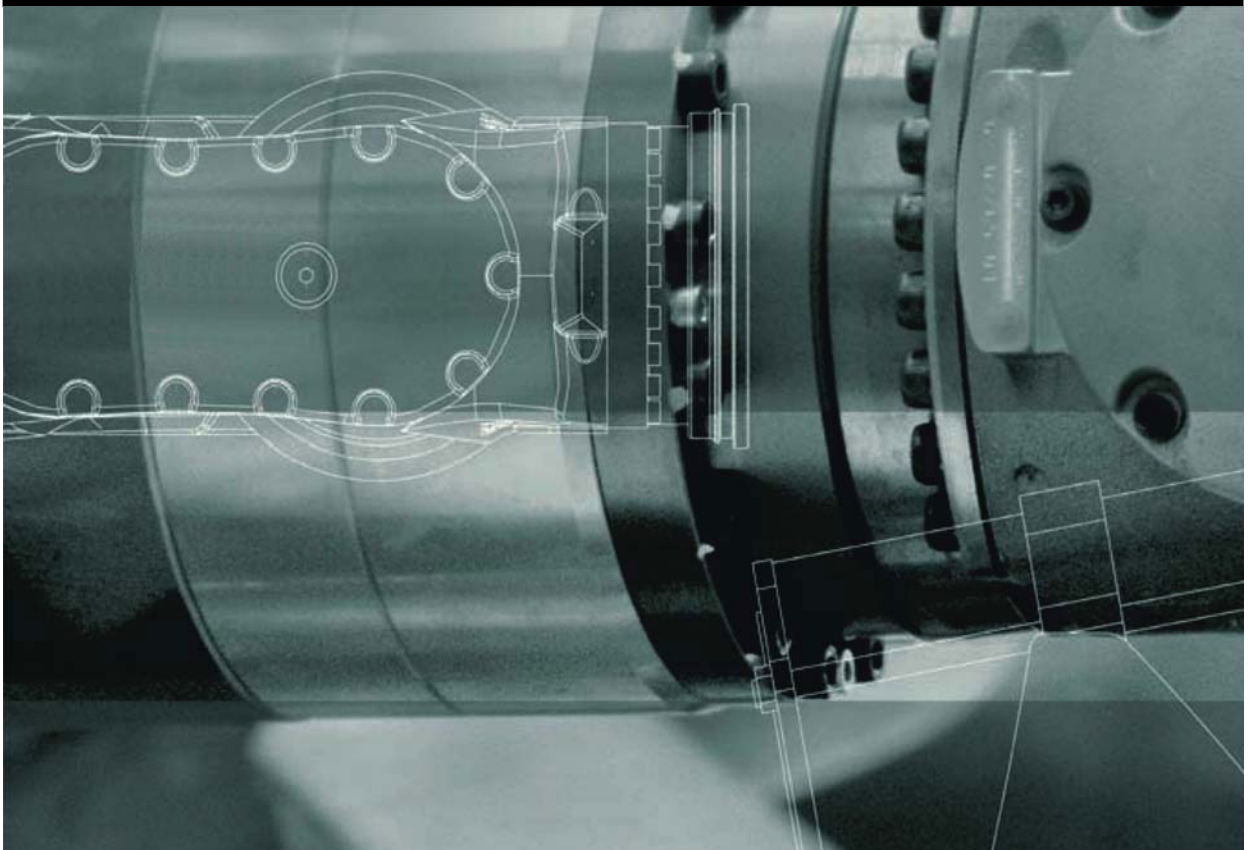


## **LBR iiwa**

**LBR iiwa 7 R800, LBR iiwa 14 R820**

### **Operating Instructions**



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Version: BA LBR iiwa V2



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

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

Subject to technical alterations without an effect on the function.

Translation of the original documentation

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# 1 Introduction

## 1.1 Industrial robot documentation

The industrial robot documentation consists of the following parts:


- Documentation for the manipulator
- Documentation for the robot controller
- Operating and programming instructions for the System Software
- Instructions for options and accessories
- Parts catalog on storage medium


Each of these sets of instructions is a separate document.


## 1.2 Representation of warnings and notes


### Safety


These warnings are relevant to safety and **must** be observed.

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


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

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

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


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

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

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

### Notes

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

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

## 1.3 Terms used

Term	Description
LBR iiwa	Lightweight robot intelligent industrial work assistant

Term	Description
Manipulator	The robot arm and the associated electrical installations
KUKA smartPAD	<p>The smartPAD is the hand-held control panel for the robot cell (station).</p> <p>The smartPAD has all the operator control and display functions required for operation.</p>

## 2 Purpose

### 2.1 Target group

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

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



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

### 2.2 Intended use

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

**Misuse** Any use or application deviating from the intended use is deemed to be impermissible misuse; examples of such misuse include:

- Transportation of persons and animals
- Use as a climbing aid
- Operation outside the permissible operating parameters
- Use in potentially explosive environments
- Outdoor operation
- Leaning on the robot arm
- Underground operation

#### **NOTICE**

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





## 3 Product description

### 3.1 Overview of the robot system

A robot system (>>> Fig. 3-1 ) comprises all the assemblies of an industrial robot, including the manipulator (mechanical system and electrical installations), controller, connecting cables, end effector (tool) and other equipment.

The industrial robot consists of the following components:

- Manipulator
- KUKA Sunrise Cabinet robot controller
- KUKA smartPAD control panel
- Connecting cables
- Software
- Options, accessories



**Fig. 3-1: Description of lightweight robot**

- 1 Connecting cable to the smartPAD
- 2 KUKA smartPAD control panel
- 3 Manipulator
- 4 Connecting cable
- 5 KUKA Sunrise Cabinet robot controller

### 3.2 Description of the LBR iiwa

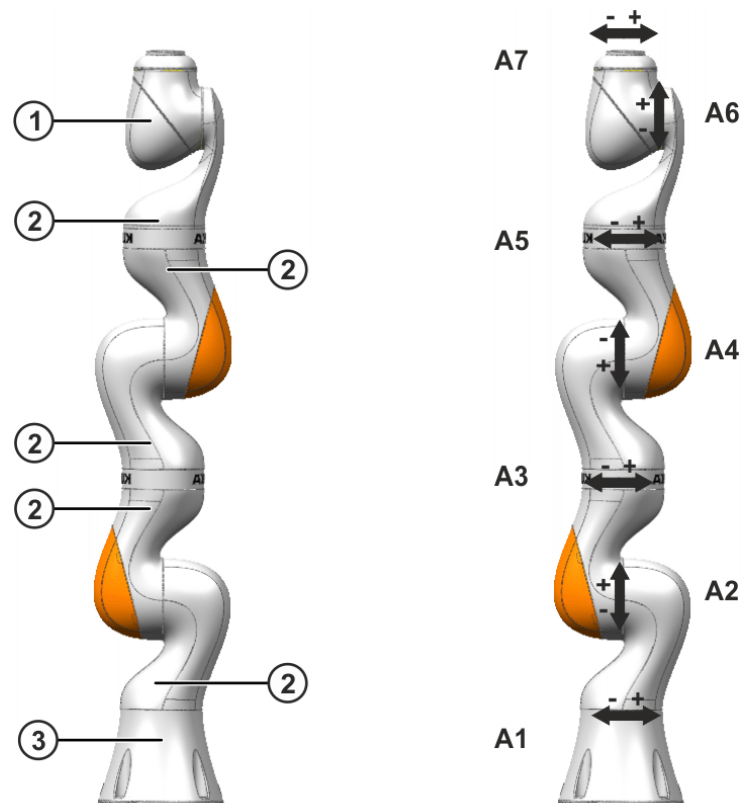
#### Overview

The LBR iiwa is classified as a lightweight robot and is a jointed-arm robot with 7 axes. All motor units and current-carrying cables are protected beneath cover plates.

Each axis is protected by means of axis range sensors and can be adjusted by means of internal sensors.

Each joint is equipped with a position sensor on the input side and torque sensors on the output side. The robot can thus be operated with position and impedance control.

The robot is equipped redundantly and consists of the following principal components:



**Fig. 3-2: Main assemblies and robot axes**

- 1 In-line wrist
- 2 Joint module
- 3 Base frame

#### In-line wrist

The robot is fitted with a 2-axis in-line wrist. The motors are located in axes A6 and A7.

#### Joint module

The joint modules consist of an aluminum structure. The drive units are situated inside these modules. In this way, the drive units are linked to one another via the aluminum structures.

#### Base frame

The base frame is the base of the robot. Interface A1 is located at the rear of the base frame. It constitutes the interface for the connecting cables between the robot, the controller and the energy supply system.

#### Electrical installations

The electrical installations include all the supply and control cables for the motors of axes A1 (J1) to A7 (J7). All the connections on the motors are plug-and-socket connections. The entire cabling is routed internally in the robot.

The connecting cable is connected to the robot controller. The energy supply system cables are connected to the periphery.



## 4 Technical data

### 4.1 Basic data

#### General

Max. continuous wattage of the power supply unit	1100 watts
--	------------

#### Basic data

##### ■ LBR iiwa 7 R800

Type	LBR iiwa 7 R800
Number of axes	7
Volume of working envelope	LBR iiwa 7 R800: 1.7 m <sup>3</sup>
Pose repeatability (ISO 9283)	±0.1 mm
Working envelope reference point	Intersection of axis 6 and axis 7
Weight	LBR iiwa 7 R800: 22.3 kg
Principal dynamic loads	See Loads acting on the foundation
Protection classification of the robot	IP 54 ready for operation, with connecting cables plugged in (according to EN 60529)
Protection classification of the in-line wrist	IP 54
Sound level	< 65 dB (A) outside the working envelope
Mounting position	Floor
Surface finish, paintwork	Supporting structures: RAL 9006 (white aluminum); cover: KUKA orange; surface: cast structure (not smooth)

#### Ambient temperature

##### ■ LBR iiwa 7 R800

Operation	+5 °C to +33 °C (278 K to 306 K)
Storage and transportation	-25 °C to +70 °C (248 K to 343 K)
Start-up	+10 °C to +33 °C (283 K to 306 K) At these temperatures the robot may have to be warmed up before normal operation.
Humidity class	Class 3K3 EN 50178

#### Basic data

##### ■ LBR iiwa 14 R820

Type	LBR iiwa 14 R820
Number of axes	7
Volume of working envelope	LBR iiwa 14 R820: 1.8 m <sup>3</sup>
Pose repeatability (ISO 9283)	±0.1 mm
Working envelope reference point	Intersection of axis 6 and axis 7
Weight	LBR iiwa 14 R820: 29.5 kg

Principal dynamic loads	See Loads acting on the foundation
Protection classification of the robot	IP 54 ready for operation, with connecting cables plugged in (according to EN 60529)
Protection classification of the in-line wrist	IP 54
Sound level	< 65 dB (A) outside the working envelope
Mounting position	Floor
Surface finish, paintwork (IND variant)	Supporting structures: RAL 9006 (white aluminum); cover: KUKA orange; surface: cast structure (not smooth)

