KUKA

Robots

KR 1000 titan, KR 1000 L750 titan

With F Variants and KR C4 extended

Specification

Issued: 09.11.2020

Spez KR 1000 titan KR C4 V8

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

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

Subject to technical alterations without an effect on the function.

KIM-PS5-DOC

Translation of the original documentation

Publication:	Pub Spez KR 1000 titan KR C4 (PDF) en PB2731
Book structure:	Spez KR 1000 titan KR C4 V6.1 BS1769
Version:	Spez KR 1000 titan KR C4 V8

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 (if used)
- Operating and programming instructions for the System Software
- Instructions for options and accessories
- Spare parts overview in KUKA Xpert

Each of these sets of instructions is a separate document.

1.3 Representation of warnings and notes

Safety

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

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

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

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

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

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

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

SAFETY INSTRUCTION
The following procedure must be followed exactly!

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

Notices

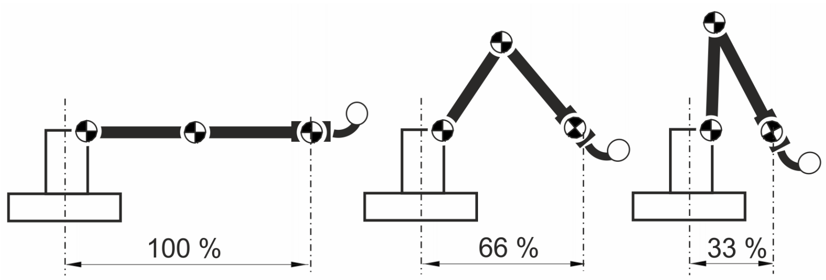
These notices serve to make your work easier or contain references to further information.

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

1.4 Terms used

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

Term	Description
Axis range	Range of each axis, in degrees or millimeters, within which it may move. The axis range must be defined for each axis.
Stopping distance	Stopping distance = reaction distance + braking distance The stopping distance is part of the danger zone.
Workspace	Area within which the robot may move. The workspace is derived from the individual axis ranges.
Arctic	Arctic for use in temperature ranges under 0°
Extension	Distance (l in %) between axis 1 and the intersection of axes 4 and 5. With parallelogram robots, the distance between axis 1 and the intersection of axis 6 and the mounting flange.



Term	Description
C	Ceiling
CR	Clean Room Designation for KUKA products developed for use in cleanrooms.
EDS	Electronic Data Storage (memory card)
EMD	Electronic Mastering Device
SPP	Spare parts package

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

RDC	Resolver Digital Converter The resolver digital converter is used to acquire motor data (e.g. position data, motor temperatures).
SC	Special Connection
SE	Second Encoder
SI	Safe Interaction
SL	Washdown
smartPAD	Programming device for the robot controller The smartPAD has all the operator control and display functions required for operating and programming the industrial robot. 2 models exist: • smartPAD • smartPAD-2 In turn, for each model there are variants, e.g. with different lengths of connecting cables. For robot controllers of the KR C5 series, only the model “smartPAD-2” is used. For other robot controllers, the designation “KUKA smartPAD” or “smartPAD” always refers to both models unless an explicit distinction is made.
Stop category 0	The drives are deactivated immediately and the brakes are applied. The manipulator and any external axes (optional) perform path-oriented braking. **Note:** This stop category is called STOP 0 in this document.
Stop category 1	The manipulator and any external axes (optional) perform path-maintaining braking. • Operating mode T1: the drives are deactivated as soon as the robot has stopped, but no later than after 680 ms. • Operating modes T2, AUT (KR C controller), AUT EXT (KR C controller), EXT (VKR C controller): The drives are switched off after 1.5 s. **Note:** This stop category is called STOP 1 in this document.
Stop category 1 – Drive Ramp Stop	The manipulator and any external axes (optional) perform path-oriented braking. • Operating mode T1: the drives are deactivated as soon as the robot has stopped, but no later than after 680 ms. • Operating modes T2, AUT (KR C controller), AUT EXT (KR C controller), EXT (VKR C controller): The drives are switched off after 1.5 s. **Note:** This stop category is called STOP 1 - DRS in this document.
Stop category 2	The drives are not deactivated and the brakes are not applied. The manipulator and any external axes (optional) are braked with a path-maintaining braking ramp. **Note:** This stop category is called STOP 2 in this document.

T1	Test mode, Manual Reduced Velocity (<= 250 mm/s)
T2	Test mode, Manual High Velocity (> 250 mm/s permissible)
W	Wall
WP	Waterproof
External axis	Axis of motion that does not belong to the manipulator, yet is controlled with the robot controller. e.g. KUKA linear unit, turn-tilt table, Posiflex

2 Product description

2.1 Overview of the industrial robot

A robot system 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 1000 titan product family comprises the types:

- KR 1000 titan
- KR 1000 L750 titan

The robots are also available as F variants.

The industrial robot consists of the following components:

- Manipulator
- Robot controller
- Teach pendant
- Connecting cables
- Software
- Options, accessories

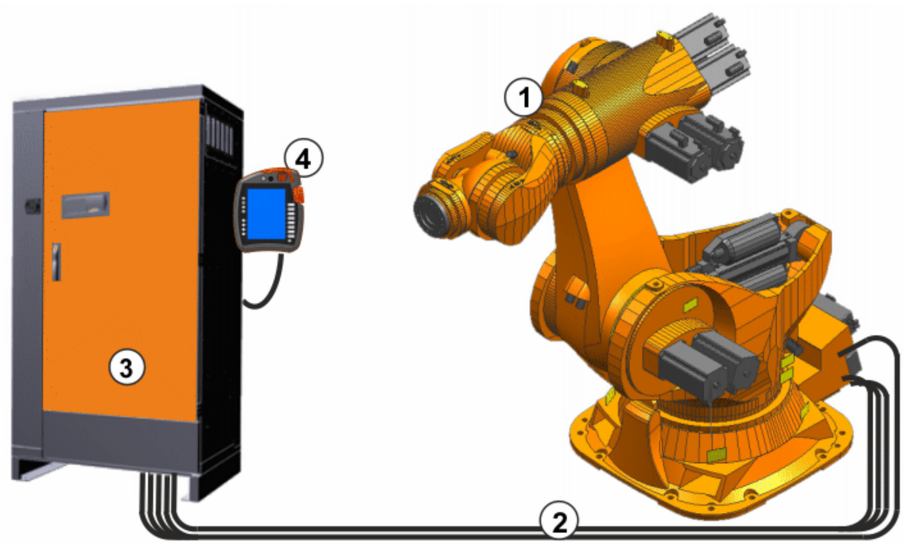


Fig. 2-1: Example of an industrial robot

1	Manipulator
2	Connecting cables
3	KR C4 control cabinet
4	KUKA smartPAD teach pendant

2.2 Description of the robot

Overview

The robots are designed as 6-axis jointed-arm kinematic systems. The structural components of the robot are made of iron castings.

The robot consists of the following principal components:

- In-line wrist

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

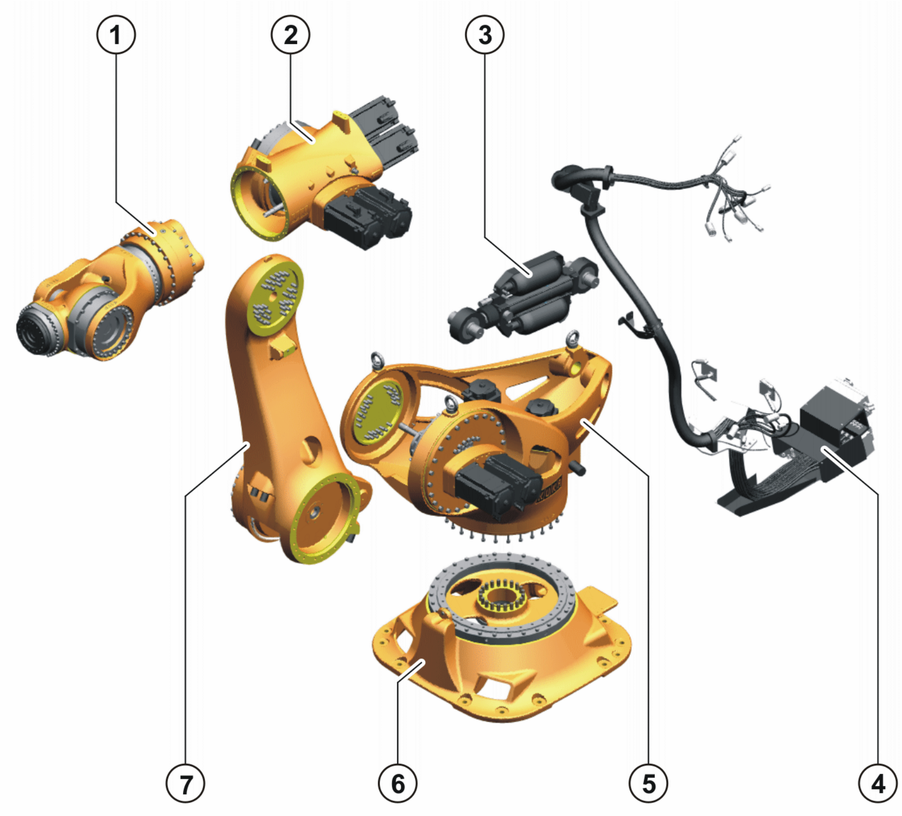


Fig. 2-2: Principal components of the KR 1000 titan

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

In-line wrist

The robot is fitted with a 3-axis in-line wrist. The in-line wrist comprises axes 4, 5 and 6. It is driven by 3 motors installed at the rear end of the arm via connecting shafts. For attaching end effectors (tools), the in-line wrist has a mounting flange.The gear units of the in-line wrist are supplied with oil from 3 separate oil chambers. The robot can be equipped with an in-line wrist for a rated payload of 1000 kg or 750 kg, depending on the variant. The in-line wrist with a rated payload of 750 kg offers a longer reach of 400 mm. Both wrist variants are also available in foundry versions.

Arm

The arm is the link between the in-line wrist and the link arm. It houses the motors of the wrist axes A4, A5 and A6 and the motors of main axis A3. The arm is driven by the 2 motors of axis 3, which drive the gear unit between the arm and the link arm via an input stage. 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.

If the robot is operated in the foundry version, a special arm variant is employed. This arm is pressurized via a pressure regulator with compressed air, which is supplied via a compressed air line.

Link arm

The link arm is the assembly located between the arm and the rotating column. It is mounted in the rotating column with a gear unit on each side and is driven by 2 motors. The two motors engage with an input stage before driving both gear units via a shaft.

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. It is screwed to the base frame via the gear unit of axis 1. The motors for driving axis 1 are mounted inside the rotating column. The bearings of the counterbalancing system are situated at the rear.

Base frame

The base frame is the base of the robot. It is screwed to the mounting base. The interfaces for the electrical installations and the energy supply systems (accessory) are housed in the base frame. For transportation by fork lift truck, fork slots are provided on the base frame.

Counterbalancing system

The counterbalancing system is installed between the rotating column and the link arm and serves to minimize the moments generated about axis 2 when the robot is in motion and at rest. A closed, hydropneumatic system is used. The system consists of 2 diaphragm accumulators and a cylinder with associated hoses, pressure gauge and safety valve.

When the link arm is vertical, the counterbalancing system has no effect. With increasing deflection in the plus or minus direction, the hydraulic oil is pressed into the two diaphragm accumulators, thereby generating the necessary counterforce to compensate the moment of the axis. The diaphragm accumulators are filled with nitrogen.

Electrical installations

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

Options

The robot can, for example, be equipped with the following options. The options are described in separate documentation or in the assembly instructions.

- Axis limitation A1, A2 and A3
- Brake release device
- Energy supply systems A1 to A3
- Energy supply systems A3 to A6
- 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. KUKA Deutschland GmbH must be consulted.

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

3 Safety

3.1 General

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

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

3.1.1 Disclaimer

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

Components of the industrial robot:

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

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

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

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

Safety information

Information about safety may not be construed against the manufacturer. Even if all safety instructions are followed, this is not a guarantee that the industrial robot will not cause personal injuries or material damage.

No modifications may be carried out to the industrial robot without the authorization of the manufacturer. Unauthorized modifications will result in the loss of warranty and liability claims.

Additional components (tools, software, etc.), not supplied by the manufacturer, may be integrated into the industrial robot. The user is liable for any damage these components may cause to the industrial robot or to other material property.

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

3.1.2 EC declaration of conformity and declaration of incorporation

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

- The industrial robot is integrated into a complete system.

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

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

EC declaration of conformity

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

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

Declaration of incorporation

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

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

3.1.3 Terms in the “Safety” chapter

Term	Description
Axis range	Range of each axis, in degrees or millimeters, within which it may move. The axis range must be defined for each axis.
Stopping distance	Stopping distance = reaction distance + braking distance The stopping distance is part of the danger zone.
Workspace	Area within which the robot may move. The workspace is derived from the individual axis ranges.
User	The user of the industrial robot can be the management, employer or delegated person responsible for use of the industrial robot.

Service life	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.
Safety options	Generic term for options which make it possible to configure additional safe monitoring functions in addition to the standard safety functions. Example: SafeOperation
smartPAD	Programming device for the robot controller The smartPAD has all the operator control and display functions required for operating and programming the industrial robot. 2 models exist: • smartPAD • smartPAD-2 In turn, for each model there are variants, e.g. with different lengths of connecting cables. For robot controllers of the KR C5 series, only the model “smartPAD-2” is used. For other robot controllers, the designation “KUKA smartPAD” or “smartPAD” always refers to both models unless an explicit distinction is made.
Stop category 0	The drives are deactivated immediately and the brakes are applied. The manipulator and any external axes (optional) perform path-oriented braking. **Note:** This stop category is called STOP 0 in this document.
Stop category 1	The manipulator and any external axes (optional) perform path-maintaining braking. • Operating mode T1: the drives are deactivated as soon as the robot has stopped, but no later than after 680 ms. • Operating modes T2, AUT (KR C controller), AUT EXT (KR C controller), EXT (VKR C controller): The drives are switched off after 1.5 s. **Note:** This stop category is called STOP 1 in this document.

Stop category 1 – Drive Ramp Stop

The manipulator and any external axes (optional) perform path-oriented braking.

- Operating mode T1: the drives are deactivated as soon as the robot has stopped, but no later than after 680 ms.
- Operating modes T2, AUT (KR C controller), AUT EXT (KR C controller), EXT (VKR C controller):

  The drives are switched off after 1.5 s.

Note: This stop category is called STOP 1 - DRS in this document.

Stop category 2

The drives are not deactivated and the brakes are not applied. The manipulator and any external axes (optional) are braked with a path-maintaining braking ramp.

Note: This stop category is called STOP 2 in this document.

System integrator (plant integrator)

The system integrator is responsible for safely integrating the industrial robot into a complete system and commissioning it.

T1

Test mode, Manual Reduced Velocity (<= 250 mm/s)

T2

Test mode, Manual High Velocity (> 250 mm/s permissible)

External axis

Axis of motion that does not belong to the manipulator, yet is controlled with the robot controller. e.g. KUKA linear unit, turn-tilt table, Posiflex

3.2 Personnel

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

- User
- Personnel

> **Qualification of personnel**
> Work on the system must only be performed by personnel that is able to assess the tasks to be carried out and detect potential hazards. Death, severe injuries or damage to property may otherwise result. The following qualifications are required:
> - Adequate specialist training, knowledge and experience
> - Knowledge of the relevant operating or assembly instructions, knowledge of the relevant standards
> - All persons working with the industrial robot must have read and understood the industrial robot documentation, including the safety chapter.

User

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

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

Personnel

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

Personnel includes:

- System integrator
- Operators, subdivided into:
  - Start-up, maintenance and service personnel
  - Operating personnel
  - Cleaning personnel

System integrator

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

The system integrator is responsible for the following tasks:

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

Operators

The operator must meet the following preconditions:

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

3.3 Workspace, safety zone and danger zone

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

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

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

3.4 Overview of protective equipment

The protective equipment of the mechanical component may include:

- Mechanical end stops

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

Not all equipment is relevant for every mechanical component.

3.4.1 Mechanical end stops

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

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

WARNING

Danger to life and limb following collision with obstacle
If the manipulator or an external axis hits an obstruction or a mechanical end stop or mechanical axis limitation, the manipulator can no longer be operated safely. Death, injuries or damage to property may result.

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

3.4.2 Mechanical axis limitation (optional)

Some manipulators can be fitted with 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 obstacles on the system side. There must be no shearing or crushing hazards at the loading and transfer areas.

This option is not available for all robot models. Information on specific robot models can be obtained from 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 are available for moving the manipulator without drive energy after an accident or malfunction:

- Release device (optional)

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

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

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

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

NOTICE

Damage to property due to moving the manipulator without drive energy

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

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

3.4.4 Labeling on the industrial robot

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

Labeling on the industrial robot consists of:

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

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

3.5 Safety measures

3.5.1 General safety measures

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

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

DANGER

Risk of fatal injury due to non-operational safety functions or external safeguards
In the absence of operational safety functions or safeguards, the industrial robot can cause death, severe injuries or damage to property.

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

DANGER

Danger to life and limb of persons under the robot arm
Sagging or falling parts can cause death or serious injuries. This applies at all times, e.g. also for assembly tasks or with the controller switched off.

- Never loiter under the robot arm.

CAUTION

Risk of burns from hot motors
The motors reach temperatures during operation which can cause burns.

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

KCP/smartPAD

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

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

WARNING

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

External keyboard, external mouse

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

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

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

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

Modifications

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

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

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

Faults

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

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

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.

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

WARNING

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

- Only connect the manipulator to the corresponding robot controller.

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

- Additional components must not impair or disable safety functions.

