KUKA

Robots

KR QUANTEC nano

Specification

Issued: 24.01.2024

Spez KR QUANTEC nano V6

KUKA Deutschland GmbH

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.

KIM-PS5-DOC

Translation of the original documentation

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Contents

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 or smartPAD pro (if used)
- Documentation for the System Software
- Instructions for options and accessories
- Spare parts overview in KUKA Xpert

Each set 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.

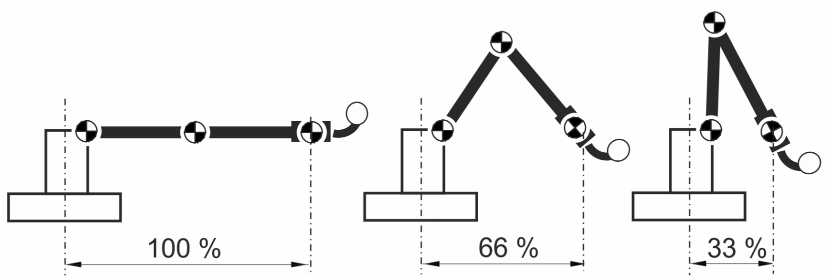
Notices

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 within which the axis 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° C (273 K).
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
HI	High Inertia
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	Teach pendant for the robot controller The smartPAD has all the operator control and display functions required for operation and programming. The following models exist: • KUKA smartPAD • KUKA smartPAD-2 • KUKA smartPAD pro For robot controllers of the KR C5 series with KUKA System Software or VW System Software, only the model **KUKA smartPAD-2** is used. For robot controllers of the KR C5 series with KUKA iiQKA.OS, only the model **KUKA smartPAD pro** is used. For other robot controllers, the designation “KUKA smartPAD” or “smartPAD” always refers to all models possible for the respective controller unless an explicit distinction is made.
Stop categories	**Note:** Information about the stop categories for KUKA robot controllers can be found in the “Safety” chapter of the robot controller assembly instructions.
T1	Test mode, Manual Reduced Velocity (<= 250 mm/s) **For KUKA iiQKA.OS:** With manual guidance in T1, the velocity is not reduced, but rather limited through a safety-oriented velocity monitoring in accordance with the safety configuration.
T2	**For KUKA iiQKA.OS:** not relevant at present **For KUKA System Software / VW System Software:** Test mode, Manual High Velocity (> 250 mm/s permissible)
W	Wall
WP	Waterproof

External axis	**For KUKA iiQKA.OS:** not relevant at present **For KUKA System Software / VW System Software:** Axis of motion that does not belong to the manipulator, yet is controlled with the robot controller. For example, KUKA linear unit, turn-tilt table and 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), control cabinet, connecting cables, end effector (tool) and other equipment. The KR QUANTEC nano product family comprises the variants:

- KR 120 R1800 nano
- KR 120 R1800 nano C
- KR 160 R1570 nano
- KR 160 R1570 nano C

An industrial robot of this type comprises the following components:

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

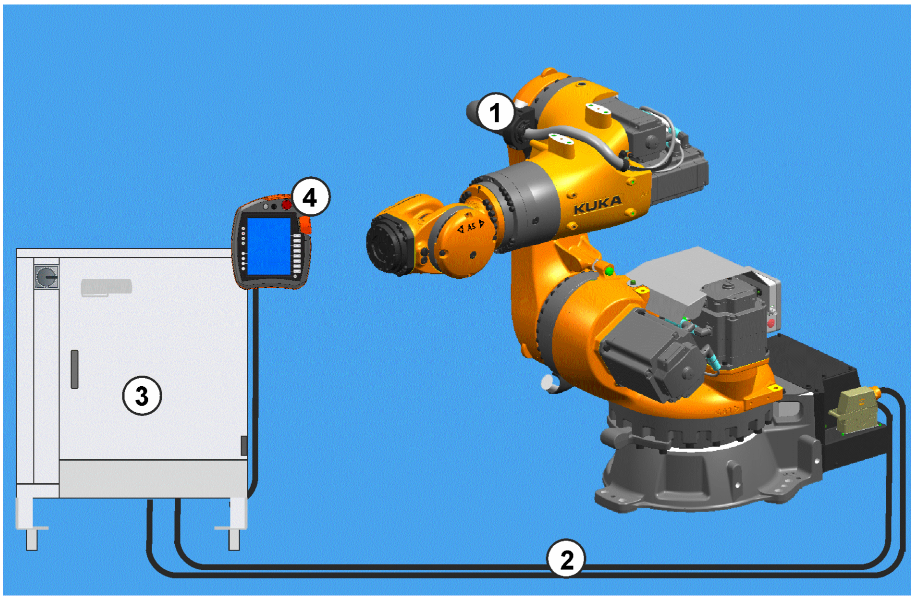


Fig. 2-1: Example of a robot system

1	Manipulator	3	Robot controller
2	Connecting cables	4	KUKA smartPAD teach pendant

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
- Rotating column
- Base frame
- Electrical installations

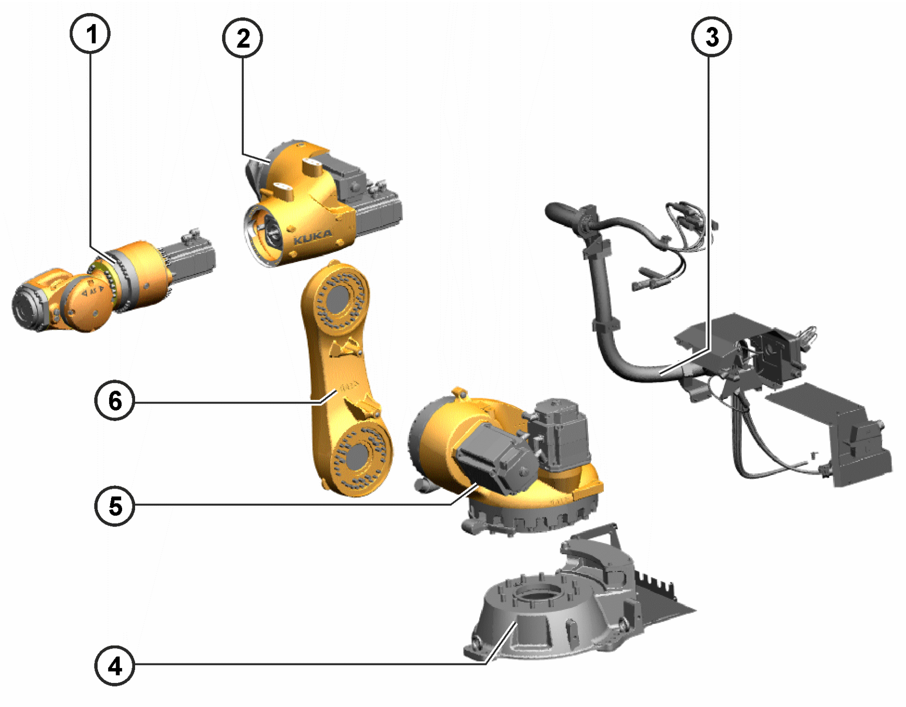


Fig. 2-2: Principal components

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

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. With both of the payload categories 120 kg and 160 kg, a mounting flange with a 125 mm hole circle is used. A separate in-line wrist version is available for each of the two variants. The in-line wrist can additionally be fitted with an adapter flange to achieve a hole circle diameter of 160 mm. Both mounting flanges conform, with minimal deviations, to DIN/ISO 9409-1-A.

Arm

The arm is the link between the in-line wrist and the link arm. It houses the motors of wrist axes 3, 4 and 5. The arm is driven by the motor and the gear unit of axis 3. The maximum permissible swivel angle is mechanically limited by a stop for each direction, plus and minus. The associated buffers are attached to the arm. The gear unit of axis 3 is integrated into the arm. There is an interface on the arm with 4 holes for fastening supplementary loads.

Link arm

The link arm is the assembly located between the arm and the rotating column. It consists of the link arm body with the buffers for axis 2. Two arm variants are available to obtain the specified reach. Depending on the reach of the robot variant, the “link arm, short” or the “link arm, long” is used.

Rotating column

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

Base frame

The base frame is the base of the robot. It is screwed to the mounting base. The push-in module and the electrical installations are fastened in the base frame. It thus forms the interface for the motor and data cable and the energy supply system.

Electrical installations

The electrical installations include all the motor and control cables for the motors of axes 1 to 6. All connections are implemented as plug-in connectors in order to enable the motors to be exchanged quickly and reliably. The electrical installations also include the RDC box and the multi-function housing (MFH). The RDC box is located in the rotating column. The MFH and the connector for the 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 and A3
- Energy supply systems A1 to A3
- Energy supply systems A3 to A6
- Booster Frame C590

The following options are also available:

- Mounting flange (adapter)
- Control cable for single axis
- Release device

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, for example. KUKA Service must be consulted in this event.

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 within which the axis 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	The service life of a safety-relevant component begins at the time of delivery of the component to the customer. The service life is not affected by whether the component is used or not, as safety-relevant components are also subject to aging during storage.
Danger zone	The danger zone consists of the workspace and the stopping distances of the manipulator and external axes (optional).
KCP	KUKA Control Panel Teach pendant for the KR C2/KR C2 edition2005 The KCP has all the operator control and display functions required for operating and programming the industrial robot.
KUKA smartPAD	see “smartPAD”
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.
smartPAD	Teach pendant for the robot controller The smartPAD has all the operator control and display functions required for operation and programming. The following models exist: • KUKA smartPAD • KUKA smartPAD-2 • KUKA smartPAD pro For robot controllers of the KR C5 series with KUKA System Software or VW System Software, only the model **KUKA smartPAD-2** is used. For robot controllers of the KR C5 series with KUKA iiQKA.OS, only the model **KUKA smartPAD pro** is used. For other robot controllers, the designation “KUKA smartPAD” or “smartPAD” always refers to all models possible for the respective controller unless an explicit distinction is made.
Stop categories	**Note:** Information about the stop categories for KUKA robot controllers can be found in the “Safety” chapter of the robot controller assembly instructions.
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) **For KUKA iiQKA.OS:** With manual guidance in T1, the velocity is not reduced, but rather limited through a safety-oriented velocity monitoring in accordance with the safety configuration.
T2	**For KUKA iiQKA.OS:** not relevant at present **For KUKA System Software / VW System Software:** Test mode, Manual High Velocity (> 250 mm/s permissible)

External axis	**For KUKA iiQKA.OS:** not relevant at present **For KUKA System Software / VW System Software:** Axis of motion that does not belong to the manipulator, yet is controlled with the robot controller. For example, KUKA linear unit, turn-tilt table and 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 (PPE).

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 the risk assessment
- Implementing the required safety functions and safeguards
- Issuing the EC declaration of conformity
- Affixing 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.
- Put external axis out of operation.
- KUKA must be consulted before they are 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.

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 caused by motors and brakes

Electric motors and brakes 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 motors and brakes. This applies to both energized and deenergized motors and brakes.

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.

The enabling switches on the smartPAD must be subjected to a function test at least once every 12 months and in certain specific cases.

Information about function testing for KUKA robot controllers can be found in the “Safety” chapter of the operating or assembly instructions of the robot controller.

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 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
The external application of force, 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 jam 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 can be avoided, there must be no persons inside the safeguarded area.

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 more than one person 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 the 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 regulations must be observed for this check. The correct functioning of all safety functions must also be tested.

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

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

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

DANGER

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 Technical data, overview

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

Robot	Technical data
KR 120 R1800 nano	• Technical data (>>> 4.2 "Technical data, KR 120 R1800 nano" Page 29) • Plates and labels (>>> 4.6 "Plates and labels" Page 73) • Stopping distances and times (>>> 4.8.2 "Stopping distances and times, KR 120 R1800 nano and KR 120 R1800 nano C" Page 78)
KR 120 R1800 nano C	• Technical data (>>> 4.3 "Technical data, KR 120 R1800 nano C" Page 40) • Plates and labels (>>> 4.6 "Plates and labels" Page 73) • Stopping distances and times (>>> 4.8.2 "Stopping distances and times, KR 120 R1800 nano and KR 120 R1800 nano C" Page 78)
KR 160 R1570 nano	• Technical data (>>> 4.4 "Technical data, KR 160 R1570 nano" Page 51) • Plates and labels (>>> 4.6 "Plates and labels" Page 73) • Stopping distances and times (>>> 4.8.3 "Stopping distances and times, KR 160 R1570 nano and KR 160 R1570 nano C" Page 83)
KR 160 R1570 nano C	• Technical data (>>> 4.5 "Technical data, KR 160 R1570 nano C" Page 62) • Plates and labels (>>> 4.6 "Plates and labels" Page 73) • Stopping distances and times (>>> 4.8.3 "Stopping distances and times, KR 160 R1570 nano and KR 160 R1570 nano C" Page 83)

4.2 Technical data, KR 120 R1800 nano

4.2.1 Basic data, KR 120 R1800 nano

Basic data

	KR 120 R1800 nano
Number of axes	6
Number of controlled axes	6
Volume of working envelope	21.1 m^3
Pose repeatability (ISO 9283)	± 0.06 mm

	KR 120 R1800 nano
Weight	approx. 684 kg
Rated payload	120 kg
Maximum payload	197 kg
Maximum reach	1803 mm
Protection rating (IEC 60529)	IP65
Protection rating, robot wrist (IEC 60529)	IP65
Sound level	< 75 dB (A)
Mounting position	Floor
Footprint	901 mm x 610 mm
Hole pattern: mounting surface for kinematic system	C590
Permissible angle of inclination	± 45 °
Default color	Base frame: black (RAL 9005); Moving parts: KUKA orange 2567
Controller	KR C5 M6/M7; KR C4
Transformation name	KR C4: KR120R1800 NANO C4 FLR; KR C5: KR120R1800 NANO C4 FLR

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

Ambient conditions

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

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

Connecting cables, KR C4

Cable designation	Connector designation Robot controller - robot	Interface with robot
Motor cable	X20 – X30	Han® 24
Control cable	X21 – X31	Han® 3A Q12
Ground conductor / equipotential bonding 16 mm^2		M8 ring cable lug at both ends

Cable lengths	7 m, 15 m, 25 m, 35 m, 50 m
Max. cable length	50 m
Number of extensions	1

Minimum bending radius	5x D

Connecting cables, KR C5

Cable designation	Connector designation Robot controller - robot	Interface with robot
Motor cable	6 motor connectors: XD20.1 … XD20.6 - XD30 2 brake connectors: XD10.1, XD10.2 - XD30	Han® 24
Control cable	XF21 – XF31	Han® 3A Q12
Ground conductor / equipotential bonding 16 mm^2		M8 ring cable lug at both ends

Cable lengths	7 m, 10 m 15 m, 25 m, 35 m, 50 m
Max. cable length	50 m
Number of extensions	1

Minimum bending radius	5x D

4.2.2 Axis data, KR 120 R1800 nano

Axis data

Motion range	
A1	±180 °
A2	-145 ° / 45 °
A3	-130 ° / 150 °
A4	±350 °
A5	±125 °
A6	±350 °
Speed with rated payload	
A1	123 °/s
A2	114 °/s
A3	86 °/s
A4	292 °/s
A5	258 °/s
A6	284 °/s

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

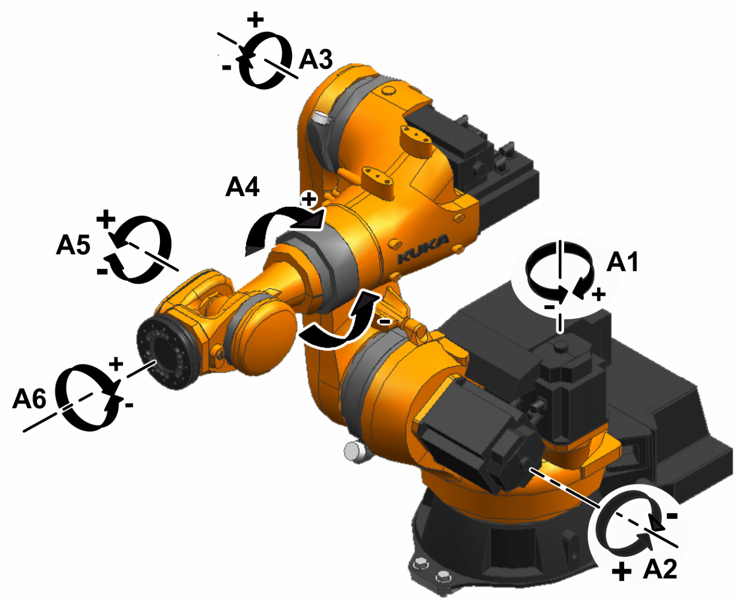


Fig. 4-1: Direction of rotation of the axes

Mastering position

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

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.

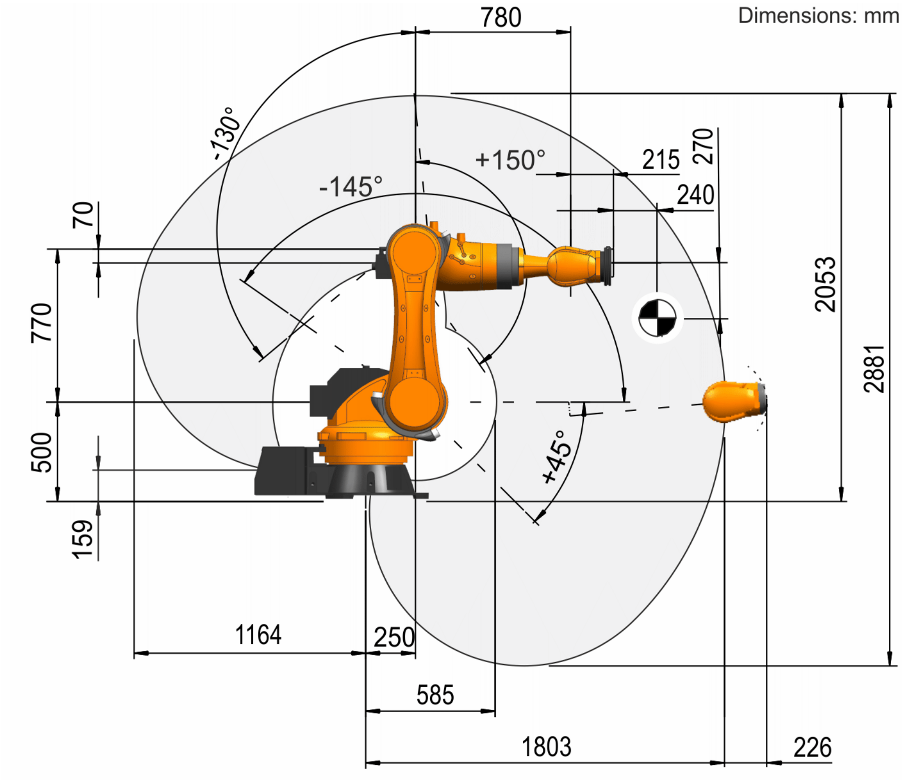


Fig. 4-2: KR 120 R1800 nano working envelope, side view

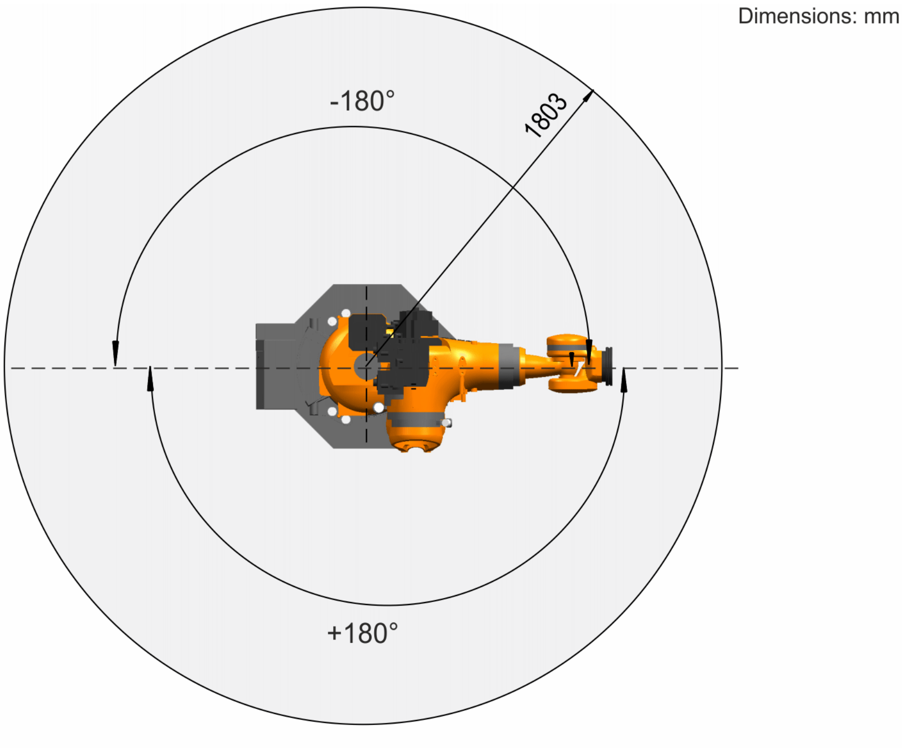


Fig. 4-3: KR 120 R1800 nano working envelope, top view

Inclined installation

The robot can be installed in any position from 0° (floor) to 180° (ceiling). The following figure shows the possible limitation of the motion range of axis 1, as a function of the angle of inclination of the robot.

The inclination angles for the robot must be entered correctly into the controller if the robot is not operated in the floor-mounted position. Configuration of the angles is possible via WorkVisual.

The inclination angles for an unchanged main working direction of the robot:

Floor: A:0°, B:0°, C:0°

Wall: A:0°, B:90°, C:0°

Ceiling: A:0°, B:0°, C:180°

CAUTION

The inclined installation angles must be individually checked and entered. An incorrectly entered inclined installation angle can lead to unforeseen motion and/or to an overload and, potentially, damage to the robot.

