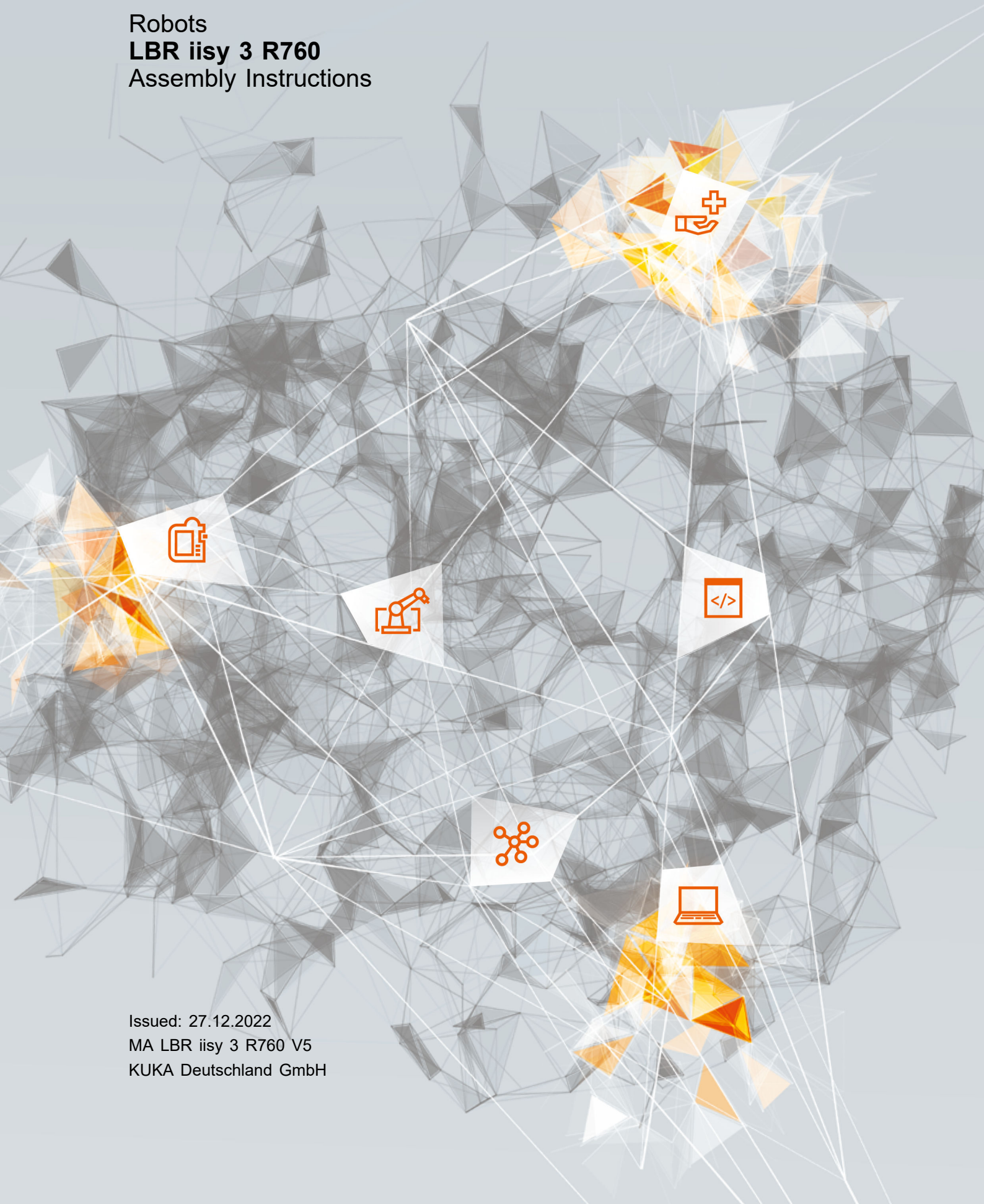
KUKA

Robots
LBR iisy 3 R760
Assembly Instructions



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1 Introduction

1.1 Target group

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

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

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

1.2 LBR iisy documentation

The LBR iisy documentation consists of the following parts:

- Documentation for LBR iisy 3 R760
- Documentation for KR C5 micro
- Operating and programming instructions for KUKA iiQKA.OS
- Documentation for KUKA smartPAD pro
- Instructions for options and accessories
- Spare parts in KUKA.Xpert
- Supplier documentation for gripper (SCHUNK)

Each set of instructions is a separate document.

1.3 Representation of warnings and notes

Safety

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

DANGER

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

WARNING

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

CAUTION

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

NOTICE

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

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

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

SAFETY INSTRUCTION

The following procedure must be followed exactly!

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

Notices

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

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

1.4 Terms used

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

Term	Description
Axis range	Range within which the axis may move The axis range must be defined for each axis.
Workspace	Area within which the robot may move. The workspace is derived from the individual axis ranges.
EDS	Electronic Data Storage (memory card)
EMD	Electronic Mastering Device
Danger zone	The danger zone consists of the workspace and the stopping distances of the manipulator and external axes (optional).
LBR	Lightweight robot
KR C	KUKA Robot Control Robot controller
KUKA smartPAD	see “smartPAD”
KUKA smartPAD pro	see “smartPAD”
Manipulator	The robot arm and the associated electrical installations
MEMD	Micro Electronic Mastering Device

smartPAD	Teach pendant for the robot controller The smartPAD has all the operator control and display functions required for operation and programming. The following models exist: • KUKA smartPAD • KUKA smartPAD-2 • KUKA smartPAD pro For robot controllers of the KR C5 series with KUKA System Software or VW System Software, only the model **KUKA smartPAD-2** is used. For robot controllers of the KR C5 series with KUKA iiQKA.OS, only the model **KUKA smartPAD pro** is used. For other robot controllers, the designation “KUKA smartPAD” or “smartPAD” always refers to all models possible for the respective controller unless an explicit distinction is made.
Stop category 0	The drives are deactivated immediately and the brakes are applied. The manipulator and any external axes (optional) perform path-oriented braking. **Note:** This stop category is called “STOP 0” in this document.
Stop category 1	The manipulator and any external axes (optional) perform path-maintaining braking. The drives are only disconnected once the machine has come to a standstill. **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. The drives are only disconnected once the machine has come to a standstill. **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)
TPC	Torque Position Converter The torque position converter is used to record motor data (e.g. position data, motor temperatures) and to evaluate data of the joint torque sensors.

2 Product description

2.1 Overview of the robot system

A robot system (>>> *Fig. 2-1*) comprises all the assemblies of an industrial robot, including the manipulator (robot arm and electrical installations), controller, connecting cables, end effector (tool) and other equipment.

The industrial robot consists of the following components:

- Manipulator
- Robot controller
- smartPAD control panel
- Connecting cables
- Software
- Options, accessories

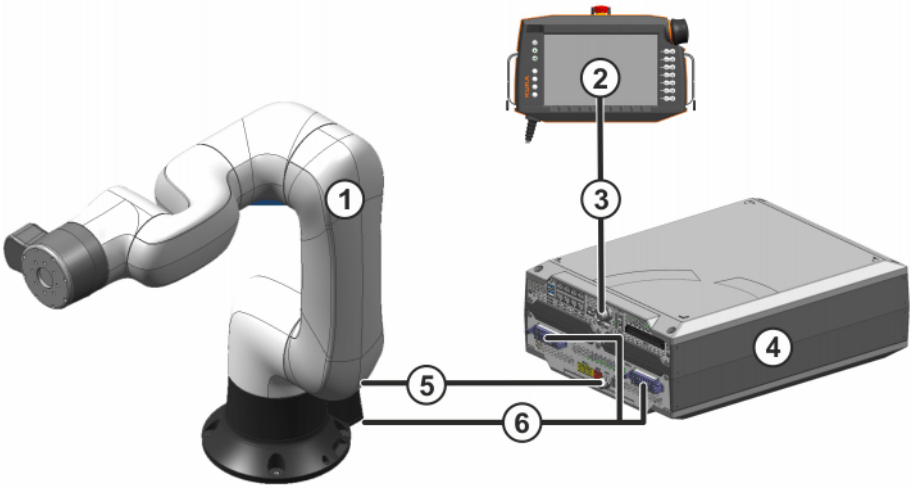


Fig. 2-1: Overview of robot system

1 Manipulator
2 Teach pendant smartPAD pro
3 Connecting cable / smartPAD pro
4 Robot controller
5 Connecting cable / data cable
6 Connecting cable / motor cable

2.2 Description of the manipulator

Overview

The LBR iisy 3 R760 is classified as a lightweight robot and is an articulated robot with 6 axes. All drive units and current-carrying cables are located inside the robot.

Every axis contains multiple sensors that provide signals for robot control (e.g. position control and impedance control) and that are also used as a protective function for the robot. Every axis is thus monitored by sensors: axis range sensors ensure that the permissible axis range is adhered to, torque sensors ensure that the permissible axis loads are not exceeded, and temperature sensors monitor the thermal limit values of the electronics.

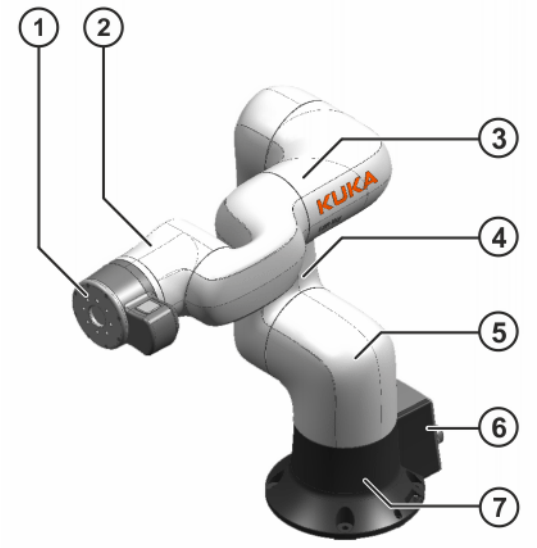


Fig. 2-2: Main groups

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

In-line wrist A4, A5, A6

The robot is fitted with a 3-axis in-line wrist. The in-line wrist consists of axes 4, 5 and 6.

Arm A3

The arm is connected to the link arm via gear unit A3 and links the in-line wrist with the link arm. It houses motors A3 and A4.

Link arm A2

The link arm is the assembly located between the arm and the rotating column. It is connected to adjacent structural components via gear units A2 and A3.

Rotating column A1

The rotating column houses the motor of axis 2. The rotational motion of axis 1 is performed by the rotating column. This is screwed to the base frame via the gear unit of axis 1 and is driven by motor A1 in the base frame.

Base frame

The base frame is the base of the robot. Interface A1 is located at the rear of the base frame. The connecting cable set is pre-installed with a plate at this interface between the robot and the controller. There are also connections for the customer-specific energy supply system on interface A1.

Electrical installations

The electrical installations include all the supply and control cables for the motors of axes A1 to A6. The entire cabling and an integrated energy supply system are routed internally in the robot.

The cable set of the connecting cables to be connected to the robot controller is pre-installed on the base frame of the robot and contains the motor and data cables. The electrical installations also include a protective circuit.

Commander

The Commander is a universal operator interface enabling the connection of external tools as well as the manual guidance of the manipulator.

The Commander is located on the in-line wrist and consists of:

- External interface A6
- LED status indicator
- Back key
- Jog dial with OK key
- Manual guidance handle
- Enabling switch

Further information is contained in the operating and programming instructions for the KUKA.OS software.

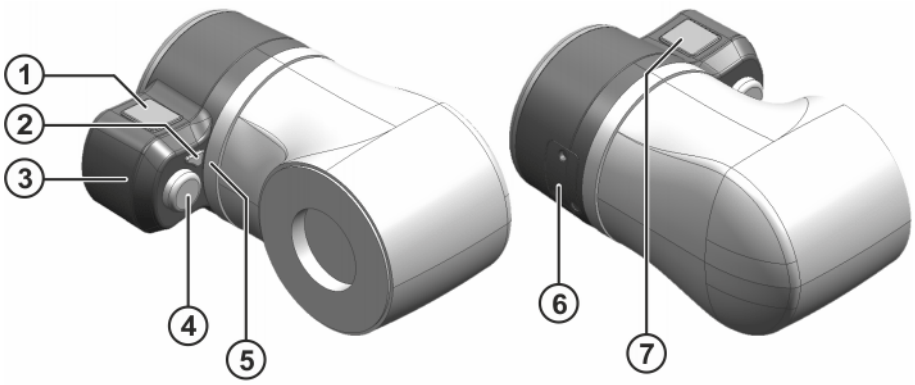


Fig. 2-3: Commander

1 Enabling switch 1
2 Back key
3 Manual guidance handle
4 Jog dial with OK key
5 LED status indicator
6 External interface A6
7 Enabling switch 2

Options

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

- Energy supply systems A1 to A6
- 24 V desktop power supply

The following options are also available:

- Gripper and finger set
  (>>> *11.1 "Gripper and finger set (optional)" Page 105*)
- Output flange
  (>>> *11.2 "Output flange (optional)" Page 111*)

- Adapter for external centering (>>> *11.3 "Adapter for external centering (optional)" Page 116*)
- Connector bypack X94/X96 for external interface A6 (>>> *11.4 "Connector bypack X94/X96 (optional)" Page 118*)
- Optional connecting cables (>>> *11.5 "Connecting cables (optional)" Page 122*)
  - I/O connecting cable
  - Gigabit connecting cable
  - External ground conductor

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

3 Safety

3.1 General

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

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

3.1.1 Disclaimer

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

Components of the industrial robot:

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

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

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

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

Safety information

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

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

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

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

3.1.2 EC declaration of conformity and declaration of incorporation

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

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

EC declaration of conformity

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

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

Declaration of incorporation

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

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

3.1.3 Terms in the “Safety” chapter

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

Service life	The service life of a safety-relevant component begins at the time of delivery of the component to the customer. The service life is not affected by whether the component is used or not, as safety-relevant components are also subject to aging during storage.
Danger zone	The danger zone consists of the workspace and the stopping distances of the manipulator and external axes (optional).
KCP	KUKA Control Panel Teach pendant for the KR C2/KR C2 edition2005 The KCP has all the operator control and display functions required for operating and programming the industrial robot.
KUKA smartPAD	see “smartPAD”
KUKA smartPAD-2	see “smartPAD”
Manipulator	The robot arm and the associated electrical installations
Safety zone	The safety zone is situated outside the danger zone.
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	Teach pendant for the robot controller The smartPAD has all the operator control and display functions required for operation and programming. The following models exist: • KUKA smartPAD • KUKA smartPAD-2 • KUKA smartPAD pro For robot controllers of the KR C5 series with KUKA System Software or VW System Software, only the model **KUKA smartPAD-2** is used. For robot controllers of the KR C5 series with KUKA iiQKA.OS, only the model **KUKA smartPAD pro** is used. For other robot controllers, the designation “KUKA smartPAD” or “smartPAD” always refers to all models possible for the respective controller unless an explicit distinction is made.
Stop category 0	The drives are deactivated immediately and the brakes are applied. The manipulator and any external axes (optional) perform path-oriented braking. **Note:** This stop category is called “STOP 0” in this document.
Stop category 1	The manipulator and any external axes (optional) perform path-maintaining braking. The drives are only disconnected once the machine has come to a standstill. **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. The drives are only disconnected once the machine has come to a standstill. **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	Motion axis which is not part of the manipulator but is controlled by the robot controller, e.g. KUKA linear unit, turn-tilt table, positioner.

3.2 Personnel

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

- User
- Personnel

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

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

User

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

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

Personnel

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

Personnel includes:

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

System integrator

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

The system integrator is responsible for the following tasks:

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

Operators

The operator must meet the following preconditions:

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

3.3 Workspace, safety zone and danger zone

Workspaces are to be restricted to the necessary minimum size.

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

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

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

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

3.4 Overview of protective equipment

The protective equipment of the mechanical component may include:

- Mechanical end stops
- Mechanical axis limitation (optional)
- Release device (optional)
- Brake release device (optional)

- Labeling of danger areas

Not all equipment is relevant for every mechanical component.

3.4.1 Mechanical end stops

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

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

WARNING

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

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

3.4.2 Mechanical axis limitation (optional)

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

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

If this is not possible, the workspace must be limited by means of photoelectric barriers, photoelectric curtains or mechanical limitations on the system side. There must be no shearing or crushing hazards at the loading and transfer areas.

This option is not available for all robot models. Information on specific robot models can be obtained from the manufacturer.

3.4.3 Options for moving the manipulator without drive energy

Qualification of personnel with regard to behavior in emergency situations
In emergencies or other exceptional situations, it may be necessary to move the manipulator without drive energy.

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

Description

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

- Release device (optional)

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

- Brake release device (option)

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

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

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

NOTICE

Damage to property due to moving the manipulator without drive energy

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

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

3.4.4 Labeling on the industrial robot

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

Labeling on the industrial robot consists of:

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

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

3.5 Safety measures

3.5.1 General safety measures

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

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

ble, the manipulator and external axes must be secured by appropriate means.

DANGER

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

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

DANGER

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

- Never loiter under the robot arm.

CAUTION

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

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

Implants

WARNING

Danger to life due to malfunction of implants caused by motors and brakes
Electric motors and brakes generate electric and magnetic fields. The fields can cause malfunctions in active implants, e.g. pacemakers.

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

KCP/smartPAD

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

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

WARNING

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

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

External keyboard, external mouse

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

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

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

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

Modifications

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

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

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

Faults

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

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

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

3.5.2 Transportation

Manipulator

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

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

Robot controller

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

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

External axis (optional)

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

3.5.3 Start-up and recommissioning

Before starting up systems and devices for the first time, a check must be carried out to ensure that the systems and devices are complete and operational, that they can be operated safely and that any damage is detected.

The valid national or regional work safety regulations must be observed for this check. The correct functioning of all safety circuits must also be tested.

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

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

WARNING

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

- Only connect the manipulator to the corresponding robot controller.

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

- Additional components must not impair or disable safety functions.

NOTICE

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

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

Function test

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

It must be ensured that:

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

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

WARNING

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

- Check the robot for damage that could have been caused by external forces, e.g. dents or abrasion of paintwork.
  Check the motor and counterbalancing system particularly carefully.
  (Motor inspection not relevant for robots with internal motors.)
- In the case of damage, the affected components must be exchanged.

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

3.5.4 Manual mode

General

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

- Jog mode
- Teaching
- Programming
- Program verification

The following must be taken into consideration in manual mode:

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

Setup work in T1

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

If it is necessary to carry out setup work from inside the safeguarded area, the following must be taken into consideration in the operating mode **Manual Reduced Velocity (T1)**:

- If it can be avoided, there must be no more than one person inside the safeguarded area.
- If it is necessary for there to be several persons inside the safeguarded area, the following must be observed:
  - Each person must have an enabling device.
  - All persons must have an unimpeded view of the industrial robot.
  - Eye-contact between all persons must be possible at all times.
- The operator must be so positioned that he can see into the danger zone and get out of harm's way.
- Unexpected motions of the manipulator cannot be ruled out, e.g. in the event of a fault. For this reason, an appropriate clearance must be maintained between persons and the manipulator, including the tool. Guide value: 50 cm.

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

Setup work in T2

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

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

3.5.5 Automatic mode

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

- All safety equipment and safeguards are present and operational.
- There are no persons in the system or the requirements for collaborative operation in accordance with EN ISO 10218 have been met.
- The defined working procedures are adhered to.

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

3.5.6 Maintenance and repair

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

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

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

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

DANGER

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

- Before commencing work on live parts, turn off the main switch and secure it against being switched on again.

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

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

Cleaning and preventive maintenance work is to be carried out in accordance with the operating instructions.

Robot controller

Even when the robot controller is switched off, parts connected to peripheral devices may still carry voltage. The external power sources must therefore be switched off if work is to be carried out on the robot controller.

The ESD regulations must be adhered to when working on components in the robot controller.

Voltages in excess of 50 V (up to 780 V) can be present in various components for several minutes after the robot controller has been switched off! To prevent life-threatening injuries, no work may be carried out on the industrial robot in this time.

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

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

Counterbalancing system

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

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

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

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

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

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

Hazardous substances

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

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

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

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

3.5.7 Decommissioning, storage and disposal

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

4 Technical data

4.1 Basic data, LBR iisy 3 R760

Basic data

	LBR iisy 3 R760
Number of axes	6
Number of controlled axes	6
Volume of working envelope	0.88 m³
Pose repeatability (ISO 9283)	± 0.1 mm
Weight	approx. 22.8 kg
Rated payload	3 kg
Maximum payload	3.34 kg
Maximum reach	760 mm
Protection rating (IEC 60529)	IP30
Protection rating, robot wrist (IEC 60529)	IP30
Sound level	< 75 dB (A)
Mounting position	Floor; Ceiling; Wall; Desired angle
Footprint	Ø210 mm
Hole pattern: mounting surface for kinematic system	C184
Permissible angle of inclination	± 180 °
Default color	Base frame: iron gray (RAL 7011); Moving parts: signal white (RAL 9003); Commander: iron gray (RAL 7011); Protective cover: Signal white (RAL 9003)
Controller	KR C5 micro
Transformation name	KR C5: LBR3R760 iisy

The maximum reach specified includes the output flange (optional).

Ambient conditions

Ambient temperature during operation	5 °C to 45 °C (278 K to 318 K)
Ambient temperature during storage/transportation	-25 °C to 70 °C (248 K to 343 K)
Air humidity	20 % to 80 %

In the case of an unfavorable combination of permanently high demand on robot power and external temperature influences, parts of the surface of the robot are liable to heat up excessively. The robot must have cooled down before it can be touched.

The LBR is protected by temperature monitoring which switches it off if the thermal limit values are exceeded. Following a cooling time, the LBR

can be restarted with no need for additional measures. Technical Support is available to answer any questions.

In the case of overheating, the robot switches off automatically and is thus protected against thermal destruction.

Connecting cables

Cable designation	Connector designation robot controller - robot	Interface Robot
Motor cable	XD20.1/XD20.2 - XM1/XM2-6	-
Data cable	XF21 - X15/X18	-
Ground conductor / equipotential bonding 4 mm^2		Ring cable lug, M4

Cable lengths	7 m
Max. cable length	7 m
Number of extensions	0

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

Certificates

ESD requirements	IEC61340-5-1; ANSI/ESD S20.20

An appropriate test procedure is described in IEC 61340-2-3:2016, Section 8.

4.2 Axis data, LBR iisy 3 R760

Axis data

Motion range	
A1	±185 °
A2	-230 ° / 50 °
A3	±150 °
A4	±175 °
A5	±110 °
A6	±220 °
Speed with rated payload	
A1	200 °/s
A2	200 °/s
A3	200 °/s
A4	300 °/s
A5	300 °/s
A6	400 °/s

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

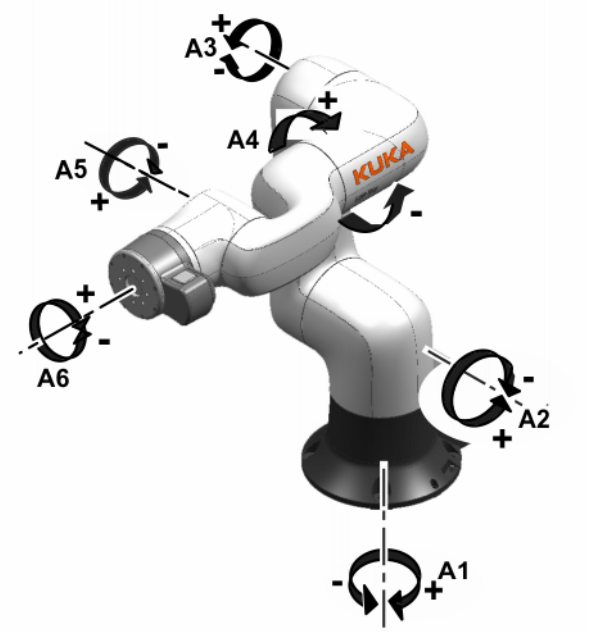


Fig. 4-1: Direction of rotation of robot axes

Mastering positions

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 the robot:

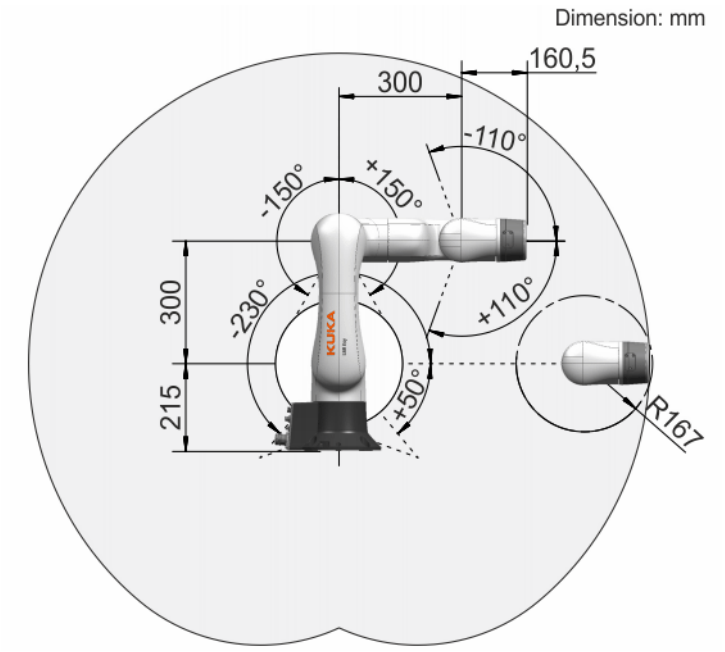


Fig. 4-2: LBR iisy 3 R760, working envelope, side view

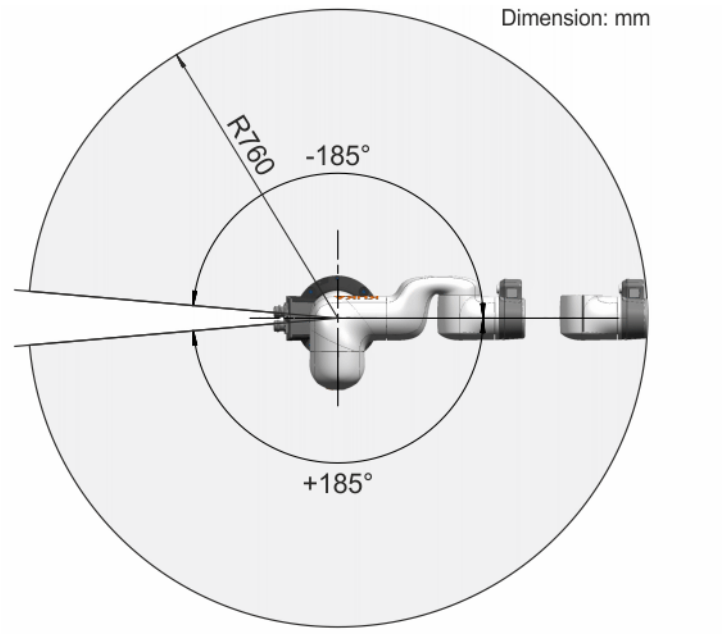


Fig. 4-3: LBR iisy 3 R760, working envelope, top view

Inclined installation

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

The inclination angles for the robot must be entered correctly into the controller if the robot is not operated in the floor-mounted position. The angles can be configured via the system software.