#### Ambient temperature

##### ■ LBR iiwa 14 R820

Operation	+5 °C to +30 °C (278 K to 303 K)
Storage and transportation	-25 °C to +70 °C (248 K to 343 K)
Start-up	+10 °C to +30 °C (283 K to 303 K) At these temperatures the robot may have to be warmed up before normal operation.
Humidity class	Class 3K3 EN 50178

## 4.2 Axis data

#### Axis data

The following axis data are preliminary values and are valid for the robot specified:

##### ■ LBR iiwa 7 R800

Axis	Range of motion, software-limited	Speed with rated payload
1	+/-140°	75 °/s
2	+/-97.5°	75 °/s
3	+/-140°	90 °/s
4	+/-97.5°	90 °/s
5	+/-140°	144 °/s
6	+/-97.5°	135 °/s
7	+/-152.5°	135 °/s

##### ■ LBR iiwa 14 R820

Axis	Range of motion, software-limited	Speed with rated payload
1	+/-140°	57 °/s
2	+/-97.5°	57 °/s
3	+/-140°	75 °/s
4	+/-97.5°	75 °/s
5	+/-140°	144 °/s
6	+/-97.5°	135 °/s
7	+/-152.5°	135 °/s

#### Working envelope

The diagram shows the shape and size of the working envelope for the robot:

##### ■ LBR iiwa 7 R800

Dimensions: mm

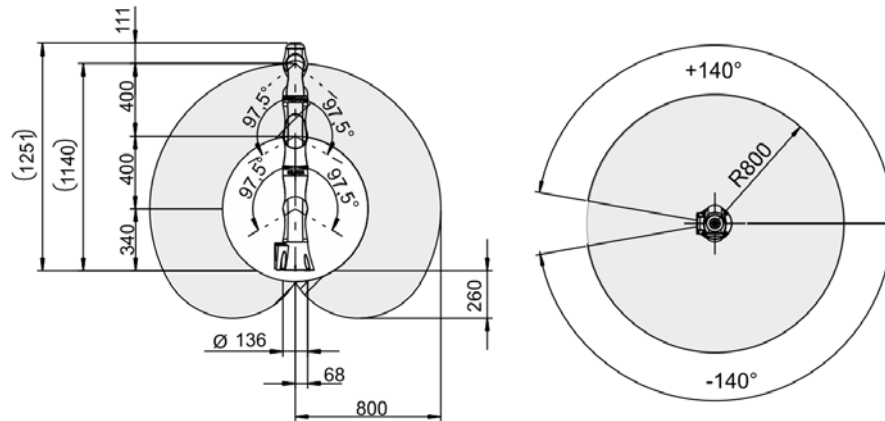


Fig. 4-1: Working envelope, LBR iiwa 7 R800

#### ■ LBR iiwa 14 R820

Maße/Dimensions: mm

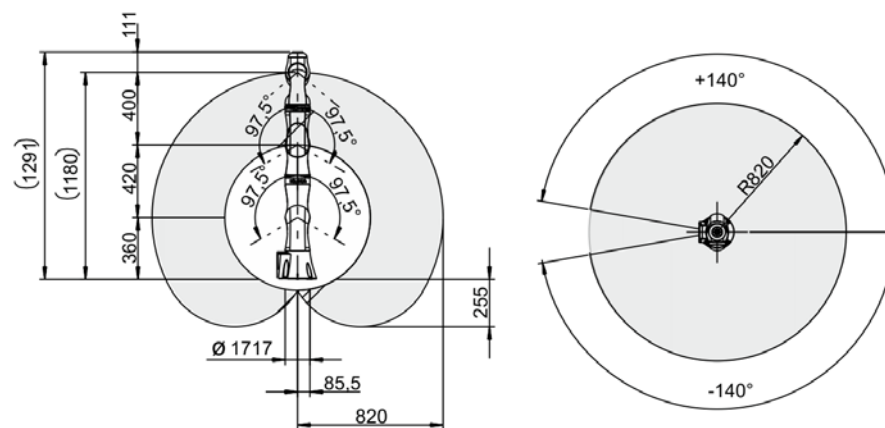


Fig. 4-2: Working envelope, LBR iiwa 14 R820

### 4.3 Payloads

The following values are preliminary values and are valid for both robot variants.

#### ■ LBR iiwa 7 R800

Robot	LBR iiwa 7 R800
Manual	IW
Rated payload	7 kg
Distance of the load center of gravity $L_z$	100 mm
Distance of the load center of gravity $L_{xy}$	20 mm
Permissible moment of inertia	0.3 kgm <sup>2</sup>
Max. total load	-
Supplementary load	none

#### ■ LBR iiwa 14 R820

Robot	LBR iiwa 14 R820
Manual	IW
Rated payload	14 kg

Robot	LBR iiwa 14 R820
Distance of the load center of gravity $L_z$	100 mm
Distance of the load center of gravity $L_{xy}$	20 mm
Permissible moment of inertia	$0.3 \text{ kgm}^2$
Max. total load	-
Supplementary load	none

For all payloads, the load center of gravity refers to the distance from the face of the mounting flange on axis A7.

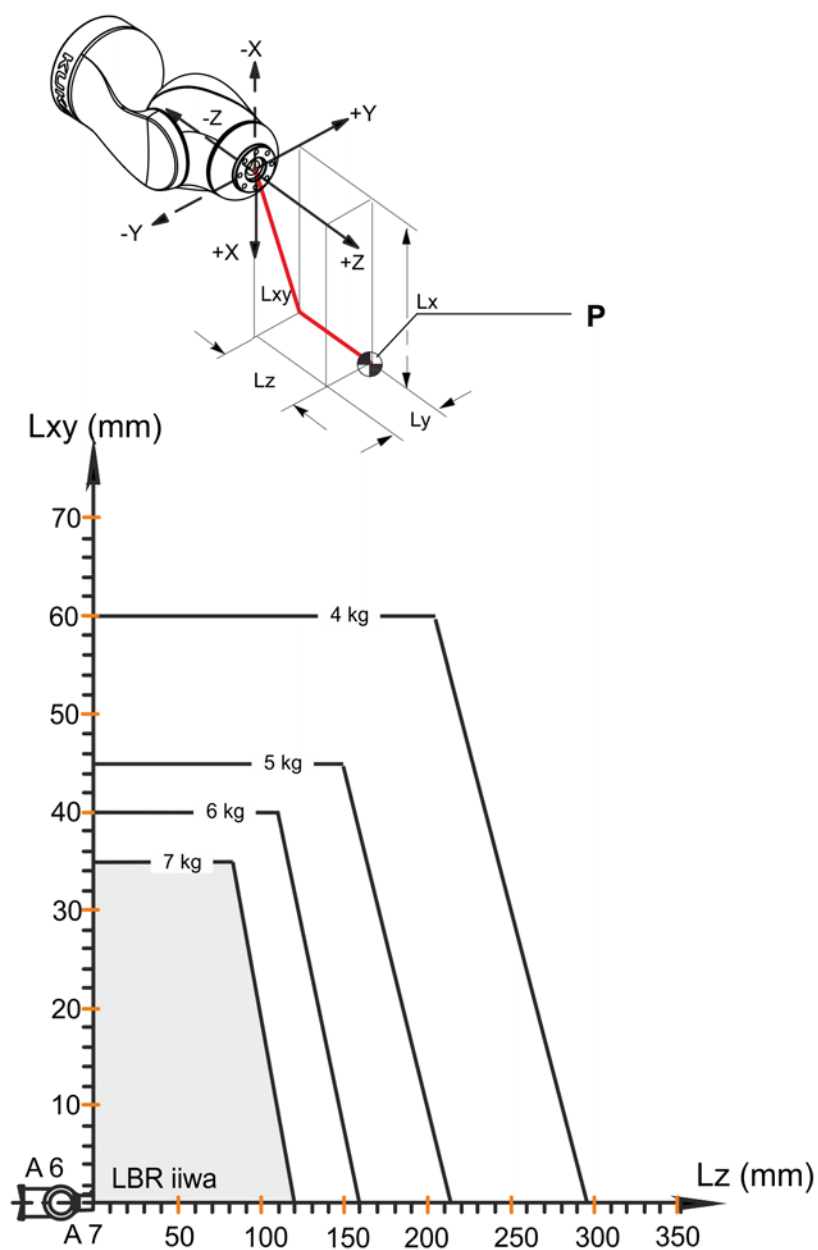


Fig. 4-3: Payload diagram, LBR iiwa 7 R800



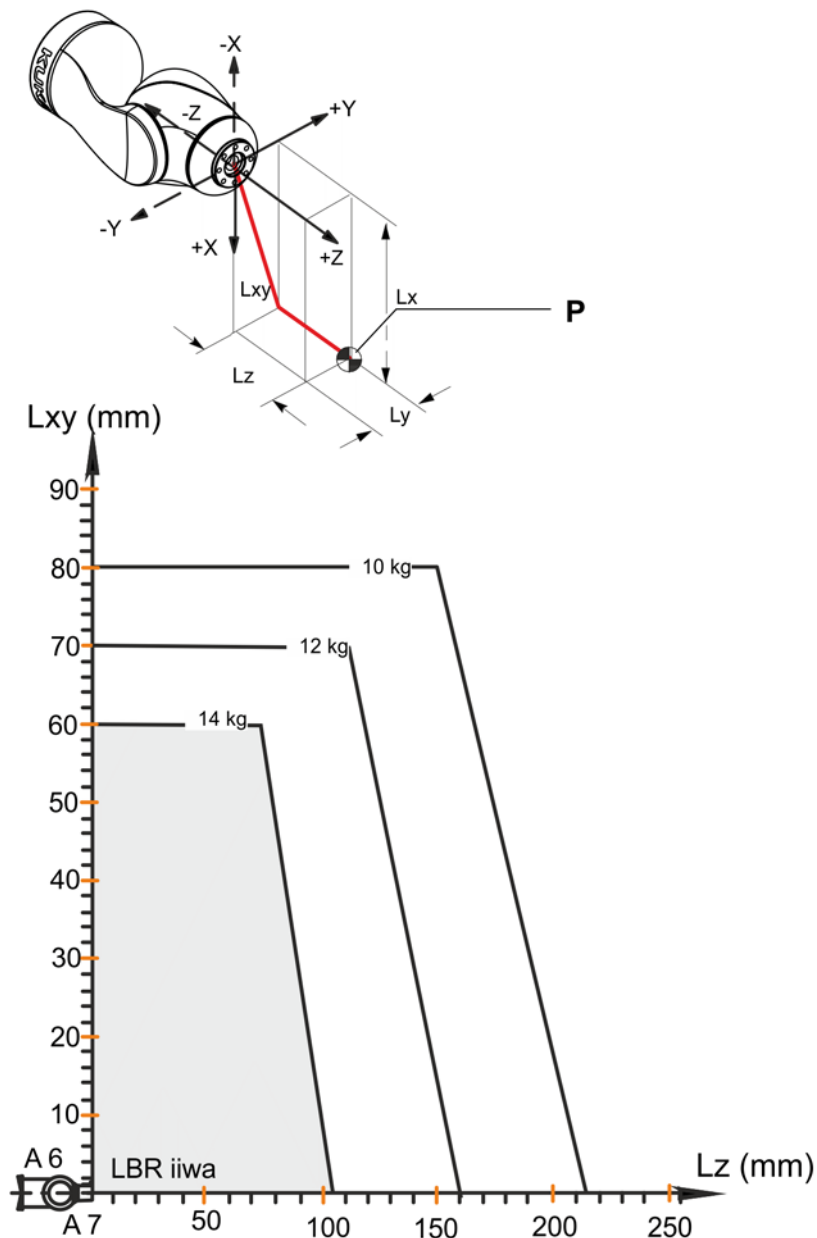


Fig. 4-4: Payload diagram, LBR iiwa 14 R820

#### 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 Customer Support 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 control software.

