 K

Dimensions: mm

Technical data

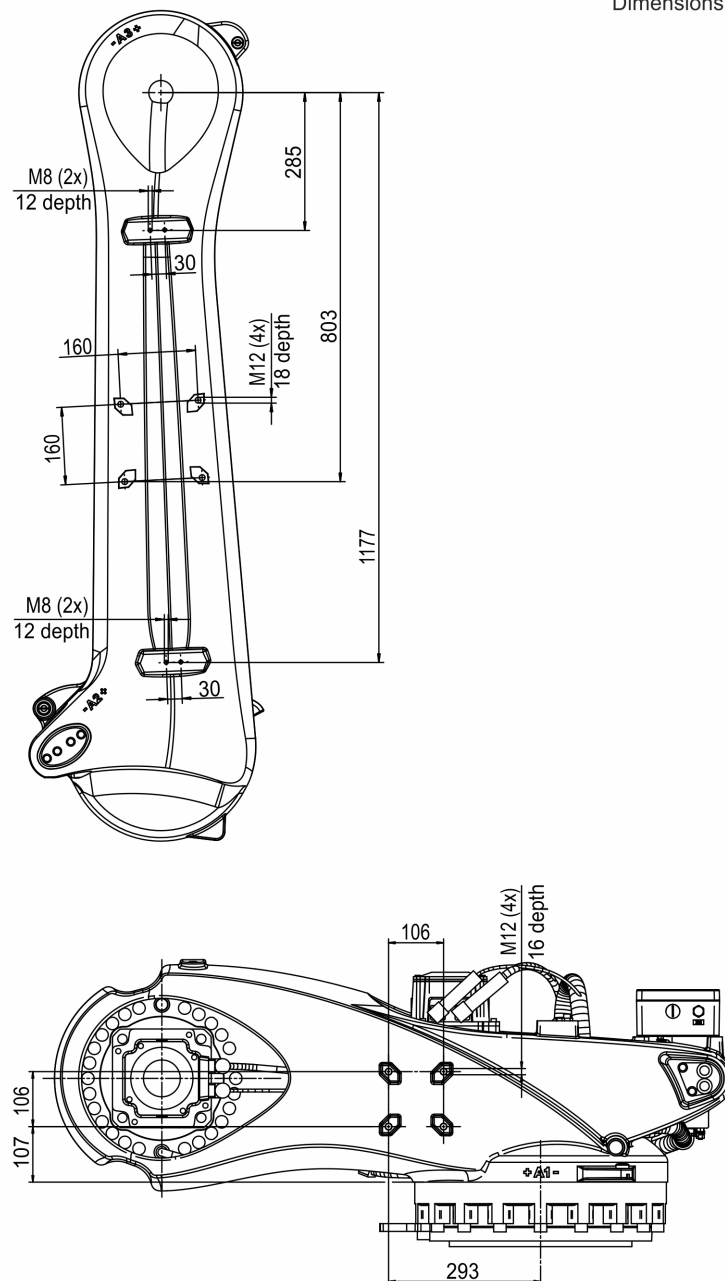


Fig. 4-35: Fastening of supplementary load on rotating column/link arm, KR 210 R3300-2 K

Supplementary load, KR 210 R3300-2 K-F

Dimensions: mm

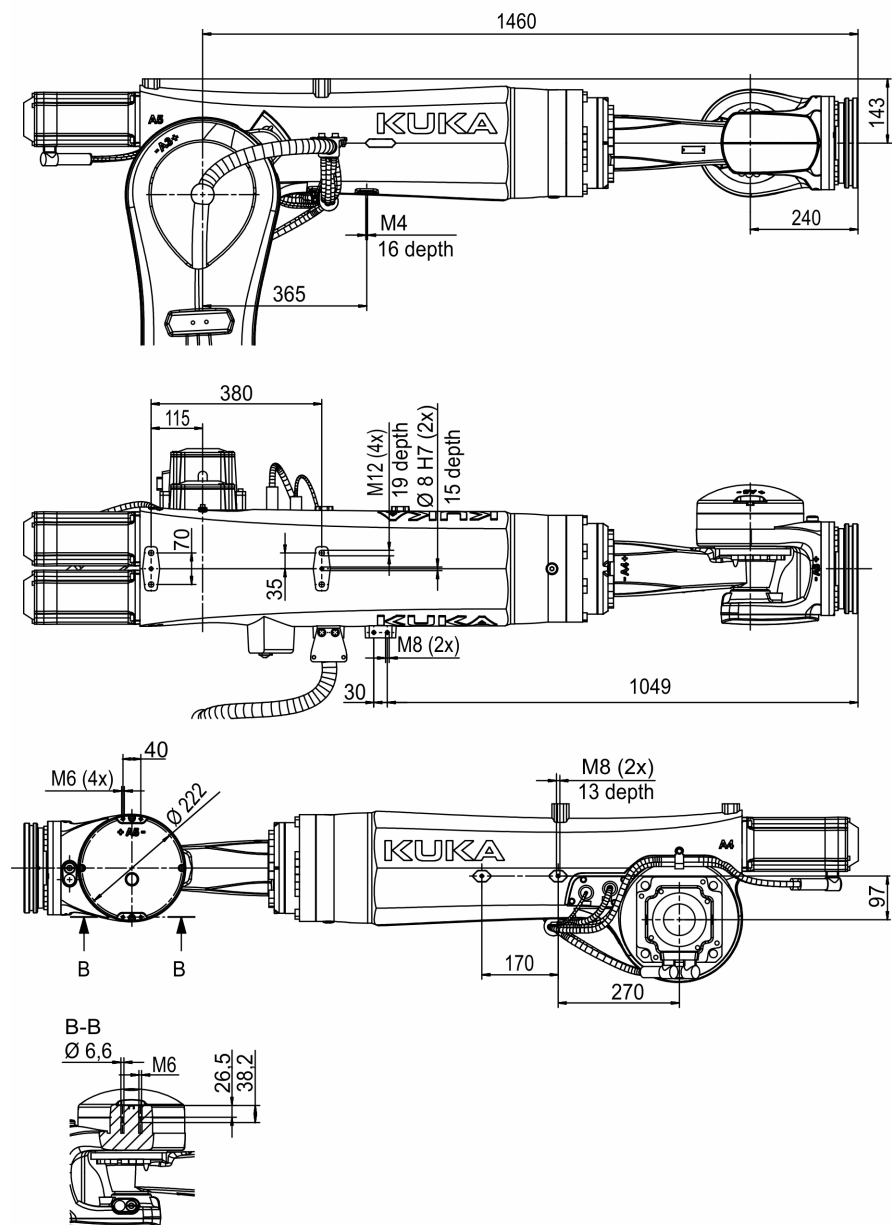


Fig. 4-36: Fastening of supplementary load, arm/in-line wrist, KR 210 R3300-2 K-F

Dimensions: mm

Technical data

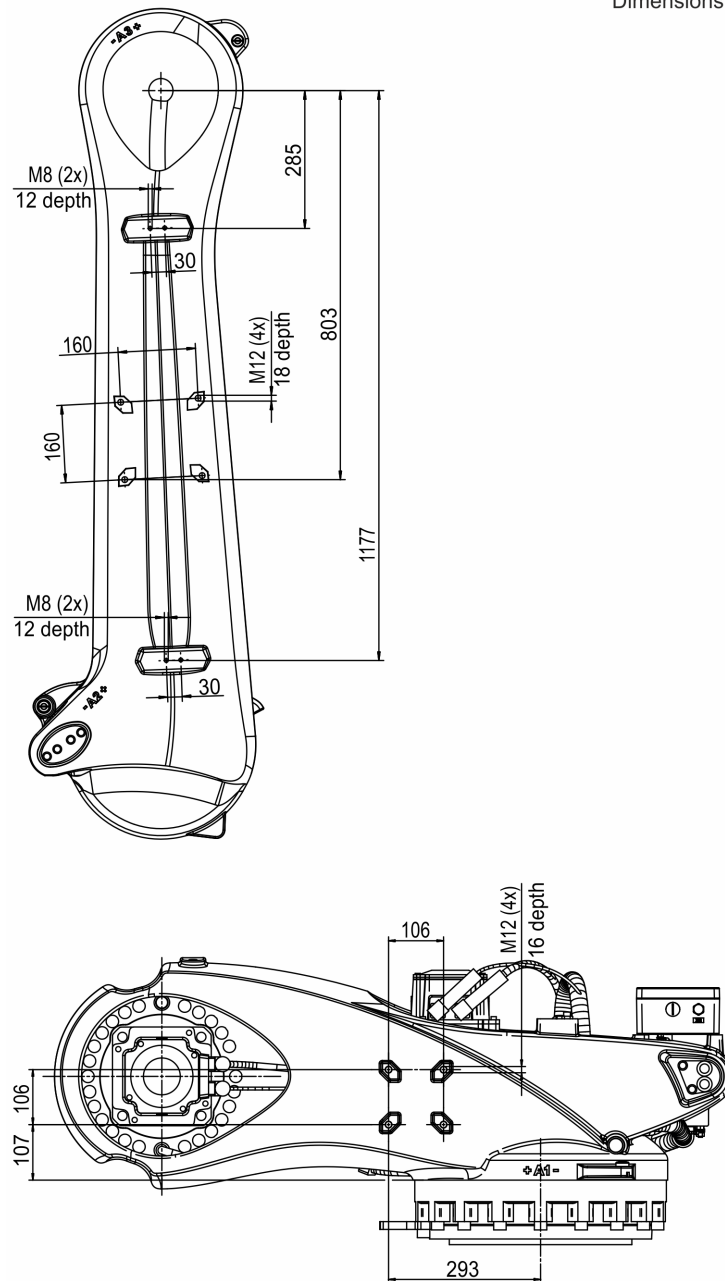


Fig. 4-37: Fastening of supplementary load on rotating column/link arm, KR 210 R3300-2 K-F

Supplementary load, KR 270 R3100-2 K

Dimensions: mm

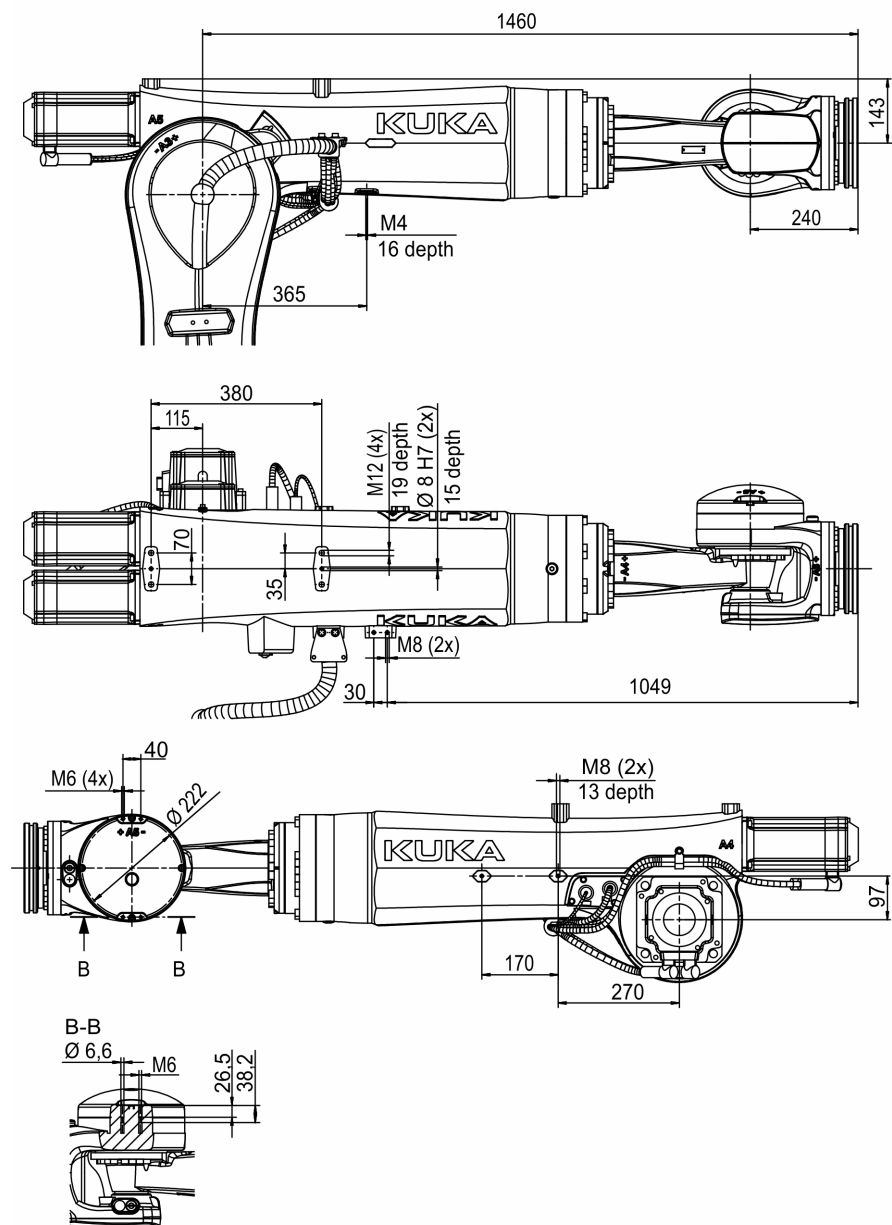


Fig. 4-38: Fastening of supplementary load, arm/in-line wrist, KR 270 R3100-2 K

Dimensions: mm

Technical data

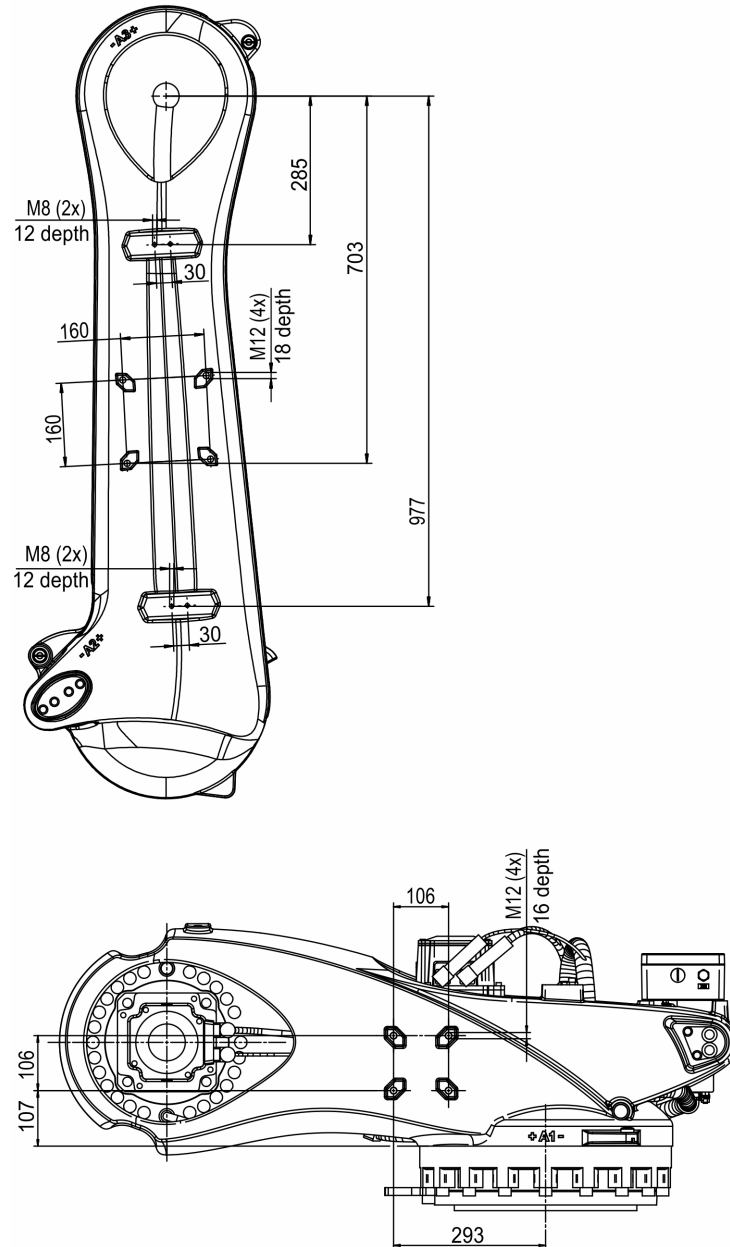


Fig. 4-39: Fastening of supplementary load on rotating column/link arm, KR 270 R3100-2 K

Supplementary load, KR 270 R3100-2 K-F

Dimensions: mm

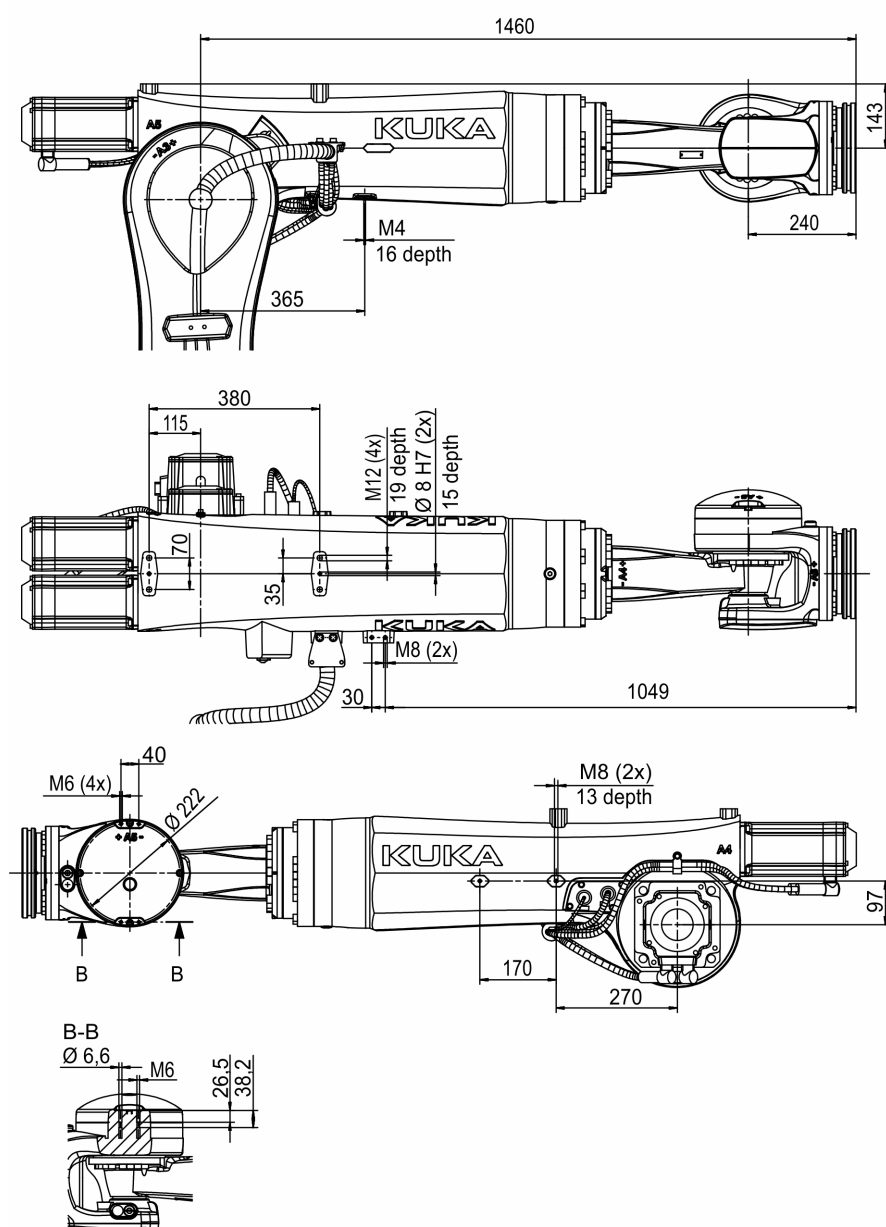


Fig. 4-40: Fastening of supplementary load, arm/in-line wrist, KR 270 R3100-2 K-F

