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FRANKA EMIKA ROBOT'S INSTRUCTION HANDBOOK

SECTION 1
General information

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Assembly instructions for Franka Emika Robot as a partly completed machinery

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Further user instructions for Franka Emika Robot system

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Other products (Hand, Franka Emika Robot for Researchers, and CE out of the box solutions)

FRANKA EMIKA

ORIGINAL HANDBOOK

Franka Emika GmbH
Frei-Otto-Straße 20
80797 Munich
Germany

The content of this document has been carefully checked against compliance with the hardware and software described. However, discrepancies cannot entirely be ruled out, which is why we assume no liability for complete compliance.

In the interest of our customers, we reserve the right to undertake improvements and corrections to hardware, software and documentation at any point in time without notice.

We are always grateful for your suggestions and criticism at documentation@franka.de

The English documentation is the ORIGINAL DOCUMENTATION. Other languages are translations of this original document.

Release Version: October 2021, valid for software version 4.2.0 and higher.

CONTENT OVERVIEW

Section 1 - General information

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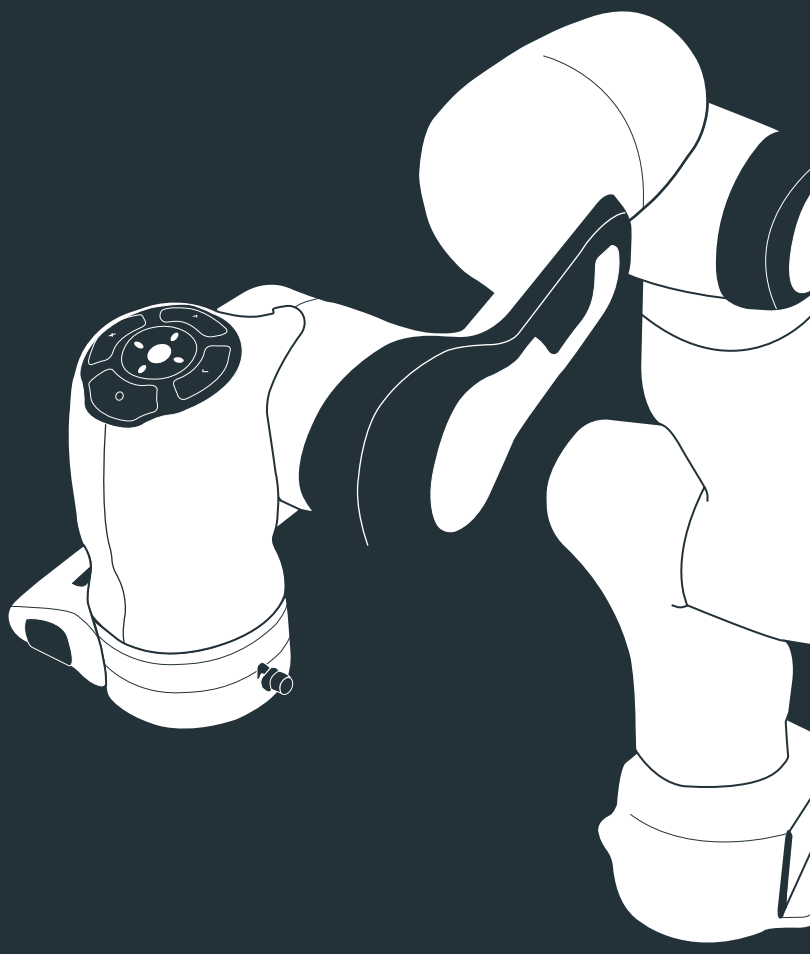
SECTION 1

General information

INTRODUCTORY ASPECTS ABOUT FRANKA EMIKA ROBOT AND THIS HANDBOOK

- Safety instructions and general indications
- Changelog
- Glossary
- Notice of liability
- Staff
- Intended use of Franka Emika Robot
- General safety measures



INTRODUCTORY ASPECTS ABOUT FRANKA EMIKA ROBOT AND THIS HANDBOOK

Safety instructions and general indications

Before installation, start-up and operation of the device carefully read this manual and any additional documentation related to it. In particular, take note of the safety instructions and general indications, which are marked as follows:

Safety

DANGER

DANGER indicates that nonobservance of instructions or measures will lead to death or severe injury.

WARNING

WARNING indicates that nonobservance of instructions or measures may lead to death or severe injury.

CAUTION

CAUTION indicates that nonobservance of instructions or measures may lead to minor or moderate injury.

Warnings marked with a yellow exclamation mark indicate general safety-related information.

SAFETY - INSTRUCTION

SAFETY INSTRUCTION indicates processes that need to be strictly observed.

Indications

NOTICE

A text section marked with NOTICE indicates that nonobservance of instructions or measures may result in damage other than physical injury.

Indicates where further information can be obtained.

Changelog

Changes to this present document with respect to previous Version October 2020 include:

- System's name changed to Franka Emika Robot.
- New color code “cyan” added (pages 73, 74, 118).
- Paragraphs “Single Point of Control” and “Initiating Motion” added (pages 148-151).

Glossary

Naming	Description
Franka Emika GmbH	Franka Emika GmbH (abbreviated FE) is the company name. We have developed and are now producing Franka Emika Robot.
Franka Emika Robot/Franka Emika Robot System	The system components Arm and Control compose the Franka Emika Robot System, hereafter simply called Franka Emika Robot.
Franka Emika Robot – CE out of the box solutions	For certain applications Franka Emika has already carried out the conformity assessment procedure according to the Machinery Directive. These so-called CE out of the box solutions can be acquired by the customer within the European Economic Area, Switzerland and Turkey. After carrying out a quick check, Franka Emika Robot - CE out of the box solutions can be used immediately without the need for further hazard and risk assessment.
Arm	The Arm is our sensitive robotic arm with 7 axes and is part of Franka Emika Robot.
Control	The Control is the main control computer and is part of Franka Emika Robot.
Hand	The Hand is an electrical two-finger parallel gripper designed for Franka Emika Robot. The Hand is optionally available.
Franka Control Interface (FCI)	The Franka Control Interface (FCI) is a low-level 1 kHz interface to command torques, joint positions/velocities or Cartesian poses/twists through an external UDP channel. This interface is only available for research purposes.
Pilot	The Pilot is the user interface on the Arm for guiding and operating the Arm and/or Desk. It includes the Grip and the Disc.
Desk	Desk is Franka Emika‘s web-based, intuitive and graphical programming and user interface.

INTRODUCTORY ASPECTS ABOUT FRANKA EMIKA ROBOT AND THIS HANDBOOK

Interface device	The interface device (a commercially available PC, tablet or notebook with web browser) is connected to the base of the Arm via Ethernet cable. Via the interface device Desk can be accessed in a web browser.
PC workstation	A PC workstation can optionally be connected to the Control via Ethernet. A workstation is required for using the real-time interface FCI of Franka Emika Robot.
Web browser	A software application running on an interface device serving as the connection to Desk, and provides the environment for the intuitive, graphical user and programming interface. Examples include: Chrome, Edge and Firefox
Franka Academy	Franka Academy (abbreviated FE Academy) is our training center
Franka World	Franka World is Franka Emika's cloud-based solution to manage entire robot fleets and get access to Apps and features through the Franka Store: https://www.franka.de/world
Franka Store	Franka Store is Franka Emika's online store. It offers Apps, bundles and hardware to be ordered easily online. It is part of Franke World: https://www.franka.de/world
App	Apps are modular robot programs, each representing a partial step of a robot task. They can be purchased in the Franka Store and can be parametrized in Desk to form entire automation tasks. On a technica level, Apps are state machines with a specific format.
Task	A Task in Desk represents an entire automation routine. A Task consists of one or several Apps.
Integrator	The integrator is the person responsible for assembling the partly completed machinery into the final machinery, and conducts appropriate analysis to identify residual risks and eliminate or minimize them, so as not to compromise safety and health. The integrator is responsible for the safety of the final application. For further information, see chapter: Introduction/ Staff.

