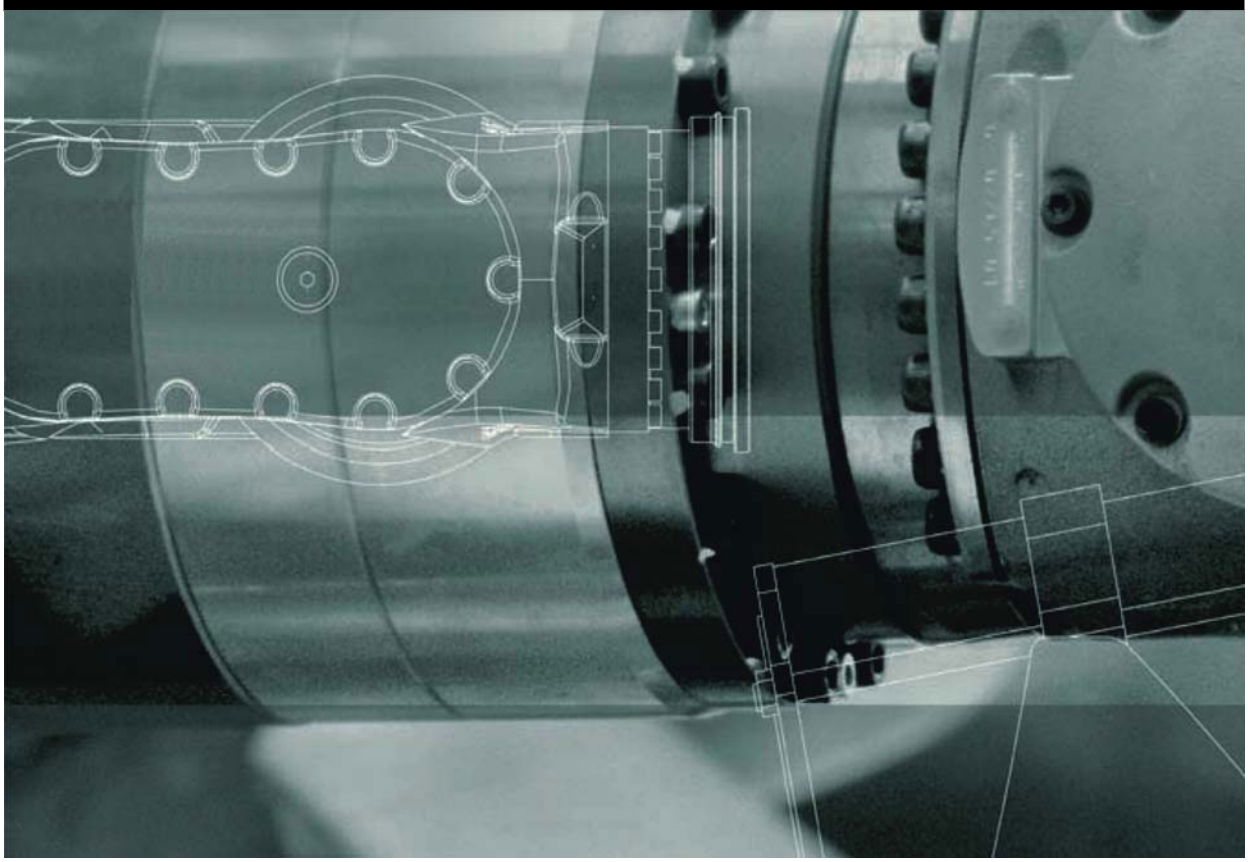
KUKA

Robots

KUKA Roboter GmbH

LBR iiwa Quick Start

First Steps



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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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Contents

1 Introduction

1.1 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.

Instructions

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.

1.2 Terms used

Term	Description
Automatic (AUT)	Operating mode for program execution. The manipulator moves at the programmed velocity.
Operator safety	Physical safeguards which ensure the safety of the operator are referred to as operator safety. This generally consists of an enclosure with a safety gate. Opening the safety gate in certain operating modes triggers a safety stop.
Floor-mounting	Floor-mounting means that the robot is installed on a level surface on the floor. The angles of rotation of the robot base coordinate system (A, B and C) are each 0.0°. If the robot is in the mechanical zero position (all axis angles = 0.0°), its weight only acts vertically on the surface on which the robot is installed.

Term	Description
CRR	**C**ontrolled **R**obot **R**etraction 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 smartHMI	KUKA smart human-machine interface Name of the graphical user interface of the robot controller
KUKA smartPAD	The smartPAD is the hand-held control panel for the robot cell (station). It has all the operator control and display functions required for operation of the station.
T1	Test mode, Manual Reduced Velocity (<= 250 mm/s)
T2	Test mode, High Velocity (> 250 mm/s permissible)
X11	Discrete safety interface of the robot controller. Safety equipment such as safety gates and external EMERGENCY STOP devices can be connected to the safe inputs of this interface.

2 Start-up and recommissioning

2.1 Safety instructions

This document does not describe a complete initial start-up of the industrial robot!

Information about the complete initial start-up of the industrial robot is contained in the chapter “Start-up and recommissioning” in the following documentation:

- Operating instructions or assembly instructions of the robot
- Operating instructions or assembly instructions of the robot controller
- Operating and programming instructions for the System Software
- Operating instructions or assembly instructions for options

NOTICE The LBR iiwa is configured for floor-mounting on delivery. If the robot is mounted on the wall or ceiling or in an inclined position and the configuration is not adapted, malfunctions or damage to the robot can result.