NOTICE

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

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

Function test

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

It must be ensured that:

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

WARNING

Danger to life and limb resulting from external forces
External forces, such as an impact or a collision, can cause non-visible damage. For example, it can lead to a gradual loss of drive power from the motor, resulting in unintended movements of the manipulator.
Death, severe injuries or damage to property may result from non-visible damage.

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

  Check the motor and counterbalancing system particularly carefully.
- In the case of damage, the affected components must be exchanged.

- There are no foreign bodies or loose parts on the industrial robot.
- All required safety equipment is correctly installed and operational.

- The power supply ratings of the industrial robot correspond to the local supply voltage and mains type.
- The ground conductor and the equipotential bonding cable are sufficiently rated and correctly connected.
- The connecting cables are correctly connected and the connectors are locked.

3.5.4 Manual mode

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

- Jog mode
- Teaching
- Programming
- Program verification

The following must be taken into consideration in manual mode:

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

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

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

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

  If it is necessary for there to be several persons inside the safeguarded area, the following must be observed:

  – Each person must have an enabling device.
  – All persons must have an unimpeded view of the industrial robot.
  – Eye-contact between all persons must be possible at all times.
- The operator must be so positioned that he can see into the danger area and get out of harm’s way.

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

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

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

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

Counterbalancing system

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

- **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. Shorter intervals are not permitted.

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, KR 1000 titan

4.1.1 Basic data, KR 1000 titan

Basic data

Type	KR 1000 titan and KR 1000 F titan
Number of axes	6
Work envelope volume	79.8 m^3
Repeatability (ISO 9283)	±0.10 mm
Work envelope reference point	Intersection of axes 4 and 5
Weight	KR 1000 titan approx. 4,690 kg KR 1000 F titan approx. 4,700 kg
Principal dynamic loads	See “Foundation loads”
Protection rating of the robot	IP65 Ready for operation, with connecting cables plugged in (according to EN 60529)
Protection rating of the in-line wrist	IP65
Protection rating of the in-line wrist F	IP67
Sound level	< 75 dB (A) outside the working envelope
Installation position	Floor
Surface finish, paintwork	Base (stationary): black (RAL 9005); counterbalancing system: black (RAL 9005); moving parts: KUKA industrial orange (RAL 2009)

Foundry robots

Overpressure in the arm	0.01 MPa (0.1 bar) ±10%
Compressed air	Free of oil and water Class 4 in accordance with ISO 8573-1
Compressed air supply line	Air line in the cable set
Air consumption	0.1 m^3/h
Air line connection	Push-in fitting for hose, 6 mm
Input pressure	0.1 - 1.2 MPa (1 - 12 bar)
Pressure regulator	0.005 - 0.07 MPa (0.05 - 0.7 bar)
Manometer range	0.0 - 0.1 MPa (0.0 - 1.0 bar)
Thermal loading	10 s/min at 453 K (180 °C)
Resistance	Increased resistance to dust, lubricants, coolants and water vapor.

Special paint finish on wrist	Heat-resistant and heat-reflecting silver paint finish on the in-line wrist.
Special paint finish on the robot	Special paint finish on the entire robot, and an additional protective clear coat.
Other ambient conditions	KUKA Deutschland GmbH must be consulted if the robot is to be used under other ambient conditions.

Ambient temperature

Operation	283 K to 328 K (+10 °C to +55 °C)
Storage and transportation	233 K to 333 K (-40 °C to +60 °C)
Start-up	In the case of start-up in the range of 278 K to 288 K (+5 °C to +15 °C), the robot may have to be warmed up. Other temperature limits available on request.
Ambient conditions	DIN EN 60721-3-3, Class 3K3

Connecting cables

Cable designation	Connector designation	Interface with robot
Motor cable 1	X20.1 - X30.1	Rectangular connector HAN size 24
Motor cable 2	X20.2 - X30.2	Rectangular connector HAN size 24
Motor cable 3	X20.3 - X30.3	Rectangular connector HAN size 24
Data cable	X21 - X31	Rectangular connector HAN 3A
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	1x

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

4.1.2 Axis data, KR 1000 titan

Axis data

Motion range	
A1	±150 °
A2	-130 ° / 17.5 °
A3	-110 ° / 145 °

A4	±350 °
A5	±118 °
A6	±350 °
Speed with rated payload	
A1	58 °/s
A2	50 °/s
A3	50 °/s
A4	60 °/s
A5	60 °/s
A6	72 °/s

Direction of rotation of robot axes

The following diagram shows the direction of motion and the arrangement of the individual axes for the listed variants of this product family.

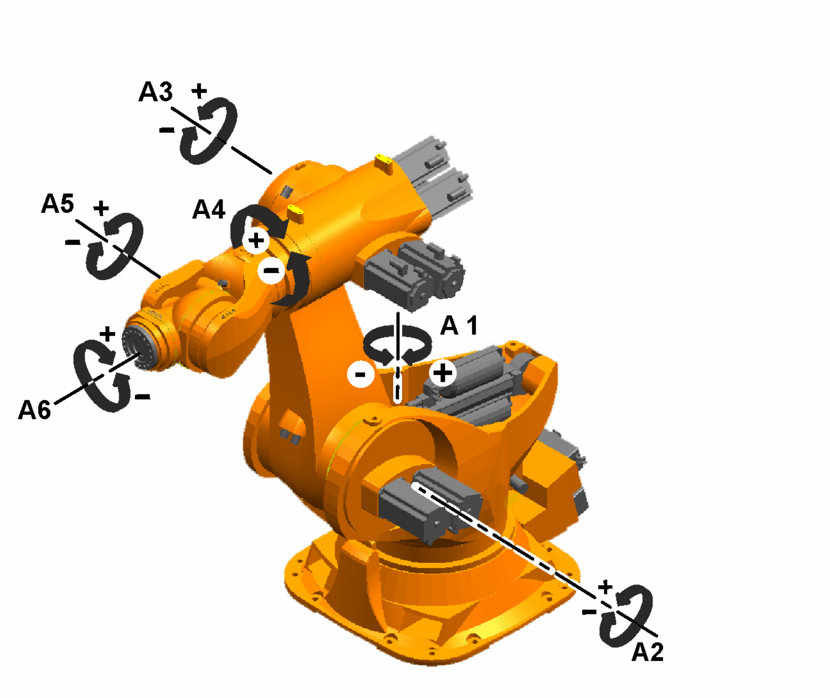


Fig. 4-1: Direction of rotation of robot axes

Mastering position

Mastering position	
A1	0 °
A2	-90 °
A3	90 °
A4	0 °
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.

Working envelope, KR 1000 titan

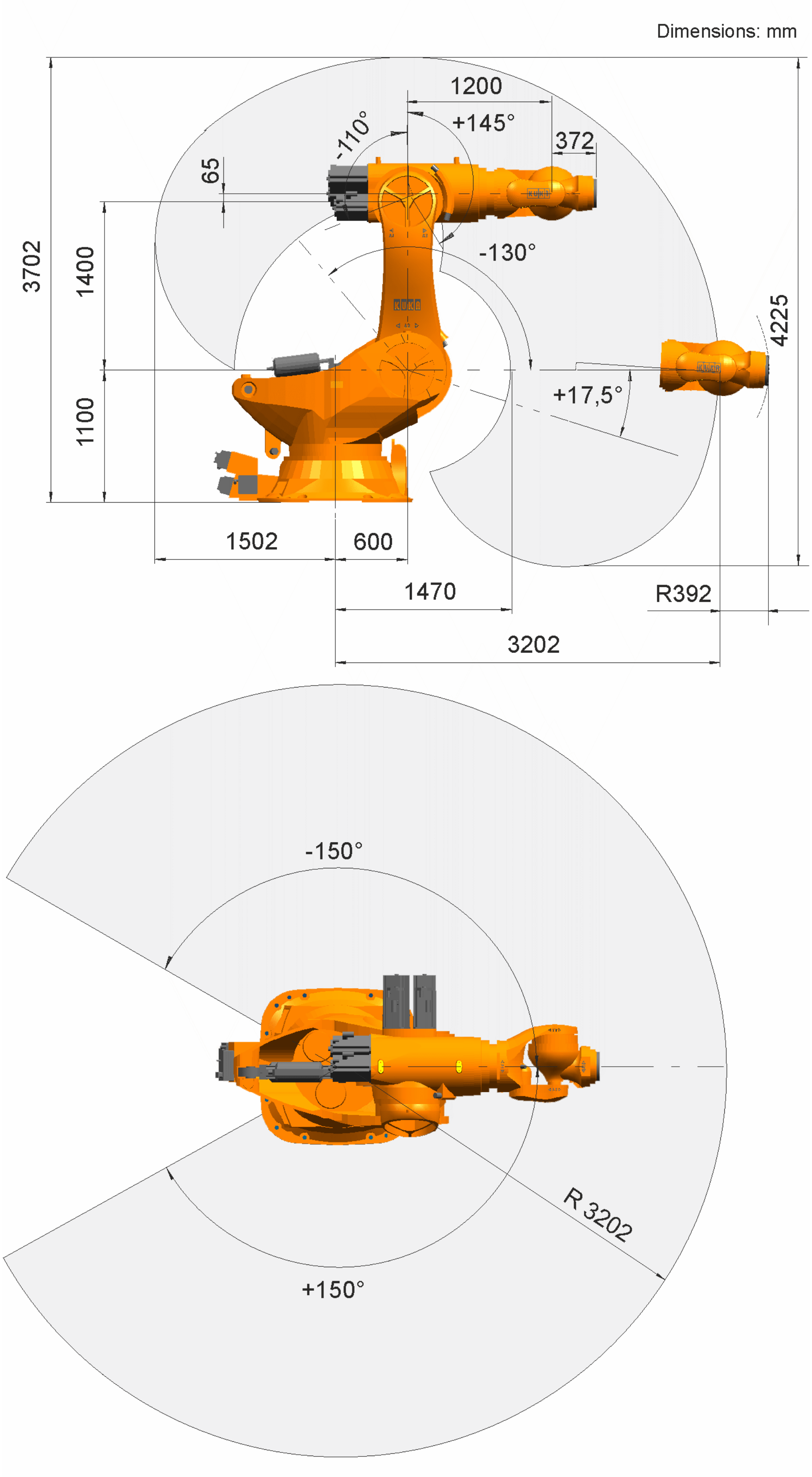


Fig. 4-2: KR 1000 titan, working envelope, overall

4.1.3 Payloads, KR 1000 titan

Payloads

Rated payload	1000 kg
Maximum payload	1000 kg
Rated supplementary load, base frame	0 kg
Maximum supplementary load, base frame	0 kg
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

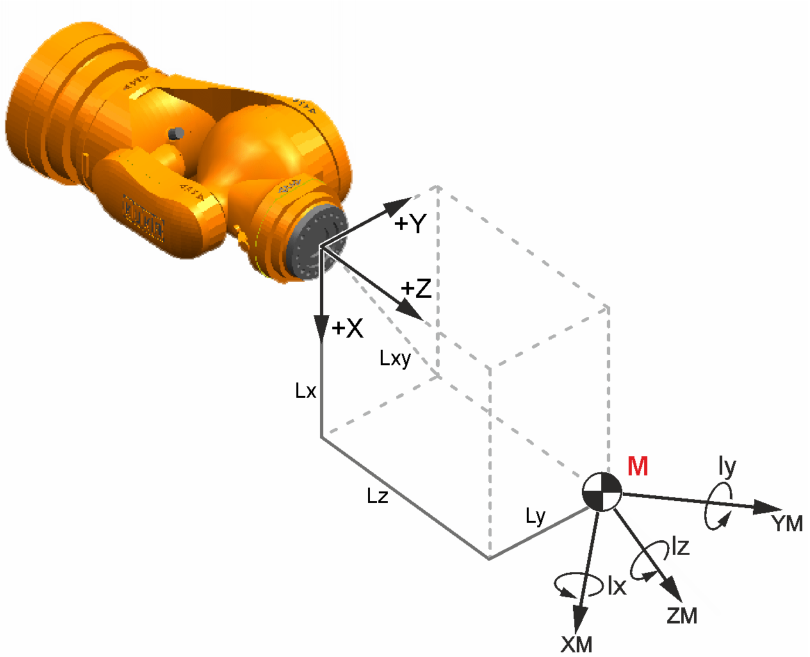


Fig. 4-3: Load center of gravity and mass moment of inertia

Parameter

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

Parameter/unit		Description
A, **B**, **C**	Degrees	Orientation of the principal inertia axes • 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.

More 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 Deutschland GmbH must be consulted beforehand. The values determined here are necessary for planning the robot application. For commissioning the robot, additional input data are required in accordance with the operating and programming instructions of the KUKA System Software. The mass inertia must be verified using KUKA.Load or KUKA Compose. It is imperative for the load data to be entered in the robot controller!

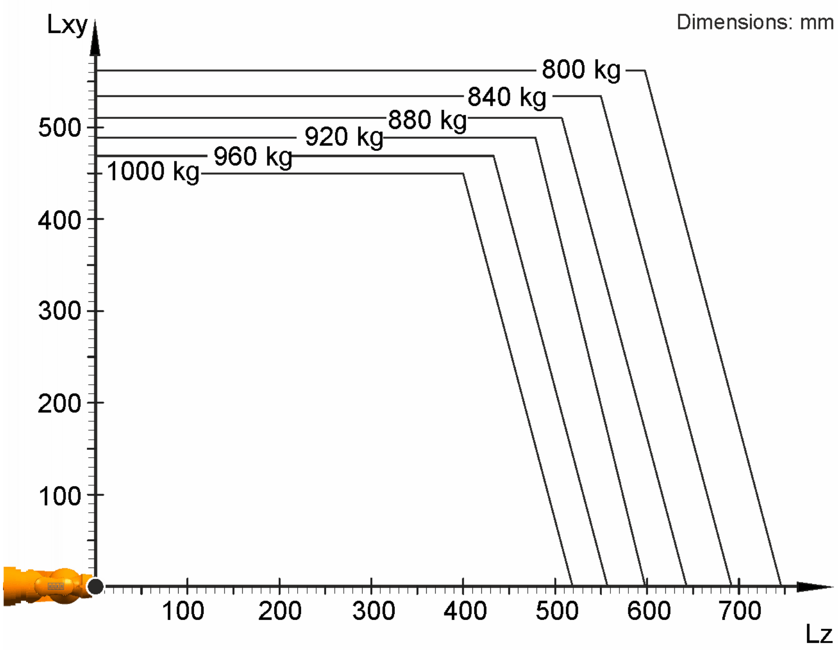


Fig. 4-4: Payload diagram for KR 1000 titan

The KR 1000 titan is designed for a rated payload of 1000 kg in order to optimize the dynamic performance of the robot. The maximum payload of 1000 kg applies only if the position of the center of mass is 0 mm and a supplementary load optimized for the load case is mounted. The specific load case must be verified using KUKA.Load or KUKA Compose. For further consultation, please contact KUKA Support.

Mounting flange

In-line wrist type	ZH 1000
Mounting flange	see drawing

Mounting flange (hole circle)	200 mm
Screw grade	10.9
Screw size	M 16
Number of fastening threads	16
Depth of engagement	min. 24 mm, max. 25 mm
Locating element	12 ^{H7}

The inner locating diameter is ø 160 ^{H7}. This deviates from the standard DIN/ISO 9409-1-A200.

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

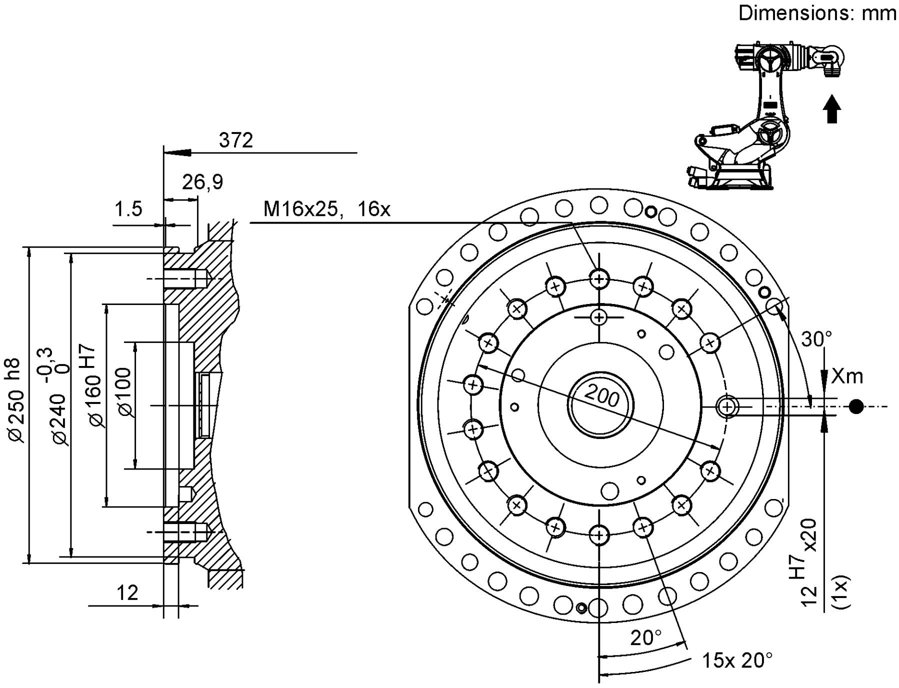


Fig. 4-5: Mounting flange

Flange loads

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

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

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

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

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

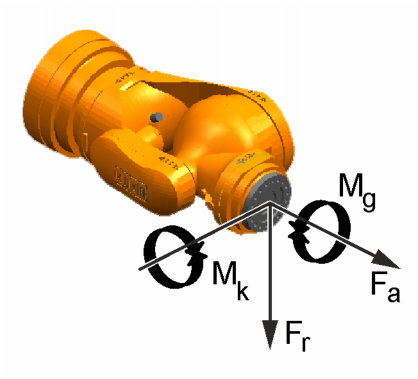


Fig. 4-6: Flange loads

Flange loads during operation	
F(a)	11200 N
F(r)	15000 N
M(k)	3300 Nm
M(g)	5400 Nm
Flange loads in the case of EMERGENCY STOP	
F(a)	12650 N
F(r)	24750 N
M(k)	9350 Nm
M(g)	8050 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 on the arm. When mounting the supplementary loads, be careful to observe the maximum permissible total load. If an energy supply system A3 - A6 is used, the maximum supplementary load is reduced by the mass of the energy supply system. The dimensions and positions of the installation options can be seen in the diagram (>>> *Fig. 4-7*). All other threads and holes on the robot are not suitable for attaching additional loads.