Dimensions: mm

Technical data

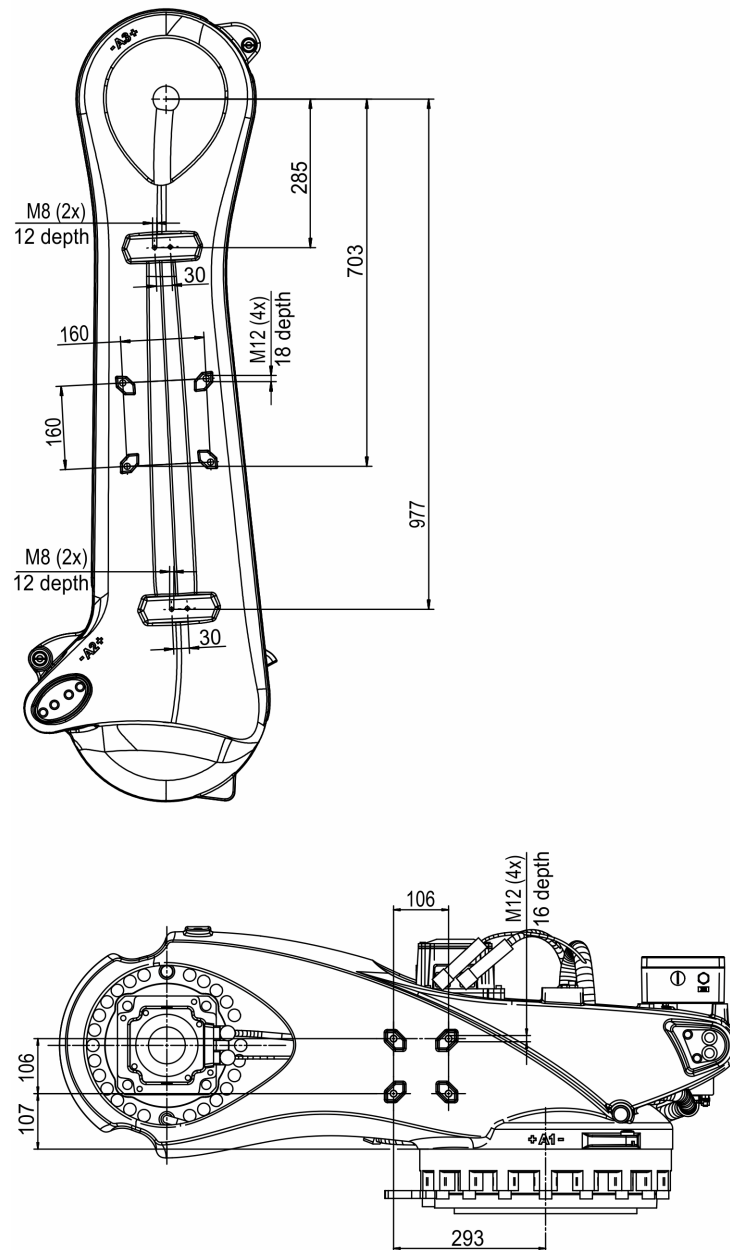


Fig. 4-41: Fastening of supplementary load on rotating column/link arm, KR 270 R3100-2 K-F

4.4 Foundation loads overview

Illustration, standard

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

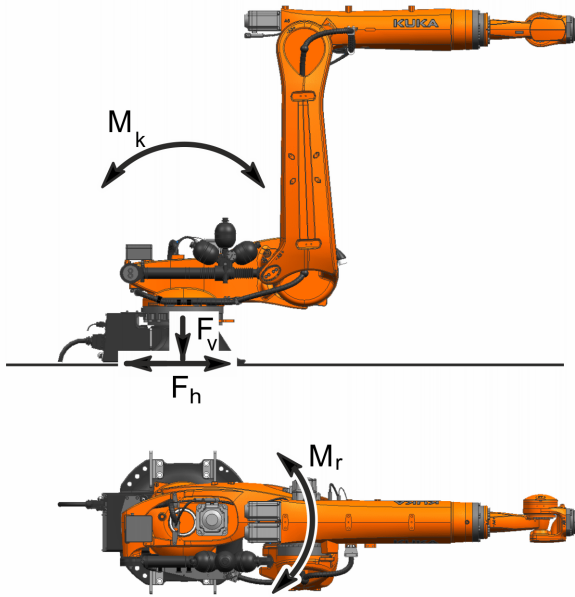


Fig. 4-42: Foundation loads

Illustration, ceiling-mounted robot

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

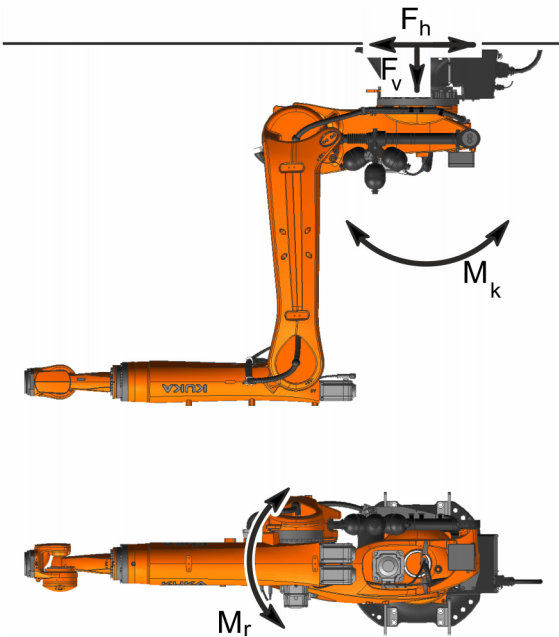


Fig. 4-43: Foundation loads

Vertical force F(v)

Vertical force F(v)	
Vertical force (normal)	Vertical force (maximum)
Designation: KR 120 R3500-2 P	
18750 N	22250 N
Designation: KR 120 R3500-2 P-C	
18750 N	22250 N
Designation: KR 120 R3900-2 K	

Vertical force F(v)	
Vertical force (normal)	Vertical force (maximum)
21100 N	25700 N
Designation: KR 180 R3500-2 K	
21100 N	25700 N
Designation: KR 180 R3500-2 K-F	
21100 N	25700 N
Designation: KR 210 R3300-2 K	
21100 N	25700 N
Designation: KR 210 R3300-2 K-F	
21100 N	25700 N
Designation: KR 270 R3100-2 K	
21100 N	25700 N
Designation: KR 270 R3100-2 K-F	
21100 N	25700 N

Horizontal force F(h)

Horizontal force F(h)	
Horizontal force (normal)	Horizontal force (maximum)
Designation: KR 120 R3500-2 P	
6750 N	18750 N
Designation: KR 120 R3500-2 P-C	
6750 N	18750 N
Designation: KR 120 R3900-2 K	
8200 N	19900 N
Designation: KR 180 R3500-2 K	
8200 N	19900 N
Designation: KR 180 R3500-2 K-F	
8200 N	19900 N
Designation: KR 210 R3300-2 K	
8200 N	19900 N
Designation: KR 210 R3300-2 K-F	
8200 N	19900 N
Designation: KR 270 R3100-2 K	
8200 N	19900 N
Designation: KR 270 R3100-2 K-F	
8200 N	19900 N

Tilting torque M(k)

Tilting moment M(k)	
Tilting moment (normal)	Tilting moment (maximum)
Designation: KR 120 R3500-2 P	
26250 Nm	46000 Nm

Tilting moment M(k)	
Tilting moment (normal)	Tilting moment (maximum)
Designation: KR 120 R3500-2 P-C	
26250 Nm	46000 Nm
Designation: KR 120 R3900-2 K	
28000 Nm	44300 Nm
Designation: KR 180 R3500-2 K	
28000 Nm	44300 Nm
Designation: KR 180 R3500-2 K-F	
28000 Nm	44300 Nm
Designation: KR 210 R3300-2 K	
28000 Nm	44300 Nm
Designation: KR 210 R3300-2 K-F	
28000 Nm	44300 Nm
Designation: KR 270 R3100-2 K	
28000 Nm	44300 Nm
Designation: KR 270 R3100-2 K-F	
28000 Nm	44300 Nm

Torque M(r)

Torque about axis 1 M(r)	
Torque about axis 1 (normal)	Torque about axis 1 (maximum)
KR 120 R3500-2 P	
11500 Nm	23000 Nm
KR 120 R3500-2 P-C	
11500 Nm	23000 Nm
KR 120 R3900-2 K	
11300 Nm	18600 Nm
KR 180 R3500-2 K	
11300 Nm	18600 Nm
KR 180 R3500-2 K-F	
11300 Nm	18600 Nm
KR 210 R3300-2 K	
11300 Nm	18600 Nm
KR 210 R3300-2 K-F	
11300 Nm	18600 Nm
KR 270 R3100-2 K	
11300 Nm	18600 Nm
KR 270 R3100-2 K-F	
11300 Nm	18600 Nm

**WARNING**

Normal loads and maximum loads for the foundations are specified in the table.

The maximum loads must be referred to when dimensioning the foundations and must be adhered to for safety reasons. Failure to observe this can result in personal injury and damage to property.

The normal loads are average expected foundation loads. The actual loads are dependent on the program and on the robot loads and may therefore be greater or less than the normal loads.

The supplementary loads (A1 and A2) are not taken into consideration in the calculation of the mounting base load. These supplementary loads must be taken into consideration for F_v .

4.5 Plates and labels

Plates and labels

The following plates and labels (>>> [Fig. 4-44](#)) are attached to the robot. They must not be removed or rendered illegible. Illegible plates and labels must be replaced.

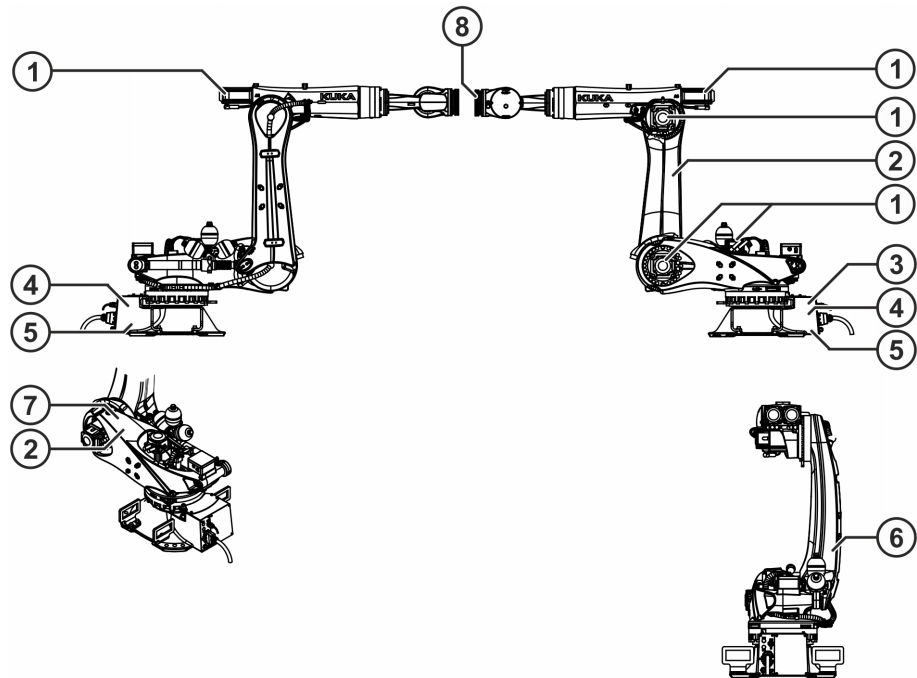


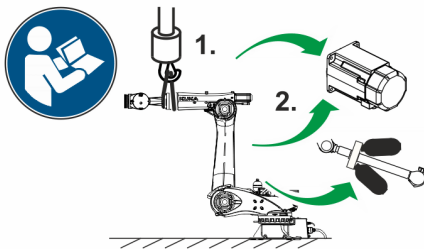
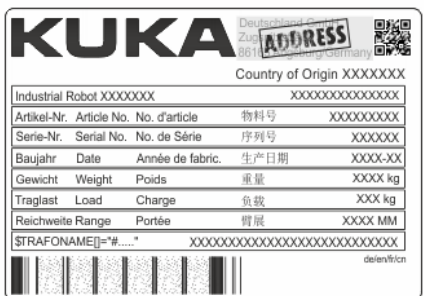



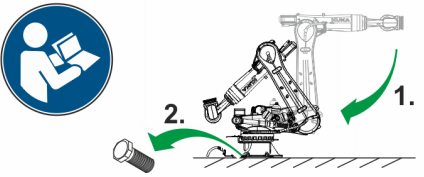
Fig. 4-44: Location of plates and labels

Item	Description
1	 <p>Hot surface During operation of the robot, surface temperatures may be reached that could result in burn injuries. Protective gloves must be worn!</p>

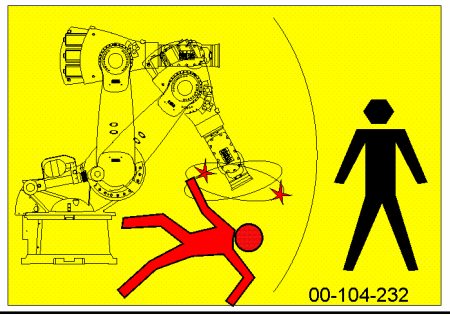

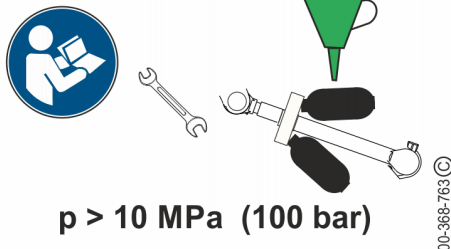

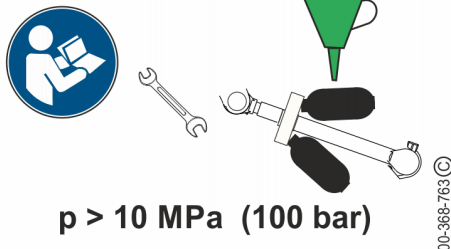

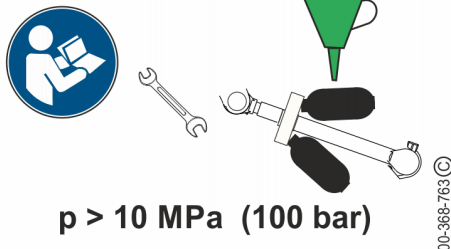

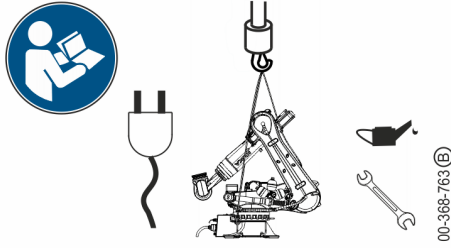

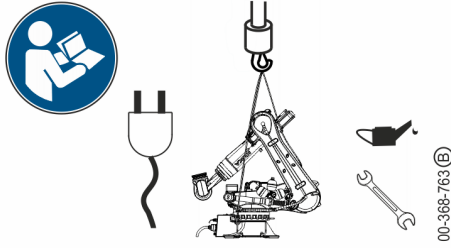

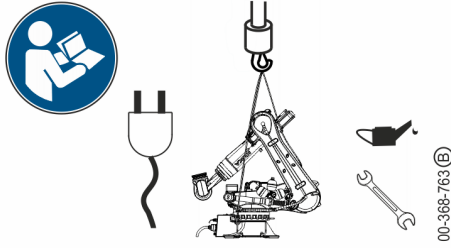
2		 <p>00-368-763 (E)</p>
	⚠ CAUTION	Before removing the motor or counter-balancing system, secure robot axis to prevent it from moving!
	⚠ ATTENTION	Avant de retirer le moteur ou le système d'équilibrage, protéger l'axe du robot pour éviter tout mouvement!
	⚠ VORSICHT	Vor Entfernen des Motors oder des Gewichtsausgleichs, Roboterachse gegen Bewegungen sichern!

Secure the axes
Before exchanging any motor, secure the corresponding axis through safeguarding by suitable means/devices to protect against possible movement. The axis can move. Risk of crushing!

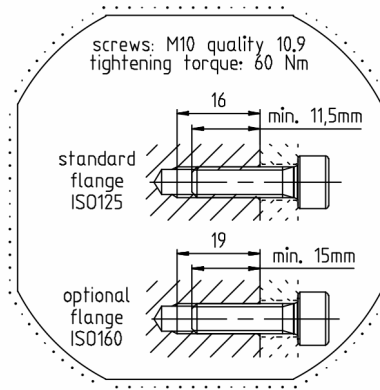
3		<p>Identification plate example Content according to Machinery Directive.</p> <p>The QR code contains a link to product information in KUKA Xpert.</p>
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4		 <p>00-368-763 (A)</p> <table> <tr> <th>A1</th><th>A2</th><th>A3</th><th>A4</th><th>A5</th><th>A6</th></tr> <tr> <td>0°</td><td>-115°</td><td>-108°</td><td>0°</td><td>+115°</td><td>0°</td></tr> </table>	A1	A2	A3	A4	A5	A6	0°	-115°	-108°	0°	+115°	0°
A1	A2	A3	A4	A5	A6									
0°	-115°	-108°	0°	+115°	0°									
	⚠ CAUTION	Move the robot into its transport position before removing the mounting base!												
	⚠ ATTENTION	Amener le robot en position de transport avant de défaire la fixation aux fondations!												
	⚠ VORSICHT	Roboter vor Lösen der Fundamentbefestigung in Transportstellung bringen!												

Transport position
Before loosening the bolts of the mounting base, the robot must be in the transport position as indicated in the table. Risk of toppling!

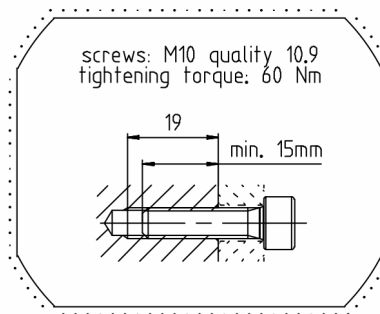
5	 <p>Danger zone Entering the danger zone of the robot is prohibited if the robot is in operation or ready for operation. Risk of injury!</p>								
6	<table border="1"> <tr> <td data-bbox="587 611 879 891">  </td><td data-bbox="879 611 1374 891">  <p>p > 10 MPa (100 bar)</p> </td></tr> <tr> <td data-bbox="587 891 879 969"> ⚠ CAUTION </td><td data-bbox="879 891 1374 969"> Counterbalancing system pressurized – read and observe safety instructions before beginning work! </td></tr> <tr> <td data-bbox="587 969 879 1048"> ⚠ ATTENTION </td><td data-bbox="879 969 1374 1048"> Le système d'équilibrage est sous pression, lire et respecter les remarques relatives à la sécurité avant d'effectuer des travaux! </td></tr> <tr> <td data-bbox="587 1048 879 1104"> ⚠ VORSICHT </td><td data-bbox="879 1048 1374 1104"> Gewichtsausgleich unter Druck, vor Arbeiten Sicherheitshinweise lesen und beachten! </td></tr> </table> <p>Counterbalancing system The system is pressurized with oil and nitrogen. Read and follow the assembly and operating instructions before commencing work on the counterbalancing system. Risk of injury!</p>		 <p>p > 10 MPa (100 bar)</p>	⚠ CAUTION	Counterbalancing system pressurized – read and observe safety instructions before beginning work!	⚠ ATTENTION	Le système d'équilibrage est sous pression, lire et respecter les remarques relatives à la sécurité avant d'effectuer des travaux!	⚠ VORSICHT	Gewichtsausgleich unter Druck, vor Arbeiten Sicherheitshinweise lesen und beachten!
	 <p>p > 10 MPa (100 bar)</p>								
⚠ CAUTION	Counterbalancing system pressurized – read and observe safety instructions before beginning work!								
⚠ ATTENTION	Le système d'équilibrage est sous pression, lire et respecter les remarques relatives à la sécurité avant d'effectuer des travaux!								
⚠ VORSICHT	Gewichtsausgleich unter Druck, vor Arbeiten Sicherheitshinweise lesen und beachten!								
7	<table border="1"> <tr> <td data-bbox="587 1283 879 1563">  </td><td data-bbox="879 1283 1374 1563">  </td></tr> <tr> <td data-bbox="587 1563 879 1619"> ⚠ CAUTION </td><td data-bbox="879 1563 1374 1619"> Secure the system before beginning work on the robot. Read and observe the safety instructions! </td></tr> <tr> <td data-bbox="587 1619 879 1697"> ⚠ ATTENTION </td><td data-bbox="879 1619 1374 1697"> Bloquer le système avant d'effectuer des travaux sur le robot. Lire et respecter les remarques relatives à la sécurité! </td></tr> <tr> <td data-bbox="587 1697 879 1753"> ⚠ VORSICHT </td><td data-bbox="879 1697 1374 1753"> Vor Arbeiten am Roboter, System sichern. Sicherheitshinweise lesen und beachten! </td></tr> </table> <p>Work on the robot Before start-up, transportation or maintenance, read and follow the assembly and operating instructions.</p>			⚠ CAUTION	Secure the system before beginning work on the robot. Read and observe the safety instructions!	⚠ ATTENTION	Bloquer le système avant d'effectuer des travaux sur le robot. Lire et respecter les remarques relatives à la sécurité!	⚠ VORSICHT	Vor Arbeiten am Roboter, System sichern. Sicherheitshinweise lesen und beachten!
									
⚠ CAUTION	Secure the system before beginning work on the robot. Read and observe the safety instructions!								
⚠ ATTENTION	Bloquer le système avant d'effectuer des travaux sur le robot. Lire et respecter les remarques relatives à la sécurité!								
⚠ VORSICHT	Vor Arbeiten am Roboter, System sichern. Sicherheitshinweise lesen und beachten!								

8



Mounting flange on in-line wrist type IW210

The values specified on this plate apply for the installation of tools on the mounting flange of the wrist and must be observed.



Mounting flange on in-line wrist type IW300

The values specified on this plate apply for the installation of tools on the mounting flange of the wrist and must be observed.

4.6 REACH duty to communicate information acc. to Art. 33

As of June 2007, the Regulation (EC) 1907/2006 of the European Parliament and of the Council dated 18 December 2006 on the registration, evaluation and authorization of chemicals (REACH Regulation) is in force. Detailed REACH information can be found in the product information in KUKA Xpert.

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 stops triggered. It is therefore advisable to check the stopping distance at least once a year.