Responsible person	The responsible person for Franka Emika Robot can be e.g. the entrepreneur, director of the institute, the employer or a delegate responsible for the use of Franka Emika Robot. The responsible person is responsible for compliance with regulations of occupational health and the operational safety ordinance (e.g. for the US: e.g. OSHA regulations and public laws).
Operator	The operator is a person authorized to access Franka Emika Robot and utilize the user interface Desk to use Franka Emika Robot within the limits defined by the responsible person and the administrator. Within Desk, the role “operator” can be assigned to users. Operators only have limited access to Desk.
Administrator	Administrator is a person authorized by the responsible person to access the robotic system and utilize the user interface Desk to: - set and change roles, access rights and passwords - set and change non safety-related parameters of the system (e.g. change end-effector settings,...) - program and teach the robot system
Grip	The Grip is part of the Pilot and is used for manual guiding.
Disc	The Disc is part of the Pilot and is used for interacting with the Arm and/or Desk.
Enabling button	The enabling button is part of the Grip and thereby the Pilot. It allows the activation of the Arm’s motion.

INTRODUCTORY ASPECTS ABOUT FRANKA EMIKA ROBOT AND THIS HANDBOOK

Emergency stop device	The emergency stop device is integrated between the mains electricity and the Control, in order to cut off the power supply to Franka Emika Robot in the case of an emergency. This will cause Franka Emika Robot to brake at maximum capacity and the locking bolts to mechanically lock the Arm.
External enabling device	The external enabling device is plugged into the Arm‘s base. When the external enabling device is half pressed it is possible to test and run automatic robot programs, as long as the device remains half pressed.
External activation device	The external activation device is plugged into the female connector X3 of the Arm. Once the external activation device is in the position ‘up state’, automatic execution of tasks can be carried out with the Arm.
Connecting cable	The connecting cable connects the Arm with the Control.
Fail-safe safety locking system	The fail-safe safety locking system locks all 7 axes of the Arm, as soon as the Arm is no longer powered, such that the Arm stays in position even when turned off. Hereinafter it will also be referred to as safety locking system.
Unlocking tool	The unlocking tool can be used for manually unlocking the safety locking system in case of emergency to move the Arm even when the Arm is not energized.
Emergency unlocking	Emergency unlocking is the process of using the unlocking tool to unlock the safety locking system in order to manually move the Arm when the Arm is not energized.
Emergency unlock	The emergency unlock labels on the Arm indicate the three positions on the Arm where an emergency unlock can be carried out.
Axes/joints	The robotic arm consists of 7 consecutive joints or axes. The motion is created in these joints.
Guiding	Guiding describes the procedure of taking the Arm by the hand and moving it manually, for example to teach a new pose.
Guiding mode	Guiding modes facilitate guiding by locking or unlocking different directions or rotations in space. For example, the Arm can be moved in three directions in space. You can switch between guiding modes either using the guiding mode button on the Grip or directly from Desk.
Guiding Button	The guiding button is located on the grip of the Pilot. By using this button you can guide the Arm, as long as the enabling button is half-pressed too.

Teaching	The process of teaching uses guiding in order to move the Arm into a certain pose and then learn and memorize this pose, for example.
Tracking Error	The actual motion of the Arm follows the target motion with a small deviation, a so-called tracking error.
Pose	A pose is the position of the Arm including its positioning and orientation in space.
Working Space	Space which can be swept by the wrist reference point increased by the range of rotation or translation of each joint in the wrist. For further information, see also the description in chapter: Planning ahead/ Hazardous and safe areas.
Hazardous Zone	Hazardous or danger zone - any space with and/or around machinery in which a person can be exposed to a hazard. See also the description in chapter: Planning ahead/ Hazardous and safe areas.
Safeguarded Space	Space defined by the perimeter safeguarding. See also the description in chapter: Planning ahead/ Hazardous and safe areas.
Protective Measures	Measure intended to achieve risk reduction, implemented - by the designer and/ or integrator (inherently safe design, safeguarding and complementary protective measures, information for use) and/or - by the responsible person/integrator (organization: safe working procedures, supervision, permit-to-work systems; provision and use of additional safeguards; use of personal protective equipment; training)

INTRODUCTORY ASPECTS ABOUT FRANKA EMIKA ROBOT AND THIS HANDBOOK

Stopping Distance	The stopping distance is the distance the Arm will cover after activation of the emergency stop device until it comes to a full stop.
Stopping Time	The stopping time is the time that passes after the emergency stop device has been activated until the Arm comes to a full stop.
Cartesian	The Cartesian space is the three dimensional space in which all axes (x, y and z) are perpendicular to each other.
Interaction	Franka Emika Robot is designed to be easily and safely programmed and operated, and to be able to quickly learn and relearn new tasks. When Franka Emika Robot is in “monitored stop” mode or is being guided (teaching mode), Franka Emika Robot glows white to indicate that the Arm is ready for interaction.
Center Of Mass (COM)	The center of mass is the center of gravity of an object. At this point, gravitational force comes into effect.
Machinery Directive (2006/42/EU)	The Machinery Directive (2006/42/EG), hereinafter referred to as Machinery Directive or MD, regulates a standardized level of protection for the prevention of accidents for machinery and partly completed machinery within the European Economic Area, Switzerland and Turkey.
Low Voltage Directive 2014/35/EC	The Low Voltage Directive (2014/35/EC), hereinafter referred to as Low Voltage Directive (LVD), regulates the safety of electronically operated devices within the European Economic Area, Switzerland and Turkey.
Stop category 0	Stopping by immediate removal of power to the machine actuators (acc. to EN 60204).
Stop category 1	A controlled stop with power available to the machine actuators to achieve the stop and then removal of power when the stop is achieved (acc. to EN 60204).
Stop category 2	A controlled stop with power remaining available to the machine actuators (acc. to EN 60204).
EMI Directive 2014/30/EU	The EMI Directive (2014/30/EC), hereinafter referred to as EMI Directive, regulates the electromagnetic compatibility of devices within the European Economic Area, Switzerland and Turkey.
RoHs Directive 2011/65/EU	The RoHs Directive (2011/65/EU), hereinafter referred to as RoHs Directive, restricts the use of certain dangerous substances in electrical and electronic equipment within the European Economic Area, Switzerland and Turkey.

REACH 1907/2006	The REACH regulation (EG) 1907/2006, hereinafter referred to as REACH, is a chemicals regulation.
FCC rule 47 CFR part 15	FCC stands for Federal Communications Commission. It is an independent US agency regulating communications by radio, satellite and cable. In particular, it regulates issues regarding the electromagnetic compatibility of devices.
OSHA	OSHA is the Occupational Safety and Health Administration. It is a US federal authority regulating occupational safety and health issues.
libfranka	libfranka is a C++ software library that implements the client-side interface of the FCI, i.e. the drivers implementing the 1 kHz UDP-based communication with the robot. It also gives access to the robot model library, which provides the kinematic and dynamic model of the robot. It can be accessed by: https://www.github.com/frankaemika/
franka_ros	franka_ros is a software library that integrates libfranka into the ROS ecosystem (https://www.ros.org/). It can be accessed by: https://www.github.com/frankaemika/

INTRODUCTORY ASPECTS ABOUT FRANKA EMIKA ROBOT AND THIS HANDBOOK

Notice of liability

The present Franka Emika Robot system is intended exclusively for use as described in this Handbook.

Franka Emika Robot has been developed according to the quality standards of EN ISO 9001. The production of our devices is carried out in a production company certified according to EN ISO 9001. A hazard and risk assessment according to EN ISO 12100 has been carried out through the course of development and is the basis for Franka Emika Robot and this Handbook. Misuse can, nevertheless, cause danger to life and limb and impairments and damages to the robot and other material assets.

Therefore:

- Franka Emika Robot may only be used in sound technical condition, for its intended purpose and within the technical specifications and operating conditions, with awareness of safety and possible dangers
- Use must comply with the instructions of this Handbook
- Malfunctions that may impair safety need to be rectified immediately
- Modifications of Franka Emika Robot are not permissible

The producer is not liable for damages caused by misuse as exemplified above.

Staff

WARNING

Insufficiently qualified staff may cause severe damage to persons or material damage to machinery and equipment!

Therefore:

- All persons that may enter the Working Space of the Arm need to have read and understood this documentation, in particular see chapter: Planning ahead/, chapter: Emergency operation guidelines/ and chapter: Start-up/. They need to be able to use their knowledge and experience to understand any risks the robot system may present and be adequately prudent in their behavior.
- The responsible person has to inform these persons explicitly about the limitations and restrictions of Franka Emika Robot.

WARNING

Persons using Franka Emika Robot in any form must be in full possession of their physical and mental powers at all times. Failing this, serious injuries may occur.
Therefore:

- Never operate Franka Emika Robot under the influence of drugs, alcohol or medication impacting reactions.