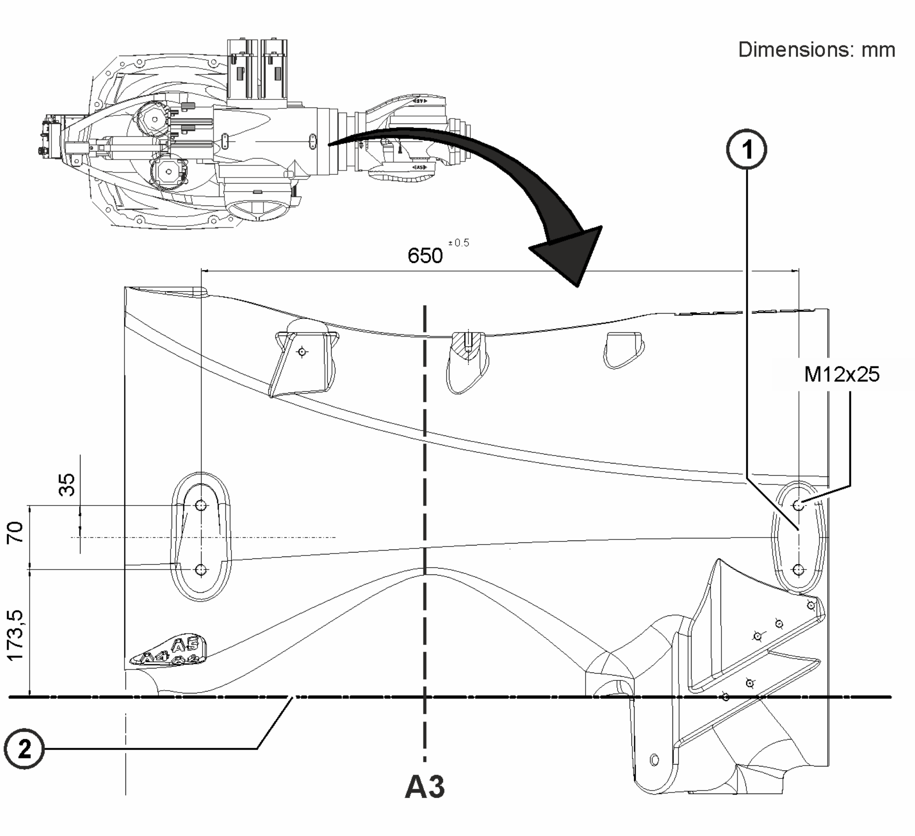


Fig. 4-7: Supplementary load, arm

4.1.4 Foundation loads, KR 1000 titan

Foundation loads

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

Vertical force F(v)	
F(v normal)	61500 N
F(v max)	70000 N
Horizontal force F(h)	
F(h normal)	21400 N
F(h max)	35500 N
Tilting moment M(k)	
M(k normal)	102200 Nm
M(k max)	133700 Nm
Torque about axis 1 M(r)	
M(r normal)	36600 Nm
M(r max)	99700 Nm

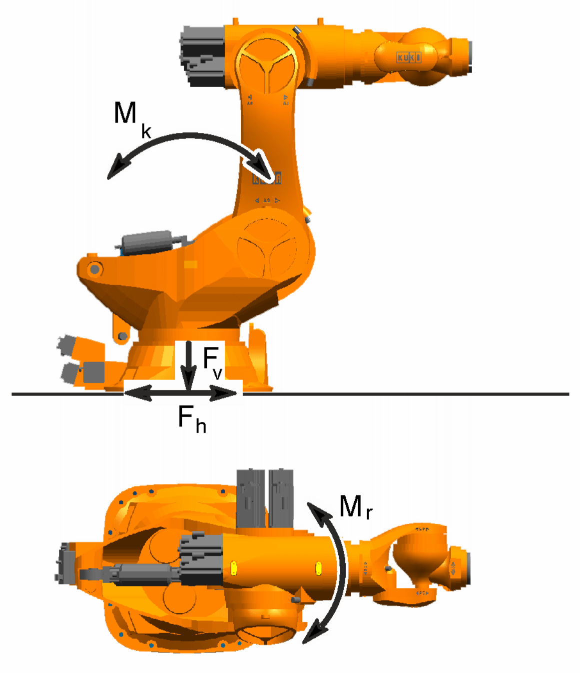


Fig. 4-8: Foundation loads

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

4.2 Technical data, KR 1000 L750 titan

4.2.1 Basic data, KR 1000 L750 titan

Basic data

Type	KR 1000 L750 titan and KR 1000 L750 F titan
Number of axes	6
Work envelope volume	122.6 m^3
Repeatability (ISO 9283)	±0.10 mm
Work envelope reference point	Intersection of axes 4 and 5
Weight	KR 1000 L750 titan approx. 4,740 kg KR 1000 L750 F titan approx. 4,750 kg
Principal dynamic loads	See “Foundation loads”

Protection rating of the robot	IP65 Ready for operation, with connecting cables plugged in (according to EN 60529)
Protection rating of the in-line wrist	IP65
Protection rating of the in-line wrist F	IP67
Sound level	< 75 dB (A) outside the working envelope
Installation position	Floor
Surface finish, paint-work	Base (stationary): black (RAL 9005); counter-balancing system: black (RAL 9005); moving parts: KUKA industrial orange (RAL 2009)

Foundry robots

Overpressure in the arm	0.01 MPa (0.1 bar) ±10%
Compressed air	Free of oil and water Class 4 in accordance with ISO 8573-1
Compressed air supply line	Air line in the cable set
Air consumption	0.1 m^3/h
Air line connection	Push-in fitting for hose, 6 mm
Input pressure	0.1 - 1.2 MPa (1 - 12 bar)
Pressure regulator	0.005 - 0.07 MPa (0.05 - 0.7 bar)
Manometer range	0.0 - 0.1 MPa (0.0 - 1.0 bar)
Thermal loading	10 s/min at 453 K (180 °C)
Resistance	Increased resistance to dust, lubricants, coolants and water vapor.
Special paint finish on wrist	Heat-resistant and heat-reflecting silver paint finish on the in-line wrist.
Special paint finish on the robot	Special paint finish on the entire robot, and an additional protective clear coat.
Other ambient conditions	KUKA Deutschland GmbH must be consulted if the robot is to be used under other ambient conditions.

Ambient temperature

Operation	283 K to 328 K (+10 °C to +55 °C)
Storage and transportation	233 K to 333 K (-40 °C to +60 °C)
Start-up	In the case of start-up in the range of 278 K to 288 K (+5 °C to +15 °C), the robot may have to be warmed up. Other temperature limits available on request.
Ambient conditions	DIN EN 60721-3-3, Class 3K3

Connecting cables

Cable designation	Connector designation	Interface with robot
Motor cable 1	X20.1 - X30.1	Rectangular connector HAN size 24
Motor cable 2	X20.2 - X30.2	Rectangular connector HAN size 24
Motor cable 3	X20.3 - X30.3	Rectangular connector HAN size 24
Data cable	X21 - X31	Rectangular connector HAN 3A
Ground conductor / equipotential bonding 16 mm^2 (optional)		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	1x

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

4.2.2 Axis data, KR 1000 L750 titan

Axis data

Motion range	
A1	±150 °
A2	-130 ° / 17.5 °
A3	-110 ° / 145 °
A4	±350 °
A5	±118 °
A6	±350 °
Speed with rated payload	
A1	58 °/s
A2	50 °/s
A3	50 °/s
A4	60 °/s
A5	60 °/s
A6	72 °/s

Direction of rotation of robot axes

The following diagram shows the direction of motion and the arrangement of the individual axes for the listed variants of this product family.

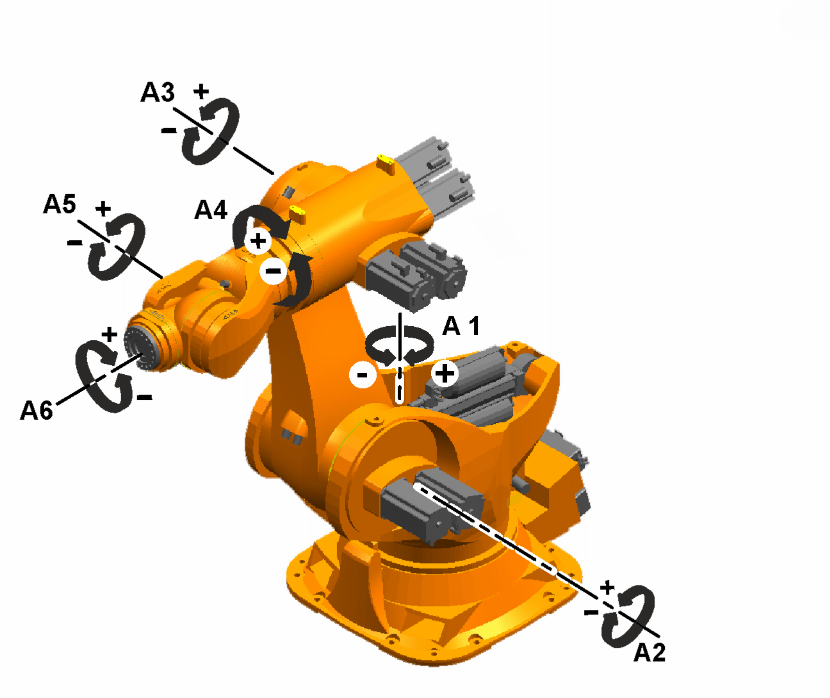


Fig. 4-9: Direction of rotation of robot axes

Mastering position

Mastering position	
A1	0 °
A2	-90 °
A3	90 °
A4	0 °
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.

Working envelope, KR 1000 L750 titan

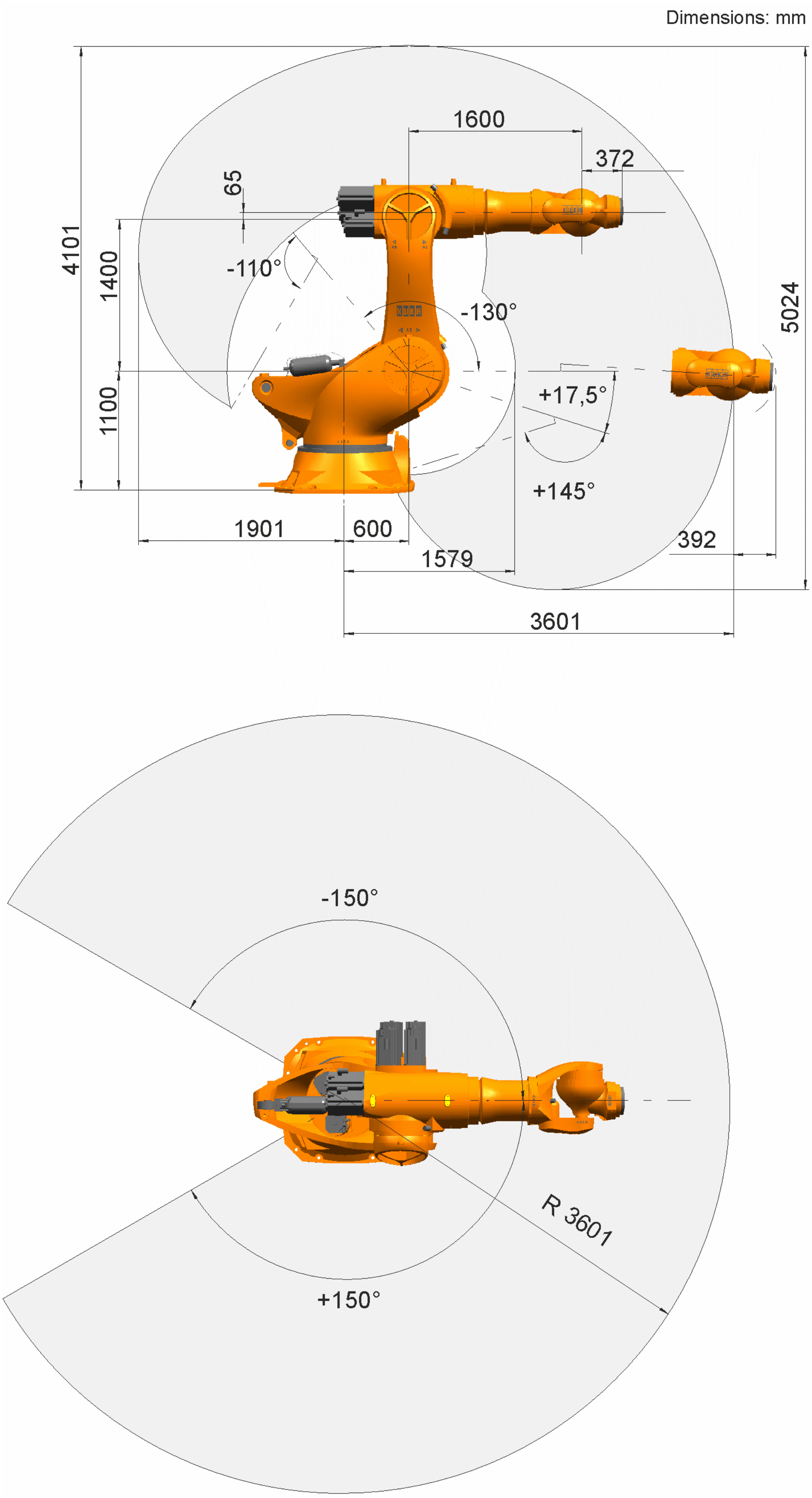


Fig. 4-10: KR 1000 L750 titan, working envelope, overall

4.2.3 Payloads, KR 1000 L750 titan

Payloads

Rated payload	750 kg
Maximum payload	750 kg
Rated supplementary load, base frame	0 kg
Maximum supplementary load, base frame	0 kg
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

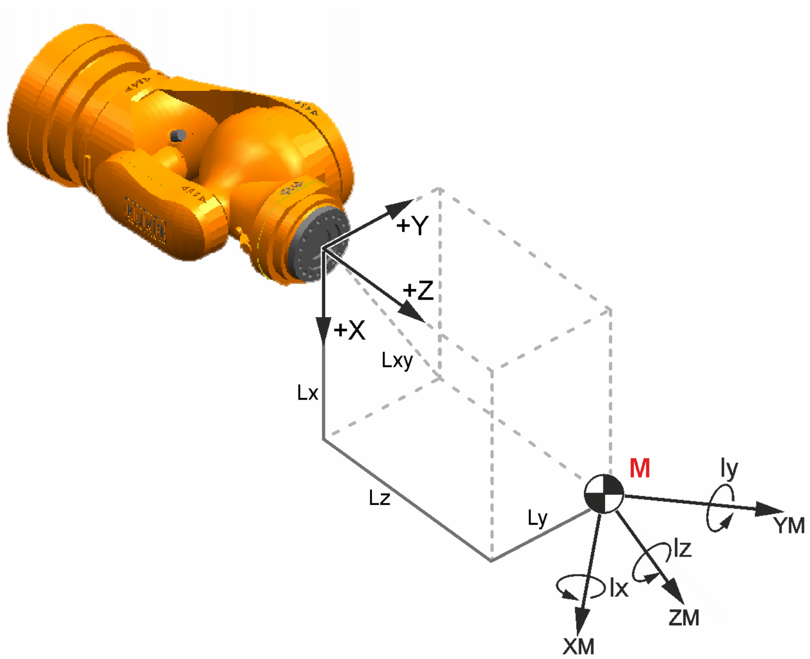


Fig. 4-11: Load center of gravity and mass moment of inertia

Parameter

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

Parameter/unit		Description
A, **B**, **C**	Degrees	Orientation of the principal inertia axes • 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.

More 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 Deutschland GmbH must be consulted beforehand.
The values determined here are necessary for planning the robot application. For commissioning the robot, additional input data are required in accordance with the operating and programming instructions of the KUKA System Software.
The mass inertia must be verified using KUKA.Load or KUKA Compose. It is imperative for the load data to be entered in the robot controller!