4.7.2 Stopping distances and times, KR 120 R3500-2 P and KR 120 R3500-2 P-C

4.7.2.1 Stopping distances and stopping times, STOP 0, A1 to A3

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	
A1	25.66 °
A2	24.64 °
A3	19.09 °
Stopping time	
A1	0.70 s
A2	0.52 s
A3	0.35 s

4.7.2.2 Stopping distances and stopping times, STOP 1, A1

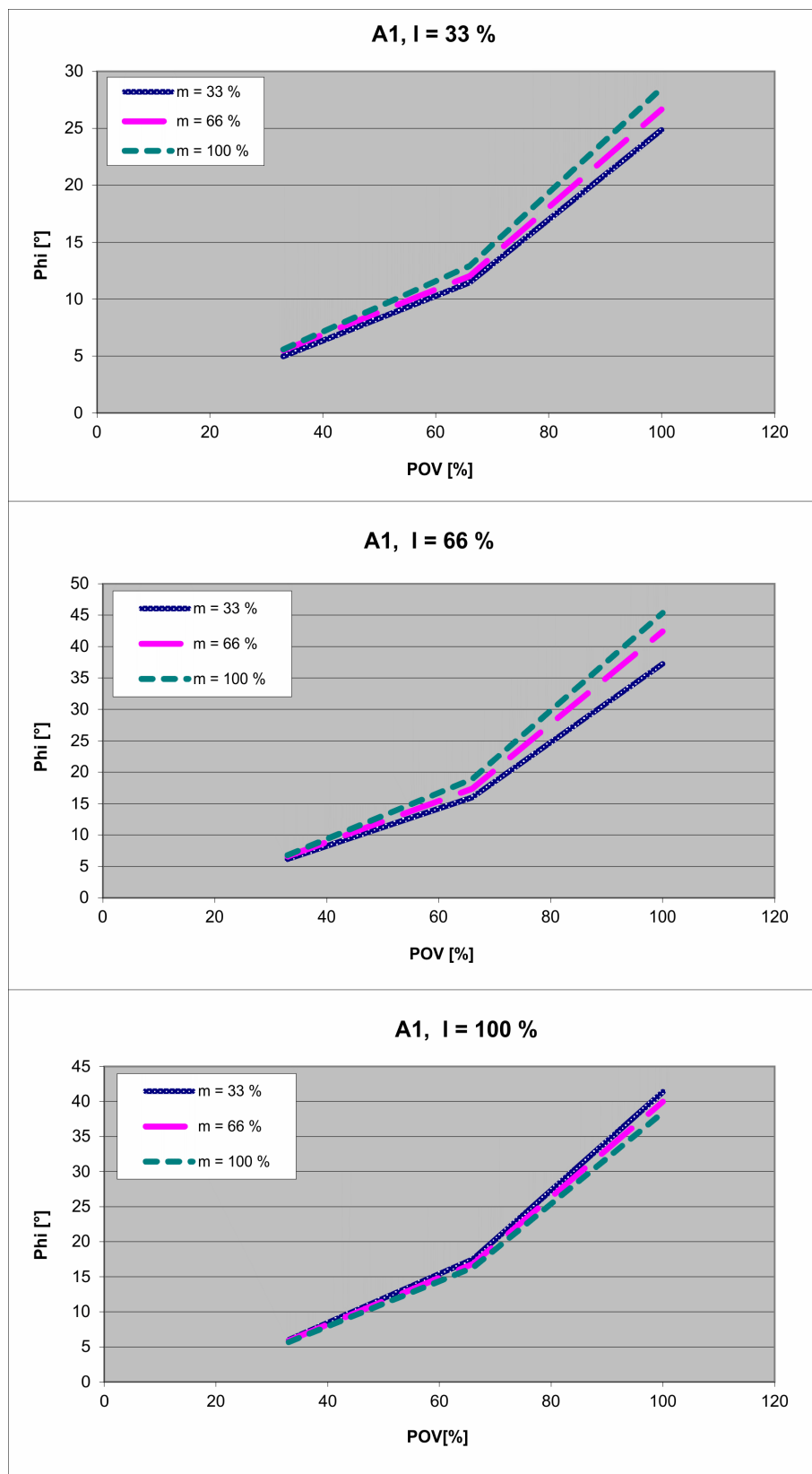


Fig. 4-45: Stopping distances for STOP 1, axis 1

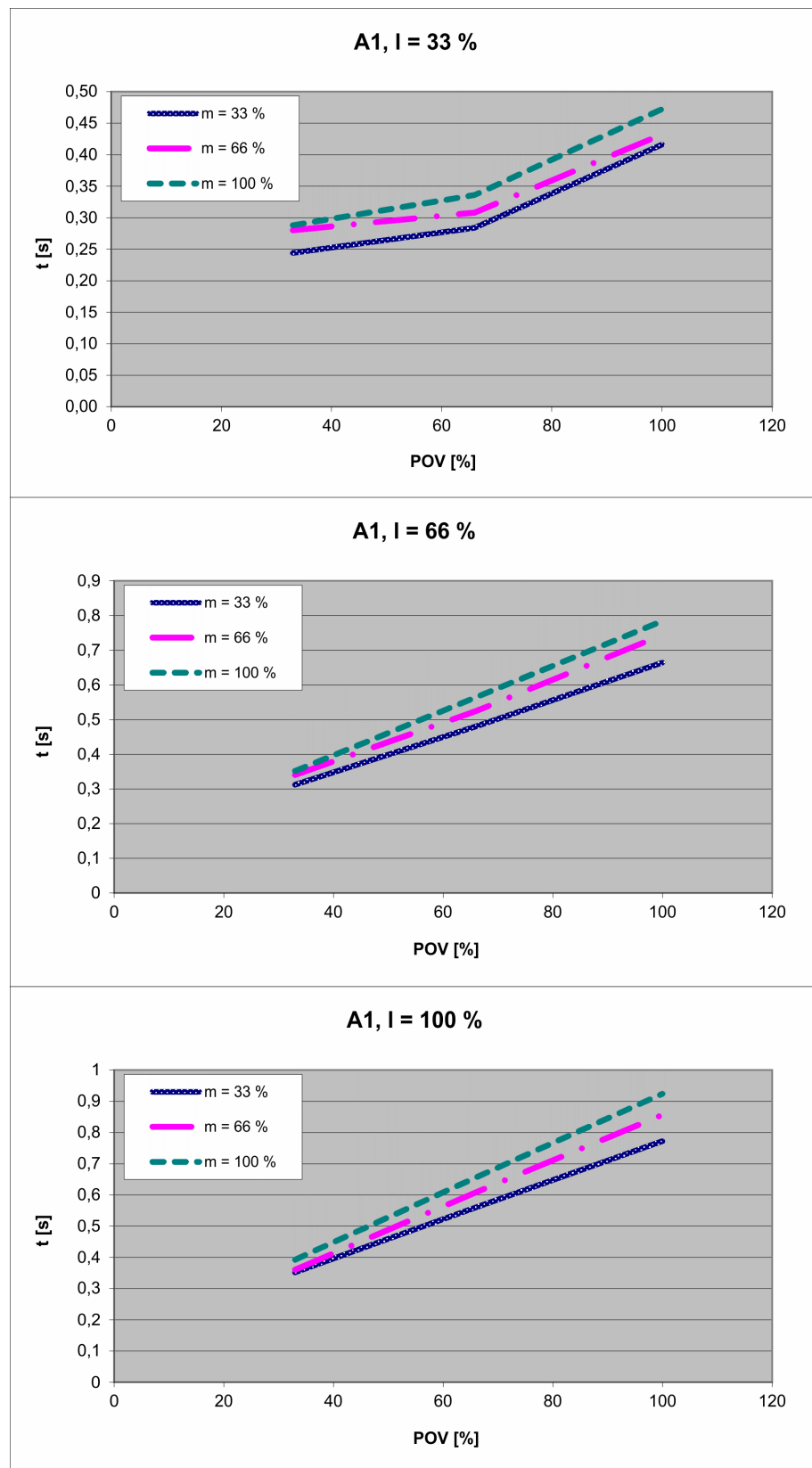


Fig. 4-46: Stopping times for STOP 1, axis 1

4.7.2.3 Stopping distances and stopping times, STOP 1, A2

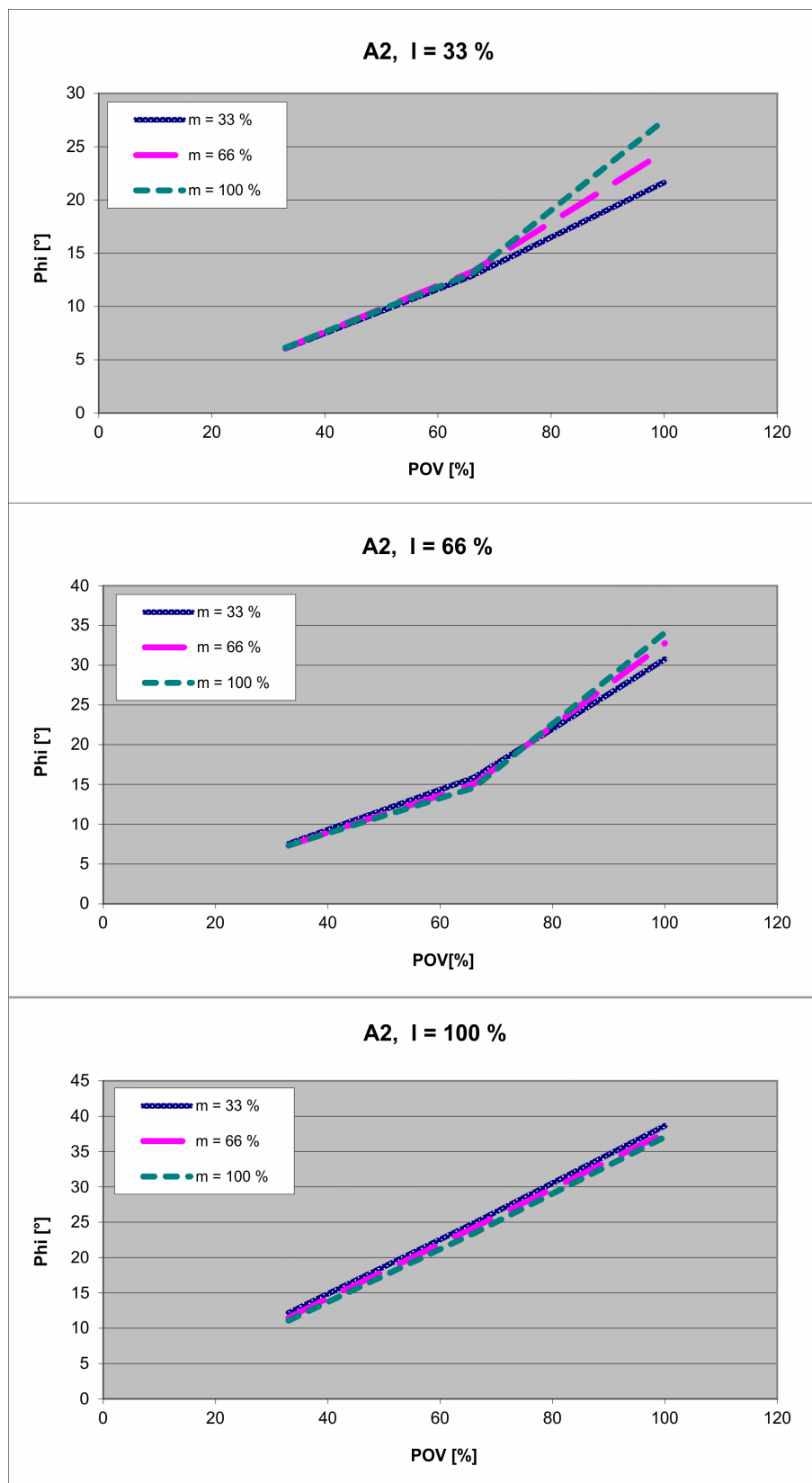


Fig. 4-47: Stopping distances for STOP 1, axis 2

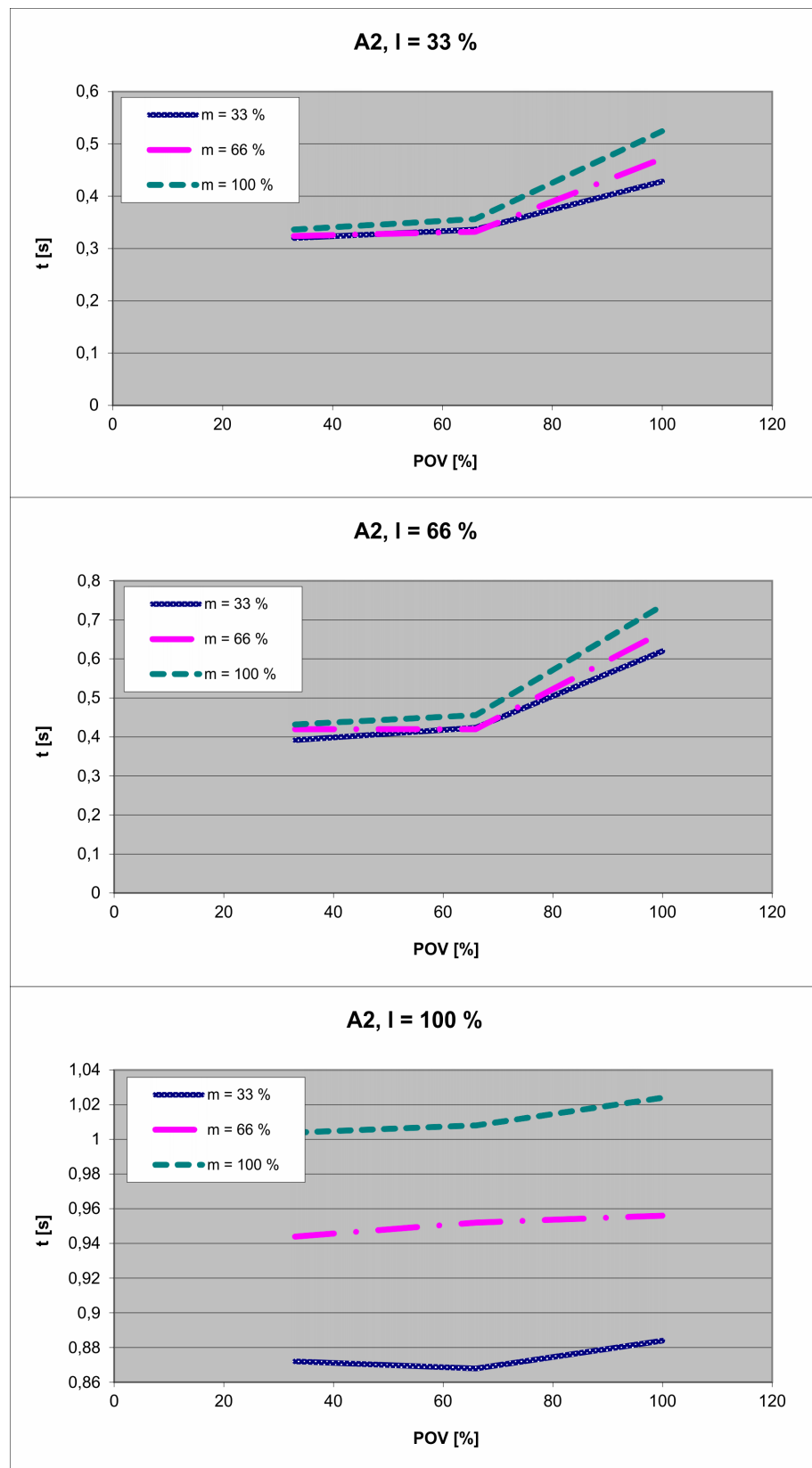


Fig. 4-48: Stopping times for STOP 1, axis 2

4.7.2.4 Stopping distances and stopping times, STOP 1, A3

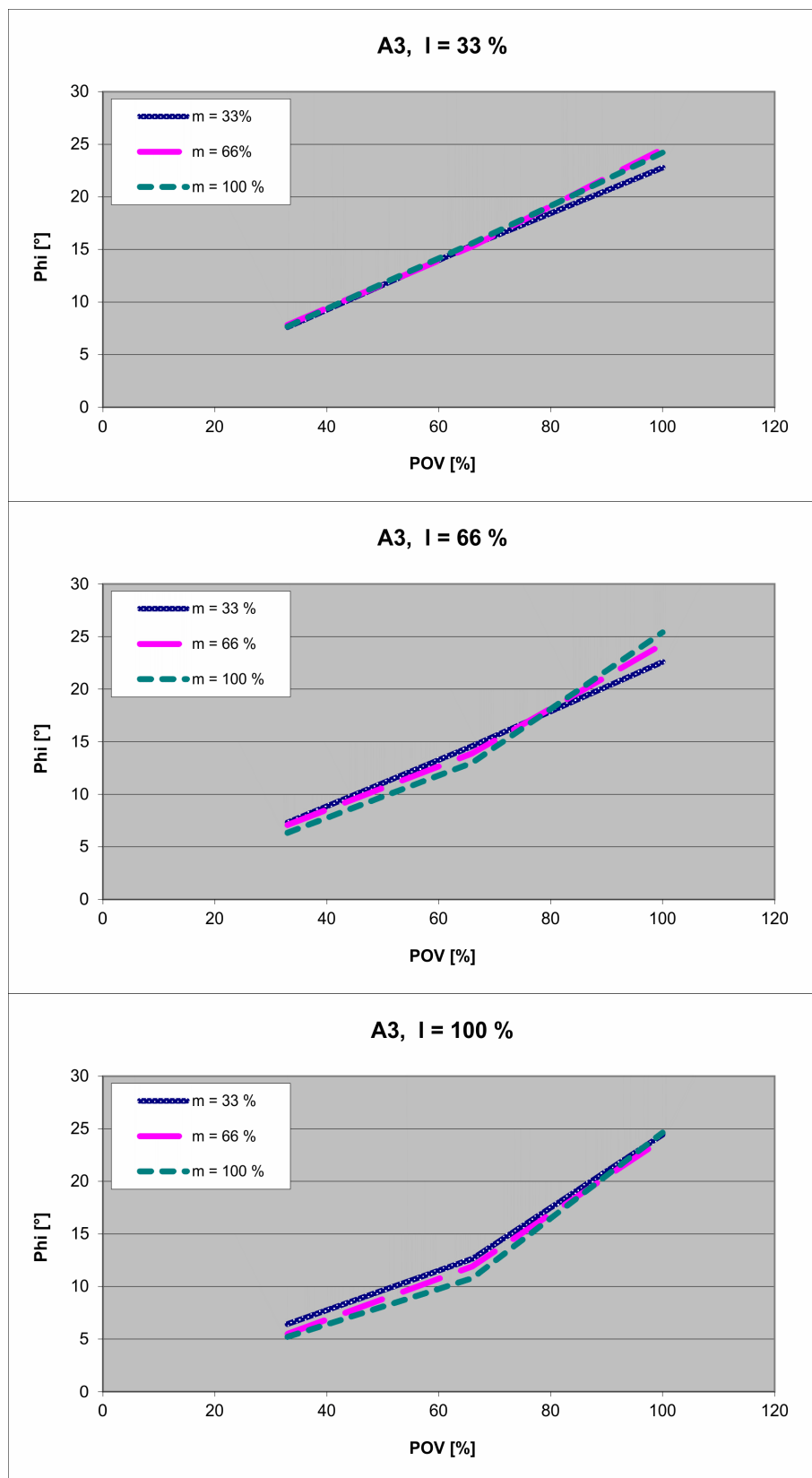


Fig. 4-49: Stopping distances for STOP 1, axis 3

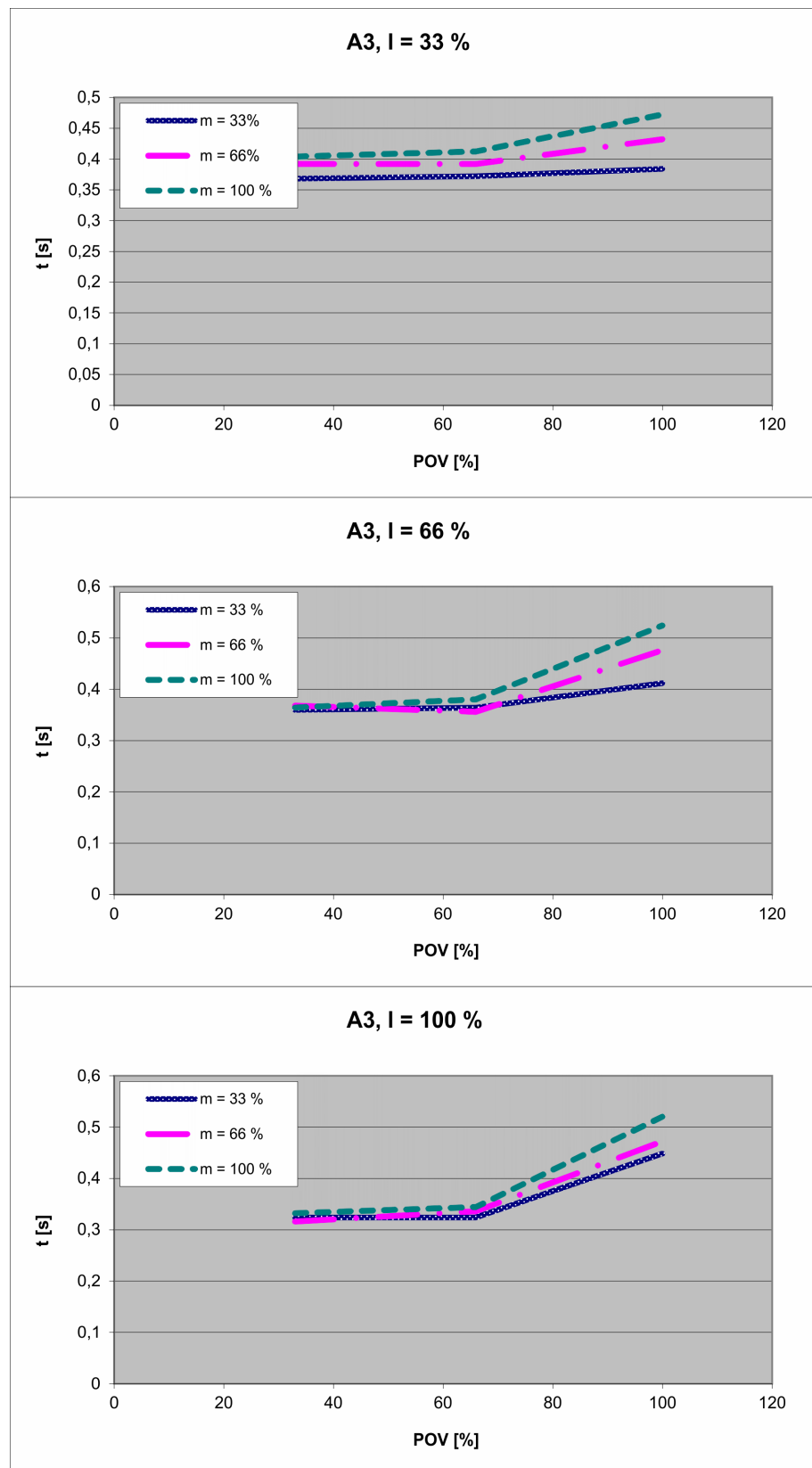


Fig. 4-50: Stopping times for STOP 1, axis 3

4.7.3 Stopping distances and times, KR 120 R3900-2 K

4.7.3.1 Stopping distances and stopping times, STOP 0, A1 to A3

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	
A1	31.78 °
A2	19.28 °
A3	18.44 °
Stopping time	
A1	0.68 s
A2	0.68 s
A3	0.61 s