#### Mounting flange

Mounting flange	ISO 9409-1-50-7-M6
Screw grade	10.9
Screw size	M6
Depth of engagement	6 mm
Locating element	6 <sup>H7</sup>

The mounting flange is depicted with axis 7 in the zero position.

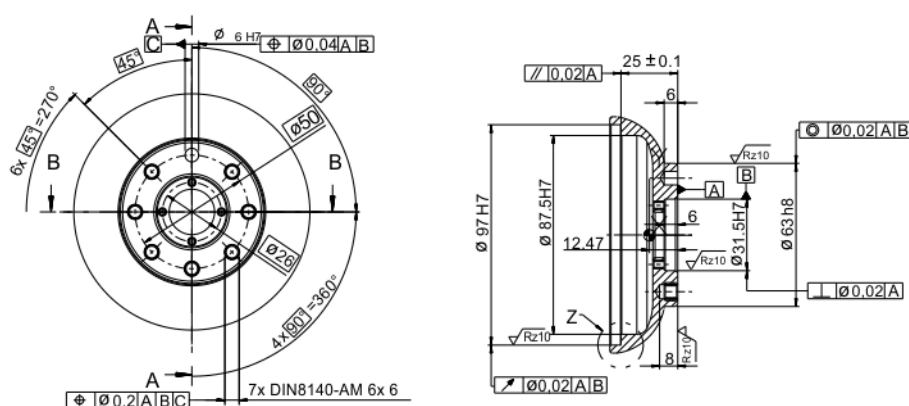


Fig. 4-5: Mounting flange

#### Supplementary load

The robot cannot carry a supplementary load.

#### 4.4 Loads acting on the foundation

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

#### NOTICE

The foundation loads specified in the table are the maximum loads that may occur. They must be referred to when dimensioning the foundations and must be adhered to for safety reasons. Failure to do so may result in material damage.

#### 4.4.1 Foundation loads for floor-mounted robots

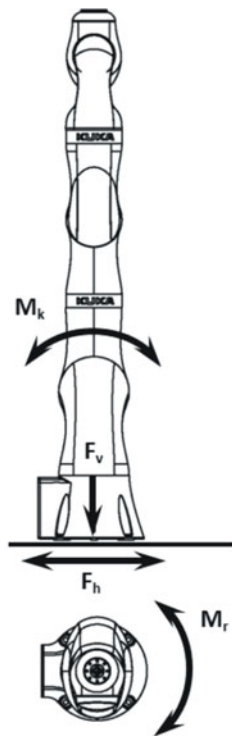


Fig. 4-6: Foundation loads for floor-mounted robots

##### ■ LBR iiwa 7 R800

Type of load	Force/torque/mass
$F_v$ = vertical force	$F_{vmax} = 524 \text{ N}$
$F_h$ = horizontal force	$F_{hmax} = 240 \text{ N}$
$M_k$ = tilting moment	$M_{kmax} = 310 \text{ Nm}$
$M_r$ = torque	$M_{rmax} = 156 \text{ Nm}$
Total mass for foundation load	30 kg
Robot	approx. 23 kg
Supplementary load	none

##### ■ LBR iiwa 14 R820

Type of load	Force/torque/mass
$F_v$ = vertical force	$F_{vmax} = 541.2 \text{ N}$
$F_h$ = horizontal force	$F_{hmax} = 228.4 \text{ N}$
$M_k$ = tilting moment	$M_{kmax} = 281.6 \text{ Nm}$
$M_r$ = torque	$M_{rmax} = 172.6 \text{ Nm}$
Total mass for foundation load	45 kg
Robot	approx. 29.5 kg
Supplementary load	none

#### 4.5 Plates and labels

##### Identification plate

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.

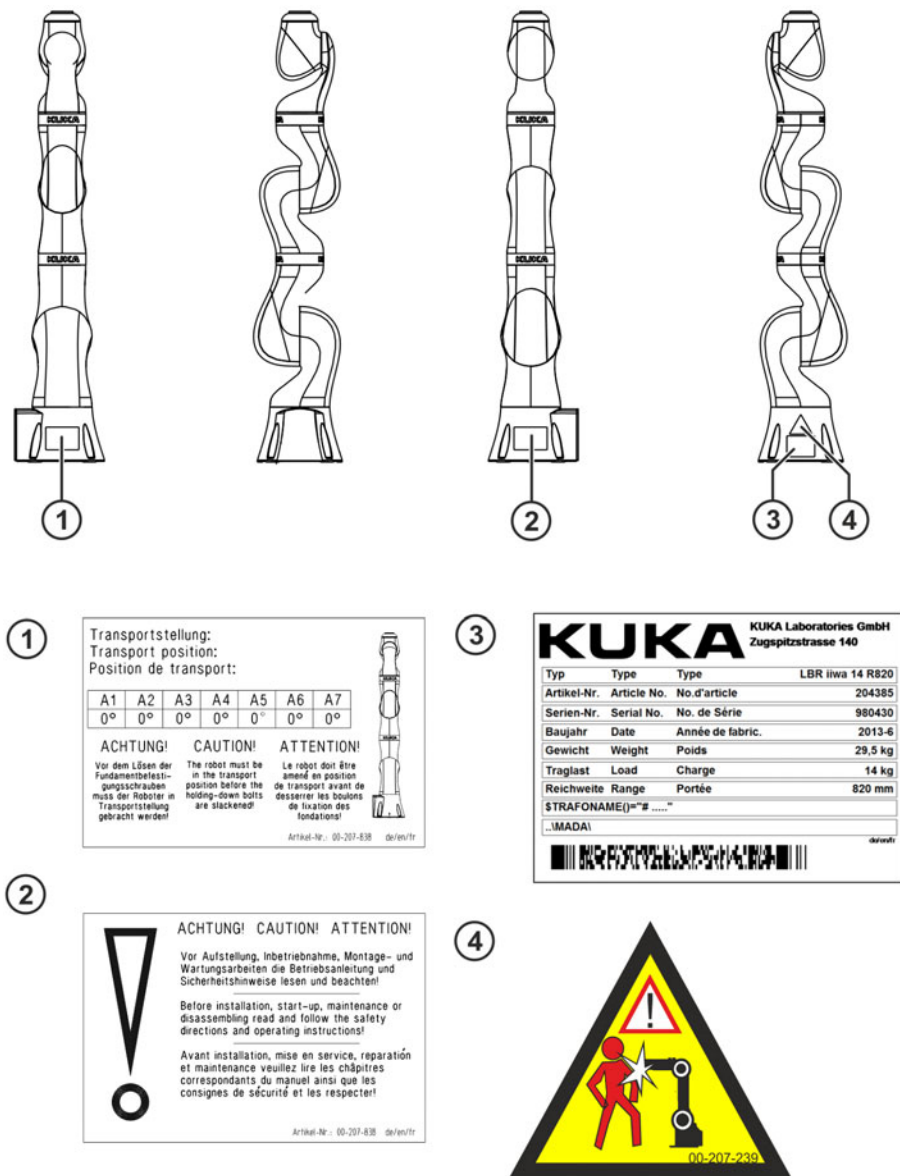


Fig. 4-7: Plates and labels

## 4.6 Stopping distances and times

### 4.6.1 General information

Information concerning the data:

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

according to IEC 60204-1

- The values specified for Stop 0 are guide values determined by means of tests and simulation. They are average values which conform to the requirements of DIN EN ISO 10218-1. The actual stopping distances and stopping times may differ due to internal and external influences on the braking torque. It is therefore advisable to determine the exact stopping distances and stopping times where necessary under the real conditions of the actual robot application.
- Measuring technique  
The stopping distances were measured using the robot-internal measuring technique.
- The wear on the brakes varies depending on the operating mode, robot application and the number of STOP 0 triggered. It is therefore advisable to check the stopping distance at least once a year.

#### 4.6.2 Terms used

Term	Description
m	Mass of the rated load and the supplementary load on the arm.
Phi	Angle of rotation (°) about the corresponding axis. This value can be entered in the controller via the KCP and is displayed on the KCP.
POV	Program override (%) = velocity of the robot motion. This value can be entered in the controller via the KCP and is displayed on the KCP.
Extension	Distance (l in %) (>>> Fig. 4-8 ) between axis 1 and the intersection of axes 4 and 5. With parallelogram robots, the distance between axis 1 and the intersection of axis 6 and the mounting flange.
KCP	The KCP teach pendant has all the operator control and display functions required for operating and programming the robot system.

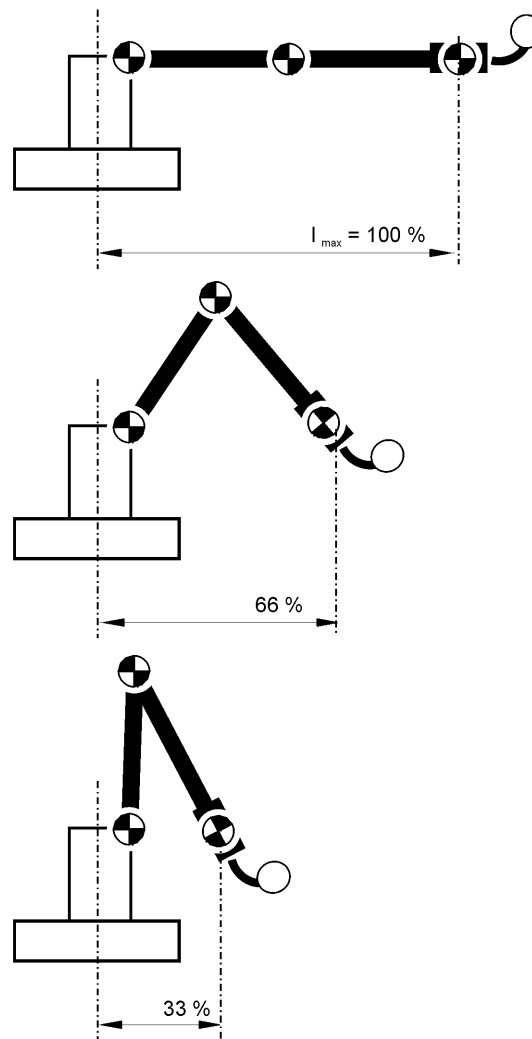


Fig. 4-8: Extension

#### 4.6.3 Stopping distances and times, LBR iiwa 7 R800



EN ISO 10218-1, Annex B, specifies the need for information about the stopping time and distance. These have not yet been determined in full for all robot types in conjunction with the KUKA Sunrise Cabinet robot controller.  
In this respect, the lightweight robot does not conform to the requirements of EN ISO 10218-1.