All persons working with the industrial robot must have read and understood the separate documentation on industrial robot safety.

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.

DANGER All external safeguards are disabled on delivery. The service personnel are responsible for ensuring that there is no-one in or near the danger zone of the manipulator as long as the safeguards are disabled or no safety measures have been taken for collaborative operation in accordance with EN ISO 10218.
Failure to observe this may result in death to persons, injuries or damage to property.

DANGER The robot moves during mastering, jogging or when an application is being carried out. It must be ensured that the robot motions cannot cause personal injury or material damage.

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.

2.2 Components

Overview The following components are required for performing initial start-up:

Fig. 2-1: Components (1/2)

Item	Description
1	LBR iiwa
2	KUKA Sunrise Cabinet

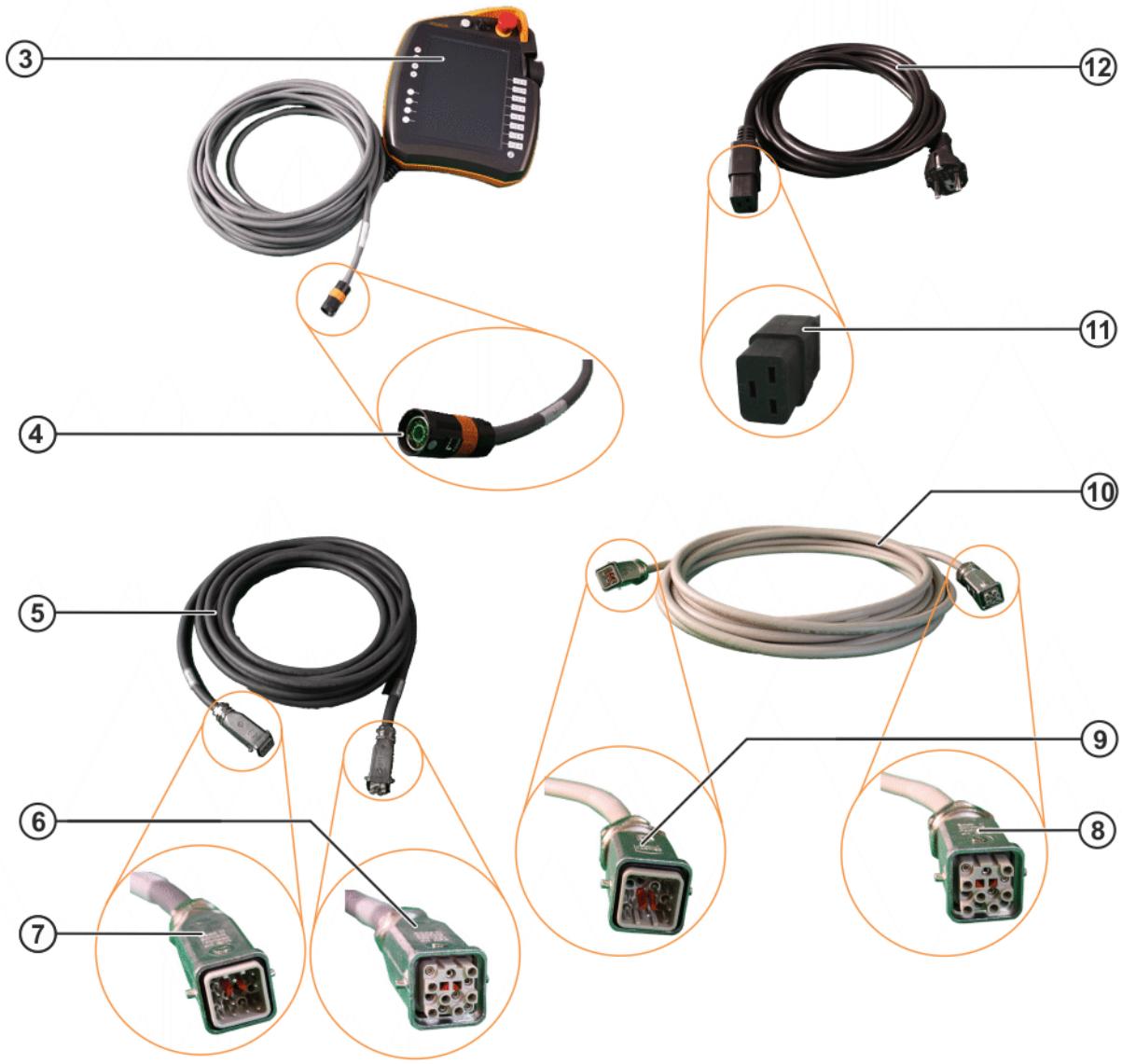

Fig. 2-2: Components (2/2)

Item	Description
3	KUKA smartPAD control panel
4	Connector X19
5	Data cable for controller
6	Connector X31
7	Connector X21
8	Connector X651
9	Connector X650
10	Data cable for media flange MF (optional) **Note**: The data cable for media flange MF is only required if the robot has a media flange with media.
11	Connector K1
12	Power supply cable

Connections

The figure shows all interfaces on the robot controller which are relevant for initial start-up. A complete description of the interfaces can be found in the operating and assembly instructions for the robot controller.