Inclination angles with unchanged main working direction of the robot:

Floor: A:0°, B:0°, C:0°

Wall: A:0°, B:90°, C:0°

Ceiling: A:0°, B:0°, C:180°

CAUTION

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

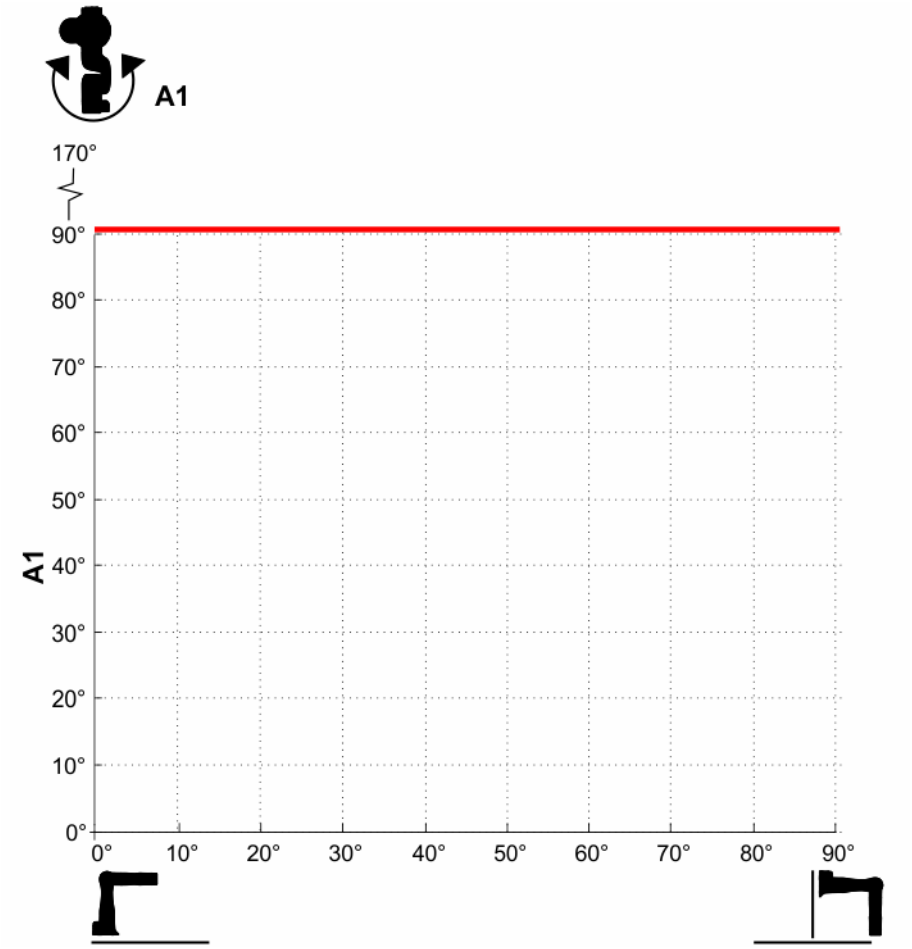


Fig. 4-4: Motion range of axis 1 with inclined installation

4.3 Payloads, LBR iisy 3 R760

Payloads

Rated payload	3 kg
Maximum payload	3.34 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	0 kg
Maximum supplementary load, arm	0 kg

Load center of gravity

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

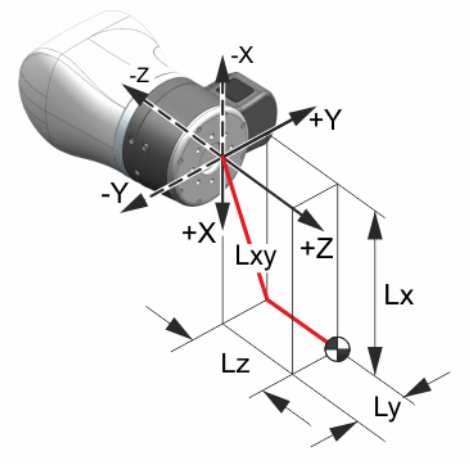


Fig. 4-5: Load center of gravity

Payload diagram

NOTICE

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

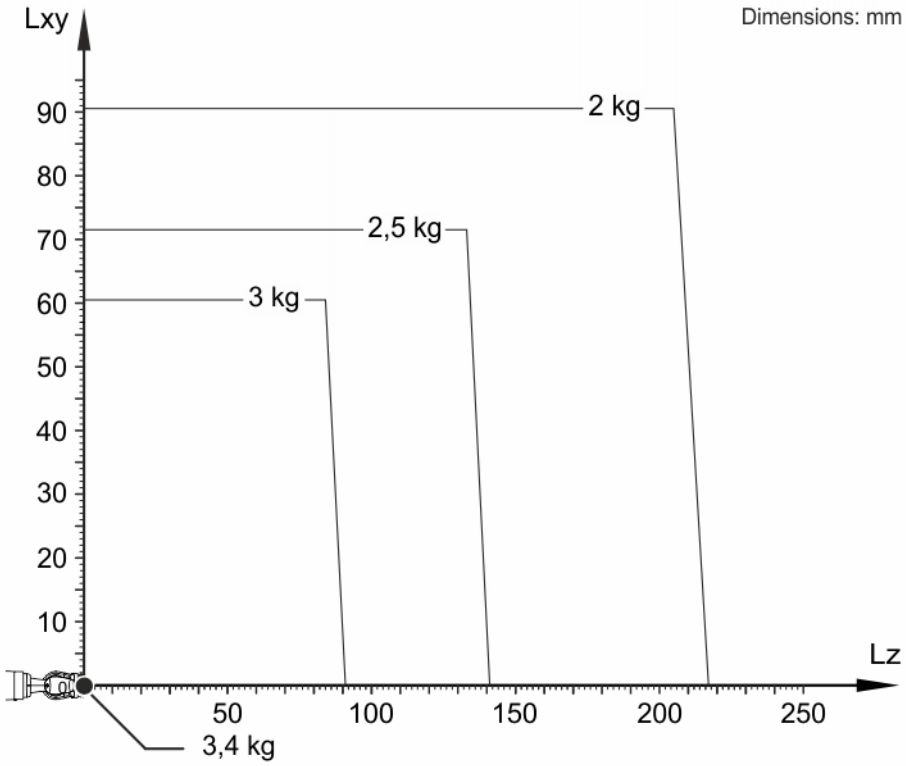


Fig. 4-6: LBR iisy 3 R760, payload diagram

The LBR iisy 3 R760 is designed for a rated payload of 3 kg in order to optimize the dynamic performance of the robot. The maximum payload of 3.34 kg only applies if the position of the center of mass is 0 mm. The specific load case must be verified using KUKA.Load or KUKA Compose. For further consultation, please contact KUKA Support.

Mechanical interface on the Commander

Robot wrist type	ZH
Mounting flange standard	ISO 9409-1-50-7-M6

Diameter (hole circle)	88 mm
Thread diameter	M3
Depth of engagement	min. 5.5 mm, max. 6 mm
Number of threads	8
Screw grade	12.9
Locating element	3^{H7}

The mounting flange is depicted with axis 6 in the zero position.

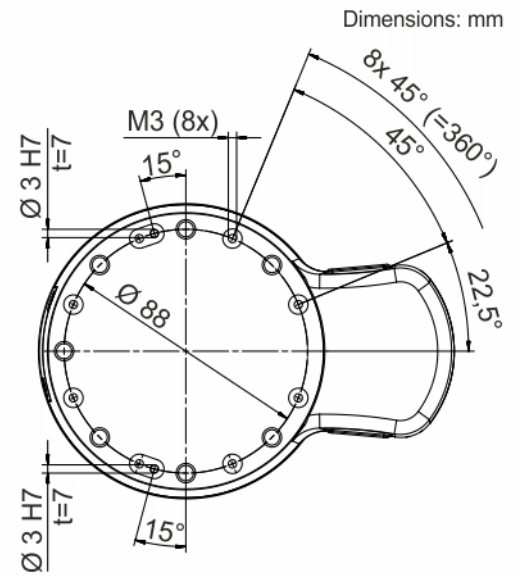


Fig. 4-7: Mechanical interface on the Commander

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 any safety factors. It is imperative for the load data to be entered in the robot controller. For this, the output flange (optional) must be taken into consideration as part of the load. The interface between the load and the robot is the mechanical interface on the Commander.

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.

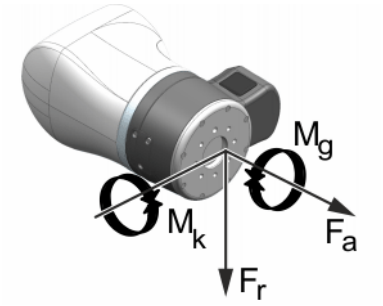


Fig. 4-8: Flange loads

Flange loads during operation	
F(a)	65 N
F(r)	65 N
M(k)	9 Nm
M(g)	5 Nm
Flange loads in the case of EMERGENCY STOP	
F(a)	155 N
F(r)	120 N
M(k)	25 Nm
M(g)	30 Nm

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

Supplementary load

No supplementary loads may be mounted on the robot.

4.4 Foundation loads, LBR iisy 3 R760

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

The specified values refer to nominal payloads and do not include any safety factors. The actual forces and torques depend on the motion profile as well as the mass, load center of gravity and mass moment of inertia of the payload. It is imperative for the load data to be entered in the robot controller. The robot controller takes the payload into consideration during path planning.

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

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

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

WARNING

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

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

Foundation loads for floor mounting position	
F(v normal)	280 N
F(v max)	530 N
F(h normal)	120 N
F(h max)	530 N
M(k normal)	100 Nm

M(k max)	380 Nm
M(r normal)	70 Nm
M(r max)	240 Nm
Foundation loads for ceiling mounting position	
F(v normal)	310 N
F(v max)	530 N
F(h normal)	160 N
F(h max)	510 N
M(k normal)	10 Nm
M(k max)	390 Nm
M(r normal)	70 Nm
M(r max)	240 Nm
Foundation loads for wall mounting position	
F(v normal)	130 N
F(v max)	390 N
F(h normal)	310 N
F(h max)	630 N
M(k normal)	140 Nm
M(k max)	40 Nm
M(r normal)	75 Nm
M(r max)	250 Nm

Vertical force F(v), horizontal force F(h), tilting torque M(k), torque about axis 1 M(r)

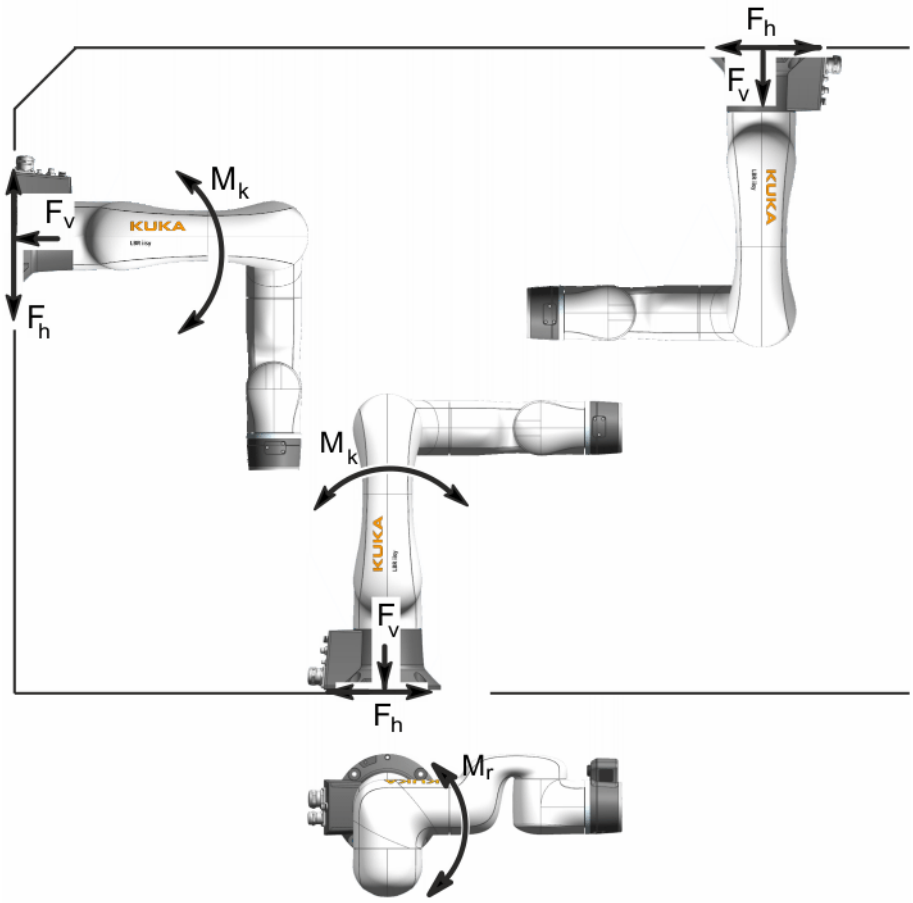


Fig. 4-9: Foundation loads

4.5 LBR iisy plates and labels

Plates and labels

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

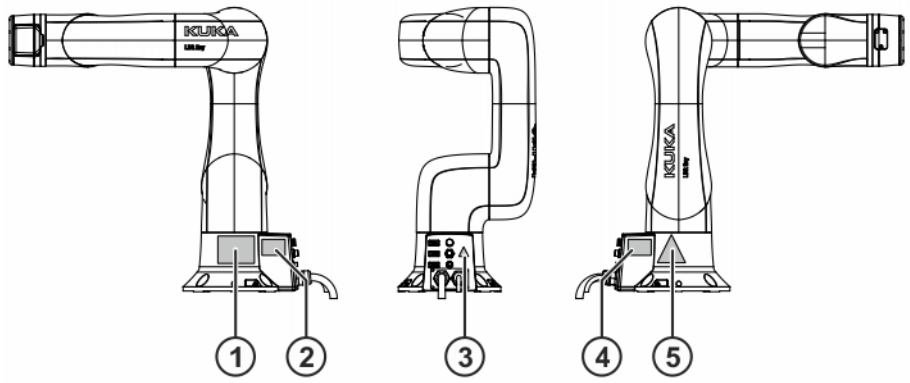
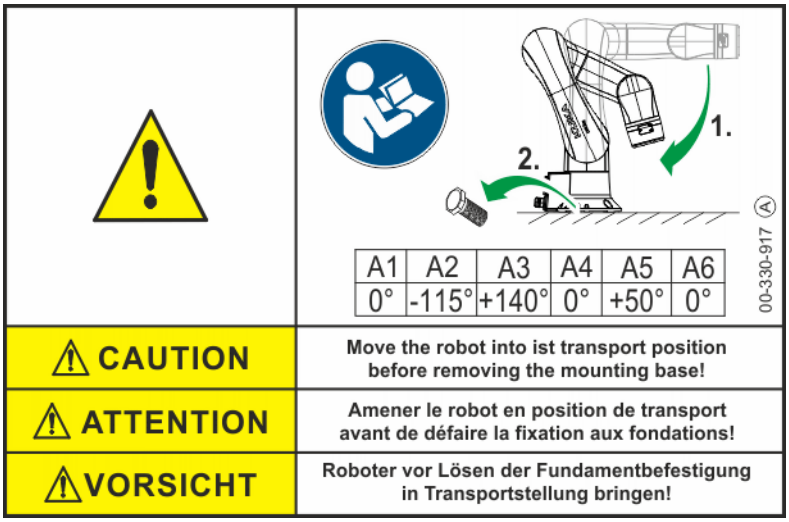
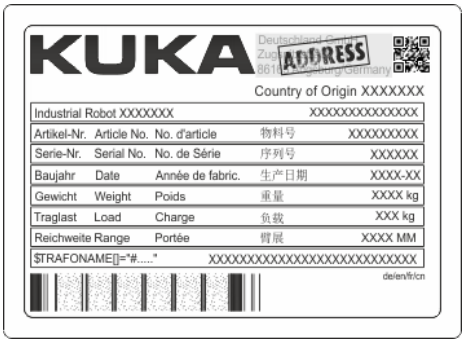
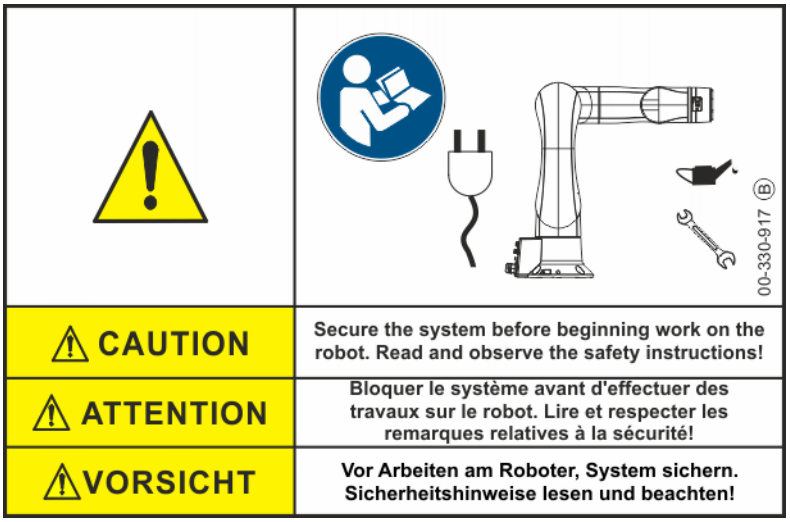


Fig. 4-10: Plates and labels

Item	Description
1	 **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!
2	 **Identification plate** example Content according to Machinery Directive. The QR code contains a link to product information in KUKA Xpert.
3	 **High voltage** Any improper handling can lead to contact with current-carrying components. Electric shock hazard!

Item	Description
4	 **Work on the robot** Before start-up, transportation or maintenance, read and follow the assembly and operating instructions.
5	 **Danger zone** Entering the danger zone of the robot is prohibited if the robot is in operation or ready for operation. Risk of injury!

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

As of June 2007, the Regulation (EC) 1907/2006 of the European Parliament and of the Council dated 18 December 2006 on the registration, evaluation and authorization of chemicals (REACH Regulation) is in force.

Detailed REACH information can be found in the product information in KUKA Xpert.

4.7 Stopping distances and times

4.7.1 General information

Information concerning the data:

- The 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.
- Measurement method

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

Detailed information about the brake test is contained in the operating and programming instructions for the system software.

- STOP 0 stops generally exert a very high load on the robot system and result in a shorter service life. They should therefore be avoided as far as possible.

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

System configuration

- Measurement with single-axis motion (A1, A2 and A3 respectively)
- Weight with maximum payload on the flange (no supplementary loads on the robot)

Motion sequence

- Axes that are not moved are positioned in such a way that the maximum distance of the load center of gravity from the moved axis is reached.
- Use the maximum motion radius of the axis to achieve as high a velocity as possible.
- Trigger point at maximum velocity

Measurement method

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

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

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

   Standstill is used as the end time of the measurement.

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

Information concerning the data

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

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

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

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

Stopping distance	
A1	16.01 °
A2	18.15 °
A3	5.77 °
Stopping time	
A1	0.17 s
A2	0.17 s
A3	0.12 s