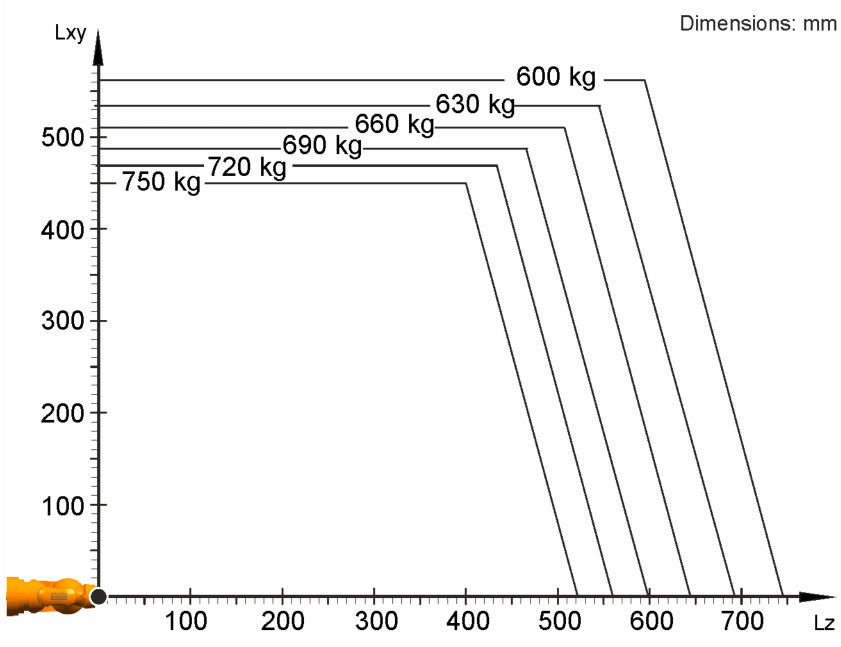


Fig. 4-12: Payload diagram for KR 1000 L750 titan

The KR 1000 L750 titan is designed for a rated payload of 750 kg in order to optimize the dynamic performance of the robot. The maximum payload of 750 kg applies only if the position of the center of mass is 0 mm and a supplementary load optimized for the load case is mounted. The specific load case must be verified using KUKA.Load or KUKA Compose. For further consultation, please contact KUKA Support.

Mounting flange

In-line wrist type	ZH 750
Mounting flange	see drawing

Mounting flange (hole circle)	200 mm
Screw grade	10.9
Screw size	M 16
Number of fastening threads	16
Depth of engagement	min. 24 mm, max. 25 mm
Locating element	12 ^{H7}

The inner locating diameter is ø 160 ^{H7}. This deviates from the standard DIN/ISO 9409-1-A200.

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

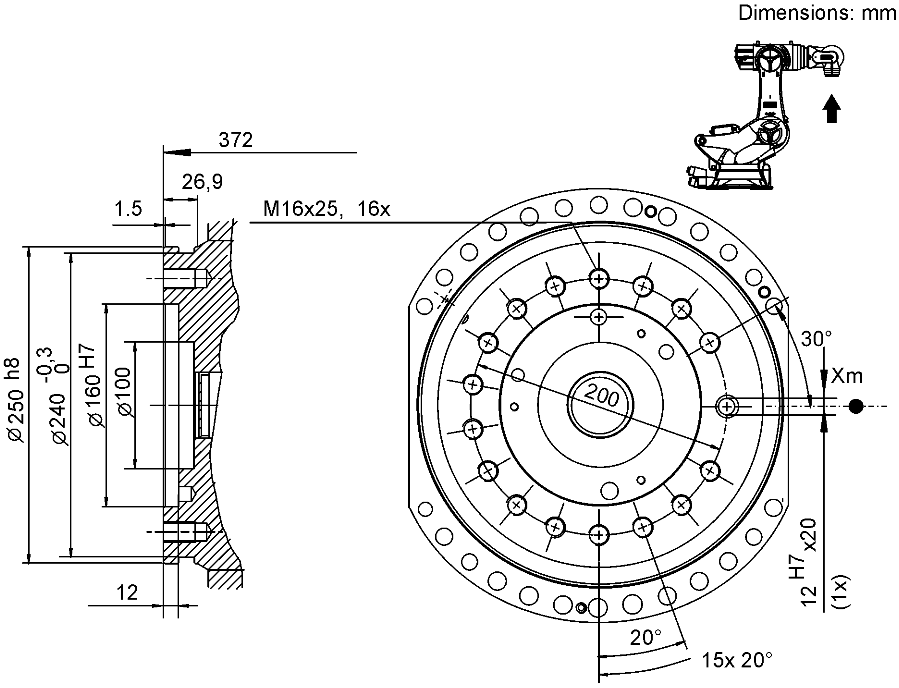


Fig. 4-13: Mounting flange

Flange loads

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

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

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

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

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

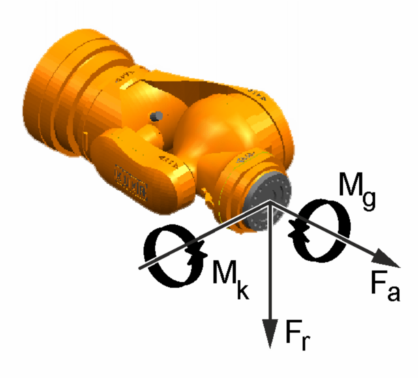


Fig. 4-14: Flange loads

Flange loads during operation	
F(a)	11200 N
F(r)	15000 N
M(k)	3300 Nm
M(g)	5400 Nm
Flange loads in the case of EMERGENCY STOP	
F(a)	12650 N
F(r)	24750 N
M(k)	9350 Nm
M(g)	8050 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 on the arm. When mounting the supplementary loads, be careful to observe the maximum permissible total load. If an energy supply system A3 - A6 is used, the maximum supplementary load is reduced by the mass of the energy supply system. The dimensions and positions of the installation options can be seen in the diagram (>>> *Fig. 4-15*). All other threads and holes on the robot are not suitable for attaching additional loads.

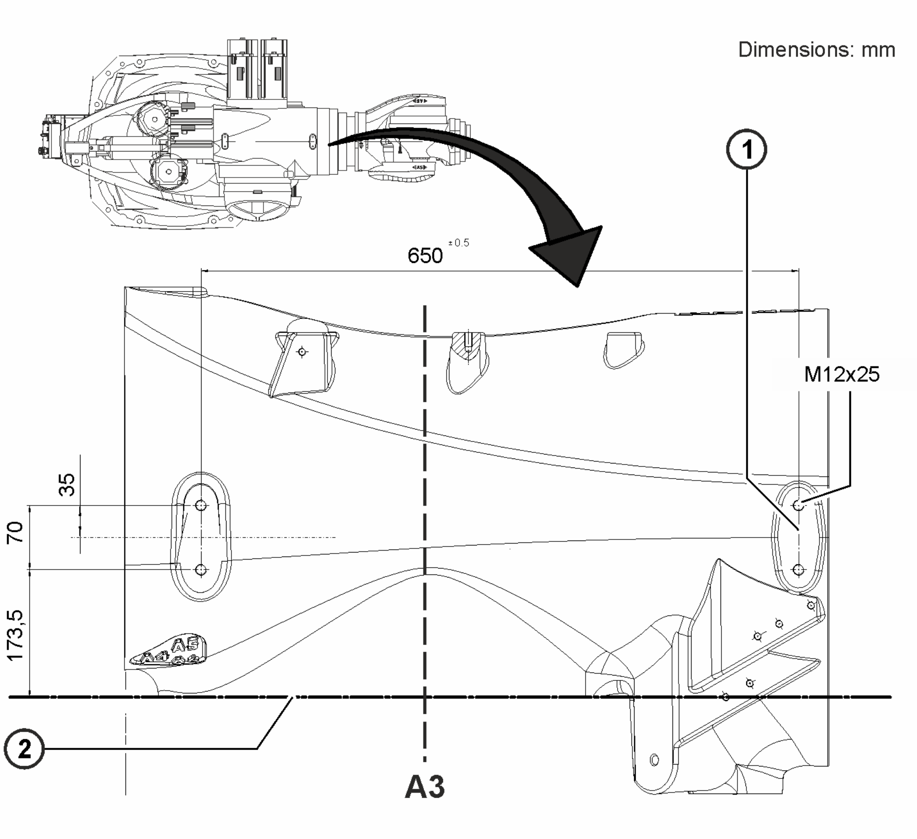


Fig. 4-15: Supplementary load, arm

4.2.4 Foundation loads, KR 1000 L750 titan

Foundation loads

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

Vertical force F(v)	
F(v normal)	61500 N
F(v max)	70000 N
Horizontal force F(h)	
F(h normal)	21400 N
F(h max)	35500 N
Tilting moment M(k)	
M(k normal)	102200 Nm
M(k max)	133700 Nm
Torque about axis 1 M(r)	
M(r normal)	36600 Nm
M(r max)	99700 Nm

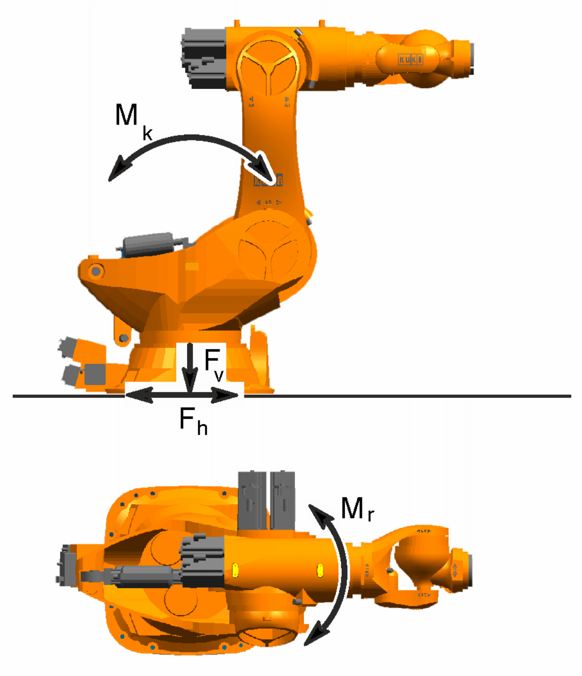


Fig. 4-16: Foundation loads

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

4.3 Plates and labels

Plates and labels

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

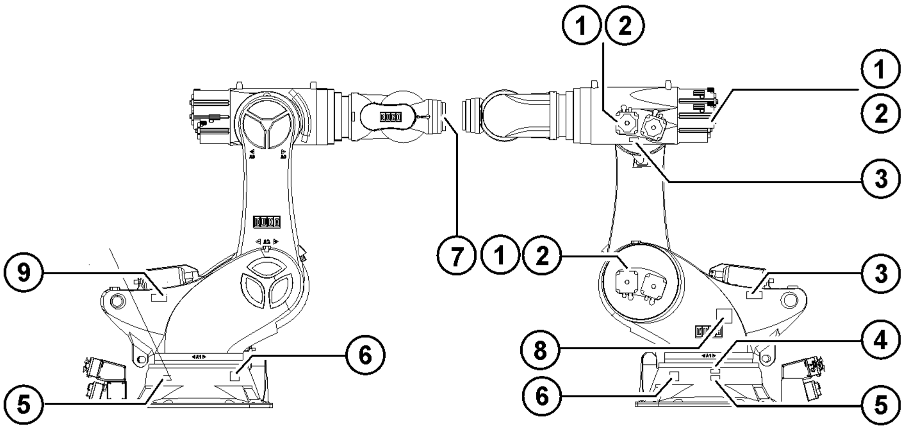
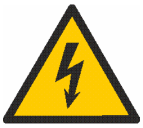
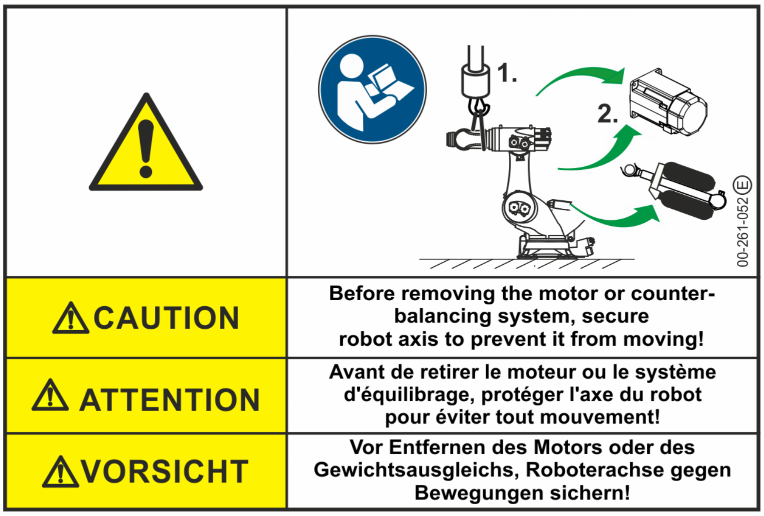
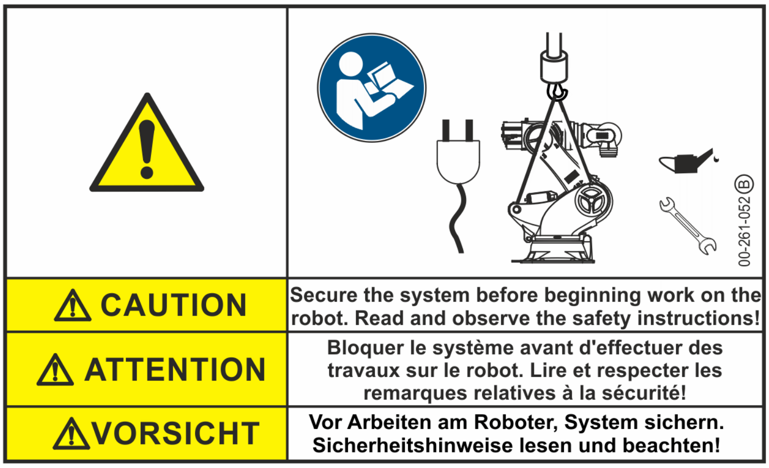
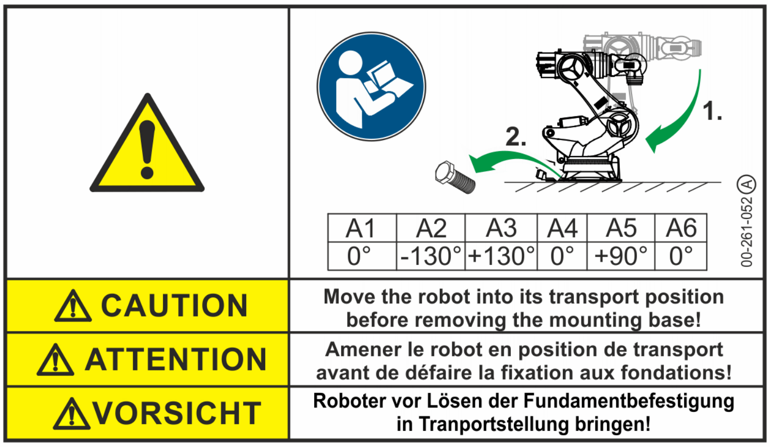
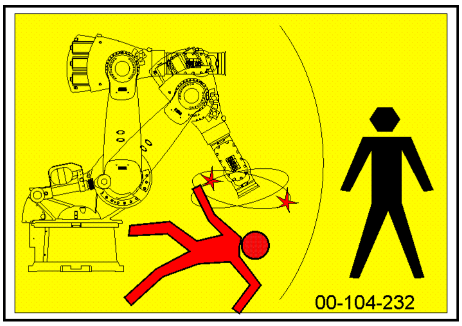


Fig. 4-17: Location of plates and labels

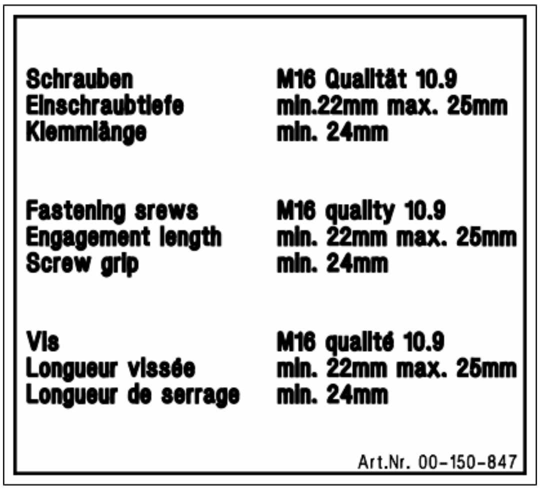
Item	Description
1	 **High voltage** Any improper handling can lead to contact with current-carrying components. Electric shock hazard!
2	 **Hot surface** During operation of the robot, surface temperatures may be reached that could result in burn injuries. Protective gloves must be worn!
3	 **Secure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

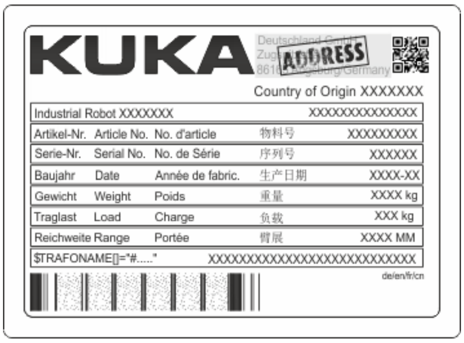
<table>
<tr><th>Item</th><th>Description</th></tr>
<tr><td>4</td><td>


Work on the robot
Before start-up, transportation or maintenance, read and follow the assembly and operating instructions.</td></tr>
<tr><td>5</td><td>


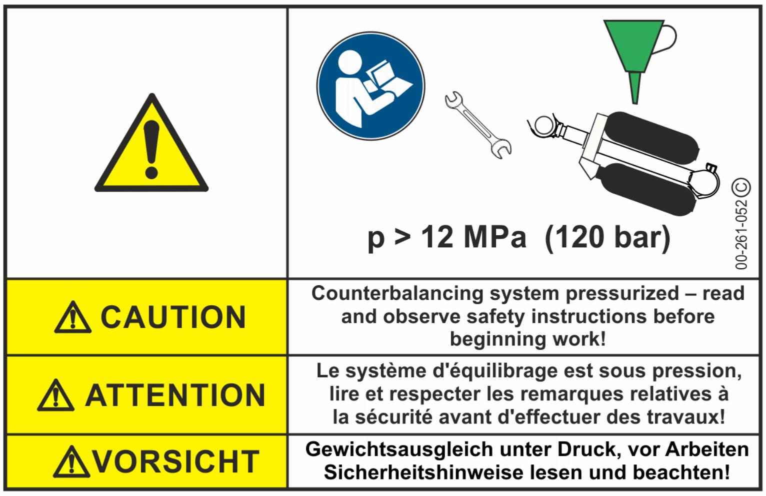
Transport position
Before loosening the bolts of the mounting base, the robot must be in the transport position as indicated in the table. Risk of toppling!</td></tr>
<tr><td>6</td><td>


Danger zone
Entering the danger zone of the robot is prohibited if the robot is in operation or ready for operation. Risk of injury!</td></tr>
</table>

<table>
<tr><th>Item</th><th>Description</th></tr>
<tr><td>7</td><td>

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.</td></tr>
<tr><td>8</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>9</td><td>

Counterbalancing system
The system is pressurized with oil and nitrogen. Read and follow the assembly and operating instructions before commencing work on the counterbalancing system. Risk of injury!</td></tr>
</table>

4.4 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.