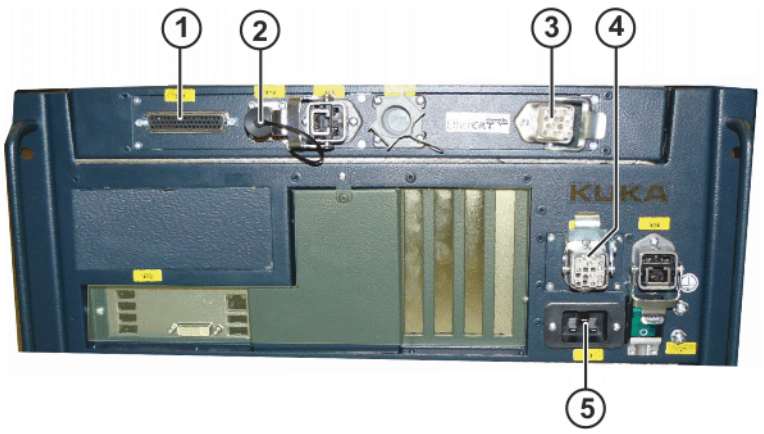

Fig. 2-3: KUKA Sunrise Cabinet interfaces

Item	Interface
1	X11 Safety interface for the connection of operator safety (if required)
2	X19 smartPAD interface
3	X650 Interface for media flange MF
4	X21 Manipulator interface
5	K1 Power supply connection

2.3 First steps

Procedure

1. Floor-mount the robot on a suitable surface in accordance with the operating or assembly instructions.

> **⚠ WARNING** The robot can be moved in T1 mode without operator safety. In operating modes T2 and AUT, operator safety is essential. Operator safety must be connected to X11.

> Further information on interface X11 can be found in the operating instructions for **KUKA Sunrise Cabinet**.

2. Connect the connecting cables:
   - smartPAD to interface X19
   - Data cable for controller: X21 to controller and X31 to robot base
   - Data cable for media flange MF (optional) to controller and robot base
   - Operator safety (if required) to interface X11
   - Power supply: K1 power supply connection to K1 and mains connector to socket (230 V)

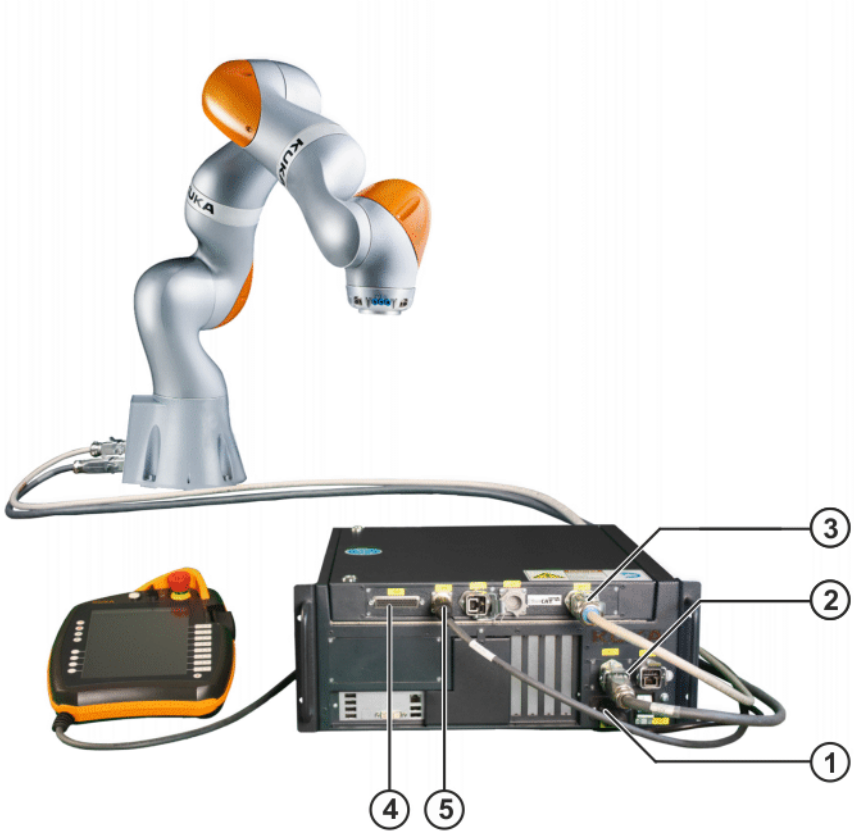

Fig. 2-4: Overview of connecting cables

Item	Description
1	Power supply (controller/mains)
2	Connecting cable (controller/robot base)
3	Data cable
4	Operator safety (if required)
5	Connecting cable to the smartPAD

3. Turn the main switch on the robot controller to the “I” position.

Fig. 2-5: Main switch

Item	Description
1	Main switch

The system software starts automatically. The system is booted. The controller is ready for operation when the smartHMI can be seen on the smartPAD.