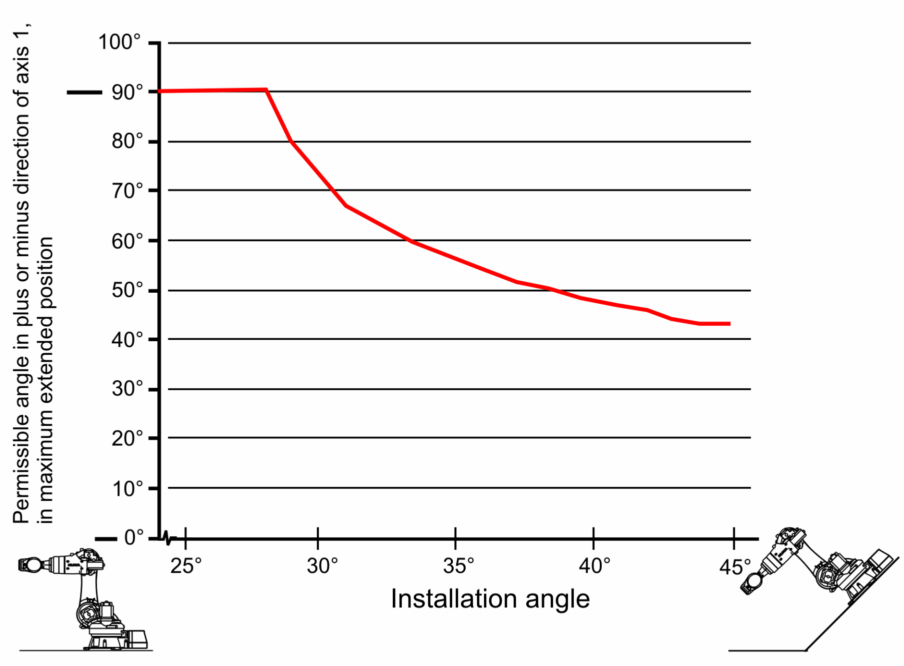


Fig. 4-4: Permissible axis angle for axis 1 at an inclined position

4.2.3 Payloads, KR 120 R1800 nano

Payloads

Rated payload	120 kg
Maximum payload	197 kg
Rated supplementary load, base frame	0 kg
Maximum supplementary load, base frame	-
Rated supplementary load, rotating column	0 kg
Maximum supplementary load, rotating column	0 kg
Rated supplementary load, link arm	0 kg

Maximum supplementary load, link arm	0 kg
Rated supplementary load, arm	50 kg
Maximum supplementary load, arm	100 kg

Load center of gravity and mass moment of inertia

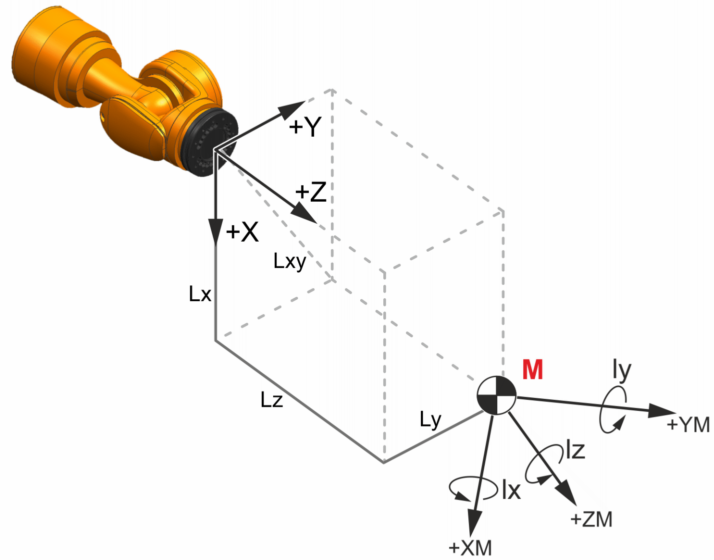


Fig. 4-5: Load center of gravity and mass moment of inertia

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
A, B, C	Degrees	Orientation of the principal inertia axes • 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'' **Note:** A, B and C are not shown in the diagram.
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.

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

Payload diagram

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

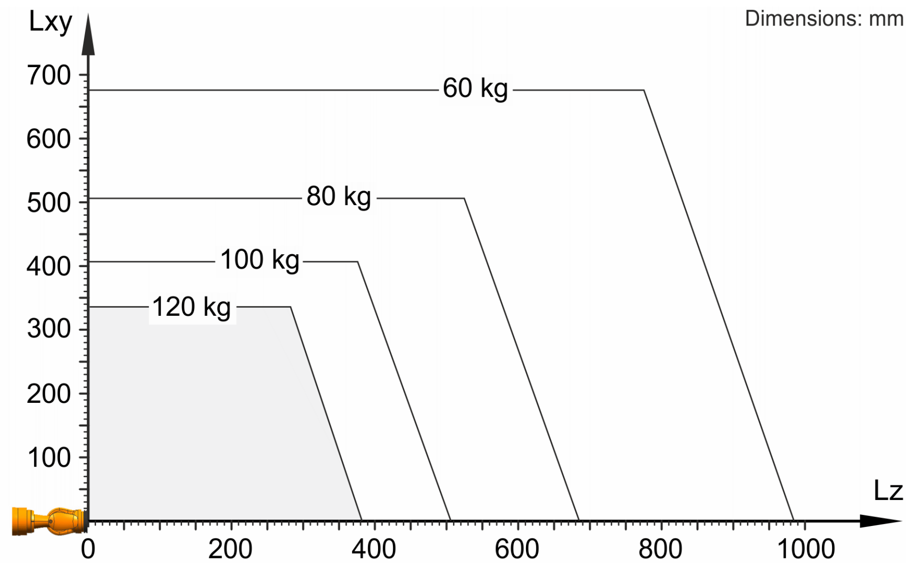


Fig. 4-6: Payload diagram, KR 120 R1800 nano

Mounting flange

Robot wrist type	ZH 90/120
Mounting flange standard	Deviation, see figure

Diameter (hole circle)	125 mm
Thread diameter	M10
Depth of engagement	min. 12 mm, max. 16 mm
Number of threads	11
Screw grade	10.9
Locating element	10^{H7}

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

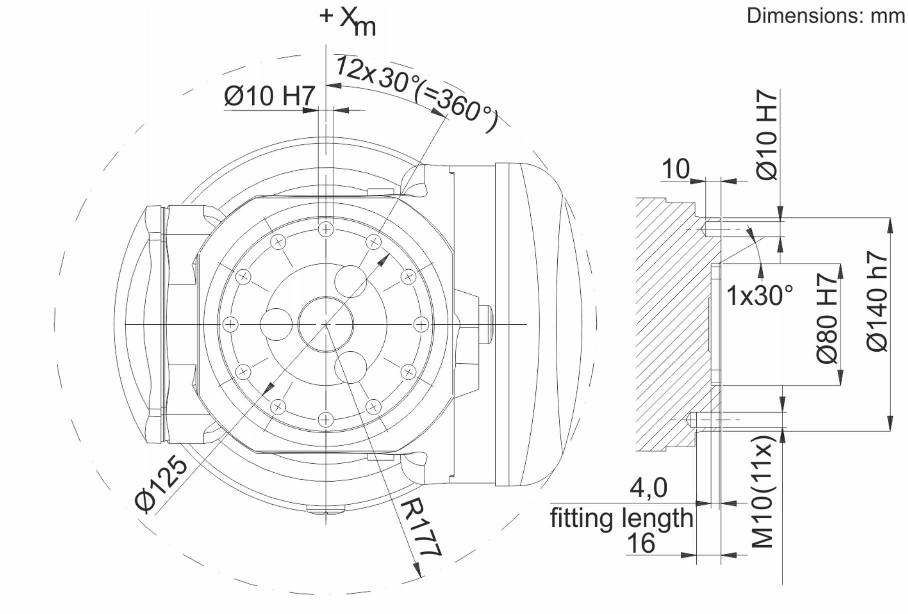


Fig. 4-7: Mounting flange D=125

Flange loads

The motion of the robot causes forces and torques to act on the mounting flange, which are transmitted to the mounted payload (e.g. tool).

The specified values refer to nominal payloads and do not include any safety factors. The actual 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. 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.

The payload must be able to permanently withstand the forces and torques generated during normal operation.

The EMERGENCY STOP values only rarely occur during the service life of the robot (emergency situations). The frequency depends on the configuration of the system.

WARNING
Danger to life and limb due to insufficient stability of the tool Incorrectly dimensioned tools can fracture and fail. Death, severe injuries or damage to property may result. • Calculate the tool for each individual case, taking the load data into consideration. • Use the specified installation equipment.

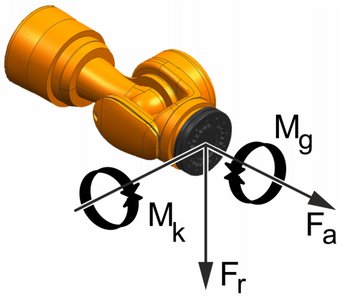


Fig. 4-8: Flange loads

Flange loads during operation	
F(a)	2518 N
F(r)	2906 N
M(k)	2184 Nm
M(g)	899 Nm
Flange loads in the case of EMERGENCY STOP	
F(a)	3558 N
F(r)	3923 N
M(k)	2746 Nm
M(g)	2525 Nm

Axial force F(a), radial force F(r), tilting torque M(k), torque about mounting flange M(g)

Supplementary load

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

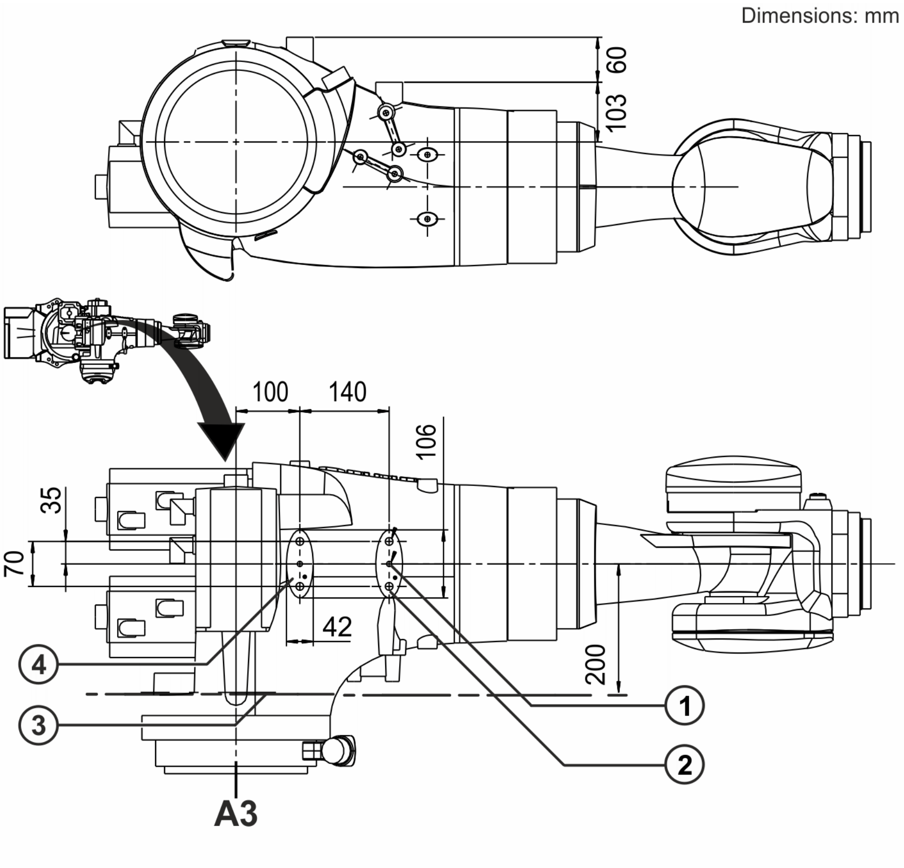


Fig. 4-9: Supplementary load, arm

1 Fastening borehole, 8 mm, 15 deep, 2x
2 Fastening threads, M12, 24 deep, 4x
3 Interference contour, arm
4 Mounting surface, 2x

4.2.4 Foundation loads, KR 120 R1800 nano

Depending on the payload (e.g. tool), supplementary load and the robot's own mass (weight), the motion of the robot generates forces and torques which are transmitted to the foundation.

The specified values refer to nominal payloads and do not include any safety factors. The actual 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. 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.

Supplementary loads on A1 (rotating column) and A2 (link arm) are not taken into consideration in the calculation of the foundation load. These must be taken into account in the vertical force (F_v).

The foundation must be able to permanently withstand the forces and torques generated during normal operation.

The EMERGENCY STOP values only rarely occur during the service life of the robot (emergency situations). The frequency depends on the configuration of the system.

WARNING

Danger to life and limb due to insufficient stability of the foundation

An incorrectly dimensioned foundation can fracture and fail. Death, severe injuries or damage to property may result.

- Calculate the foundation loads for each individual case.
- Use the specified installation equipment.

Vertical force F(v)	
F(v normal)	10828 N
F(v max)	12396 N
Horizontal force F(h)	
F(h normal)	3955 N
F(h max)	5226 N
Tilting moment M(k)	
M(k normal)	9467 Nm
M(k max)	14433 Nm
Torque about axis 1 M(r)	
M(r normal)	5534 Nm
M(r max)	5726 Nm

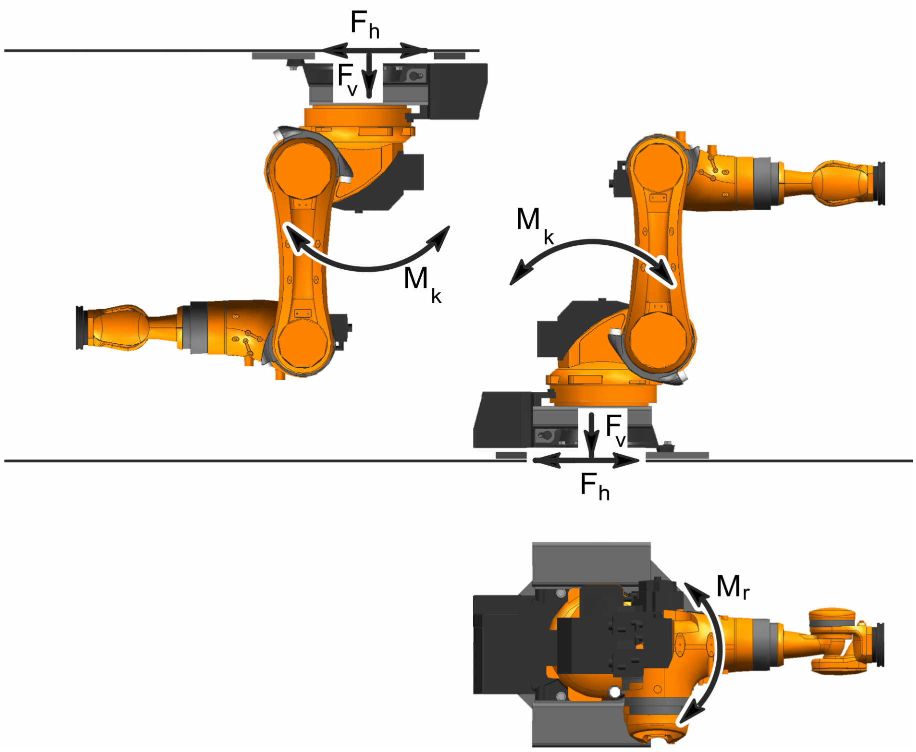


Fig. 4-10: Foundation loads

4.3 Technical data, KR 120 R1800 nano C

4.3.1 Basic data, KR 120 R1800 nano C

Basic data

	KR 120 R1800 nano C
Number of axes	6
Number of controlled axes	6
Volume of working envelope	21.1 m^3
Pose repeatability (ISO 9283)	± 0.06 mm
Weight	approx. 684 kg
Rated payload	120 kg
Maximum payload	197 kg
Maximum reach	1803 mm
Protection rating (IEC 60529)	IP65
Protection rating, robot wrist (IEC 60529)	IP65
Sound level	< 75 dB (A)
Mounting position	Ceiling
Footprint	901 mm x 610 mm
Hole pattern: mounting surface for kinematic system	C590
Permissible angle of inclination	± 45 °
Default color	Base frame: black (RAL 9005); Moving parts: KUKA orange 2567

	KR 120 R1800 nano C
Controller	KR C5 M6/M7; KR C4
Transformation name	KR C4: KR120R1800 NANO C4 CLG; KR C5: KR120R1800 NANO C4 CLG

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

Ambient conditions

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

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

Connecting cables, KR C4

Cable designation	Connector designation Robot controller - robot	Interface with robot
Motor cable	X20 – X30	Han® 24
Control cable	X21 – X31	Han® 3A Q12
Ground conductor / equipotential bonding 16 mm^2		M8 ring cable lug at both ends

Cable lengths	7 m, 15 m, 25 m, 35 m, 50 m
Max. cable length	50 m
Number of extensions	1

Minimum bending radius	5x D

Connecting cables, KR C5

Cable designation	Connector designation Robot controller - robot	Interface with robot
Motor cable	6 motor connectors: XD20.1 … XD20.6 - XD30 2 brake connectors: XD10.1, XD10.2 - XD30	Han® 24
Control cable	XF21 – XF31	Han® 3A Q12
Ground conductor / equipotential bonding 16 mm²		M8 ring cable lug at both ends

Cable lengths	7 m, 10 m 15 m, 25 m, 35 m, 50 m
Max. cable length	50 m
Number of extensions	1

Minimum bending radius	5x D

4.3.2 Axis data, KR 120 R1800 nano C

Axis data

Motion range	
A1	±180 °
A2	-145 ° / 45 °
A3	-130 ° / 150 °
A4	±350 °
A5	±125 °
A6	±350 °
Speed with rated payload	
A1	123 °/s
A2	114 °/s
A3	86 °/s
A4	292 °/s
A5	258 °/s
A6	284 °/s

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

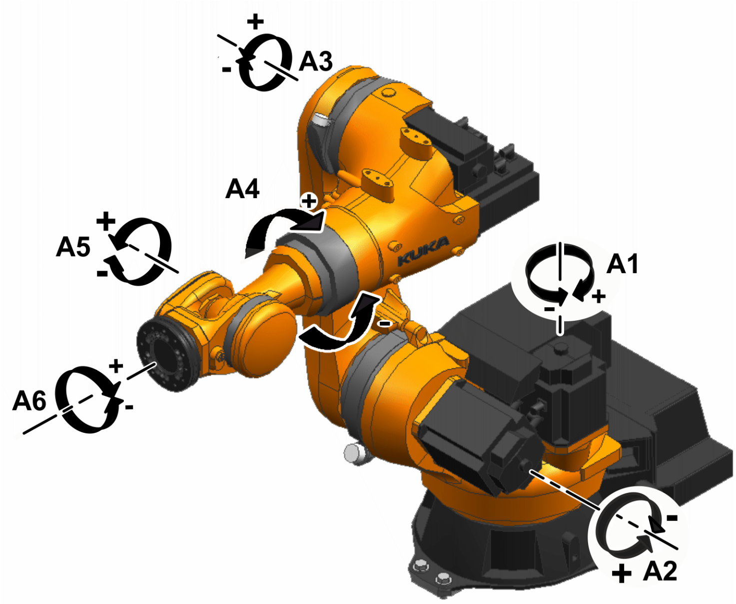


Fig. 4-11: Direction of rotation of the axes

Mastering position

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

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.

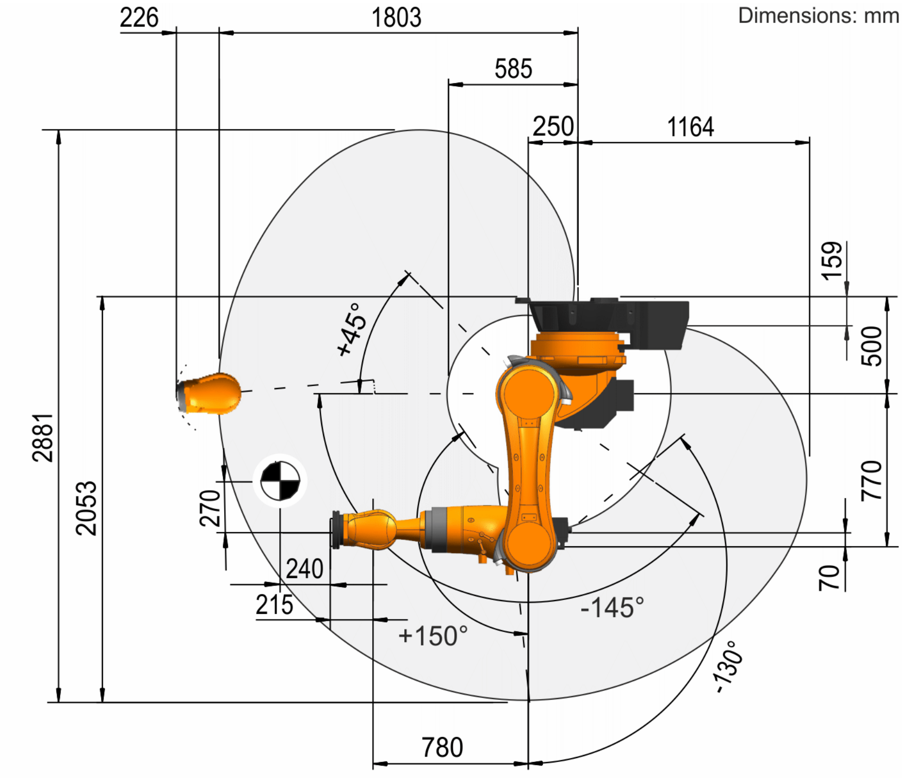


Fig. 4-12: KR 120 R1800 nano C working envelope, side view

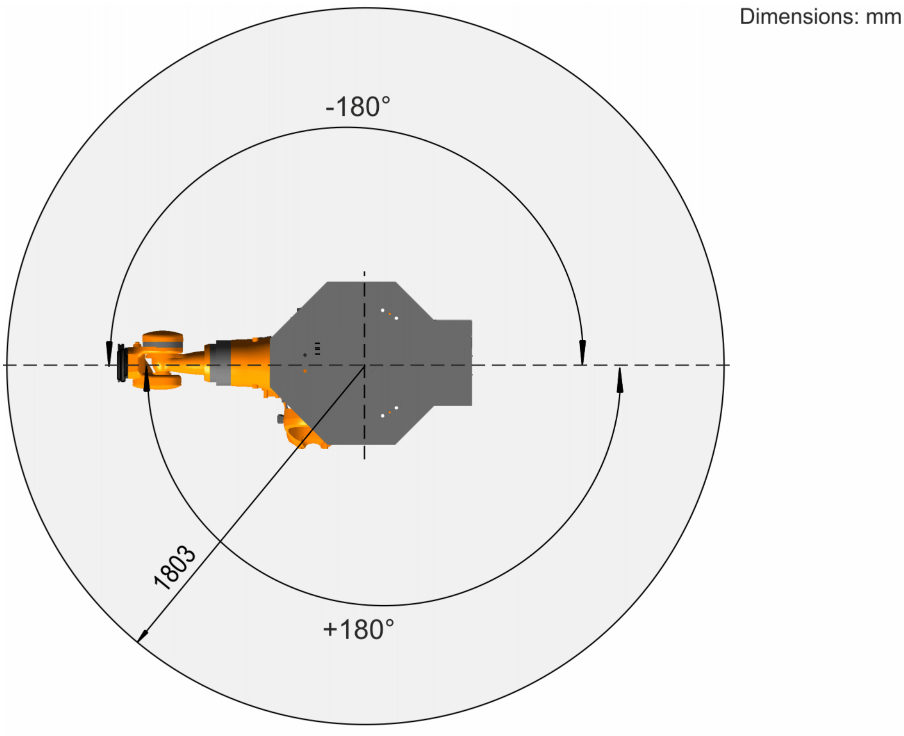


Fig. 4-13: KR 120 R1800 nano C working envelope, top view

Inclined installation

The robot can be installed in any position from 0° (floor) to 180° (ceiling). The following figure shows the possible limitation of the motion range of axis 1, as a function of the angle of inclination of the robot.

The inclination angles for the robot must be entered correctly into the controller if the robot is not operated in the floor-mounted position. Configuration of the angles is possible via WorkVisual.

The inclination angles for an unchanged main working direction of the robot:

Floor: A:0°, B:0°, C:0°

Wall: A:0°, B:90°, C:0°

Ceiling: A:0°, B:0°, C:180°

CAUTION

The inclined installation angles must be individually checked and entered. An incorrectly entered inclined installation angle can lead to unforeseen motion and/or to an overload and, potentially, damage to the robot.