4.5 Stopping distances and times

4.5.1 General information

Information concerning the data:

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

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

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

4.5.2 Stopping distances and times, KR 1000 titan

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

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

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

	Stopping distance (°)	Stopping time (s)
Axis 1	34.94	0.914
Axis 2	35.00	1.000
Axis 3	25.00	0.700

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

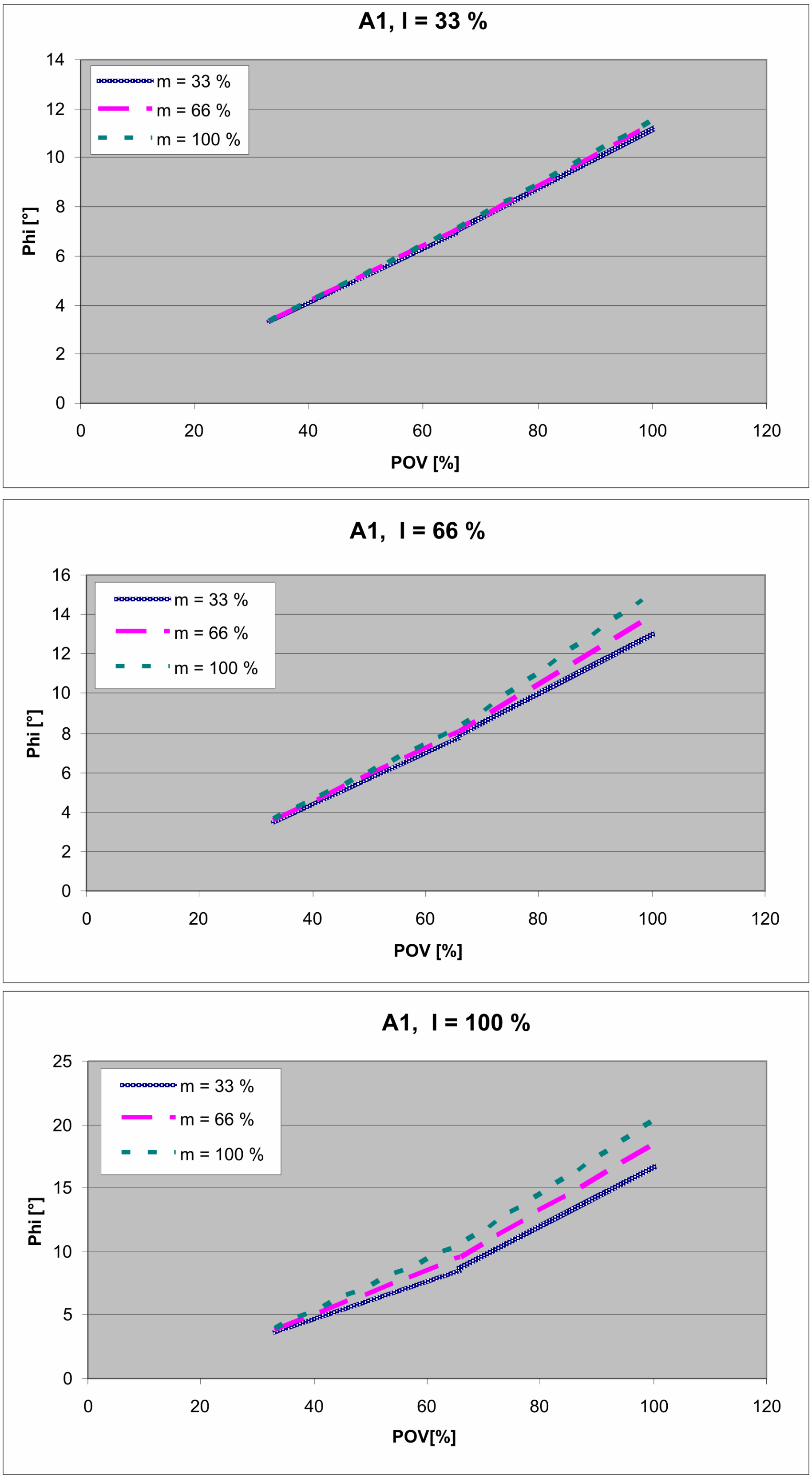


Fig. 4-18: Stopping distances for STOP 1, axis 1

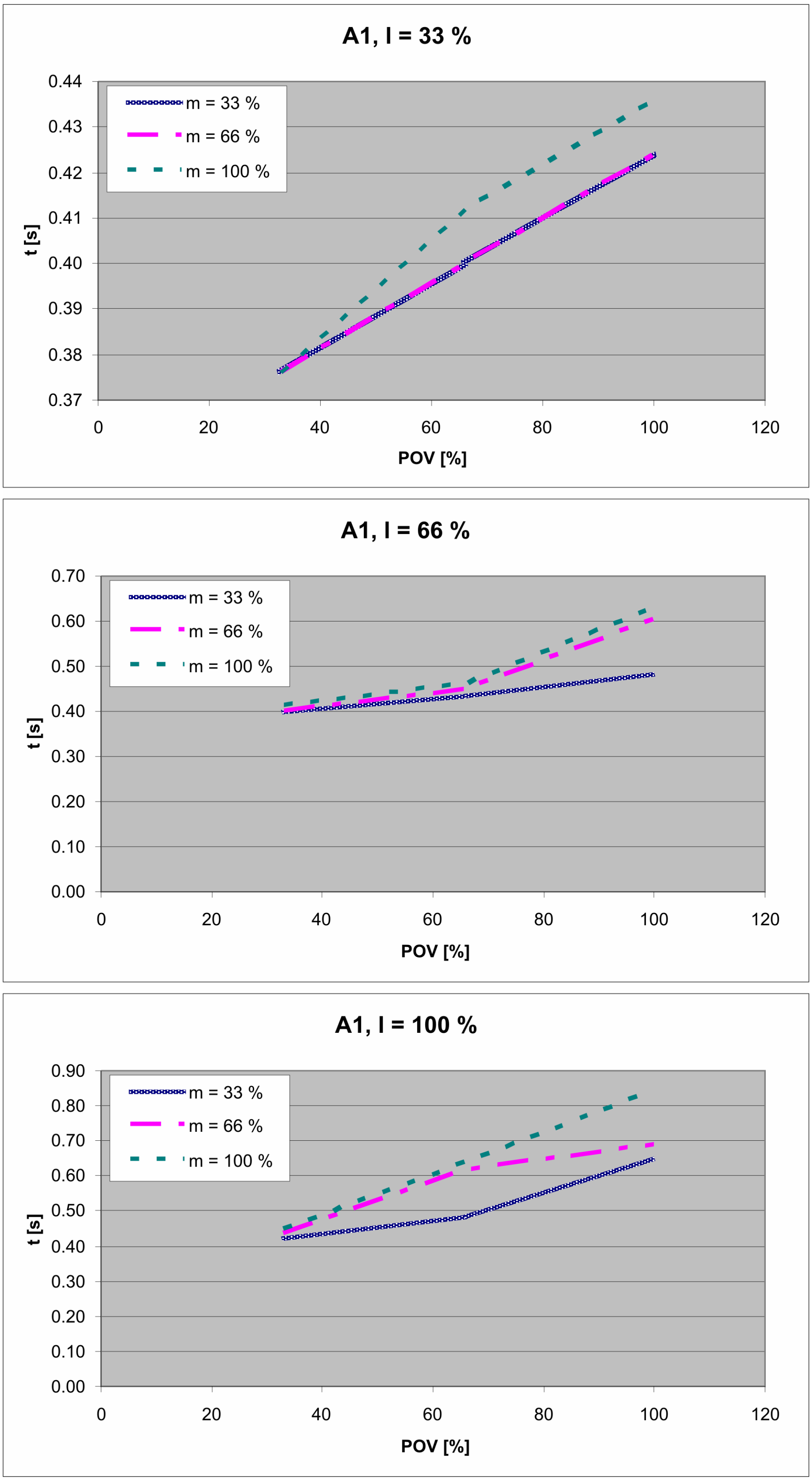


Fig. 4-19: Stopping times for STOP 1, axis 1

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

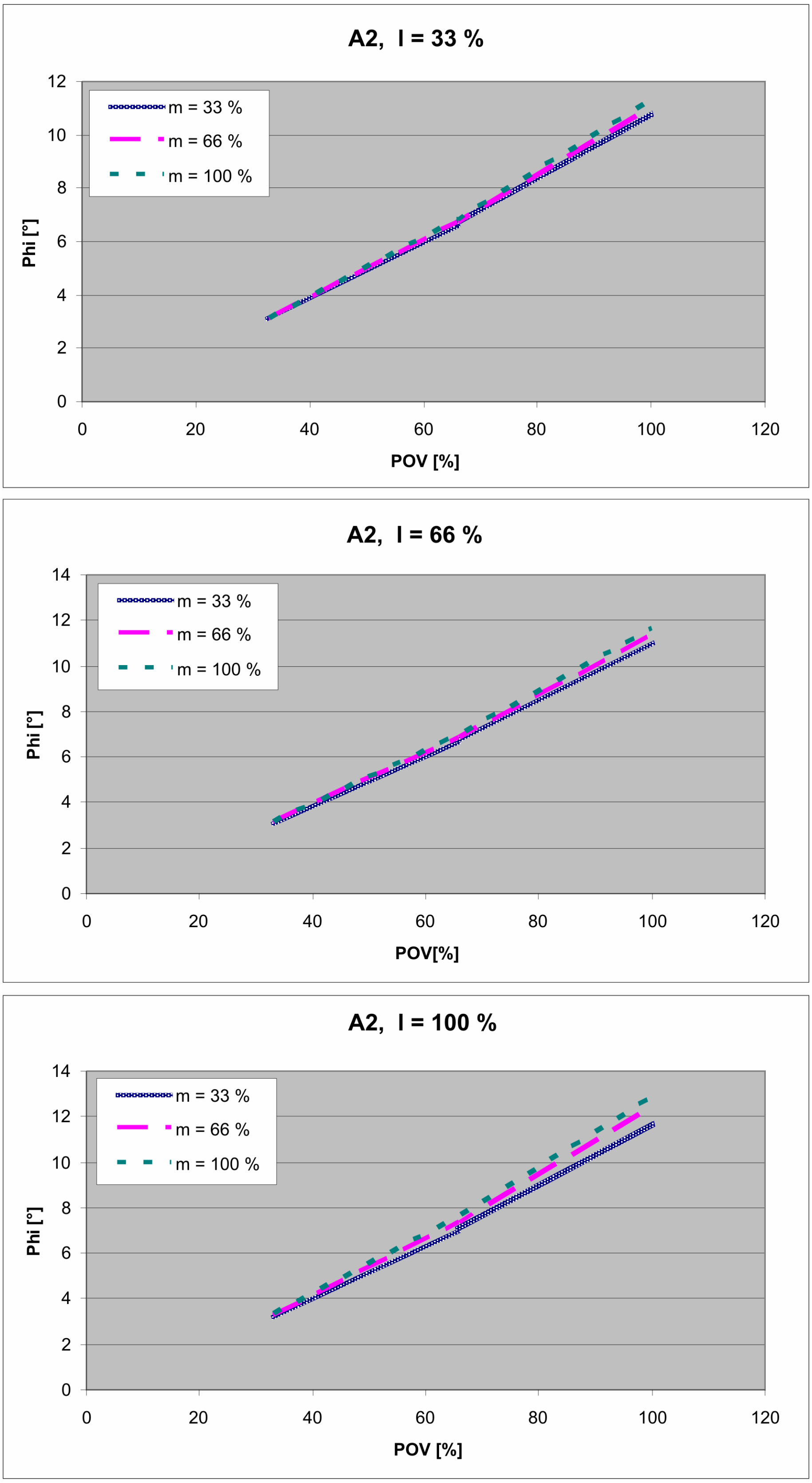


Fig. 4-20: Stopping distances for STOP 1, axis 2

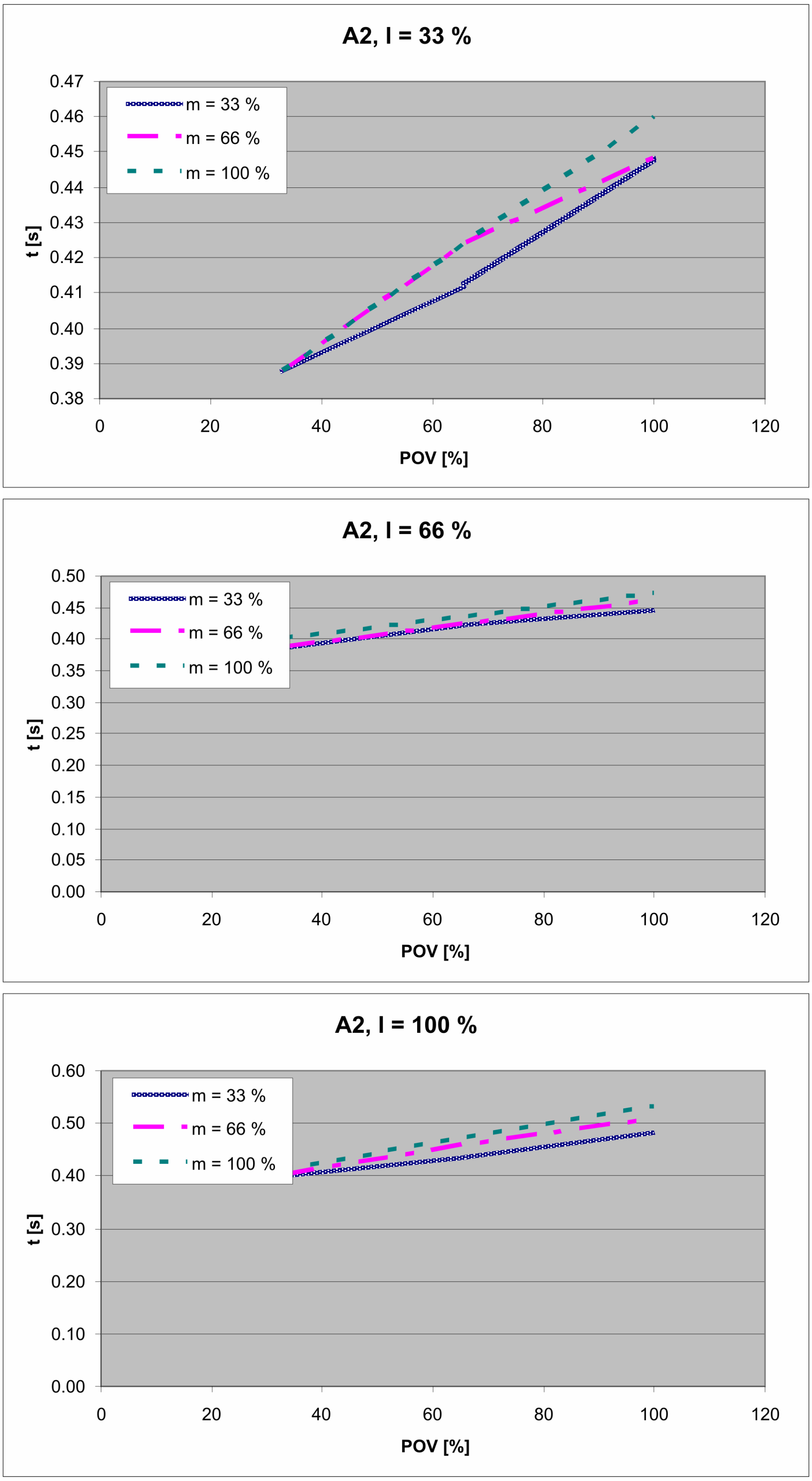


Fig. 4-21: Stopping times for STOP 1, axis 2

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

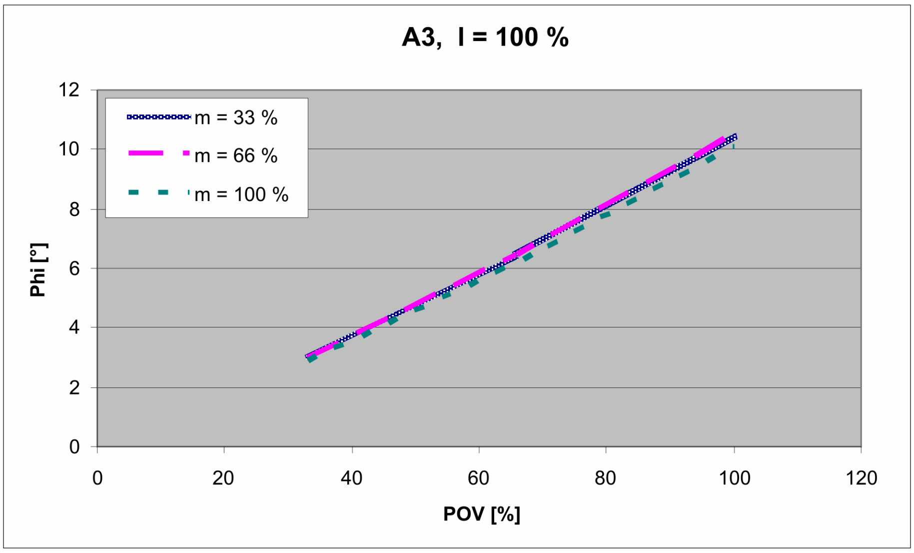


Fig. 4-22: Stopping distances for STOP 1, axis 3

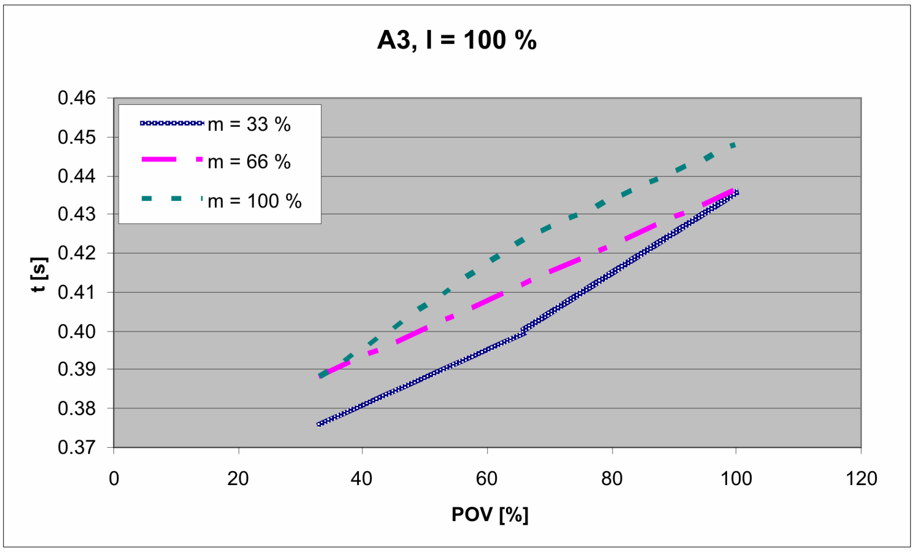


Fig. 4-23: Stopping times for STOP 1, axis 3

4.5.3 Stopping distances and times, KR 1000 L750 titan

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

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

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

	Stopping distance (°)	Stopping time (s)
Axis 1	36.25	1.013
Axis 2	19.39	0.533
Axis 3	16.41	0.442