#### 4.6.4 Stopping distances and times, LBR iiwa 14 R820



EN ISO 10218-1, Annex B, specifies the need for information about the stopping time and distance. These have not yet been determined in full for all robot types in conjunction with the KUKA Sunrise Cabinet robot controller.  
In this respect, the lightweight robot does not conform to the requirements of EN ISO 10218-1.

## 5 Safety

### 5.1 Legal framework

#### 5.1.1 Liability

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

Components of the industrial robot:

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

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

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

#### Safety information

Safety information cannot be held against KUKA Laboratories GmbH. Even if all safety instructions are followed, this is not a guarantee that the industrial robot will not cause personal injuries or material damage.

No modifications may be carried out to the industrial robot without the authorization of KUKA Laboratories GmbH. Additional components (tools, software, etc.), not supplied by KUKA Laboratories GmbH, may be integrated into the industrial robot. The user is liable for any damage these components may cause to the industrial robot or to other material property.

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

#### 5.1.2 Intended use of the industrial robot

The industrial robot is intended exclusively for the use designated in the "Purpose" chapter of the operating instructions or assembly instructions.

Any use or application deviating from the intended use is deemed to be misuse and is not allowed. The manufacturer is not liable for any damage resulting from such misuse. The risk lies entirely with the user.

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.

The user is responsible for the performance of a risk analysis. This indicates the additional safety equipment that is required, the installation of which is also the responsibility of the user.

#### Misuse

Any use or application deviating from the intended use is deemed to be misuse and is not allowed. This includes e.g.:

- Transportation of persons and animals
- Use as a climbing aid
- Operation outside the specified operating parameters
- Use in potentially explosive environments
- Operation without the required additional safety equipment
- Outdoor operation
- Underground operation

### 5.1.3 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 an assessment of conformity.

#### Declaration of conformity

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

The robot controller is CE certified under the EMC Directive and the Low Voltage Directive.

#### Declaration of incorporation

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

The declaration of incorporation declares that the start-up of the partly completed machinery 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.

## 5.2 Safety functions


Safety functions are distinguished according to the safety requirements that they fulfill:


- Safety-oriented functions for the protection of personnel  
The safety-oriented functions of the industrial robot meet the following safety requirements:
  - **Category 3** and **Performance Level d** in accordance with EN ISO 13849-1:2008
  - **SIL 2** according to EN 62061


The requirements are only met on the following condition, however:



- The EMERGENCY STOP device is pressed and tested for correct functioning during start-up and at least once every 6 months.
- Non-safety-oriented functions for the protection of machines  
The non-safety-oriented functions of the industrial robot do not meet specific safety requirements:

 **DANGER** In the absence of the required operational safety functions and safeguards, the industrial robot can cause personal injury or material damage. If the required safety functions or safeguards are dismantled or deactivated, the industrial robot may not be operated.

 During system planning, the safety functions of the overall system must also be planned and designed. The industrial robot must be integrated into this safety system of the overall system.

 in the case of a safety stop 1, the robot only comes to a complete standstill after one second. For this reason, use of the safety stop 0 is recommended in situations in which there could be persons in the danger zone of the robot, e.g. in test mode or collaborative operation.

### 5.2.1 Terms used

Term	Description
Axis range	Range of each axis, in degrees or millimeters, within which it may move. The axis range must be defined for each axis.
Stopping distance	Stopping distance = reaction distance + braking distance The stopping distance is part of the danger zone.
Workspace	The manipulator is allowed to move within its workspace. The workspace is derived from the individual axis ranges.
Automatic (AUT)	Operating mode for program execution. The manipulator moves at the programmed velocity.
Operator (User)	The user of the industrial robot can be the management, employer or delegated person responsible for use of the industrial robot.
Danger zone	The danger zone consists of the workspace and the stopping distances.
Service life	The service life of a safety-relevant component begins at the time of delivery of the component to the customer.  The service life is not affected by whether the component is used in a robot controller or elsewhere or not, as safety-relevant components are also subject to aging during storage.
CRR	<b>Controlled Robot Retraction</b>  CRR is an operating mode that is available if a collision has been detected, or if the robot has violated a safely monitored space, a safely monitored Cartesian velocity limit or a safely monitored force or torque limit and is stopped by the safety controller.  In CRR mode, the robot can be jogged and moved back to a position in which the monitoring function that triggered the stop is no longer violated.
KUKA smartPAD	The smartPAD is the hand-held control panel for the robot cell (station). The smartPAD has all the operator control and display functions required for operation.
Manipulator	The robot arm and the associated electrical installations

Term	Description
Safety zone	The manipulator is not allowed to move within the safety zone. The safety zone is the area outside the danger zone.
Safety stop	<p>The safety stop is triggered by the safety controller, interrupts the work procedure and causes all robot motions to come to a standstill. The program data are retained in the case of a safety stop and the program can be resumed from the point of interruption.</p> <p>The safety stop can be executed as a Stop category 0 or Stop category 1.</p> <p><b>Note:</b> In this document, a safety stop of Stop category 0 is referred to as safety stop 0 and a safety stop of Stop category 1 as safety stop 1.</p>
Stop category 0	The drives are deactivated immediately and the brakes are applied. The manipulator is stopped with path-oriented braking.
Stop category 1	The manipulator is braked and stays on the programmed path. The drives are deactivated after 1 s and the brakes are applied.
System integrator (plant integrator)	System integrators are people who safely integrate the industrial robot into a complete system and commission it.
T1	Test mode, Manual Reduced Velocity ( $\leq 250$ mm/s)
T2	Test mode, Manual High Velocity ( $> 250$ mm/s permissible)

### 5.2.2 Personnel

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

- User
- Personnel



All persons working with the industrial robot must have read and understood the industrial robot documentation, including the safety chapter.

#### User

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

- The user must comply with his monitoring obligations.
- The user must carry out instructions at defined intervals.

#### Personnel

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

Personnel includes:

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



Installation, exchange, adjustment, operation, maintenance and repair must be performed only as specified in the operating or assembly instructions for the relevant component of the industrial robot and only by personnel specially trained for this purpose.

#### System integrator

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

The system integrator is responsible for the following tasks:

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

### Operator

The operator must meet the following preconditions:

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



Work on the electrical and mechanical equipment of the manipulator may only be carried out by KUKA Laboratories GmbH.

### 5.2.3 Workspace, safety zone and danger zone

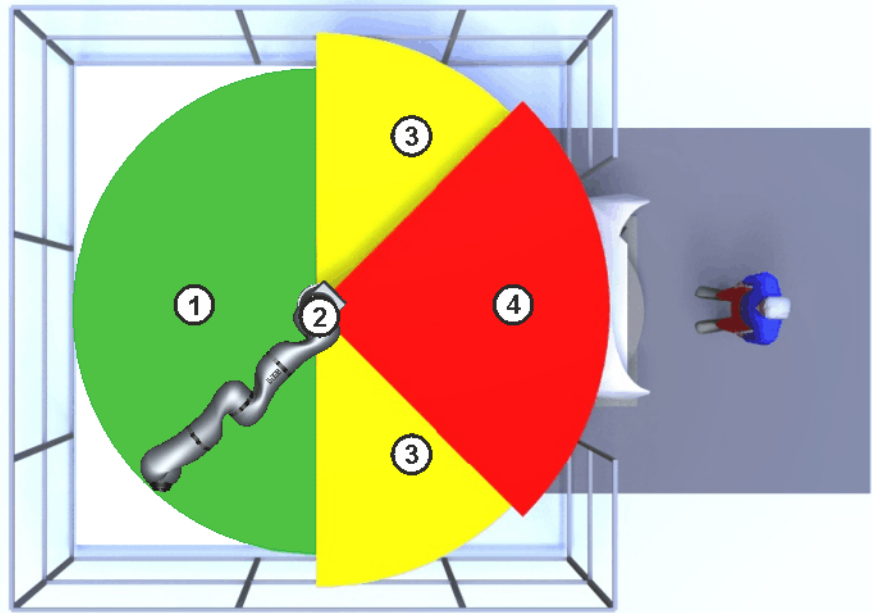
Working zones are to be restricted to the necessary minimum size in order to prevent danger to persons or the risk of material damage. Safe axis range limitations required for personnel protection are configurable.



Further information about configuring safe axis range limitations is contained in the "Safety configuration" chapter of the operating and programming instructions.

The danger zone consists of the workspace and the stopping distances of the manipulator. In the event of a stop, the manipulator is braked and comes to a stop within the danger zone. The safety zone is the area outside the danger zone.

The danger zone must be protected by means of physical safeguards, e.g. by light barriers, light curtains or safety fences. If there are no physical safeguards present, the requirements for collaborative operation in accordance with EN ISO 10218 must be met. There must be no shearing or crushing hazards at the loading and transfer areas.



**Fig. 5-1: Example: axis range A1**

- |   |             |   |                   |
|---|-------------|---|-------------------|
| 1 | Workspace   | 3 | Stopping distance |
| 2 | Manipulator | 4 | Safety zone       |

#### 5.2.4 Safety-oriented functions

The following safety-oriented functions are present and permanently defined in the industrial robot:

- EMERGENCY STOP device
- Enabling device
- Locking of the operating mode (by means of a keyswitch)

The following safety-oriented functions are preconfigured and can be integrated into the system via the safety interface of the robot controller:

- Operator safety (= connection for the guard interlock)
- External EMERGENCY STOP device
- External safety stop 1

Other safety-oriented functions that are not present by default may be configured, e.g.:

- External enabling device
- External safe operational stop
- Axis-specific workspace monitoring
- Cartesian workspace monitoring
- Cartesian protected space monitoring
- Velocity monitoring
- Standstill monitoring
- Axis torque monitoring
- Collision detection



Further information about configuring the safety functions is contained in the "Safety configuration" chapter of the operating and programming instructions.

The default configuration of the preconfigured safety functions is described in the following sections on safety.