4.7.3.2 Stopping distances and stopping times, STOP 1, A1

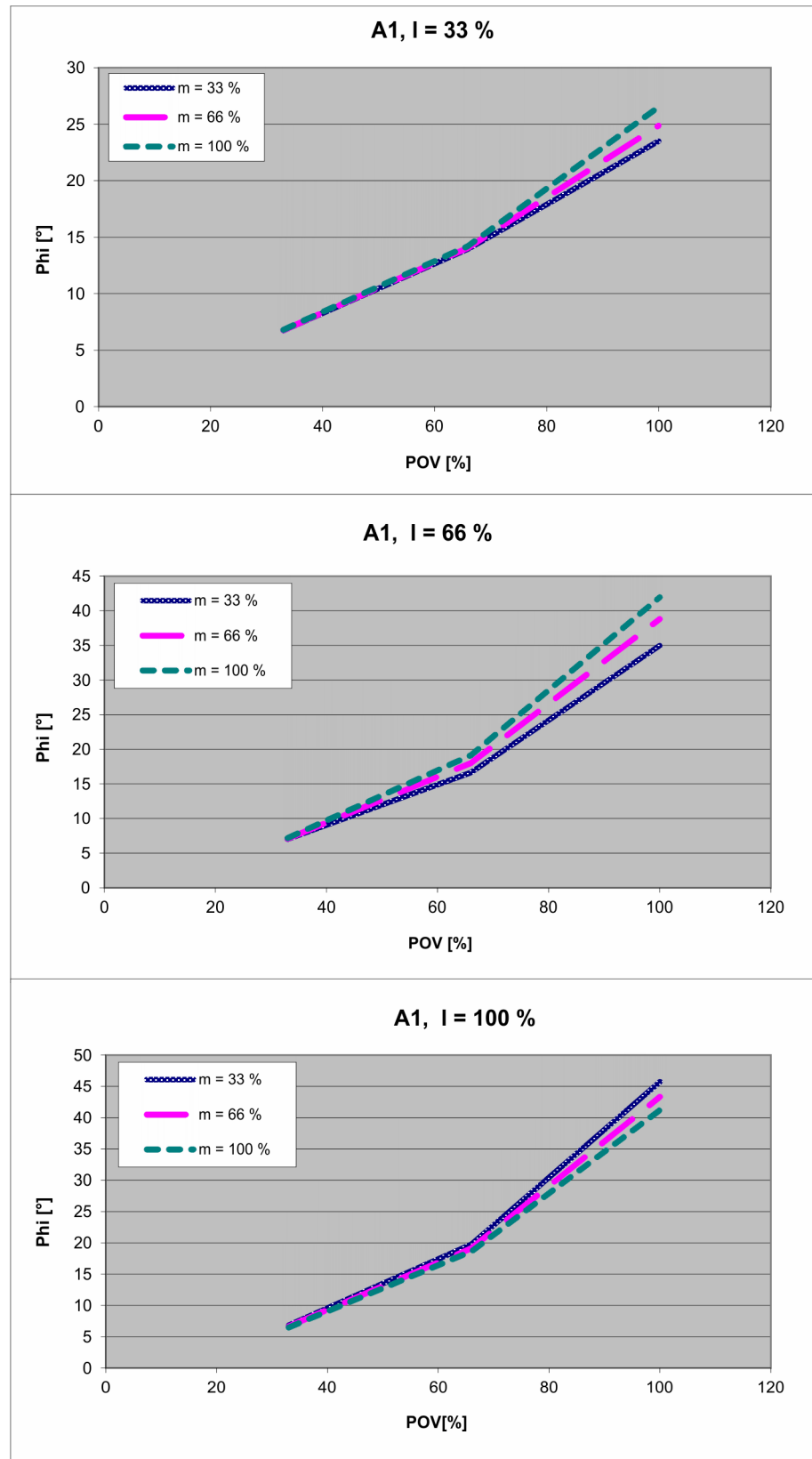


Fig. 4-51: Stopping distances for STOP 1, axis 1

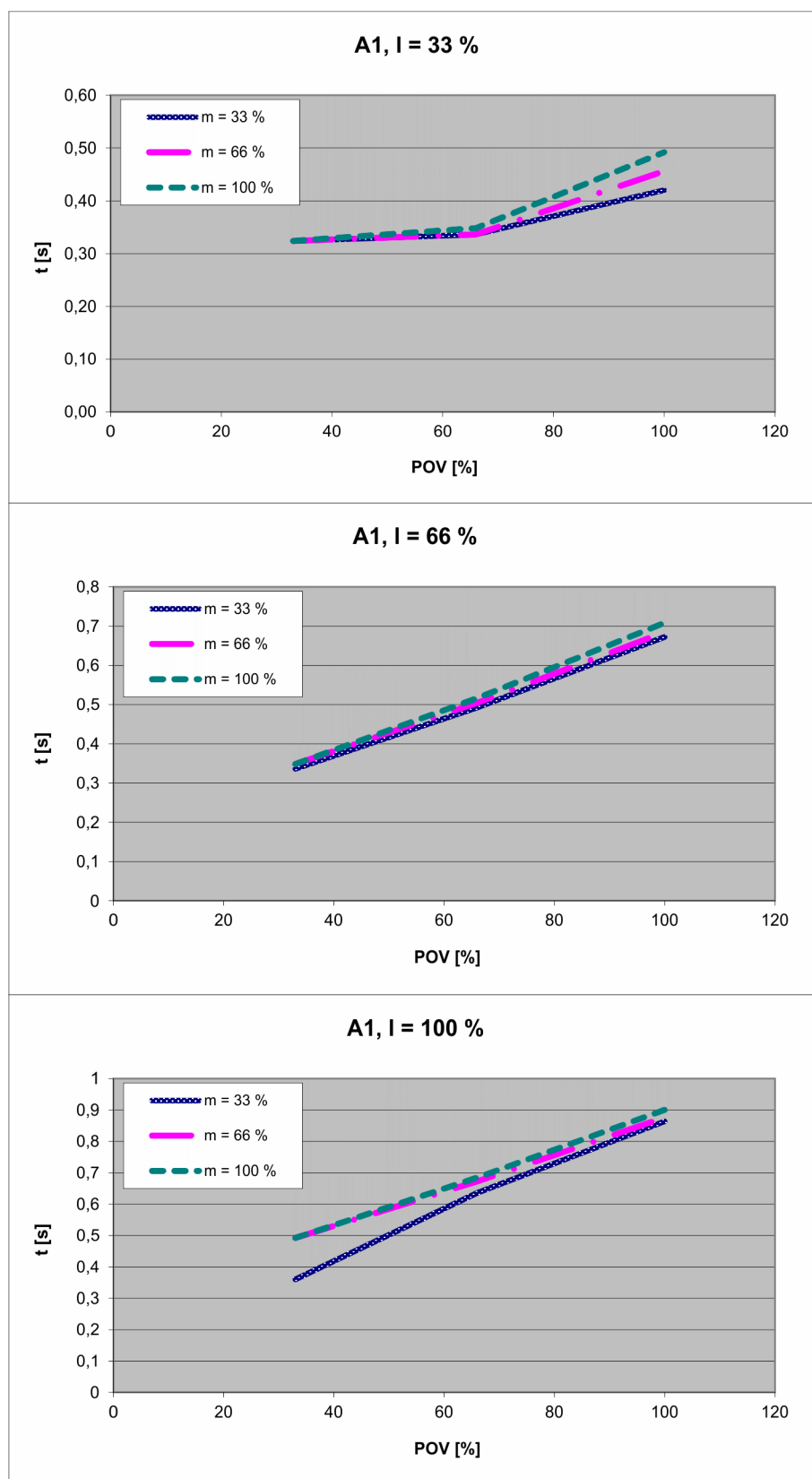


Fig. 4-52: Stopping times for STOP 1, axis 1

4.7.3.3 Stopping distances and stopping times, STOP 1, A2

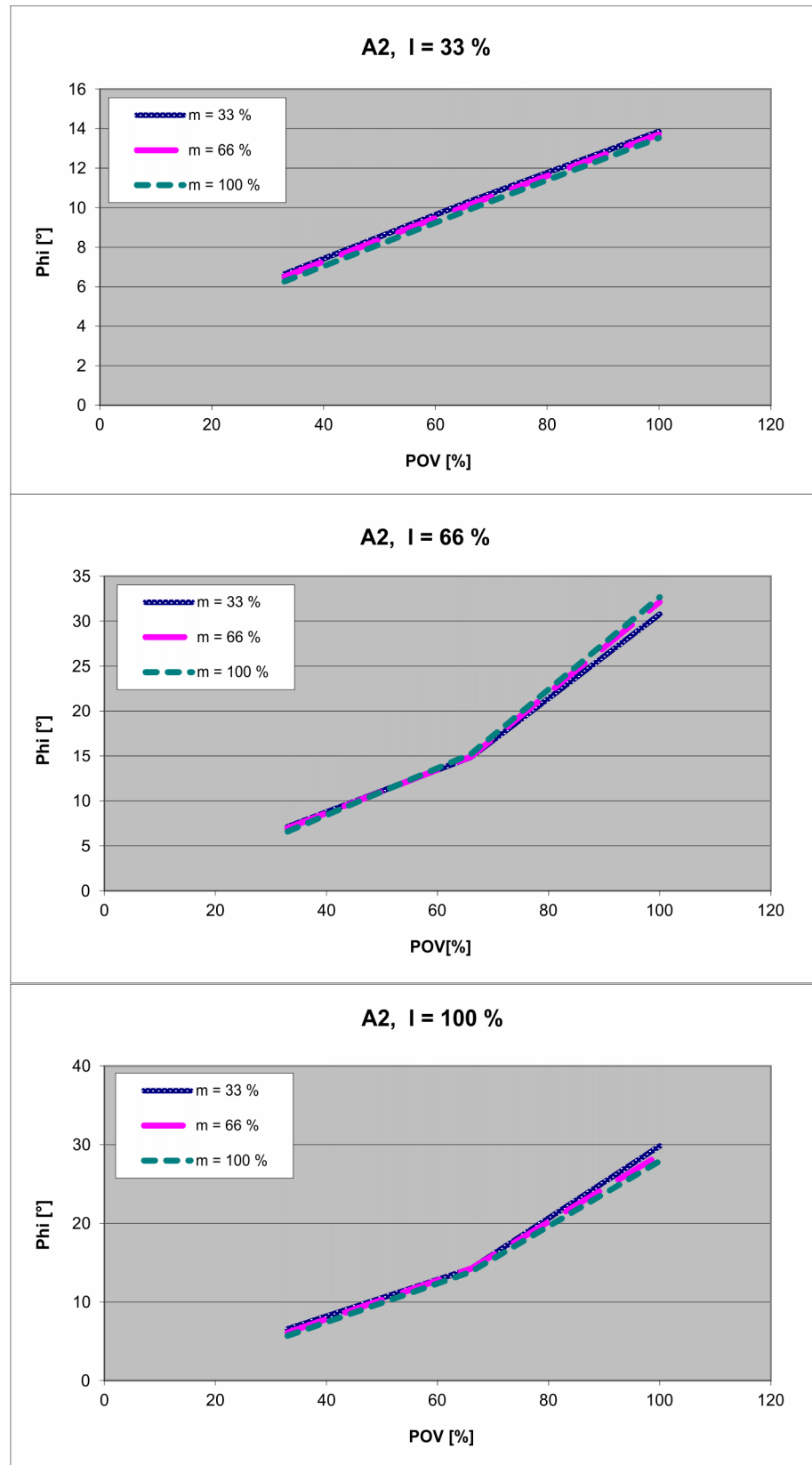


Fig. 4-53: Stopping distances for STOP 1, axis 2

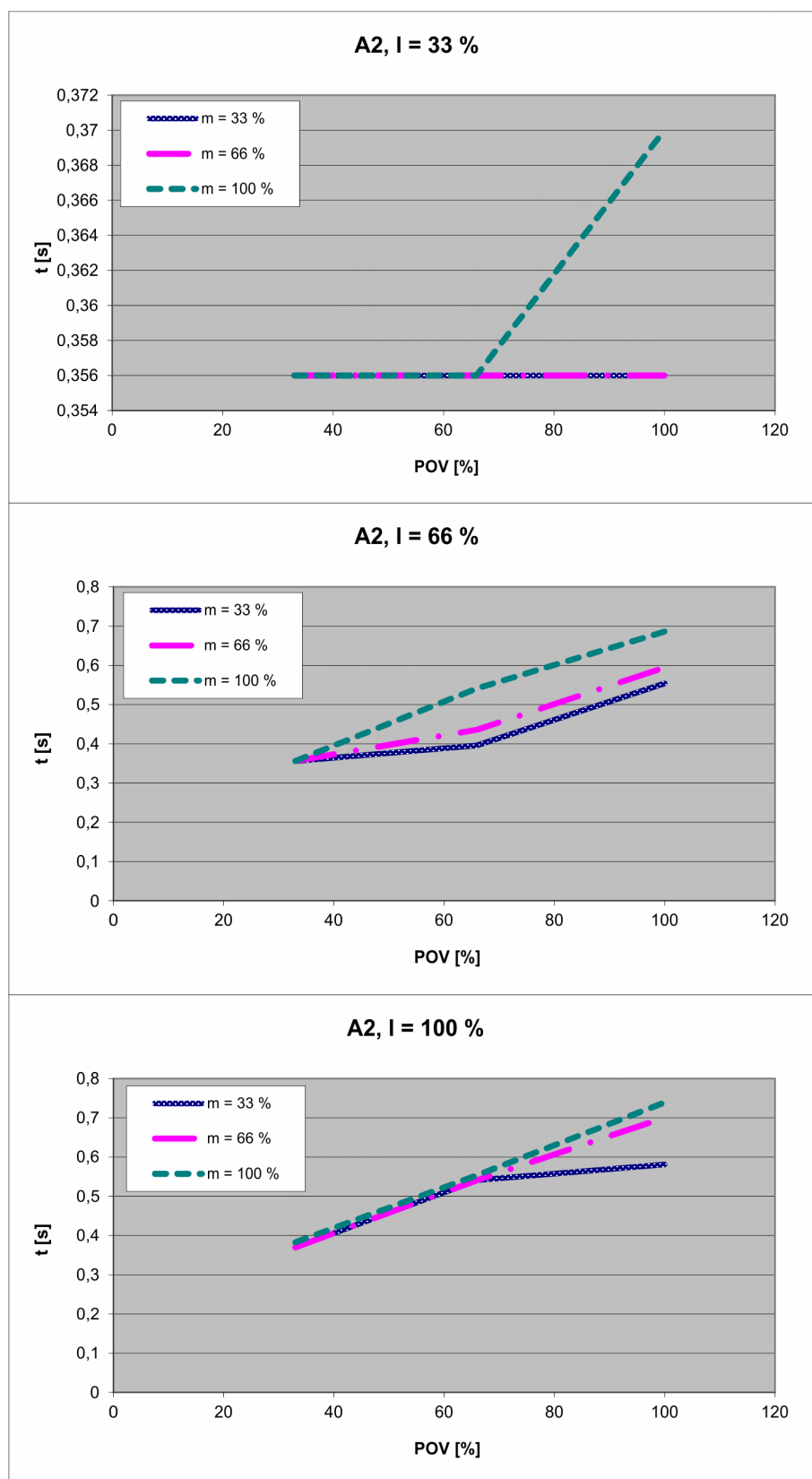


Fig. 4-54: Stopping times for STOP 1, axis 2

4.7.3.4 Stopping distances and stopping times, STOP 1, A3

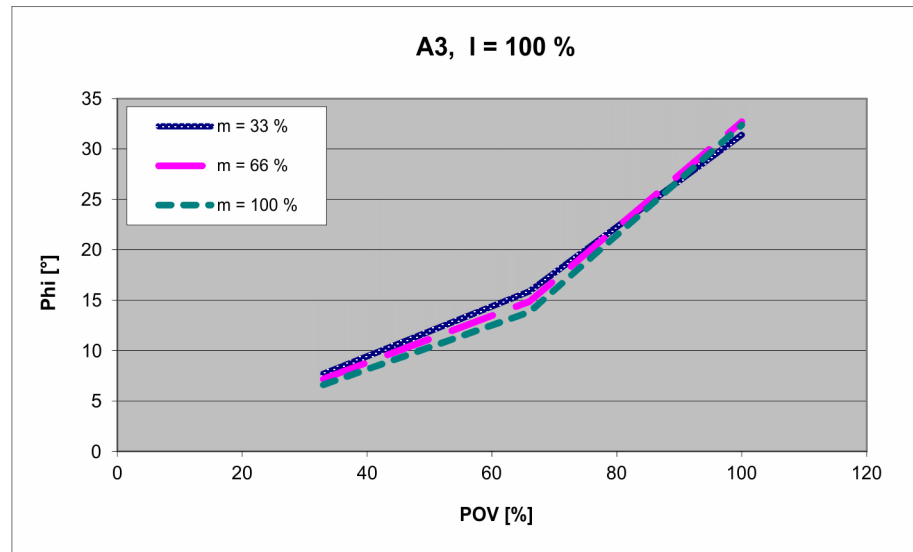


Fig. 4-55: Stopping distances for STOP 1, axis 3

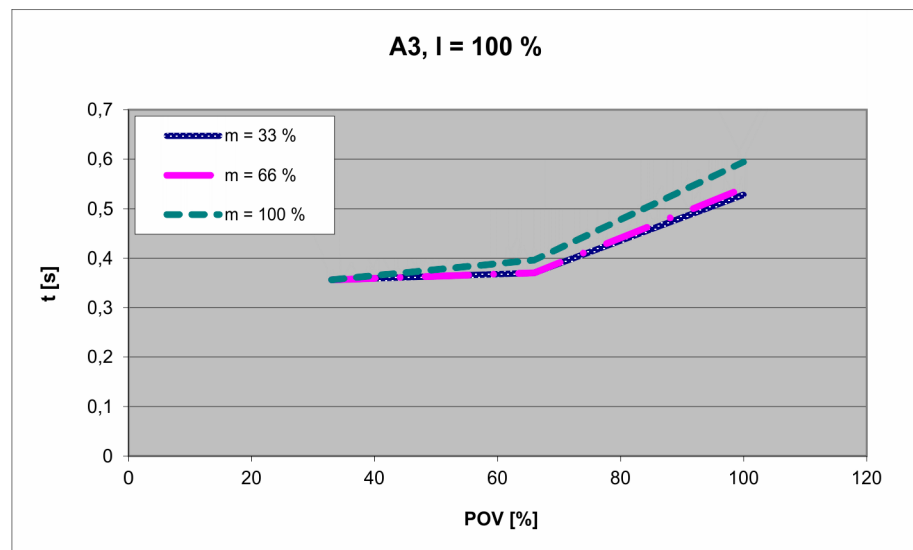


Fig. 4-56: Stopping times for STOP 1, axis 3

4.7.4 Stopping distances and times, KR 180 R3500-2 K and KR 180 R3500-2 K-F

4.7.4.1 Stopping distances and stopping times, STOP 0, A1 to A3

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	
A1	33.80 °
A2	26.00 °

A3	18.85 °
Stopping time	
A1	0.75 s
A2	0.64 s
A3	0.58 s

4.7.4.2 Stopping distances and stopping times, STOP 1, A1

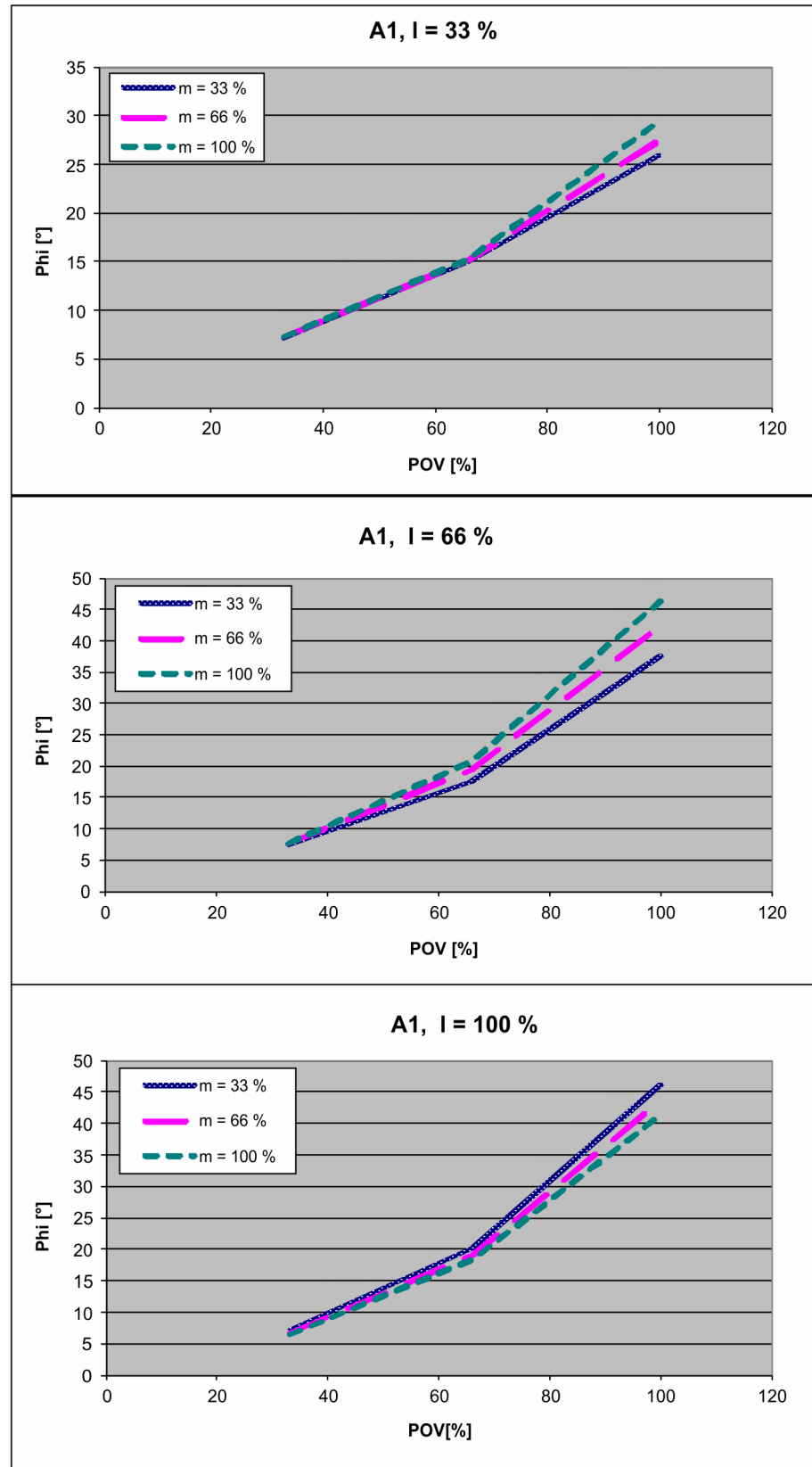


Fig. 4-57: Stopping distances for STOP 1, axis 1

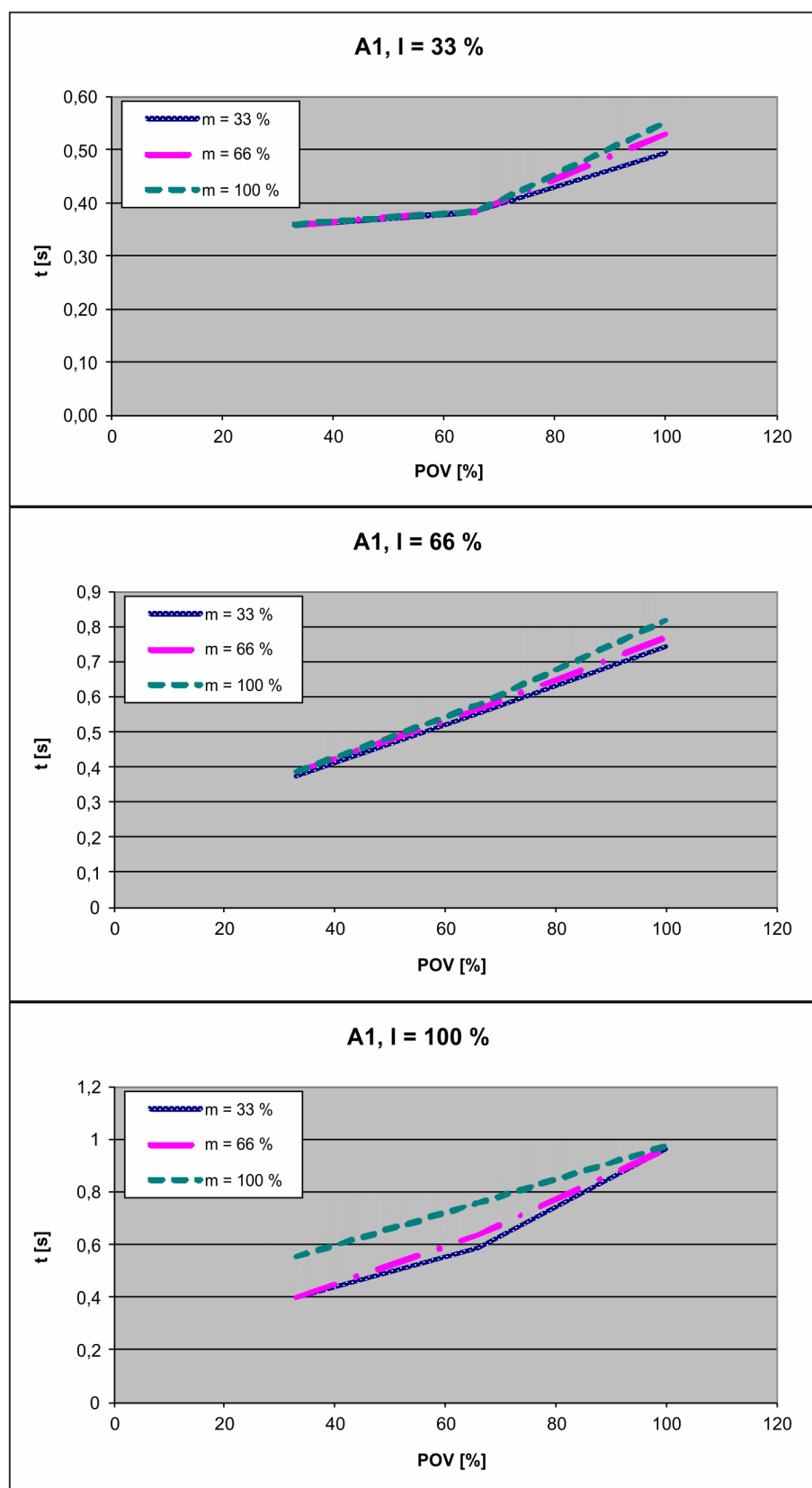


Fig. 4-58: Stopping times for STOP 1, axis 1

4.7.4.3 Stopping distances and stopping times, STOP 1, A2

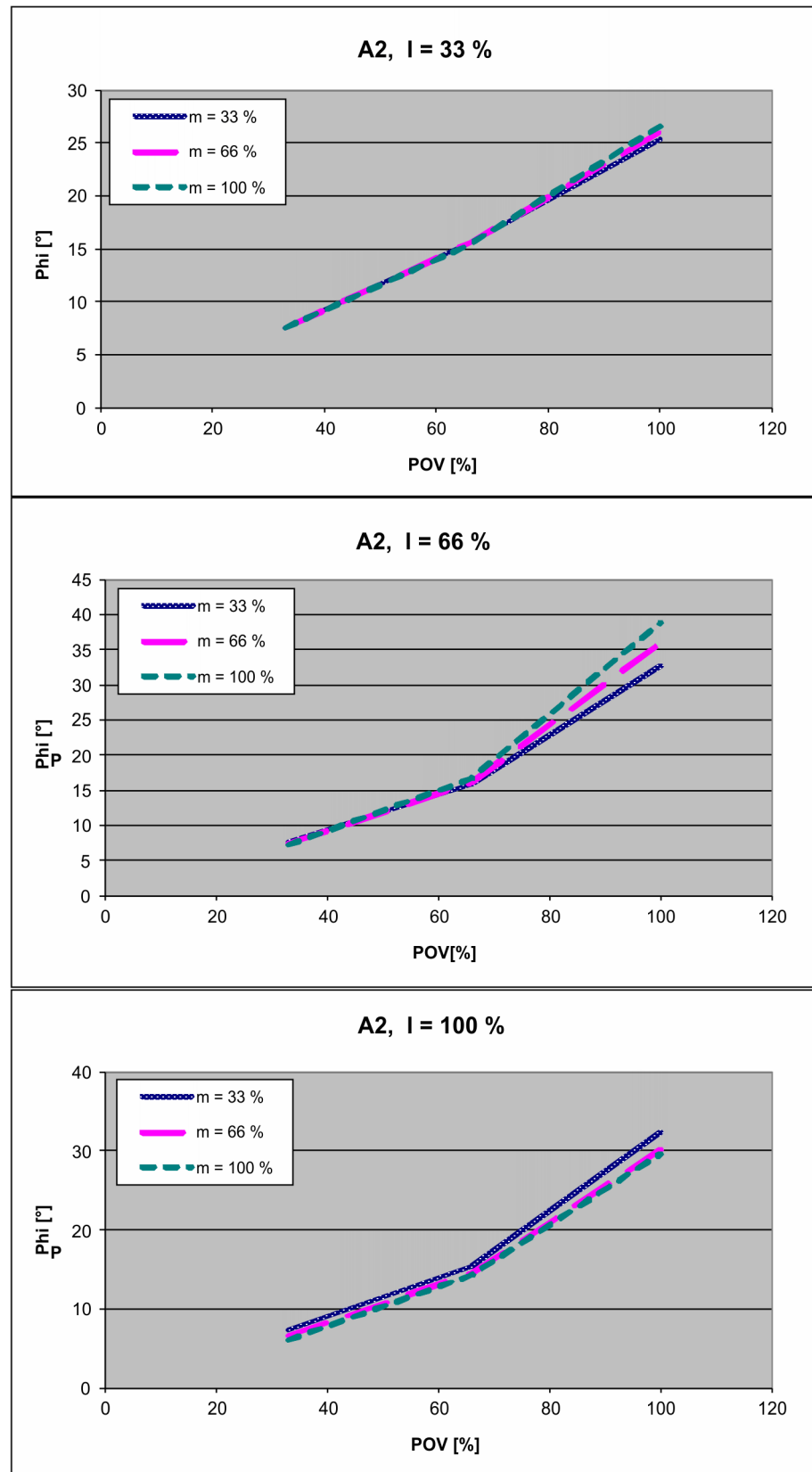


Fig. 4-59: Stopping distances for STOP 1, axis 2

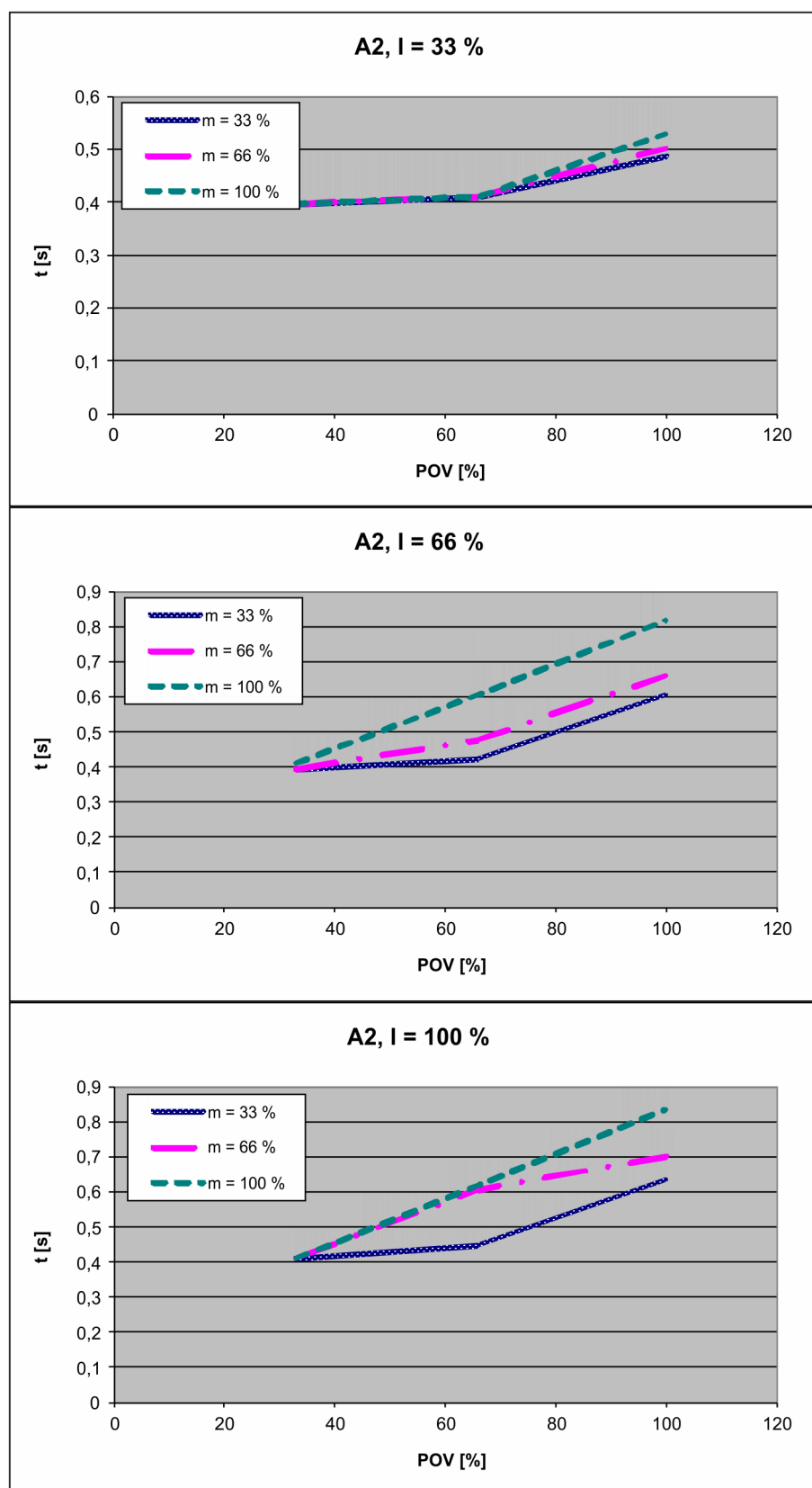


Fig. 4-60: Stopping times for STOP 1, axis 2

4.7.4.4 Stopping distances and stopping times, STOP 1, A3

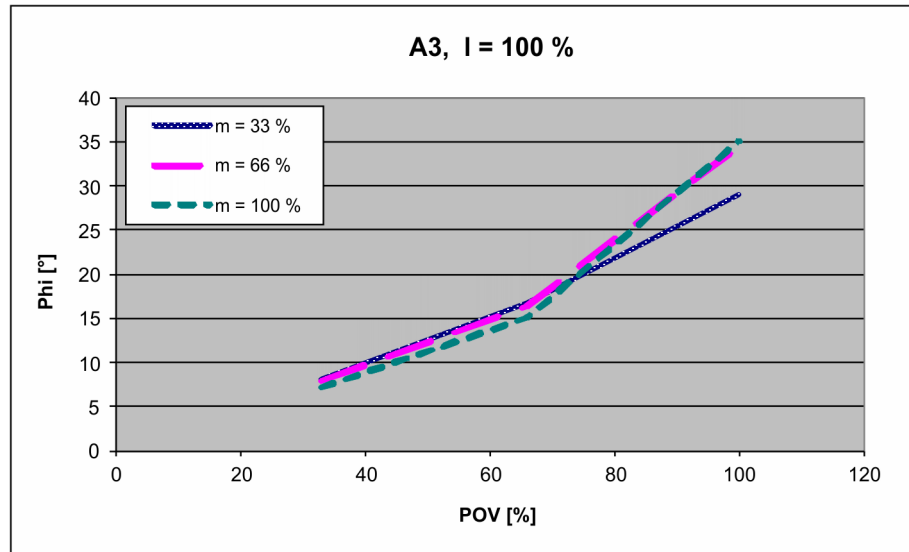


Fig. 4-61: Stopping distances for STOP 1, axis 3

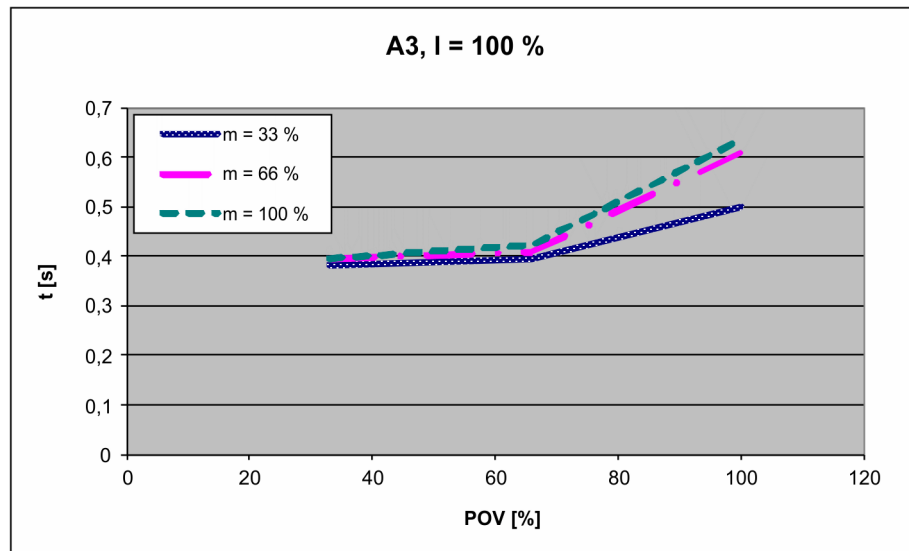


Fig. 4-62: Stopping times for STOP 1, axis 3

4.7.5 Stopping distances and times, KR 210 R3300-2 K and KR 210 R3300-2 K-F