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

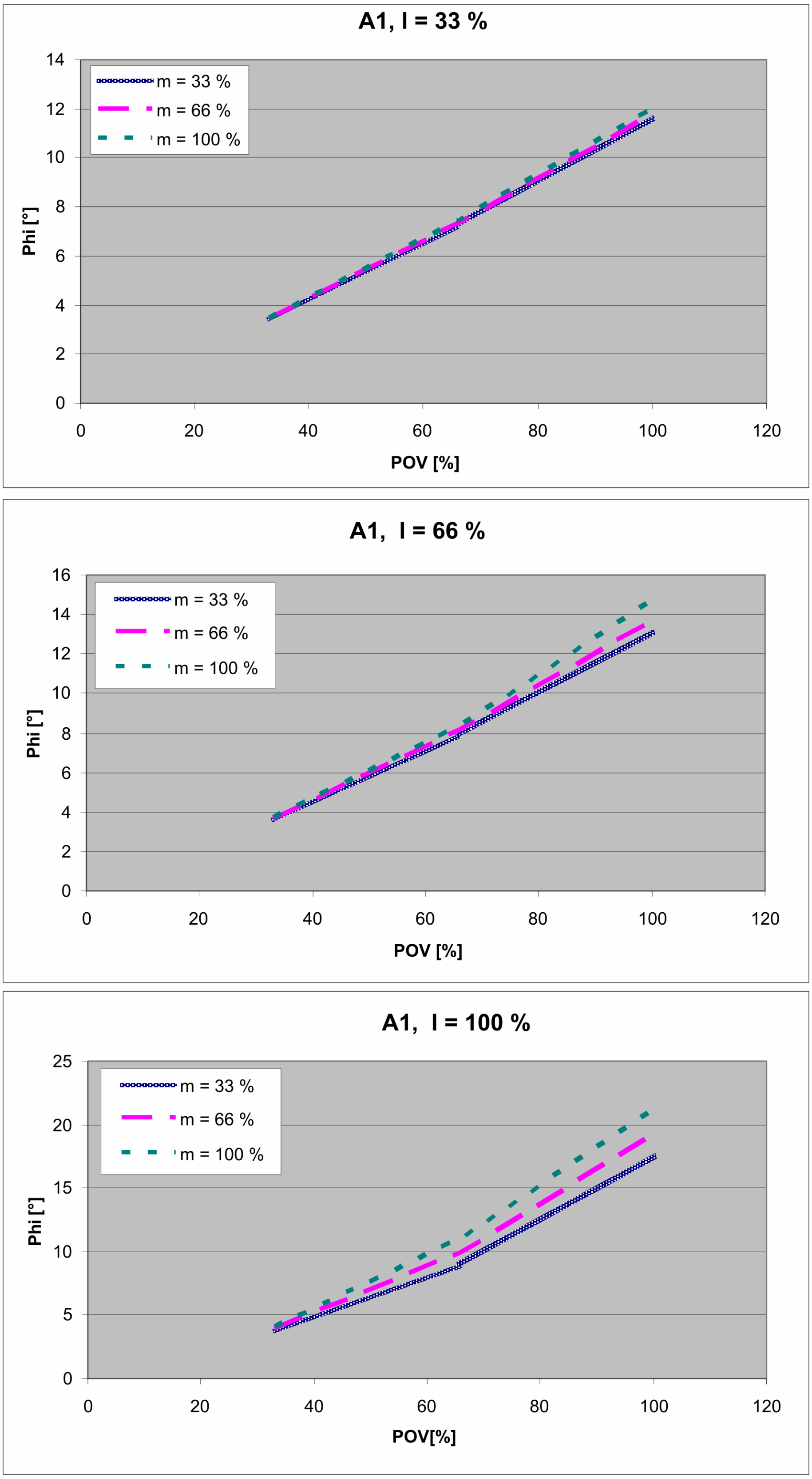


Fig. 4-24: Stopping distances for STOP 1, axis 1

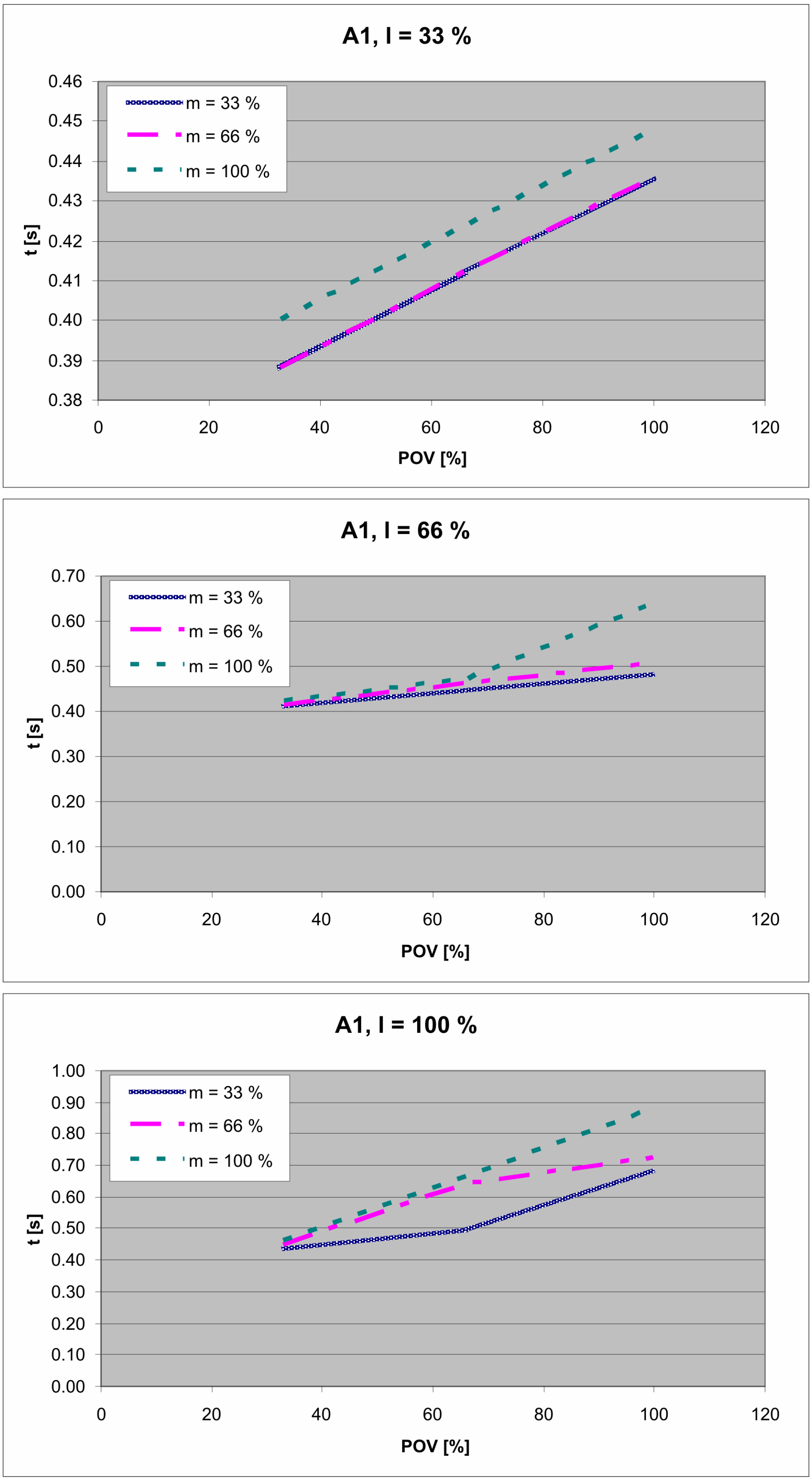


Fig. 4-25: Stopping times for STOP 1, axis 1

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

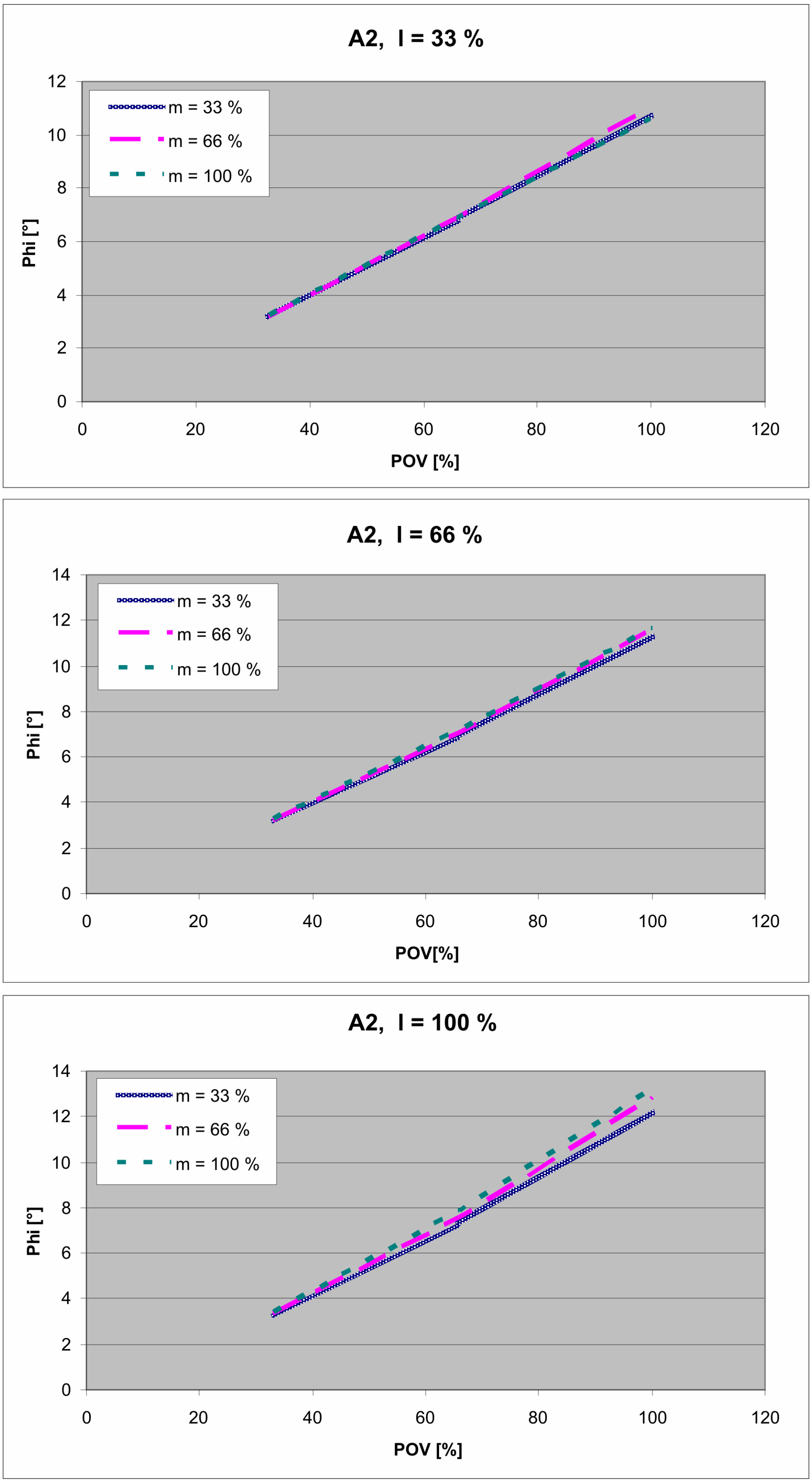


Fig. 4-26: Stopping distances for STOP 1, axis 2

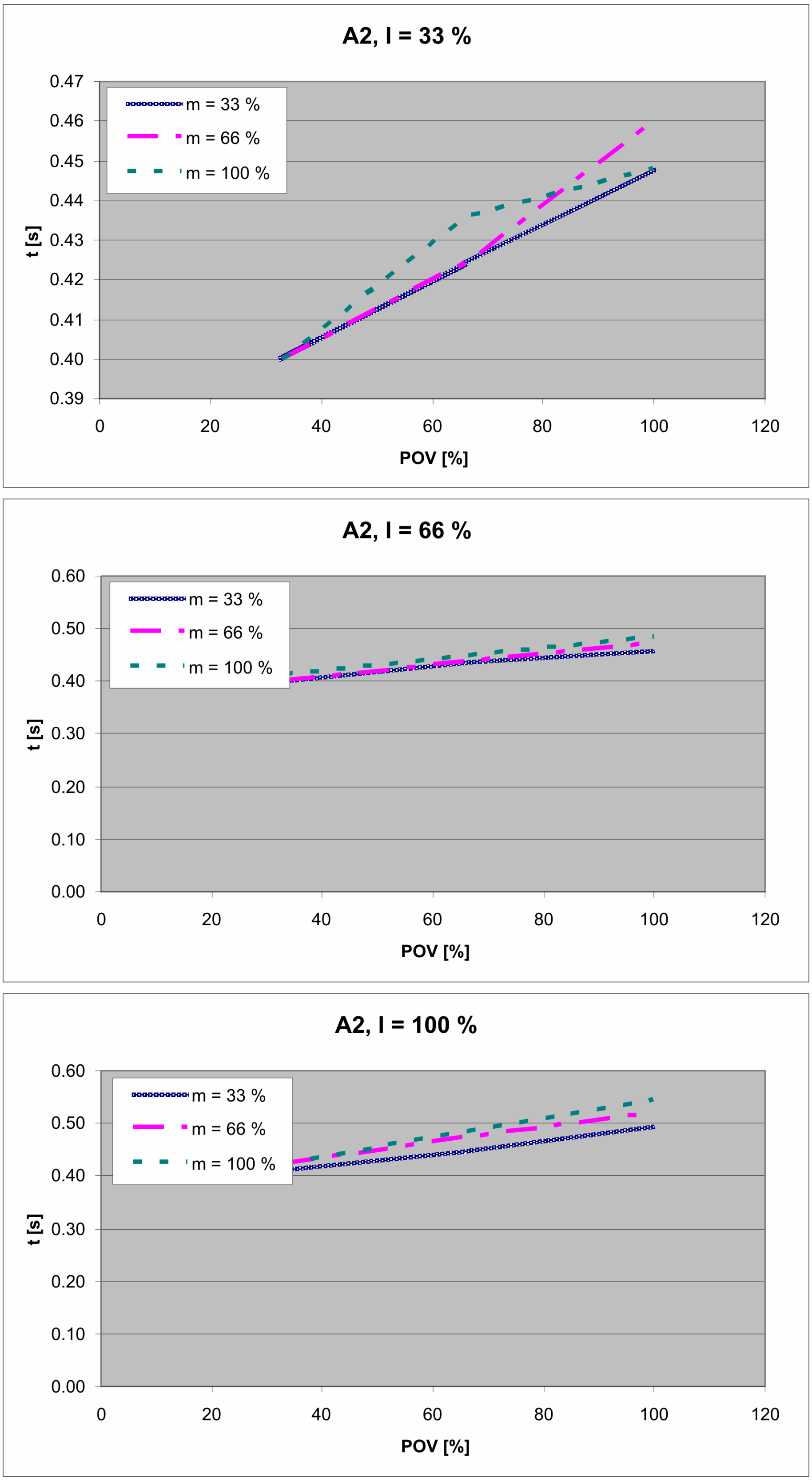


Fig. 4-27: Stopping times for STOP 1, axis 2

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

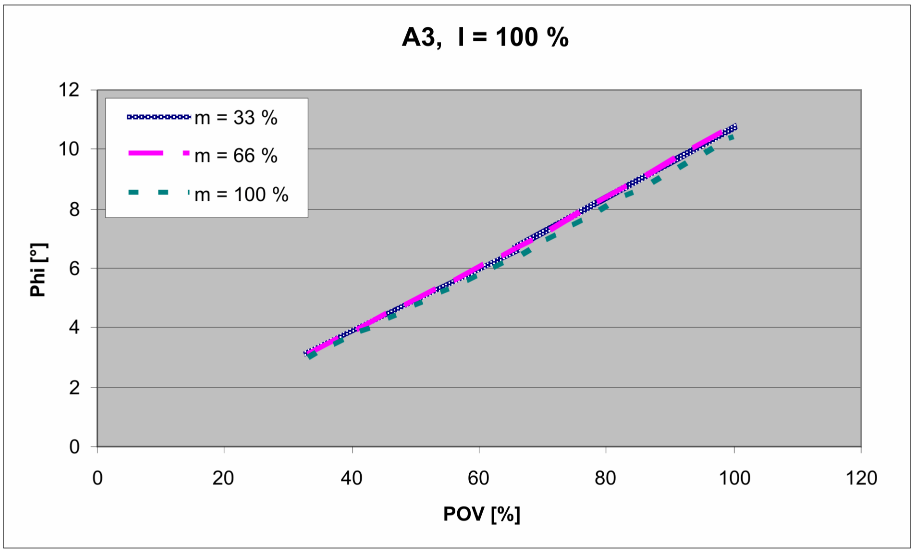


Fig. 4-28: Stopping distances for STOP 1, axis 3

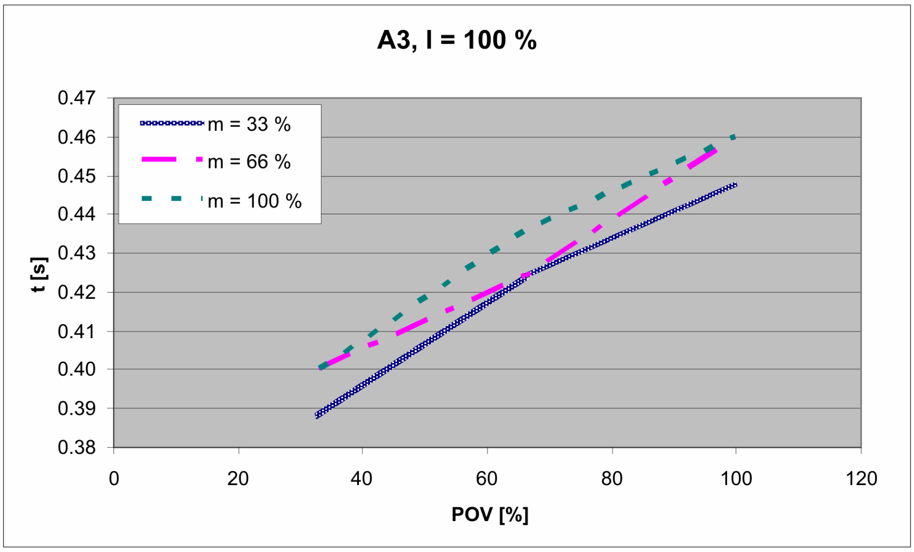


Fig. 4-29: Stopping times for STOP 1, axis 3

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

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

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

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

5.2 Mounting base with centering

Description

The mounting base with centering is used when the robot is fastened to the floor.

The mounting base with centering consists of:

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

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

The minimum dimensions must be observed.

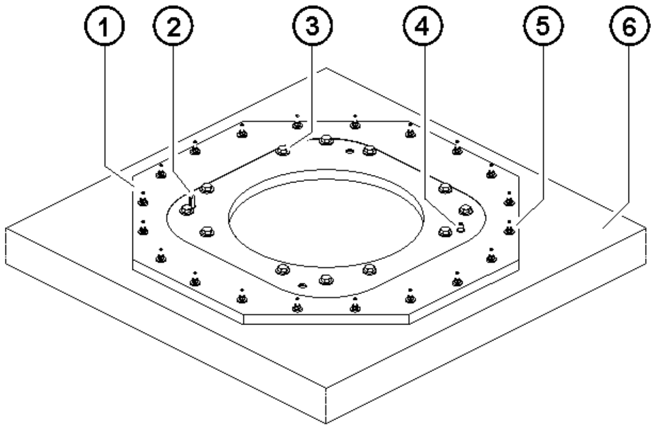


Fig. 5-1: Mounting base

1	Bedplate
2	Sword pin
3	Hexagon bolt with conical spring washer
4	Resin-bonded anchor
5	M20 tapped hole for leveling screws (4x)
6	Concrete foundation

Grade of concrete for foundations

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

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

WARNING

Danger to life and limb due to incorrect mounting
If not mounted correctly, the kinematic system may topple over or fall down. Death, severe injury or damage to property may result.

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

Dimensioned drawing

The following illustration (>>> *Fig. 5-2*) provides all the necessary information on the mounting base, together with the required foundation data.

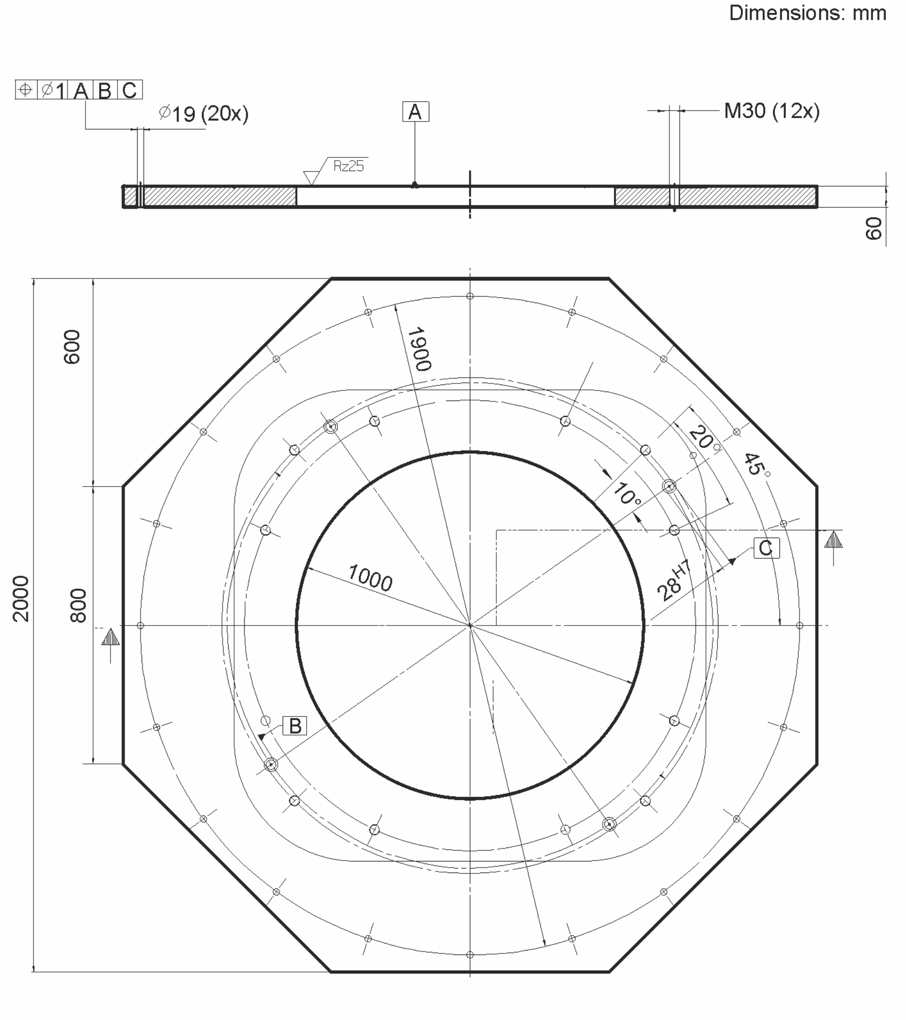


Fig. 5-2: Mounting base with centering, dimensioned drawing

To ensure that the anchor forces are safely transmitted to the foundation, observe the dimensions for concrete foundations specified in the following illustration (>>> *Fig. 5-3*).

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

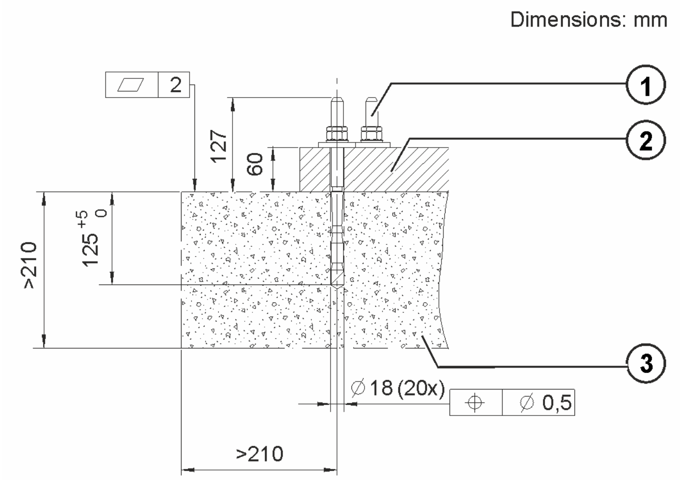


Fig. 5-3: Foundation cross-section

1 Resin-bonded anchor

2 Bedplate

3 Concrete foundation

5.3 Machine frame mounting

Description

The machine frame mounting assembly is used when the robot is fastened on a steel structure, a booster frame (pedestal) or a KUKA linear unit. 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.

The following values must be taken into consideration in the design:

- Stripping safety: The material of the substructure must be selected so that the stripping safety is ensured (e.g. S355J2G3).

The machine frame mounting assembly consists of (>>> *Fig. 5-4*):

- Centering pin with fasteners
- Sword pin with fasteners
- Hexagon bolts with conical spring washers

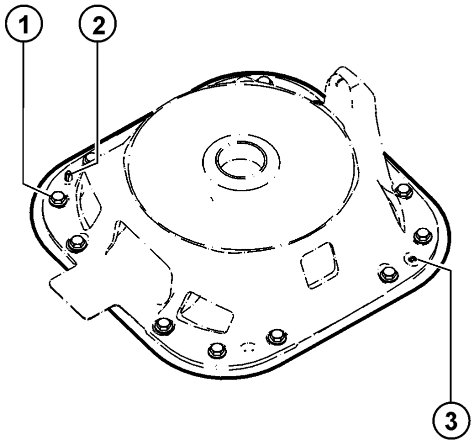