INTRODUCTORY ASPECTS ABOUT FRANKA EMIKA ROBOT AND THIS HANDBOOK

Responsible person	The responsible person for Franka Emika Robot can be e.g. the entrepreneur, director of the institute, the employer or a delegate responsible for the use of Franka Emika Robot. The responsible person is responsible for compliance with regulations of occupational health and the operational safety ordinance (e.g. for the US: e.g. OSHA regulations and public laws). These include the following things: • The responsible person must fulfill his monitoring obligations. • The responsible person must ensure that all staff members working with Franka Emika Robot are suitably qualified to do so and have been informed about the possible dangers Franka Emika Robot may present. • The responsible person must provide training and instructions in given intervals in order to create and consolidate risk awareness.
Integrator	The integrator is the person responsible for assembling the partly completed machinery into the final machinery, and conducts appropriate analysis to identify residual risks and eliminate or minimize them, so as not to compromise safety and health. The integrator is responsible for the safety of the final application.
Operator	The operator is a person authorized to access Franka Emika Robot and utilize the user interface Desk to use Franka Emika Robot within the limits defined by the responsible person and the administrator. Within Desk, the role “operator” can be assigned to users. Operators only have limited access to Desk. For further details, see chapter: Software setup/.
Administrator	Administrator is a person authorized by the responsible person to access the robotic system and utilize the user interface Desk to: - set and change roles, access rights and passwords - set and change non safety-related parameters of the system (e.g. change end-effector settings,...) - program and teach the robot system
Transport and logistics	Persons handling Franka Emika Robot or parts of it need to have received: • Training for handling heavy and sensitive devices
Installation	The person in charge of installation requires the following expertise: • advanced expertise in electrical installations and safety engineering (particularly in the installation of emergency stop and the mains fuse and any safeguards) • Instruction in the handling and installation according to this Handbook
Cleaning staff	Cleaning may only be carried out by trained persons. For information on the correct cleaning, see chapter: Maintenance, Service & Support/.

INTRODUCTORY ASPECTS ABOUT FRANKA EMIKA ROBOT AND THIS HANDBOOK

Intended use of Franka Emika Robot

The producer is not liable for damages caused by misuse. All the risk is borne by the responsible person/integrator alone.

If applicable, already existing, internal operating policies of the responsible person, such as trainings, safety instructions, operating policies and, possibly, country-specific restrictions are to be taken into account and respected.

Intended use

Franka Emika Robot is exclusively intended for industrial use. The system may be applied only in the ambient and operating conditions described in this document for the tasks of:

- testing and inspection
- handling
- mounting

For further information, please refer to the following section, which includes examples of misuse.

Misuse

Any application different to the intended purpose is considered to be misuse and is not permitted. This includes:

- transportation of people and animals
- use outside of the specified operating limits
- use as climbing assistance or leaning against the robotic arm
- use in potentially explosive areas
- use below ground
- handling of radioactive objects
- use outdoors
- use as a medical product
- use as a service robot arm e.g. for care of the elderly
- use in the vicinity of children

General safety measures

In addition to the “general safety measures” described here, this documentation includes information on safety during installation, start-up, operation, maintenance, reparation and disposal, which must also be noted.

Functionalities and Features of Various Safety Levels

WARNING

Franka Emika Robot offers functionalities and features of various safety levels. They are described in the chapter “Planning ahead/ Operating modes of Franka Emika Robot”, where a clear distinction is made between functionalities that are safe to use and others which are only available as features. These features are not classified as safety functions according to EN ISO 13849-1 or EN 62061. You may therefore NOT rely on the availability of these functionalities. When they are used, dangerous and uncontrolled motions of the robotic arm are to be expected at any given moment! Such a malfunctioning is to be regarded as extremely rare and will only occur under very unfavorable conditions. Therefore, maintaining attention focused and alert for any malfunctioning presents a challenge. The mentioned motions can lead to risks of crushing, shearing, impact, puncture or penetration and may cause severe injury.

Therefore:

- When using these features the responsible person/integrator is solely responsible for conducting a hazard and risk assessment based on the contents of this manual and subsequently implementing appropriate measures (constructional or organizational measures).
- It needs to be ensured that the operator is aware that the mentioned features could be not available.

Sound condition

WARNING

Franka Emika Robot may only be used in sound condition. In particular cables, plugs, mechanical housings etc. need to be free of damages like cracks, broken insulations. If damages are found, the devices are to be taken out of operation immediately (e.g. ‘disabled’ label). In cases of doubt, contact the manufacturer.

INTRODUCTORY ASPECTS ABOUT FRANKA EMIKA ROBOT AND THIS HANDBOOK

Modifications

WARNING

The Arm is equipped with an ISO end effector flange. Different end effectors can be mounted on it. The responsible person/integrator is responsible for carrying out the appropriate hazard and risk assessment and implement the corresponding measures. We are not liable for damages caused by mounted equipment.

Apart from mounting end effectors, modifications to Franka Emika Robot are not allowed and will lead to loss of warrenty and liability claims.
Such modifications may include:

- drilling holes, screw threads in the casing structures (modification of the load carrying capacity of the casing, pollution or damage to internal parts caused by chippings, etc.)
- varnishing (modification of drain-off capacity, contamination of the fail-safe safety locking systems caused by entering of varnish, heating, etc.)
- enwrapping the robotic structure (prevention of adequate convection, etc.)
- opening the devices (if devices are opened by the customer we will assume that a modification has been carried out by the customer) etc.

Disruptions

WARNING

If Franka Emika Robot indicates possible malfunctions or the operator notices malfunctions, these need to be rectified before continuing operation. Until malfunctions have been rectified the system must remain shut down.

Dead weight

WARNING

The Arm weighs approx. 18kg and the Control approx. 7kg. Due to the dead weight and partly geometric design (e.g. mounting flanges), lifting and handling the device can lead to back injury, and, should it fall, to serious injury to fingers, hands, toes and feet.

Therefore:

- always wear personal protective equipment (e.g. safety shoes), when transporting, mounting or demounting these devices
- the devices must be placed such as to prevent tilting or sliding
- when lifting or handling the devices, pay attention to lift correctly (lift with your legs, not your back)

NOTICE

The Arm contains sensitive mechanical and mechatronic components. These can be decalibrated or damaged due to wrong handling or misuse!

Therefore:

- The Arm may only be handled, lifted and transported at the points indicated in this manual in order to avoid overstressing the joints of the Arm
- The Arm is to be handled gently even when set-up and switched on or off. If, for example, the arm is moved by force when in stopped and locked state, an internal safety system is triggered and will cause a momentary slipping of internal parts. This slipping causes decalibration and damage to the Arm, which will be detected during next start-up of Franka Emika Robot and the operator will be notified by Desk to take Franka Emika Robot out of operation.

NOTICE

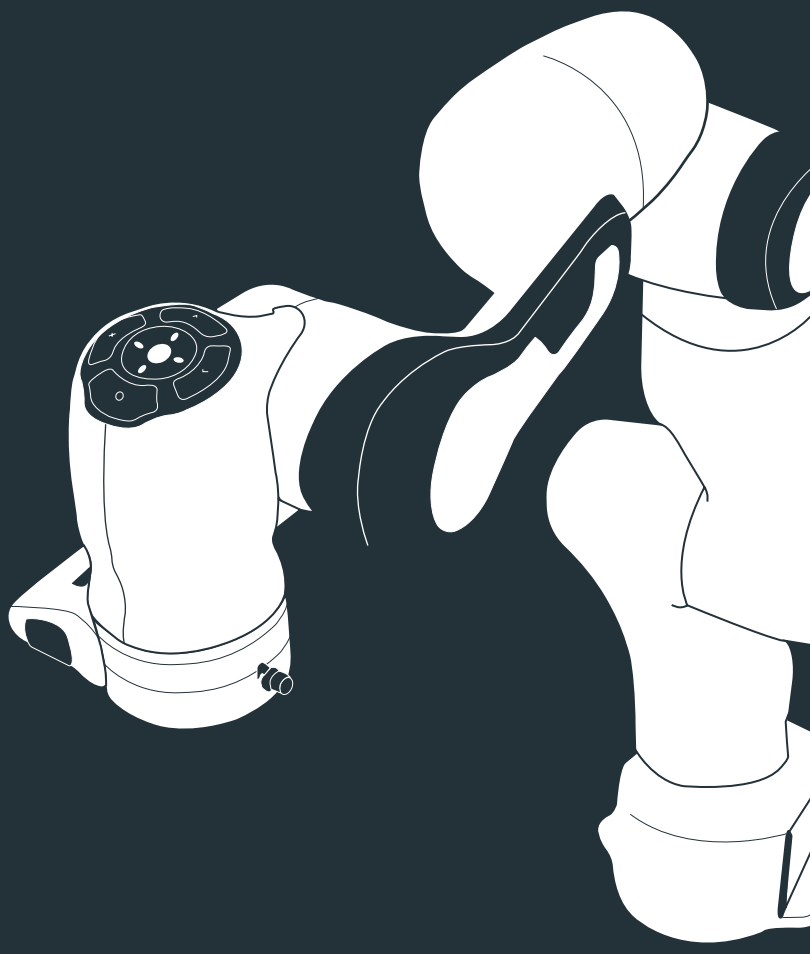
The Arm and Control contain sensitive electromechanical components. These can be decalibrated or damaged by mechanical shock!