4.7.3 Stopping distances and stopping times, STOP 1, A1

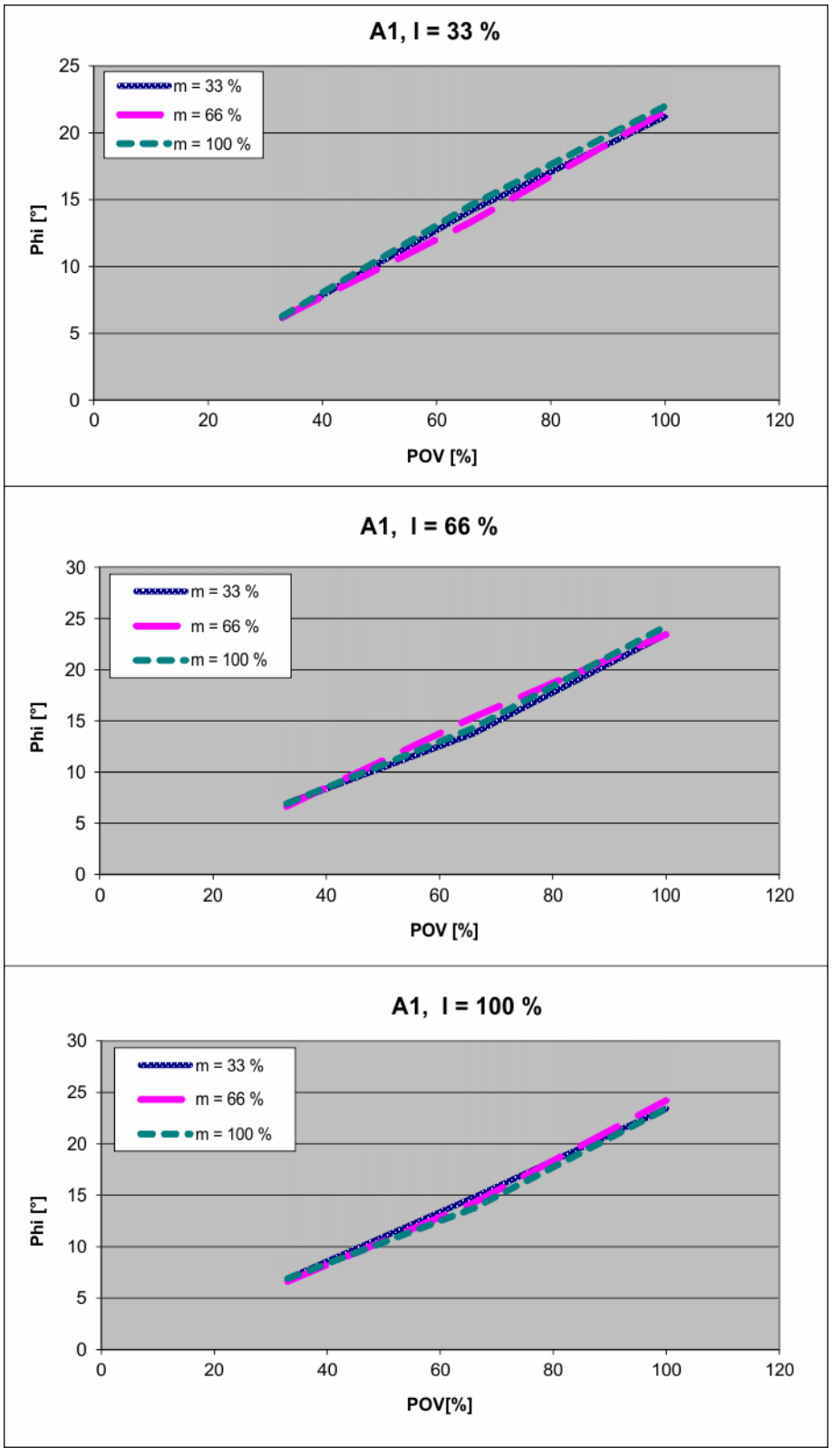


Fig. 4-11: Stopping distances for STOP 1, axis 1

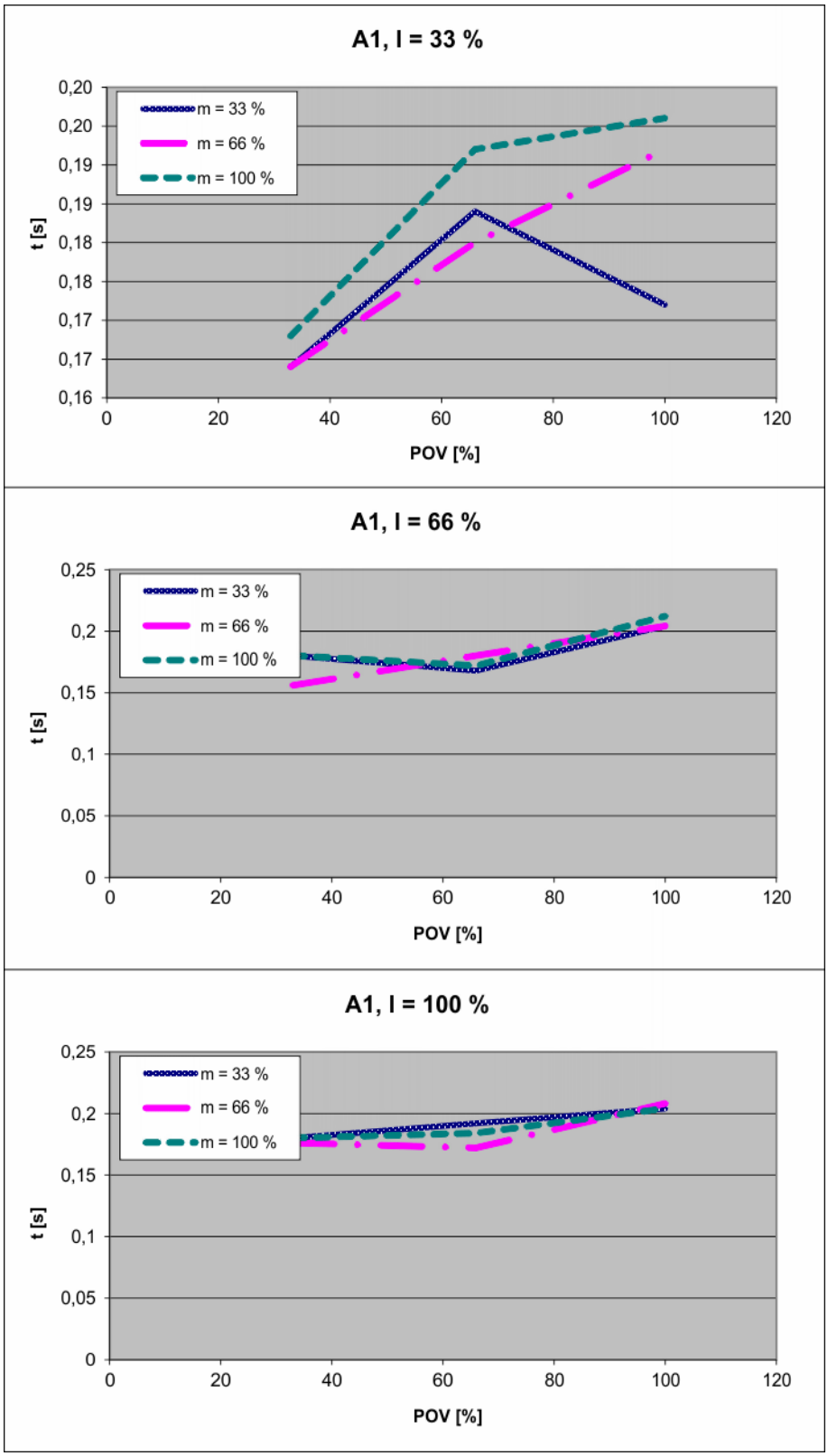


Fig. 4-12: Stopping times for STOP 1, axis 1

4.7.4 Stopping distances and stopping times, STOP 1, A2

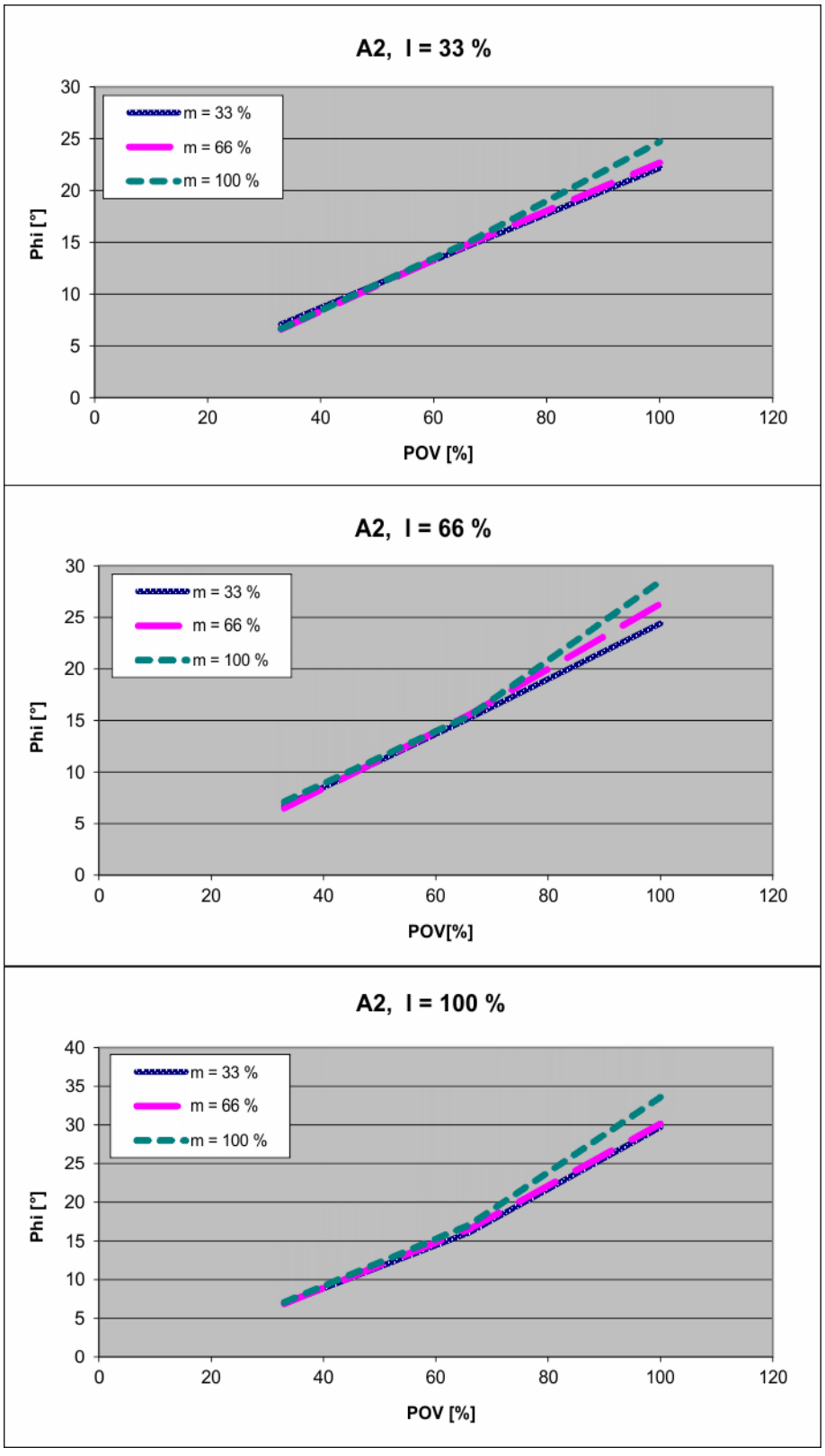


Fig. 4-13: Stopping distances for STOP 1, axis 2

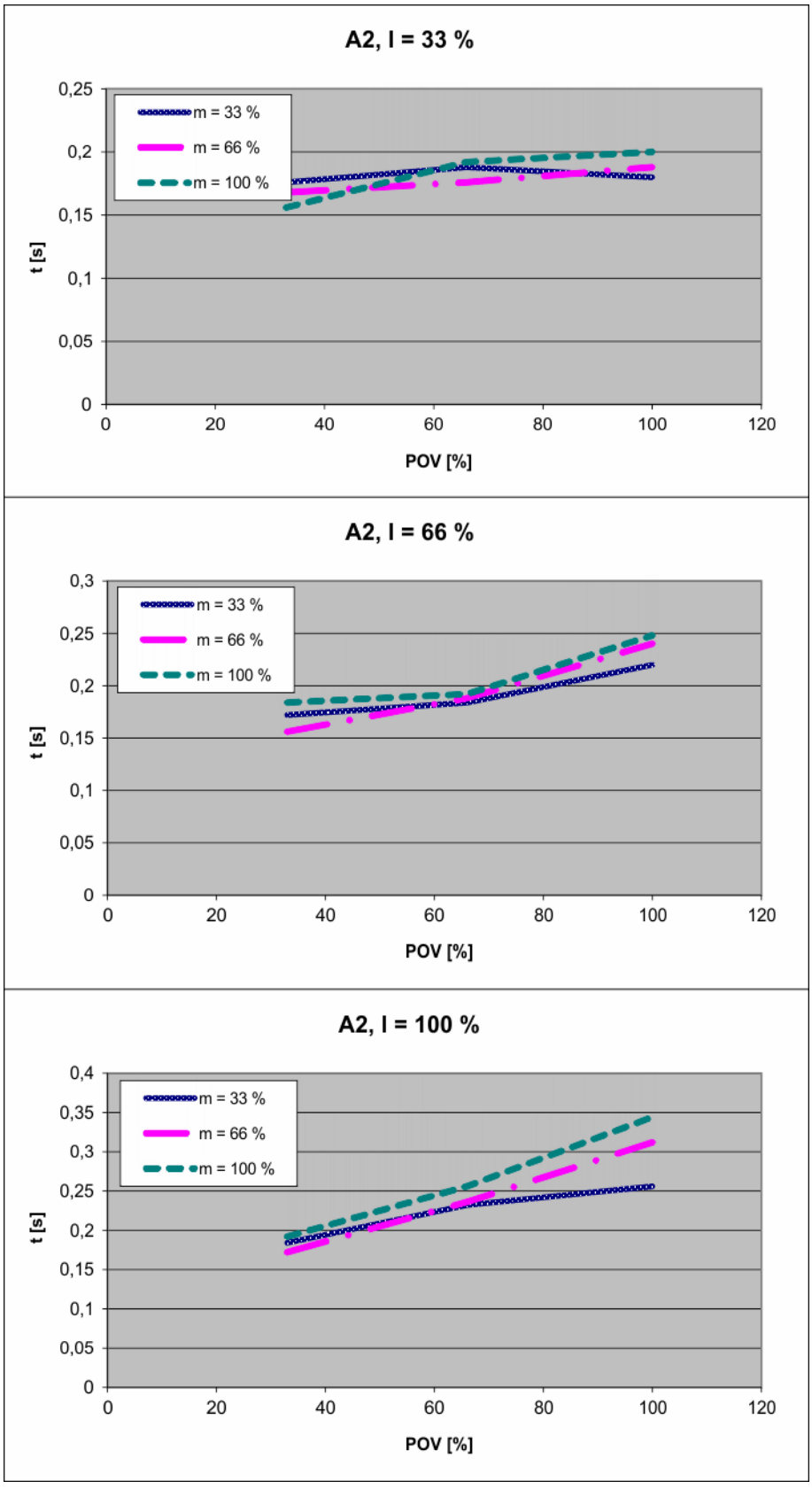


Fig. 4-14: Stopping times for STOP 1, axis 2

4.7.5 Stopping distances and stopping times, STOP 1, A3

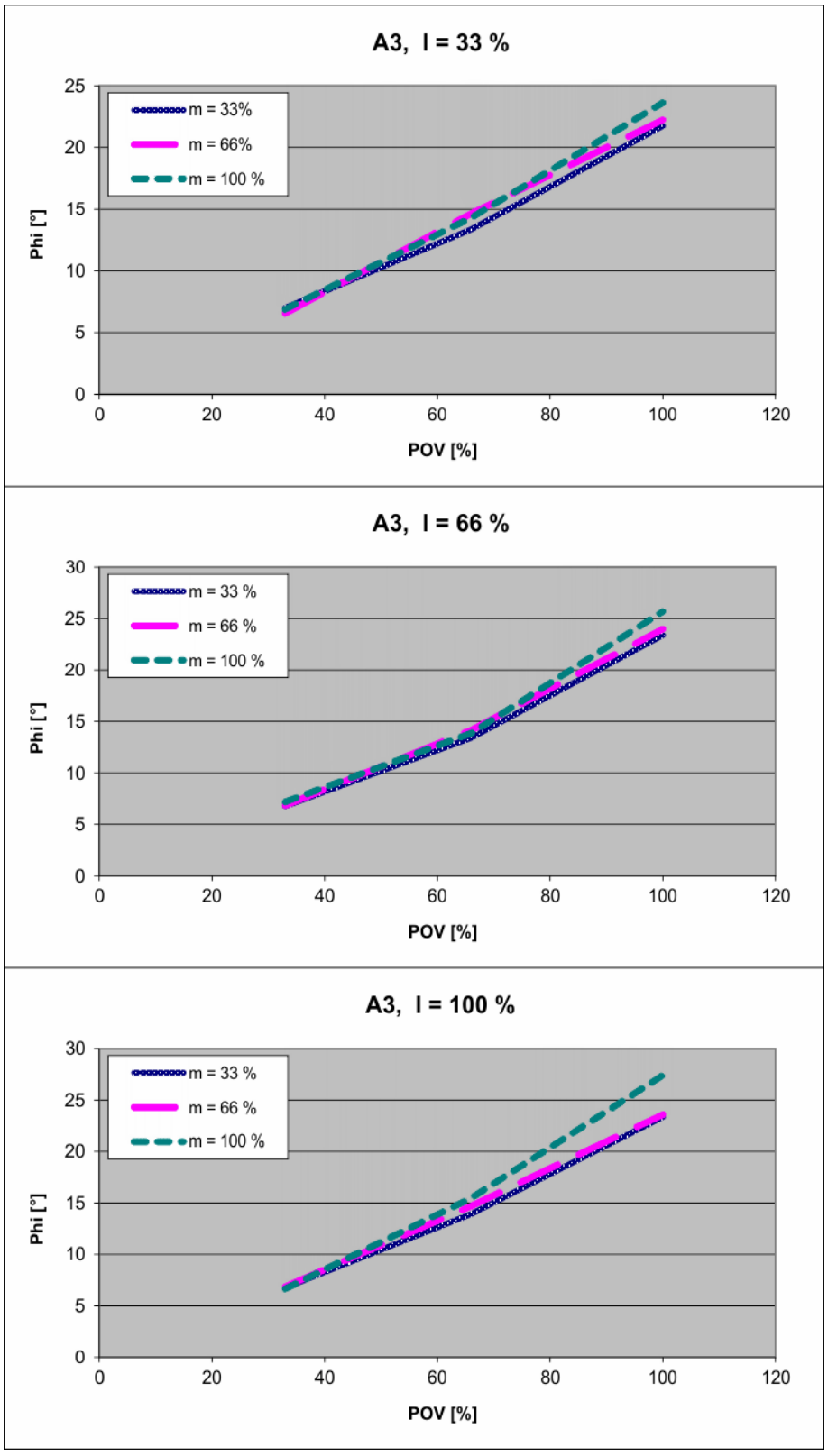


Fig. 4-15: Stopping distances for STOP 1, axis 3

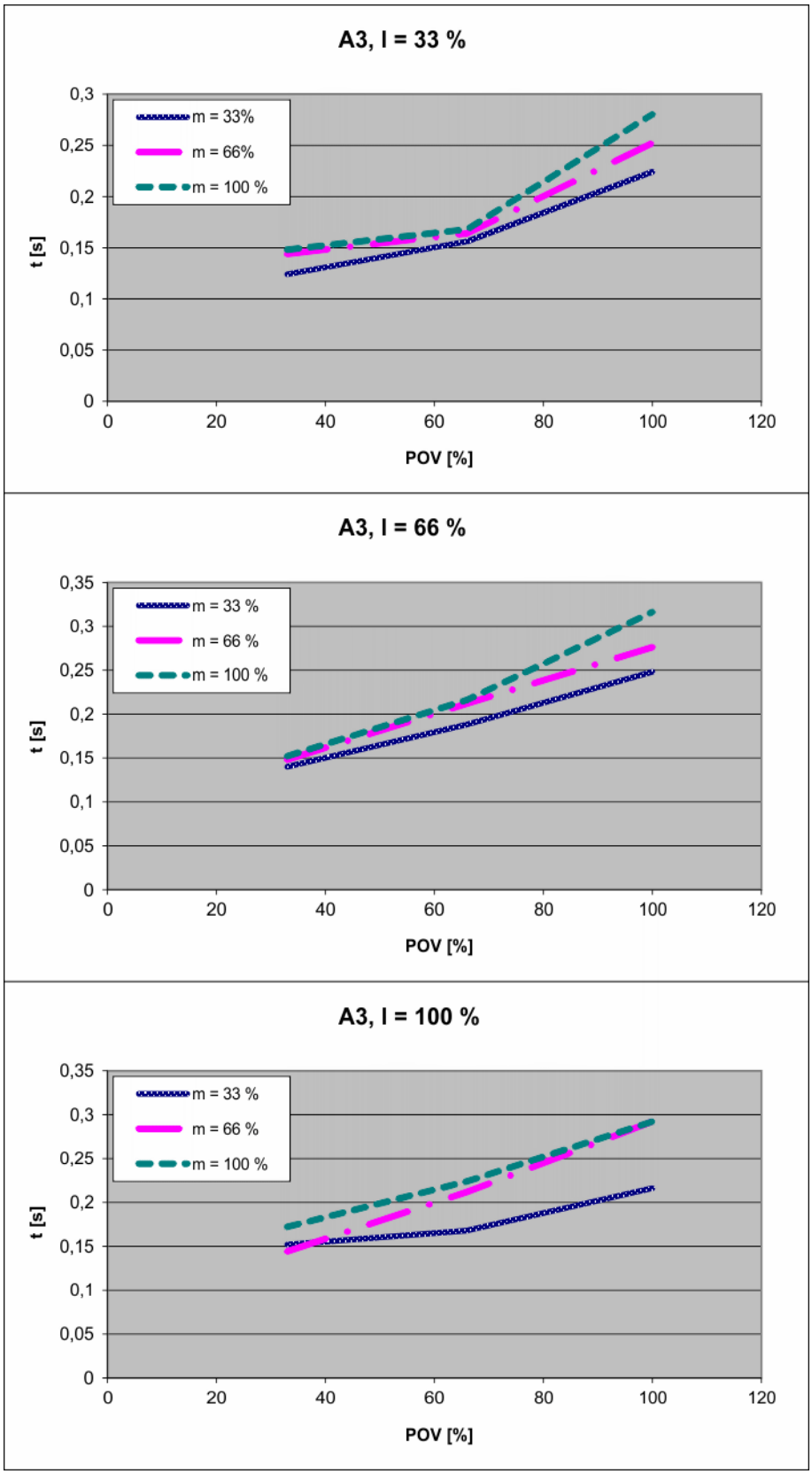


Fig. 4-16: Stopping times for STOP 1, axis 3

5 Planning

5.1 Information for planning

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

- Continuous operation near temperature limits
- Continuous operation in abrasive environments
- Continuous operation close to the performance limits, e.g. high rpm of an axis
- 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.

CAUTION

Risk of injury and damage to property due to conductive dirt or condensation

If the manipulator is operated in an environment with conductive dirt or condensation, this can lead to uncontrolled electrical connections inside the manipulator. Injuries or damage to property may result.

- The manipulator may only be operated in environments without conductive dirt.
- Avoid humidity and condensation.

CAUTION

Risk of injury and damage to property due to operation in non-approved environment

If the manipulator is operated in an environment with a higher degree of fouling and possibly with formation of condensation, this can lead to uncontrolled electrical connections inside the manipulator. These ambient conditions correspond to degree of fouling 3 or 4.

Non-compliance can result in injury or damage to property.

- It must be ensured that the installation site is protected against conductive fouling and condensation.

5.2 Machine frame mounting with centering

Description

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

must be ensured that the substructure is able to withstand safely the forces occurring during operation (foundation loads). The following diagram contains all the necessary information that must be observed when preparing the mounting surface.

The machine frame mounting assembly consists of:

- Locating pins
- Allen screws with conical spring washers

Dimensioned drawing

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

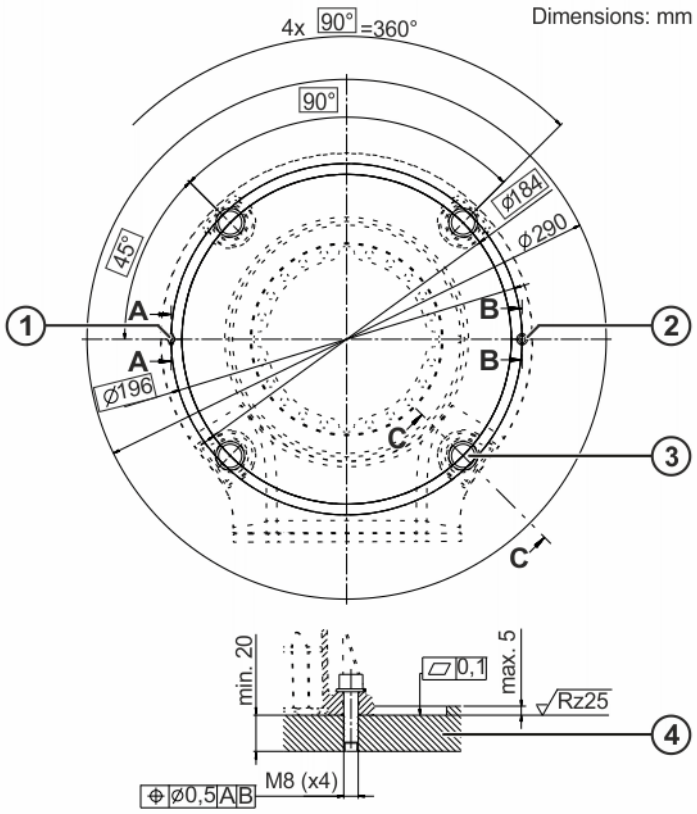


Fig. 5-1: Machine frame mounting, dimensioned drawing

1 Flat-sided locating pin 6x12
2 Cylindrical locating pin 6x12
3 M8x30-8.8 Allen screw (4x) with conical spring washer
4 Steel structure

5.3 Connecting cables and interfaces

Connecting cables

The connecting cables comprise all the cables for transferring energy and signals between the robot and the robot controller. On the robot side, the connecting cables are permanently connected to the cable set.

Cable lengths of 7 m are standard. The maximum length of the connecting cables must not exceed 25 m. The maximum number of connectors is 1, i.e. a maximum of 2 connecting cables may be combined with each other. Thus if the robot is operated on a linear unit which has its own energy supply chain, this cable must also be taken into account.

For the connecting cables, an additional ground conductor is always required to provide a low-resistance connection between the robot and the control cabinet in accordance with DIN EN 60204. The ground conductor is connected via ring cable lugs. The threaded bolts for connecting the two ground conductors are located on the base frame of the robot.

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

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

CAUTION

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

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

Interface A1

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

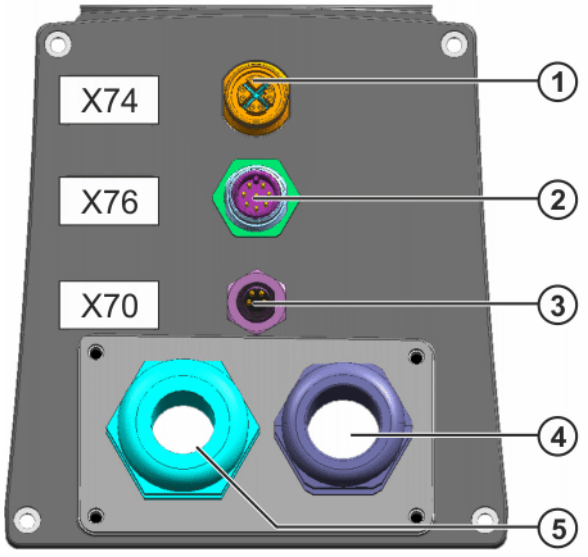


Fig. 5-2: Interface A1

1 Connection X74, Gigabit cable, M12 connector
2 Connection X76, I/O cable, M12 connector
8 individual wires, e.g. for digital inputs and outputs and power supply
3 Connection X70, power supply (internal interface), M8 connector
4 Data cable (X15/X18)

5 Motor cable (XM1/XM2-6)

Connection X76

Designation	Limit values
Rated current	2 A
Rated voltage	24 V
Connector type	M12
Number of poles	8
Coding	A standard

The entire energy supply system must be safeguarded against overload and short circuit by the customer upstream of connector X76.

Connection X70

Designation	Limit values
Rated current	2 A
Rated voltage	24 V
Connector type	M8
Number of poles	4
Coding	A standard

The entire energy supply system must be safeguarded against overload and short circuit by the customer upstream of connector X70.

External interface A6 (optional)

External interface A6 is located on the Commander. The connector bypack (>>> *11.4 "Connector bypack X94/X96 (optional)" Page 118*) must be used for contacting.

CAUTION

Only the KUKA connector bypack may be used for the contacting of external interface A6. Failure to observe this may result in severe injuries or damage to property.

External interface A6 is supplied with power by interface A1. The pre-assignment can be modified for customer-specific applications.

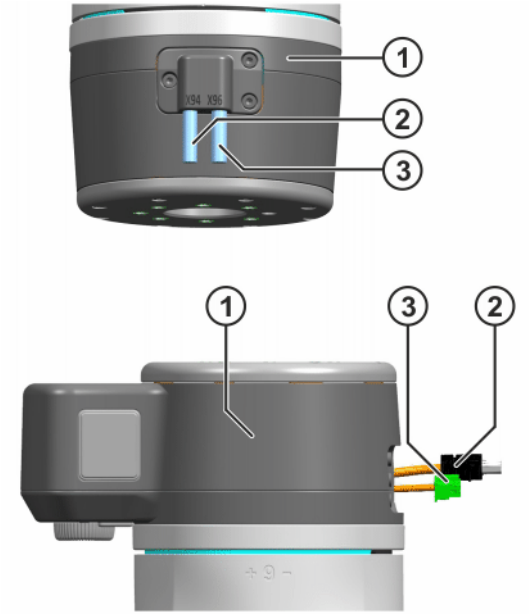


Fig. 5-3: Interface A6

1 Commander

2 Connection X94, Gigabit interface (CAT5e), 8-pole
8 individual wires, e.g. for digital inputs and outputs and power supply

3 Connection X96, power supply, digital inputs and outputs, 8-pole

Example configuration for LBR iisy with Schunk gripper:

Power supply	
Power supply	24 V DC (-15%/+20%), 2 A
Max. cable length	0.5 m

Digital outputs	
Rated voltage	24 V DC (-15%/+20%), 24 V switching
Output current	max. 0.5 A per output
Max. cable length	0.5 m

Digital inputs	
Reference point	0 V
Rated voltage	24 V DC (-15%/+20%)
Max. cable length	0.5 m

Wiring diagram, Gigabit cable, X74 - X94

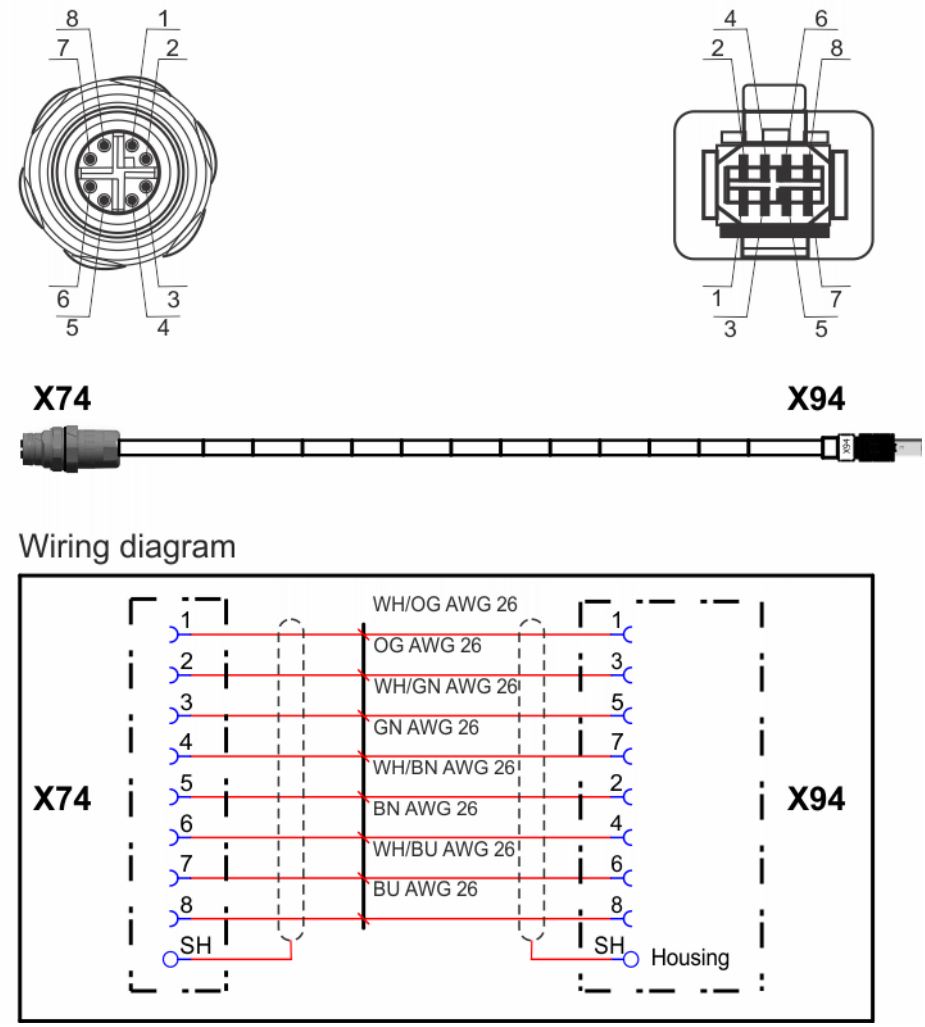


Fig. 5-4: Wiring diagram, Gigabit cable, X74 - X94

Wiring diagram, I/O cable, X76 - X96

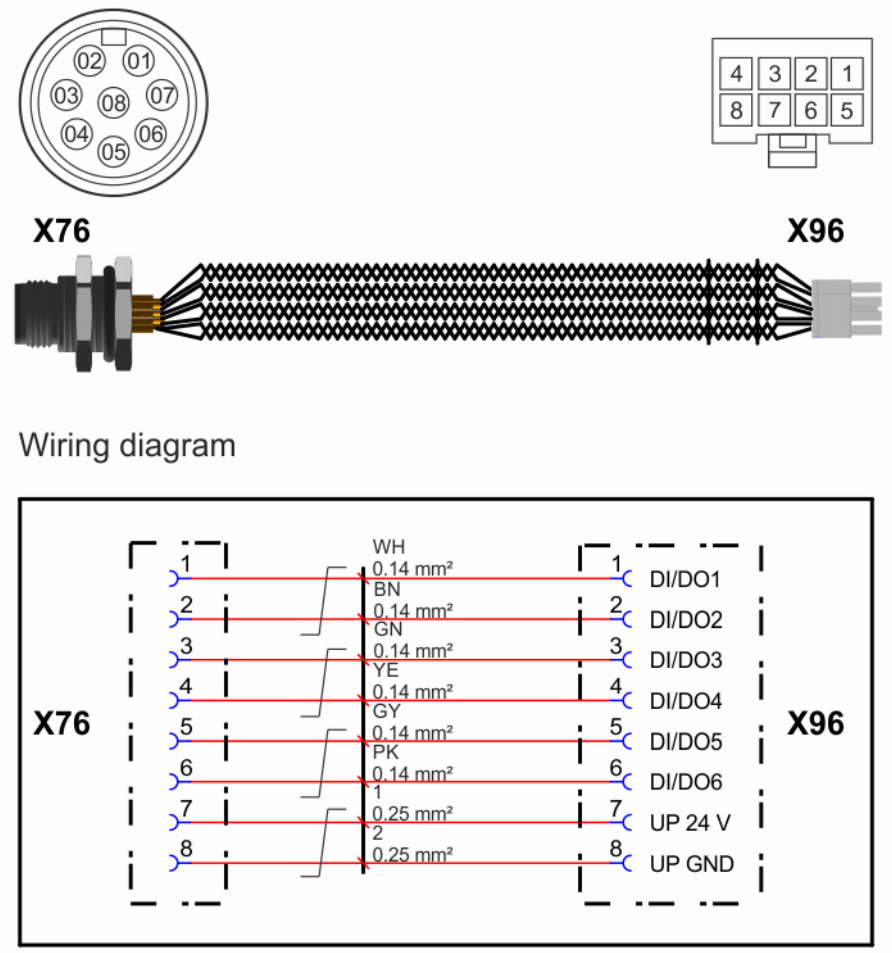


Fig. 5-5: Wiring diagram, I/O cable, X76 - X96

DI/DOx and UP specify the respective recommended functions of the cable.