4.7.5.1 Stopping distances and stopping times, STOP 0, A1 to A3

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	
A1	44.03 °

A2	24.54 °
A3	25.54 °
Stopping time	
A1	0.83 s
A2	0.50 s
A3	0.58 s

4.7.5.2 Stopping distances and stopping times, STOP 1, A1

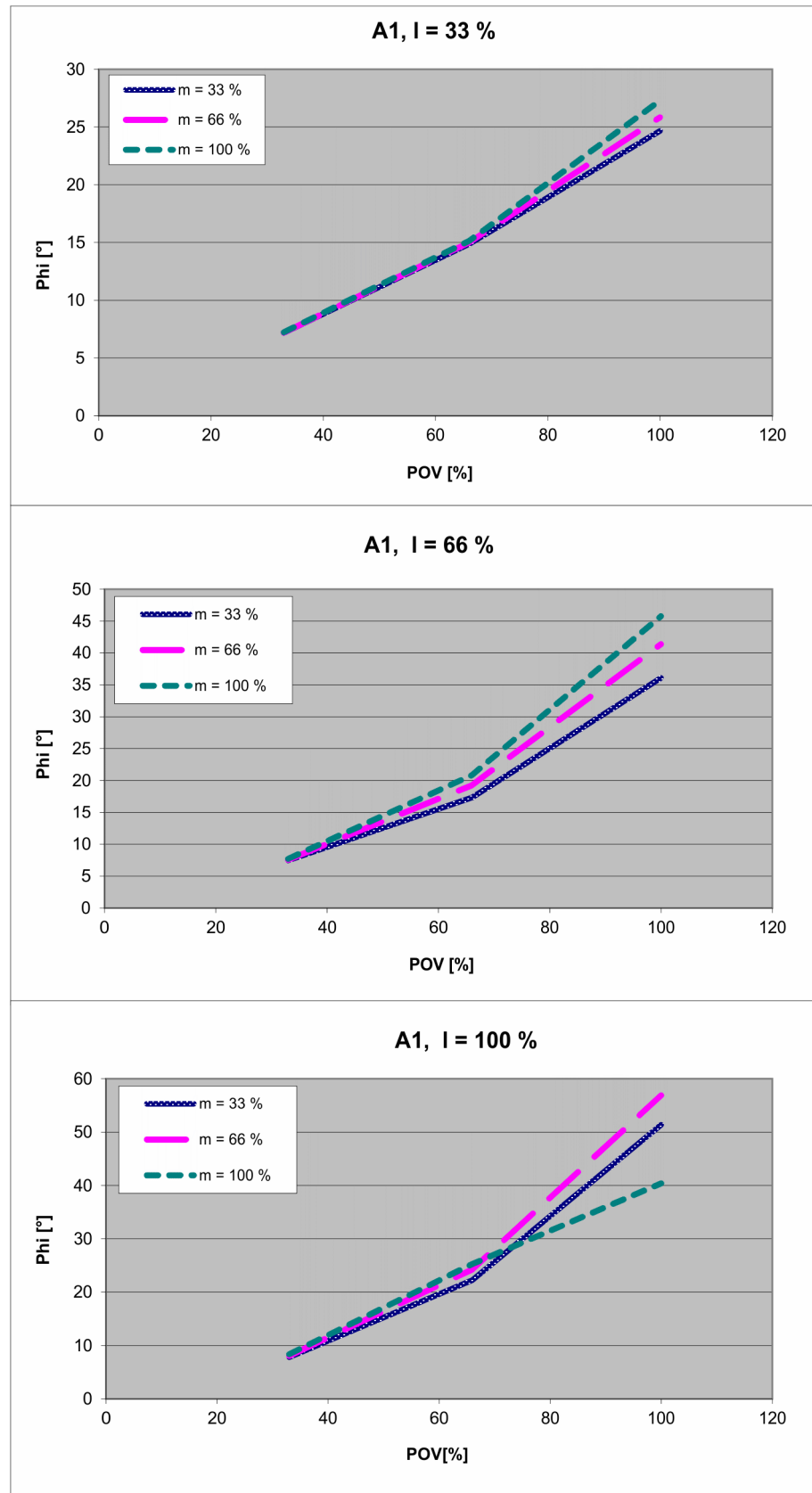


Fig. 4-63: Stopping distances for STOP 1, axis 1

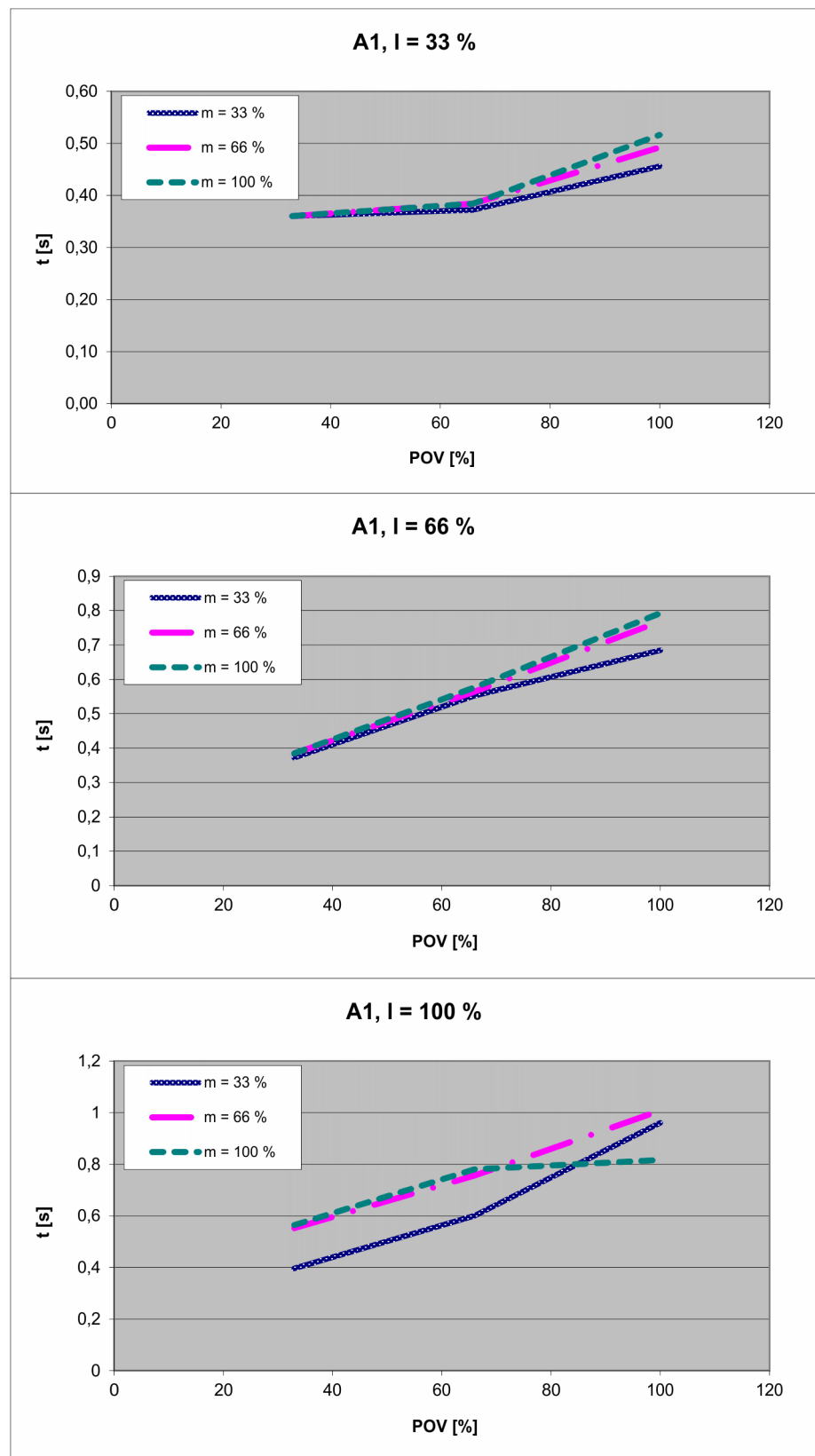


Fig. 4-64: Stopping times for STOP 1, axis 1

4.7.5.3 Stopping distances and stopping times, STOP 1, A2

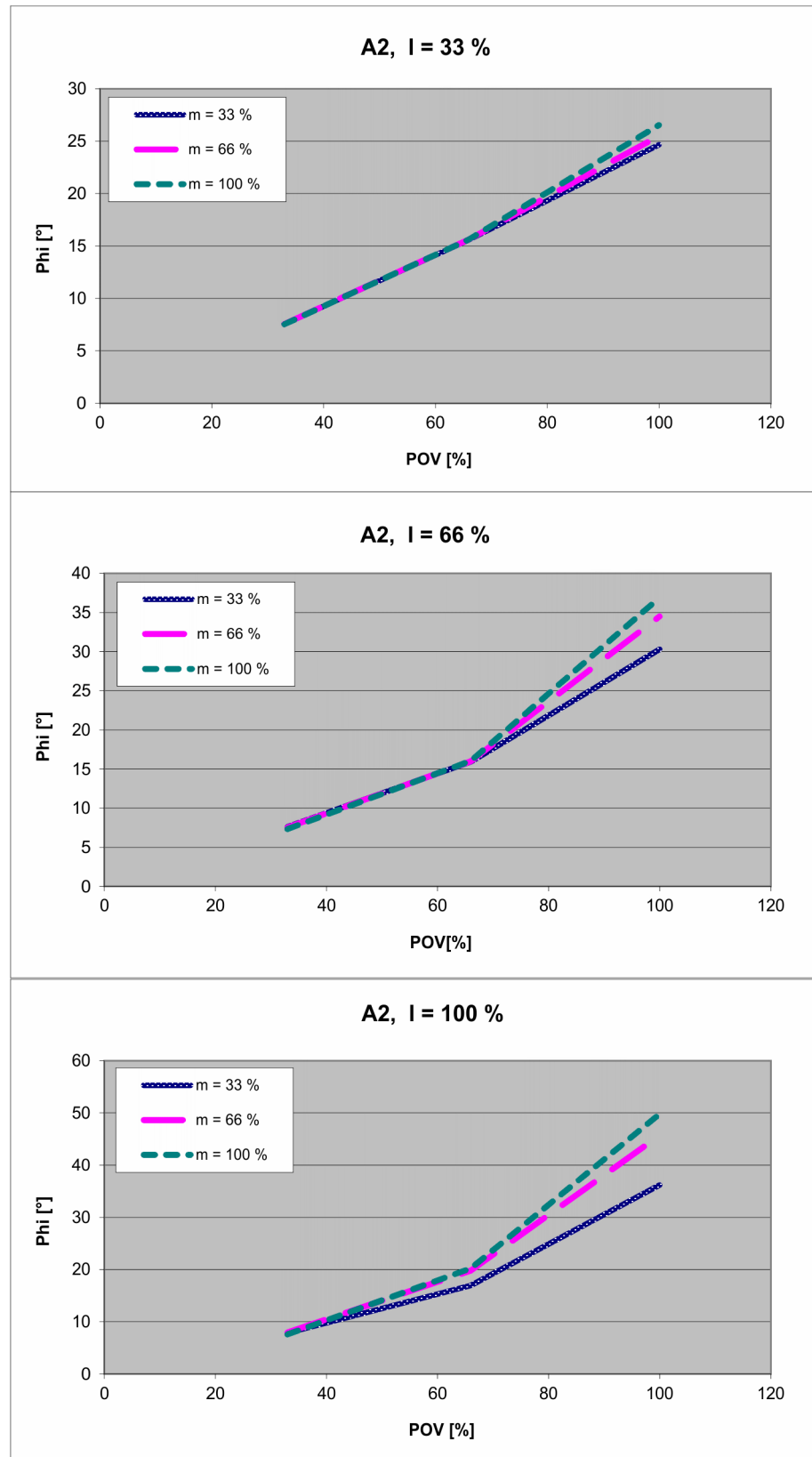


Fig. 4-65: Stopping distances for STOP 1, axis 2

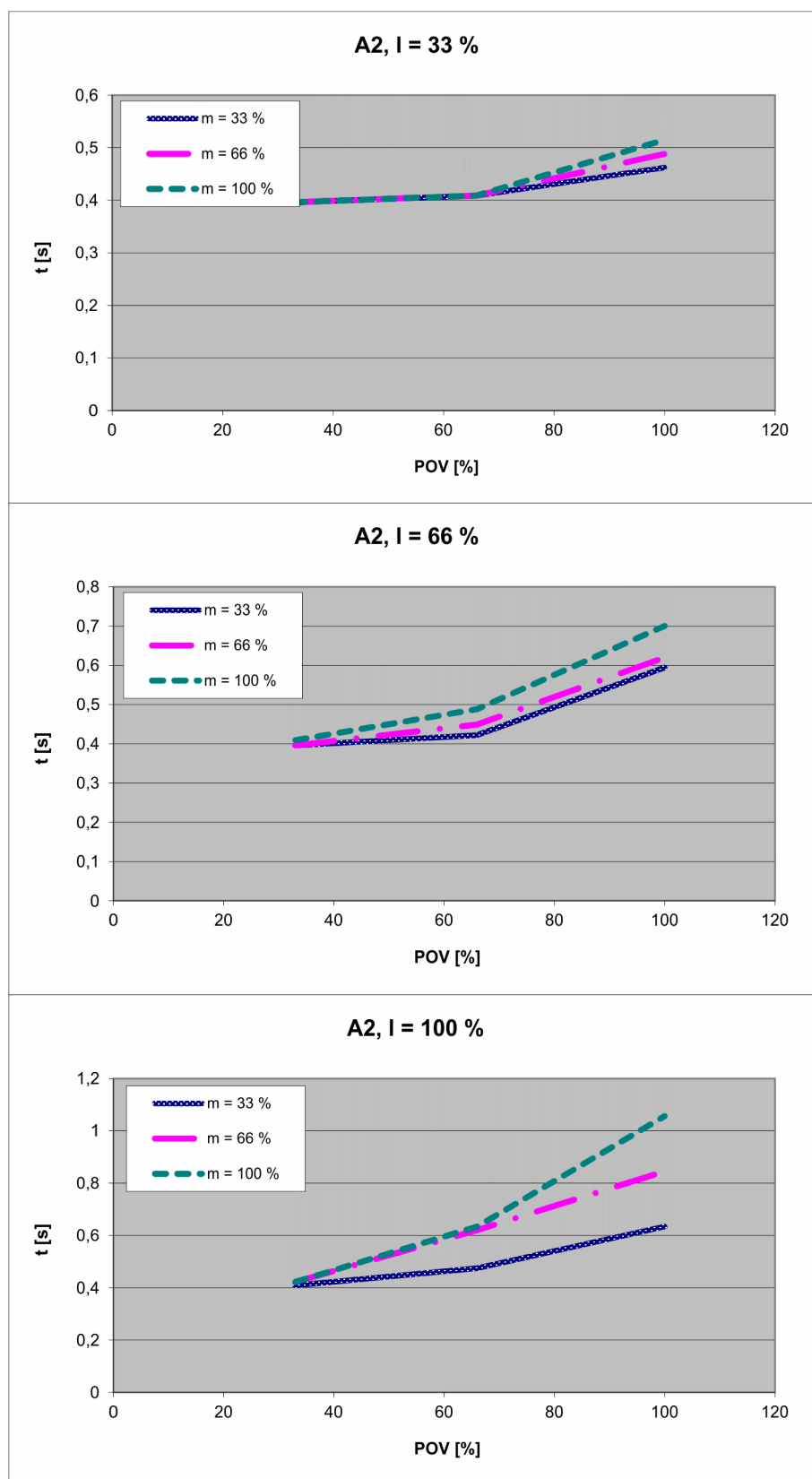


Fig. 4-66: Stopping times for STOP 1, axis 2

4.7.5.4 Stopping distances and stopping times, STOP 1, A3

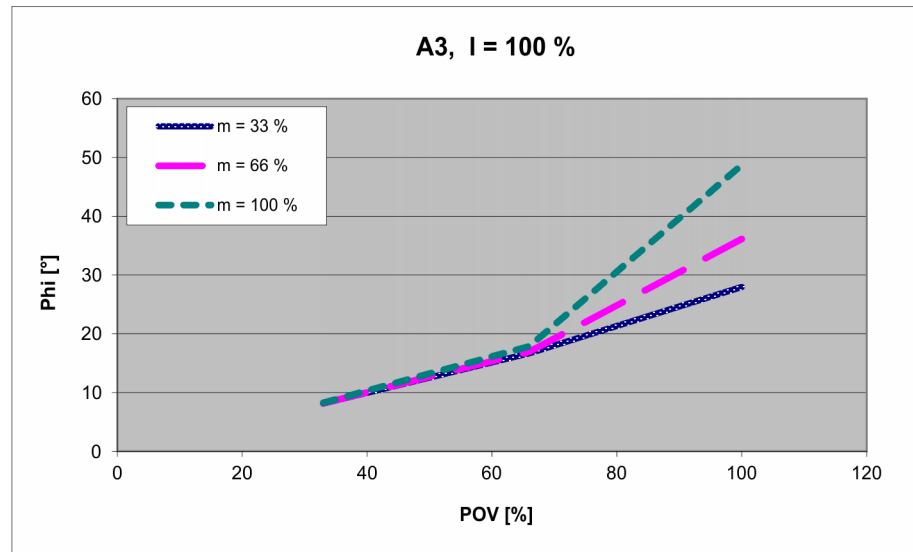


Fig. 4-67: Stopping distances for STOP 1, axis 3

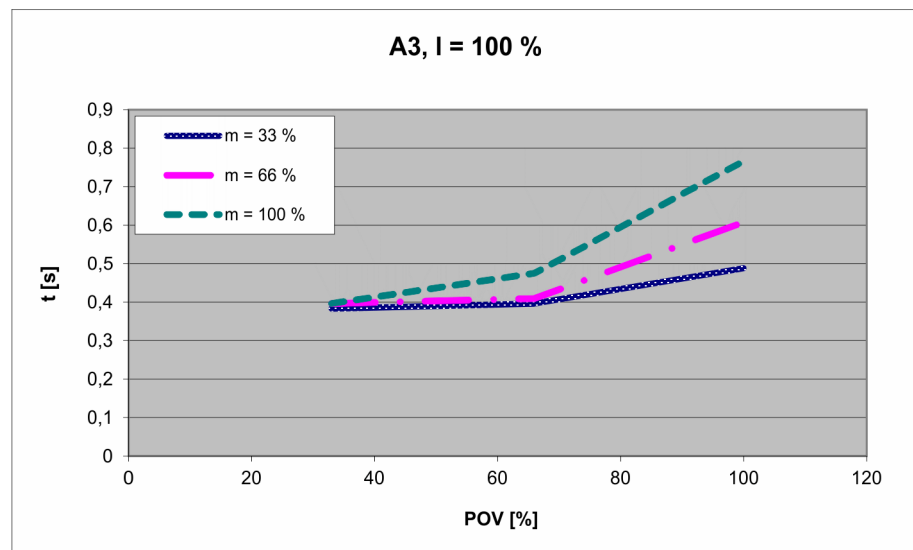


Fig. 4-68: Stopping times for STOP 1, axis 3

4.7.6 Stopping distances and times, KR 270 R3100-2 K and KR 270 R3100-2 K-F

4.7.6.1 Stopping distances and stopping times, STOP 0, A1 to A3

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	
A1	29.22 °
A2	19.51 °

A3	16.83 °
Stopping time	
A1	0.66 s
A2	0.55 s
A3	0.37 s

4.7.6.2 Stopping distances and stopping times, STOP 1, A1

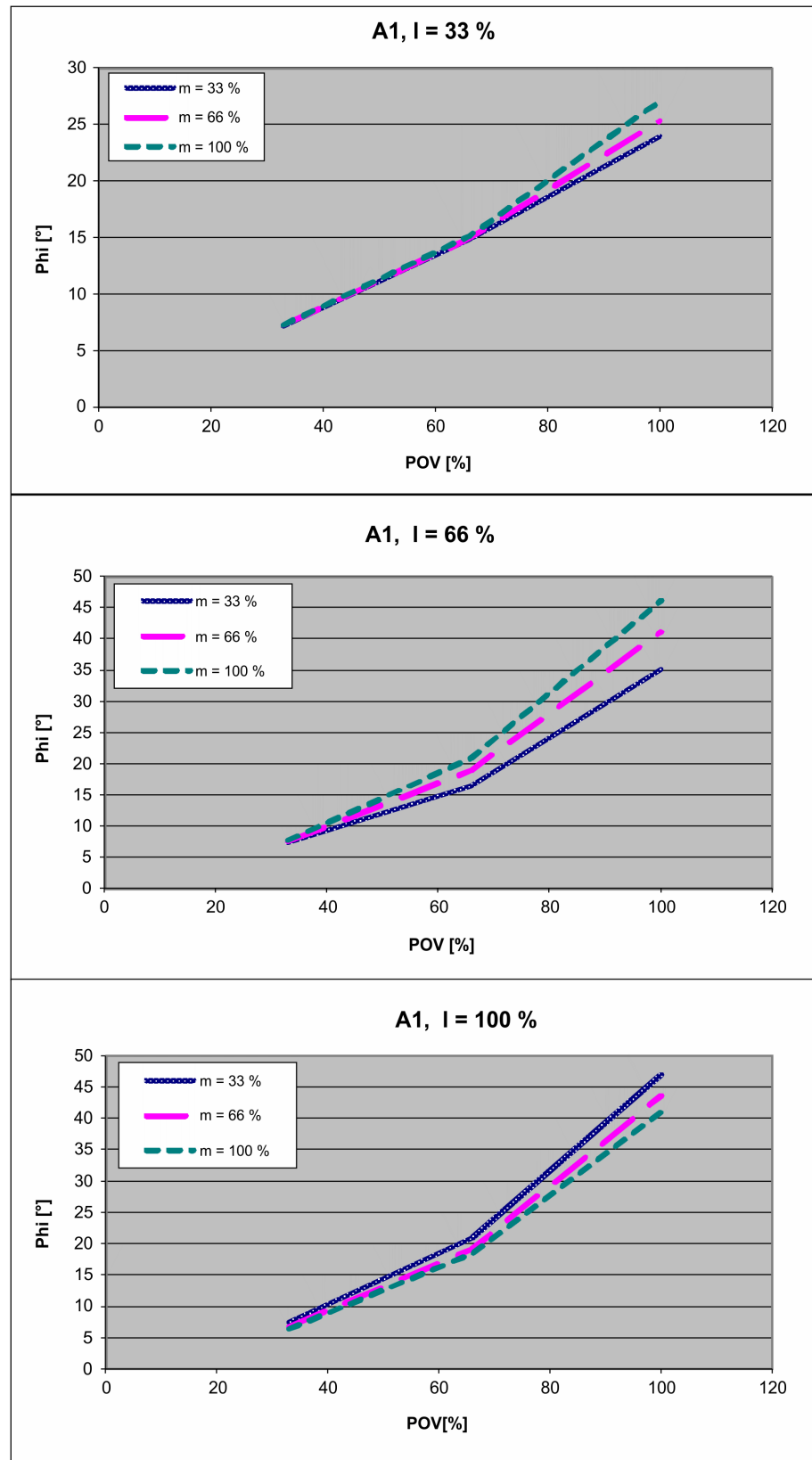


Fig. 4-69: Stopping distances for STOP 1, axis 1

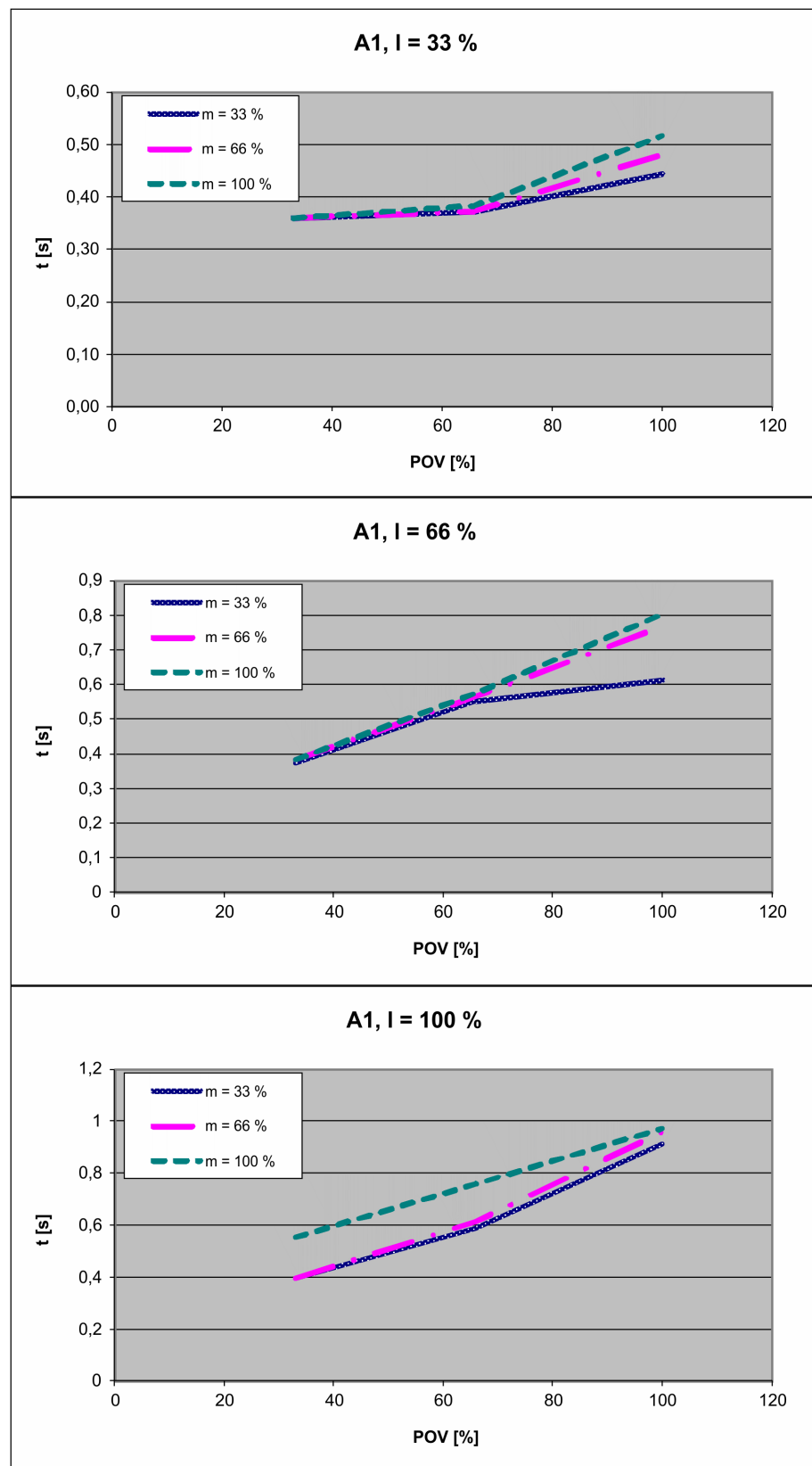


Fig. 4-70: Stopping times for STOP 1, axis 1

4.7.6.3 Stopping distances and stopping times, STOP 1, A2

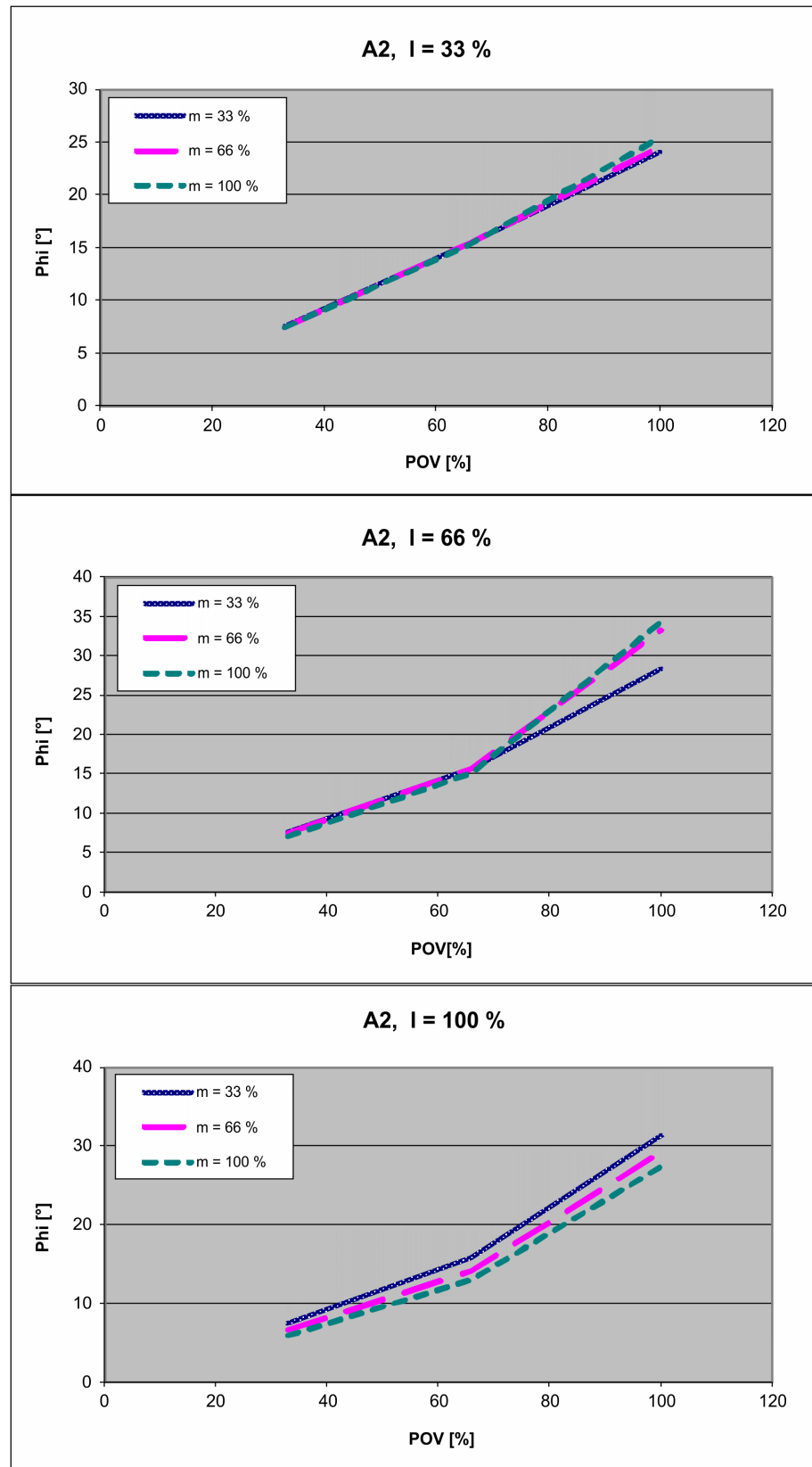


Fig. 4-71: Stopping distances for STOP 1, axis 2

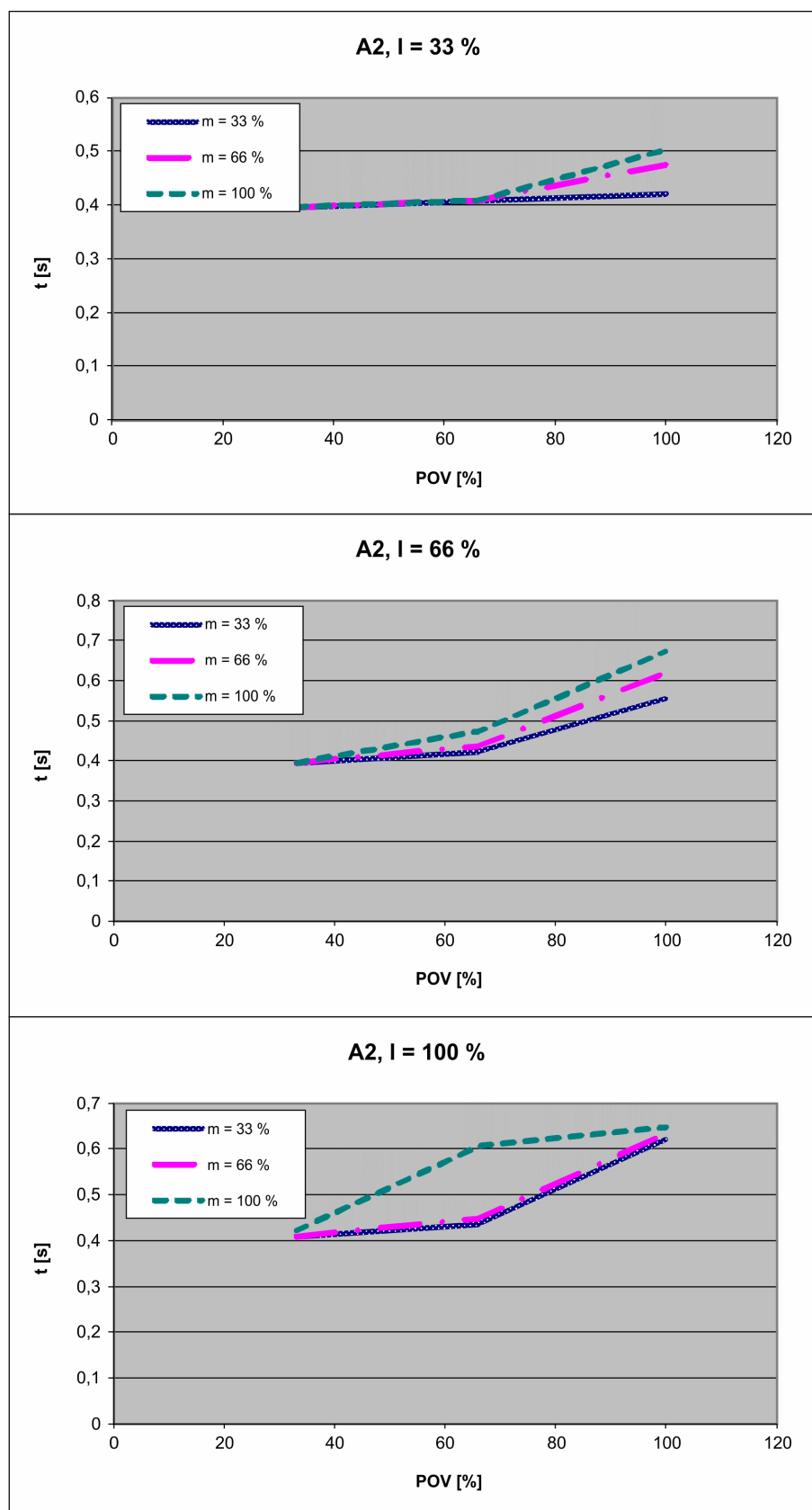


Fig. 4-72: Stopping times for STOP 1, axis 2

4.7.6.4 Stopping distances and stopping times, STOP 1, A3