Therefore:

- Avoid shocks or setting the device down roughly.
- Always store and transport devices in their original packing, even during transport inside buildings

ABOUT US

- Franka Emika GmbH



ABOUT US

FRANKA EMIKA

REDEFINING ROBOTICS

At Franka Emika – a deep-tech company from Munich, Germany – we redefined robotics with the world's most advanced robotic system Franka Emika Robot Powertool. In pursuit of high-performance and accessibility, we have combined human-centered design with trustworthy German engineering, giving rise to a masterpiece of technology. Highest mechatronic integration, exceptional soft-robot performance, as well as advanced and extendable functionalities unleashed unprecedented usability, best affordability and unlimited scalability.

ESTABLISHING A COMMUNITY

Having set the groundwork by redefining robotics, a broad spectrum of users gained access to an empowering technology. With decades of experience in world leading soft-robotics research, in 2017 we started shipping to experts worldwide to share our breakthrough. Besides elevating robotics and control research, our AI-enabled robot platform is being used by the most renowned Machine Learning and Artificial Intelligence research institutes and enterprises as well as in health care and education. We then established a global partner network of software and hardware developers, distributors and solution providers to transfer our technology into elegant, robust and profitable robot-assisted automation solutions. Franka Emika Robot Powertool thus became the fastest selling industry-suited robotic system within the first year of delivery. Since then, users – from highly-skilled robotics professionals to factory workers of small medium businesses as well as global enterprises – are benefiting from this novel easy-to-use, flexible, cost-efficient and scalable approach.

INTRODUCING FRANKA WORLD

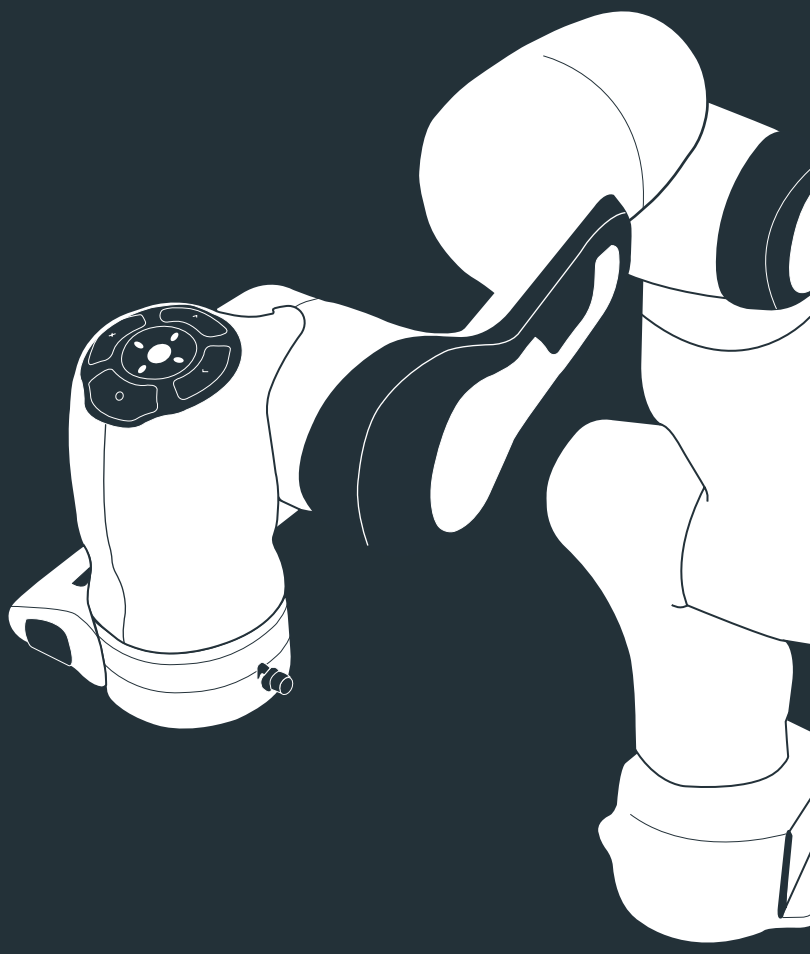
After redefining robotics and establishing a community, we launched a novel digital robotics platform to interconnect the digital with the physical world. Franka World enables community interaction between researchers, partners, customers, developers, suppliers and… robots to push the frontiers of Industrie 4.0. Besides communication, everyone is able to easily gain integrated access to products, services and management of entire robot fleets, independent of their physical location.

We are committed to create novel robotics platform technologies, improve performance and accessibility for everyone to overcome one of the biggest challenges of modern society, relieving an entire generation of tedious, potentially dangerous, vastly time-consuming and monotonous labor. We strive for a world where everyone can use a robot and we can reach that by connecting the world.

Franka Emika – products designed, developed and made in Germany.

TECHNICAL SPECIFICATIONS OF FRANKA EMIKA ROBOT

- Datasheet
- Additional technical specifications
- Reachable Space of Franka Emika Robot
- Correct site of installation



DATASHEET [1]
ROBOT ARM & CONTROL

Release Version: April 2020

HARDWARE

Arm

Degrees of freedom	7
Payload	3 kg
Workspace	see page 36
Maximum reach	855 mm
Force/ Torque sensing	link-side torque sensors in all 7 axes
Expected nominal lifetime [3,4]	20,000 h
Joint position limits	A1, A3, A5, A7: -166°/166° A2: -101°/101° A4: -176°/-4° A6: -1°/215°
Mounting flange	DIN ISO 9409-1-A50
Installation position	upright
Weight	~ 17.8 kg
Moving mass	~ 12.8 kg
Protection rating	IP30
Ambient temperature [2]	15 – 25 °C (typical) 5 – 45 °C (extended)
Air humidity	20 – 80 % non-condensing
Power consumption	• max. ~ 350 W • typical application ~ 60 W
Interfaces	• ethernet (TCP/IP) for visual intuitive programming with Desk • input for external enabling device • input for external activation device or safeguard • Control connector • Connector for end effector

Control

Controller size (19")	355 x 483 x 89 mm (D x W x H)
Supply voltage	100 – 240 V_{AC}
Mains frequency	47 – 63 Hz
Power consumption	~ 80 W
Active power factor correction (PFC)	yes
Weight	~ 7 kg
Protection rating	IP20
Ambient temperature	15 – 25 °C (typical) 5 – 45 °C (extended)
Air humidity	20 – 80 % non-condensing
Interfaces	• ethernet (TCP/IP) for internet and/or shop-floor connection • power connector IEC 60320-C14 (V-Lock) • Arm connector

1. Technical data are subject to change.
2. Lifetime and performance can potentially be reduced when operating outside the typical temperature range.
3. Based on ISO 9283 (Annex A), specified values refer to a workspace of 0.4 x 0.4 x 0.4 m centered at [0.515, 0.0, 0.226] m, with the Z-Axis of the flange oriented parallel to earth-gravity and the elbow positioned upwards.
4. Nominal conditions (66% load).