6 Transportation

6.1 Transporting the robot

Description

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

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

WARNING

Danger to life and limb due to non-authorized handling equipment
If unsuitable handling equipment is used, the robot may topple or be damaged during transportation. Death, severe injuries or damage to property may result.

- Only use authorized handling equipment with a sufficient load-bearing capacity.
- Only transport the robot in the manner specified here.

Transport position, transport packaging

The robot must be in the transport position before it can be transported. The robot is in the transport position when the axes are in the following positions:

Transport position	
A1	0 °
A2	-115 °
A3	140 °
A4	0 °
A5	50 °
A6	0 °

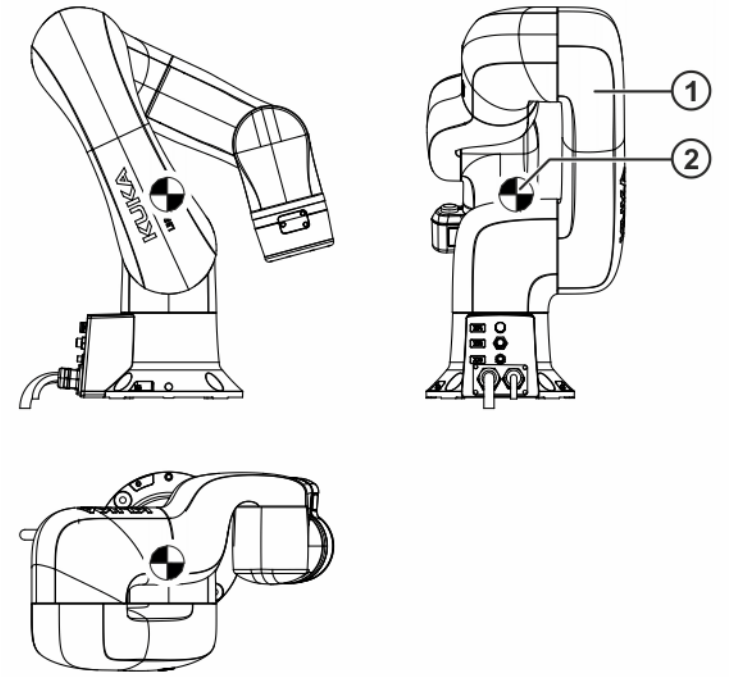


Fig. 6-1: Transport position

1	Robot	2	Center of gravity

Transport dimensions, transport packaging

Transport the robot in the transport packaging provided that has the following outer dimensions:

- Length: 800 mm
- Width: 600 mm
- Height: 620 mm

7 Start-up and recommissioning

7.1 Starting up robots (machine frame mounting)

Description

The machine frame mounting is used for installing robots on a steel structure prepared by the customer.

Fastening is carried out using 4 Allen screws with conical spring washers. A cylindrical pin and a flat-sided pin are provided to ensure correct positioning.

The installation and start-up of the robot controller, the tools mounted and the applications are not described here.

Equipment

The following equipment is required:

Designation	Article number
Set of Allen keys 1.5; 2; 2.5; 3; 4; 5; 6; 8; 10 mm	-
Torque wrench min. 2 to 20 Nm	-

Material

The following material is required:

Designation	Article number	Quantity
Machine frame mounting	0000-204-931	1

Tightening torques

The tightening torques can be found under: (>>> *12.1 "Tightening torques" Page 125*)

These are valid for screws and nuts where no other specifications are given.

Screws of strength class 10.9 and higher as well as screws with test certification may only be tightened once with the rated tightening torque. When the screws are first slackened they must be replaced with new ones.

Precondition

- The robot is in the transport position.
- The substructure has been checked for sufficient safety.
- The mounting surface has been prepared.
- The machine frame mounting assembly is complete.
- Any tools or other system components which would hinder the work have been removed.

Work safety

WARNING

Danger to life and limb due to live parts
When work is performed on this system, live parts can lead to unintentional motions of the robot, positioner or other components. Failure to observe this may result in physical injuries and damage to property.

- If work is carried out on an operable system, the main switch on the control cabinet must be turned to the OFF position and secured with a padlock to prevent unauthorized persons from switching it on again.
- Inform the persons involved by means of a sign (e.g. affix a warning sign).
- Warn all persons concerned before putting the system back into operation.

WARNING

Danger to life and limb due to non-authorized handling equipment
If unsuitable handling equipment is used, the robot may topple or be damaged during transportation. Death, severe injuries or damage to property may result.

- Only use authorized handling equipment with a sufficient load-bearing capacity.
- Only transport the robot in the manner specified here.

WARNING

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

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

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.

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.

7.1.1 Installing the robot with the machine frame mounting assembly

Procedure

1. Clean the mounting surface.
2. Check the hole pattern on the mounting surface.
3. Screw 2 locating pins into the mounting surface and check that they are fitted securely.
4. Move the robot to the installation site.
5. Clean the lower mounting surface on the robot.
6. Lower the robot vertically onto the mounting surface. Ensure that an entirely vertical position is maintained in order to prevent damage to the locating pins.
7. Insert 4 M8x30-8.8-A2K Allen screws with conical spring washers.
8. Tighten 4 M8x30-8.8-A2K Allen screws with a torque wrench in diagonally opposite sequence. Increase the tightening torque to the specified value in several stages.

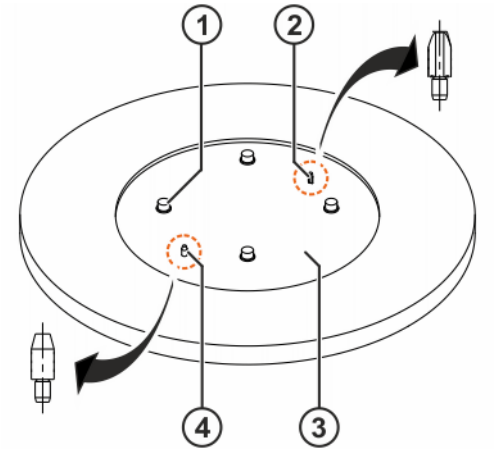


Fig. 7-1: Machine frame mounting

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

7.1.2 Connecting the connecting cables

Procedure

1. Fasten the ground conductor between the robot controller and the robot to the ground conductor connection with 1 M4 hexagon nut including conical spring washer; tightening torque M_A= 2.8 Nm.
2. Fasten the ground conductor between the system component and the robot to the ground conductor connection with 1 M4 hexagon nut including conical spring washer; tightening torque M_A= 2.8 Nm.
3. Check the equipotential bonding in accordance with VDE 0100 and EN 60204-1.

Further information is contained in the operating and assembly instructions of the robot controller.

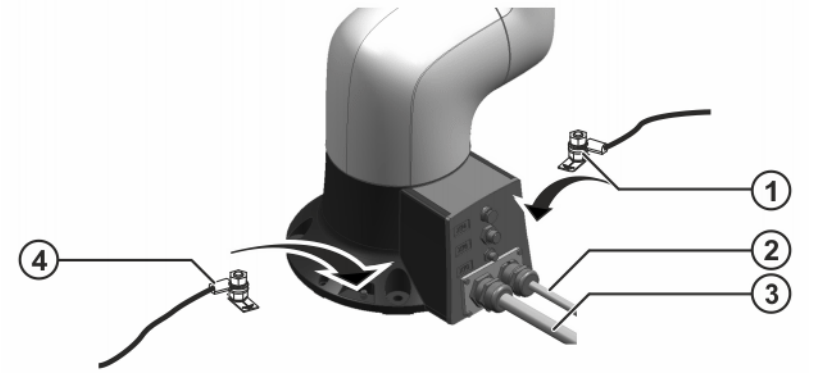


Fig. 7-2: Connecting the connecting cables

1 System ground conductor (optional)
2 Cable set, data cable X15/X18
3 Cable set, motor cable XM1/XM2-6
4 External ground conductor (KRC)

Put the robot into operation in accordance with the “Start-up” chapter of the operating and programming instructions for the System Software and/or the assembly instructions or operating instructions for the robot controller.

7.1.3 Concluding work

The following concluding work must be carried out:

- If applicable, mount the tool.
- Start up the robot system in accordance with the chapter “Start-up and recommissioning” in the operating instructions for the robot controller.
- Put the robot system into operation in accordance with the chapter “Start-up and recommissioning” of the operating and programming instructions for the KUKA System Software (KSS).

7.2 Description of the connecting cables, KR C5 micro

Configuration

The connecting cables are used to transfer power and data between the robot controller and the robot.

The connecting cables comprise:

- Motor cable
- Data cable

Interface

Cable designation	Connector designation robot controller - robot	Interface Robot
Motor cable	Motor connector 1: XD20.1 - XD30 Connection A1-A3 incl. brakes Motor connector 2: XD20.2 - XD30 Connection A4-A6 incl. brakes	-
Data cable	XF21 - X15/X18	-
Ground conductor / equipotential bonding 4 mm^2		Ring cable lug, M4

The following connecting cables are also optionally available. Further information can be found in Section (>>> *11.5 "Connecting cables (optional)" Page 122*).

- I/O connecting cable
- GigaBit connecting cable
- External ground conductor

Standard connecting cable

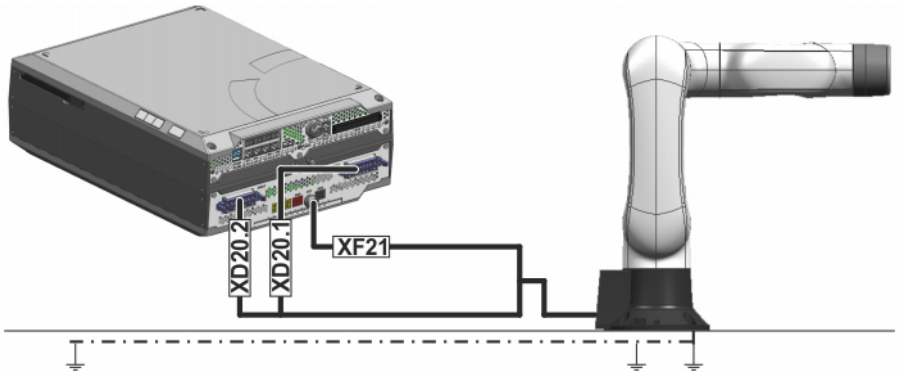


Fig. 7-3: Connecting cables, overview

7.2.1 Description of the Motor cable

Cable overview

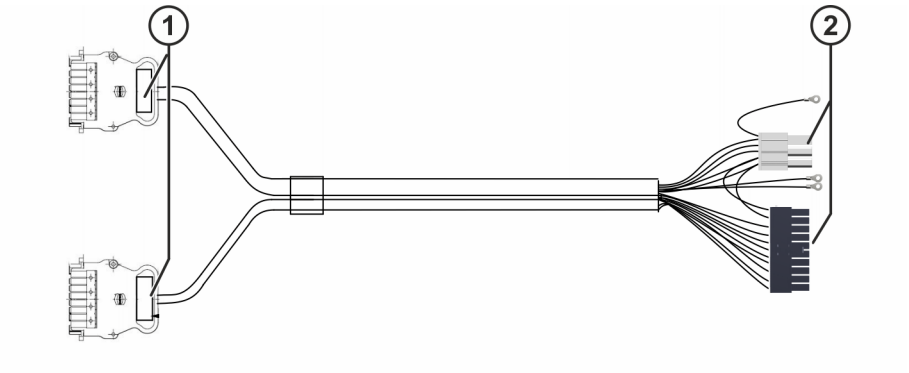
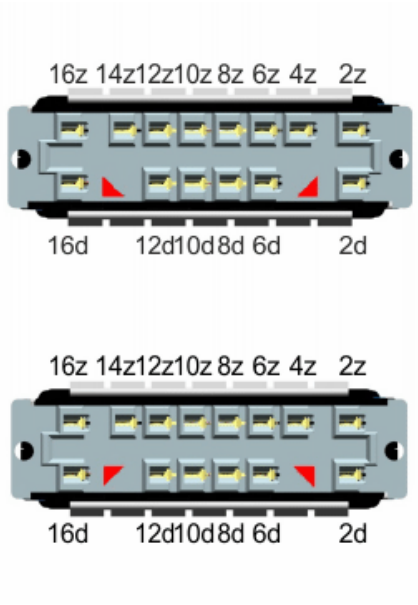
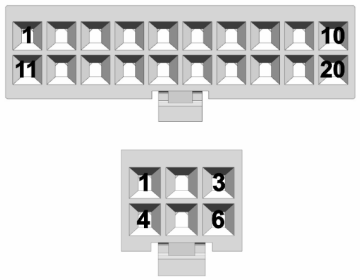


Fig. 7-4: Motor cable

1 XD20.1 / XD20.2
2 XM2-6 / XM1

Connector pin allocation

Connector pin allocation XD20.1 / XD20.2	Connector pin allocation XM2-6 / XM1
	

The contact assignment on the connector side is shown in each case.

Wiring diagram

XD20.1 / XD20.2 Pin	Description		XM2-6 / XM1 Pin
XD20.1 / 8d	XM1_U	Twisted	XM1 / 1
XD20.1 / 8z	XM1_V		XM1 / 3
XD20.1 / 6d	XM1_W		XM1 / 5

XD20.1 / XD20.2 Pin	Description		XM2-6 / XM1 Pin
XD20.1 / 2d	24V_brake_A1	Twisted	XM1 / 6
XD20.1 / 2z	GND_brake_A1		XM1 / 4
	XM1_PE Jumpered PE_axis 1		XM1 / 2
XD20.1 / 12z	XM2_U	Twisted	XM2-6 / 3
XD20.1 / 10d	XM2_V		XM2-6 / 13
XD20.1 / 10z	XM2_W		XM2-6 / 14
XD20.1 / 16d	XM3_U	Twisted	XM2-6 / 4
XD20.1 / 16z	XM3_V		XM2-6 / 5
XD20.1 / 12d	XM3_W		XM2-6 / 15
XD20.1 / 2d	24V_brake_A1-A3	Twisted	XM2-6 / 11
XD20.1 / 2z	GND_brake_A1-A3		XM2-6 / 1
XD20.1 / 6z	PE		PE
	XM1_PE jumpered XM1 / 2		PE_axis 1
XD20.1 / housing	Shield, pins XD20.1 / 8d, 8z, 6d, 12z, 10d, 10z, 16d, 16z, 12d, 2d, 2z, 6z		Cable gland
XD20.2 / 12d	XM4_U	Twisted	XM2-6 / 6
XD20.2 / 10d	XM4_V		XM2-6 / 16
XD20.2 / 10z	XM4_W		XM2-6 / 17
XD20.2 / 8d	XM5_U	Twisted	XM2-6 / 7
XD20.2 / 8z	XM5_V		XM2-6 / 8
XD20.2 / 6d	XM5_W		XM2-6 / 18
XD20.2 / 6z	XM6_U	Twisted	XM2-6 / 9
XD20.2 / 2d	XM6_V		XM2-6 / 19
XD20.2 / 2z	XM6_W		XM2-6 / 20

XD20.1 / XD20.2 Pin	Description		XM2-6 / XM1 Pin
XD20.2 / 16d	24V_brake_A4-A6	Twisted	XM2-6 / 12
XD20.2 / 16z	GND_brake_A4-A6		XM2-6 / 2
XD20.2 / 12z	PE		PE
XD20.2 / housing	Shield, pins XD 20.2 / 12d, 10d, 10z, 8d, 8z, 6d, 6z, 2d, 2z, 16d, 16z, 12z		Cable gland

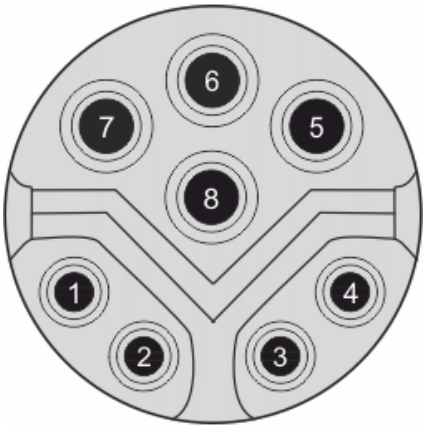
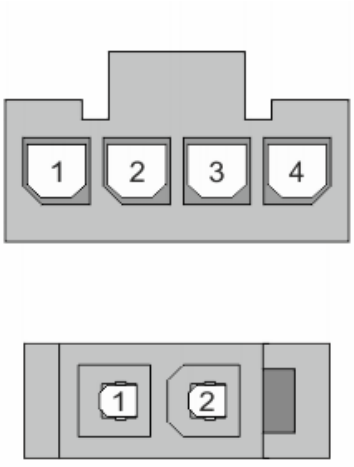
7.2.2 Description of the Data cable

Cable overview

Fig. 7-5: Data cable

1 XF21
2 X18 / X15

Connector pin allocation

Connector pin allocation XF21	Connector pin allocation X18 / X15
	

The contact assignment on the connector side is shown in each case.

Wiring diagram

XF21 Pin	Description		X18 / X15 Pin
XF21 / 3	TX+		X18 / 1
4	TX+		X18 / 2
1	RX+		X18 / 3
2	RX-		X18 / 4
Housing	Shield, pins 3, 4, 1, 2	Shield, pins X18 / 1, 2, 3, 4	Cable gland
5	27 V		
6	GND		
7	27 V		X15 / 1
8	GND		X15 / 2

7.2.3 Description of the ground conductor

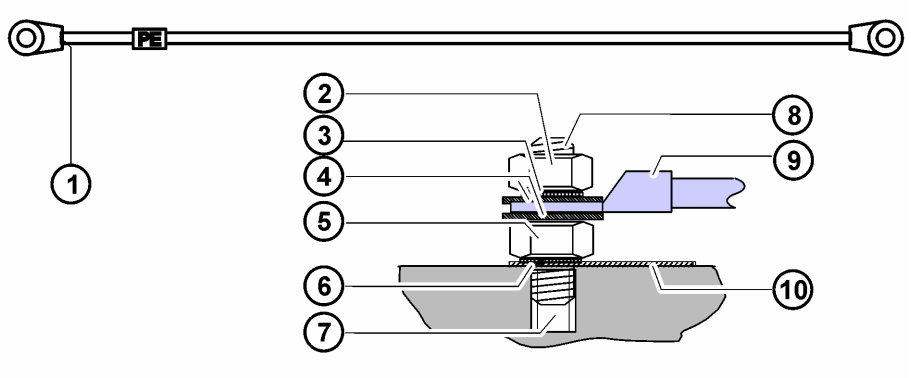


Fig. 7-6: Connecting cable, ground conductor

1	Ground conductor	6	Conical spring washer
2	Hexagon nut	7	Robot
3	Conical spring washer	8	Setscrew
4	2x plain washer	9	Ground conductor connection Ring cable lug
5	Hexagon nut	10	Ground sign

7.3 Moving the manipulator without drive energy

Description

In order to be able to move the manipulator after an accident or malfunction without drive energy, it must be either dismounted or pushed against the brakes.

This option is only for use in exceptional circumstances and emergencies, e.g. for rescuing people.

8 Maintenance

Only maintenance and repair work described in this document may be performed.

Work that exceeds this scope may only be carried out by personnel specially trained by KUKA. Information about KUKA College and its training program can be found at college.kuka.com or can be obtained directly from our subsidiaries.

In the case of support and repair services provided by KUKA, KUKA Service must be informed in advance about potential contamination or hazards.

Non-compliance nullifies warranty and liability claims.

8.1 Maintenance overview

Description

The maintenance intervals given in the tables are valid for the operating conditions specified in the technical data (>>> *4 "Technical data" Page 31*). KUKA Deutschland must be consulted in the event of deviations in working conditions or the use of special functions or applications.

Further information can be found in the section “Information for planning” .

A general inspection of the manipulator is recommended after 7 years or upon modifying its use. Please contact KUKA Service for this.

If the robot is fitted with a KUKA energy supply system (optional), additional maintenance work must be carried out.

NOTICE

Only auxiliary substances and consumables approved by KUKA Deutschland GmbH may be used. Non-approved auxiliary substances and consumables may cause premature wear and failure of assemblies.

Precondition

- The maintenance points must be freely accessible.
- Remove the tools and any additional items of equipment if they impede maintenance work.

WARNING

Danger to life and limb due to unintended robot motions
Unintended robot motions may result in death, severe injuries and damage to property.

- Secure the robot by pressing the EMERGENCY STOP device.
- Warn all persons concerned before starting to put it back into operation.

8.1.1 Maintenance table

Maintenance symbols

The overview may contain maintenance symbols that are not relevant for the maintenance work on this product. The maintenance illustrations provide an overview of the relevant maintenance work.

Oil change

Lubricate with grease gun

Lubricate with brush

Lubricate with spray grease

Tighten screw/nut

Check component, visual inspection

Clean component

Exchange battery

Exchange component

Check toothed belt tension

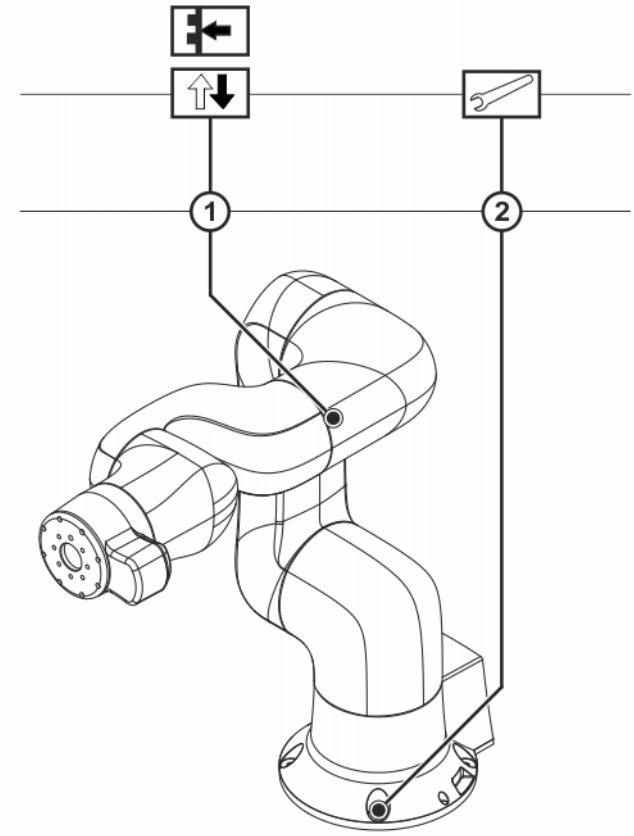


Fig. 8-1: Maintenance diagram

Interval	Item	Activity
100 h*	2	Check tightening torque for fastening screws; M = 23.0 Nm. *Once only, after initial start-up or recommissioning
5 000 h or 1 year at the latest	1	Exchange toothed belt A5. (>>> *8.2 "Exchanging the toothed belt" Page 75*)

The service life of the cable set corresponds to that of the robot, provided that programs are executed in the normal range. If, however, the programs are at the limits, the service life of the cable set is reduced and it may be necessary to exchange the cable set prematurely.

8.2 Exchanging the toothed belt

Description

The following instructions describe how to exchange the toothed belt on A5.