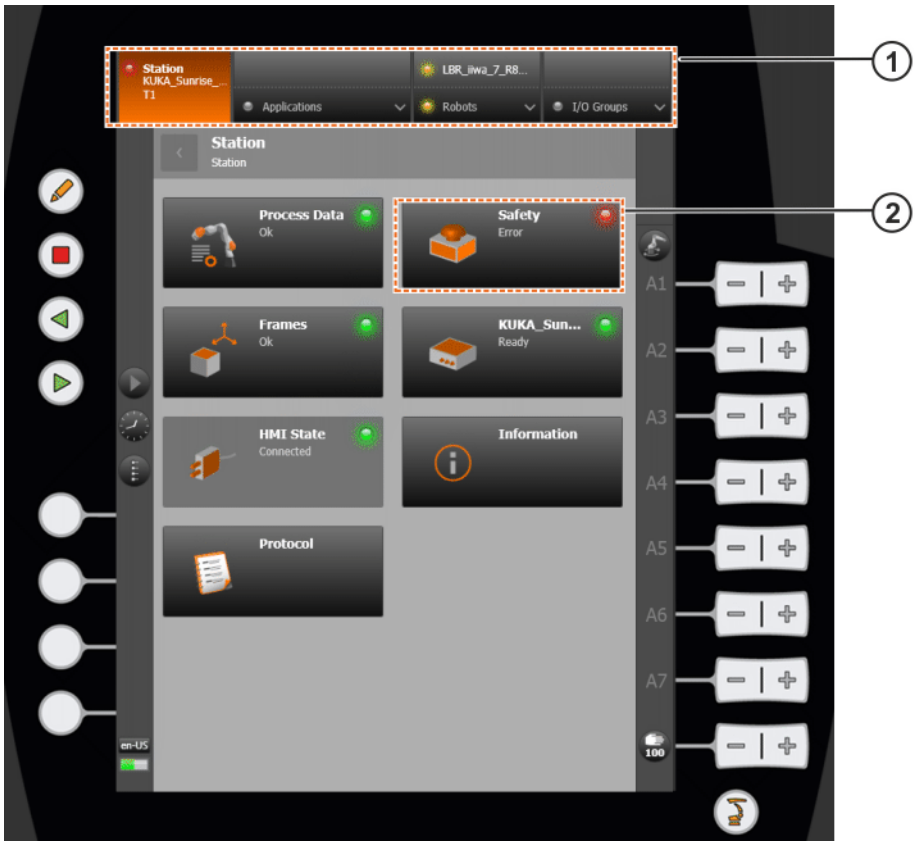

Fig. 2-6: Controller ready for operation

Item	Description
1	Navigation bar
2	Safety tile

4. In order to select T1 mode, the keyswitch on the smartPAD must be turned to the right.
5. Select T1 mode and turn the keyswitch back to the left. The selected operating mode is displayed on the navigation bar.
6. Activate the safety configuration on the robot controller:
   a. In the Station view, select **Safety** > **Activation**.
   b. Enter the password (default: **argus**) and confirm with **Activate**.
7. Before the robot can be moved, the EMERGENCY STOP device on the smartPAD must be released.
   Turn the EMERGENCY STOP device clockwise to release it.

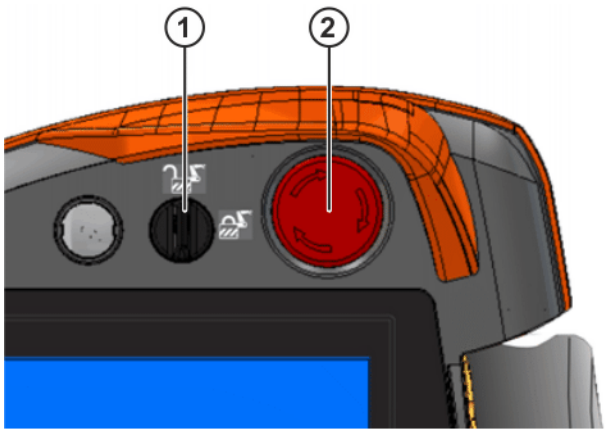

Fig. 2-7: EMERGENCY STOP device

Item	Description
1	Keyswitch
2	EMERGENCY STOP device on the smartPAD

8. Select the **Robots** level. The robot view is opened.
   Select **Mastering** in the Robots view. The **Mastering** view opens.

Fig. 2-8: Mastering status display

Item	Description
1	**Robots** level
2	**Mastering** tile

9. The mastering status of the axes is displayed in the **Mastering** view. If an axis is unmastered, the status display lights up red.
   To master unmastered axes, press the enabling switch (rear of the smartPAD) to the center position, hold it down and simultaneously press the **Master** button. The axis is mastered.