SOFT-ROBOT PERFORMANCE

Motion

Joint velocity limits	A1, A2, A3, A4: 150°/s A5, A6, A7: 180°/s
Cartesian velocity limits	up to 2 m/s end effector speed
Pose repeatabillity	<+/- 0.1 mm (ISO 9283)
Path deviation [3]	<+/- 1.25 mm

Force

Sensing [3]

Force resolution	<0.05 N
Relative force accuracy	0.8 N
Force repeatability	0.15 N
Force noise (RMS)	0.035 N
Torque resolution	0.02 Nm
Relative torque accuracy	0.15 Nm
Torque repeatability	0.05 Nm
Torque noise (RMS)	0.005 Nm

1 kHz Control [3]

Minimum controllable force (Fz)		0.05 N
Force controller bandwidth (-3 dB)		10 Hz
Force range [N]	Nominal case	Local best case
Fx	-125 – 95	-150 – 115
Fy	-100 – 100	-275 – 275
Fz	-50 – 150	-115 – 155
Torque range [Nm]	Nominal case	Local best case
Mx	-10 – 10	-70 – 70
My	-10 – 10	-16 – 12
Mz	-10 – 10	-12 – 12

Interaction

Guiding force	~ 2 N
Collision detection time	<2 ms
Nominal collision reaction time [3,4]	<50 ms
Worst case collision reaction time [3]	<100 ms
Adjustable translational stiffness	0 – 3000 N/m
Adjustable rotational stiffness	0 – 300 Nm/rad
Monitored signals	joint position, velocity, torque cartesian position, velocity, force

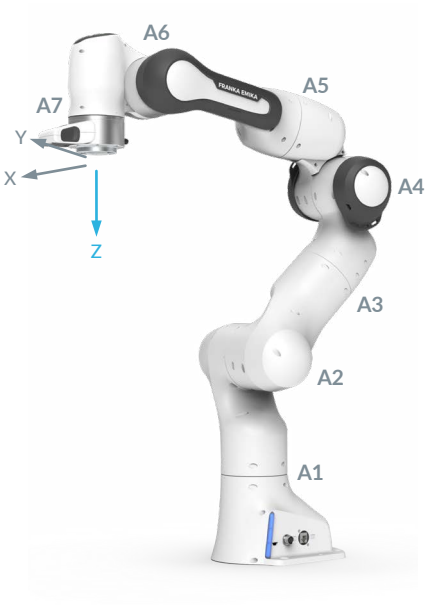
ADD-ONS

Safety retrofit option with safety-rated PLC	PLd Cat. 3 • Safe torque off (STO) • Safe OSSD inputs
Fully integrated end effectors	• 2-finger gripper • Vacuum gripper
Fast mounting	Clamping Adapter
Demonstration	Pop-up Box
Research interface	1kHz Franka Control Interface (FCI)
Fieldbuses	Modbus/TCP, OPC UA

Additional technical specifications

Respect torque limits for each joint at all times:

- Axes 1 & 2: allowed, repeatable peak torque <= 87 Nm
- Axes 3 & 4: allowed, repeatable peak torque <= 87 Nm
- Axes 5, 6, 7: allowed, repeatable peak torque <= 12 Nm



The mechanical zero position of each joint is reached when the two triangles on each side of the gap between the Arm segments align.

Joints' mechanical zero positions

No planned maintenance or service intervals within expected nominal lifetime.

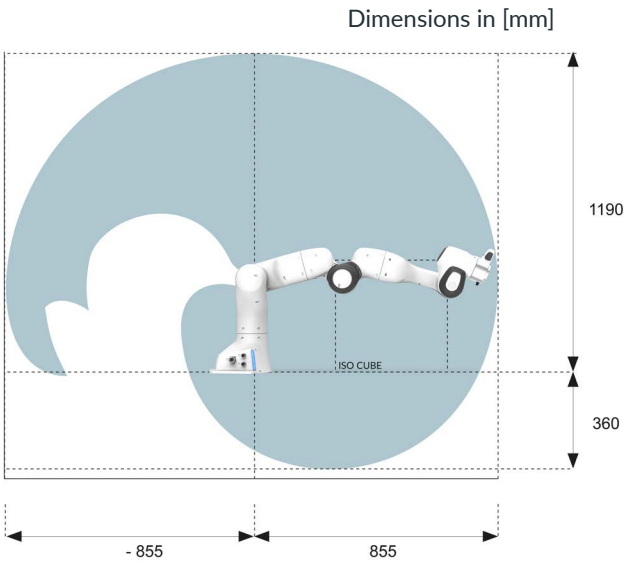
Planned maintanance

Franka Emika Robot system's weighted emission sound pressure level at workstations does not exceed 70 dB (EU Machinery Directive 2006/42/EC).

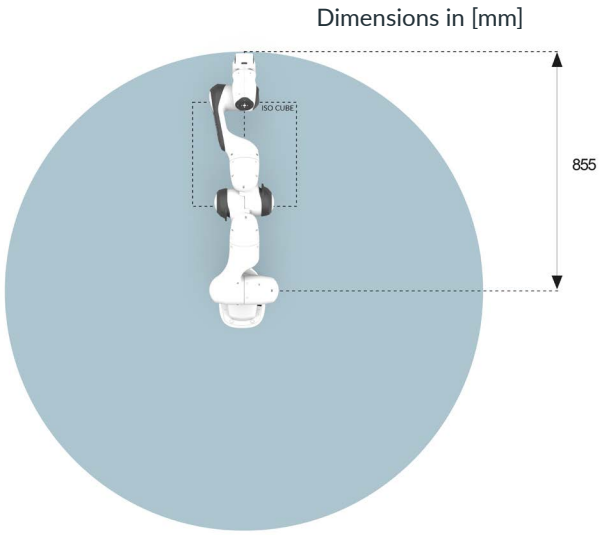
Noise emission

Reachable Space of Franka Emika Robot

Side-view: reachable space for the end effector flange



Top-view: reachable space for the end effector flange



Correct site of installation

Ambient conditions: Arm

Permissible conditions at site of installation

Site of installation

- indoors, in enclosed buildings
- not exposed to direct sunlight
- no vibrations, no accelerating fundaments
- no external magentic fields are allowed in the magnitude of the earth magnetic field only

Type of installation

- device may only be installed vertically (base horizontal to the earth's surface)
- no hanging installation permissible

Protection class

- IP 30 (according to EN 60529:1991)
  - IP 3x: protected against ingress of solid bodies with a diameter >= 2.5mm
  - IP x0: no protection against water

Ambient medium

- air
  - free from flammable substances (dust, gas, liquid)
  - free from aggressive media
  - free from corrosive substances
  - free from "flying parts"
  - free from spraying liquids
  - free from pressurized air streams

Pollution degree

- degree 2 (according to IEC 60664)
  - "only dry, non-conductive pollution occurs; occasionally temporary conductibility caused by condensation may occur"

Ambient temperature

- +15°C to 25°C (typical)
- +5°C to + 45°C (extended)
- -10°C to + 60°C (transport)
- +5°C to + 25°C (storage)

Relative air humidity

- 20 % - 80 %, non-condensing

Set-up altitude

- <= 2000 m above sea level

WARNING

If the Arm is not properly installed, this may cause malfunctions and unexpected motions of the robotic arm or cause it to fall. This may lead to severe injuries.

Therefore:

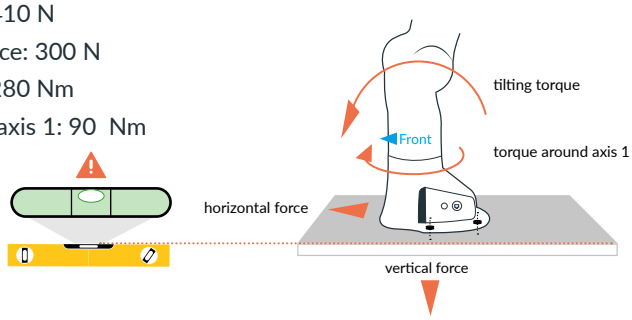
- Never switch on the robot arm as long as it is not fixed in its destination.
- always install the Arm so that its base is horizontal to the earth's surface
- the Arm may not be installed hanging
- the platform of the Arm must be stable
- the platform may not move - accelerations, vibrations are not permissible
- When used in earthquake-prone areas this needs to be considered during the hazard and risk assessment.
- the screw connection must be laid out correctly and must hold tight
- after 100 hours of operation the screws need to be tightened again with the tightening torque indicated!

Stable platform

The Arm is equipped with highly sensitive sensor technology and fine-tuned control algorithms. The Control algorithm requires installation on a stable, non-moving and non-vibrating platform.

In particular, the following maximum forces must be supported during static and dynamic operation:

- vertical force: 410 N
- horizontally force: 300 N
- tilting torque: 280 Nm
- torque around axis 1: 90 Nm



Screw connection to baseplate

The Arm has to be connected to the baseplate with 4 screws sized accordingly. For this purpose, 4 drill holes with a diameter of 9mm are provided in the base flange of the Arm. The screw connection must be suitable for withstanding the static and dynamic forces generated.