Equipment

The following equipment is required:

Designation	Article number
Set of Allen keys 1.5; 2; 2.5; 3; 4; 5; 6; 8; 10 mm	-
Set of TORX key wrenches TX5; TX6; TX7; TX8; TX9; TX10; TX15; TX20; TX25; TX27; TX30; TX40; TX45; TX55	-
Frequency meter TSM alpha 2	0071-053-386
SEMD/MEMD mastering kit	0000-228-936

Material

The following material is required:

Designation	Article number	Quantity
SPP belt set IW 3 R760	0000-332-496	1

Procurement of spare parts

Defective components must only be replaced with original spare parts from KUKA Deutschland GmbH. Non-compliance nullifies warranty and liability claims.

A “Repair Card” is supplied with the exchange parts. This must be completed and returned to KUKA Deutschland GmbH together with the defective component in the following cases.

- Within the warranty period
- If, after consultation with KUKA Deutschland GmbH, an examination of the defective component by KUKA is required.

Tightening torques

The tightening torques can be found under: (>>> *12.1 "Tightening torques" Page 125*)

These are valid for screws and nuts where no other specifications are given.

Screws of strength class 10.9 and higher as well as screws with test certification may only be tightened once with the rated tightening torque. When the screws are first slackened they must be replaced with new ones.

Precondition

- The robot is secured by means of an EMERGENCY STOP device. It must be ensured that the robot cannot be switched on by unauthorized persons.

Work safety

WARNING

Danger to life and limb due to unintended robot motions
Unintended robot motions may result in death, severe injuries and damage to property.

- Secure the robot by pressing the EMERGENCY STOP device.
- Warn all persons concerned before starting to put it back into operation.

CAUTION

Risk of burns from lubricants, components and surfaces
Immediately after the robot has been shut down, lubricants, components and surfaces in the vicinity of the gear units and motors may have high temperatures. Touching them may result in burns.

- Wear protective gloves.
- Allow components to cool if necessary.

8.2.1 Removing the toothed belt cover

Procedure

1. Unscrew 1 M3x6-10.9-A2K TORX screw from the cover over the toothed belt.

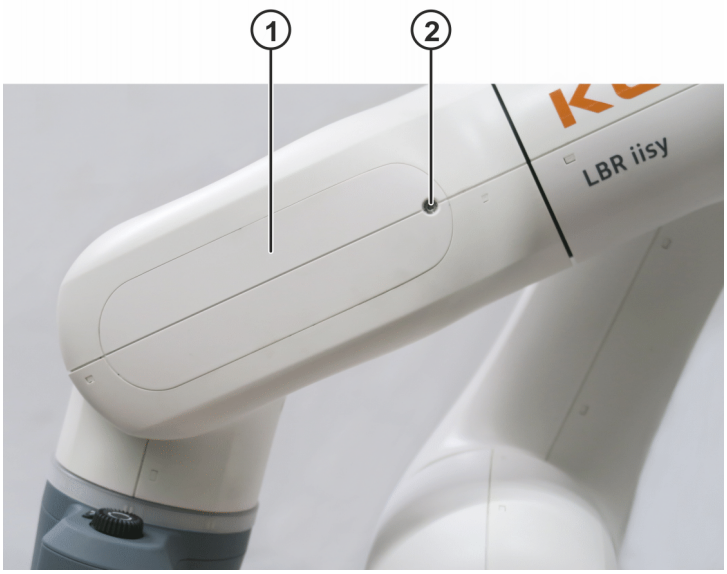


Fig. 8-2: Cover over toothed belt

1	Cover
2	M3x6-10.9-A2K TORX screw

2. Remove the cover.

8.2.2 Removing toothed belts

Procedure

1. Slacken 2 M3x10-8.8-A2K Allen screws.

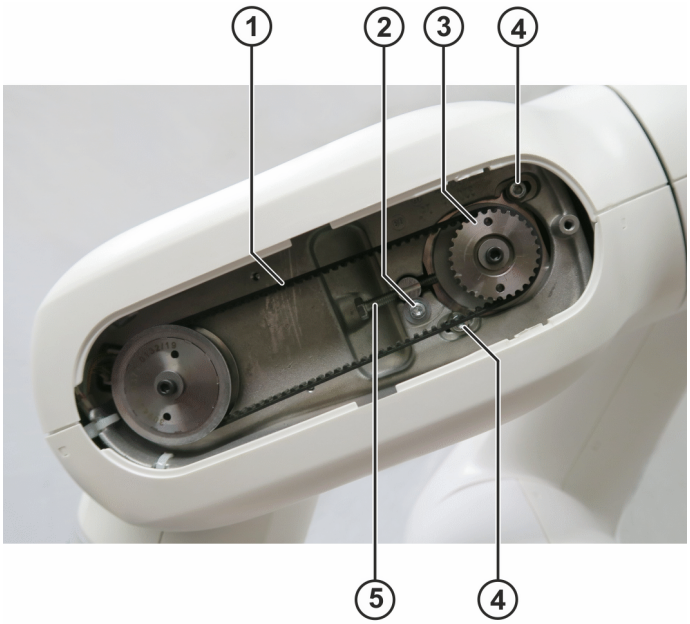


Fig. 8-3: Toothed belt

1	Toothed belt
2	PE-M3x8-A2K TORX screw
3	Belt pulley
4	M3x10-8.8-A2K Allen screw (2x)

5 M4x25-8.8-A2K hexagon bolt

2. Slacken 1 M4x25-8.8-A2K hexagon bolt until the toothed belt is without tension.
3. Take out the toothed belt.

8.2.3 Fitting the toothed belt

If motor A5 is exchanged, the toothed belt must also be exchanged.

Procedure

1. Fit toothed belt. Ensure that the toothed belt meshes with the toothed belt pinions.

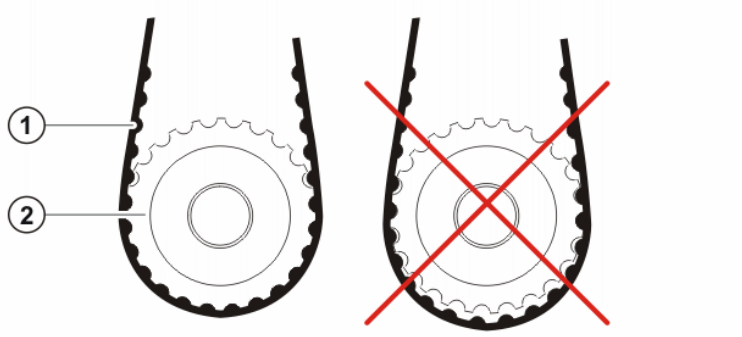


Fig. 8-4: Toothed belt and toothed belt pinion

1 Toothed belt
2 Toothed belt pinion

8.2.4 Adjusting the toothed belt tension

Procedure

1. Lightly tighten the M4x25-8.8-A2K hexagon bolt.

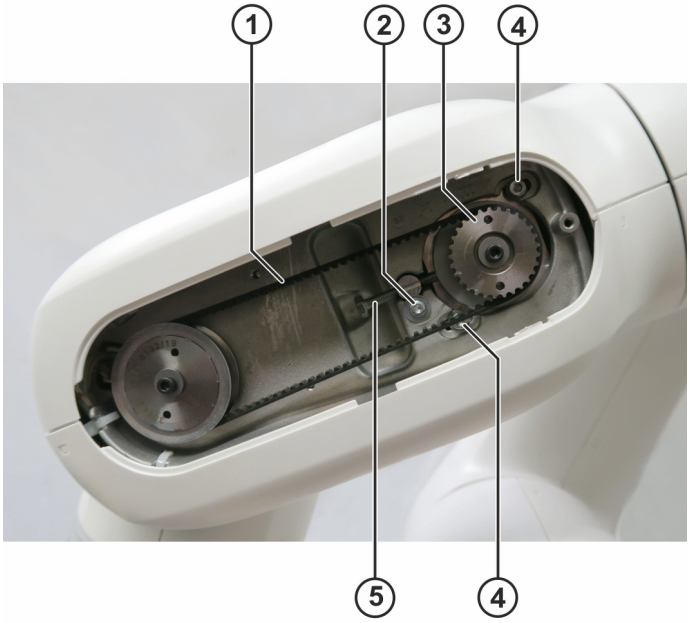


Fig. 8-5: Toothed belt

1	Toothed belt
2	PE-M3x8-A2K TORX screw
3	Belt pulley
4	M3x10-8.8-A2K Allen screw (2x)
5	M4x25-8.8-A2K hexagon bolt

2. Lightly tighten 2 M3x10-8.8-A2K Allen screws on motor A5.
3. Switch on the frequency meter.
4. Pluck toothed belt and hold the sensor at a distance of 2 to 3 mm from the center of the vibrating toothed belt. Read the measurement on the frequency meter.

   Setpoint value: 155 Hz

   If the determined value does not correspond to the setpoint value, re-tension the toothed belt using the M4x25-8.8-A2K hexagon bolt and measure it again.
5. If the determined value corresponds to the setpoint value, tighten the 2 M3x10-8.8-A2K Allen screws on motor A5 with the specified tightening torque.
6. Put the robot into operation and move axis 5 in both directions.
7. Secure the robot by pressing the EMERGENCY STOP device.
8. Measure the toothed belt tension again and check whether it still corresponds to the setpoint value.

   If the tension still corresponds to the setpoint value, the adjustment process is complete.
9. If the toothed belt tension deviates from the setpoint value, slacken the M3x10-8.8-A2K Allen screws again and re-tension the toothed belt using the M4x25-8.8-A2K hexagon bolt so that the measured tension corresponds to the setpoint value.
10. Tighten 2 M3x10-8.8-A2K Allen screws with the specified torque.
11. Put the robot into operation and move axis 5 in both directions.
12. Secure the robot by pressing the EMERGENCY STOP device.
13. Measure the toothed belt tension again and check whether it still corresponds to the setpoint value.

If the tension still corresponds to the setpoint value, the adjustment process is complete.

8.2.5 Installing the toothed belt cover

Procedure

- Position the cover and fasten it with 1 M3x6-10.9-A2K TORX screw.

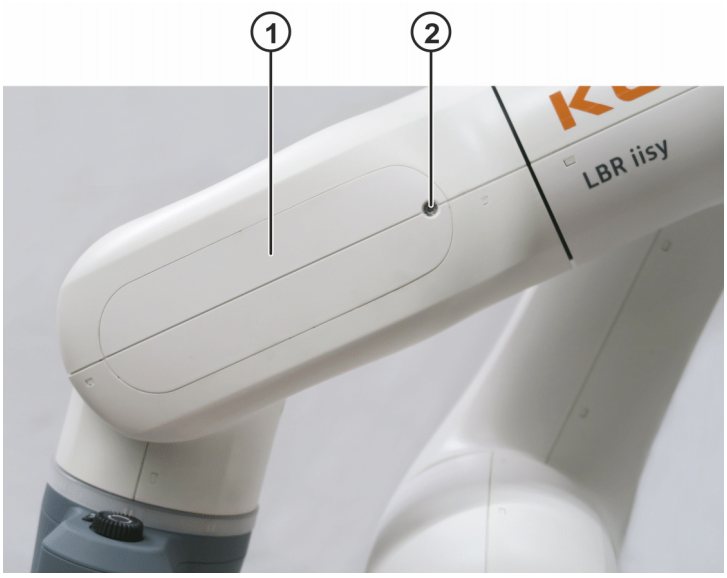


Fig. 8-6: Cover over toothed belt

1 Cover
2 M3x6-10.9-A2K TORX screw

8.2.6 Concluding work

The following concluding work must be carried out:

- Mastering of A5

Detailed information about mastering is contained in the operating and programming instructions for end users or system integrators.

- Run the program in T1 mode and look out for irregularities.

8.3 Cleaning the robot

Description

The robot must be cleaned in compliance with the instructions given here in order to prevent damage. These instructions only refer to the robot.

Equipment

The following equipment is required:

Designation	Article number
Permissible cleaning tools (e.g. cloths, brushes)	-

Material

The following material is required:

Designation	Article number	Quantity
Cleaning agent solvent-free, water-soluble, non-flammable, non-aggressive, no steam, no refrigerants	-	-

Precondition

- The robot controller is switched off.
- The robot is freely accessible.

Work safety

NOTICE

The following must be taken into consideration when carrying out cleaning work (material damage may otherwise result):

- Cleaning must be in accordance with the corresponding cleaning instructions.
- Do not use high-pressure cleaners.
- Compressed air must not be used to clean bearing and sealing points.
- It must be ensured that no cleaning agent enters electrical or mechanical system components.

8.3.1 Cleaning

Procedure

1. Shut down the robot.
2. If necessary, shut adjacent system components down and lock them.
3. Remove enclosures if this is necessary in order to carry out the cleaning work.
4. Clean the robot.
5. Fully remove all cleaning agents from the robot.
6. Clean any areas of corrosion and reapply corrosion protection.
7. Install any safety equipment that has been removed.
8. Put back in place any enclosures that have been removed.

8.3.2 Concluding work

The following concluding work must be carried out:

- Remove cleaning agents and equipment from the workspace of the robot.
- Dispose of cleaning agents in accordance with the pertinent regulations.
- Replace any damaged or illegible plates and covers.
- Install any safety equipment that has been removed and check that it is functioning correctly. Only a functional system with all safety functions may be put back into operation.

9 Repair

Only maintenance and repair work described in this document may be performed.

Work that exceeds this scope may only be carried out by personnel specially trained by KUKA. Information about KUKA College and its training program can be found at college.kuka.com or can be obtained directly from our subsidiaries.

In the case of support and repair services provided by KUKA, KUKA Service must be informed in advance about potential contamination or hazards.

Non-compliance nullifies warranty and liability claims.

9.1 Exchanging the shells

Description

The LBR iisy 3 R760 has a plastic casing.

The shells can be exchanged individually or together. The spare parts package contains a complete set of shells.

Equipment

The following equipment is required:

Designation	Article number
TORX screwdriver TX10	-
Flat-blade screwdriver	-

Material

The following material is required:

Designation	Article number	Quantity
SPP shell set	0000-332-499	1

Procurement of spare parts

Defective components must only be replaced with original spare parts from KUKA Deutschland GmbH. Non-compliance nullifies warranty and liability claims.

A “Repair Card” is supplied with the exchange parts. This must be completed and returned to KUKA Deutschland GmbH together with the defective component in the following cases.

- Within the warranty period
- If, after consultation with KUKA Deutschland GmbH, an examination of the defective component by KUKA is required.

Tightening torques

The tightening torques can be found under: (>>> *12.1 "Tightening torques" Page 125*)

These are valid for screws and nuts where no other specifications are given.

Screws of strength class 10.9 and higher as well as screws with test certification may only be tightened once with the rated tightening torque.

When the screws are first slackened they must be replaced with new ones.

Preconditions

- The robot controller is switched off and secured to prevent unauthorized persons from switching it on again.
- All power cables and connecting cables to the robot are unplugged.

Work safety

WARNING

Danger to life and limb due to live components
Components may remain energized after the robot system has been switched off. Death, severe injuries or damage to property may result.

- Switch off the robot system at the main switch and secure it to prevent unauthorized persons from switching it on again.
- Disconnect the power cable from the supply.
- After switching off, wait at least 5 minutes and then check to ensure that the robot controller and power cable are deenergized.

9.1.1 Removing shells from the rotating column

Procedure

1. Unscrew 1 M3x6-8.8-A2K TORX screw from the shell.

Fig. 9-1: Shell with screw outside, rotating column

1	M3x6-8.8-A2K TORX screw
2	Shell

2. Release the snap connection between the two shells by carefully levering it open with a flat-blade screwdriver.

Fig. 9-2: Releasing the snap connection

1 Flat-blade screwdriver

3. Take off the shell.
4. Unscrew 3 PT K30x10-10.9-A3K TORX screws from the second shell.

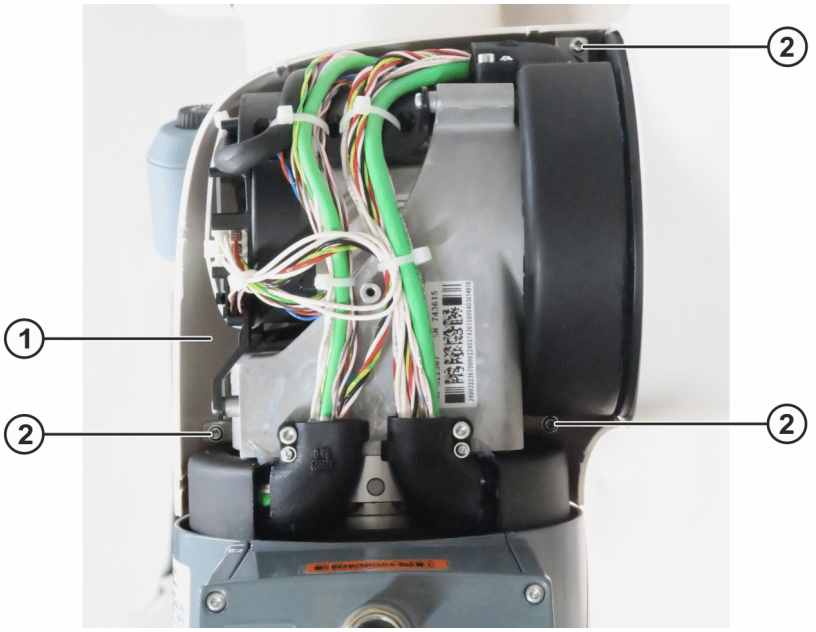


Fig. 9-3: Shell with screws inside, rotating column

1 Shell
2 PT K30x10-10.9-A3K TORX screw (3x)

5. Take off the second shell.

9.1.2 Removing shells from the link arm

Procedure

1. Unscrew 2 M3x6-10.9-A2K TORX screws from the shell.

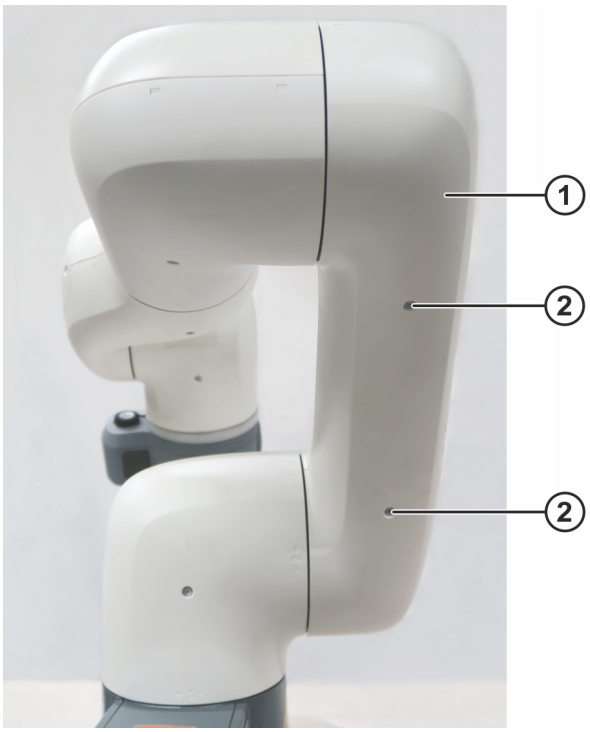


Fig. 9-4: Shell with screws outside, link arm

1	Shell
2	M3x6-10.9-A2K TORX screw (2x)

2. Release the snap connection between the two shells by carefully levering it open with a flat-blade screwdriver.

Fig. 9-5: Releasing the snap connection

1	Flat-blade screwdriver

3. Take off the shell.
4. Unscrew 6 PT K30x10-10.9-A3K TORX screws from the second shell.

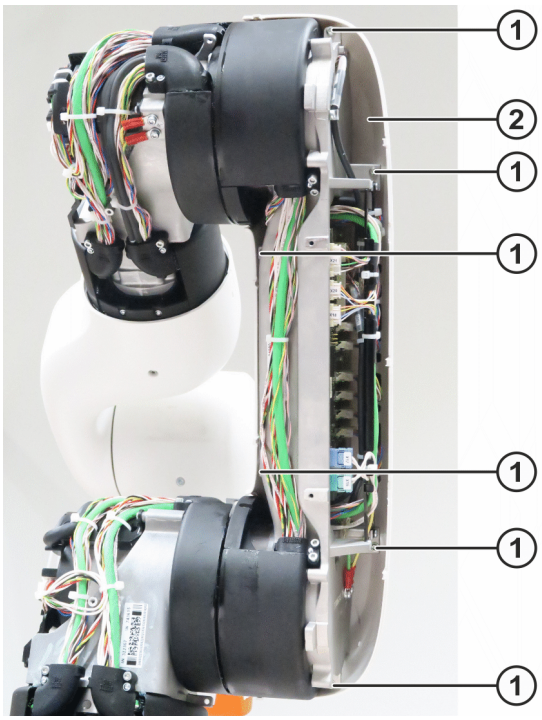


Fig. 9-6: Shell with screws inside, link arm

1	PT K30x10-10.9-A3K TORX screw (6x)
2	Shell

5. Take off the second shell.

9.1.3 Removing shells from the arm at axis 3

Procedure

1. Unscrew 1 M3x6-10.9-A2K TORX screw from the shell on the arm.

Fig. 9-7: Shell with screw outside, arm at axis 3

1	Shell
2	M3x6-10.9-A2K TORX screw

2. Release the snap connection between the two shells by carefully levering it open with a flat-blade screwdriver.

Fig. 9-8: Releasing the snap connection

1 Flat-blade screwdriver

3. Take off the shell.
4. Unscrew 3 PT K30x10-10.9-A3K TORX screws from the second shell.

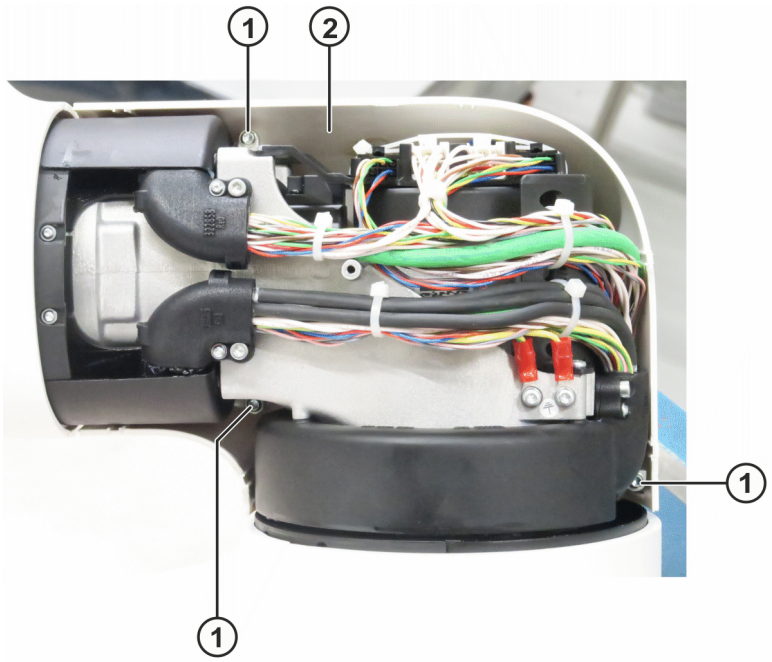


Fig. 9-9: Shell with screws inside, arm at axis 3

1 PT K30x10-10.9-A3K TORX screw (3x)
2 Shell

5. Take off the second shell.

9.1.4 Removing shells from the main body

Procedure

1. Unscrew 1 M3x6-10.9-A2K TORX screw from the cover over the toothed belt.

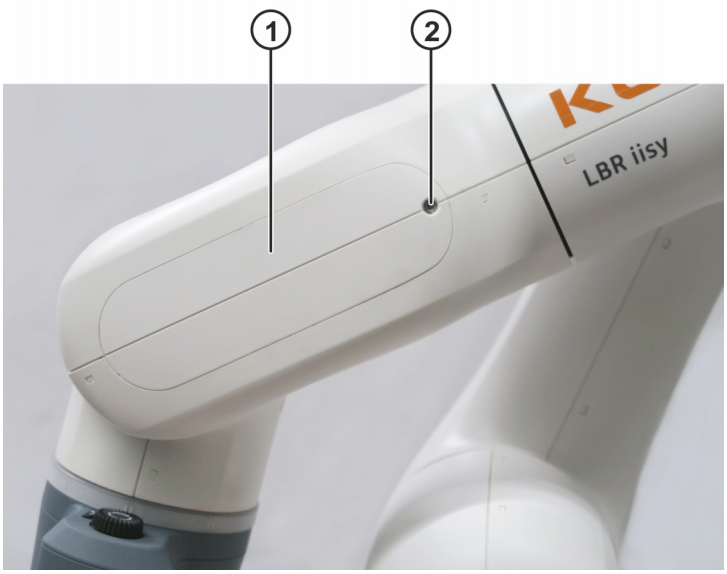


Fig. 9-10: Cover over toothed belt

1 Cover
2 M3x6-10.9-A2K TORX screw

2. Remove the cover.
3. Release the snap connection between the two shells by carefully levering it open with a flat-blade screwdriver.