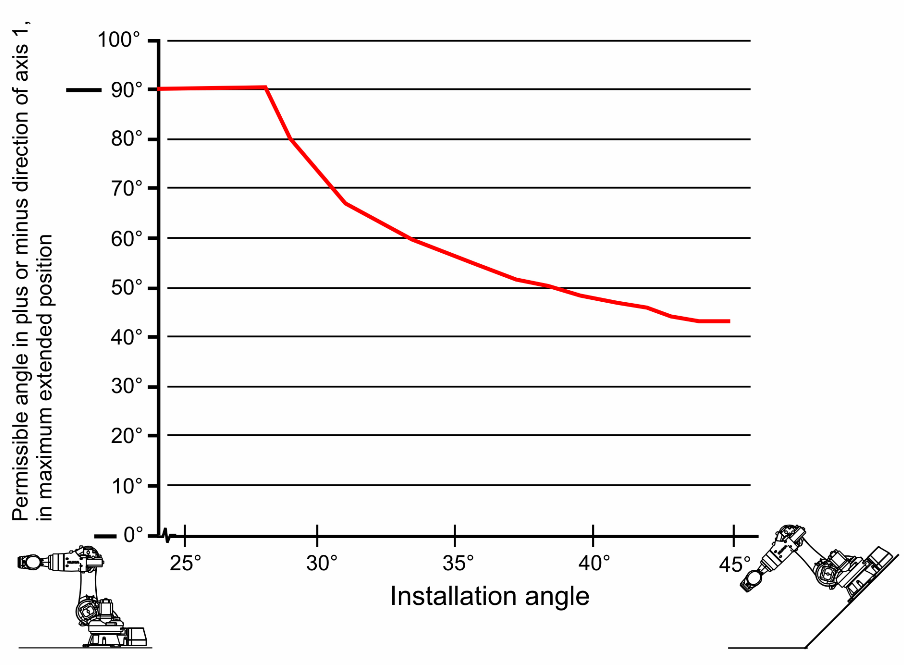


Fig. 4-14: Permissible axis angle for axis 1 at an inclined position

4.3.3 Payloads, KR 120 R1800 nano C

Payloads

Rated payload	120 kg
Maximum payload	197 kg
Rated supplementary load, base frame	0 kg
Maximum supplementary load, base frame	-
Rated supplementary load, rotating column	0 kg
Maximum supplementary load, rotating column	0 kg
Rated supplementary load, link arm	0 kg

Maximum supplementary load, link arm	0 kg
Rated supplementary load, arm	50 kg
Maximum supplementary load, arm	100 kg

Load center of gravity and mass moment of inertia

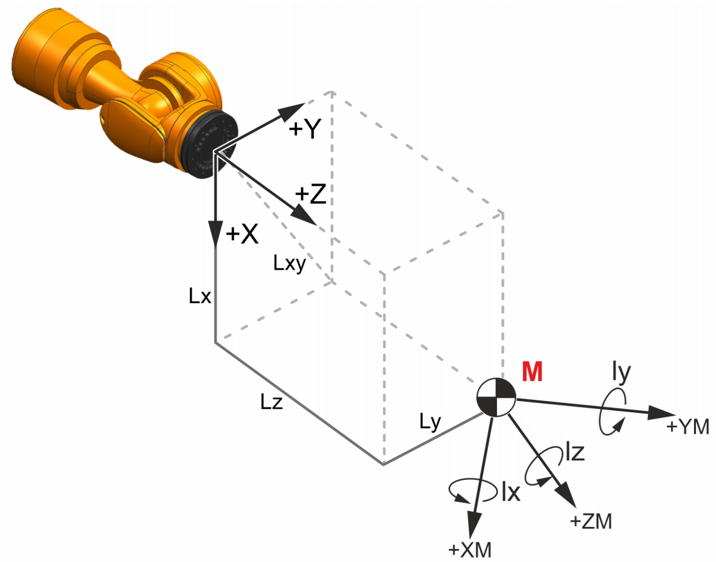


Fig. 4-15: Load center of gravity and mass moment of inertia

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
A, B, C	Degrees	Orientation of the principal inertia axes • 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'' **Note:** A, B and C are not shown in the diagram.
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.

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

Payload diagram

NOTICE

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

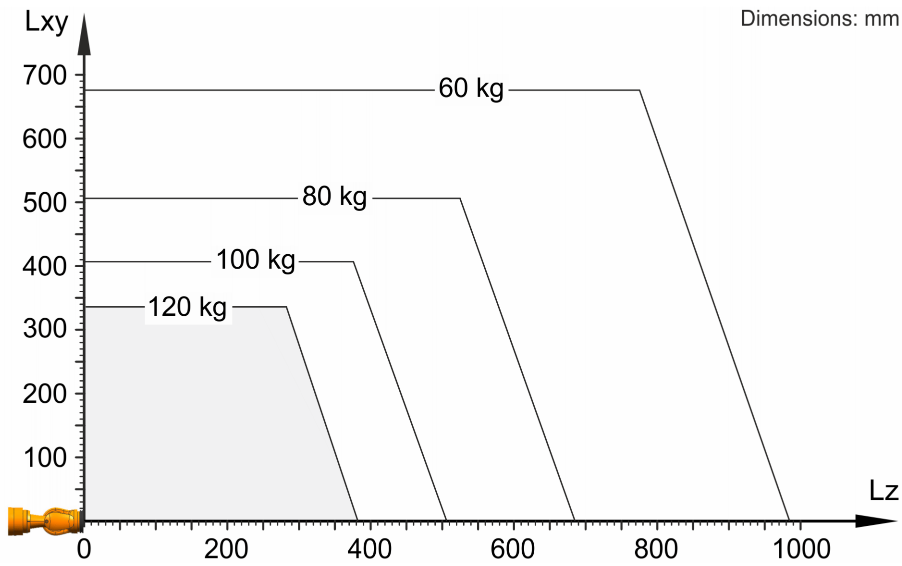


Fig. 4-16: Payload diagram, KR 120 R1800 nano C

Mounting flange

Robot wrist type	ZH 90/120
Mounting flange standard	Deviation, see figure

Diameter (hole circle)	125 mm
Thread diameter	M10
Depth of engagement	min. 12 mm, max. 16 mm
Number of threads	11
Screw grade	10.9
Locating element	10^{H7}

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

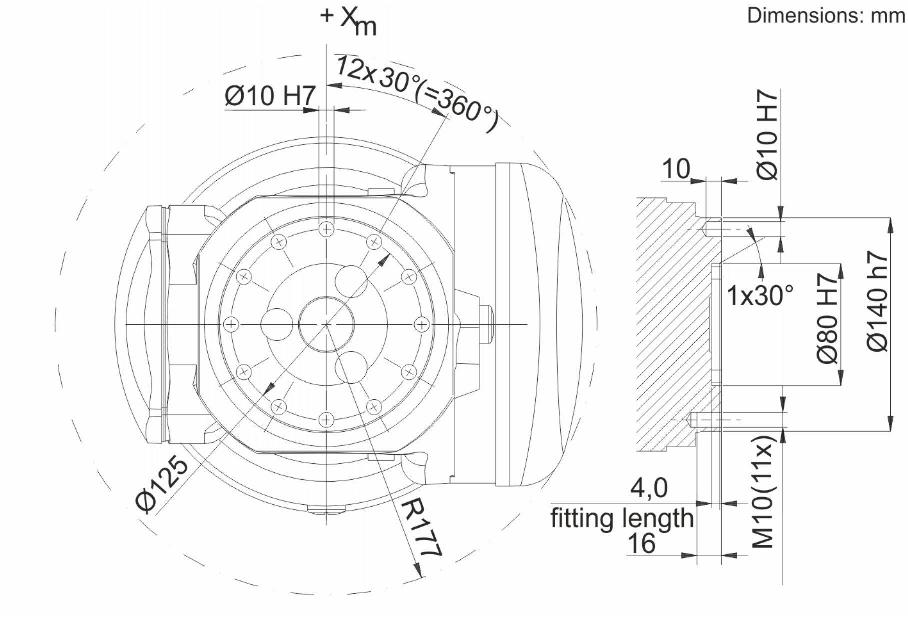


Fig. 4-17: Mounting flange D=125

Flange loads

The motion of the robot causes forces and torques to act on the mounting flange, which are transmitted to the mounted payload (e.g. tool).

The specified values refer to nominal payloads and do not include any safety factors. The actual 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. 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.

The payload must be able to permanently withstand the forces and torques generated during normal operation.

The EMERGENCY STOP values only rarely occur during the service life of the robot (emergency situations). The frequency depends on the configuration of the system.

WARNING

Danger to life and limb due to insufficient stability of the tool
Incorrectly dimensioned tools can fracture and fail. Death, severe injuries or damage to property may result.

- Calculate the tool for each individual case, taking the load data into consideration.
- Use the specified installation equipment.

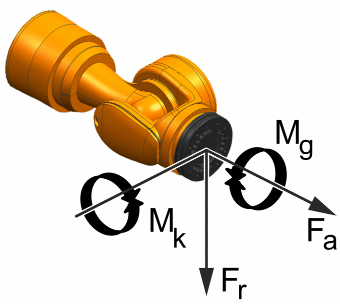


Fig. 4-18: Flange loads

Flange loads during operation	
F(a)	2518 N
F(r)	2906 N
M(k)	2184 Nm
M(g)	899 Nm
Flange loads in the case of EMERGENCY STOP	
F(a)	3558 N
F(r)	3923 N
M(k)	2746 Nm
M(g)	2525 Nm

Axial force F(a), radial force F(r), tilting torque M(k), torque about mounting flange M(g)

Supplementary load

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

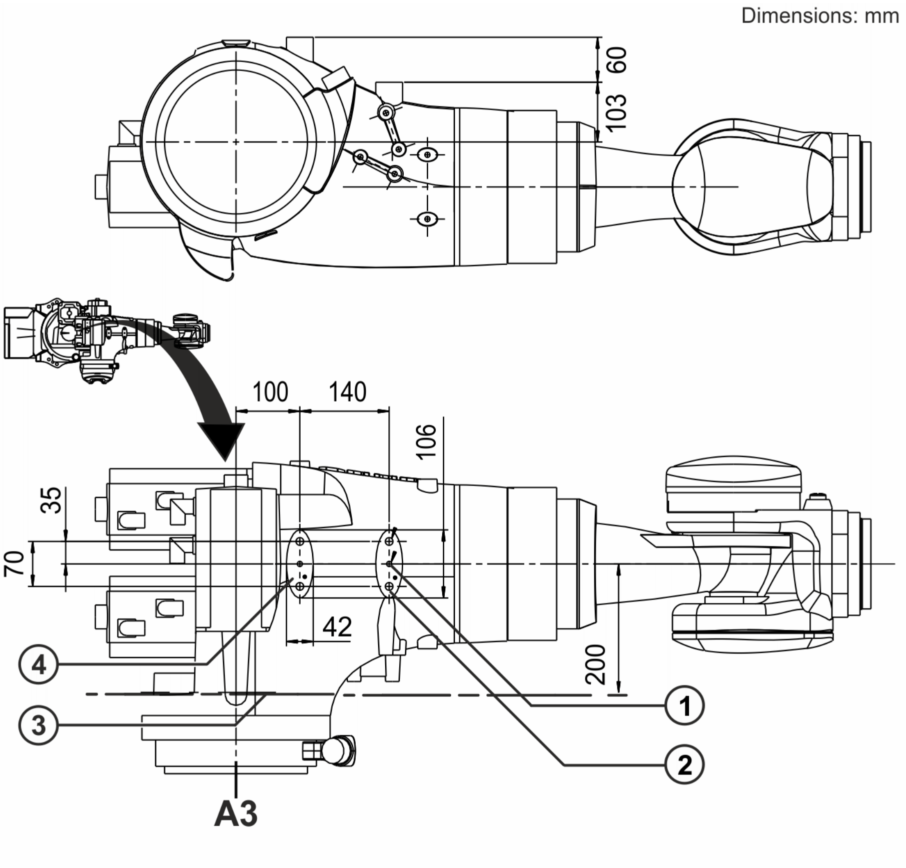


Fig. 4-19: Supplementary load, arm

1 Fastening borehole, 8 mm, 15 deep, 2x
2 Fastening threads, M12, 24 deep, 4x
3 Interference contour, arm
4 Mounting surface, 2x

4.3.4 Foundation loads, KR 120 R1800 nano C

Depending on the payload (e.g. tool), supplementary load and the robot's own mass (weight), the motion of the robot generates forces and torques which are transmitted to the foundation.

The specified values refer to nominal payloads and do not include any safety factors. The actual 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. 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.

Supplementary loads on A1 (rotating column) and A2 (link arm) are not taken into consideration in the calculation of the foundation load. These must be taken into account in the vertical force (F_v).

The foundation must be able to permanently withstand the forces and torques generated during normal operation.

The EMERGENCY STOP values only rarely occur during the service life of the robot (emergency situations). The frequency depends on the configuration of the system.

WARNING

Danger to life and limb due to insufficient stability of the foundation

An incorrectly dimensioned foundation can fracture and fail. Death, severe injuries or damage to property may result.

- Calculate the foundation loads for each individual case.
- Use the specified installation equipment.

Vertical force F(v)	
F(v normal)	10828 N
F(v max)	12396 N
Horizontal force F(h)	
F(h normal)	3955 N
F(h max)	5226 N
Tilting moment M(k)	
M(k normal)	9467 Nm
M(k max)	14433 Nm
Torque about axis 1 M(r)	
M(r normal)	5534 Nm
M(r max)	5726 Nm

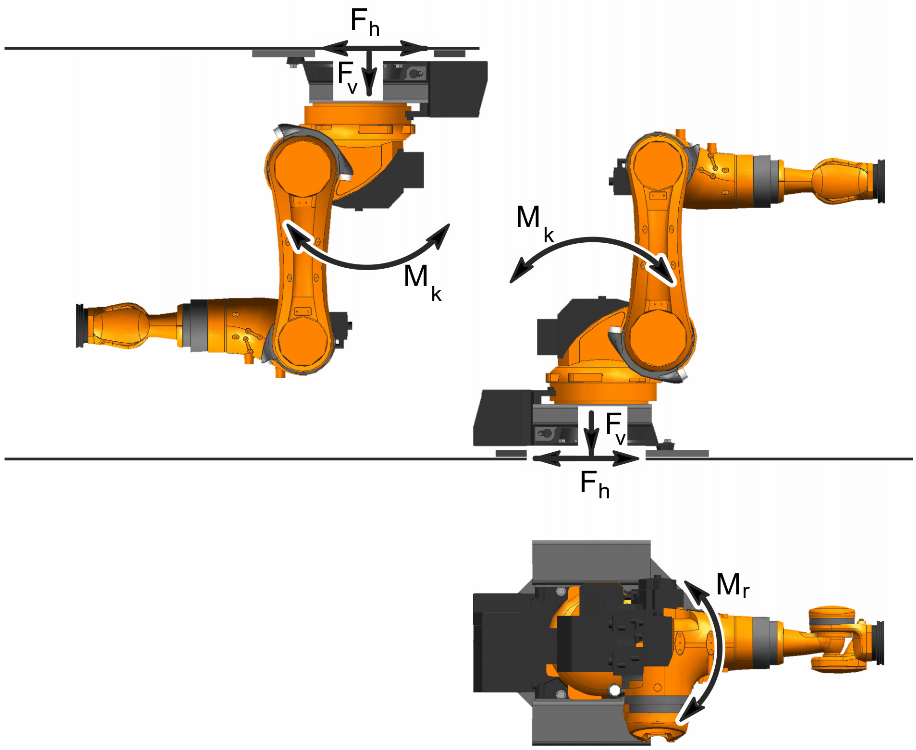


Fig. 4-20: Foundation loads

4.4 Technical data, KR 160 R1570 nano

4.4.1 Basic data, KR 160 R1570 nano

Basic data

	KR 160 R1570 nano
Number of axes	6
Number of controlled axes	6
Volume of working envelope	13.9 m³
Pose repeatability (ISO 9283)	± 0.06 mm
Weight	approx. 677 kg
Rated payload	160 kg
Maximum payload	224 kg
Maximum reach	1573 mm
Protection rating (IEC 60529)	IP65
Protection rating, robot wrist (IEC 60529)	IP65
Sound level	< 75 dB (A)
Mounting position	Floor
Footprint	901 mm x 610 mm
Hole pattern: mounting surface for kinematic system	C590
Permissible angle of inclination	± 45 °
Default color	Base frame: black (RAL 9005); Moving parts: KUKA orange 2567

	KR 160 R1570 nano
Controller	KR C5 M6/M7; KR C4
Transformation name	KR C4: KR160R1570 NANO C4 FLR; KR C5: KR160R1570 NANO C4 FLR

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

Ambient conditions

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

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

Connecting cables, KR C4

Cable designation	**Connector designation** **Robot controller - robot**	**Interface with robot**
Motor cable	X20 – X30	Han® 24
Control cable	X21 – X31	Han® 3A Q12
Ground conductor / equipotential bonding 16 mm²		M8 ring cable lug at both ends

Cable lengths	7 m, 15 m, 25 m, 35 m, 50 m
Max. cable length	50 m
Number of extensions	1
Minimum bending radius	5x D

Connecting cables, KR C5

Cable designation	Connector designation Robot controller - robot	Interface with robot
Motor cable	6 motor connectors: XD20.1 … XD20.6 - XD30 2 brake connectors: XD10.1, XD10.2 - XD30	Han® 24
Control cable	XF21 – XF31	Han® 3A Q12
Ground conductor / equipotential bonding 16 mm^2		M8 ring cable lug at both ends

Cable lengths	7 m, 10 m 15 m, 25 m, 35 m, 50 m
Max. cable length	50 m
Number of extensions	1

Minimum bending radius	5x D

4.4.2 Axis data, KR 160 R1570 nano

Axis data

Motion range	
A1	±180 °
A2	-145 ° / 45 °
A3	-130 ° / 145 °
A4	±350 °
A5	±120 °
A6	±350 °
Speed with rated payload	
A1	123 °/s
A2	114 °/s
A3	86 °/s
A4	179 °/s
A5	172 °/s
A6	220 °/s

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

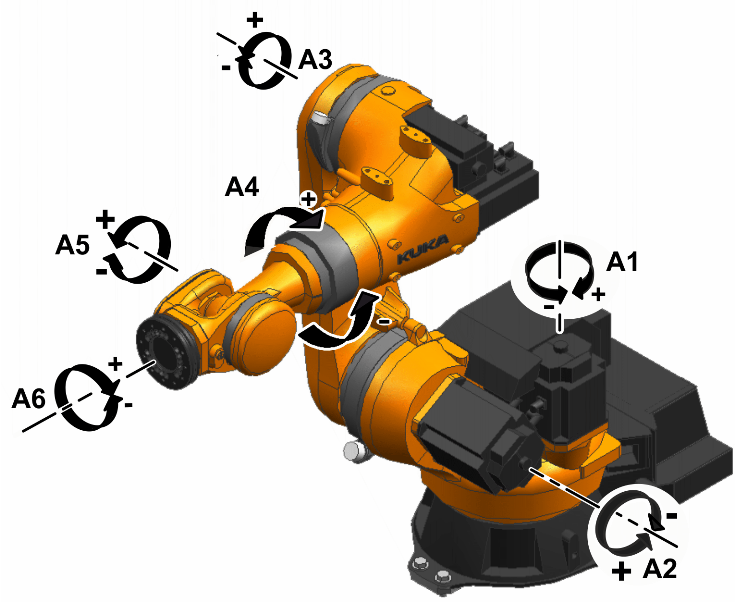


Fig. 4-21: Direction of rotation of the axes

Mastering position

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

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.

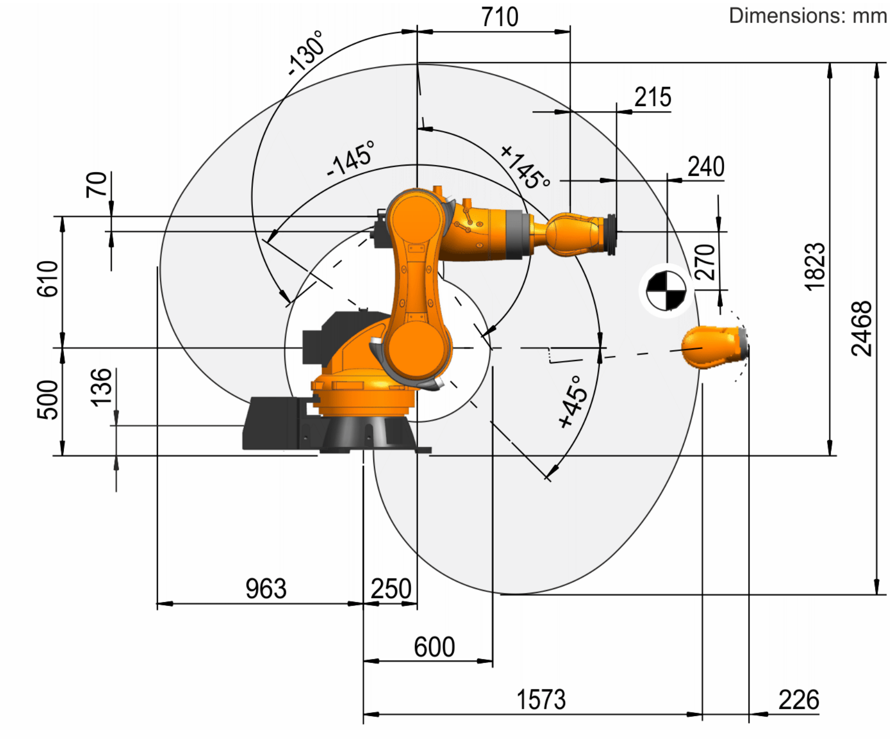


Fig. 4-22: KR 160 R1570 nano working envelope, side view

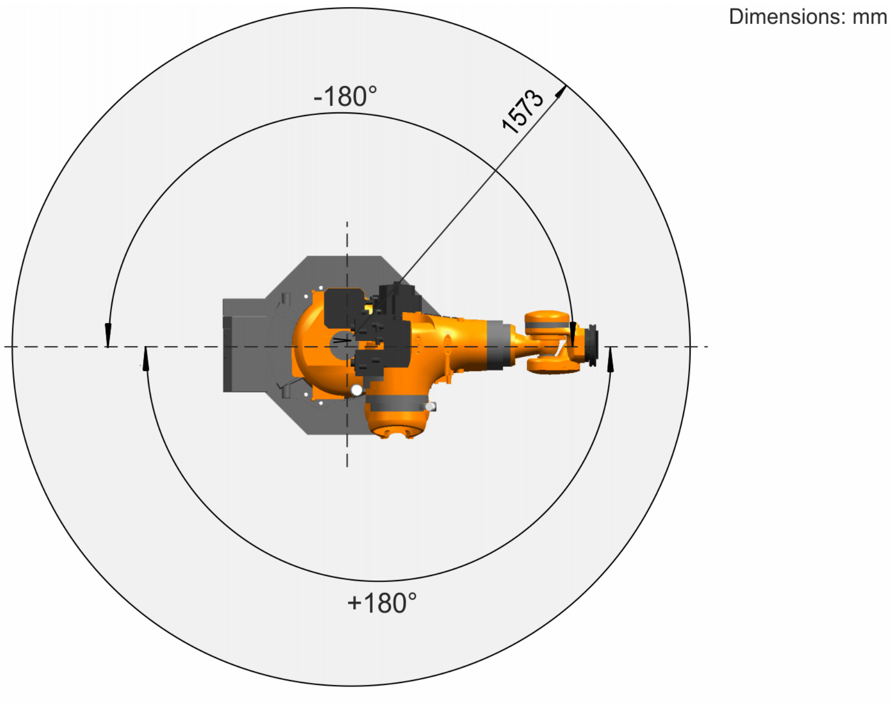


Fig. 4-23: KR 160 R1570 nano working envelope, top view

Inclined installation

The robot can be installed in any position from 0° (floor) to 180° (ceiling). The following figure shows the possible limitation of the motion range of axis 1, as a function of the angle of inclination of the robot.