Example for possible screw connection:

- thickness of baseplate: 20mm
- 4x cylindrical head screw with hexagon socket M8x25mm – strength class 8.8
- 4x washer M8
- tightening torque for screws 23 Nm
- Note that after 100 hours of operation the screws need to be tightened again with the tightening torque indicated!

Adequate ventilation

NOTICE

The Arm contains power electronic components and modules (electric drives, CPUs, etc.) which heat up depending on the stress the device is subject to. The Arm does not contain active cooling systems, meaning that the produced heat is given off via the Arm's surface.

Therefore:

- make sure that the Arm is adequately ventilated
- make sure the Arm is not exposed to direct sunlight
- make sure that the Arm is not painted, pasted up with something or enwrapped

Derating

When operating within the "extended temperature range", the possibilities for application of the Arm may be limited (e.g. the speed or acceleration may need to be reduced), in order not to overheat the system.

Ambient conditions: Control

Permissible conditions at site of installation

Site of installation

- indoors, in enclosed buildings
- not exposed to direct sunlight
- no vibrations
- no external magentic fields are allowed in the magnitude of the earth magnetic field only

Type of installation

- device can be installed vertically and horizontally to the earth's surface - but not with the front side showing upwards!
- mounting in angle brackets e.g. under tables
- mounting in control cabinets (2U, 4HP)

Protection class

- IP 20 (according to EN 60529:1991)
  - IP 2x: protected against ingress of solid bodies with a dimeter >=12.5mm
  - IP x0: no protection against water

Ambient medium

- air
  - free from flammable substances (dust, gas, liquid)
  - free from aggressive media
  - free from corrosive substances
  - free from “flying parts”
  - free from spraying liquids
  - free from pressurized air streams

Pollution degree

- degree 2 (according to IEC 60664)
  - “ only dry, non-conductive pollution occurs; occasionally temporary conductibility caused by condensation may occur”

Ambient temperature

- +15°C to 25°C (typical)
- +5°C to + 45°C (extended)
- -10°C to + 60°C (transport)
- +5°C to + 25°C (storage)

Relative air humidity

- 20 % - 80 %, non-condensing

Set-up altitude:

- <= 2000 m above sea level

WARNING

Franka Emika Robot‘s electrical isolation design is based on concrete specifications for the mains power supply. Using the Franka Emika Robot system outside these specifications can lead to electrical or fire hazards!

It needs to be ensured that Franka Emika Robot is used within its specification.

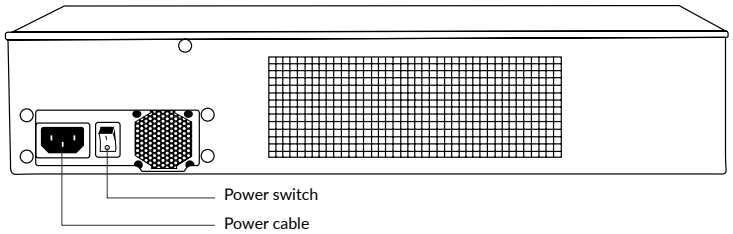
If too many devices are connected to a power outlet this can lead to an overload of the electrical installation and may result in smoldering fires.

Therefore:

- make sure that the connection of Franka Emika Robot will not lead to an overload of the electrical installation
- make sure that overload protection devices are installed accordingly

TECHNICAL SPECIFICATIONS OF FRANKA EMIKA ROBOT

Connection to power supply	The Control is equipped with a wide-range input for mains supply voltages from 100 V_{AC} to 240 V_{AC} and mains frequencies from 47 to 63 Hz. The mains needs to be of type overvoltage category II (OVC II) or OVC I. When using Franka Emika's emergency stop device (Franka Emika's article number: #78456374), mains needs to be protected with a max. 6A fuse. If a different solution than this emergency stop device is used to safely cut the power from Franka Emika Robot, then the Control needs to be protected with a 10A fuse within the mains supply.
Disconnecting Franka Emika Robot from the mains power supply	Two possibilities to disconnect Franka Emika Robot from the mains power supply are given: - the power cable can be disconnected on the backside of the Control - the power switch on the backside of the Control can be used. After using the switch to power the system off, please ensure to allow adequate waiting time (i.e. in the order of ~ 1 minute) before using it to power the system on again.



Energy consumption	Franka Emika Robot requires on average between 140 - 350W for standard operation. Temporarily, electrical power of up to 600 W can be drawn from the mains.

NOTICE

If a fuse in the upstream power supply of the Control blows, Franka Emika Robot is
disconnected from the mains power supply. The Arm reacts with braking as much as possible before the fail-safe locking bolts catch in the 7 axes. Franka Emika Robot will safely be stopped. The emergency braking system is designed for rare emergency events only, so Franka Emika Robot could be decalibrated or damaged after safely being stopped. Franka Emika Robot will then detect a possible decalibration or damage on the next start-up and inform the operator to take Franka Emika Robot out of operation.

Therefore:

- the mains fuse is to be selected accordingly

NOTICE

Adequate ventilation

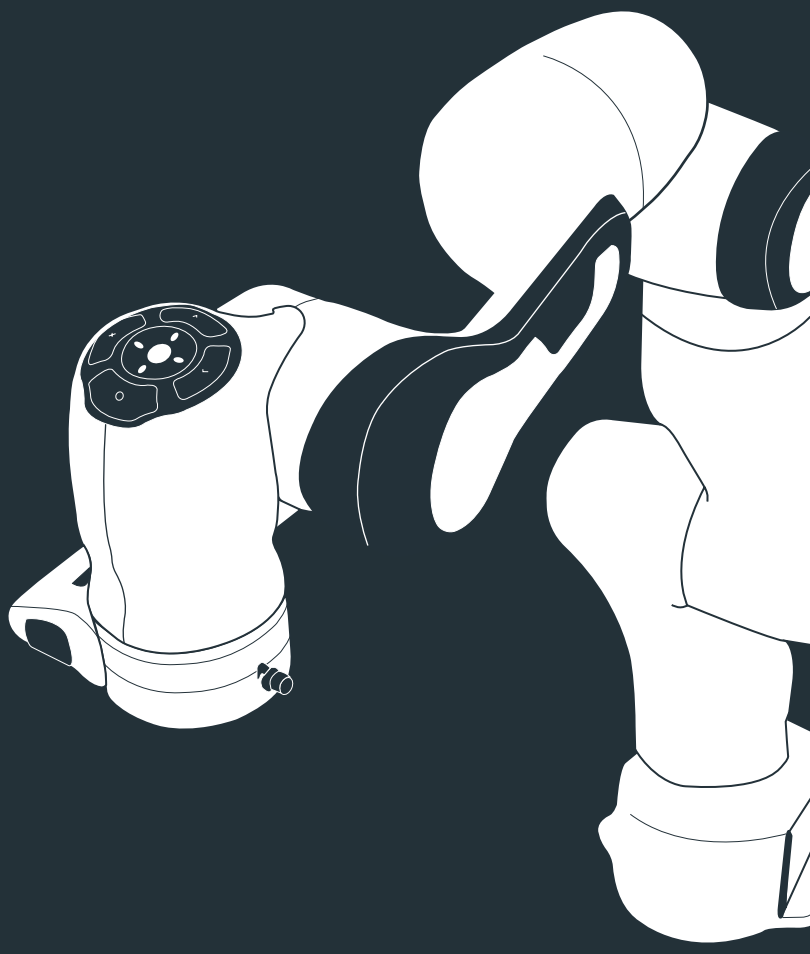
The Control contains power electronic components and modules (electric drives, CPUs, etc.) which heat up depending on the stress the device is subject to. An internal, active ventilation system sucks in air from the environment and channels it through the casing of the Control.

Therefore:

- make sure that the Control is adequately ventilated
- make sure there is enough distance between the front ventilators and covering components
- make sure there is enough distance between the back ventilators and covering components
- make sure that the ventilators are not blocked by pollution
- make sure the control is not exposed to direct sunlight

RIGHTS OF USE & PROPERTY RIGHTS

- Identifications
- Rights of use and property rights



RIGHTS OF USE AND PROPERTY RIGHTS

Identification

Removal of identification	Copyright notices, serial numbers and any other kind of labelling serving to identify the product or operating software may not be removed or modified.