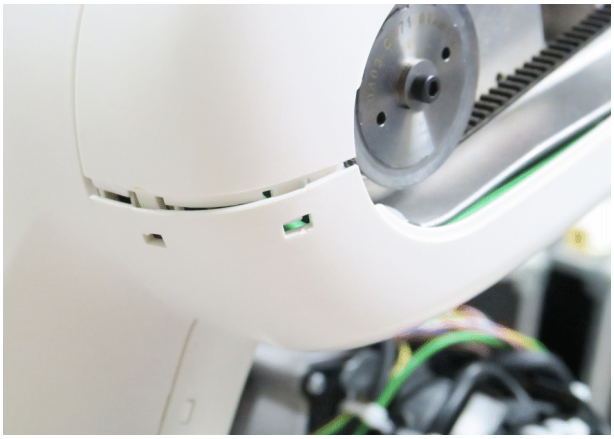


Fig. 9-11: Releasing the snap connection between the shells

4. Take off the loose shell.
5. Unscrew 3 PT K30x10-10.9-A3K TORX screws from the second shell.

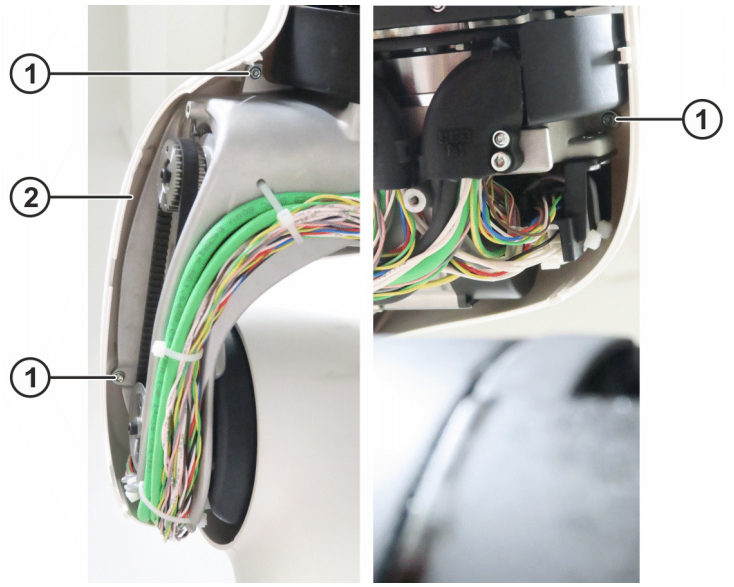


Fig. 9-12: Fastening of the second shell to the arm at axis 4

1 K30x10-10.9-A3K TORX screw (3x)
2 Shell

6. Take off the second shell.

9.1.5 Removing shells from the swivel housing

Procedure

1. Unscrew 1 M3x6-10.9-A2K TORX screw from the shell on the swivel housing.

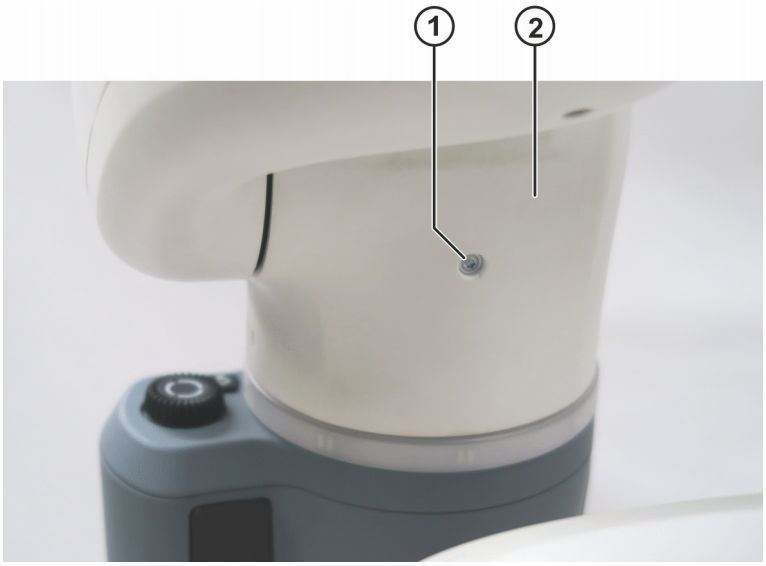


Fig. 9-13: Shell with screw outside, swivel housing

1 M3x6-10.9-A2K TORX screw
2 Shell

2. Release the snap connection between the two shells by carefully levering it open with a flat-blade screwdriver.

Fig. 9-14: Releasing the snap connection

1 Flat-blade screwdriver

3. Unscrew 3 PT K30x10-10.9-A3K TORX screws from the second shell.

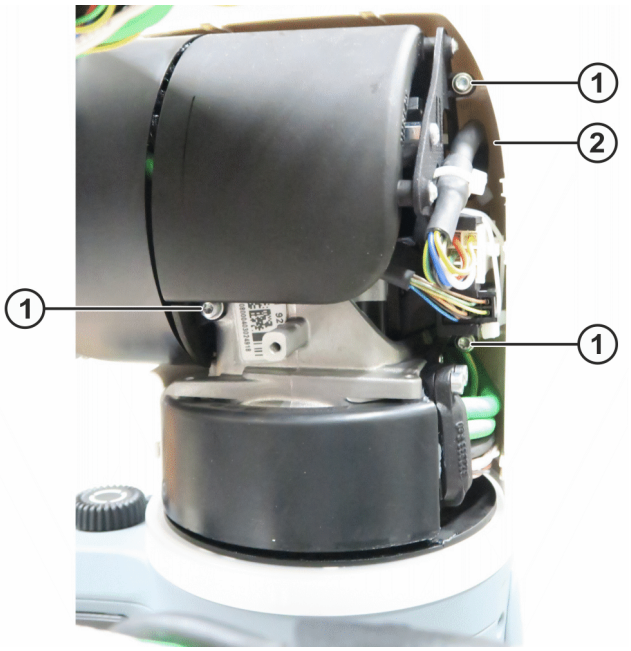


Fig. 9-15: Shell with screws inside, swivel housing

1 PT K30x10-10.9-A3K TORX screw (3x)
2 Shell

4. Take off the second shell.

9.1.6 Installing shells on the rotating column

Procedure

1. Position the shell and fasten it with 3 PT K30x10-10.9-A3K TORX screws.
   Tighten the screws with the specified torque.

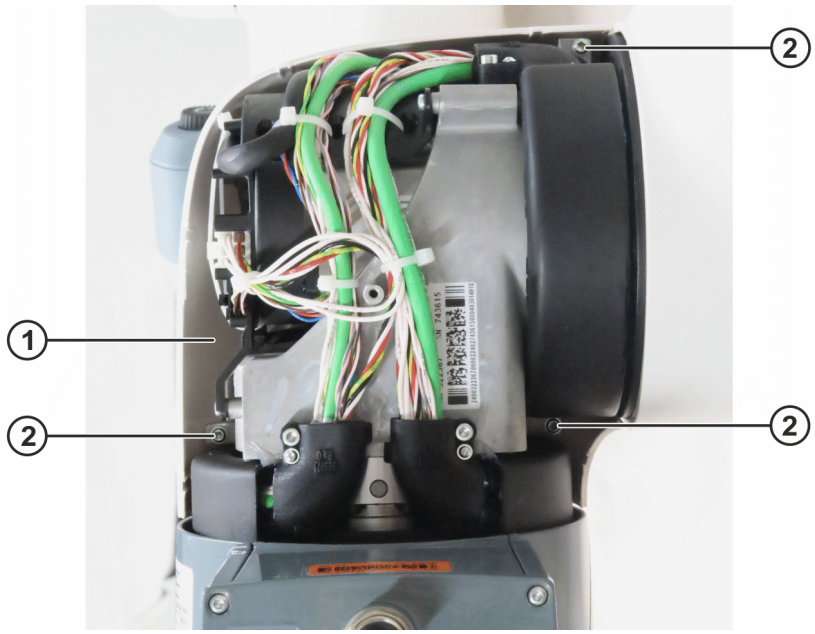


Fig. 9-16: Shell with screws inside, rotating column

1 Shell
2 PT K30x10-10.9-A3K TORX screw (3x)

2. Push the second shell onto the installed shell until it clicks into place.
3. Fasten the second shell with 1 M3x6-8.8-A2K TORX screw.
   Tighten the screw with the specified torque.

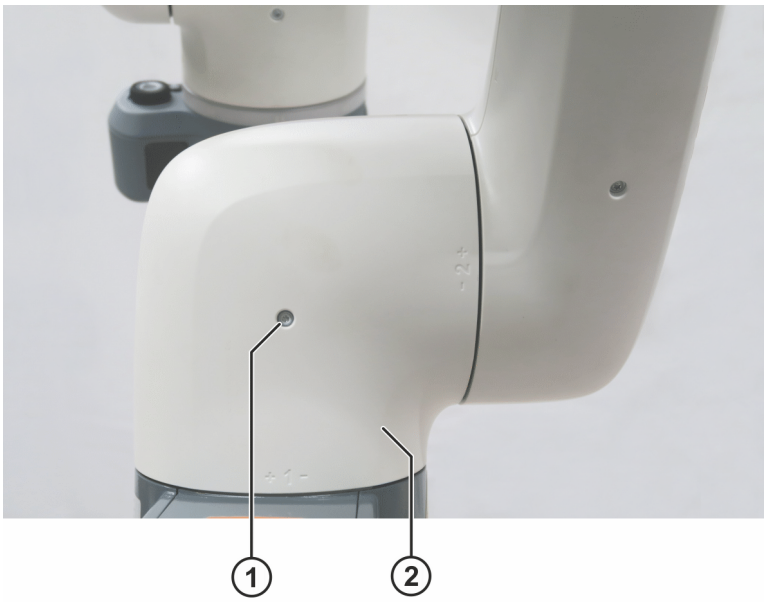


Fig. 9-17: Shell with screw outside, rotating column

1 M3x6-8.8-A2K TORX screw
2 Shell

9.1.7 Installing shells on the link arm

Procedure

1. Position the shell and fasten it with 6 K30x10-10.9-A3K TORX screws.

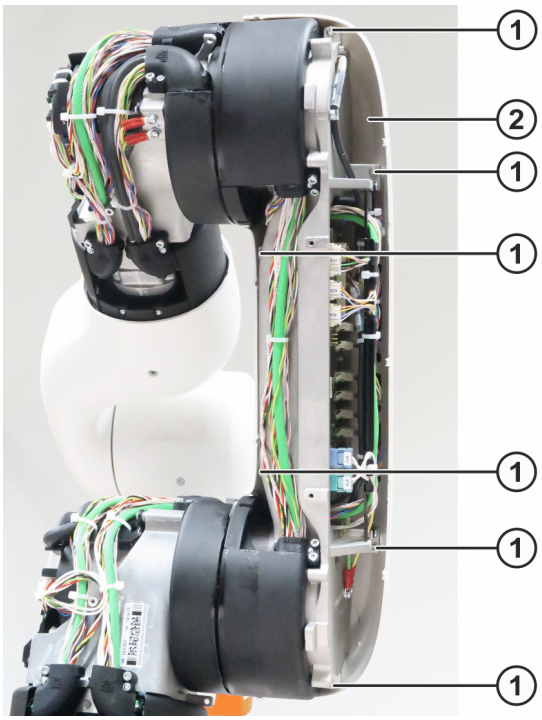


Fig. 9-18: Shell with screws inside, link arm

1	PT K30x10-10.9-A3K TORX screw (6x)
2	Shell

2. Push the second shell onto the installed shell until it clicks into place.
3. Fasten second shell with 2 M3x6-10.9-A2K TORX screws.
   Tighten the screws to the specified torque.

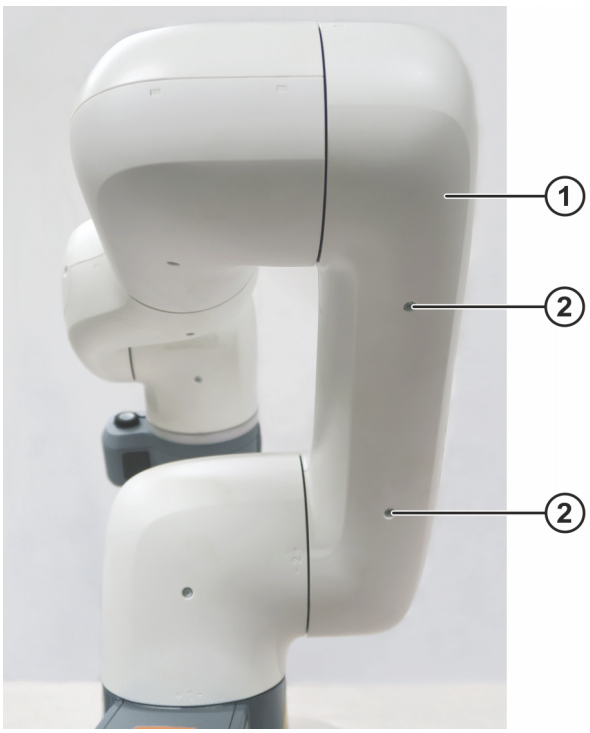


Fig. 9-19: Shell with screws outside, link arm

1	Shell
2	M3x6-10.9-A2K TORX screw (2x)

9.1.8 Installing shells on the arm at axis 3

Procedure

1. Position the shells and fasten them to the arm with 3 PT K30x10-10.9-A3K TORX screws.
   Tighten the screws with the specified torque.

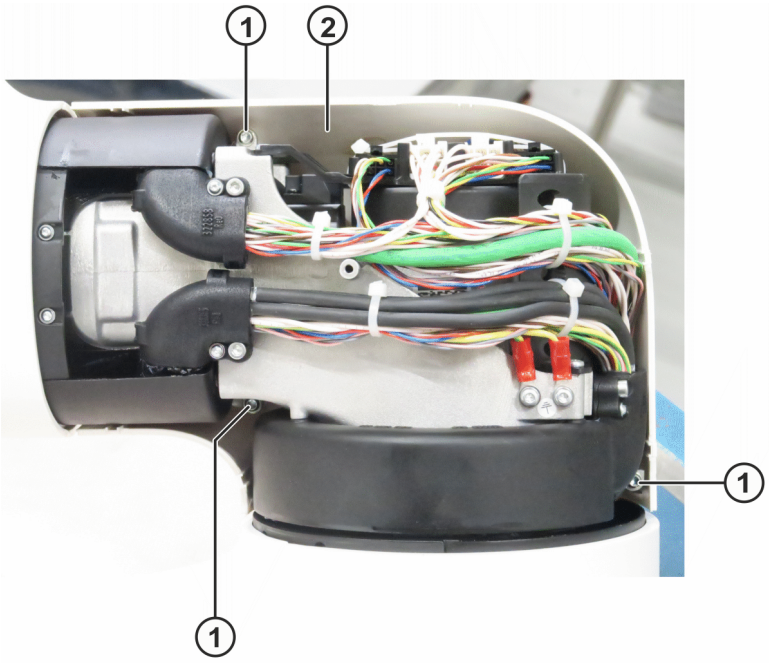


Fig. 9-20: Shell with screws inside, arm at axis 3

1	PT K30x10-10.9-A3K TORX screw (3x)
2	Shell

2. Push the second shell onto the installed shell until it clicks into place.
3. Fasten the second shell with 1 M3x6-10.9-A2K TORX screw.
   Tighten the screw with the specified torque.

Fig. 9-21: Shell with screw outside, arm at axis 3

1	Shell
2	M3x6-10.9-A2K TORX screw

9.1.9 Installing shells on the main body

Procedure

1. Position the shell and fasten it to the main body with 3 PT K30x10-10.9-A3K TORX screws.
   Tighten the screws to the specified torque.

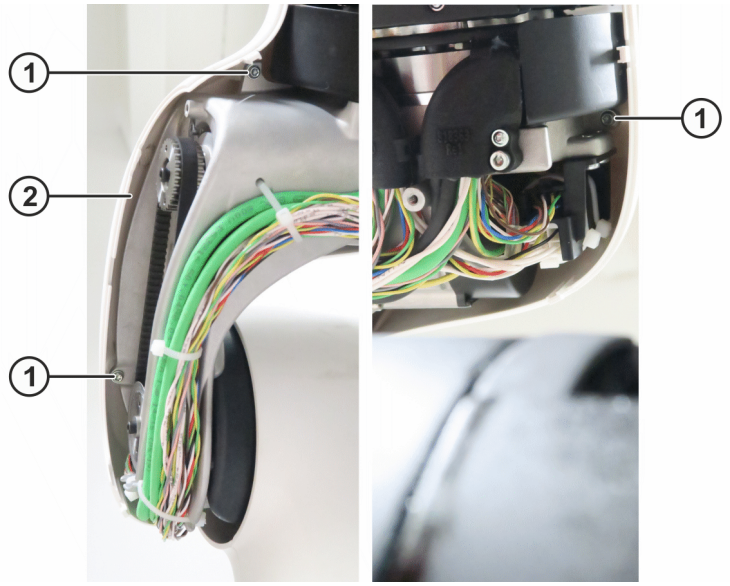


Fig. 9-22: Fastening of the second shell to the arm at axis 4

1	K30x10-10.9-A3K TORX screw (3x)
2	Shell

2. Push the second shell onto the installed shell until it clicks into place.
3. Position the toothed belt cover and fasten it with 1 M3x6-10.9-A2K TORX screw.
   Tighten the screw to the specified torque.

Fig. 9-23: Cover over toothed belt

1	Cover
2	M3x6-10.9-A2K TORX screw

9.1.10 Installing shells on the swivel housing

Procedure

1. Position the shell and fasten it with 3 PT K30x10-10.9-A3K TORX screws.
   Tighten the screws to the specified torque.

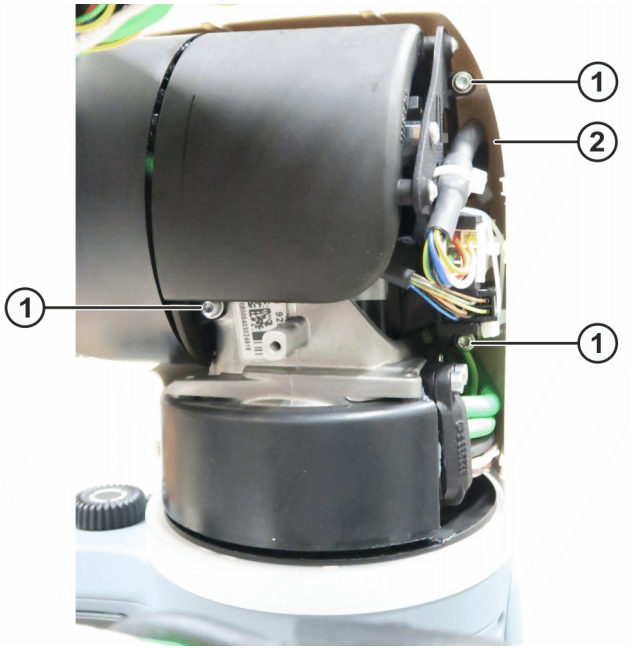


Fig. 9-24: Shell with screws inside, swivel housing

1	PT K30x10-10.9-A3K TORX screw (3x)
2	Shell

2. Push the second shell onto the installed shell until it clicks into place.
3. Fasten shell with 1 M3x6-10.9-A2K TORX screw.
   Tighten the screw to the specified torque.

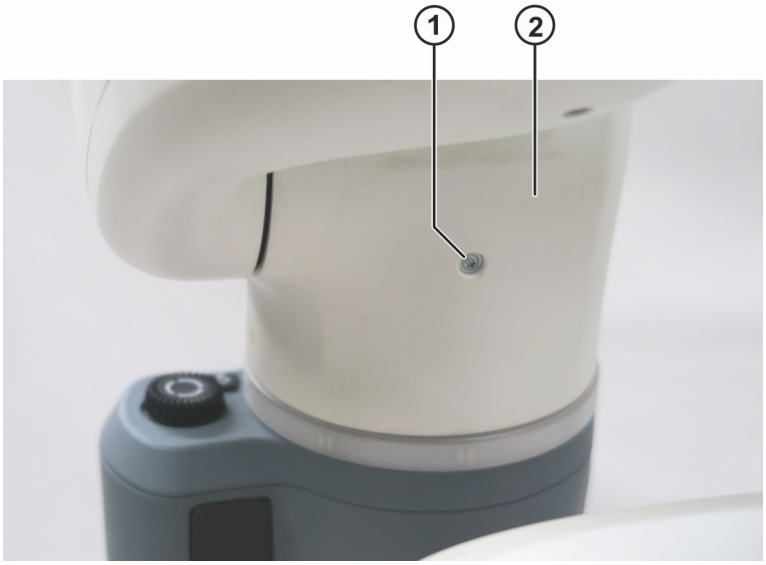


Fig. 9-25: Shell with screw outside, swivel housing

1 M3x6-10.9-A2K TORX screw
2 Shell

9.1.11 Concluding work

The following concluding work must be carried out:

- Run the program in T1 mode and look out for irregularities.

10 Decommissioning, storage and disposal

10.1 Decommissioning

Description

This section describes all the work required for decommissioning the robot if the robot is to be removed from the system. After decommissioning, it is prepared for storage or for transportation to a different location.

Equipment

The following equipment is required:

Designation	Article number
Set of Allen keys 1.5; 2; 2.5; 3; 4; 5; 6; 8; 10 mm	-

Precondition

- There is no hazard posed by system components.

Work safety

WARNING

Danger to life and limb due to unintended robot motions
When carrying out the following work, the robot must be moved several times between the individual work steps. Unintentional movements of the robot can cause death, serious injury or material damage.

- While work is being carried out on the robot, it must always be secured by actuating the EMERGENCY STOP device.
- If work is carried out on an operational robot that is switched on, the robot must only be moved at reduced velocity. It must be possible to stop the robot at any time by actuating an EMERGENCY STOP device. Operation must be limited to what is absolutely necessary.
- Warn all persons concerned before switching on and moving the robot.

10.1.1 Moving the robot into its transport position

Procedure

1. Secure the robot by pressing the EMERGENCY STOP device.
2. Remove tools and equipment.
3. Put the robot into operation and move it into the transport position .

A1	A2	A3	A4	A5	A6
0 °	-115 °	140 °	0 °	50 °	0 °

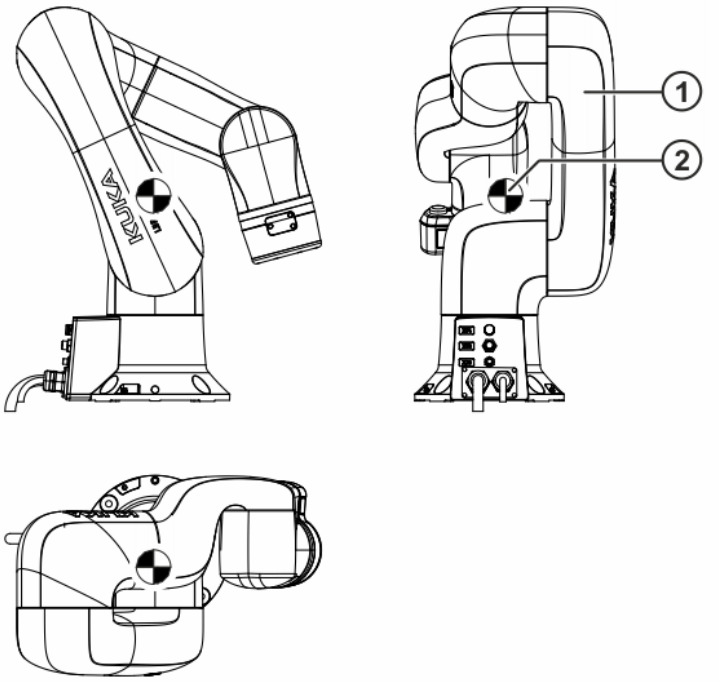


Fig. 10-1: Transport position

1	Robot	2	Center of gravity

4. Secure the robot by activating the EMERGENCY STOP device and then shut down the robot.

10.1.2 Removing the robot

Procedure

1. Release and disconnect the peripheral connections.
2. Release and disconnect the motor cable and data cable connectors.
3. Unscrew the M8 hexagon nut from the ground conductor, take off the washers and lock washers and pull off the ground conductor.
4. Unscrew 4 M8x30-8.8-A2K hexagon bolts.
5. Lift the robot vertically off the mounting surface using a crane or fork lift truck and transport it away.

   Take care not to damage the two pins when lifting off the robot.

CAUTION

Risk of injury due to abrupt detachment of the robot
If the robot is caught on the mounting surface, it may come free abruptly. Injuries or damage to property may result.
- Remove the fastening materials completely.
- Remove any adhesives.

10.1.3 Concluding work

The following concluding work must be carried out:

- Prepare the robot for storage if the robot is not to be reinstalled.

10.2 Storage

Description

For storage, the robot must be removed, cleaned and suitably covered.

Storage location

The storage location must meet the following requirements:

- Virtually dry and free of dust
- Avoid temperature fluctuations
- Avoid wind and drafts
- Avoid condensation
- No exposure to direct sunlight
- Maintain the permissible temperature ranges for storage
- The packaging film cannot be damaged.

Equipment

The following equipment is required:

Designation	Article number
Transport packaging with the following dimensions: • Length: 800 mm • Width: 600 mm • Height: 620 mm	-
Torque wrench min. 2 to 20 Nm	-
Permissible cleaning tools (e.g. cloths, brushes)	-

Material

The following material is required:

Designation	Article number	Quantity
Covers that cannot detach themselves and which can withstand the expected environmental conditions	-	-
Cleaning agent solvent-free, water-soluble, non-flammable, non-aggressive, no steam, no refrigerants	-	-

Precondition

- Loose parts or parts that might knock against other parts have been removed from the robot.
- Tools and equipment have been removed.

Work safety

WARNING

Danger to life and limb due to unintended robot motions
Unintended robot motions may result in death, severe injuries and damage to property.

- Secure the robot by pressing the EMERGENCY STOP device.
- Warn all persons concerned before starting to put it back into operation.

10.2.1 Moving the robot into its transport position

Procedure

1. Secure the robot by pressing the EMERGENCY STOP device.
2. Remove tools and equipment.
3. Put the robot into operation and move it into the transport position.
4. Secure the robot by activating the EMERGENCY STOP device and then shut down the robot.

Transport position	
A1	0 °
A2	-115 °
A3	140 °
A4	0 °
A5	50 °
A6	0 °

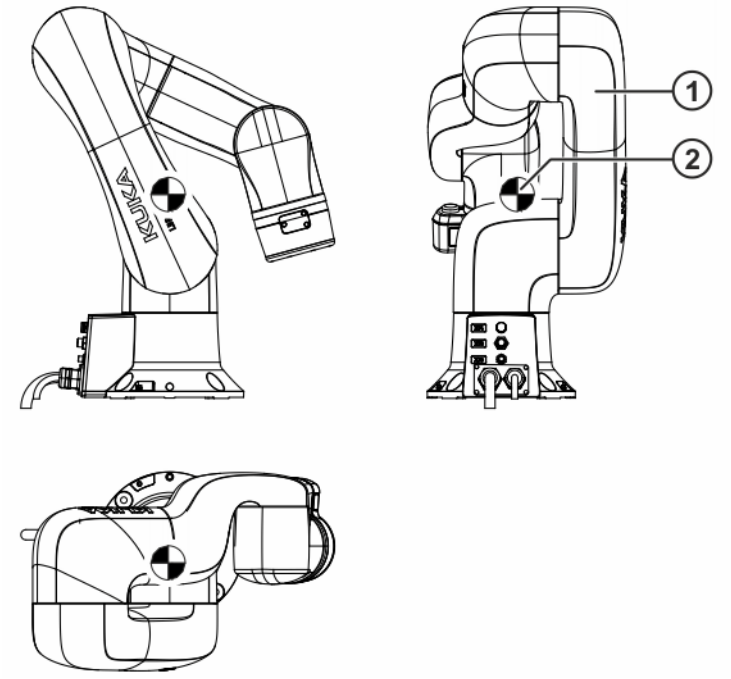


Fig. 10-2: Transport position

1 Robot 2 Center of gravity

10.2.2 Removing the robot

Procedure

1. Release and disconnect the peripheral connections.
2. Release and disconnect the motor cable and data cable connectors.
3. Unscrew the M8 hexagon nut from the ground conductor, take off the washers and lock washers and pull off the ground conductor.
4. Unscrew 4 M8x30-8.8-A2K hexagon bolts.
5. Lift the robot vertically off the mounting surface using a crane or fork lift truck and transport it away.

   Take care not to damage the two pins when lifting off the robot.

CAUTION

Risk of injury due to abrupt detachment of the robot
If the robot is caught on the mounting surface, it may come free abruptly. Injuries or damage to property may result.