The inclination angles for the robot must be entered correctly into the controller if the robot is not operated in the floor-mounted position. Configuration of the angles is possible via WorkVisual.

The inclination angles for an unchanged main working direction of the robot:

Floor: A:0°, B:0°, C:0°

Wall: A:0°, B:90°, C:0°

Ceiling: A:0°, B:0°, C:180°

CAUTION

The inclined installation angles must be individually checked and entered. An incorrectly entered inclined installation angle can lead to unforeseen motion and/or to an overload and, potentially, damage to the robot.

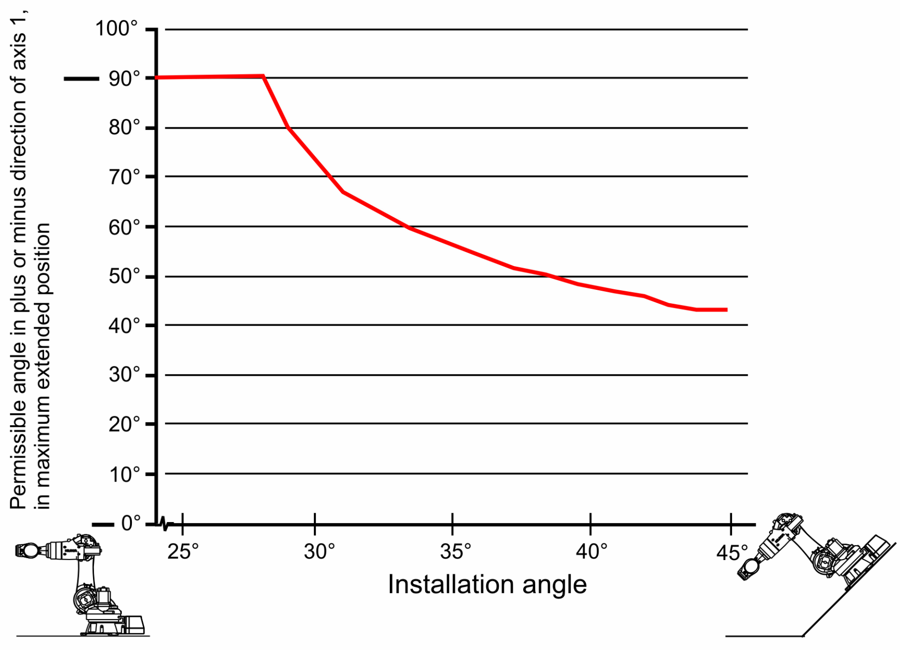


Fig. 4-24: Permissible axis angle for axis 1 at an inclined position

4.4.3 Payloads, KR 160 R1570 nano

Payloads

Rated payload	160 kg
Maximum payload	224 kg
Rated supplementary load, base frame	0 kg
Maximum supplementary load, base frame	-
Rated supplementary load, rotating column	0 kg
Maximum supplementary load, rotating column	0 kg
Rated supplementary load, link arm	0 kg
Maximum supplementary load, link arm	0 kg
Rated supplementary load, arm	50 kg

Maximum supplementary load, arm	100 kg

Load center of gravity and mass moment of inertia

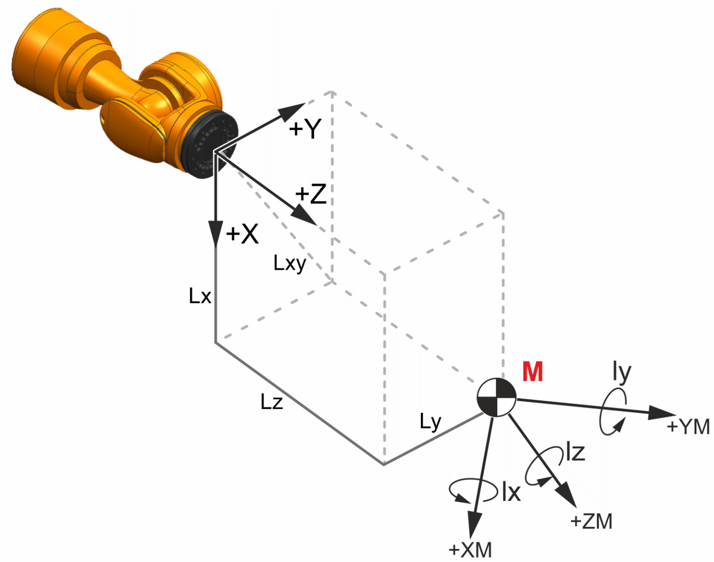


Fig. 4-25: Load center of gravity and mass moment of inertia

Parameter

Parameter/unit		Description
Mass	kg	Payload mass
$\mathbf{L_x}$, $\mathbf{L_y}$, $\mathbf{L_z}$	mm	Position of the center of mass in the reference system
A, **B**, **C**	Degrees	Orientation of the principal inertia axes • 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'' **Note:** A, B and C are not shown in the diagram.
Mass moments of inertia:		
$\mathbf{I_x}$	kgm^2	Inertia about the X axis of the main axis system
$\mathbf{I_y}$	kgm^2	Inertia about the Y axis of the main axis system
$\mathbf{I_z}$	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.

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

Payload diagram

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

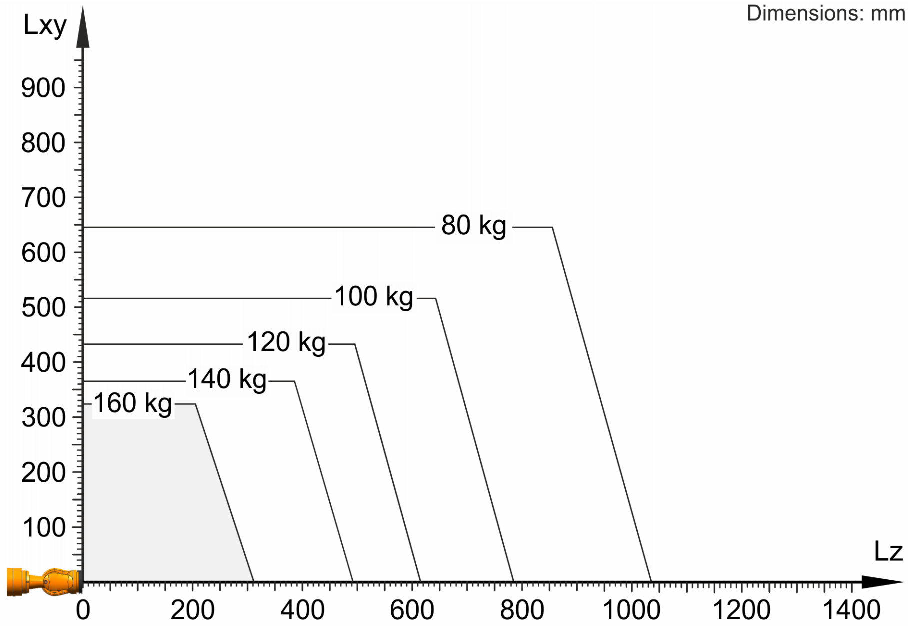


Fig. 4-26: Payload diagram, KR 160 R1570 nano

Mounting flange

Robot wrist type	ZH 160
Mounting flange standard	Deviation, see figure

Diameter (hole circle)	125 mm
Thread diameter	M10
Depth of engagement	min. 12 mm, max. 16 mm
Number of threads	11
Screw grade	10.9
Locating element	$10^{\,H7}$

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

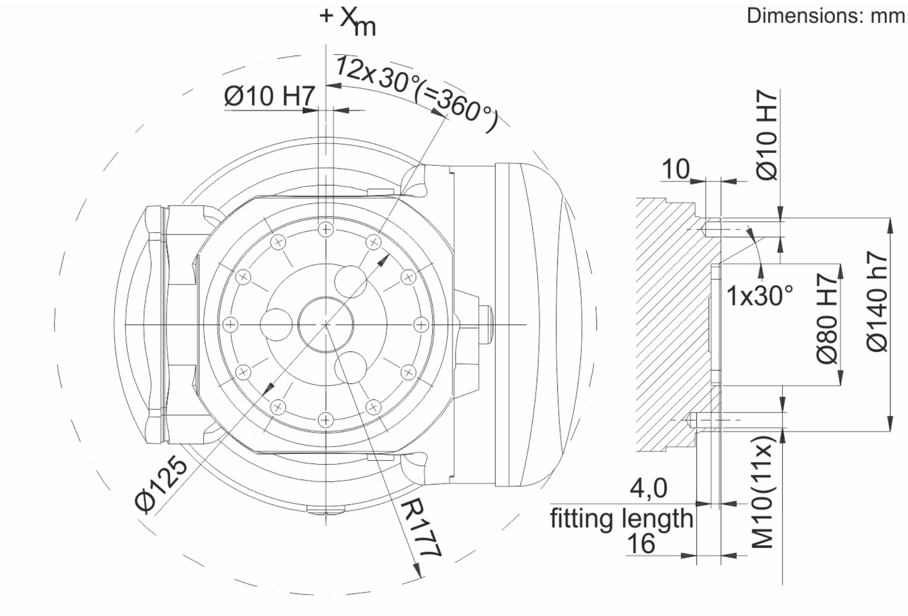


Fig. 4-27: Mounting flange D=125

Flange loads

The motion of the robot causes forces and torques to act on the mounting flange, which are transmitted to the mounted payload (e.g. tool).

The specified values refer to nominal payloads and do not include any safety factors. The actual 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. 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.

The payload must be able to permanently withstand the forces and torques generated during normal operation.

The EMERGENCY STOP values only rarely occur during the service life of the robot (emergency situations). The frequency depends on the configuration of the system.

WARNING

Danger to life and limb due to insufficient stability of the tool
Incorrectly dimensioned tools can fracture and fail. Death, severe injuries or damage to property may result.

- Calculate the tool for each individual case, taking the load data into consideration.
- Use the specified installation equipment.

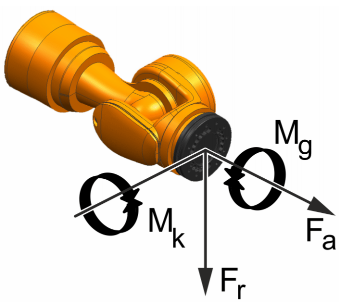


Fig. 4-28: Flange loads

Flange loads during operation	
F(a)	2518 N
F(r)	2906 N
M(k)	2184 Nm
M(g)	899 Nm
Flange loads in the case of EMERGENCY STOP	
F(a)	3558 N
F(r)	3923 N
M(k)	2746 Nm
M(g)	2525 Nm

Axial force F(a), radial force F(r), tilting torque M(k), torque about mounting flange M(g)

Supplementary load

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

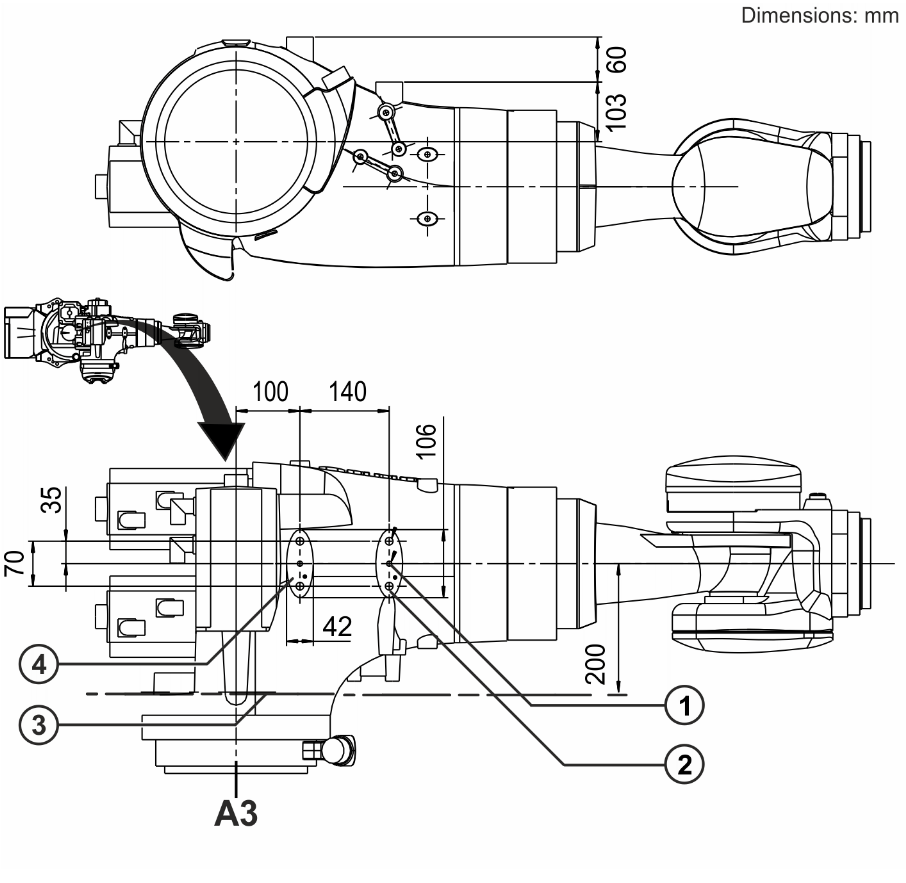


Fig. 4-29: Supplementary load, arm

1. Fastening borehole, 8 mm, 15 deep, 2x
2. Fastening threads, M12, 24 deep, 4x
3. Interference contour, arm
4. Mounting surface, 2x

4.4.4 Foundation loads, KR 160 R1570 nano

Depending on the payload (e.g. tool), supplementary load and the robot's own mass (weight), the motion of the robot generates forces and torques which are transmitted to the foundation.

The specified values refer to nominal payloads and do not include any safety factors. The actual 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. 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.

Supplementary loads on A1 (rotating column) and A2 (link arm) are not taken into consideration in the calculation of the foundation load. These must be taken into account in the vertical force (F_v).

The foundation must be able to permanently withstand the forces and torques generated during normal operation.

The EMERGENCY STOP values only rarely occur during the service life of the robot (emergency situations). The frequency depends on the configuration of the system.

WARNING

Danger to life and limb due to insufficient stability of the foundation

An incorrectly dimensioned foundation can fracture and fail. Death, severe injuries or damage to property may result.

- Calculate the foundation loads for each individual case.
- Use the specified installation equipment.

Vertical force F(v)	
F(v normal)	10828 N
F(v max)	12396 N
Horizontal force F(h)	
F(h normal)	3955 N
F(h max)	5226 N
Tilting moment M(k)	
M(k normal)	9467 Nm
M(k max)	14433 Nm
Torque about axis 1 M(r)	
M(r normal)	5534 Nm
M(r max)	5726 Nm

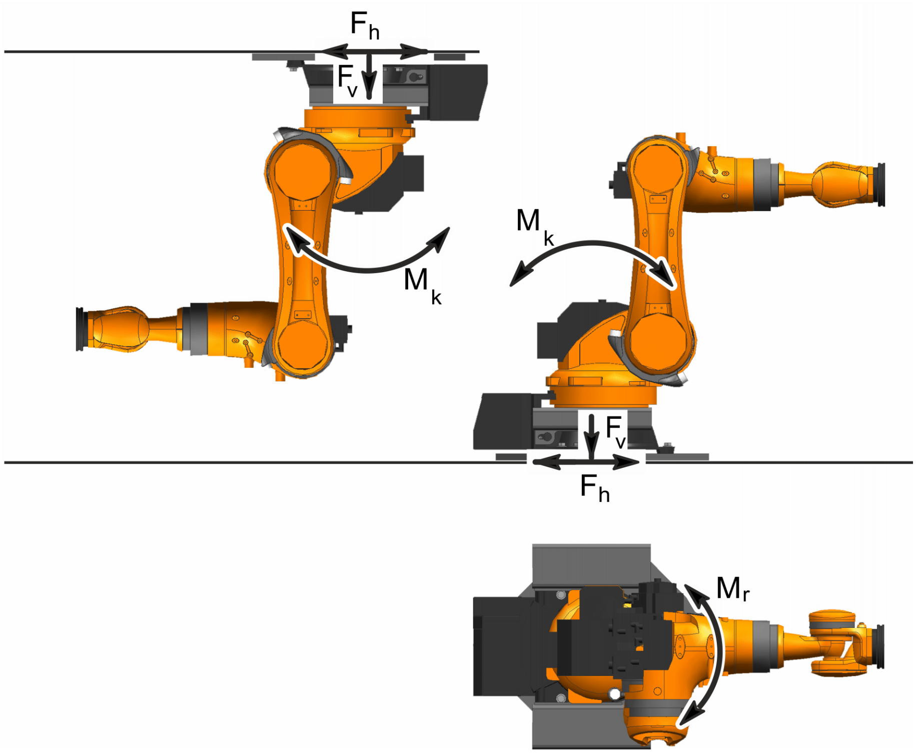


Fig. 4-30: Foundation loads

4.5 Technical data, KR 160 R1570 nano C

4.5.1 Basic data, KR 160 R1570 nano C

Basic data

	KR 160 R1570 nano C
Number of axes	6
Number of controlled axes	6
Volume of working envelope	13.9 m³
Pose repeatability (ISO 9283)	± 0.06 mm
Weight	approx. 677 kg
Rated payload	160 kg
Maximum payload	224 kg
Maximum reach	1573 mm
Protection rating (IEC 60529)	IP65
Protection rating, robot wrist (IEC 60529)	IP65
Sound level	< 75 dB (A)
Mounting position	Ceiling
Footprint	901 mm x 610 mm
Hole pattern: mounting surface for kinematic system	C590
Permissible angle of inclination	± 45 °
Default color	Base frame: black (RAL 9005); Moving parts: KUKA orange 2567

	KR 160 R1570 nano C
Controller	KR C5 M6/M7; KR C4
Transformation name	KR C4: KR160R1570 NANO C4 CLG; KR C5: KR160R1570 NANO C4 CLG

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

Ambient conditions

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

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

Connecting cables, KR C4

Cable designation	**Connector designation Robot controller - robot**	**Interface with robot**
Motor cable	X20 – X30	Han® 24
Control cable	X21 – X31	Han® 3A Q12
Ground conductor / equipotential bonding 16 mm^2		M8 ring cable lug at both ends

Cable lengths	7 m, 15 m, 25 m, 35 m, 50 m
Max. cable length	50 m
Number of extensions	1

Minimum bending radius	5x D

Connecting cables, KR C5

Cable designation	Connector designation Robot controller - robot	Interface with robot
Motor cable	6 motor connectors: XD20.1 … XD20.6 - XD30 2 brake connectors: XD10.1, XD10.2 - XD30	Han® 24
Control cable	XF21 – XF31	Han® 3A Q12
Ground conductor / equipotential bonding 16 mm^2		M8 ring cable lug at both ends

Cable lengths	7 m, 10 m 15 m, 25 m, 35 m, 50 m
Max. cable length	50 m
Number of extensions	1

Minimum bending radius	5x D

4.5.2 Axis data, KR 160 R1570 nano C

Axis data

Motion range	
A1	±180 °
A2	-145 ° / 45 °
A3	-130 ° / 145 °
A4	±350 °
A5	±120 °
A6	±350 °
Speed with rated payload	
A1	123 °/s
A2	114 °/s
A3	86 °/s
A4	179 °/s
A5	172 °/s
A6	220 °/s

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

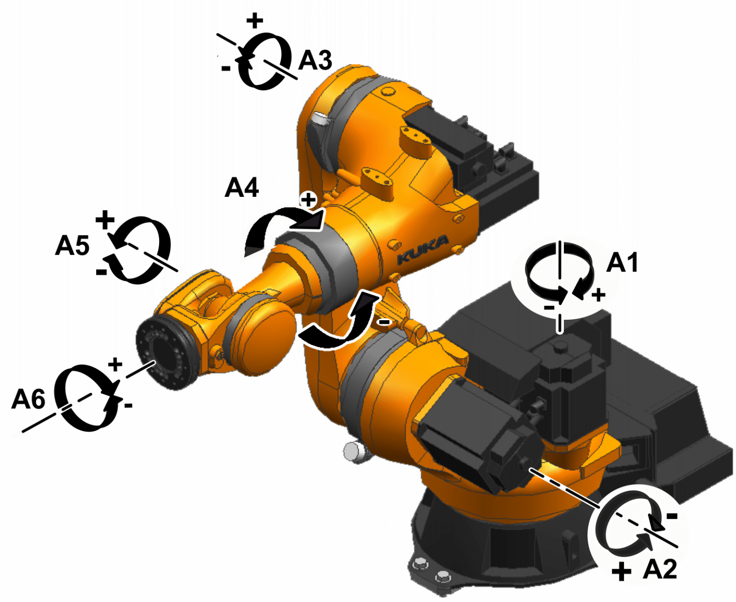


Fig. 4-31: Direction of rotation of the axes

Mastering position

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

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.

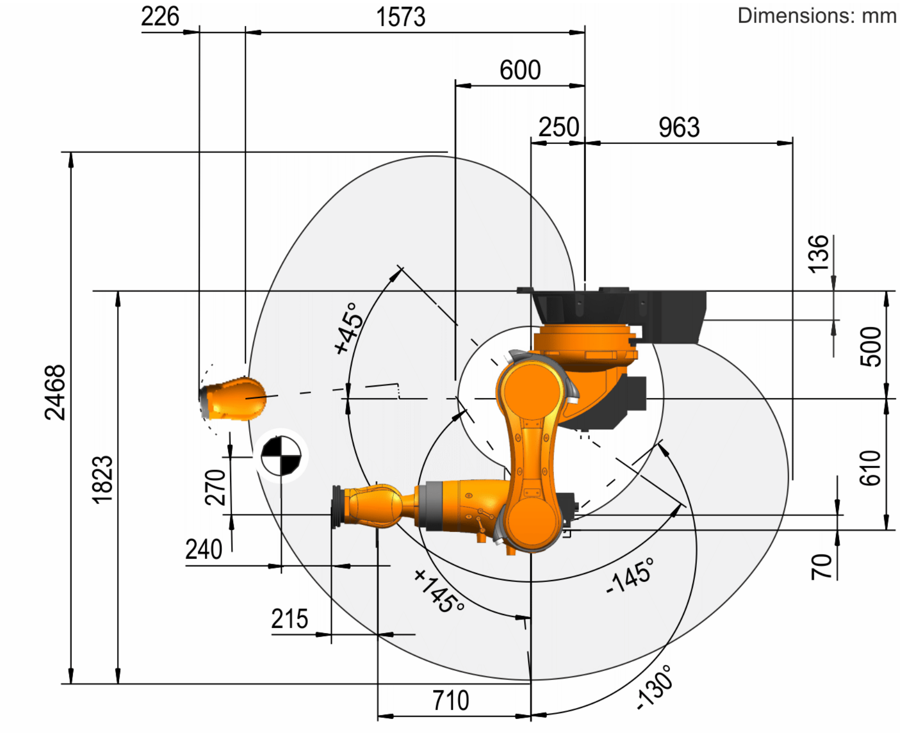


Fig. 4-32: KR 160 R1570 nano C working envelope, side view

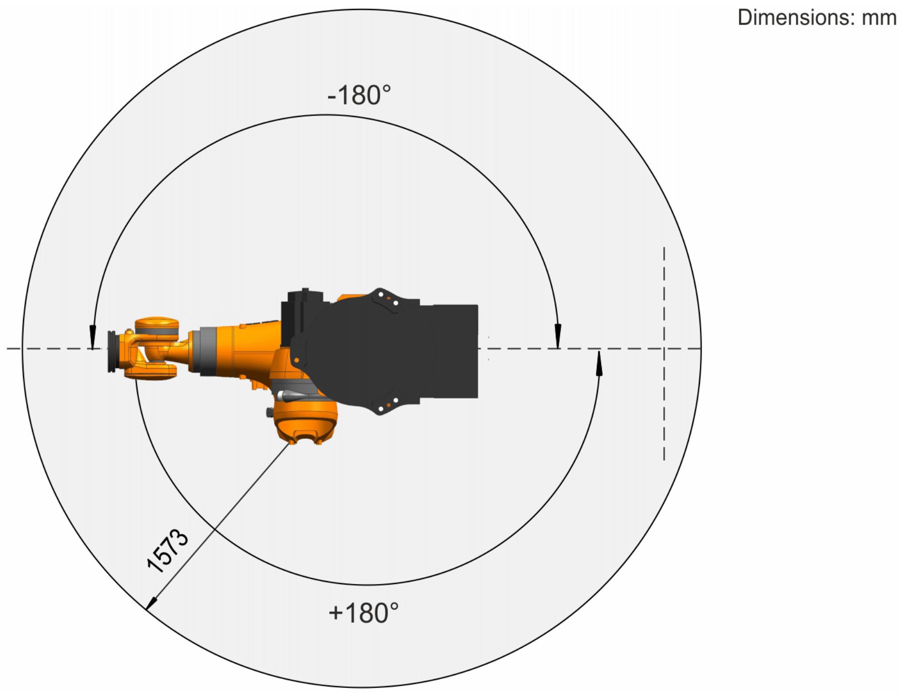


Fig. 4-33: KR 160 R1570 nano C working envelope, top view

Inclined installation

The robot can be installed in any position from 0° (floor) to 180° (ceiling). The following figure shows the possible limitation of the motion range of axis 1, as a function of the angle of inclination of the robot.