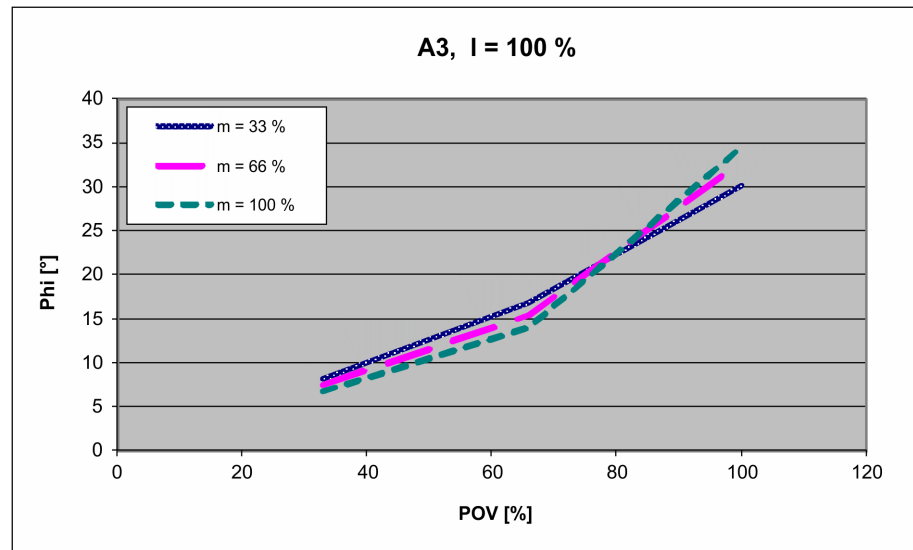


Fig. 4-73: Stopping distances for STOP 1, axis 3

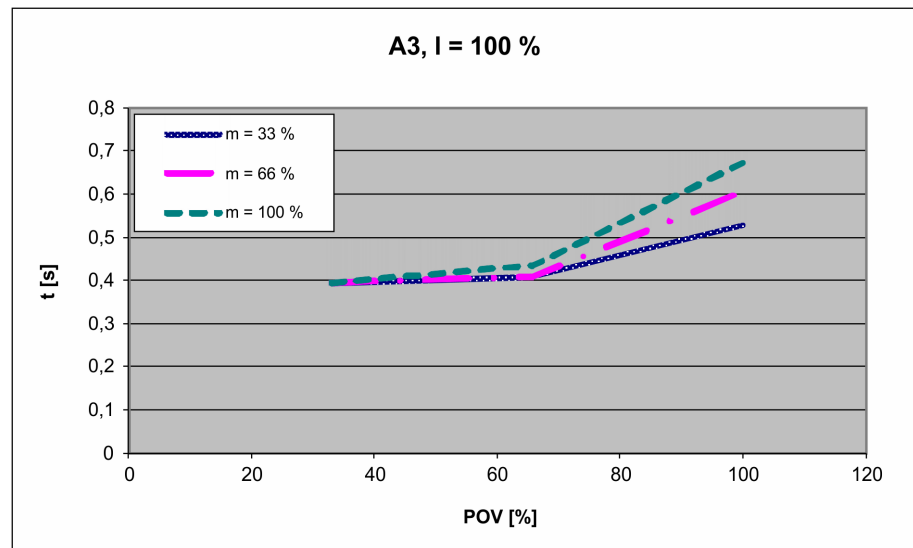


Fig. 4-74: Stopping times for STOP 1, axis 3

5 Planning

5.1 Information for planning

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

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

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

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

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

5.2 Mounting base with centering

Description

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

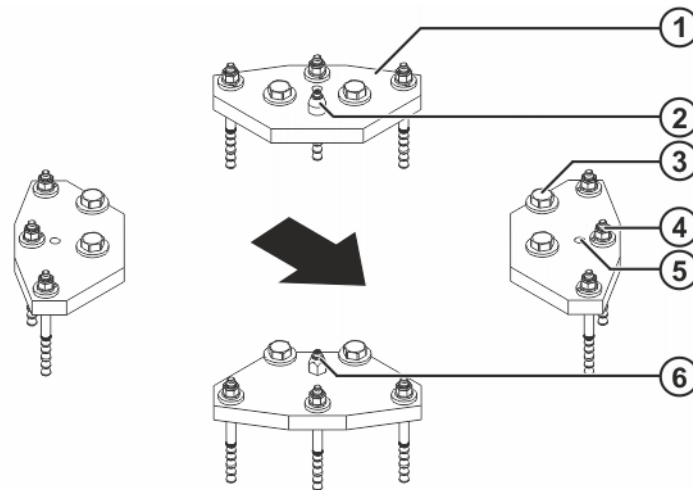
The mounting base with centering consists of:

- Bedplates
- Chemical anchor
- 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. 5-1: Mounting base**

- 1 Bedplate (4x)
- 2 Locating pin, cylindrical
- 3 M24x65-8.8-A2K hexagon bolt with conical spring washer (8x)
- 4 Chemical anchor (12x)
- 5 M20 tapped hole for leveling screws (4x)
- 6 Locating pin, flat-sided

Grade of concrete for foundations

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

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

**WARNING****Danger to life and limb due to incorrect mounting**

If not mounted correctly, the kinematic system may topple over or fall down. Death, severe injury or damage to property may result.

- Only install the kinematic system using the mounting base or machine frame mounting.
- The stability must be ensured by the integrator or start-up technician.

Dimensioned drawing

The following illustration (>>> [Fig. 5-2](#)) provides all the necessary information on the mounting base, together with the required foundation data. The specified foundation dimensions refer to the safe transmission of the foundation loads into the foundation and not to the stability of the foundation.