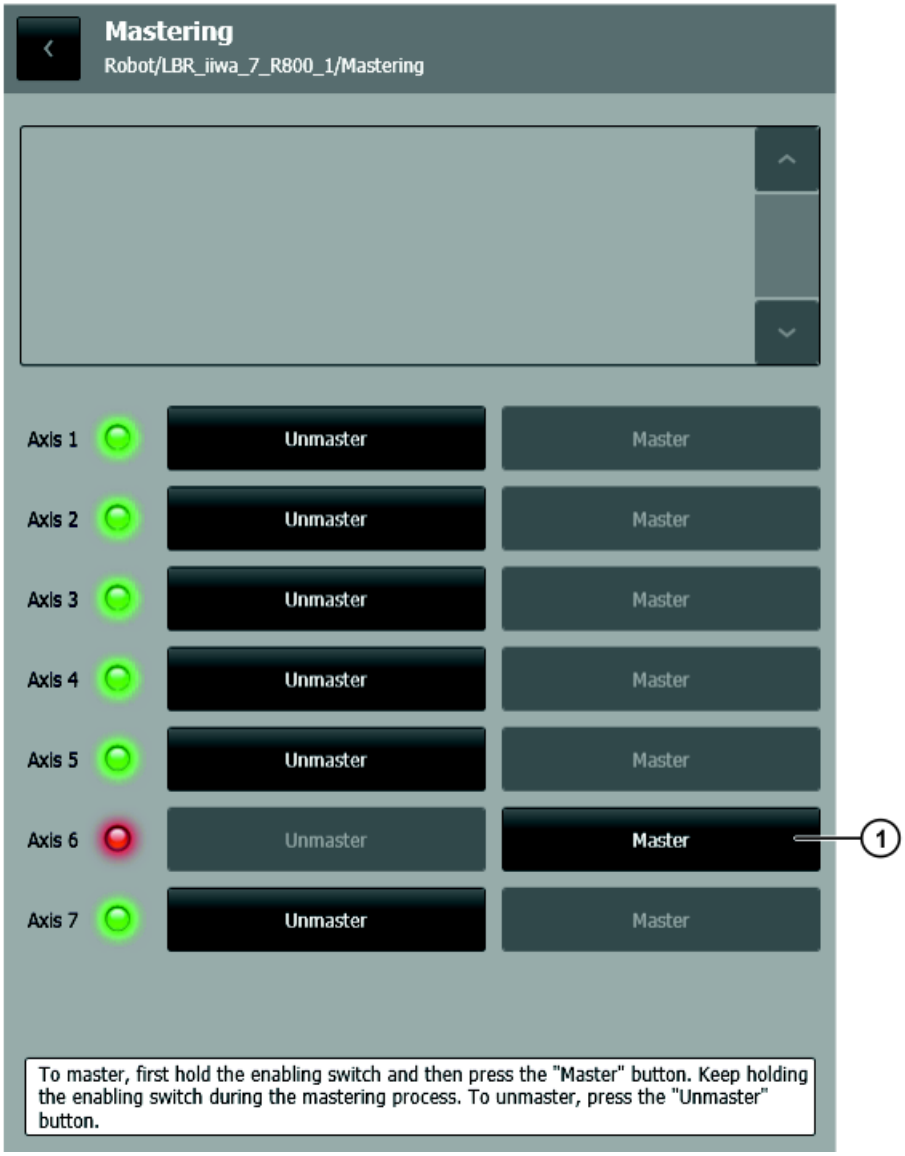

Fig. 2-9: Carrying out mastering

Item	Description
1	**Master** button

When all axes have been mastered, the robot is ready for operation. The status display in the navigation bar lights up green.

There are two options:

- The robot can be jogged.
- The supplied sample applications can be executed.
  (>>> 3.1 "Overview of sample applications" Page 19)

2.3.1 Jogging the robot

Procedure

1. Set the desired jogging type in the jogging options.
2. Set the jog override.
3. Press the enabling switch (rear of the smartPAD) and hold it down in the center position.

   When the displays next to the jog keys light up white, the robot can be jogged with the jog keys.

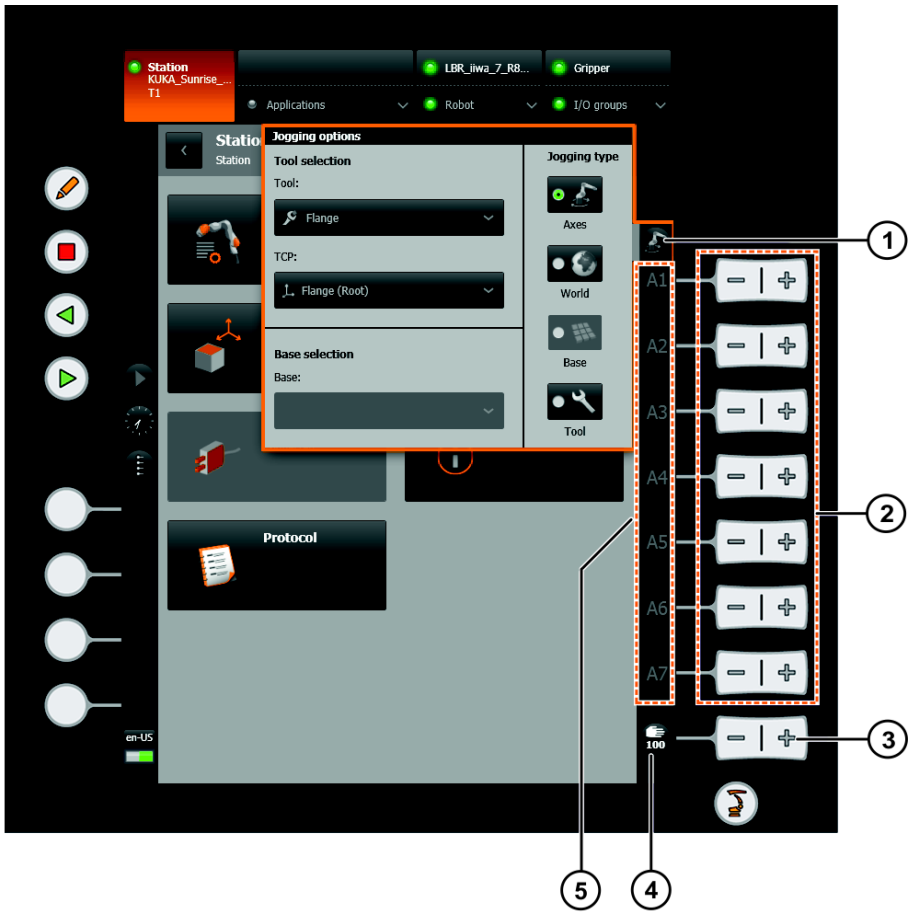

Fig. 2-10: Setting the jogging options

Item	Description
1	**Jogging options** button (opens the **Jogging options** window).
2	Jog keys for moving the robot manually
3	Key for setting the jog override
4	Jog override display
5	Displays for jog keys