#### 5.2.4.1 EMERGENCY STOP device

The EMERGENCY STOP device for the industrial robot is the EMERGENCY STOP device on the smartPAD. The device must be pressed in the event of a hazardous situation or emergency.

Reaction of the industrial robot if the EMERGENCY STOP device is pressed:

- The manipulator stops with a safety stop. (>>> 5.2.5 "Triggers for safety-oriented stop reactions" Page 31)

Before operation can be resumed, the EMERGENCY STOP device must be turned to release it.



#### **WARNING**

Tools and other equipment connected to the manipulator must be integrated into the EMERGENCY STOP circuit on the system side if they could constitute a potential hazard. Failure to observe this precaution may result in death, severe injuries or considerable damage to property.

If a holder is used for the smartPAD and conceals the EMERGENCY STOP device on the smartPAD, an external EMERGENCY STOP device must be installed that is accessible at all times.

(>>> 5.2.4.4 "External EMERGENCY STOP device" Page 30)

#### 5.2.4.2 Enabling device

The enabling devices of the industrial robot are the enabling switches on the smartPAD.

There are 3 enabling switches installed on the smartPAD. The enabling switches have 3 positions:

- Not pressed
- Center position
- Panic position

In the test modes and in CRR, the manipulator can only be moved if one of the enabling switches is held in the central position.

- Releasing the enabling switch triggers a safety stop. (>>> 5.2.5 "Triggers for safety-oriented stop reactions" Page 31)
- Pressing the enabling switch down fully (panic position) triggers a safety stop 0.
- It is possible to hold 2 enabling switches in the center position simultaneously for several seconds. This makes it possible to adjust grip from one enabling switch to another one. If 2 enabling switches are held simultaneously in the center position for longer than 15 seconds, this triggers a safety stop 1.

If an enabling switch malfunctions (e.g. jams in the central position), the industrial robot can be stopped using the following methods:

- Press the enabling switch down fully
- Actuate the EMERGENCY STOP device
- Release the Start/pause key

**WARNING**

The enabling switches must not be held down by adhesive tape or other means or tampered with in any other way.  
Death, injuries or damage to property may result.

#### 5.2.4.3 Operator safety

The operator safety signal is used for interlocking physical safeguards, e.g. safety gates. In the default configuration, automatic operation is not possible without this signal. Alternatively, the requirements for collaborative operation in accordance with EN ISO 10218 must be met.

Reaction of the industrial robot in the event of a loss of signal during automatic operation, e.g. safety gate is opened (default configuration):

- The manipulator stops with a safety stop 1.

By default, operator safety is not active in the modes T1 (Manual Reduced Velocity) and CRR, i.e. the signal is not evaluated. Operator safety is active in mode T2 (Manual High Velocity).

**WARNING**

Following a loss of signal, automatic operation must not be resumed merely by closing the safeguard; the signal for operator safety must first be set by an additional device, e.g. by an acknowledge button. It is the responsibility of the system integrator to ensure this. This is to prevent automatic operation from being resumed inadvertently while there are still persons in the danger zone, e.g. due to the safety gate closing accidentally.

- This additional device must be designed in such a way that an actual check of the danger zone can be carried out first. Devices that do not allow this (e.g. because they are automatically triggered by closure of the safeguard) are not permissible.
- Failure to observe this may result in death to persons, severe injuries or considerable damage to property.

#### 5.2.4.4 External EMERGENCY STOP device

There must be EMERGENCY STOP devices available at every operator station that can initiate a robot motion or other potentially hazardous situation. The system integrator is responsible for ensuring this.

Reaction of the industrial robot if the external EMERGENCY STOP device is pressed (default configuration):

- The manipulator stops with a safety stop 0 (T1, CRR) or with a safety stop 1 (T2, AUT).

Multiple external EMERGENCY STOP devices can be connected via the safety interface of the robot controller. External EMERGENCY STOP devices are not included in the scope of supply of the industrial robot.

#### 5.2.4.5 External safety stop 1

Safety stop 1 can be triggered via an input on the safety interface (default configuration). The state is maintained as long as the external signal is FALSE. If the external signal is TRUE, the manipulator can be moved again. No acknowledgement is required.

#### 5.2.4.6 External enabling device

External enabling devices are required if it is necessary for more than one person to be in the danger zone of the industrial robot.

Multiple external enabling devices can be connected via the safety interface of the robot controller. External enabling devices are not included in the scope of supply of the industrial robot.

#### 5.2.4.7 External safe operational stop

The safe operational stop is a standstill monitoring function. It does not stop the robot motion, but monitors whether the robot axes are stationary.

The safe operational stop can be triggered via an input on the safety interface. The state is maintained as long as the external signal is FALSE. If the external signal is TRUE, the manipulator can be moved again. No acknowledgement is required.

### 5.2.5 Triggers for safety-oriented stop reactions

Stop reactions of the industrial robot are triggered in response to operator actions or as a reaction to monitoring functions and errors. The following tables show the different stop reactions according to the operating mode that has been set.

The following triggers for stop reactions are permanently defined:

Trigger	T1, T2, CRR	AUT
Operating mode changed during operation	Safety stop 1	
Enabling switch released	Safety stop 1	-
Enabling switch pressed fully down (panic position)	Safety stop 0	-
Local E-STOP pressed	Safety stop 1	
Error in safety controller	Safety stop 0	

Depending on the safety configuration, further triggers for stop reactions may be added in order to integrate the industrial robot safely into the system.



Further information about configuring the safety functions is contained in the "Safety configuration" chapter of the operating and programming instructions.

The following triggers for stop reactions are preconfigured by KUKA and can be changed:

Trigger	T1, CRR	T2, AUT
Safety gate opened (operator safety)	-	Safety stop 1
External E-STOP pressed	Safety stop 0	Safety stop 1
External safety stop	Safety stop 1	

### 5.2.6 Non-safety-oriented functions

#### 5.2.6.1 Mode selection

The industrial robot can be operated in the following modes:

- Manual Reduced Velocity (T1)
- Manual High Velocity (T2)
- Automatic (AUT)
- Controlled robot retraction (CRR)

Operating mode	Use	Velocities
T1	Programming, teaching and testing of programs.	<ul style="list-style-type: none"> <li>■ Program verification: Reduced programmed velocity, maximum 250 mm/s</li> <li>■ Jog mode: Jog velocity, maximum 250 mm/s</li> </ul>
T2	Testing of programs Only possible with safety gate closed	<ul style="list-style-type: none"> <li>■ Program verification: Programmed velocity</li> <li>■ Jog mode: not possible</li> </ul>
AUT	Automatic execution of programs For industrial robots with and without higher-level controllers	<ul style="list-style-type: none"> <li>■ Program mode: Programmed velocity</li> <li>■ Jog mode: not possible</li> </ul>
CRR	Motion taking the industrial robot out of a violated space and retraction following collisions  CRR is an operating mode that is available if a collision has been detected, or if the robot has violated a safely monitored space, a safely monitored Cartesian velocity limit or a safely monitored force or torque limit and is stopped by the safety controller.	<ul style="list-style-type: none"> <li>■ Program mode: Reduced programmed velocity, maximum 250 mm/s</li> <li>■ Jog mode: Jog velocity, maximum 250 mm/s</li> </ul>

#### 5.2.6.2 Software limit switches

The axis ranges of all manipulator axes are limited by means of non-safety-oriented software limit switches. These software limit switches only serve as machine protection and are preset in such a way that the manipulator is stopped under servo control if the axis limit is exceeded, thereby preventing damage to the mechanical equipment.

### 5.3 Additional protective equipment

#### 5.3.1 Jog mode

In the operating modes T1 (Manual Reduced Velocity), T2 (Manual High Velocity) and CRR, the robot controller can only execute programs in jog mode. This means that it is necessary to hold down an enabling switch and the Start/pause key in order to execute a program.

- Releasing the enabling switch on the smartPAD triggers a safety stop. (>>> 5.2.5 "Triggers for safety-oriented stop reactions" Page 31)
- Pressing the enabling switch on the smartPAD fully down triggers a safety stop 0.
- Releasing the Start/pause key triggers a stop of Stop category 1.



### 5.3.2 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.

### 5.3.3 External safeguards

The access of persons to the danger zone of the industrial robot must be prevented by means of safeguards. Alternatively, the requirements for collaborative operation in accordance with EN ISO 10218 must be met. It is the responsibility of the system integrator to ensure this.

Physical safeguards must meet the following requirements:

- They meet the requirements of EN 953.
- They prevent access of persons to the danger zone and cannot be easily circumvented.
- They are sufficiently fastened and can withstand all forces that are likely to occur in the course of operation, whether from inside or outside the enclosure.
- They do not, themselves, represent a hazard or potential hazard.
- The prescribed minimum clearance from the danger zone is maintained.

Safety gates (maintenance gates) must meet the following requirements:

- They are reduced to an absolute minimum.
- The interlocks (e.g. safety gate switches) are linked to the configured operator safety inputs of the robot controller.
- Switching devices, switches and the type of switching conform to the requirements of Performance Level d and category 3 according to EN ISO 13849-1.
- Depending on the risk situation: the safety gate is additionally safeguarded by means of a locking mechanism that only allows the gate to be opened if the manipulator is safely at a standstill.
- The device for setting the signal for operator safety, e.g. the button for acknowledging the safety gate, is located outside the space limited by the safeguards.



Further information is contained in the corresponding standards and regulations. These also include EN 953.

#### Other safety equipment


Other safety equipment must be integrated into the system in accordance with the corresponding standards and regulations.


## 5.4 Safety measures

### 5.4.1 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 to sag. If work is to be carried out on a switched-off industrial robot, the manipulator must first be moved into a position in which it is unable to move on its own, whether the payload is mounted or not. If this is not possible, the manipulator must be secured by appropriate means.

 **DANGER** In the absence of operational safety functions and safeguards, the industrial robot can cause personal injury or material damage. If safety functions or safeguards are dismantled or deactivated, the industrial robot may not be operated.

 **WARNING** Standing underneath the robot arm can cause death or serious injuries. Especially if the industrial robot is moving objects that can become detached (e.g. from a gripper). For this reason, standing underneath the robot arm is prohibited!

#### smartPAD

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

#### 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 modifications to the software and configuration settings.

Following reconnection of the industrial robot, the robot controller must be rebooted in order to ensure that the correct machine data are loaded.

#### Faults

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

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

### 5.4.2 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.

### 5.4.3 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 functions must also be tested.



The password to activate the safety configuration must be changed before start-up. This password may only be communicated to trained safety maintenance technicians who are authorized to activate the safety configuration.



**DANGER** The robot controller is preconfigured for the specific industrial robot. If cables are interchanged, the manipulator may receive incorrect data and can thus cause personal injury or material damage. If a system consists of more than one manipulator, always connect the connecting cables to the manipulators and their corresponding robot controllers.