- Remove the fastening materials completely.
- Remove any adhesives.

10.2.3 Cleaning

Procedure

1. Shut down the robot.
2. If necessary, shut adjacent system components down and lock them.
3. Remove enclosures if this is necessary in order to carry out the cleaning work.
4. Clean the robot.
5. Fully remove all cleaning agents from the robot.
6. Clean any areas of corrosion and reapply corrosion protection.
7. Install any safety equipment that has been removed.
8. Put back in place any enclosures that have been removed.

10.2.4 Preparing for storage

Procedure

1. Perform a visual inspection of the robot.
2. Remove any foreign bodies.
3. Remove any corrosion.
4. Attach all covers to the robot and check that the seals are correctly in place.
5. Seal off electrical connections with suitable covers.
6. Seal hose connections by suitable means.
7. Cover the robot with plastic film and seal it at the base frame against dust.

   If necessary, add a desiccant beneath the sheeting.

10.2.5 Concluding work

No concluding work is required.

10.3 Disposal

When the manipulator reaches the end of its useful life, it can be removed from the system and dismantled, and the materials can be disposed of properly by type.

The following table provides an overview of the materials used in the manipulator. All plastic components are marked with a material designation and must be disposed of accordingly.

Material	Subassembly, component	Additional information
Metal		
Cast aluminum	Wrist, arm, link arm, rotating column	
Copper	Cables, wires	
Cast steel	Base frame	
Steel	Gear units, screws, washers, metal covers, stops	
Electrical parts		
	Electronic components, such as TPC, EDS, etc.	Dispose of as electrical scrap without disassembling
	Motors	Dispose of motors without dismantling them.
Plastics		
ABS	Enclosure panels, covers	
ETFE	Flexible tube	
FKM	Shaft sealing rings	
NBR	O-rings	
PA	Hinged clamps	
PE	End stop buffers	
PU	Hoses	
PUR	Cable sheaths	
Auxiliary substances and consumables		
Adhesive and sealant	Base frame, rotating column, link arm	Adhesive and sealant Drei Bond type 1305
	Rotating column, arm, in-line wrist	Adhesive and sealant Drei Bond type 1342
	Base frame, rotating column, link arm, arm, in-line wrist	Adhesive and sealant Drei Bond 5204HV
Lubricating grease	Gear units	Sumiplex SFB No.1 lubricating grease
	Gear teeth	Microlube GL 261 grease
	Cabling	Lubricating grease Optitemp RB2

Up-to-date safety data sheets must be requested from the manufacturers of auxiliary and operating materials. Further information about the auxiliary substances and consumables used can be found under:

11 Options

11.1 Gripper and finger set (optional)

Description

The gripper is a servo-electric 2-finger parallel gripper and is mounted on the flange. The fingers of the gripper are driven by motors and close centrically. Two adjustable finger sets are included in the scope of supply for trial operation.

The gripper requires a 24 V supply voltage as well as 2 inputs and 2 outputs on the control side. These are provided by the KR C5 micro controller via connections XG 12 and XD 12. The optional I/O connecting cable (>>> *11.5 "Connecting cables (optional)" Page 122*) and the optional 24 V desktop power supply can be used for the connection.

Further information about the 24 V desktop power supply can be found in the **24 V desktop power supply** documentation.

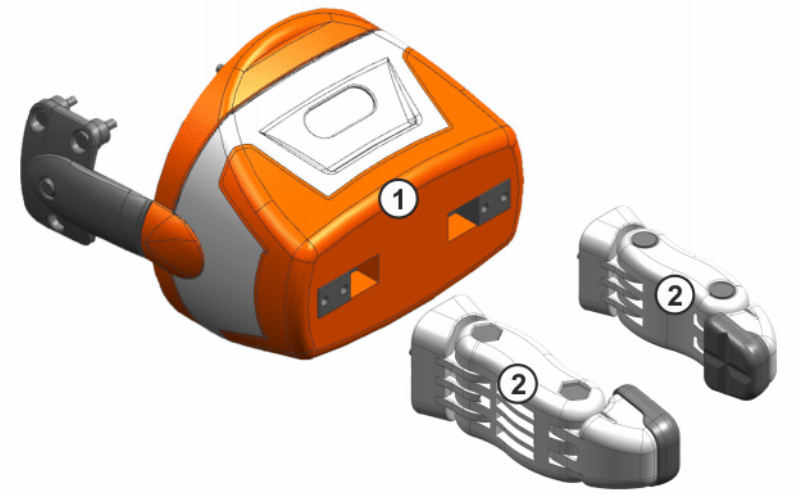


Fig. 11-1: Gripper and finger set (optional)

Further information about the gripper can be found in the **gripper** documentation.

Further information is contained in the operating and assembly instructions of the robot controller.

Basic data

Designation	Article number	Weight
Gripper Co-Act ESG-C K060	0000-334-951	approx. 0.5 kg
Finger set Co-Act ESG-C K060 finger set	0000-334-931	approx. 0.05 kg

Further information about the ambient conditions is contained in the assembly instructions for the robot and robot controller.

The clamping force of the gripper is inherently safely limited. The gripper stroke and the maximum clamping force are specified in the supplier documentation of the gripper. The safety concept of the machine is defined

on the basis of the risk assessment to be created by the system integrator.

Start-up and recommissioning

The gripper documentation must be read and understood before initial start-up.

Maintenance

Further information about the gripper can be found in the **gripper** documentation.

Repair

(>>> *11.1.1 "Exchanging the gripper" Page 106*)

11.1.1 Exchanging the gripper

Description

The following instructions describe the procedure for exchanging the optional gripper.

Further information about the gripper can be found in the **gripper** documentation.

Equipment

The following equipment is required:

Designation	Article number
Set of Allen keys 1.5; 2; 2.5; 3; 4; 5; 6; 8; 10 mm	-
Set of TORX key wrenches TX5; TX6; TX7; TX8; TX9; TX10; TX15; TX20; TX25; TX27; TX30; TX40; TX45; TX55	-

Material

The following material is required:

Designation	Article number	Quantity
Gripper Co-Act ESG-C K060	0000-334-951	1

Procurement of spare parts

Defective components must only be replaced with original spare parts from KUKA Deutschland GmbH. Non-compliance nullifies warranty and liability claims.

A “Repair Card” is supplied with the exchange parts. This must be completed and returned to KUKA Deutschland GmbH together with the defective component in the following cases.

- Within the warranty period
- If, after consultation with KUKA Deutschland GmbH, an examination of the defective component by KUKA is required.

Tightening torques

The tightening torques can be found under: (>>> *12.1 "Tightening torques" Page 125*)

These are valid for screws and nuts where no other specifications are given.

Screws of strength class 10.9 and higher as well as screws with test certification may only be tightened once with the rated tightening torque. When the screws are first slackened they must be replaced with new ones.

Precondition

- The robot controller is switched off and secured to prevent unauthorized persons from switching it on again.
- All power cables and connecting cables to the robot are unplugged.

Work safety

WARNING

Danger to life and limb due to live components
Components may remain energized after the robot system has been switched off. Death, severe injuries or damage to property may result.

- Switch off the robot system at the main switch and secure it to prevent unauthorized persons from switching it on again.
- Disconnect the power cable from the supply.
- After switching off, wait at least 5 minutes and then check to ensure that the robot controller and power cable are deenergized.

11.1.1.1 Removing the push-in connector module from the Commander

Procedure

1. Unscrew 3 M3x8-8.8 Allen screws and 1 PT 30-12 TORX screw from the push-in connector module.

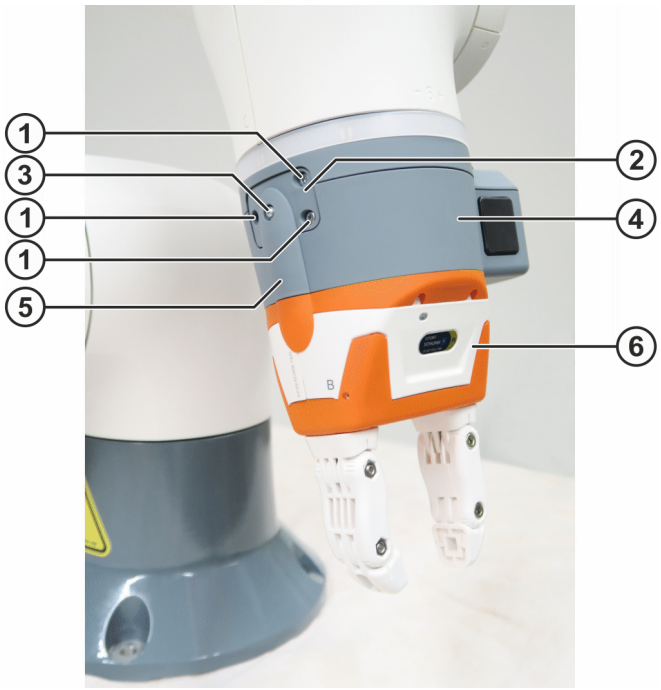


Fig. 11-2: Push-in connector module of Commander

1	M3x8-8.8 Allen screw (3x)
2	Push-in connector module
3	PT 30-12 TORX screw
4	Commander
5	Cover for gripper connecting cable
6	Gripper

2. Remove cover from the connecting cable.
3. Carefully pull out the push-in connector module, disconnecting cables X94 and X96.

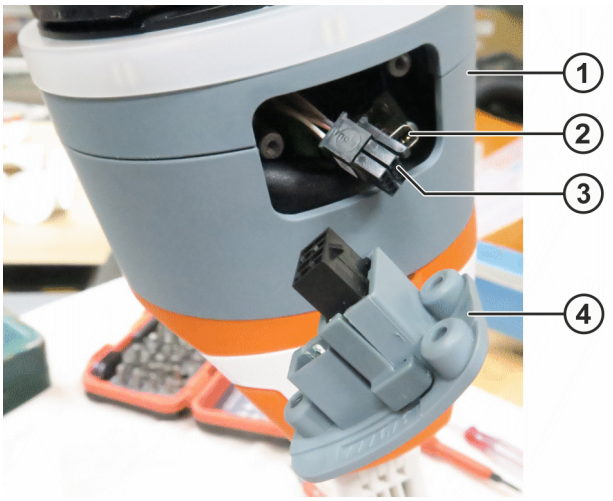


Fig. 11-3: Gripper connection

1	Commander
2	Connection X94, Gigabit interface (CAT5e)
3	Connection X96, I/O power supply
4	Push-in connector module

11.1.1.2 Removing the gripper

Procedure

1. Unscrew 4 M3x8-8.8 Allen screws from the gripper.

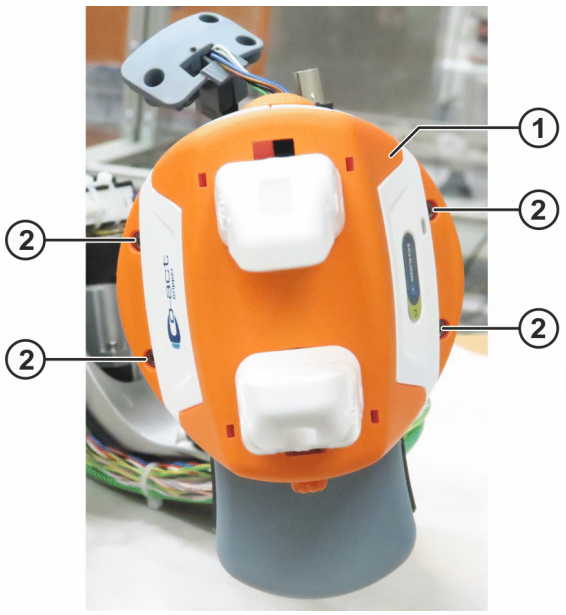


Fig. 11-4: Gripper fastening

1	Gripper
2	M3x8-8.8 Allen screw (4x)

2. Carefully remove the gripper.

11.1.1.3 Installing the gripper

Procedure

- Mount the gripper and fasten it with 4 M3x8-8.8 Allen screws; tightening torque M_A= 1.1 Nm.

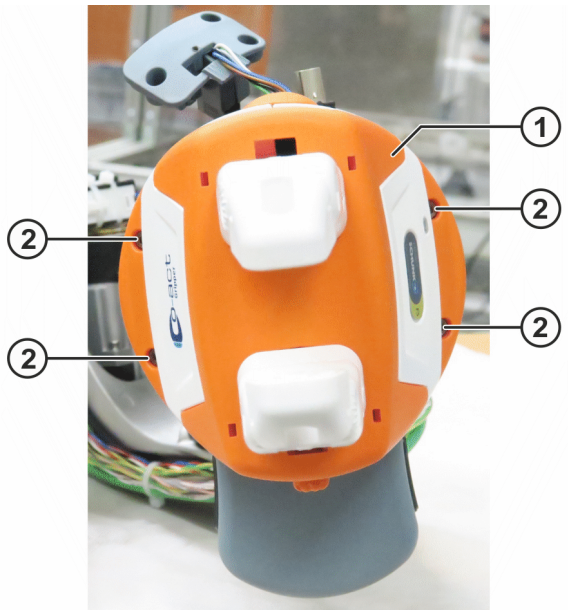


Fig. 11-5: Gripper fastening

1 Gripper
2 M3x8-8.8 Allen screw (4x)

11.1.1.4 Installing the push-in connector module on the Commander

Procedure

1. Plug cables X94 and X96 into the push-in connector module.

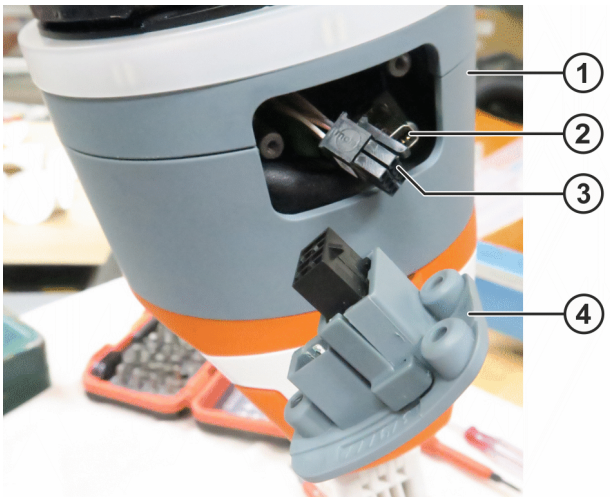


Fig. 11-6: Gripper connection

1 Commander
2 Connection X94, Gigabit interface (CAT5e)
3 Connection X96, I/O power supply
4 Push-in connector module

2. Insert the push-in connector module and fasten it to the Commander with 3 M3x8 Allen screws; tightening torque: 1.1 Nm.

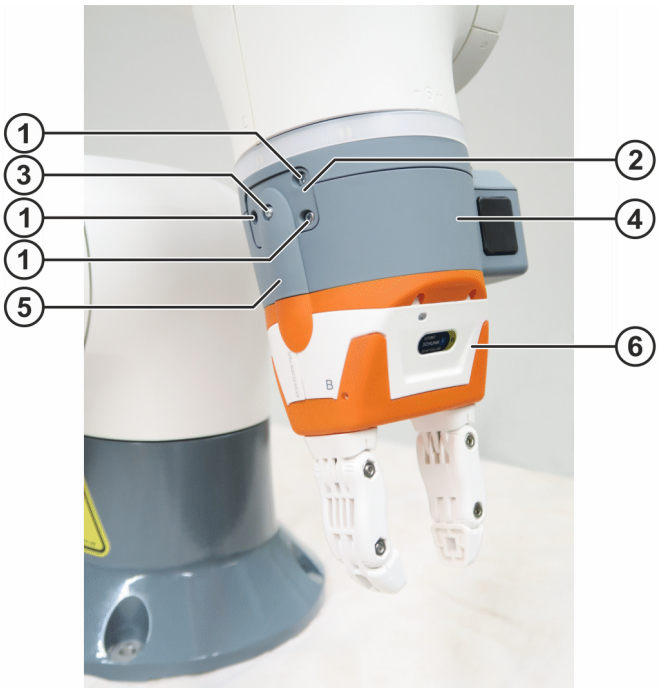


Fig. 11-7: Push-in connector module of Commander

1	M3x8-8.8 Allen screw (3x)
2	Push-in connector module
3	PT 30-12 TORX screw
4	Commander
5	Cover for gripper connecting cable
6	Gripper

3. Mount the cover of the connecting cable and fasten it to the push-in connector module with 1 PT 30-12 TORX screw; tightening torque M_A= 0.3 Nm.

11.1.1.5 Concluding work

The following concluding work must be carried out:

- Run the program in T1 mode and look out for irregularities.
- Test the function of the gripper.

11.2 Output flange (optional)

Description

The output flange allows an ISO standard hole pattern so that, for example, a customer-specific tool can be mounted.

The output flange is pre-installed if the gripper Schunk Co-Act Easy Gripper is not included in the scope of supply of the manipulator. If the manipulator is delivered with the gripper mounted, the flange is included separately in the scope of supply.

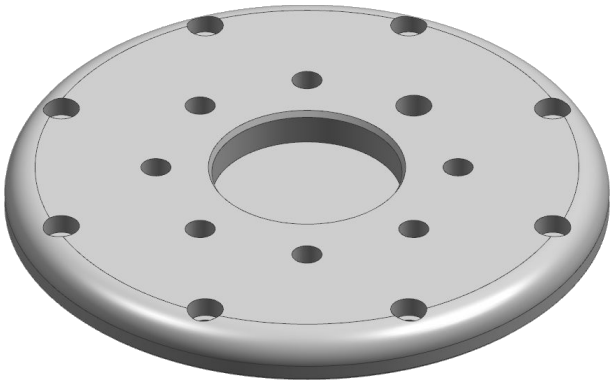


Fig. 11-8: Output flange (optional)

Basic data

Designation	Article number	Weight
ISO-Flange ISO 9409 with screws	0000-335-995	approx. 0.11 kg

Further information about the ambient conditions is contained in the assembly instructions for the robot and robot controller.

The output flange can be omitted in order to improve the payload and the load center distance.

Dimensions

Robot wrist type	ZH
Mounting flange standard	ISO 9409-1-50-7-M6

Output flange (hole circle)	50 mm
Screw grade	12.9
Screw size	M6
Number of fastening screws	7
Clamping length	min. 1.5 x nominal diameter
Depth of engagement	min. 5.5 mm, max. 6 mm
Locating element	6^{H7}

The ISO flange (>>> *Fig. 11-9*) is depicted with axis 6 in the zero position. The symbol X_m indicates the position of the locating element in the zero position.

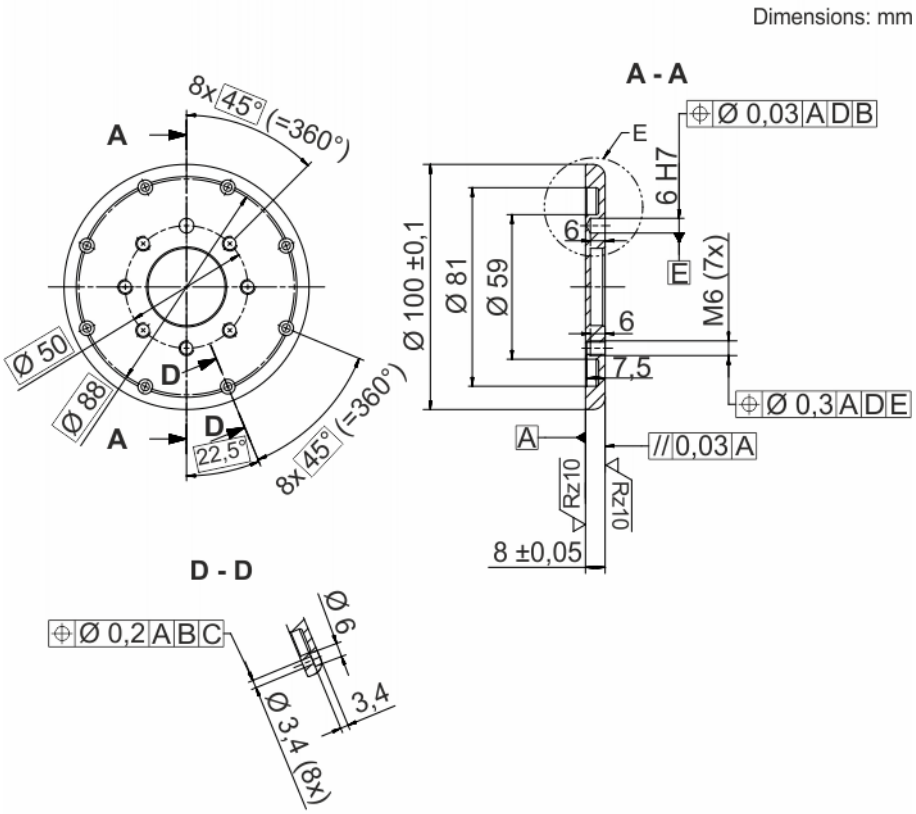


Fig. 11-9: Output flange (optional)

Transportation

The components must be suitably and properly packaged prior to transportation. The components must be protected against damage with shock-resistant and break-proof packaging.

The following measures are to be taken before assemblies and individual components are transported:

- Clean components.
- Assign small parts to their respective components in plastic bags to prevent them from getting lost.
- Protect components against impacts and slipping; fill gaps with suitable approved padding materials.

Mark transport cases and packing according to the sensitivity of their contents (e.g. TOP, FRAGILE, DO NOT BEND) and attach labels to ensure correct transportation (e.g. indication of center of gravity). In addition to these measures, the regulations and conditions of the company entrusted with the transportation are to be observed.

Maintenance

If used for its intended purpose, the option requires minimal maintenance, i.e. visual inspections are recommended. In certain operating conditions, regular visual inspections may allow timely detection of changes. The nature and scope of the maintenance work depend very much on the specific area of application. This enables early detection of damage, thereby preventing failure of components and assemblies. Exchange damaged components or assemblies.

Repair

(>>> *11.2.1 "Exchanging the output flange" Page 114*)

11.2.1 Exchanging the output flange

Description

The following instructions describe the procedure for exchanging the output flange.

Equipment

The following equipment is required:

Designation	Article number
Set of Allen keys 1.5; 2; 2.5; 3; 4; 5; 6; 8; 10 mm	-
Torque wrench min. 20 Nm to 100 Nm	-

Material

The following material is required:

Designation	Article number	Quantity
SPP flange	0000-332-498	1

Procurement of spare parts

Defective components must only be replaced with original spare parts from KUKA Deutschland GmbH. Non-compliance nullifies warranty and liability claims.

A “Repair Card” is supplied with the exchange parts. This must be completed and returned to KUKA Deutschland GmbH together with the defective component in the following cases.

- Within the warranty period
- If, after consultation with KUKA Deutschland GmbH, an examination of the defective component by KUKA is required.

Tightening torques

The tightening torques can be found under: (>>> *12.1 "Tightening torques" Page 125*)

These are valid for screws and nuts where no other specifications are given.

Screws of strength class 10.9 and higher as well as screws with test certification may only be tightened once with the rated tightening torque. When the screws are first slackened they must be replaced with new ones.

Precondition

- The robot controller is switched off and secured to prevent unauthorized persons from switching it on again.

Work safety

WARNING

Danger to life and limb due to live components
Components may remain energized after the robot system has been switched off. Death, severe injuries or damage to property may result.

- Switch off the robot system at the main switch and secure it to prevent unauthorized persons from switching it on again.
- Disconnect the power cable from the supply.
- After switching off, wait at least 5 minutes and then check to ensure that the robot controller and power cable are deenergized.

11.2.1.1 Removing the output flange

Procedure

1. Unscrew 8 M3x10-8.8-A2K Allen screws from the Commander.
2. Remove the output flange.
3. Take the 2 3x10-A-St dowel pins out of the output flange.

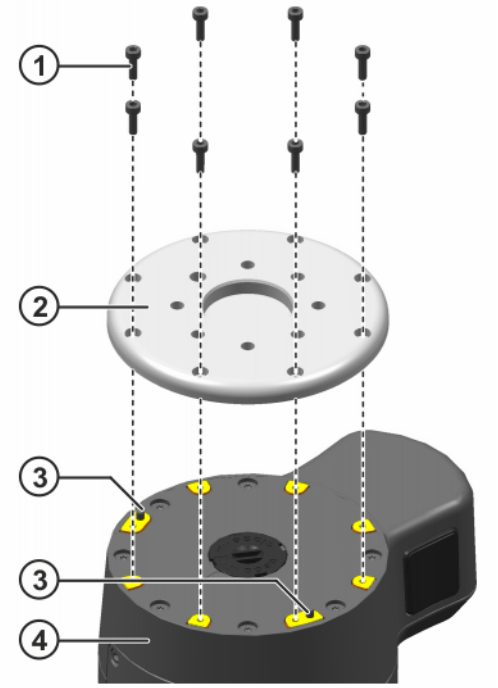


Fig. 11-10: Output flange

1	M3x10-8.8-A2K Allen screw (8x)
2	Output flange
3	3x10-A-St dowel pin
4	Commander

11.2.1.2 Installing the output flange

Procedure

1. Insert 2 3x10-A-St dowel pins into the holes provided for this purpose on the rear of the output flange.

2. Position the output flange on the Commander. When doing so, make sure that the dowel pins inserted in the output flange fit into the corresponding holes on the Commander.
3. Fasten the output flange using 8 M3x10-8.8-A2K Allen screws. Increase the tightening torque to the specified value in several stages.

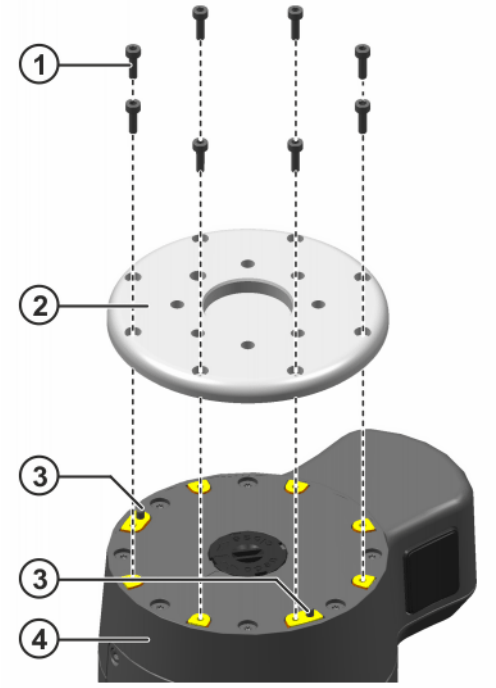


Fig. 11-11: Output flange

1	M3x10-8.8-A2K Allen screw (8x)
2	Output flange
3	3x10-A-St dowel pin
4	Commander

11.2.1.3 Concluding work

No concluding work is required.

11.3 Adapter for external centering (optional)

Description

The adapter for external centering can be mounted on the output flange if a tool with external centering is to be used.