2.3.2 Selecting and executing an application

Procedure

1. Select the desired application.
2. Set the program override.

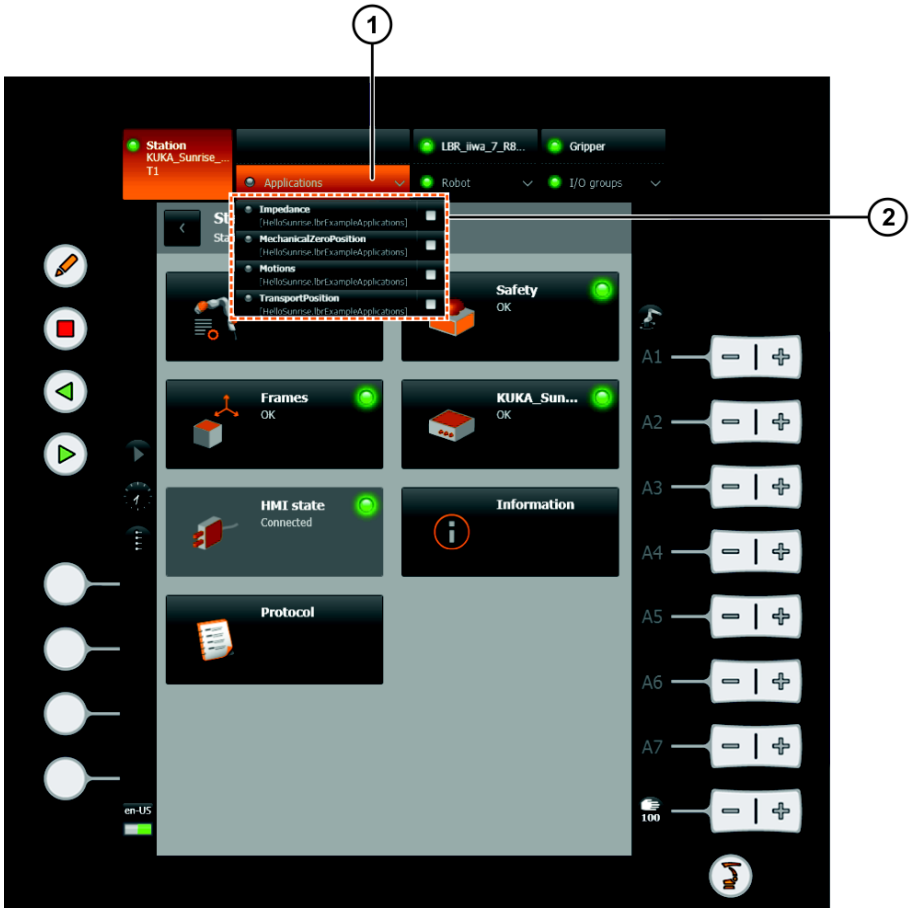

Fig. 2-11: Selecting an application

Item	Description
1	**Application** selection list
2	Supplied applications

1. Press the enabling switch (rear of the smartPAD) and hold it down in the center position.
2. Press Start key and hold it down.
   The application is executed.

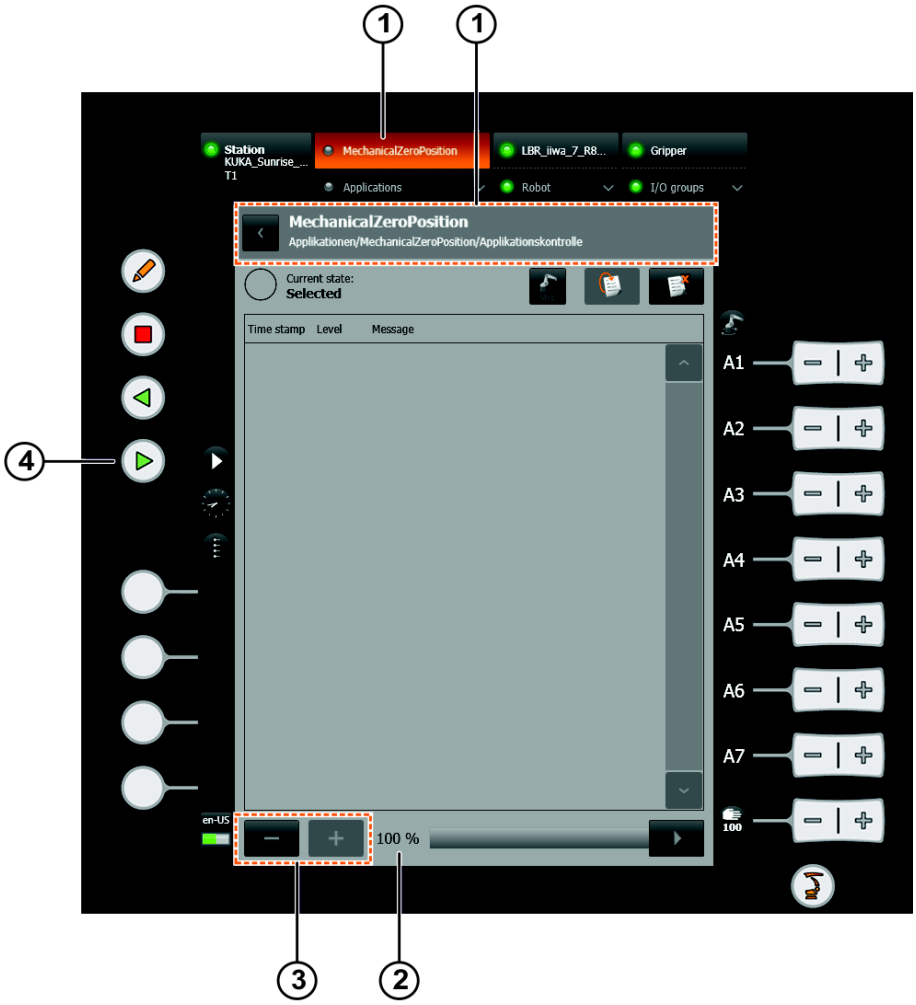

Fig. 2-12: Executing an application

Item	Description
1	Display of selected application
2	Display of program override
3	Keys for setting the program override
4	Start key

Further information about operating the industrial robot is contained in the operating and programming instructions for the System Software.