The inclination angles for the robot must be entered correctly into the controller if the robot is not operated in the floor-mounted position. Configuration of the angles is possible via WorkVisual.

The inclination angles for an unchanged main working direction of the robot:

Floor: A:0°, B:0°, C:0°
Wall: A:0°, B:90°, C:0°
Ceiling: A:0°, B:0°, C:180°

CAUTION
The inclined installation angles must be individually checked and entered. An incorrectly entered inclined installation angle can lead to unforeseen motion and/or to an overload and, potentially, damage to the robot.

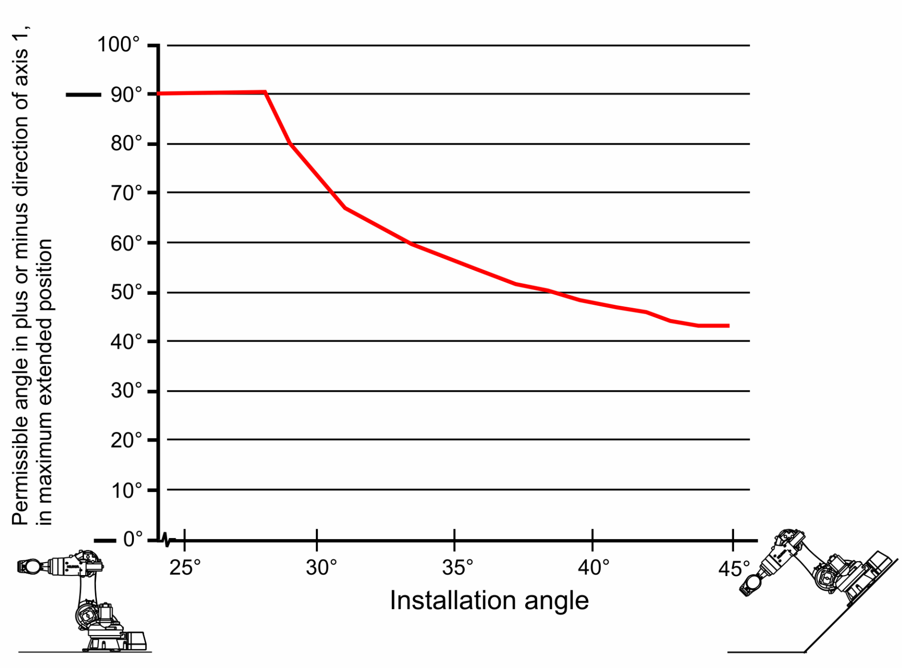


Fig. 4-34: Permissible axis angle for axis 1 at an inclined position

4.5.3 Payloads, KR 160 R1570 nano C

Payloads

Rated payload	160 kg
Maximum payload	224 kg
Rated supplementary load, base frame	0 kg
Maximum supplementary load, base frame	-
Rated supplementary load, rotating column	0 kg
Maximum supplementary load, rotating column	0 kg
Rated supplementary load, link arm	0 kg
Maximum supplementary load, link arm	0 kg
Rated supplementary load, arm	50 kg
Maximum supplementary load, arm	100 kg

Load center of gravity and mass moment of inertia

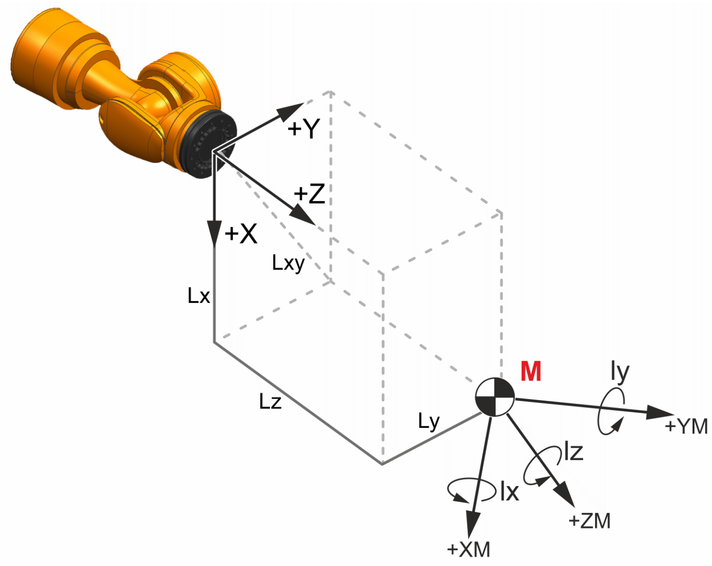


Fig. 4-35: Load center of gravity and mass moment of inertia

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
A, B, C	Degrees	Orientation of the principal inertia axes • 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'' **Note:** A, B and C are not shown in the diagram.
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.

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

Payload diagram

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

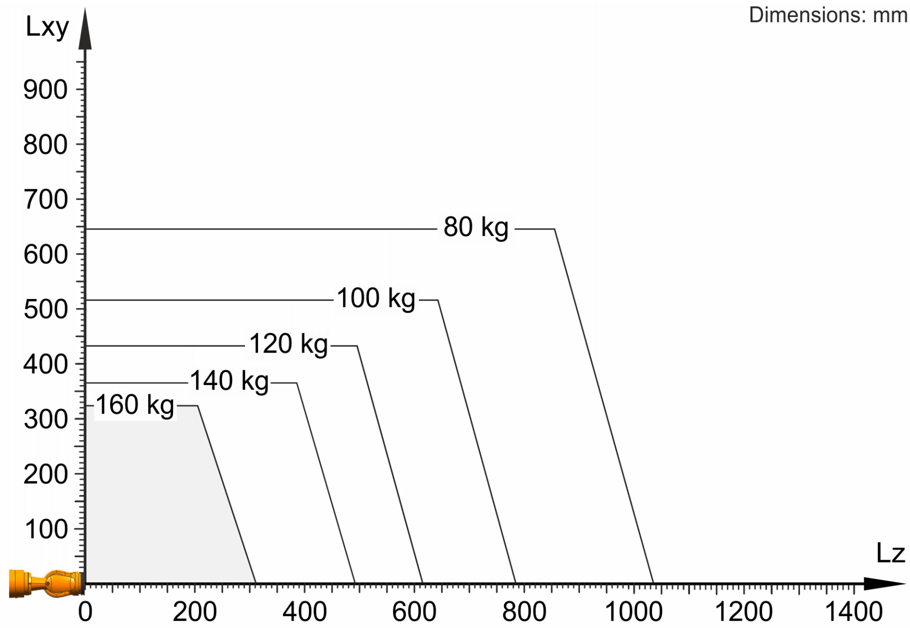


Fig. 4-36: Payload diagram, KR 160 R1570 nano C

Mounting flange

Robot wrist type	ZH 160
Mounting flange standard	Deviation, see figure

Diameter (hole circle)	125 mm
Thread diameter	M10
Depth of engagement	min. 12 mm, max. 16 mm
Number of threads	11
Screw grade	10.9
Locating element	10 ^{H7}

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

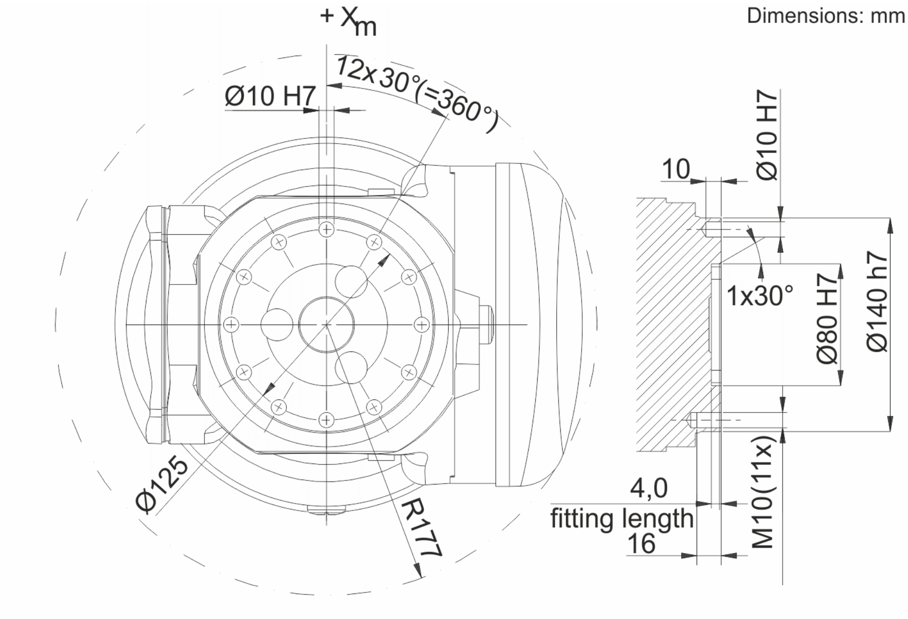


Fig. 4-37: Mounting flange D=125

Flange loads

The motion of the robot causes forces and torques to act on the mounting flange, which are transmitted to the mounted payload (e.g. tool).

The specified values refer to nominal payloads and do not include any safety factors. The actual 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. 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.

The payload must be able to permanently withstand the forces and torques generated during normal operation.

The EMERGENCY STOP values only rarely occur during the service life of the robot (emergency situations). The frequency depends on the configuration of the system.

WARNING

Danger to life and limb due to insufficient stability of the tool
Incorrectly dimensioned tools can fracture and fail. Death, severe injuries or damage to property may result.

- Calculate the tool for each individual case, taking the load data into consideration.
- Use the specified installation equipment.

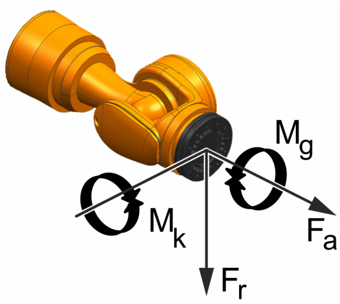


Fig. 4-38: Flange loads

Flange loads during operation	
F(a)	2518 N
F(r)	2906 N
M(k)	2184 Nm
M(g)	899 Nm
Flange loads in the case of EMERGENCY STOP	
F(a)	3558 N
F(r)	3923 N
M(k)	2746 Nm
M(g)	2525 Nm

Axial force F(a), radial force F(r), tilting torque M(k), torque about mounting flange M(g)

Supplementary load

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

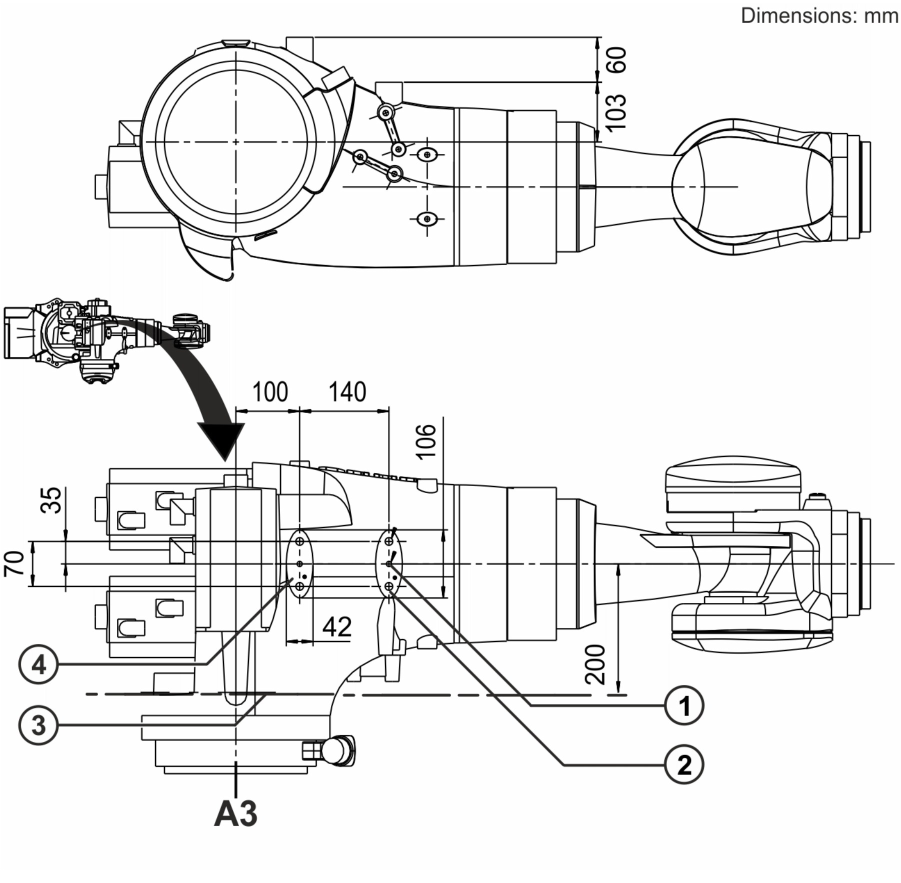


Fig. 4-39: Supplementary load, arm

1 Fastening borehole, 8 mm, 15 deep, 2x
2 Fastening threads, M12, 24 deep, 4x
3 Interference contour, arm
4 Mounting surface, 2x

4.5.4 Foundation loads, KR 160 R1570 nano C

Depending on the payload (e.g. tool), supplementary load and the robot's own mass (weight), the motion of the robot generates forces and torques which are transmitted to the foundation.

The specified values refer to nominal payloads and do not include any safety factors. The actual 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. 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.

Supplementary loads on A1 (rotating column) and A2 (link arm) are not taken into consideration in the calculation of the foundation load. These must be taken into account in the vertical force (F_v).

The foundation must be able to permanently withstand the forces and torques generated during normal operation.

The EMERGENCY STOP values only rarely occur during the service life of the robot (emergency situations). The frequency depends on the configuration of the system.

WARNING

Danger to life and limb due to insufficient stability of the foundation
An incorrectly dimensioned foundation can fracture and fail. Death, severe injuries or damage to property may result.

- Calculate the foundation loads for each individual case.
- Use the specified installation equipment.

Vertical force F(v)	
F(v normal)	10828 N
F(v max)	12396 N
Horizontal force F(h)	
F(h normal)	3955 N
F(h max)	5226 N
Tilting moment M(k)	
M(k normal)	9467 Nm
M(k max)	14433 Nm
Torque about axis 1 M(r)	
M(r normal)	5534 Nm
M(r max)	5726 Nm

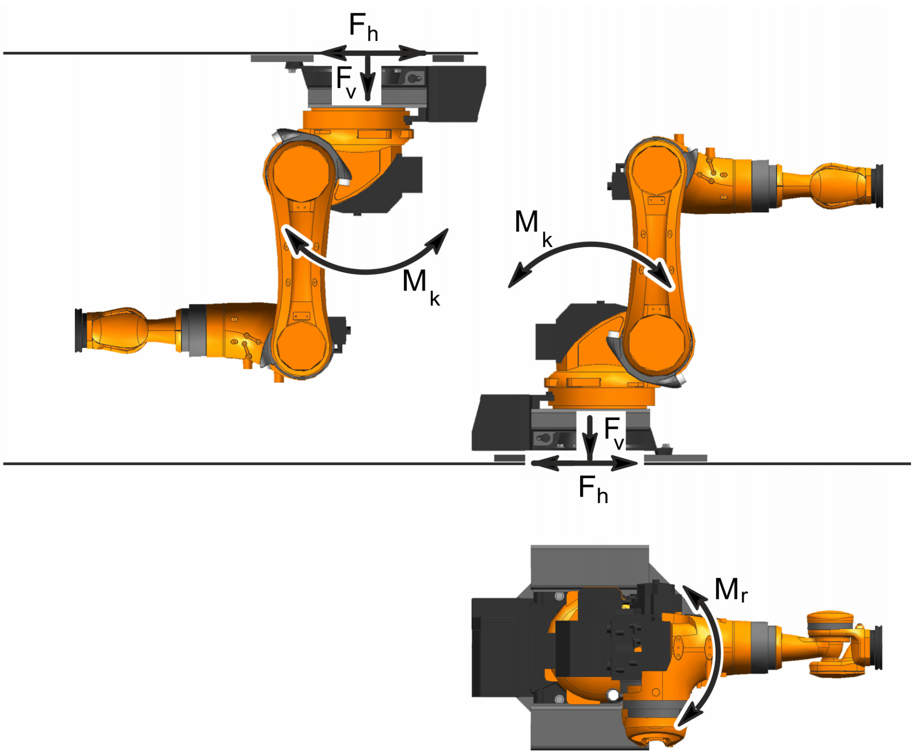


Fig. 4-40: Foundation loads

4.6 Plates and labels

Plates and labels

The following plates and labels (>>> *Fig. 4-41*) are attached to the robot. They must not be removed or rendered illegible. Illegible plates and labels must be replaced.

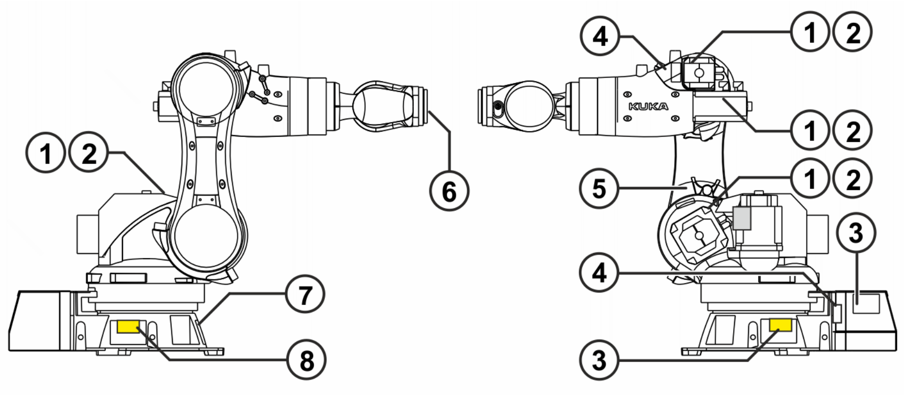
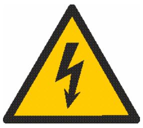
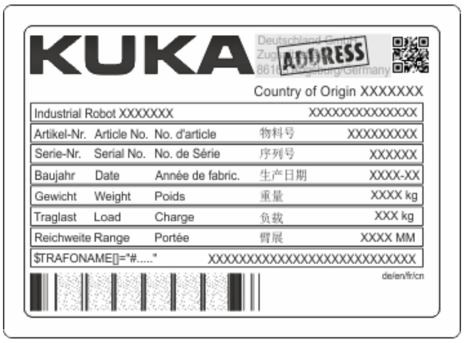


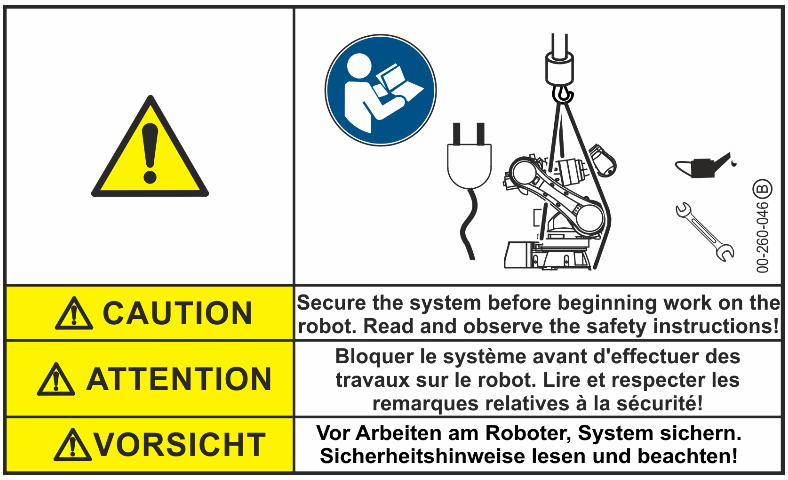
Fig. 4-41: Location of plates and labels

<table>
<tr><th>Item</th><th>Description</th></tr>
<tr><td>1</td><td>


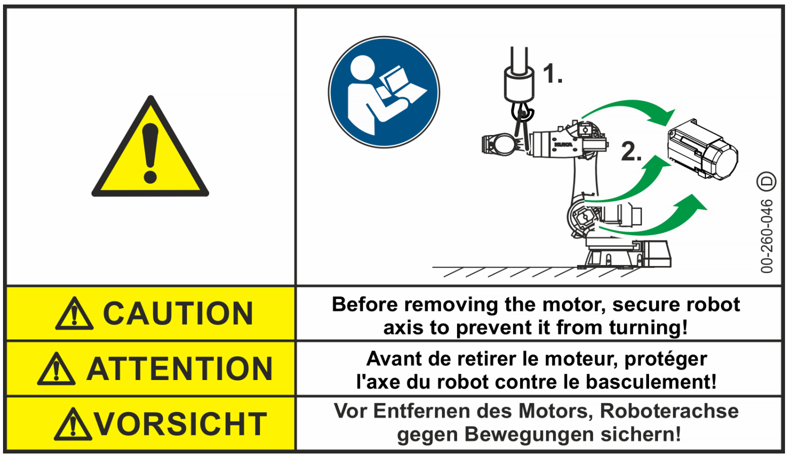
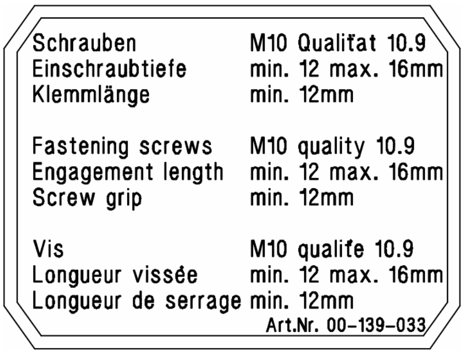
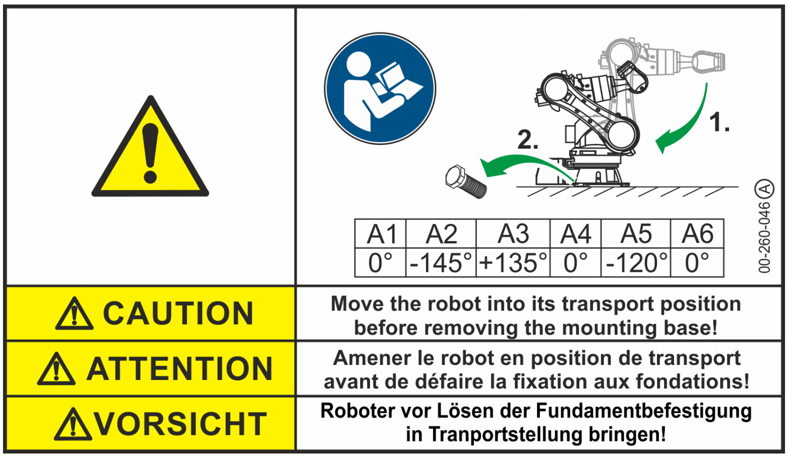
High voltage
Any improper handling can lead to contact with current-carrying components. Electric shock hazard!
</td></tr>
<tr><td>2</td><td>

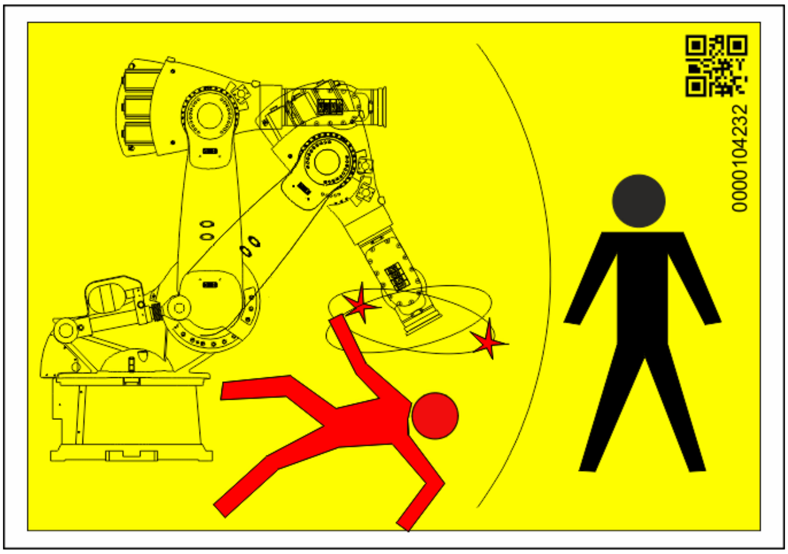
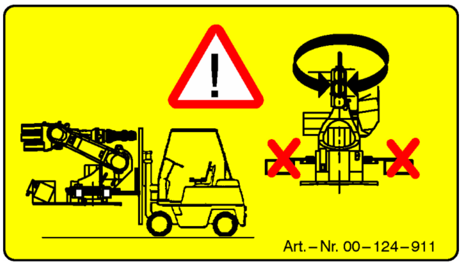

Hot surface
During operation of the robot, surface temperatures may be reached that could result in burn injuries. Protective gloves must be worn!
</td></tr>
<tr><td>3</td><td>


Identification plate example
Content according to Machinery Directive.