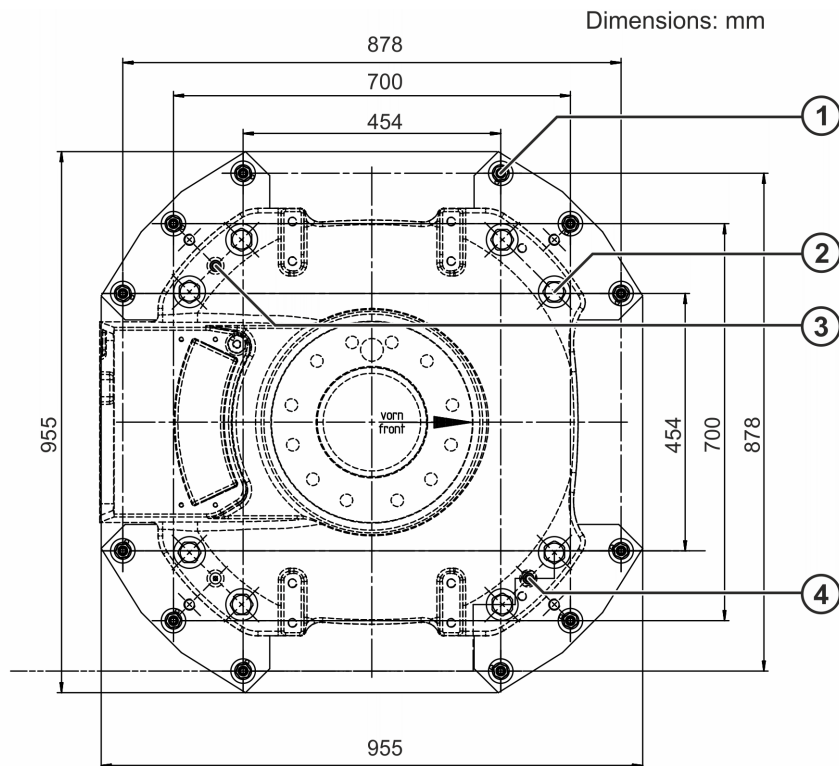


Fig. 5-2: Mounting base, dimensioned drawing

- 1 Chemical anchor (12x)
- 2 M24x65-8.8-A2K hexagon bolt (8x)
- 3 Locating pin, cylindrical
- 4 Locating pin, flat-sided

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

NOTICE

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



- | A: min. distance to edge | B: min. concrete thickness |
|--------------------------|----------------------------|
| 360 mm | 180 mm |
| 340 mm | 200 mm |
| 300 mm | 250 mm |

Description

The minimum dimensions must be observed.

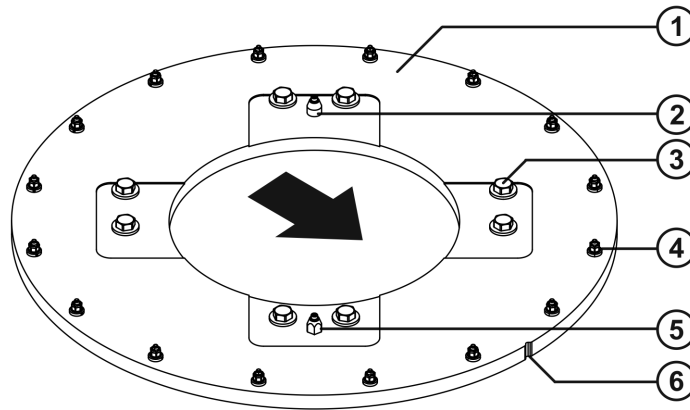


Fig. 5-4: Mounting base

- 1 Bedplate
- 2 Locating pin, cylindrical
- 3 M24x65-8.8-A2K hexagon bolt with conical spring washer (8x)
- 4 Chemical anchor (12x)
- 5 Locating pin, flat-sided
- 6 Orientation notch, zero position

Grade of concrete for foundations

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

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



WARNING

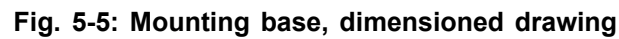
Danger to life and limb due to incorrect mounting

If not mounted correctly, the kinematic system may topple over or fall down. Death, severe injury or damage to property may result.

- Only install the kinematic system using the mounting base or machine frame mounting.
- The stability must be ensured by the integrator or start-up technician.

Dimensioned drawing

The following illustration (>>> [Fig. 5-2](#)) provides all the necessary information on the mounting base, together with the required foundation data. The specified foundation dimensions refer to the safe transmission of the foundation loads into the foundation and not to the stability of the foundation.