3 Application examples

3.1 Overview of sample applications

Following initial start-up, the active project on the robot controller contains 4 sample applications which present several core functions of KUKA Sunrise and the LBR iiwa.

The following points must be observed when carrying out the applications:

- Until the necessary safety functions have been configured, it is only permissible to execute the applications in T1 mode.
- The robot moves while an application is being executed. The end positions for each application are described below. It must be ensured in advance that the robot motions cannot cause personal injury or material damage.
- The robot velocity for all motions in the application is specified as 25% of the maximum velocity. In order to detect and avoid collisions in time, the robot must be monitored very precisely while the application is being carried out.

The sample applications can be downloaded from the controller and used as a basis for user-specific applications.
Further information about the procedure is contained in the operating and programming instructions for the System Software.

3.1.1 “MechanicalZeroPosition” application

The application moves the robot to its mechanical zero position.

Procedure

1. After the application is started, a dialog describing the application sequence is displayed on the smartHMI.
2. When the operator confirms the dialog with **OK**, the application is continued.
3. Starting from the current robot position, all robot axes are moved with a PTP motion to their mechanical zero position:

Axis	A1	A2	A3	A4	A5	A6	A7
Position	0.0°	0.0°	0.0°	0.0°	0.0°	0.0°	0.0°

4. The application ends when all axes have reached their mechanical zero position.

Fig. 3-1: Robot in mechanical zero position

3.1.2 “TransportPosition” application

The application moves the robot to the transport position (= position in which the robot is transported in the transport packaging provided).

Procedure

1. After the application is started, a dialog describing the application sequence is displayed on the smartHMI.
2. When the operator confirms the dialog with **OK**, the application is continued.
3. Starting from the current robot position, the robot is moved with a PTP motion to the transport position:

Axis	A1	A2	A3	A4	A5	A6	A7
Position	0.0°	25.0°	0.0°	90.0°	0.0°	0.0°	0.0°

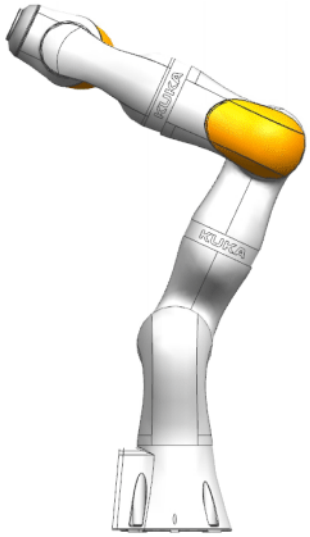

Fig. 3-2: Robot in transport position

4. When the robot has reached the transport position, the application ends.

3.1.3 “Impedance” application

The application moves the robot to a position in which it is compliant in the X, Y and Z directions of the flange coordinate system. The robot is under impedance control.

Procedure

1. After the application is started, a dialog describing the application sequence is displayed on the smartHMI.
2. When the operator confirms the dialog with **OK**, the application is continued.
3. Starting from the current robot position, the robot is moved with a PTP motion to the following position:

Axis	A1	A2	A3	A4	A5	A6	A7
Position	0.0°	10.0°	0.0°	-80.0°	0.0°	90.0°	0.0°

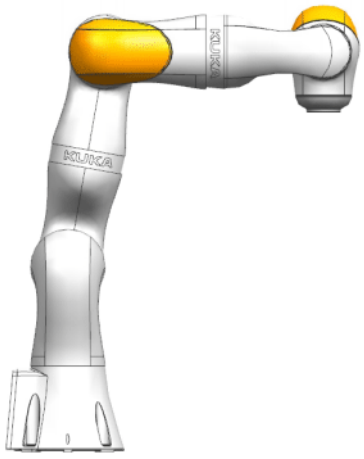

Fig. 3-3: Start position

4. When the position has been reached, the robot is under impedance control. The robot remains in this position but can be pushed away in the X, Y and Z directions of the flange coordinate system. The following stiffness values are parameterized:
   - X: 1500 N/m
   - Y: 700 N/m
   - Z: 2500 N/m

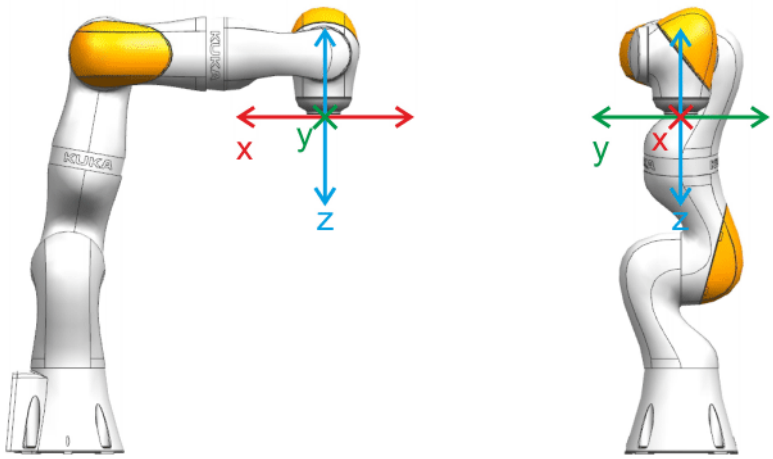

Fig. 3-4: Flange coordinate system

5. When the position has been reached, a dialog is displayed on the smartHMI.

6. The application is ended when the operator confirms the dialog with **OK**.

3.1.4 “Motions” application

The application moves the robot to a start position from which it carries out various motions.