If additional components (e.g. cables), which are not part of the scope of supply of KUKA Laboratories GmbH, are integrated into the industrial robot, the user is responsible for ensuring that these components do not adversely affect or disable safety functions.



**NOTICE** If the internal cabinet temperature of the robot controller differs greatly from the ambient temperature, condensation can form, which may cause damage to the electrical components. Do not put the robot controller into operation until the internal temperature of the cabinet has adjusted to the ambient temperature.

#### Function test

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

##### General test:

It must be ensured that:

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

##### Test of the safety functions:

A function test must be carried out for all the safety-oriented functions to ensure that they are working correctly:



In the case of incomplete start-up of the system, additional substitute measures for minimizing risk must be taken and documented, e.g. installation of a safety fence, attachment of a warning sign, locking of the main switch, etc. Start-up is incomplete, for example, if not all safety functions have yet been implemented, or if a function test of the safety functions has not yet been carried out.

#### Machine data

It must be ensured that the rating plate on the robot controller has the same machine data as those entered in the declaration of incorporation. The machine data on the rating plate of the manipulator must be entered during start-up.

#### 5.4.4 Manual mode

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

- Jog mode
- Teaching
- 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 and its tooling must never touch or project beyond the safety fence.
- Workpieces, tooling and other objects must not become jammed as a result of the industrial robot motion, nor must they lead to short-circuits or be liable to fall off.
- All setup work must be carried out, where possible, from outside the safeguarded area.

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

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

- If it can be avoided, there must be no other persons inside the safeguarded area.  
If it is necessary for there to be several persons inside the safeguarded area, the following must be observed:
  - Each person must have an enabling device.
  - All persons must have an unimpeded view of the industrial robot.
  - Eye-contact between all persons must be possible at all times.
- The operator must be so positioned that he can see into the danger area and get out of harm's way.

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

- This mode may only be used if the application requires a test at a velocity higher than Manual Reduced Velocity.
- Teaching is 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-one present inside the safeguarded area. It is the responsibility of the operator to ensure this.

#### 5.4.5 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. Alternatively, the requirements for collaborative operation in accordance with EN ISO 10218 have been met.
- The defined working procedures are adhered to.

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

#### 5.4.6 Maintenance and repair

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

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

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

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



Before work is commenced on live parts of the robot system, the main switch must be turned off and secured against being switched on again. The system must then be checked to ensure that it is deenergized.

It is not sufficient, before commencing work on live parts, to execute an EMERGENCY STOP or a safety stop, or to switch off the drives, as this does not disconnect the robot system from the mains power supply. Parts remain energized. Death or severe injuries may result.

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


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

- Robot controller** Even when the robot controller is switched off, parts connected to peripheral devices may still carry voltage. The external power sources must therefore be switched off if work is to be carried out on the robot controller.
- The ESD regulations must be adhered to when working on components in the robot controller.
- Voltages in excess of 60 V can be present in various components for several minutes after the robot controller has been switched off! To prevent life-threatening injuries, no work may be carried out on the industrial robot in this time.
- Water and dust must be prevented from entering the robot controller.

#### 5.4.7 Decommissioning, storage and disposal

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

#### 5.4.8 Safety measures for “single point of control”

- Overview** If certain components in the industrial robot are operated, safety measures must be taken to ensure complete implementation of the principle of “single point of control” (SPOC).
- Components:
- Tools for configuration of bus systems with online functionality
- 

The implementation of additional safety measures may be required. This must be clarified for each specific application; this is the responsibility of the user of the system.
- Since only the system integrator knows the safe states of actuators in the periphery of the robot controller, it is his task to set these actuators to a safe state.
- T1, T2, CRR** In modes T1, T2 and CRR, a robot motion can only be initiated if an enabling switch on the smartPAD is held down.
- Tools for configuration of bus systems** If these components have an online functionality, they can be used with write access to modify programs, outputs or other parameters of the robot controller, without this being noticed by any persons located inside the system.
- KUKA Sunrise.Workbench
  - WorkVisual from KUKA
  - Tools from other manufacturers
- Safety measures:
- In the test modes, programs, outputs or other parameters of the robot controller must not be modified using these components.

### 5.5 Applied norms and regulations

Name	Definition	Edition
------	------------	---------

<b>2006/42/EC</b>	<b>Machinery Directive:</b> Directive 2006/42/EC of the European Parliament and of the Council of 17 May 2006 on machinery, and amending Directive 95/16/EC (recast)	2006
<b>2004/108/EC</b>	<b>EMC Directive:</b> Directive 2004/108/EC of the European Parliament and of the Council of 15 December 2004 on the approximation of the laws of the Member States relating to electromagnetic compatibility and repealing Directive 89/336/EEC	2004
<b>EN ISO 13850</b>	<b>Safety of machinery:</b> Emergency stop - Principles for design	2008
<b>EN ISO 13849-1</b>	<b>Safety of machinery:</b> Safety-related parts of control systems - Part 1: General principles of design	2008
<b>EN ISO 13849-2</b>	<b>Safety of machinery:</b> Safety-related parts of control systems - Part 2: Validation	2012
<b>EN ISO 12100</b>	<b>Safety of machinery:</b> General principles of design, risk assessment and risk reduction	2010
<b>EN ISO 10218-1</b>	<b>Industrial robots:</b> Safety <b>Note:</b> Content equivalent to <b>ANSI/RIA R.15.06-2012, Part 1</b>	2011
<b>EN 614-1</b>	<b>Safety of machinery:</b> Ergonomic design principles - Part 1: Terms and general principles	2009
<b>EN 61000-6-2</b>	<b>Electromagnetic compatibility (EMC):</b> Part 6-2: Generic standards; Immunity for industrial environments	2005
<b>EN 61000-6-4</b>	<b>Electromagnetic compatibility (EMC):</b> Part 6-4: Generic standards; Emission standard for industrial environments	2007
<b>EN 60204-1 + A1</b>	<b>Safety of machinery:</b> Electrical equipment of machines - Part 1: General requirements	2009





## 6 Planning

### 6.1 Mounting variant

The following mounting variants are available for installing the robot:

- Machine frame mounting with centering (>>> 6.1.1 "Machine frame mounting with centering" Page 41)

#### 6.1.1 Machine frame mounting with centering

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.

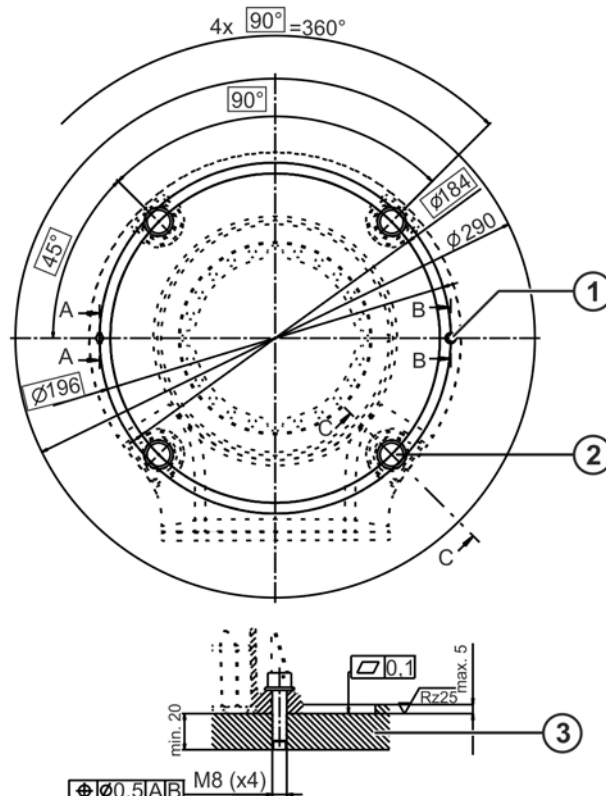
The machine frame mounting assembly consists of:

- Locating pins
- Allen screws

#### Dimensioned drawing

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

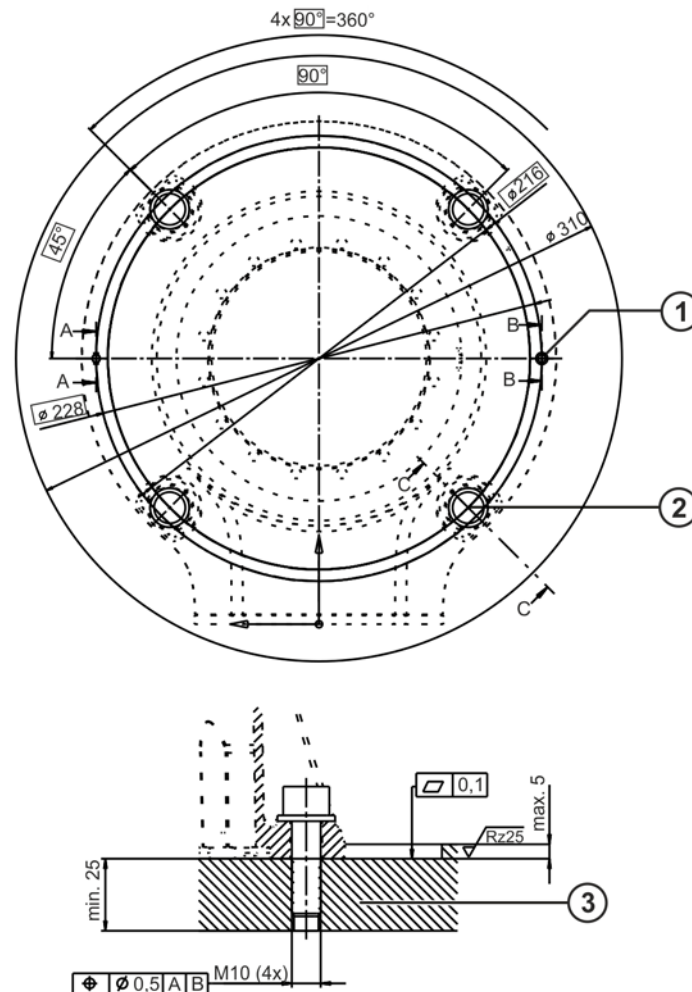
- LBR iiwa 7 R800**



**Fig. 6-1: Dimensioned drawing of machine frame mounting, LBR iiwa 7 R800**

- 6x12 locating pin
- M8x30-8.8 Allen screw (4x) with washer
- Steel structure

## ■ LBR iiwa 14 R820



**Fig. 6-2: Dimensioned drawing of machine frame mounting, LBR iiwa 14 R820**

- 1 6x12 locating pin
- 2 M10x35-8.8 Allen screw (4x) with washer
- 3 Steel structure

## 6.2 Connecting cables and interfaces

### Connecting cables

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

- Data cable with power supply

Depending on the specification of the robot, various connecting cables are used. The standard cable length is 7 m. Cable lengths of 1 m, 3 m, 4 m, 7 m, 15 m and 25 m are optionally available. The maximum length of the connecting cables must not exceed 25 m. If the robot is operated on a linear unit which has its own energy supply chain these cables must also be taken into account.