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

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

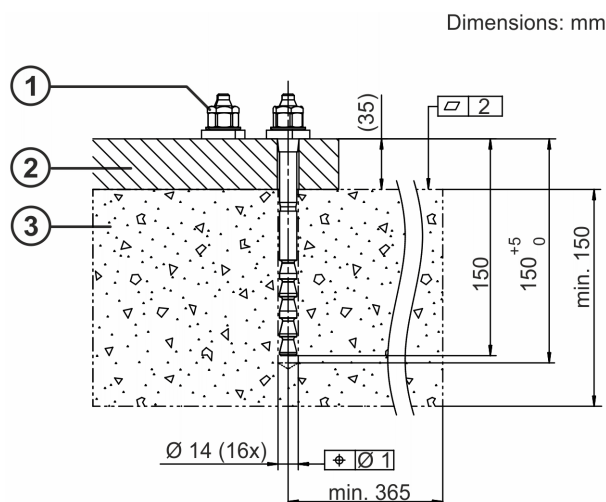


Fig. 5-6: Foundation cross-section

- 1 Chemical anchor (16x)
- 2 Bedplate
- 3 Concrete foundation

5.4 Machine frame mounting

Description

The machine frame mounting assembly is used when the robot is fastened on a steel structure, a booster frame (pedestal) or a KUKA linear unit. This assembly is also used if the robot is installed on the 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. 5-7](#)).

The machine frame mounting assembly consists of:

- Locating pins
- Hexagon bolts with conical spring washers

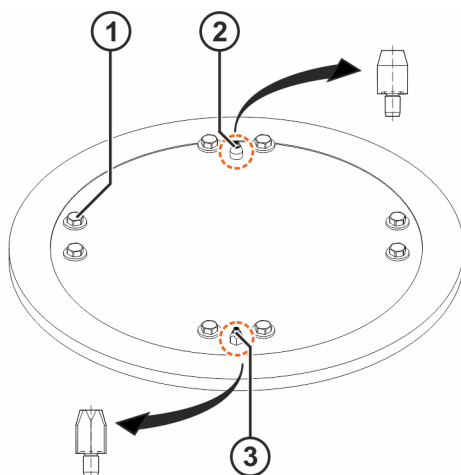


Fig. 5-7: Machine frame mounting

- 1 M24x65-8.8-A2K hexagon bolt (8x)
- 2 Locating pin, cylindrical

3 Locating pin, flat-sided

**WARNING****Danger to life and limb due to incorrect mounting**

If not mounted correctly, the kinematic system may topple over or fall down. Death, severe injury or damage to property may result.

- Only install the kinematic system using the mounting base or machine frame mounting.
- The stability must be ensured by the integrator or start-up technician.

Dimensioned drawing

The following illustration (>>> *Fig. 5-8*) provides all the necessary information on machine frame mounting, together with the required foundation data.

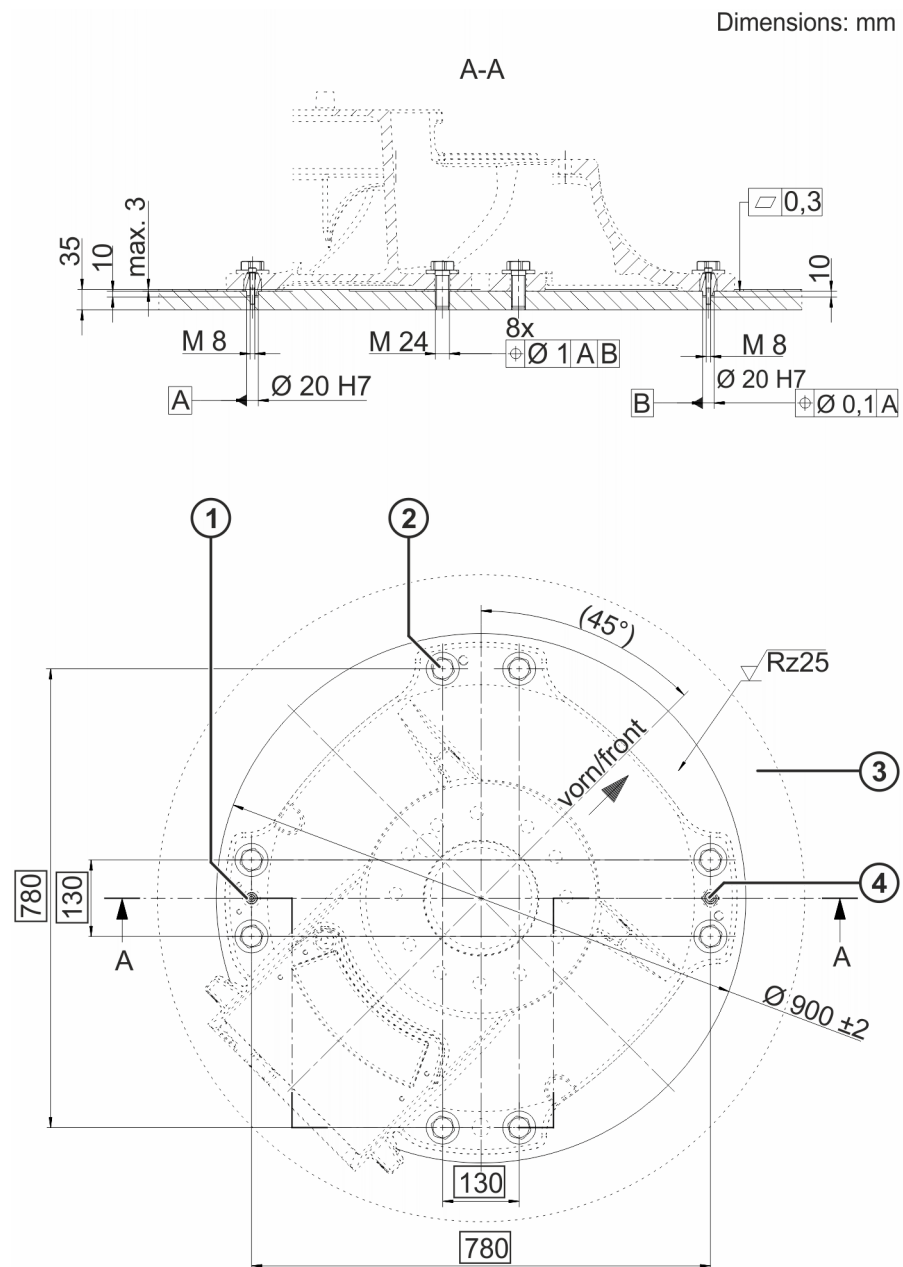


Fig. 5-8: Machine frame mounting, dimensioned drawing

- | | |
|------------------------------------|----------------------------|
| 1 Locating pin, cylindrical | 3 Mounting surface |
| 2 M24x65-8.8-A2K hexagon bolt (8x) | 4 Locating pin, flat-sided |

5.5 Connecting cables and interfaces

Connecting cables

The connecting cables comprise all the cables for transferring energy and data between the robot and the robot controller. They are connected on the robot side with connectors at interface A1.

Cable lengths of 7 m, 10 m, 15 m, 20 m, 25 m, 30 m, 35 m and 50 m are available as standard. The maximum length of the connecting cables must not exceed 50 m. The maximum number of connectors is 1, i.e. a maximum of 2 connecting cables may be combined with each other. Thus

if the robot is operated on a linear unit which has its own energy supply chain, this cable 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 conductor is connected via ring cable lugs. The threaded bolts for connecting the two ground conductors are located on the base frame of the robot.

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

- The bending radius for fixed routing must not be less than 150 mm for motor cables and 60 mm for data cables.
- Protect cables against exposure to mechanical stress.
- Route the cables without mechanical stress – no tensile forces on the connectors.
- Cables are only to be installed indoors.
- Observe the permissible temperature range (fixed installation) of 263 K (-10 °C) to 343 K (+55 °C).
- Route the motor cables and the data cables separately in metal ducts. If necessary, take additional measures to ensure electromagnetic compatibility (EMC).



CAUTION

Risk of injury due to tripping hazards

Improper installation of cables can cause tripping hazards. Injuries or damage to property may result.

- The connecting cables must be installed in such a way (e.g. cable ducts) as to prevent tripping hazards.
- Potential tripping hazards must be marked accordingly.

Interface A1

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

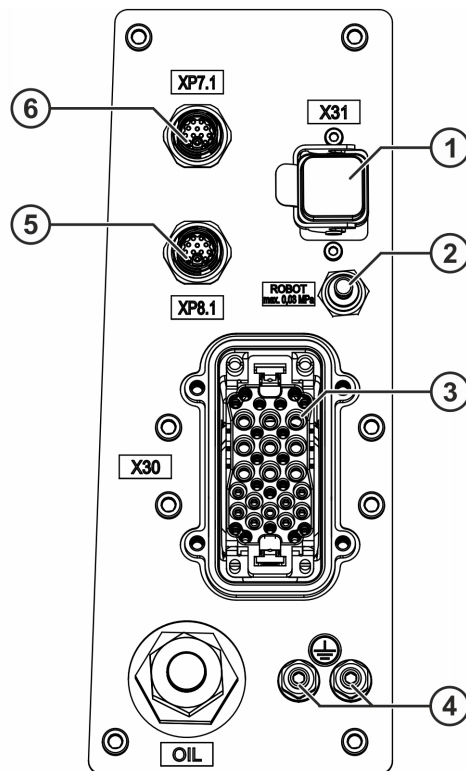


Fig. 5-9: Interface A1

- | | |
|----------------------------------|-------------------------|
| 1 Data cable X31 | 4 Ground conductor (2x) |
| 2 Purging air (for Foundry only) | 5 External axis XP8.1 |
| 3 Motor cable X30 | 6 External axis XP7.1 |

Interface for energy supply system

The robot can be equipped with an energy supply system between axis 1 and axis 2 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, for example, with connections for cables and hoses. Detailed information on the connector pin allocation, threaded unions, etc. is given in separate documentation.

6 Transportation

6.1 Transporting the robot

Description

Move the robot into its transport position each time it is transported. It must be ensured that the robot is stable while it is being transported. The robot must remain in its transport position until it has been fastened 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 adhesive on contact surfaces.

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

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:

Transport position	
A1	0 °
A2	-115 °
A3	-108 °
A4	0 °
A5	115 °
A6	0 °

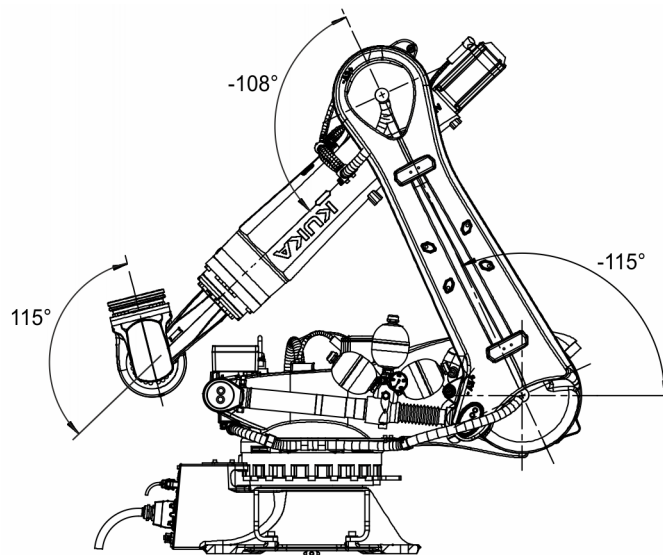
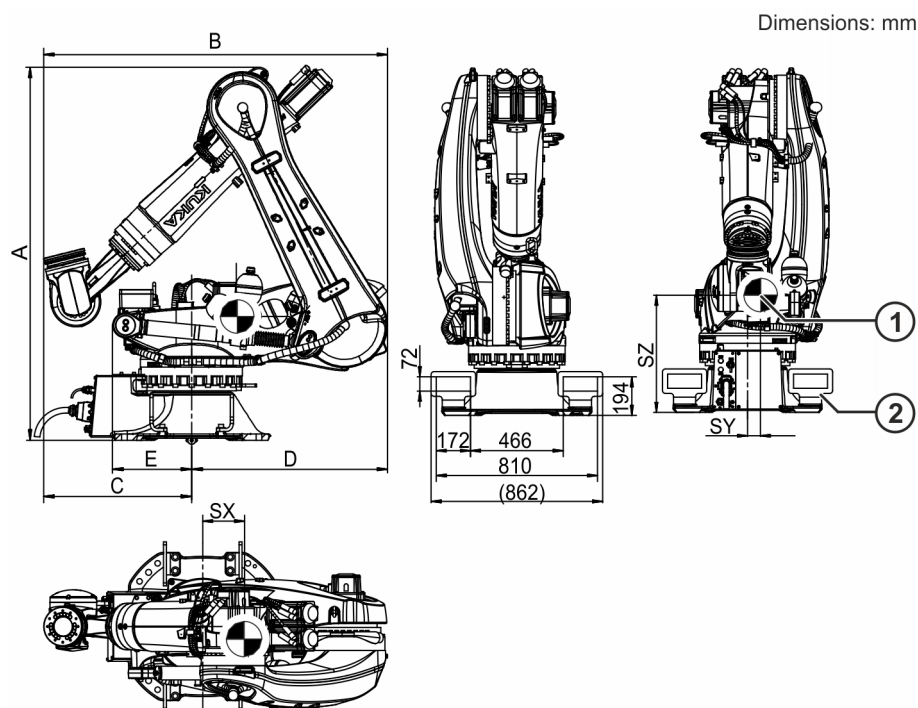


Fig. 6-1: Transport position

Transport dimensions

The transportation dimensions (>>> [Fig. 6-2](#)) for the robot can be noted from the following diagram. The position of the center of gravity and the weight vary according to the specific configuration and the position of axes 2 and 3. The specified dimensions refer to the robot without equipment.

**Fig. 6-2: Transport dimensions**

1 Center of gravity

2 Fork slots

Transport dimensions and centers of gravity in mm:

Robot	A	B	C	D	E	SX	SY	SZ
KR 120 R3500-2 P	1 967	1 904	967	937	379	177	-50	738
KR 120 R3500-2 P-C								
KR 120 R3900-2 K	1 967	2 191	1 254	937	379	144	-49	739
KR 180 R3500-2 K	1 967	1 904	967	937	379	177	-50	738
KR 180 R3500-2 K-F								
KR 210 R3300-2 K	1 967	1 760	823	937	379	132	-62	732
KR 210 R3300-2 K-F								
KR 270 R3100-2 K	1 785	1 675	738	937	379	210	-47	686
KR 270 R3100-2 K-F								

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. 6-3*), four fork slots are mounted on 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.

Ceiling-mounted machines can also be transported in a transport frame (already in the correct orientation).

NOTICE**Damage to property due to overloading of the fork slots**

Overloading the fork slots during transportation can cause damage to property.

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

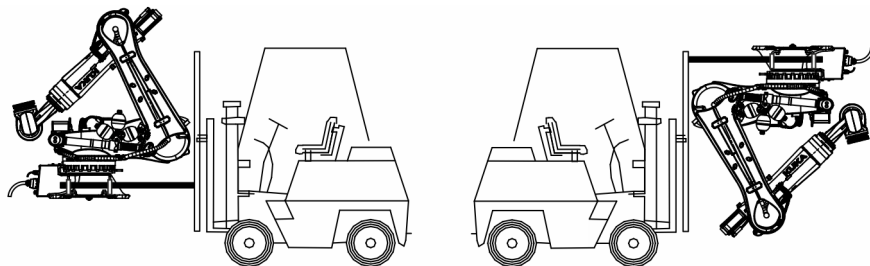


Fig. 6-3: Transportation by fork lift truck

Transportation with lifting tackle (optional)

The robot can also be transported using a crane and lifting tackle (optional) (>>> *Fig. 6-4*). For this, it must be in the transport position. The lifting tackle (optional) is attached to the 2 front fork slots and the rotating column. All the legs must be routed as shown in the following illustration so that the robot is not damaged. Installed tools and items of equipment can cause undesirable shifts in the center of gravity. Items of equipment, especially energy supply systems, must be removed to the extent necessary to avoid them being damaged by the legs of the lifting tackle during transportation.

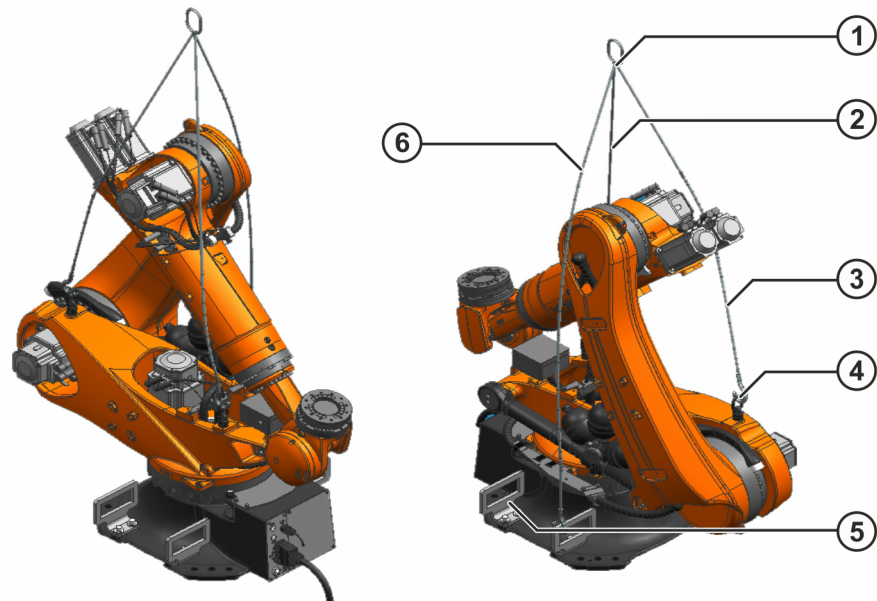


Fig. 6-4: Transportation using lifting tackle

- 1 Lifting tackle assembly
- 2 Leg G1
- 3 Leg G2
- 4 Attachment point for swivel
- 5 Fork slot
- 6 Leg G3



WARNING

The robot may tip during transportation. Risk of personal injury and damage to property.
If the robot is being transported using lifting tackle (optional), 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!

Transport safeguard

A transport safeguard is available if the robot is transported by truck, for example. The robot can be tied down by means of a lashing belt. Care must be taken to position the lashing belt over the transport safeguard. The lashing belt must not be placed over the motor or other robot components and thus subjected to a load. Damage to property may otherwise result.

The transport safeguard and fork slots can be removed for operation.

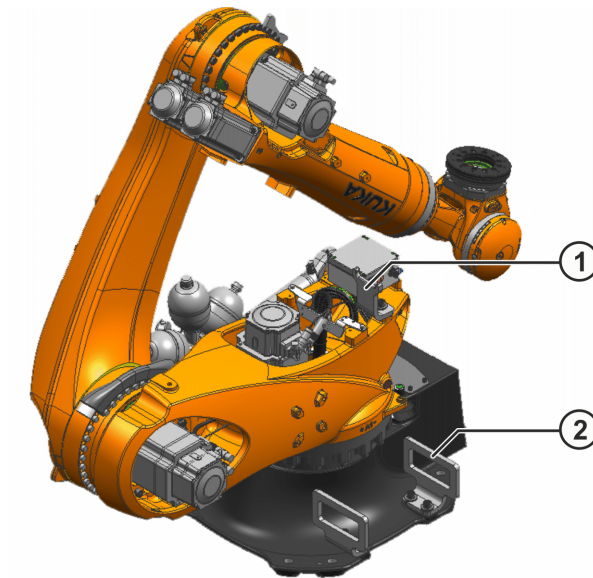


Fig. 6-5: Transport safeguard

- 1 Transport safeguard
- 2 Fork slot

7 Appendix

7.1 Applied standards and regulations

Name/Edition	Definition
2006/42/EC:2006	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)
2014/68/EU:2014	Pressure Equipment Directive: Directive 2014/68/EU of the European Parliament and of the Council dated 15 May 2014 on the approximation of the laws of the Member States concerning pressure equipment (Only applicable for robots with hydropneumatic counterbalancing system.)
EN 60204-1:2018	Safety of machinery: Electrical equipment of machines – Part 1: General requirements
EN 61000-6-2:2005	Electromagnetic compatibility (EMC): Part 6-2: Generic standards; Immunity for industrial environments
EN 61000-6-4:2007 + A1:2011	Electromagnetic compatibility (EMC): Part 6-4: Generic standards; Emission standard for industrial environments
EN 614-1:2006+A1:2009	Safety of machinery: Ergonomic design principles - Part 1: Terms and general principles
EN ISO 10218-1:2011	Industrial robots – Safety requirements: Part 1: Robots Note: Content equivalent to ANSI/RIA R.15.06-2012, Part 1
EN ISO 12100:2010	Safety of machinery: General principles of design, risk assessment and risk reduction
EN ISO 13849-1:2015	Safety of machinery: Safety-related parts of control systems - Part 1: General principles of design
EN ISO 13849-2:2012	Safety of machinery: Safety-related parts of control systems - Part 2: Validation
EN ISO 13850:2015	Safety of machinery: Emergency stop - Principles for design

8 KUKA Service

8.1 Requesting support

Introduction

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

Information

The following information is required for processing a support request:

- Description of the problem, including information about the duration and frequency of the fault
- The greatest possible amount of information about the hardware and software components of the overall system

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

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

8.2 KUKA Customer Support

The contact details of the local subsidiaries can be found at:
www.kuka.com/customer-service-contacts

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