Rights of use and property rights

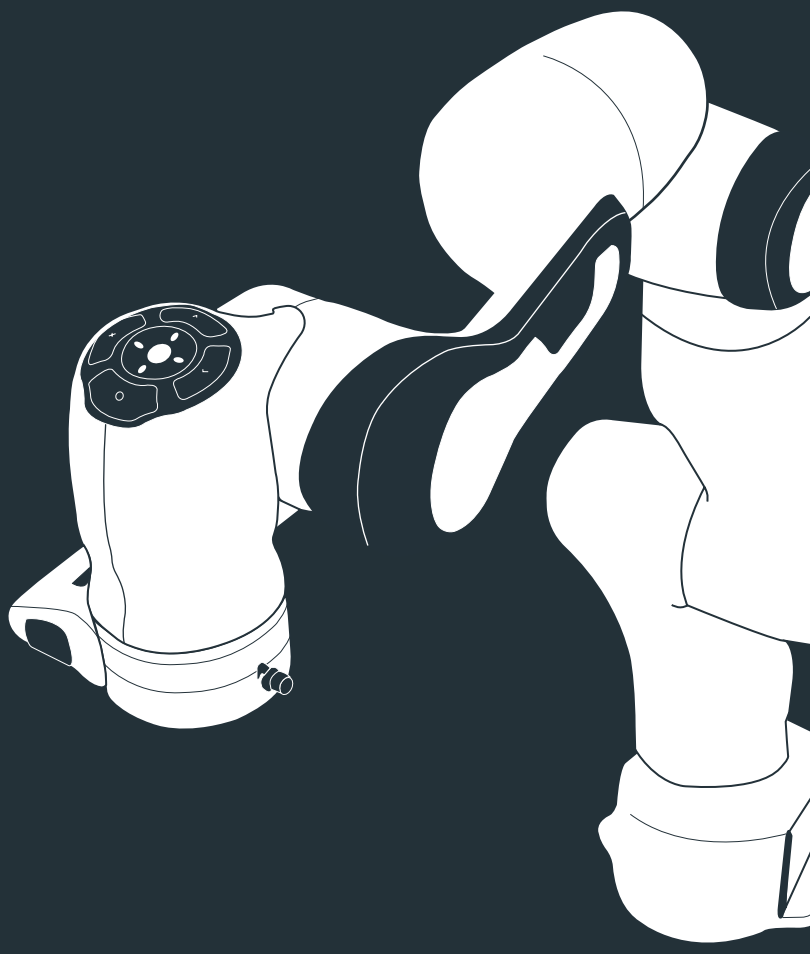
Granting of rights of use	The terms of use for Franka Emika Robot, the operating software, the apps etc. are provided in a separate document.
Protected trademarks	In this Handbook, we refer to protected trademarks that are not designated explicitly as such in the continuing text. The absence of such indication may not imply that the corresponding product name is free of third-party rights. The following trademarks are protected trademarks: • **Franka Emika Robot** is a trademark of Franka Emika GmbH • **Microsoft** is a registered trademark, and **Windows** is an indication of the Microsoft Corporation of the United States and other countries • **GOOGLE, Mozilla, CHROME, ITEM** are registered trademarks
Trademark rights	The responsible person is not granted any rights or claims to the trademark, logo or trade names of Franka Emika.
Use of open source codes	A complete list of all open source licenses used by Franka Emika Robot can be accessed via the Settings of Desk.

SECTION 2

Assembly instructions for Franka Emika Robot as a partly completed machinery

TO THE INTEGRATOR

- Message to the Integrator



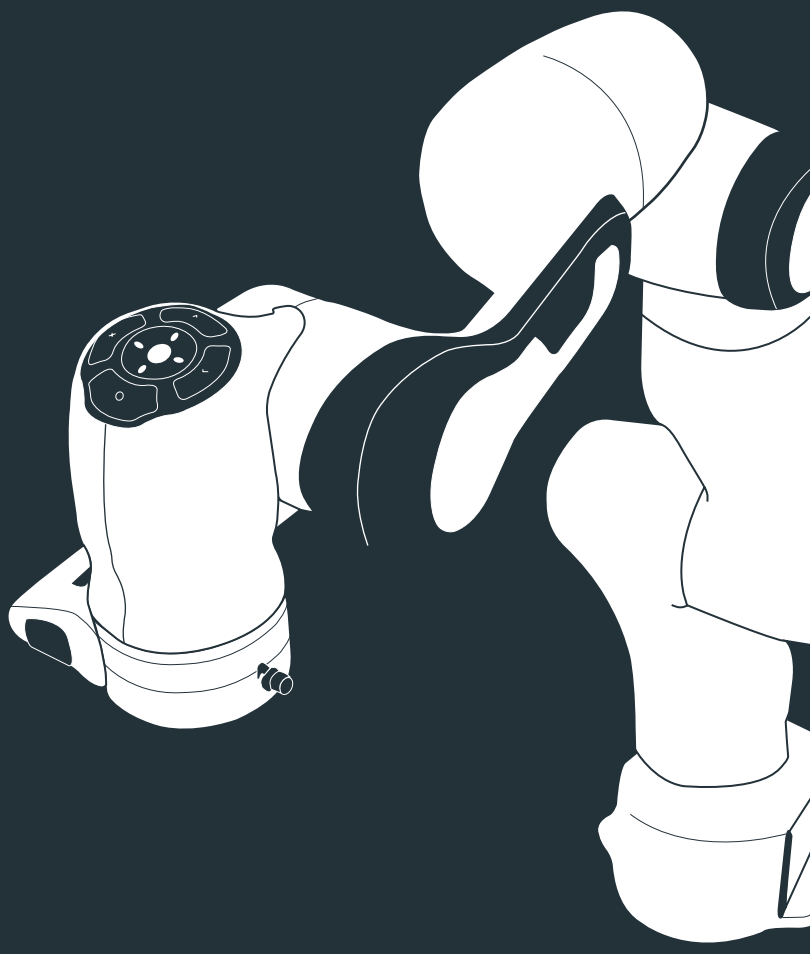
TO THE INTEGRATOR

Message to the Integrator

The present document includes assembly instructions for Franka Emika Robot as a partly completed machinery and contains description of the conditions which must be met with a view to correct incorporation in the final machinery, so as not to compromise safety and health (e.g. Annex I of Machinery Directive 2006/42/EC). The integrator is the person responsible for assembling the partly completed machinery into the final machinery, and conducts appropriate hazard and risk assessment (based on these assembly instructions and additional aspects, such as the specific target application, general shop safety rules, safety standards and general safety culture) to identify residual risks and eliminate or minimize them, so as not to compromise safety and health. The responsible person/integrator is responsible for the safety of the final application, and shall provide operators with relevant instructions and training, making them aware of residual risks and recommending best practice tips.

FRANKA EMIKA ROBOT'S CONFORMITIES

- Declaration of Incorporation
- Further statements
- Labeling on the equipment



FRANKA EMIKA ROBOT'S CONFORMITIES

Machinery Directive EMC Directive Low-Voltage Directive	The system component Control in connection with the Arm is CE-compliant according to: • to Machinery Directive (2006/42/EC) as a partly completed machinery • to EMC Directive (2014/30/EC) • and to the Low Voltage Directive (2014/35/EC).
RoHS, REACH, WEEE	Control and Arm are exempt from regulations according to RoHs, REACH and WEEE directives. Nevertheless, our products comply with the requirements according RoHS.

Declaration of Incorporation

Declaration of Incorporation
according to directive 2006/42/EC on machinery (Annex II B) for partly completed machinery

Description of the partly completed machinery:

Product identification: Panda system components: *Control*, *Arm*
Modell/Type:
Control (#75674215) in combination with *Arm* (#73681342)

We declare that the product complies with the following essential requirements of the Machinery Directive2006/42/EC:
1.1.2; 1.1.3; 1.1.5; 1.1.6; 1.2.1; 1.2.2; 1.2.3; 1.2.4.1; 1.2.4.2; 1.2.4.4; 1.2.5; 1.2.6; 1.3.1; 1.3.2; 1.3.3; 1.3.4; 1.3.6; 1.3.7; 1.3.9; 1.5.1; 1.5.2; 1.5.4; 1.5.5; 1.5.6; 1.5.7; 1.5.8; 1.5.9; 1.5.10; 1.5.11; 1.5.13; 1.5.14; 1.5.16; 1.6.1; 1.6.2; 1.6.3; 1.6.4; 1.6.5; 1.7.1; 1.7.2; 1.7.3; 1.7.4; 4.1.2.1; 4.1.2.3; 4.2.1; 4.4.2

In addition, the partly completed machinery is in conformity with the following EC Directives:
EC Directives 2014/35/EC relating to electrical equipment (LVD)
EC Directives 2014/30/EC relating to electromagnetic compatibility (EMC)

We declare that the relevant technical documentation is compiled in accordance with part B of Annex VII.