The QR code contains a link to product information in KUKA Xpert.
</td></tr>
<tr><td>4</td><td>


Work on the robot
Before start-up, transportation or maintenance, read and follow the assembly and operating instructions.
</td></tr>
</table>

Item	Description
5	 **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!
6	 Schrauben M10 Qualität 10.9 Einschraubtiefe min. 12 max. 16mm Klemmlänge min. 12mm Fastening screws M10 quality 10.9 Engagement length min. 12 max. 16mm Screw grip min. 12mm Vis M10 qualité 10.9 Longueur vissée min. 12 max. 16mm Longueur de serrage min. 12mm Art.Nr. 00-139-033 **Mounting flange on in-line wrist** The values specified on this plate apply for the installation of tools on the mounting flange of the wrist and must be observed.
7	 **Transport position** Before loosening the bolts of the mounting base, the robot must be in the transport position as indicated in the table. Risk of toppling!

Item	Description
8	 **Danger zone** Entering the danger zone of the robot is prohibited if the robot is in operation or ready for operation. Risk of injury!
	 **Remove the fork slots** To be affixed to the fork slots. Remove the fork slots prior to start-up! Operation with installed fork slots can result in significant damage to the robot.

4.7 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.

4.8 Stopping distances and times

4.8.1 General information

Information concerning the data:

- 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.
- Measurement method

  The stopping distances were measured using the robot-internal measurement method.
- 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.

Determination of stopping distances and times with KR C4

- 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.

Measurement method for determining the STOP 0 stopping distances and stopping times according to ISO 10218-1 with KR C5

Motion sequence

- Measurement with single-axis motion (A1, A2 and A3 respectively)
- Axes that are not moved are positioned in such a way that the maximum distance of the load center of gravity from the moved axis is reached.
- Use the maximum motion radius of the axis to achieve as high a velocity as possible.
- Trigger point at maximum velocity

Measurement method

1. A **safe operational stop** is activated at the trigger point; this causes a STOP 0 to be triggered if the robot is moving.

   Start recording with trace functionality.
2. Brakes are closed.

   Brake closes (WDI motor status bit 2) is used as the start time of the measurement.
3. The axis comes to a standstill.

   Standstill is used as the end time of the measurement.

As an approximation, it is also possible to carry out the measurement by means of a STOPMESS interrupt program in which the stopping distance results from the difference between the position at the trigger point ($AXIS_INT) and the position at standstill.

Information concerning the data

- The stopping distance is the angle covered by the axis from the **Brake closes** signal (WDI motor status bit 2) to complete standstill.

- The stopping time is the time that elapses from the **Brake closes** signal (WDI motor status bit 2) until the robot comes to a complete standstill.

4.8.2 Stopping distances and times, KR 120 R1800 nano and KR 120 R1800 nano C

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

The values for stop category 0 when a STOP 0 is triggered refer to the following configuration:

- Extension l = 100%
- Program override POV = 100%
- Mass m = rated payload

Stopping distance	
A1	28.00 °
A2	17.50 °
A3	9.40 °
Stopping time	
A1	0.40 s
A2	0.29 s
A3	0.18 s

4.8.2.2 Stopping distances and stopping times, STOP 1, A1

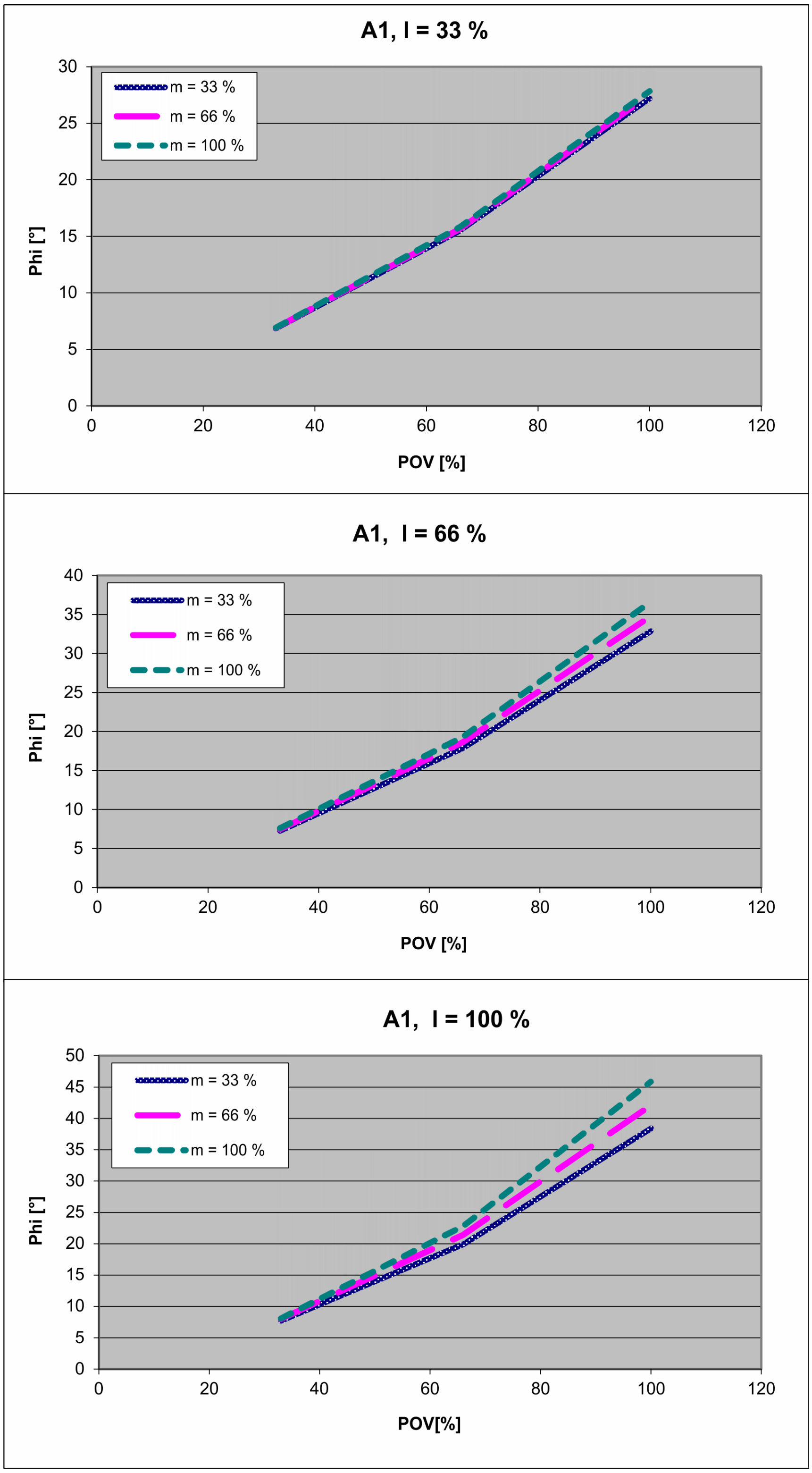


Fig. 4-42: Stopping distances for STOP 1, axis 1

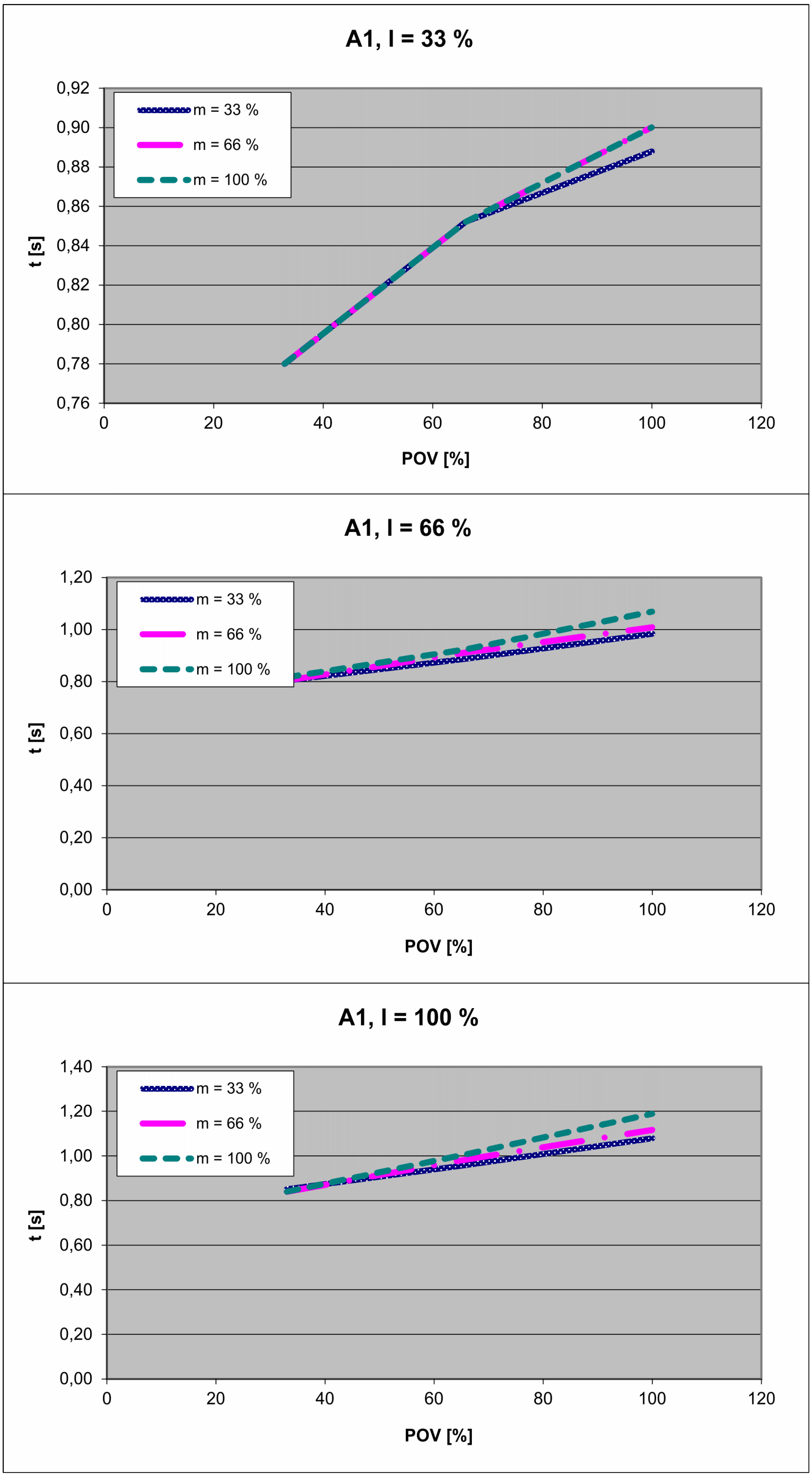


Fig. 4-43: Stopping times for STOP 1, axis 1

4.8.2.3 Stopping distances and stopping times, STOP 1, A2

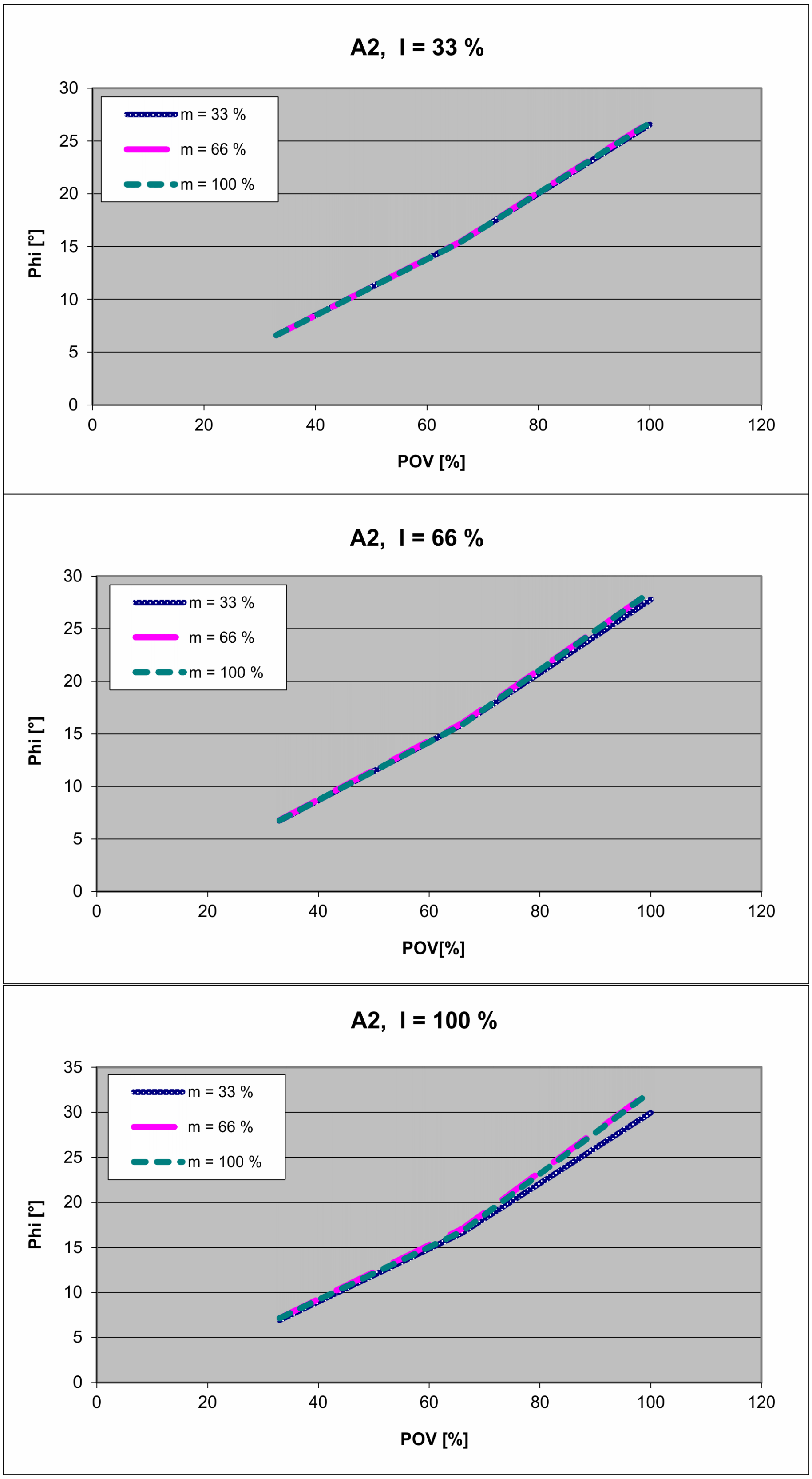


Fig. 4-44: Stopping distances for STOP 1, axis 2

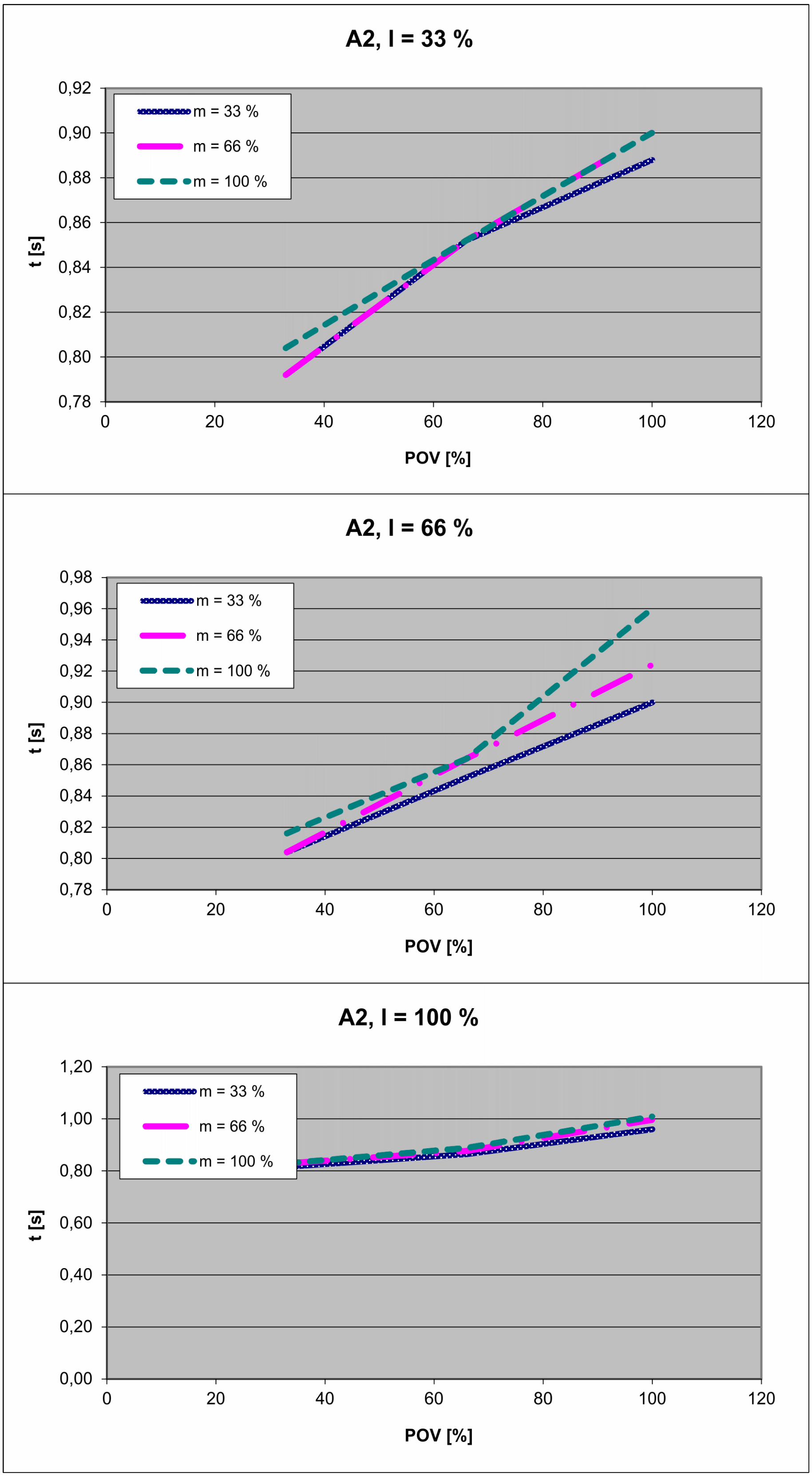


Fig. 4-45: Stopping times for STOP 1, axis 2

4.8.2.4 Stopping distances and stopping times, STOP 1, A3

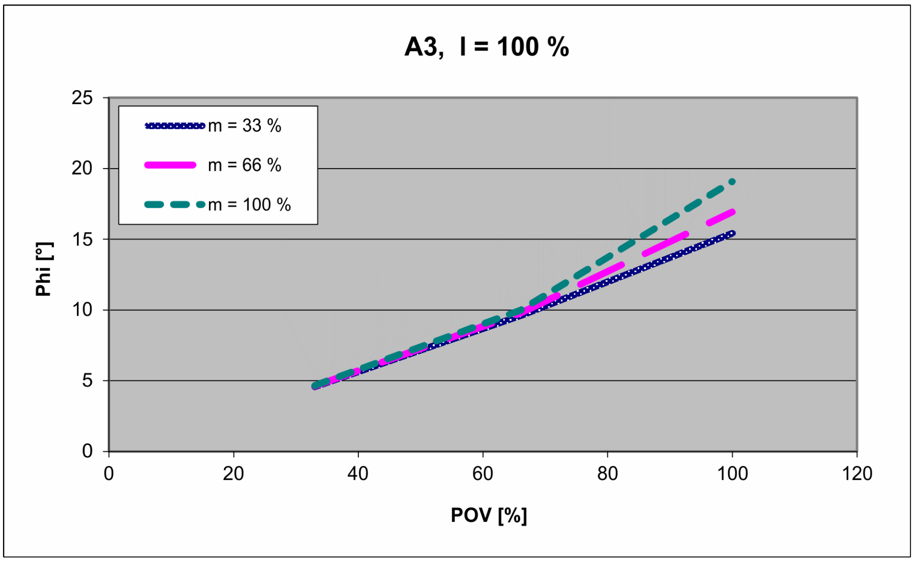


Fig. 4-46: Stopping distances for STOP 1, axis 3

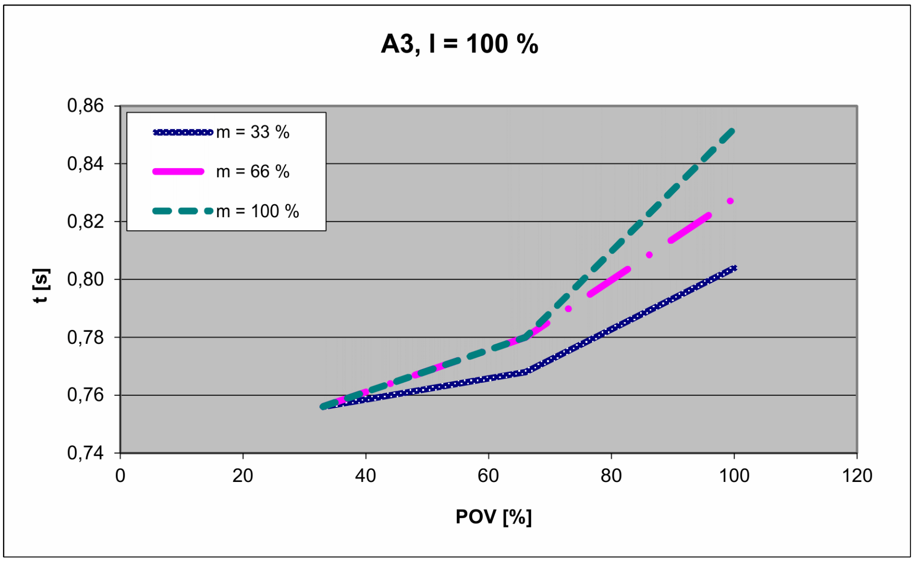


Fig. 4-47: Stopping times for STOP 1, axis 3

4.8.3 Stopping distances and times, KR 160 R1570 nano and KR 160 R1570 nano C

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

The values for stop category 0 when a STOP 0 is triggered refer to the following configuration:

- Extension l = 100%
- Program override POV = 100%
- Mass m = rated payload

Stopping distance	
A1	28.00 °
A2	17.50 °

A3	9.40 °
Stopping time	
A1	0.40 s
A2	0.29 s
A3	0.18 s

4.8.3.2 Stopping distances and stopping times, STOP 1, A1

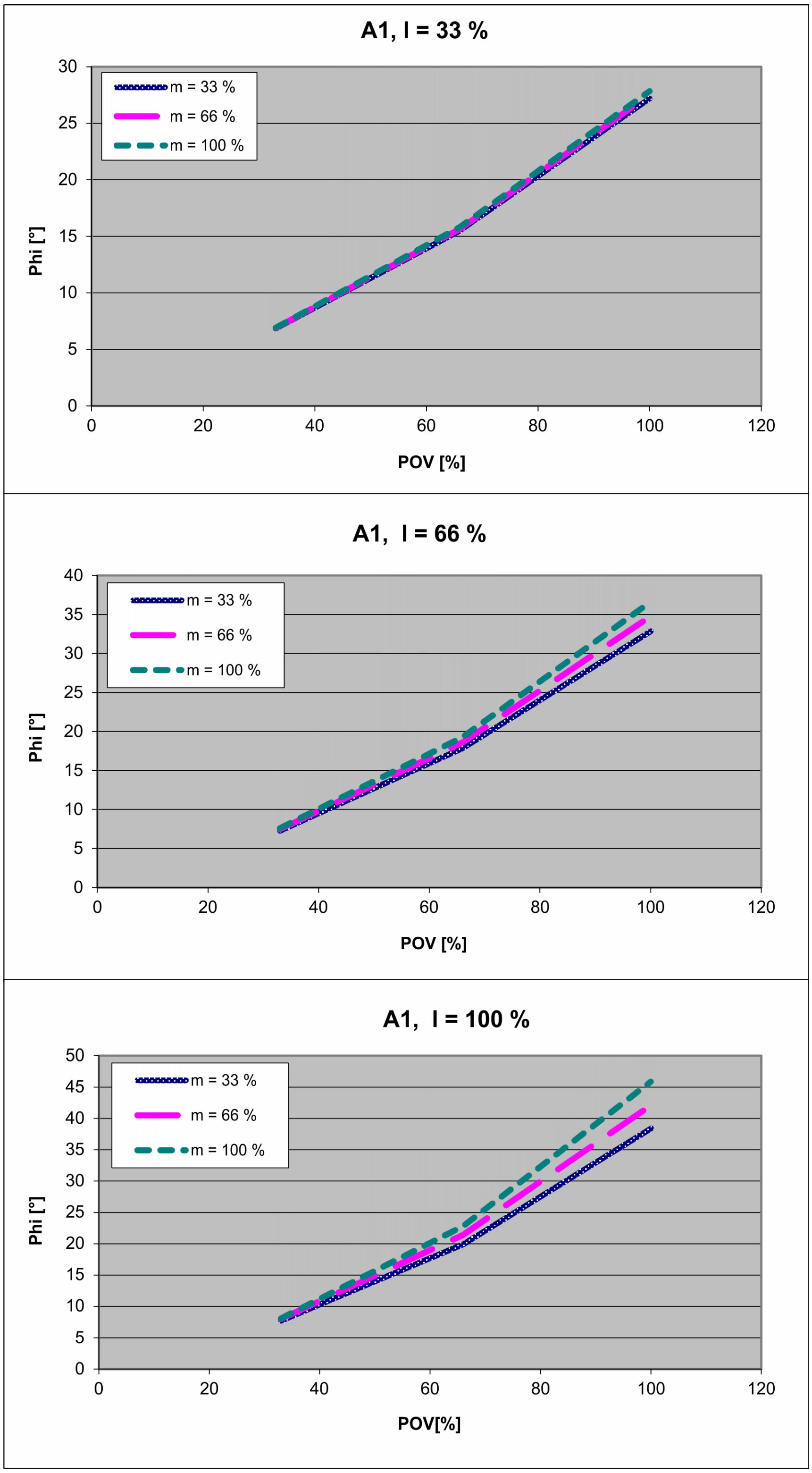


Fig. 4-48: Stopping distances for STOP 1, axis 1

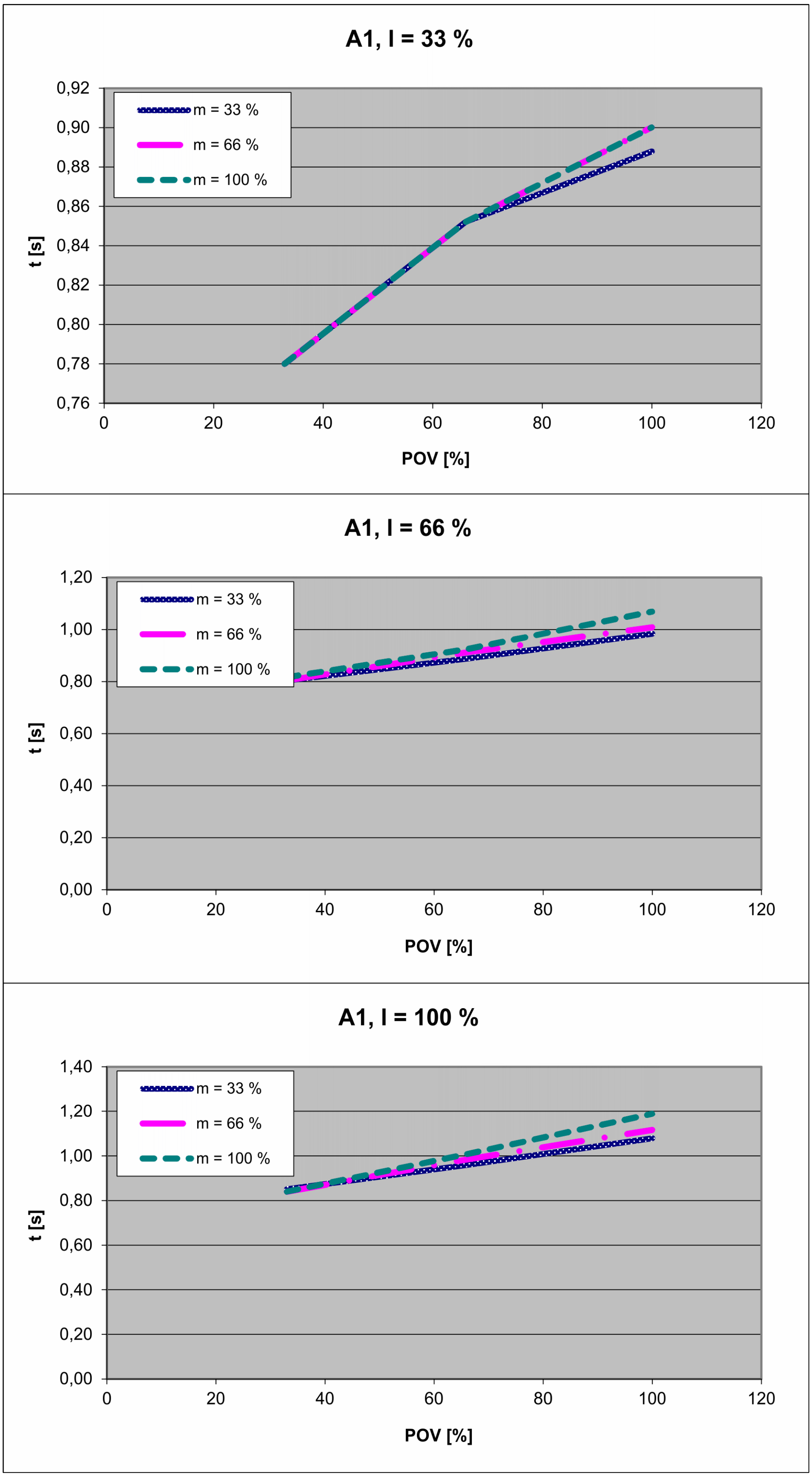
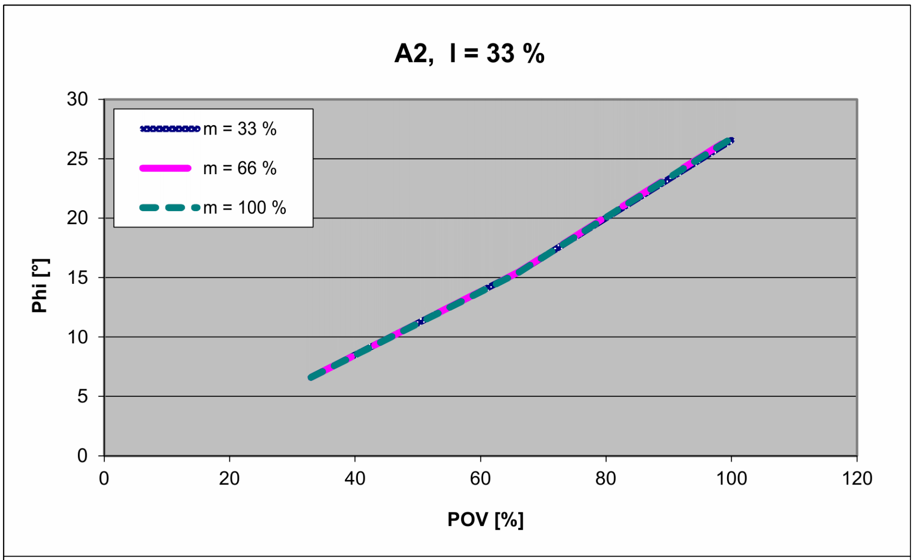
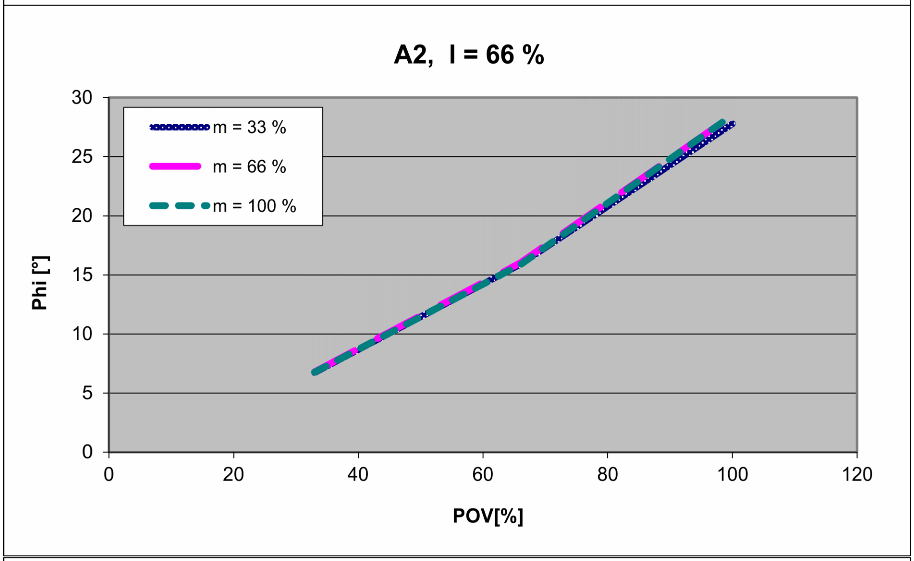


Fig. 4-49: Stopping times for STOP 1, axis 1

4.8.3.3 Stopping distances and stopping times, STOP 1, A2





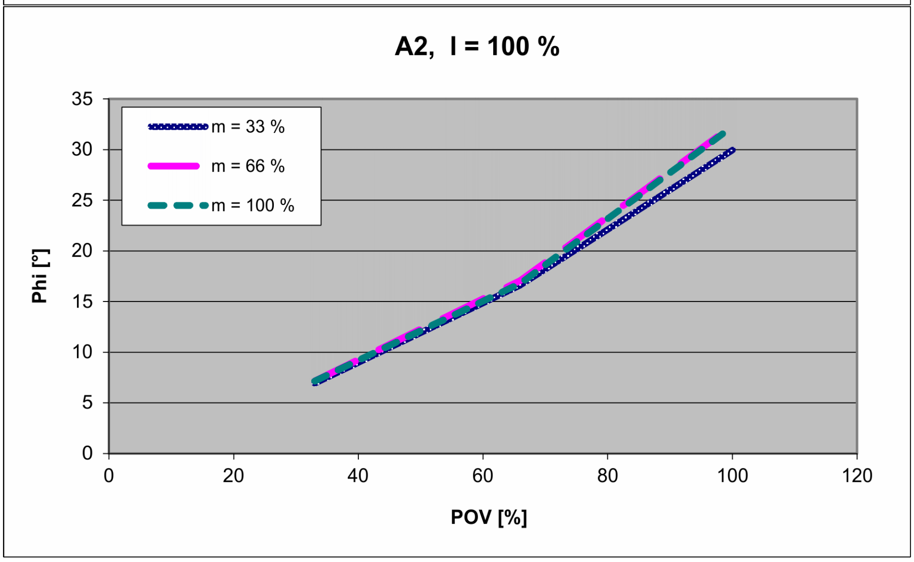


Fig. 4-50: Stopping distances for STOP 1, axis 2

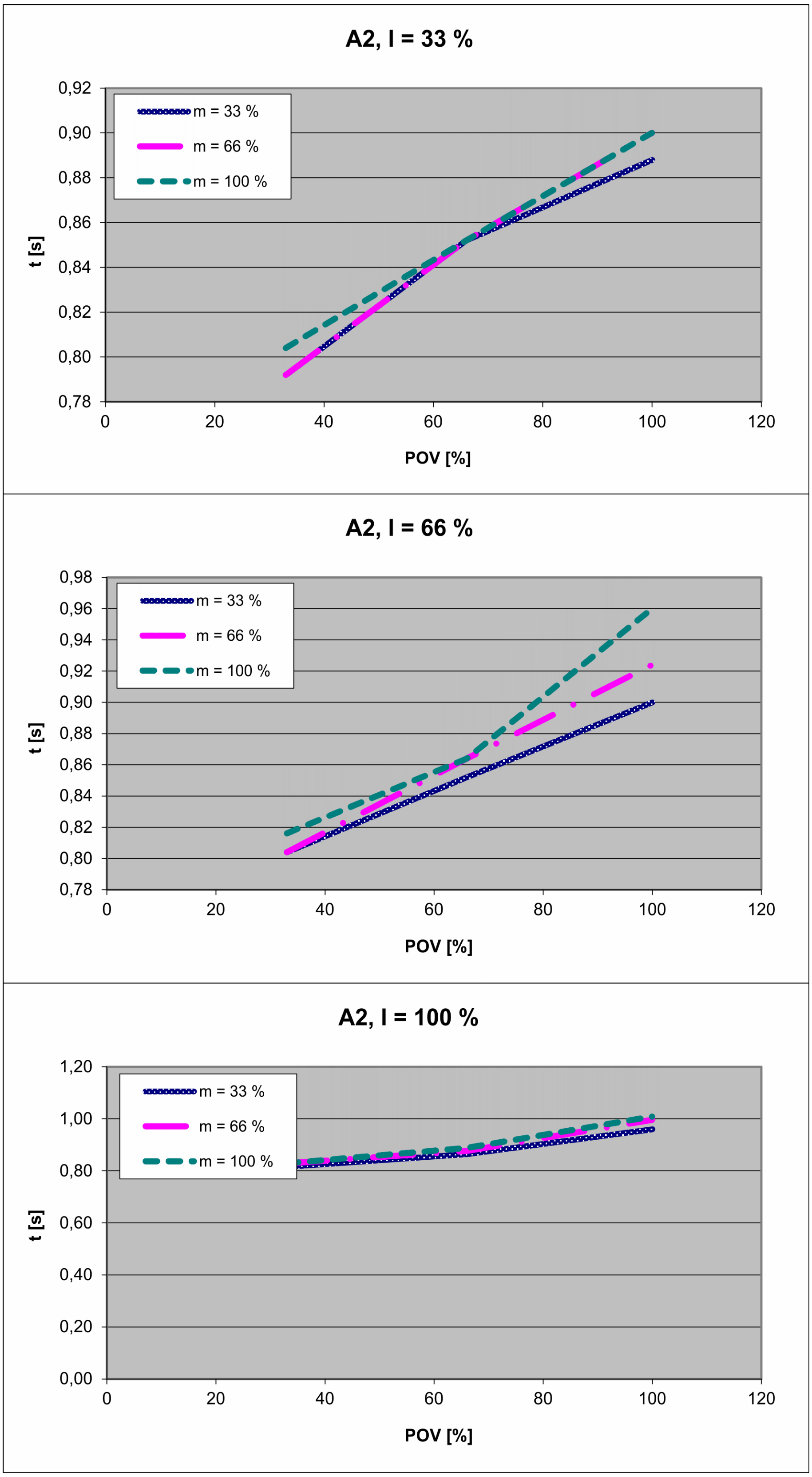


Fig. 4-51: Stopping times for STOP 1, axis 2

4.8.3.4 Stopping distances and stopping times, STOP 1, A3

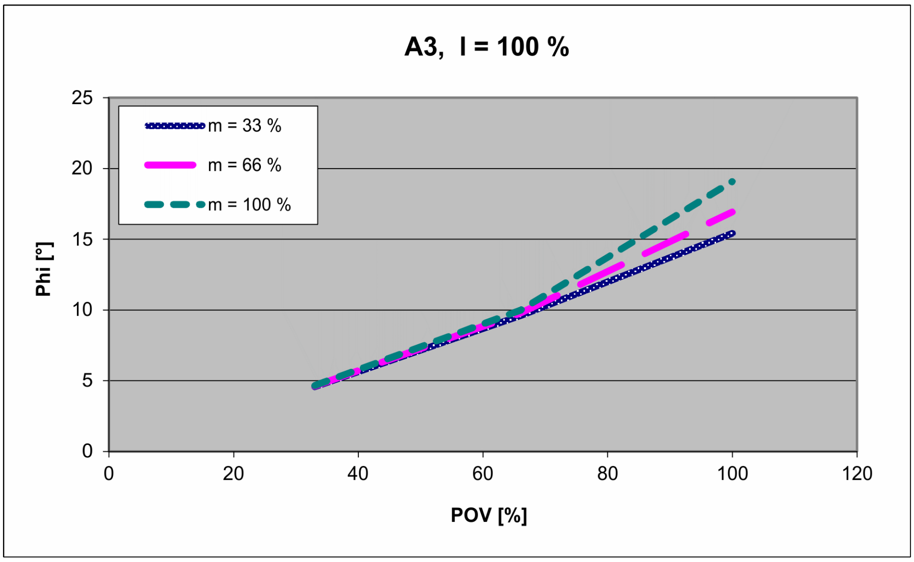


Fig. 4-52: Stopping distances for STOP 1, axis 3

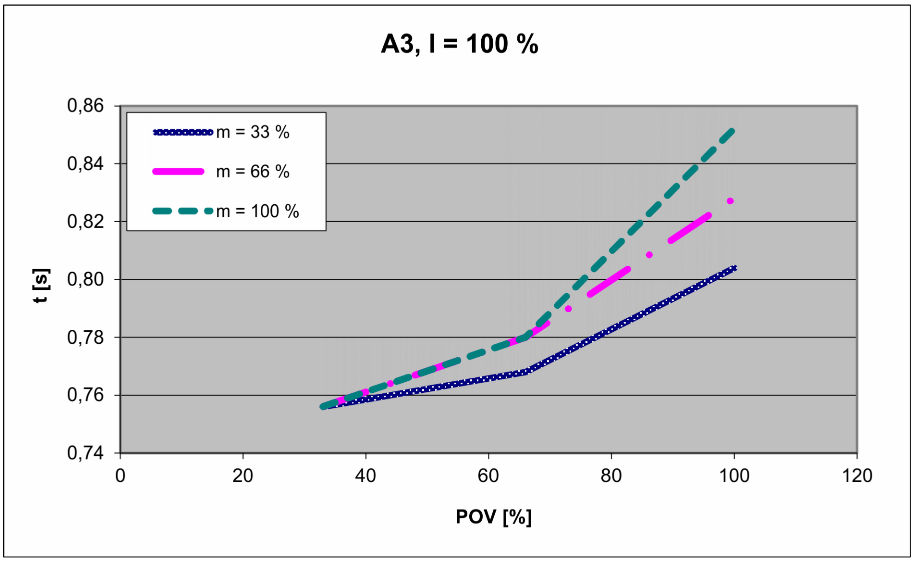


Fig. 4-53: Stopping times for STOP 1, axis 3

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 in abrasive environments
- Continuous operation close to the performance limits, e.g. high rpm of an axis
- Start of operation at maximum power from cold, e.g. after an idle period
- High duty cycle of individual axes
- Monotonous motion profiles, e.g. short, frequently recurring axis motions
- Static axis positions, e.g. continuous vertical position of a wrist axis
- External forces (process forces) acting on the robot

If one or more of these conditions are to apply during operation of the kinematic system, KUKA Service 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

Designation	Article number	Weight
Mounting base C590	0000-312-446	approx. 35.4 kg

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 anchors
- Fastening elements

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

The minimum dimensions must be observed.