Procedure

1. After the application is started, a dialog describing the application sequence is displayed on the smartHMI.
2. When the operator confirms the dialog with **OK**, the application is continued.
3. Starting from the current robot position, the robot is moved with a PTP motion to the start position:

Axis	A1	A2	A3	A4	A5	A6	A7
Position	0.0°	20.0°	0.0°	-110.0°	0.0°	-40.0°	90.0°

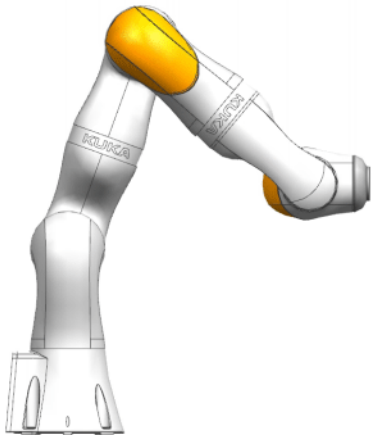

Fig. 3-5: Start position

4. From the start position, the robot flange is moved along a horizontal figure eight. Roughly the following path results:

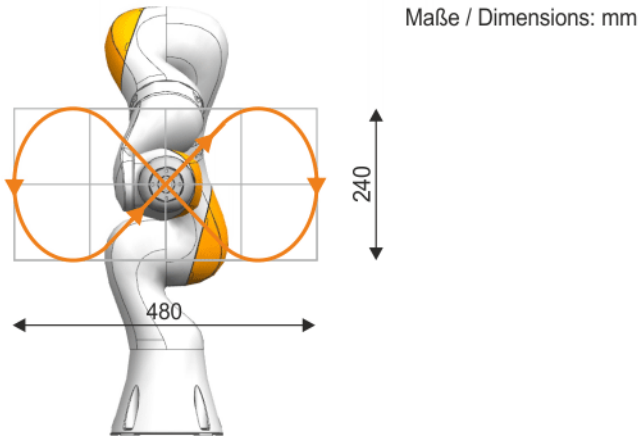

Fig. 3-6: Path

5. The path ends at the start position. From the start position, a null space is executed. In the process, the redundancy angle/elbow angle is changed to -80.0°. During the motion, the robot flange maintains its position and orientation in space; the robot elbow is swiveled to the side.

   The robot now has the following axis configuration:

Axis	A1	A2	A3	A4	A5	A6	A7
Position	57.0°	50.0°	-80.0°	-110.0°	16.0°	-47.0°	152.0°

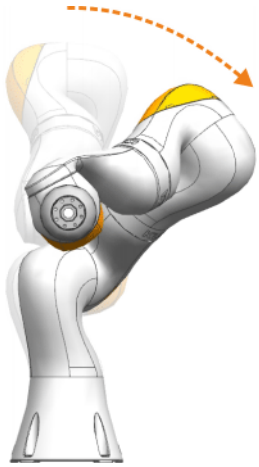

Fig. 3-7: Null space motion (1st position)

6. Another null space motion is executed from this axis configuration. In the process, the redundancy angle/elbow angle is changed to 80.0°. During the motion, the robot flange maintains its position and orientation in space; the elbow of the robot is swiveled to the other side.

   The robot now has the following axis configuration:

Axis	A1	A2	A3	A4	A5	A6	A7
Position	-57.0°	50.0°	80.0°	-110.0°	16.0°	-47.0°	28.0°

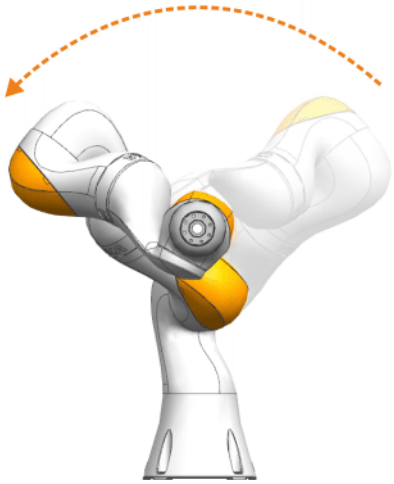

Fig. 3-8: Null space motion (2nd position)

7. From this axis configuration, another null space motion is executed back to the start position. The robot elbow is straightened in the process.
8. When the robot has reached the start position, the application ends.

3.2 Safety configuration on delivery

The robot controller is shipped with a safety configuration that is active on initial start-up.

The following stop reaction triggers are active on delivery:

Trigger	T1, CRR	T2	AUT
Safety gate opened (operator safety)	-	Safety stop 1 (path-maintaining)	
Enabling switch released	Safety stop 1 (path-maintaining)		-
Enabling switch pressed fully down (panic position)	Safety stop 1 (path-maintaining)		-
Local E-STOP pressed	Safety stop 1 (path-maintaining)		

Index