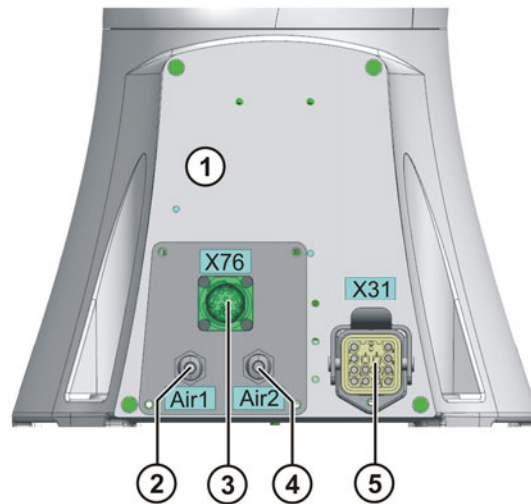
The following points must be observed when planning and routing the connecting cables:

- The bending radius for fixed routing must not be less than 50 mm for motor cables and 30 mm for control cables.
- Protect cables against exposure to mechanical stress.

- Route the cables without mechanical stress – no tensile forces on the connectors
- Cables are only to be installed indoors.
- Observe permissible temperature range (fixed installation) of 263 K (-10 °C) to 343 K (+70 °C).
- Route the connecting cable in a metal duct; if necessary, additional measures must be taken to ensure electromagnetic compatibility (EMC).

### Interface A1

Interface A1 is located at the rear of the base frame. The connections for the motor and data cables are shown in the following illustration.



**Fig. 6-3: Interface A1**

- 1 Base frame
- 2 Air line connection Air1
- 3 Control cable connection X76
- 4 Air line connection Air2
- 5 Data cable with power supply connection X31

### Connection Air1

Customer-specific air connection with the following values:

Designation	Limit values
Max. pressure	7 bar
Vacuum	0.95 bar

### Connection Air2

Customer-specific air connection with the following values:

Designation	Limit values
Max. pressure	7 bar
Vacuum	0.95 bar



## 7 Transportation

### 7.1 Transportation

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 transported, the tooling must be dismantled and the connecting cables must be unplugged.

On delivery of the robot, the transport safeguards such as nails or screws must be removed before installation. If the robot is installed before transportation, it may be jammed tight by rust or glue on contact surfaces.

The robot can be transported in a suitable transport container.



#### **WARNING**

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

#### 7.1.1 Transportation with transport container

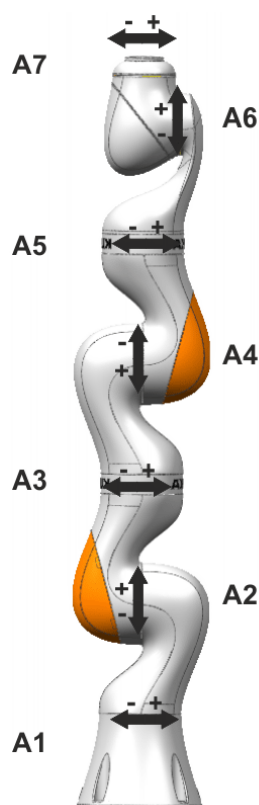
#### **NOTICE**

The robot may only be transported in the transport position and in the transport container provided.

#### **Transport position**

Move the robot into the corresponding transport position each time it is transported. The robot is in the transport position when the axes are in the following positions:

A1 (J1)	A2 (J2)	A3 (J4)	A4 (J5)	A5 (J6)	A6 (J7)	A7 (J8)
0°	0°	0°	0°	0°	0°	0°



**Fig. 7-1: Robot axes**

#### Transport dimensions

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

- Length: 1450 mm
- Width: 480 mm
- Height: 340 mm

The transport dimensions of the transport container provided for this purpose are the same for both robot variants.

The transport container is fitted with antistatic Ethafoam 220. This holds the robot in position and serves as shock-resistant and break-proof packing.

#### Shipment dimensions

The robot is transported in the shipping carton provided for this purpose with the following outer dimensions:

- Length: 1180 mm
- Width: 780 mm
- Height: 560 mm

Move the robot into the corresponding shipping position each time it is transported. The robot is in the shipping position when the axes are in the following positions:

A1 (J1)	A2 (J2)	A3 (J4)	A4 (J5)	A5 (J6)	A6 (J7)	A7 (J8)
0°	25°	0°	90°	0°	0°	0°

The shipment dimensions of the shipping carton provided for this purpose are the same for both robot variants.



**Fig. 7-2: Shipping position**





## 8 Start-up and recommissioning

### 8.1 Installing the machine frame mounting assembly

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

**Precondition**

- The mounting surface is prepared as shown in (>>> Fig. 6-1 )/ (>>> Fig. 6-2 ).
- The substructure has been checked for sufficient safety.
- The machine frame mounting assembly is complete.

**Procedure**

1. Clean the mounting surface of the robot.
2. Check the hole pattern.
3. Insert the sword pin into the hole pattern.
4. Prepare Allen screws and washers.

Robot variant	Allen screws	Nm
LBR iiwa 7 R800	4x M8x30-8.8	23
LBR iiwa 14 R820	4x M10x35-8.8	45

The foundation is now ready for the robot to be installed.

### 8.2 Installing a floor-mounted robot

**Description** This description is valid for the installation of floor-mounted robots.

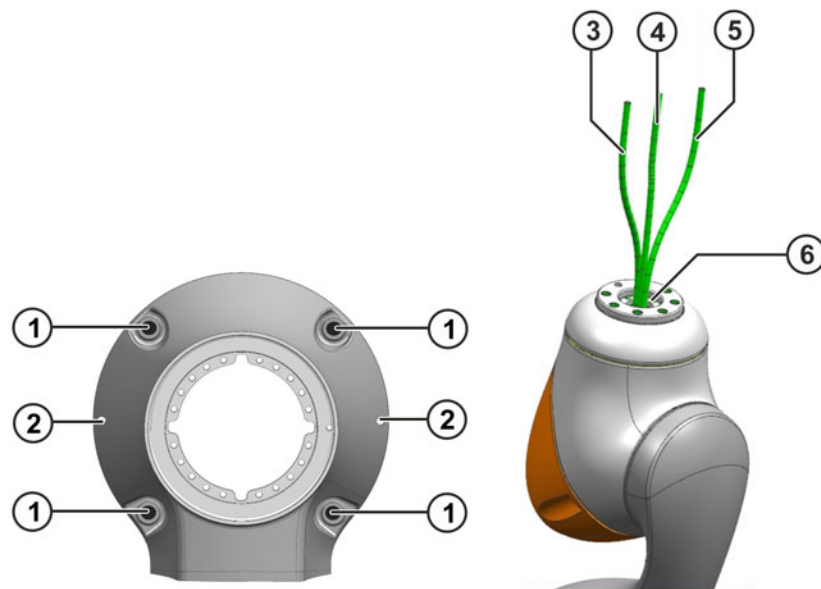
4 Allen screws with washers are used for fastening the robot to the bedplate or to a machine frame. 2 locating pins are provided to ensure correct positioning.

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

**Precondition**

- Holes must be drilled in the mounting base in accordance with the hole pattern.
- The connecting cables must be installed on the system side.
- Any tools or other system components which would hinder the work have been removed.

## Procedure



**Fig. 8-1: Robot installation position**

- |                |                 |
|----------------|-----------------|
| 1 Allen screws | 4 Air line Air1 |
| 2 Locating pin | 5 Air line Air2 |
| 3 Data cable   | 6 Allen screw   |

1. Check that the locating pins are undamaged and fitted securely.
2. Move the robot to the installation site.
3. Carefully 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.
4. Insert 4 Allen screws with washers into the base frame and tighten with a torque wrench in diagonally opposite sequence. Increase the tightening torque to the required value in several stages.

Robot variant	Allen screws	Nm
LBR iiwa 7 R800	4x M8x30-8.8	23
LBR iiwa 14 R820	4x M10x35-8.8	45



Retighten the 4 Allen screws of the base frame with a torque wrench after 100 hours of operation.

5. Connect the data cable.
6. Connect the ground conductor between the robot controller and the robot to the ground conductor connection.
7. Mount tooling, if present.
8. Check the position of all cables. They must not be under mechanical strain nor be able to chafe against other components.
9. If required, mount the tool and connect the energy supply systems.

### 8.3 Overview of connecting cables and interfaces

#### Configuration

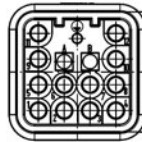
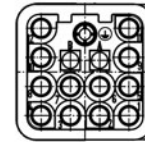
The connecting cable is used to transfer power and signals between the robot controller and the robot.

The connecting cable comprises:

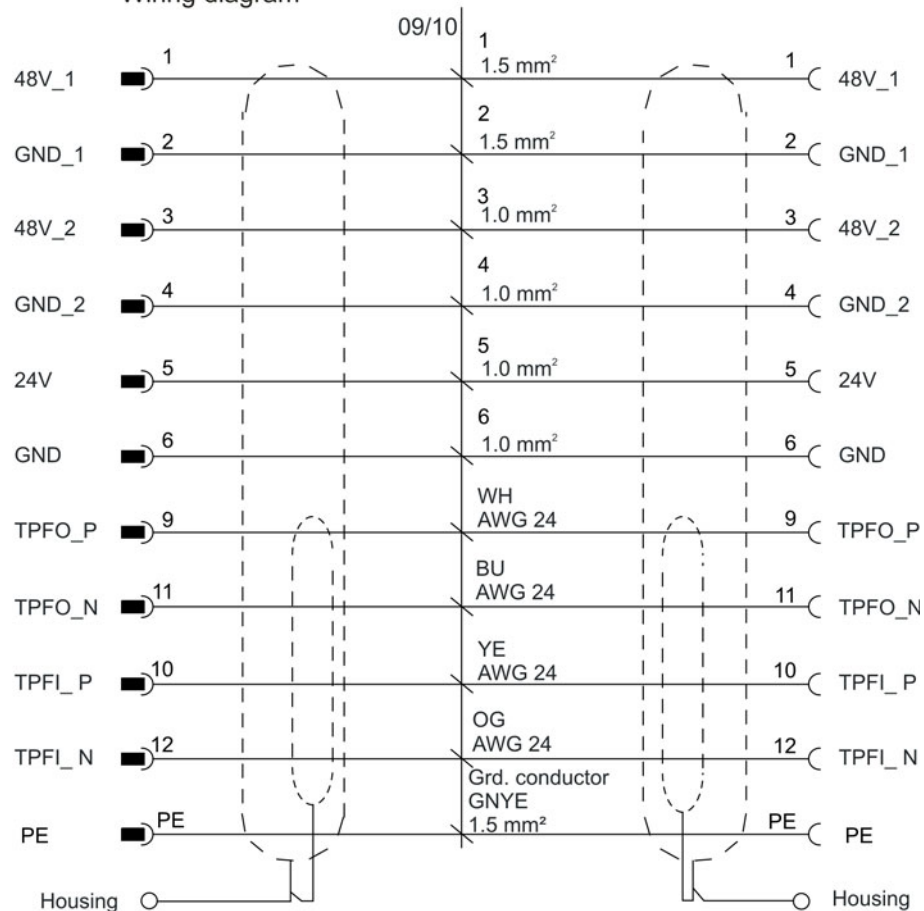
- Data cable with power supply

**Interface**

For connection of the connecting cable between the robot controller and the robot, the following connectors are available at the interfaces:

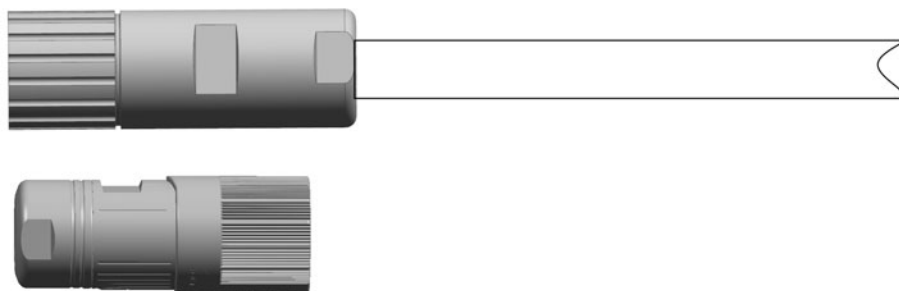
**Standard connecting cable****X21****X31**

Wiring diagram

**Fig. 8-2: Connecting cable, data cable X21 - X31****8.4 Control cable wiring diagram**

The control cable for the energy supply system has the following characteristics:

Characteristic	Description
Operating voltage	60 V AC/DC
Current	EN 60204-1 (derating factors must be taken into account)



Wiring diagram

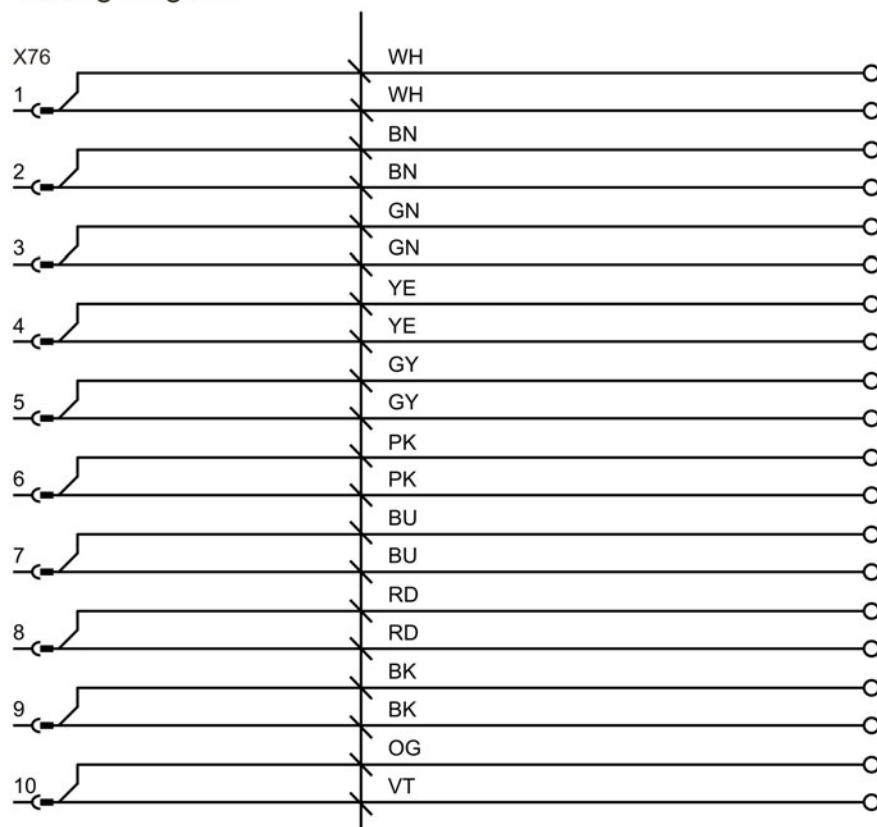


Fig. 8-3: Data cable

### Bypack connector

The following connector shows the connector pin allocation for the energy supply system on the robot.

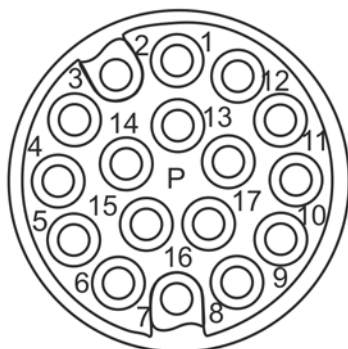


Fig. 8-4: M17 connector, 17-pole, view from contact side

### 8.4.1 Dimensions of the cable

The cable has the following dimensions:

Dimensions	
Outside diameter	4 mm
Inside diameter	2.8 mm
Wall thickness	0.6 mm

The cable has the following characteristics:

Characteristic	Description
Permissible pressure	At 20 °C: 7 bar
	The permissible pressure is dependent on the temperature:
	At 50 °C: 70% of the operating pressure
	At 70 °C: 50% of the operating pressure
	At 80 °C: 45% of the operating pressure
Minimum bending radius	8 mm



## 9 Maintenance

### 9.1 Maintenance

No maintenance required if used for designated purpose.

### 9.2 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. System components, tools and the robot controller must be cleaned in accordance with the cleaning instructions relevant to them.

The following must be taken into consideration when using cleaning agents and carrying out cleaning work:

- Only use solvent-free, water-soluble cleaning agents.
- Do not use flammable cleaning agents.
- Do not use aggressive cleaning agents.
- Do not use steam or refrigerants for cleaning.
- Do not use high-pressure cleaners.
- It must be ensured that no cleaning agent enters electrical or mechanical system components.
- Personnel protection measures must be taken.



#### **WARNING**

Unintentional robot motions can cause injuries and damage to property. If work is carried out on an operational robot, the robot must be secured by activating the EMERGENCY STOP device.

Warn all persons concerned before starting to put it back into operation.

#### Procedure

1. Shut down the robot.
2. If necessary, stop adjacent system components 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. Remove cleaning agents and equipment from the workspace of the robot.
8. Dispose of cleaning agents properly.
9. Install any safety equipment that has been removed and check that it is functioning correctly.
10. Replace any damaged or illegible plates and covers.
11. Put back in place any enclosures that have been removed.
12. Only put fully functional robots and systems back into operation.





## 10 Repair

No repair work is planned for the robot. For further information, please contact your local KUKA Customer Support.



## 11 Decommissioning, storage and disposal

### 11.1 Decommissioning, floor-mounted robots

**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.

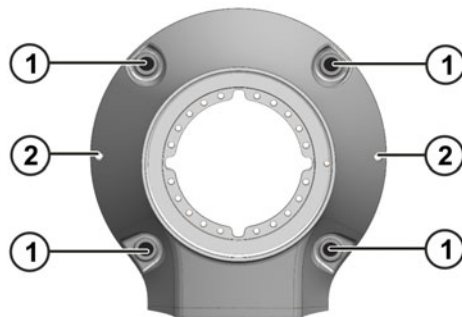
The robot can be transported using the correct transport container (>>> 7 "Transportation" Page 45).

**Precondition** ■ The robot has been brought into the position for removing tooling and other equipment.

**Procedure** 1. Secure the robot.

**⚠ WARNING** Unintentional robot motions can cause injuries and damage to property. If work is carried out on an operational robot, the robot must be secured by activating the EMERGENCY STOP device.  
Warn all persons concerned before starting to put it back into operation.

2. Remove tools and equipment.
3. Put the robot into operation and move it into the transport position.
4. Secure the robot again.
5. Switch the robot controller off.
6. Release and unplug the connecting cables.
7. Remove Allen screws and sword pin.



**Fig. 11-1: Removing a floor-mounted robot**

- 1 Allen screw
- 2 Locating pin
8. Protect the connectors and hose lines against fouling.
9. Lift the robot and place it in the transport container.
10. Prepare the robot for storage (>>> 11.2 "Storage" Page 59).

### 11.2 Storage

**Description** If the robot is to be put into long-term storage, the following points must be observed:

- The place of storage must be as dry and dust-free as possible.
- Avoid temperature fluctuations.
- Avoid wind and drafts.
- Avoid condensation.
- Use appropriate coverings that cannot detach themselves and which can withstand the expected environmental conditions.

- Do not leave any loose parts on the robot, especially ones that might knock against other parts.
- Do not leave the robot exposed to direct sunlight while in storage.
- Observe and comply with the permissible temperature ranges for storage.
- Select a storage location in which the packaging materials cannot be damaged.

### Procedure

1. Move robot into its transport position and remove it.
2. Remove tools and equipment.
3. Clean and dry the robot. No dirt or cleaning agents may remain on or in the robot.
4. Inspect the robot, both internally and externally.
5. Remove any foreign bodies.
6. Remove any corrosion.
7. Attach all covers to the robot and check that the seals are correctly in place.
8. Seal off electrical connections with suitable covers.
9. Seal hose connections by suitable means.
10. Place the robot in the transport container.

## 11.3 Disposal

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

The following table provides an overview of the materials used in the robot.

Material, designation	Subassembly, component	Note
Aluminum, steel	Load-bearing structures	Contain adhesives and paint
	Robot base	
Copper	Cables	
Steel	Screws, locating pin	
PUR	Cable sheaths	
	Joint module	Dispose of joint module without dismantling it.
	Electronic components	Dispose of electronic components without dismantling them.

## 12 KUKA Service

### 12.1 Requesting support

<b>Introduction</b>	This documentation provides information on operation and operator control, and provides assistance with troubleshooting. For further assistance, please contact your local KUKA subsidiary.
<b>Information</b>	<p>The following information is required for processing a support request:</p> <ul style="list-style-type: none"> <li>■ Model and serial number of the manipulator</li> <li>■ Model and serial number of the controller</li> <li>■ Model and serial number of the linear unit (if present)</li> <li>■ Model and serial number of the energy supply system (if present)</li> <li>■ Version of the system software</li> <li>■ Optional software or modifications</li> <li>■ Diagnostic package <b>KrcDiag</b>:            Additionally for KUKA Sunrise: Existing projects including applications            For versions of KUKA System Software older than V8: Archive of the software (<b>KrcDiag</b> is not yet available here.)</li> <li>■ Application used</li> <li>■ External axes used</li> <li>■ Description of the problem, duration and frequency of the fault</li> </ul>

### 12.2 KUKA Customer Support

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