Fig. 5-4: Machine frame mounting

1 Hexagon bolt (12x)
2 Sword pin
3 Centering pin

WARNING

Danger to life and limb due to incorrect mounting
If not mounted correctly, the kinematic system may topple over or fall down. Death, severe injury or damage to property may result.

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

Dimensioned drawing

The following illustration (>>> *Fig. 5-2*) provides all the necessary information on the mounting base, together with the required foundation data.

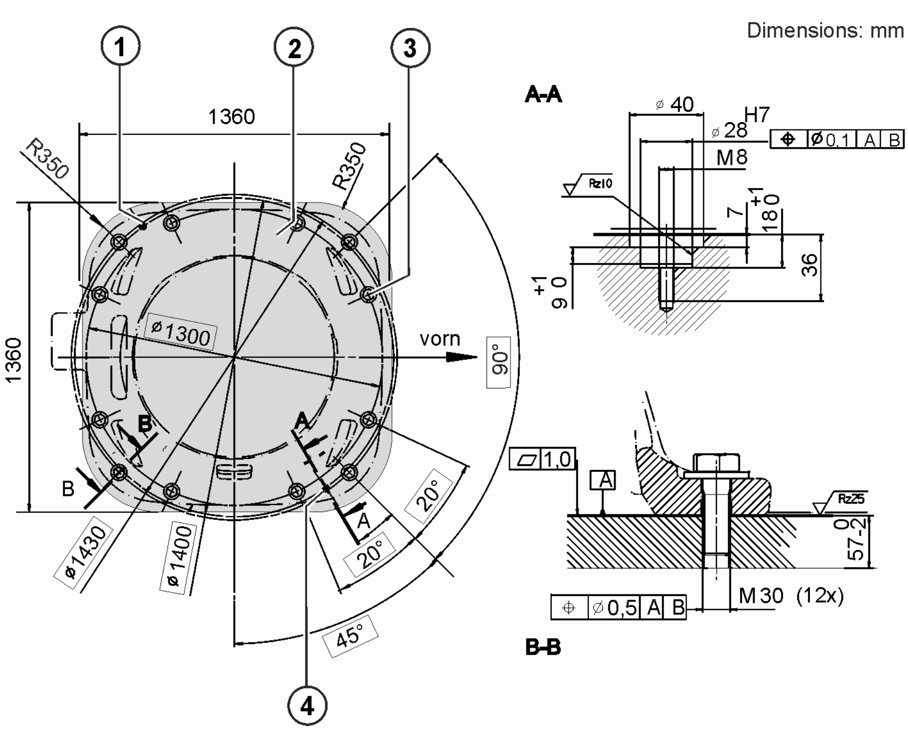


Fig. 5-5: Machine frame mounting, dimensioned drawing

1	Sword pin
2	Mounting surface, machined
3	Hexagon bolt (12x)
4	Centering pin

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 push-in module via multi-function housings (MFH) with connectors. The set of connecting cables comprises:

- Motor cable, X20.1 - X30.1
- Motor cable, X20.2 - X30.2
- Motor cable, X20.3 - X30.3
- Data cable, X21 - X31
- Ground conductor

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

For the connecting cables, an additional ground conductor is always required to provide a low-resistance connection between the robotic system and the control cabinet in accordance with DIN EN 60204. The ground conductor is not included in the scope of supply. The ground conductors are connected with ring cable lugs via threaded bolts 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.

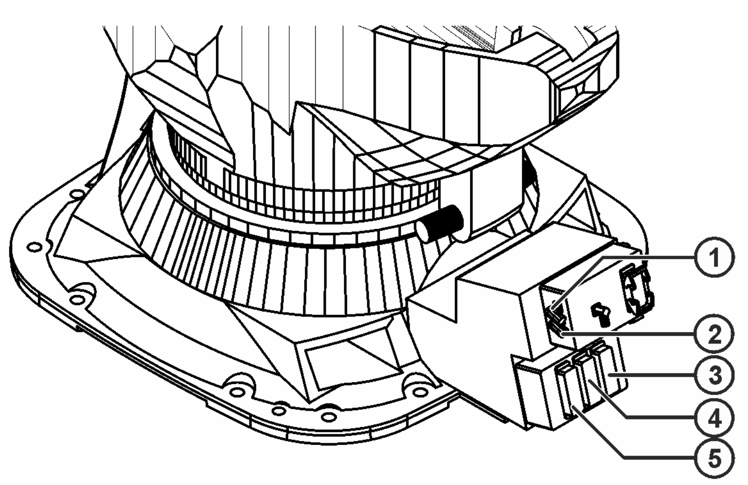


Fig. 5-6: Interface A1

1	Data cable X31
2	EMD connection X32
3	Motor cable X30.3
4	Motor cable X30.2
5	Motor cable X30.1

6 Transportation

6.1 Transporting the robot arm

Before transporting the robot, always move the robot into its transport position (>>> Fig. 6-1). 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.

If the robot is sent via airfreight, the counterbalancing system must be fully depressurized (both oil and nitrogen) .

> A hydropneumatic counterbalancing system is classified as hazardous. For this reason, the applicable national regulations must be observed when shipping. If the robot with built-in counterbalancing system is, for example, shipped via airfreight, country regulations may require that the counterbalancing system be fully depressurized.

Transport position

The robot must be in the transport position (>>> Fig. 6-1) before it can be transported. The robot is in the transport position when the axes are in the following positions:

Axis	A1	A2	A3	A4	A5	A6
Angle [1)]	0º	-130°	+130°	0º	+90º	0º
Angle [2)]	0º	-140°	+140°	0º	+90º	0º

[1)] Robot with buffer installed on axis 2

[2)] Robot without buffer on 2

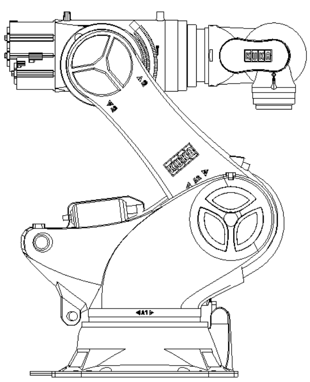


Fig. 6-1: Transport position

Transport dimensions

The transport dimensions (>>> Fig. 6-2) and (>>> Fig. 6-3) for the robot can be noted from the following diagrams. The position of the center of gravity and the weight vary according to the specific configuration and the position of axis 2. The specified dimensions refer to the robot without equipment.

The dimensions with the index [1)] apply for normal transportation. The dimensions with the index [2)] are obtained if the buffer on the minus side of axis 2 is removed.