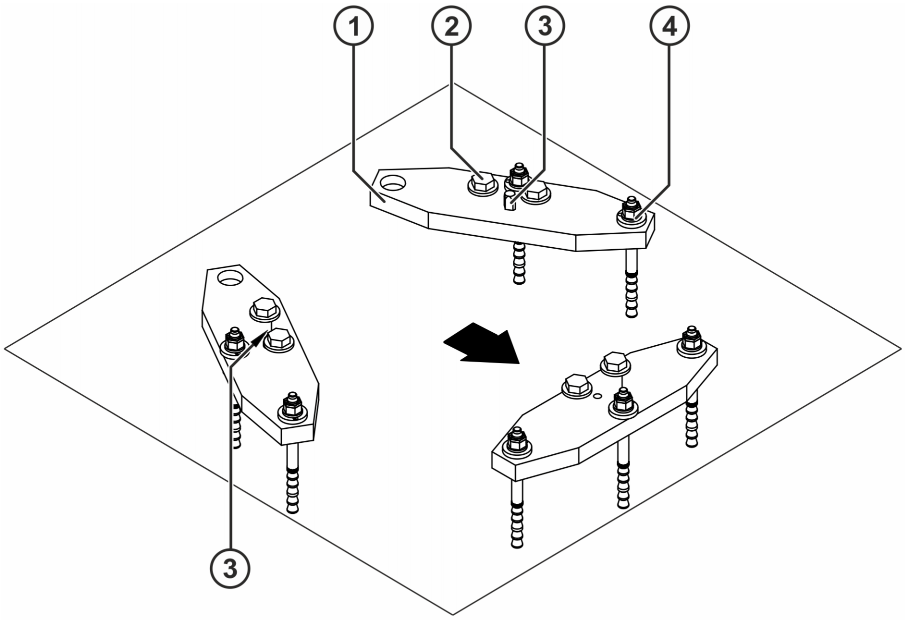


Fig. 5-1: Mounting base with centering

1 Foundation plate
2 Hexagon bolt with conical spring washer
3 Locating pin
4 Resin-bonded anchors with Dynamic Set

Grade of concrete for foundations

When producing concrete foundations, the load-bearing capacity of the ground and the country-specific construction regulations must be observed. 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 EN 206

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 illustrations provide all the necessary information on the mounting base, together with the required foundation data (>>> *Fig. 5-2*).

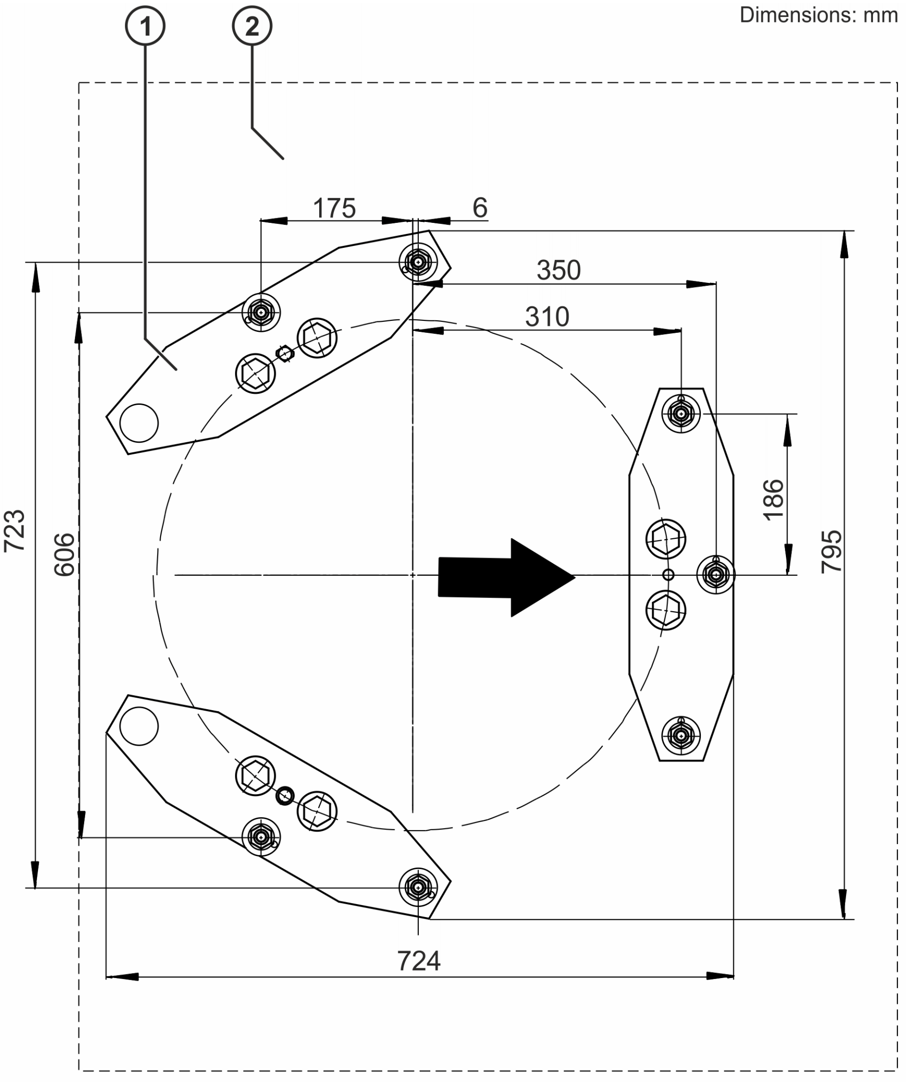


Fig. 5-2: Mounting base, dimensioned drawing

1 Foundation plate
2 Concrete foundation

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

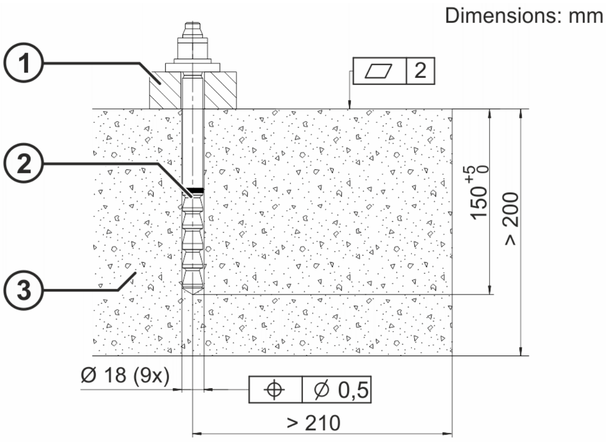


Fig. 5-3: Foundation cross-section

1 Bedplate
2 Chemical anchor (resin-bonded anchor)
3 Concrete foundation

5.3 Machine frame mounting

Description

Designation	Article number	Weight
Machine frame mounting	0000-119-653	approx. 1.5 kg

The “machine frame mounting” assembly is used when the robot is fastened on a steel structure, a booster frame (pedestal) or a KUKA linear unit. This assembly is also used if the robot is installed on the wall or in an inverted position, i.e. on the ceiling. It must be ensured that the substructure is able to withstand safely the forces occurring during operation (foundation loads). The following diagram contains all the necessary information that must be observed when preparing the mounting surface (>>> *Fig. 5-4*).

The steel structure used by the customer must be designed in such a way that the forces generated (mounting base load, maximum load (>>> *4 "Technical data" Page 29*)) are safely transmitted via the screw connection. The specified surface values and tightening torques must be observed.

The machine frame mounting assembly consists of:

- Support pin
- Locating pins
- Hexagon bolts with conical spring washers

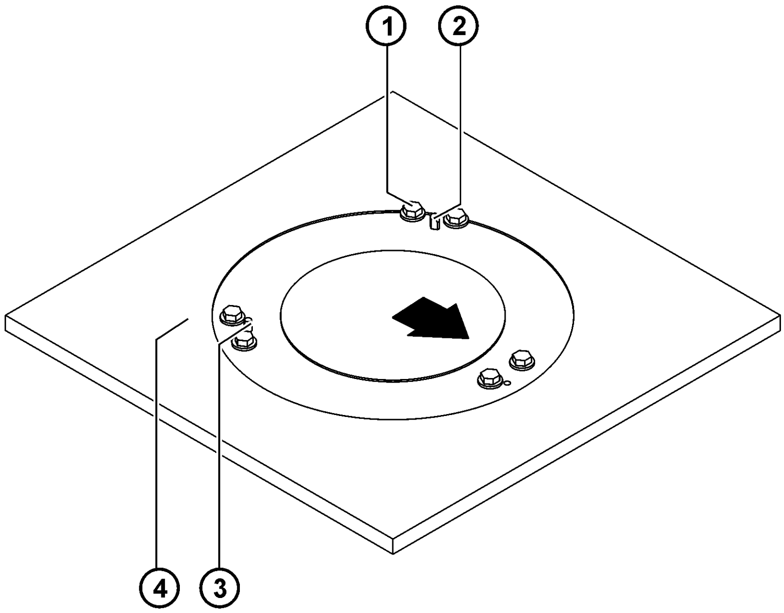


Fig. 5-4: Machine frame mounting

1 Hexagon bolt with conical spring washer
2 Locating pin
3 Support pin
4 Steel structure

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

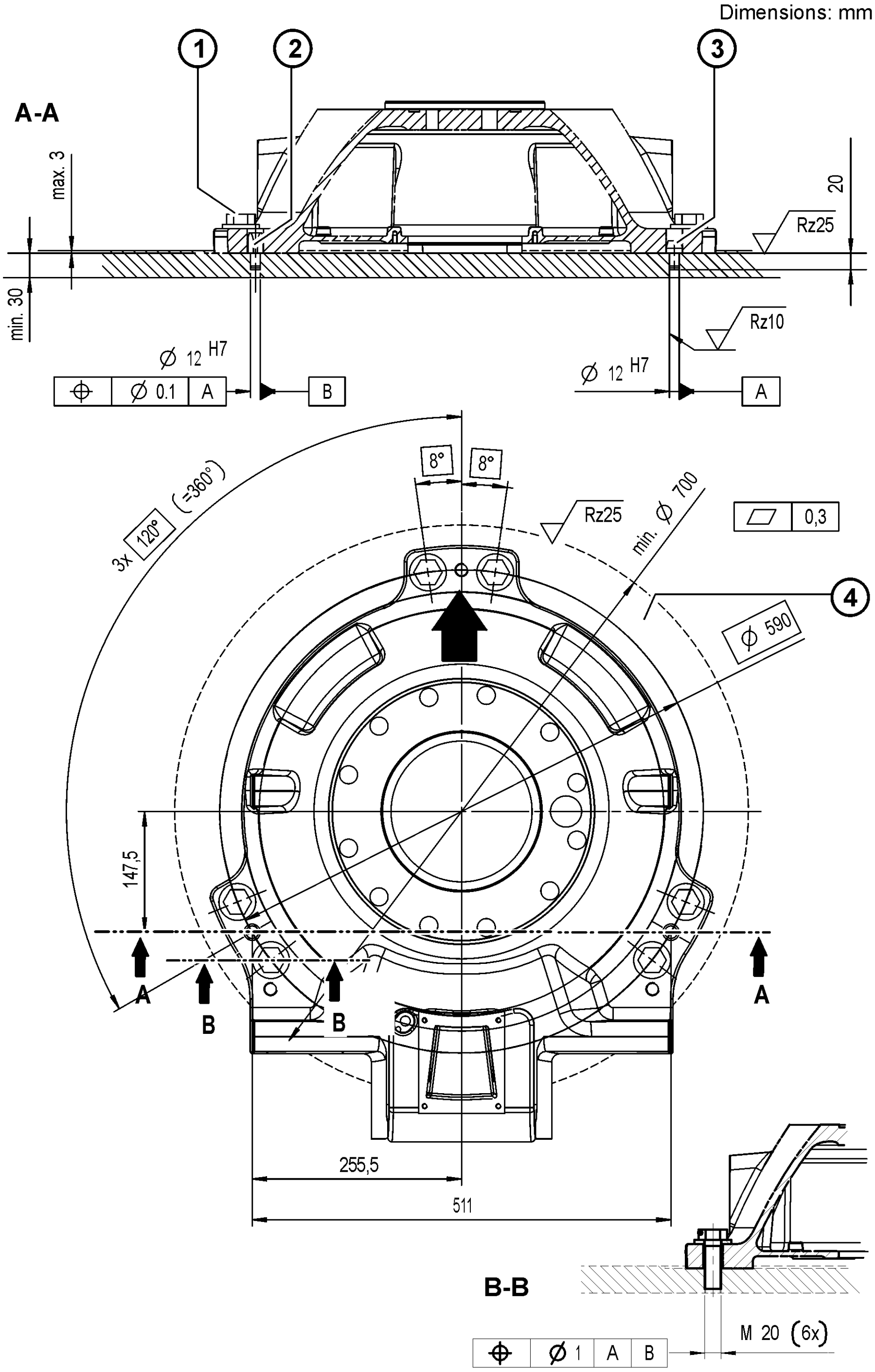


Fig. 5-5: Machine frame mounting, dimensioned drawing

1	Hexagon bolt with conical spring washer, 6x	3	Locating pin, cylindrical
2	Locating pin, flat-sided	4	Mounting surface

5.4 Connecting cables and interfaces

Connecting cables

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

Depending on the specification of the robot, various connecting cables are used. Cable lengths of 7 m, 15 m, 25 m, 35 m and 50 m are available. The maximum length of the connecting cables must not exceed 50 m. 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 cable carrier, 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 bolt for connecting the ground conductor is located on the base frame of the robot.

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

- The bending radius for fixed routing must not be less than 150 mm for motor cables and 60 mm for 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 for energy supply system

The robot can be equipped with an energy supply system between axis 1 and axis 3 and a second energy supply system between axis 3 and axis 6. The A1 interface required for this is located on the rear of the base frame, the A3 interface is located on the side of the arm and the interface for axis 6 is located on the robot tool. Depending on the application, the interfaces differ in design and scope. They can be equipped, 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 arm

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	-145 °
A3	135 °
A4	0 °
A5	-120 °
A6	0 °

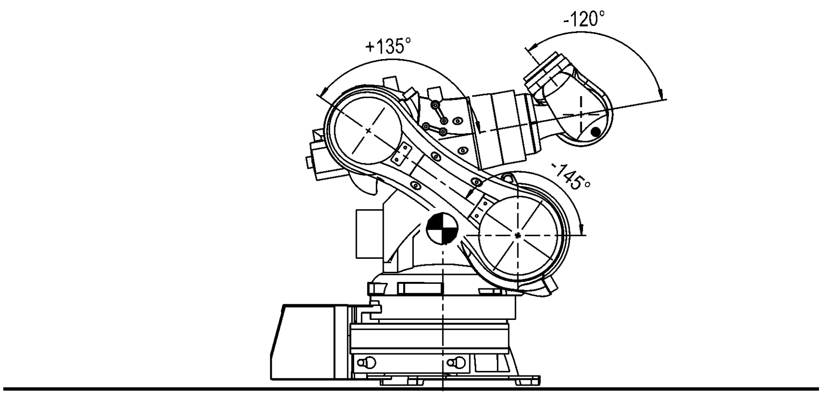


Fig. 6-1: Transport position

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. The specified dimensions refer to the robot without equipment.

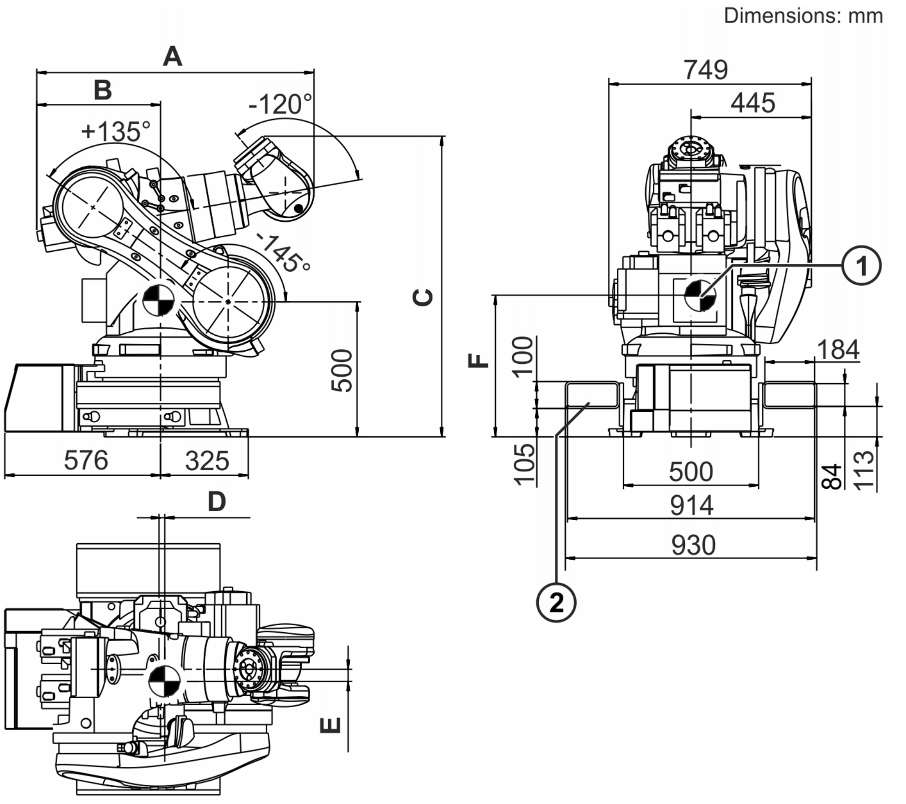


Fig. 6-2: Transport dimensions for floor-mounted robots

1 Center of gravity
2 Fork slots

Transport dimensions and centers of gravity in mm:

Robot	A	B	C	D	E	F
KR 120 R1800 nano KR 120 R1800 nano C	1095	589	1218	-26.5	51.4	597
KR 160 R1570 nano KR 160 R1570 nano C	1026	458	111428	15.7	45	525

Transportation

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

WARNING

Danger to life and limb due to non-authorized handling equipment

If unsuitable handling equipment is used, the robot may topple or be damaged during transportation. Death, severe injuries or damage to property may result.

- 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*), two fork slots must be installed in the base frame. The robot can be picked up by the fork lift truck from the front and rear. The base frame must not be damaged when inserting the forks into the fork slots. The forklift truck must have a minimum payload capacity of 1,000 kg and an adequate fork length.

Without the transport frame, ceiling-mounted robots can only be transported by fork lift truck.

CAUTION

The fork slots are situated within the interference circle of the rotating column. Operation with installed fork slots can result in significant damage to components. Be sure to remove the fork slots before starting up the robot.

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.

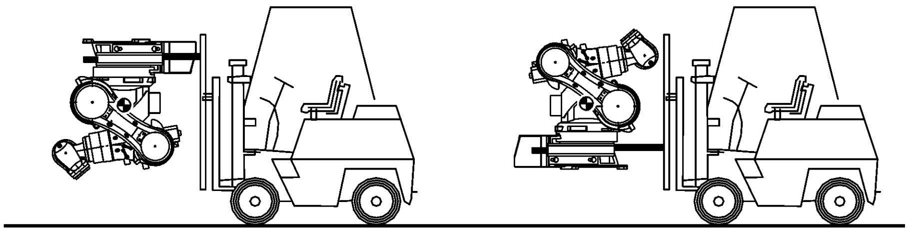


Fig. 6-3: Transportation by fork lift truck

Transportation with lifting tackle

Designation	Article number	Weight
Lifting tackle	0000-228-154	-

The robot can also be transported using lifting tackle (>>> *Fig. 6-4*). For this, it must be in the transport position. The lifting tackle is attached at 3 points to M16 DIN 580 eyebolts. All the legs must be routed as shown in the following illustration so that the robot is not damaged. Installed tools and items of equipment can cause undesirable shifts in the center of gravity. Items of equipment, especially energy supply systems, must be removed to the extent necessary to avoid them being damaged by the legs of the lifting tackle during transportation.

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

The ceiling-mounted robot must be transported in its transport frame; all four eyebolts must be used to attach the lifting tackle. The robot must be secured with 6 M20x55-8.8 hexagon bolts and conical spring washers. Tighten the hexagon bolts with a torque wrench.

Installed tools and items of equipment can cause undesirable shifts in the center of gravity.

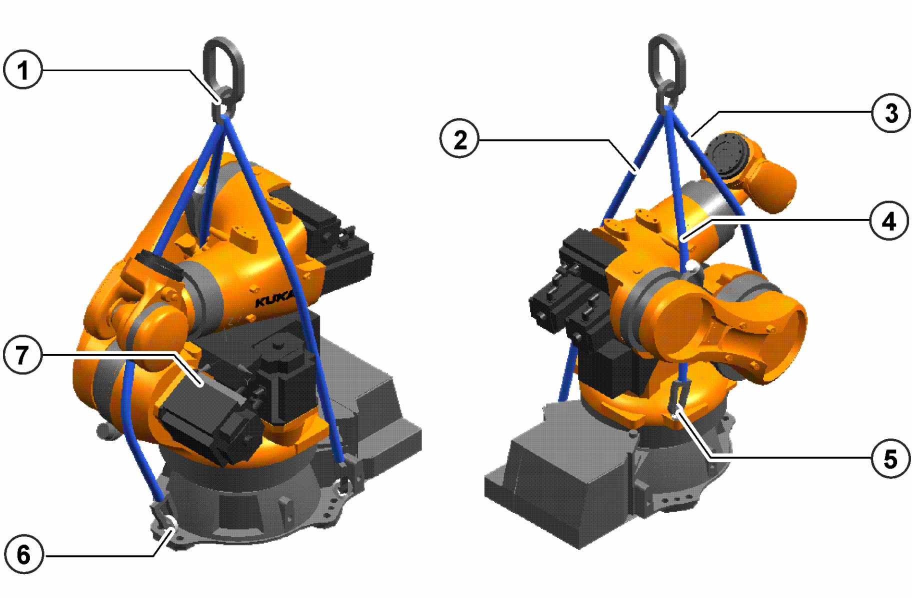


Fig. 6-4: Transportation using lifting tackle, floor-mounted robot

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

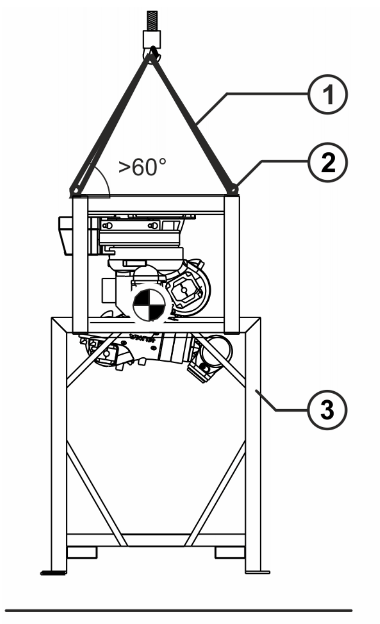


Fig. 6-5: Transportation using lifting tackle, ceiling-mounted robot

1 Lifting tackle
2 Eyebolts
3 Transport frame

WARNING

Risk of injury during transportation

The robot may tip during transportation. Death, severe injuries or damage to property may result.

- When transporting the robot using lifting tackle (optional) / rope sling, care must be exercised to prevent it from tipping.
- If necessary, additional safeguarding measures must be taken.
- It is forbidden to pick up the robot in any other way using a crane!

7 Appendix

7.1 Applied standards and regulations

Name/Edition	Definition
2006/42/EC	**Machinery Directive:** Directive 2006/42/EC of the European Parliament and of the Council of 17 May 2006 on machinery, and amending Directive 95/16/EC (recast)
2014/30/EU	**EMC Directive:** Directive 2014/30/EU of the European Parliament and of the Council dated 26 February 2014 on the approximation of the laws of the Member States concerning electromagnetic compatibility
2014/68/EU	**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 IEC 61000-6-2:2019	**Electromagnetic compatibility (EMC):** Part 6-2: Generic standards – Immunity for industrial environments
EN IEC 61000-6-4:2019	**Electromagnetic compatibility (EMC):** Part 6-4: Generic standards; Emission standard for industrial environments
EN ISO 10218-1:2011	**Robots and robotic devices – Safety requirements for industrial robots:** Part 1: Robots
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 support, please contact your local 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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