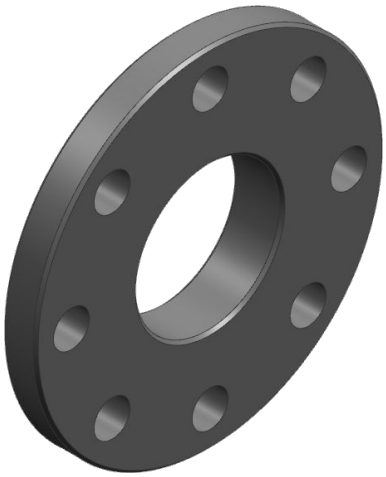


Fig. 11-12: Adapter for external centering (optional)

Basic data

Designation	Article number	Weight
Adapter for outer centering	0000-334-480	approx. 0.039 kg

Further information about the ambient conditions is contained in the assembly instructions for the robot and robot controller.

Dimensions

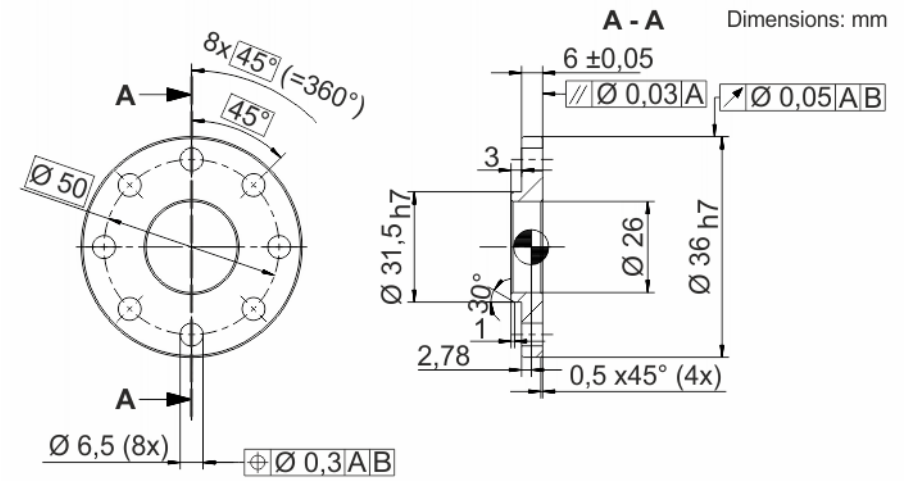


Fig. 11-13: Dimensions of adapter for external centering (optional)

Transportation

The components must be suitably and properly packaged prior to transportation. The components must be protected against damage with shock-resistant and break-proof packaging.

The following measures are to be taken before assemblies and individual components are transported:

- Clean components.
- Assign small parts to their respective components in plastic bags to prevent them from getting lost.
- Protect components against impacts and slipping; fill gaps with suitable approved padding materials.

Mark transport cases and packing according to the sensitivity of their contents (e.g. TOP, FRAGILE, DO NOT BEND) and attach labels to ensure correct transportation (e.g. indication of center of gravity). In addition to these measures, the regulations and conditions of the company entrusted with the transportation are to be observed.

Maintenance

If used for its intended purpose, the option requires minimal maintenance, i.e. visual inspections are recommended. In certain operating conditions, regular visual inspections may allow timely detection of changes. The nature and scope of the maintenance work depend very much on the specific area of application. This enables early detection of damage, thereby preventing failure of components and assemblies. Exchange damaged components or assemblies.

11.4 Connector bypack X94/X96 (optional)

Description

The connector bypack for external interface A6 contains Gigabit, I/O and power supply connections.

Fig. 11-14: Connector bypack X94/X96

Technical data

Designation	Article number	Weight
Plug package A6 GIG CTR	0000-325-201	approx. 0.1 kg

Further information about the ambient conditions is contained in the assembly instructions for the robot and robot controller.

Connection	Connector bypack with open breakout cable
CAT5e cable	4x2xAWG26 Bending radius: ≙ 18 mm for single bending ≙ 45 mm for continuous bending
I/O and power supply	8x 0.25 mm^2 Bending radius moving: 10x cable diameter fixed installation: 5x cable diameter
Cable length	0.5 m
Mating cycles	max. 50

Planning

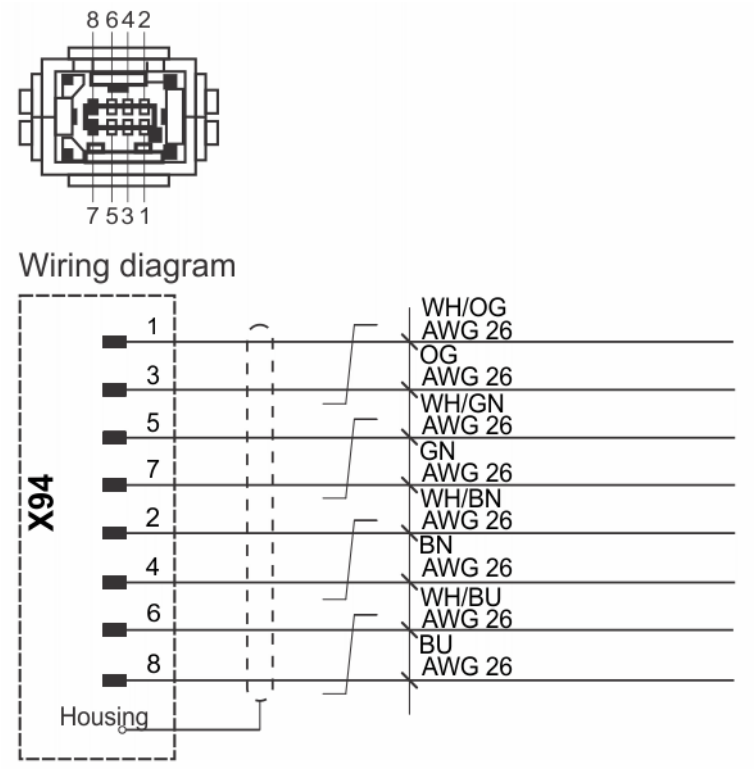


Fig. 11-15: Wiring diagram X94

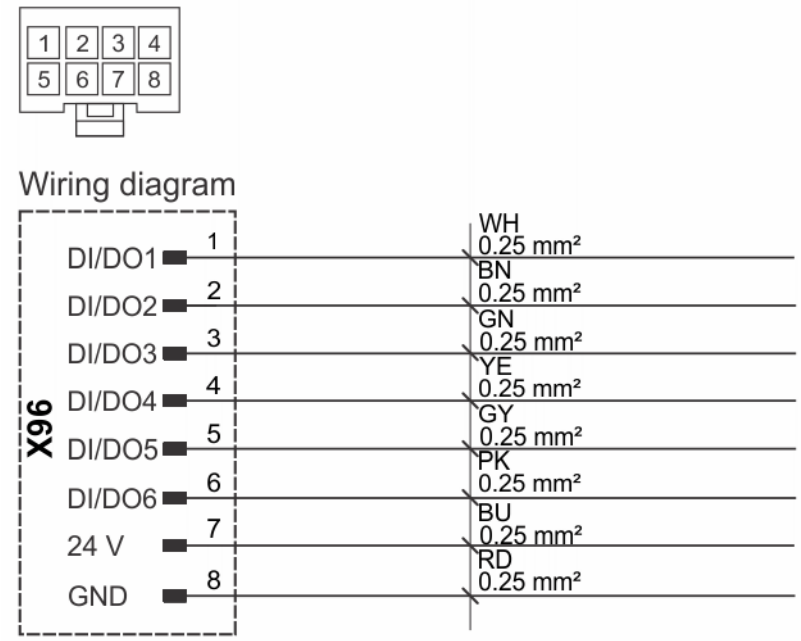


Fig. 11-16: Wiring diagram X96

DI/DOx and 24 V and GND specify the respective recommended functions of the cable.

Start-up and recommissioning

(>>> *11.4.1 "Putting connector bypack X94/X96 into operation" Page 120*)

Transportation

The components must be suitably and properly packaged prior to transportation. The components must be protected against damage with shock-resistant and break-proof packaging.

The following measures are to be taken before assemblies and individual components are transported:

- Clean components.
- Assign small parts to their respective components in plastic bags to prevent them from getting lost.
- Protect components against impacts and slipping; fill gaps with suitable approved padding materials.

Mark transport cases and packing according to the sensitivity of their contents (e.g. TOP, FRAGILE, DO NOT BEND) and attach labels to ensure correct transportation (e.g. indication of center of gravity). In addition to these measures, the regulations and conditions of the company entrusted with the transportation are to be observed.

Maintenance

If used for its intended purpose, the option requires minimal maintenance, i.e. visual inspections are recommended. In certain operating conditions, regular visual inspections may allow timely detection of changes. The nature and scope of the maintenance work depend very much on the specific area of application. This enables early detection of damage, thereby preventing failure of components and assemblies. Exchange damaged components or assemblies.

11.4.1 Putting connector bypack X94/X96 into operation

Description

The following instructions describe the installation of connector bypack X94/X96.

Equipment

The following equipment is required:

Designation	Article number
Set of Allen keys 1.5; 2; 2.5; 3; 4; 5; 6; 8; 10 mm	-
Torque wrench min. 5 Nm to 50 Nm	-

Material

The following material is required:

Designation	Article number	Quantity
Plug package A6 GIG CTR	0000-325-201	1

Tightening torques

The tightening torques can be found under: (>>> *12.1 "Tightening torques" Page 125*)

These are valid for screws and nuts where no other specifications are given.

Screws of strength class 10.9 and higher as well as screws with test certification may only be tightened once with the rated tightening torque. When the screws are first slackened they must be replaced with new ones.

Precondition

- The robot must be deenergized.

Work safety

WARNING

When routing the cables, attention must be paid to suitable strain and bending relief. The bending radii must be observed. Loose or freely suspended cables must be fastened. Failure to observe this may result in death, severe injuries or damage to property.

WARNING

If the connector bypack is removed, cover A6 must be fastened. The interface must not be left open. Failure to observe this may result in death, severe injuries or damage to property.

11.4.1.1 Fastening connector bypack X94/X96

Procedure

1. Unscrew 3 M3x8-8.8-A2K Allen screws from the cover of A6 and remove the cover (>>> *Fig. 11-17*).
2. Release and unplug connectors X94 and X96.
3. Plug connectors X94 and X96 into the connector bypack. Check whether the connectors are locked.
4. Fasten the connector bypack to the Commander with 3 M3x8-8.8-A2K Allen screws; tightening torque M_A= 0.5 Nm.
5. Cut off any cables that are not required with diagonal cutting pliers.

   NOTICE

   If a cable has been cut off, nothing may be connected to the corresponding connector of interface A1 and the wires must be protected against electrical contact. Failure to observe this precaution may result in a short-circuit.

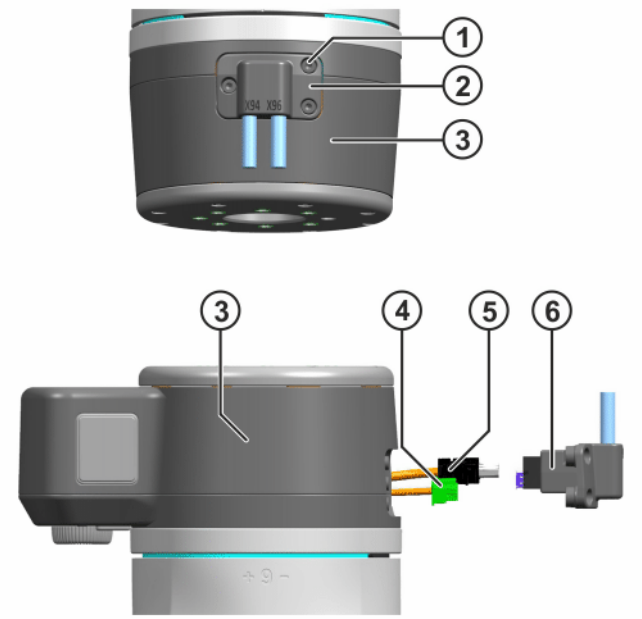


Fig. 11-17: Fastening the connector bypack

1	M3x8-8.8-A2K Allen screw
2	Cover A6
3	Commander
4	Connection X96, I/O power supply
5	Connection X94, Gigabit interface (CAT5e)
6	Connector bypack X94/X96

11.4.1.2 Concluding work

The following concluding work must be carried out:

- Carry out a test run in T1 mode and look out for irregularities.

11.5 Connecting cables (optional)

Description

The following connecting cables are optionally available for transferring signals between the robot and the robot controller.

- I/O connecting cable
  (>>> *Fig. 11-19*)
- Gigabit connecting cable
  (>>> *Fig. 11-20*)
- External ground conductor
  (>>> *Fig. 11-21*)

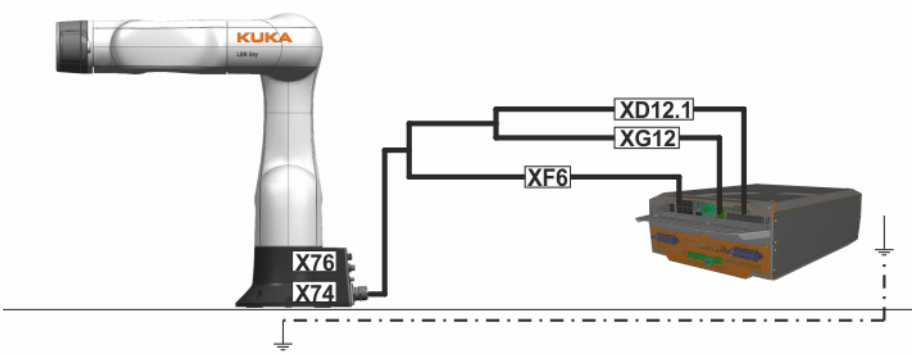


Fig. 11-18: Optional connecting cables, overview

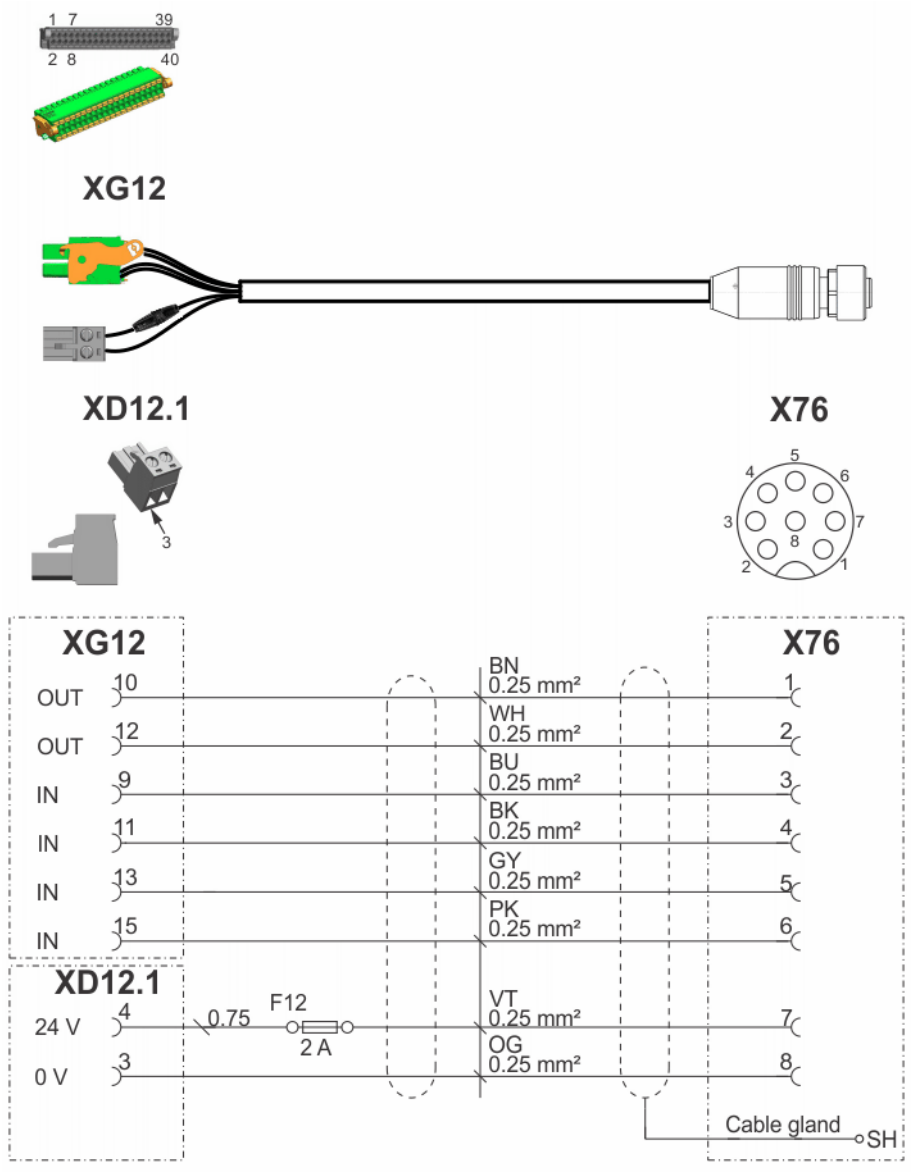


Fig. 11-19: Wiring diagram, connecting cable XG12/XD12.1 - X76

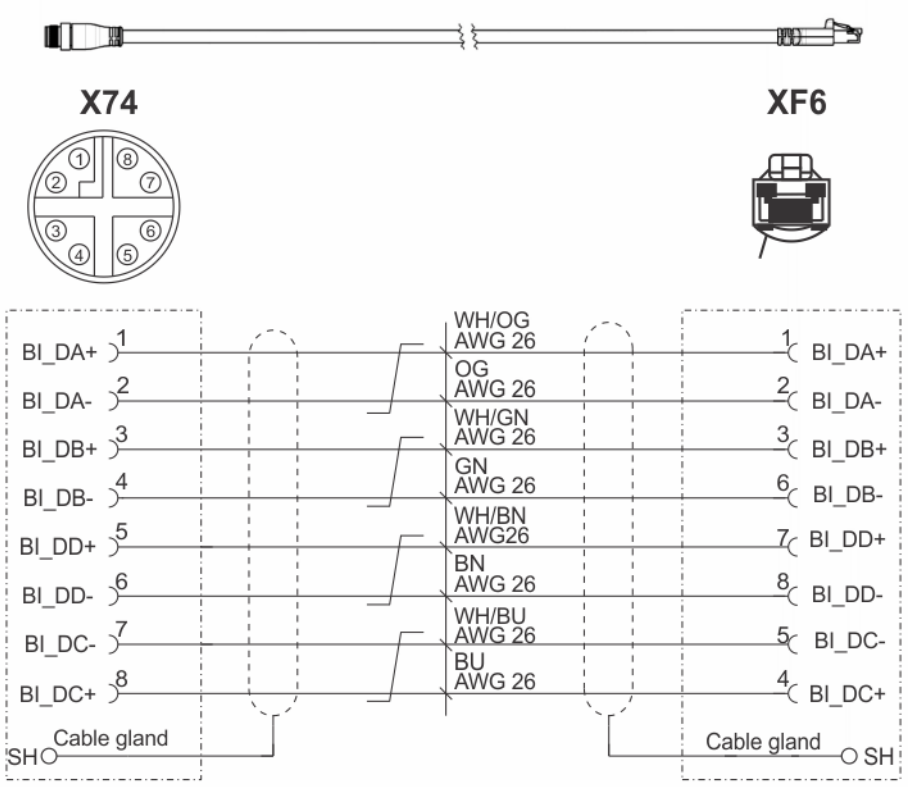


Fig. 11-20: Wiring diagram, Gigabit connecting cable, X74 - XF6

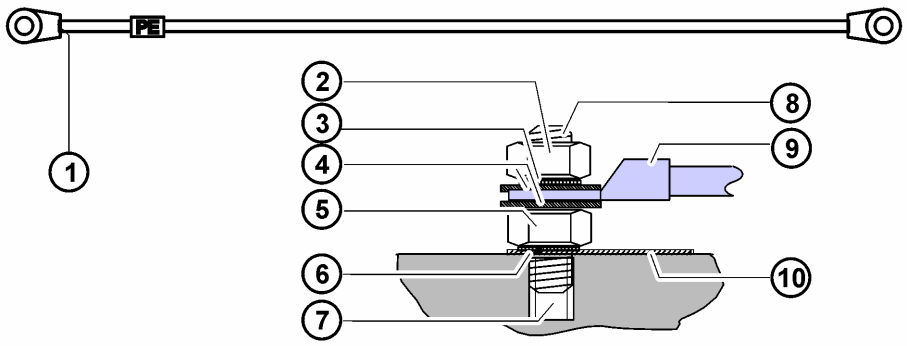


Fig. 11-21: Connecting cable, ground conductor

1	Ground conductor	6	Conical spring washer
2	Hexagon nut	7	Robot
3	Conical spring washer	8	Setscrew
4	2x plain washer	9	Ground conductor connection Ring cable lug
5	Hexagon nut	10	Ground sign

12 Appendix

12.1 Tightening torques

Tightening torques

The following tightening torques (Nm) are valid for screws and nuts where no other specifications are given.

The specified values apply to lightly oiled black (e.g. phosphated) and coated (e.g. mech. galv., zinc flake plating, screw locking elements) screws and nuts.

	Strength class		
Thread	**8.8**	**10.9**	**12.9**
M1.6	0.17 Nm	0.24 Nm	0.28 Nm
M2	0.35 Nm	0.48 Nm	0.56 Nm
M2.5	0.68 Nm	0.93 Nm	1.10 Nm
M3	1.2 Nm	1.6 Nm	2.0 Nm
M4	2.8 Nm	3.8 Nm	4.4 Nm
M5	5.6 Nm	7.5 Nm	9.0 Nm
M6	9.5 Nm	12.5 Nm	15.0 Nm
M8	23.0 Nm	31.0 Nm	36.0 Nm
M10	45.0 Nm	60.0 Nm	70.0 Nm
M12	78.0 Nm	104.0 Nm	125.0 Nm
M14	125.0 Nm	165.0 Nm	195.0 Nm
M16	195.0 Nm	250.0 Nm	305.0 Nm
M20	370.0 Nm	500.0 Nm	600.0 Nm
M24	640.0 Nm	860.0 Nm	1030.0 Nm
M30	1330.0 Nm	1700.0 Nm	2000.0 Nm

	Strength class	
Thread	**8.8 ISO7991 Allen screw**	**10.9 ISO7380, ISO07381 Fillister head screw**
M3	0.8 Nm	0.8 Nm
M4	1.9 Nm	1.9 Nm
M5	3.8 Nm	3.8 Nm

	Strength class
Thread	**10.9 DIN7984 Pan head screws**
M4	2.8 Nm

Tighten M5 domed cap nuts with a torque of 4.2 Nm.

12.2 Auxiliary and operating materials used

Product designation / Article number	Use	Manufacturer designation / Address
Drei Bond type 1118 0000-265-996	Surface sealant	**Drei Bond GmbH** Carl-Zeiss-Ring 13 D-85737 Ismaning Germany
Drei Bond type 1305 0000-184-175	Adhesive and sealant	**Drei Bond GmbH** Carl-Zeiss-Ring 13 D-85737 Ismaning Germany
Drei Bond type 5204HV 0000-251-505	Adhesive and sealant	**Drei Bond GmbH** Carl-Zeiss-Ring 13 D-85737 Ismaning Germany
Optitemp RB 2 0000-101-456	Lubricating grease	**Deutsche BP Aktiengesellschaft - Industrial Lubricants & Services** Erkelenzer Strasse 20 D-41179 Mönchengladbach Germany
PETAMO GHY 133 N 0000-269-159	Lubricating grease	**Klüber Lubrication München KG** Geisenhausenerstr. 7 D-81379 Munich Germany
Sumiplex SFB No.1 0000-326-962	Lubricating grease	**LUBRICANT CO., LTD.** 11-3, Shimbashi 5-chome Minato-ku, Tokyo 105-0004 Japan

To ensure safe use of our products, we recommend regularly requesting up-to-date safety data sheets from the manufacturers of auxiliary and operating materials.

12.3 Applied standards and regulations

Name/Edition	Definition
2006/42/EC	**Machinery Directive:** Directive 2006/42/EC of the European Parliament and of the Council of 17 May 2006 on machinery, and amending Directive 95/16/EC (recast)
2014/30/EU	**EMC Directive:** Directive 2014/30/EU of the European Parliament and of the Council dated 26 February 2014 on the approximation of the laws of the Member States concerning electromagnetic compatibility

ANSI/RIA R15.06-2012	**Industrial Robots and Robot System**
CAN/CSA-C22.2 No. 14-13	**Industrial Control Equipment**
CAN/CSA-Z434-14	**Industrial Robots and Robot Systems:** General Safety Requirements
EN 55011:2016 + A1:2017	**Industrial, scientific and medical equipment:** Radio disturbance characteristics – Limits and methods of measurement
EN 60204-1:2018	**Safety of machinery:** Electrical equipment of machines – Part 1: General requirements
EN 61000-6-2:2005	**Electromagnetic compatibility (EMC):** Part 6-2: Generic standards; Immunity for industrial environments
EN 61000-6-3:2007 + A1:2011	**Electromagnetic compatibility (EMC)** Part 6-3: Generic standards – Emission standard for residential, commercial and light-industrial environments
EN 61000-6-4:2007 + A1:2011	**Electromagnetic compatibility (EMC):** Part 6-4: Generic standards; Emission standard for industrial environments
EN IEC 61000-6-2:2019	**Electromagnetic compatibility (EMC):** Part 6-2: Generic standards – Immunity for industrial environments
EN ISO 10218-1:2011	**Robots and robotic devices – Safety requirements for industrial robots:** Part 1: Robots **Note:** Content equivalent to **ANSI/RIA R15.06-2012, 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
NFPA 79:2018	**Electrical Standard for Industrial Machinery**
UL 1740:2018	Robots and Robotic Equipment
UL 1998:2013	**Standard for Safety:** Software in Programmable Components

UL 61010-1:2012	**Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use** Part 1: General Requirements
UL 61010-2-201:2018	**Safety requirements for electrical equipment for measurement, control, and laboratory use** Part 2-201: Particular requirements for control equipment

13 KUKA Service

13.1 Requesting support

Introduction

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

Information

The following information is required for processing a support request:

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

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

  – Model and serial number of the kinematic system, e.g. the manipulator
  – Model and serial number of the controller
  – Model and serial number of the energy supply system
  – Designation and version of the system software
  – Designations and versions of other software components or modifications
  – System Software diagnosis package

    Additionally for KUKA Sunrise: Existing projects including applications

    For versions of KUKA System Software older than V8: Archive of the software (Diagnosis package is not yet available here.)
  – Application used
  – External axes used

13.2 KUKA Customer Support

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

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