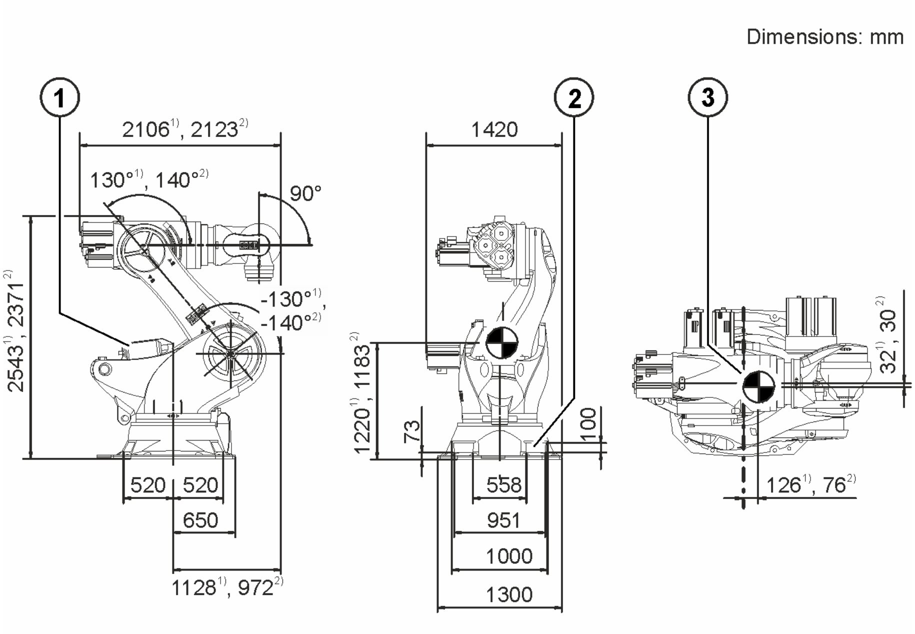


Fig. 6-2: Transport dimensions with in-line wrist IW 1000

1 Robot
2 Fork slots
3 Center of gravity

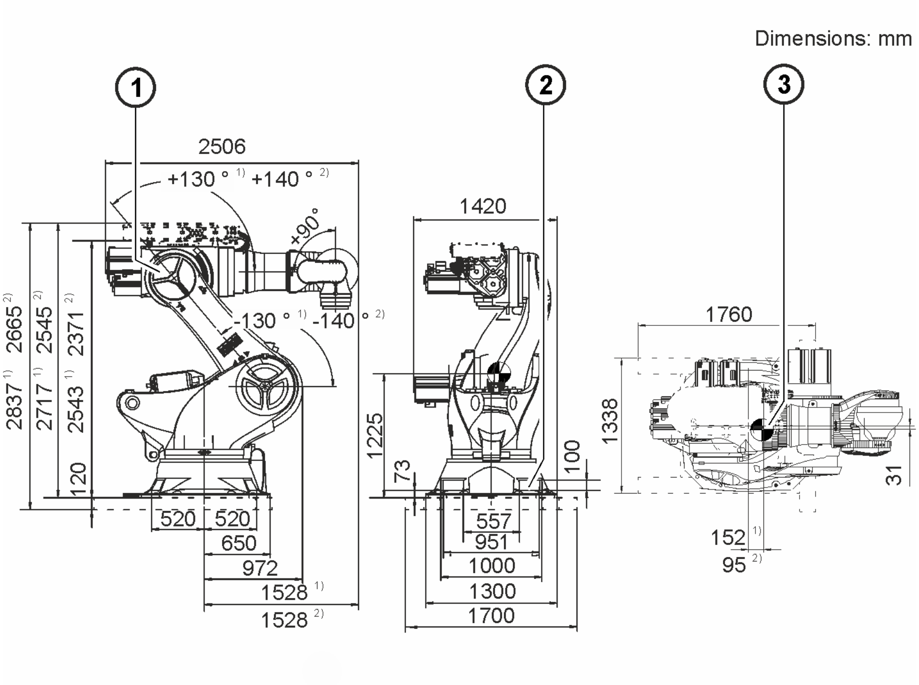


Fig. 6-3: Transport dimensions with in-line wrist IW 750

1 Robot
2 Fork slots
3 Center of gravity

Transportation

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

WARNING

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

Transportation by fork lift truck

For transport by fork lift truck (>>> *Fig. 6-4*), cast fork slots are provided in the base frame. The fork lift truck must have a minimum payload capacity of 6 t.

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.

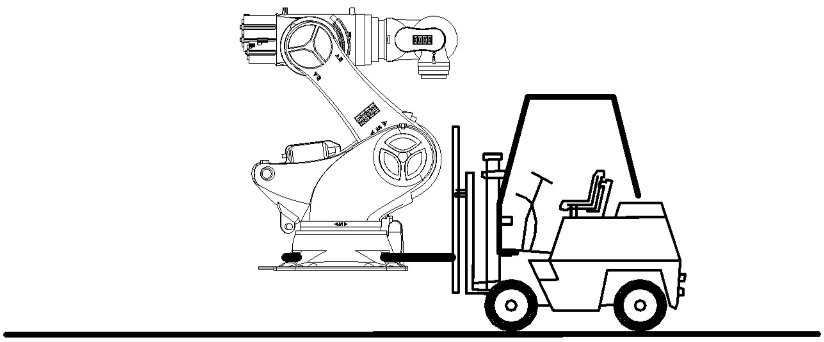


Fig. 6-4: Transportation by fork lift truck

Transportation with lifting tackle

The robot can also be transported using lifting tackle . For this, it must be in the transport position. The lifting tackle is attached to 3 eyebolts that are securely screwed into the rotating column. All the legs must be routed as shown in the following illustration so that the robot is not damaged. Installed tools and items of equipment can cause undesirable shifts in the center of gravity. Items of equipment, especially energy supply systems, must be removed to the extent necessary to avoid them being damaged by the legs of the lifting tackle during transportation.

All legs are labeled from “G1” to “G3”.

WARNING

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

If the robot is equipped with remote junction boxes, the robot can also be transported by crane. Minor shifts in the center of gravity are to be expected.

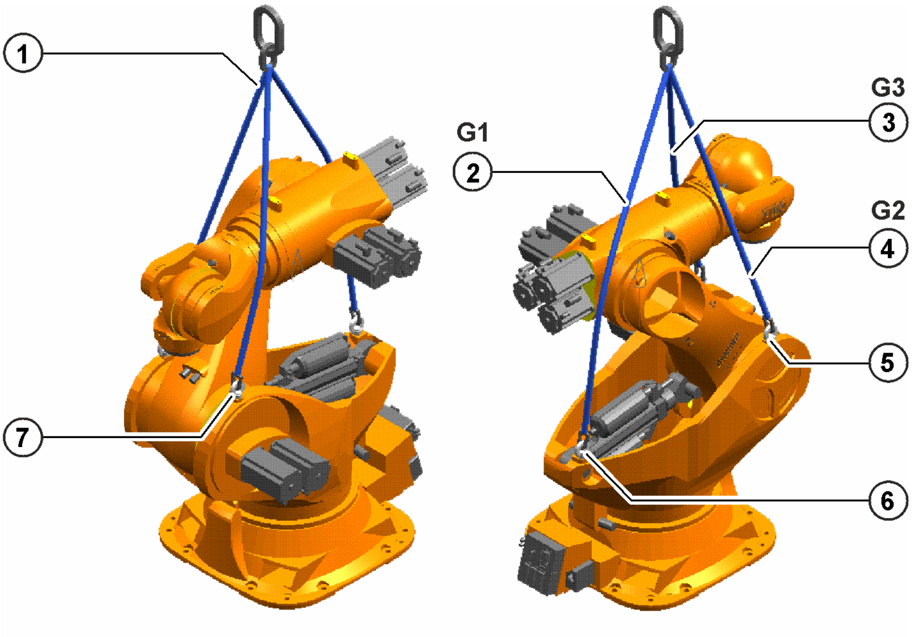


Fig. 6-5: Transportation using lifting tackle

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

Transportation with transport frame

If the permitted height for transportation is exceeded in the transport position, the robot can be moved into a different position. To do this, the robot must be secured to the transport frame with all holding-down bolts. Once this has been done, axes 2 and 3 can be moved so as to reduce the overall height (>>> *Fig. 6-6*) and (>>> *Fig. 6-7*). The robot can be transported on the transport frame by crane or fork lift truck (minimum payload capacity 8,000 kg). Both robot variants, with transport frame and without equipment, have an overall weight of approx. 5,600 kg.

Before the robot can be transported on the transport frame, the robot axes must be in the following positions:

Axis	**A 1**	**A 2**	**A 3**	**A 4**	**A 5**	**A 6**
Angle	0º	-16°	+145°	0º +25°*	0º +120°*	-90º
	* Angle for in-line wrist IW 750					

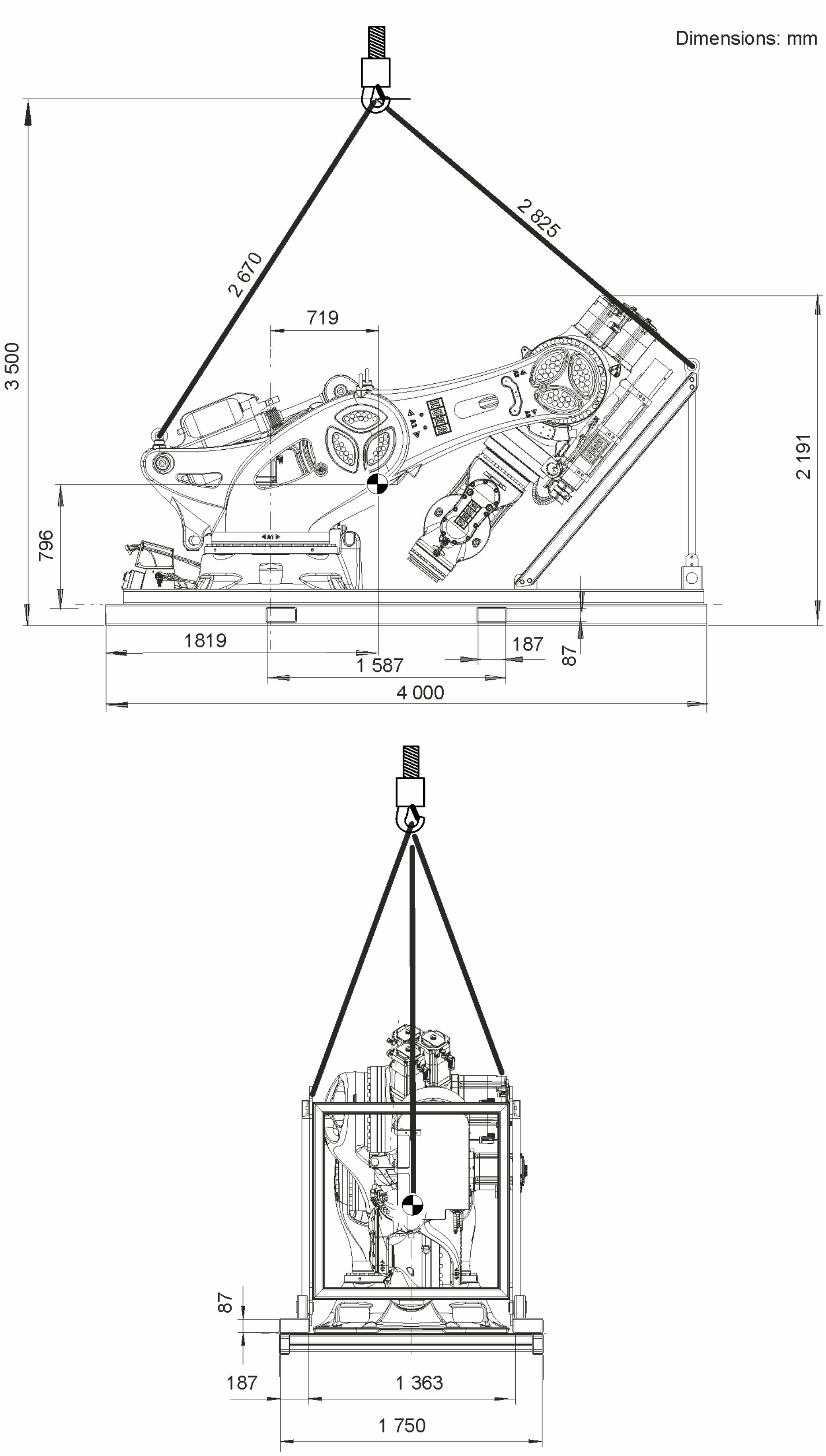


Fig. 6-6: Transport frame for in-line wrist IW 1000

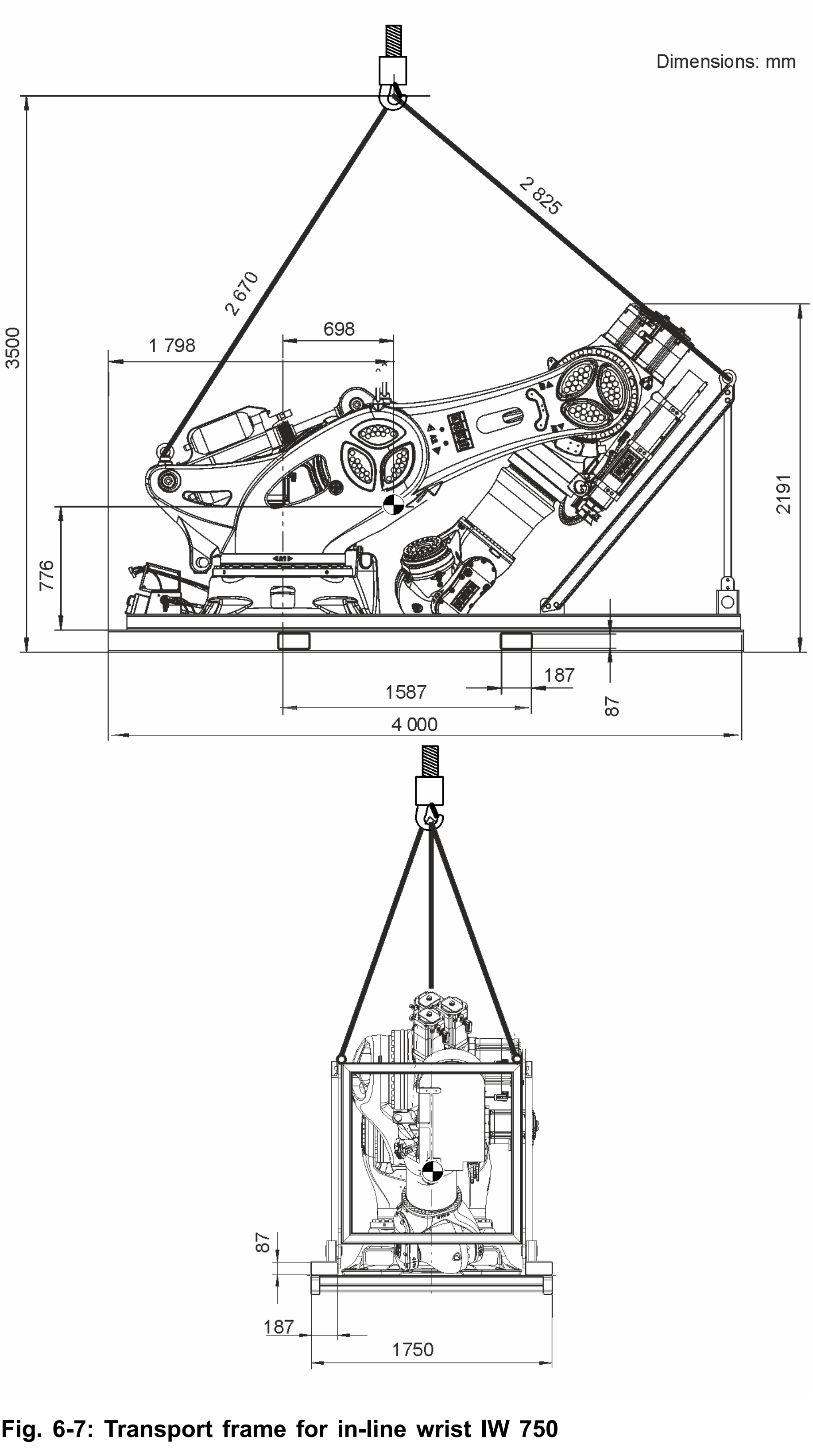


Fig. 6-7: Transport frame for in-line wrist IW 750

7 Appendix

7.1 Applied standards and regulations

Name/Edition	Definition
2006/42/EC:2006	**Machinery Directive:** Directive 2006/42/EC of the European Parliament and of the Council of 17 May 2006 on machinery, and amending Directive 95/16/EC (recast)
2014/68/EU:2014	**Pressure Equipment Directive**: Directive 2014/68/EU of the European Parliament and of the Council dated 15 May 2014 on the approximation of the laws of the Member States concerning pressure equipment (Only applicable for robots with hydropneumatic counterbalancing system.)
EN 60204-1:2006/ A1:2009	**Safety of machinery:** Electrical equipment of machines - Part 1: General requirements
EN 61000-6-2:2005	**Electromagnetic compatibility (EMC):** Part 6-2: Generic standards; Immunity for industrial environments
EN 61000-6-4:2007 + A1:2011	**Electromagnetic compatibility (EMC):** Part 6-4: Generic standards; Emission standard for industrial environments
EN 614-1:2006+A1:2009	**Safety of machinery:** Ergonomic design principles - Part 1: Terms and general principles
EN ISO 10218-1:2011	**Industrial robots – Safety requirements:** Part 1: Robots **Note:** Content equivalent to **ANSI/RIA R.15.06-2012, Part 1**
EN ISO 12100:2010	**Safety of machinery:** General principles of design, risk assessment and risk reduction
EN ISO 13849-1:2015	**Safety of machinery:** Safety-related parts of control systems - Part 1: General principles of design
EN ISO 13849-2:2012	**Safety of machinery:** Safety-related parts of control systems - Part 2: Validation
EN ISO 13850:2015	**Safety of machinery:** Emergency stop - Principles for design

8 KUKA Service

8.1 Requesting support

Introduction

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

Information

The following information is required for processing a support request:

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

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

  - Model and serial number of the kinematic system, e.g. the manipulator
  - Model and serial number of the controller
  - Model and serial number of the energy supply system
  - Designation and version of the system software
  - Designations and versions of other software components or modifications
  - Diagnostic package KRCDiag

    Additionally for KUKA Sunrise: existing projects including applications

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

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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