Applied harmonized standards
Electrical safety

Standard	Name
EN 61010-1:2010 IEC 61010-1:2010 + Cor. :2011	Safety requirements for electrical equipment for measurement, control and laboratory use - Part 1: General requirements
EN 61010-2-201:2013 + AC:2013 IEC 61010-2-201:2013	Safety requirements for electrical equipment for measurement, control and laboratory use - Part 2-201: Particular requirements for control equipment
EN 60204-1:2006/A1:2009/ AC:2010 IEC 60204-1:2005/A1:2008	Safety of machinery - Electrical equipment of machines - Part 1: General requirements
EN 61800-5-1:2007 IEC 61800-5-1:2007	Adjustable speed electrical power drive systems - Part 5-1: Safety requirements - Electrical, thermal and energy

Machinery safety

Standard	Name
EN ISO 12100:2010 ISO 12100:2010	Safety of machinery - General principles for design - Risk assessment and risk reduction
EN ISO 13857:2008 ISO 13857:2008	Safety of machinery - Safety distances to prevent hazard zones being reached by upper and lower limbs
EN ISO 13732-1:2006	Ergonomics of the thermal environment - Methods for the assessment of human responses to contact with surfaces - Part 1: Hot surfaces
EN ISO 13850:2015 ISO 13850:2015	Safety of machinery - Emergency stop - Principles for design
EN 61800-5-2:2007 IEC 61800-5-2:2007	Adjustable speed electrical power drive systems - Part 5-2: Safety requirements - Functional IEC 61800-5-2:2007

EMC

Standard	Name
EN 61000-6-1:2007 IEC 61000-6-1:2005	Electromagnetic compatibility (EMC) - Part 6-1: Generic standards - Immunity for residential, commercial and light-industrial environments
EN 61000-6-2:2005/ AC:2005 IEC 61000-6-2:2005	Electromagnetic compatibility (EMC) - Part 6-2: Generic standards - Immunity for industrial environments
EN 61000-6-3:2007/ A1:2011/AC:2012 IEC 61000-6-3:2006/ A1:2010	Electromagnetic compatibility (EMC) - Part 6-3: Generic standards - Emission standard for residential, commercial and light-industrial environments
EN 61000-6-4:2007/ A1:2011 IEC 61000-6-4:2006/ A1:2010	Electromagnetic compatibility (EMC) - Part 6-4: Generic standards - Emission standard for industrial environments
EN 61000-6-1:2007 IEC 61000-6-1:2005	Electromagnetic compatibility (EMC) - Part 6-1: Generic standards - Immunity for residential, commercial and light-industrial environments

We commit to transmit, in response to a reasoned request by the market surveillance authorities, relevant documents on the partly completed machinery. The industrial property rights remain unaffected!

Important note!
The partly completed machinery must not be put into service until the final machinery into which it is to be incorporated has been declared in conformity with the provisions of Directive 2006/42/EC on Machinery, where appropriate, and until the EC Declaration of Conformity according to Annex II A is issued.

Manufacturer:
Franka Emika GmbH
Frei-Otto-Straße 20
80797 München
Deutschland

Representative in EU, authorized to compile the relevant technical documentation:
Johannes Schmid
Franka Emika GmbH
Frei-Otto-Straße 20
80797 München
Deutschland

Date, location
03.04.2020
Munich, Germany

Dr. Simon Haddadin, CEO & MD

Dirk Engelmann, Managing Director

FRANKA EMIKA ROBOT'S CONFORMITIES

Further statements

Further Information

status: 04.05.2018 Franka Emika Robot

Restriction of Hazardous Substances (RoHS):

The products *Control*, *Arm* and *Hand* do not fall within the scope of EU RoHS Directive 2011/65/EU, but still meet the requirements of the restricted substances and maximum concentration values that are allowed in homogenous materials:

- Lead (0.1%)
- Mercury (0.1%)
- Cadmium (0.01%)
- Hexavalent chromium (0.1%)
- Polybrominated biphenyls (PBB) (0.1%)
- Polybrominated diphenyl ethers (PBDE) (0.1%)

The following exceptions are also applied:

6a: Lead as an alloying element in steel for machining purposes and in galvanized steel containing up to 0,35 % lead by weight

6b: Lead as an alloying element in aluminum containing up to 0,4 % lead by weight

6c: Copper alloy containing up to 4 % lead by weight

REACH:

FRANKA EMIKA GmbH is a "downstream user" as defined in REACH. Our products are exclusively non-chemical products (manufactured items). In addition, under normal conditions of use and the conditions which can reasonably be predicted, no substances are released (Article 7, REACH).
We confirm that our products do not contain more than 0.1 percent by mass of any of the listed substances on the published ECHA candidate list (SVHC). Extensions published by the ECHA candidate list are matched with our products and if it is known that one of these newly added substances contained in our products, we will inform you immediately.
This confirmation was created based on currently available information of our suppliers.

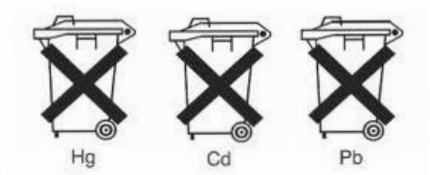
WEEE Directive:

The products *Control*, *Arm* and *Hand* are not subject to the WEEE Directive 2002/96/EC for collection, recycling and recovery for electrical goods.

Battery Directive:

The product *Control* contains a BIOS battery.

Disposal of batteries:
There is an obligation to return rechargeable and non-rechargeable batteries by Battery Directive 2006/66/EC; do not dispose them with consumer waste. Dispose them according to statutory orders and lead them to a recycler. Batteries will be recycled.
The signs below the crossed out trashcan indicate the substances lead (Pb), cadmium (Cd), or mercury (Hg).



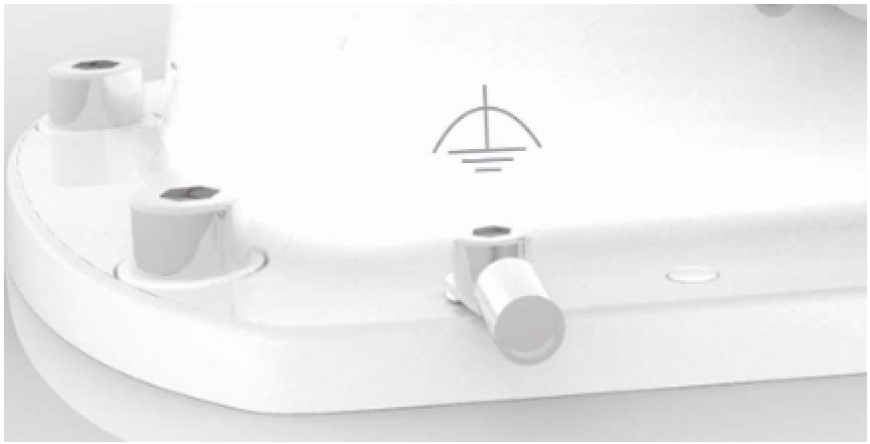
Labeling on the equipment

Name plate: Arm

There are 3 labels for the EMERGENCY UNLOCK on the Arm. They indicate the places in which the unlocking tool can be inserted in order to manually unlock the fail-safe safetv locking manually in case of emergency.

Emergency unlock label on Arm

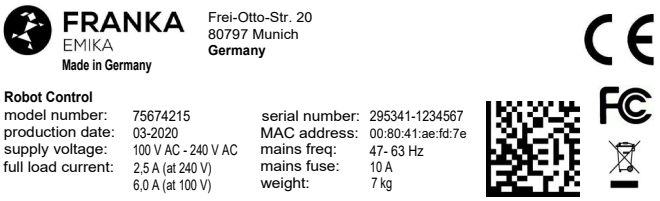
Indicates where a functional earth can be connected on the base of the Arm.



Functional earth label on Arm

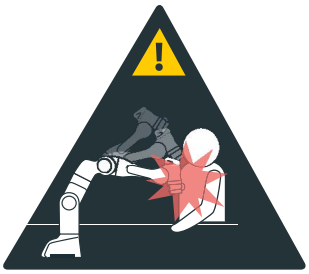
FRANKA EMIKA ROBOT'S CONFORMITIES

Name plate: Control



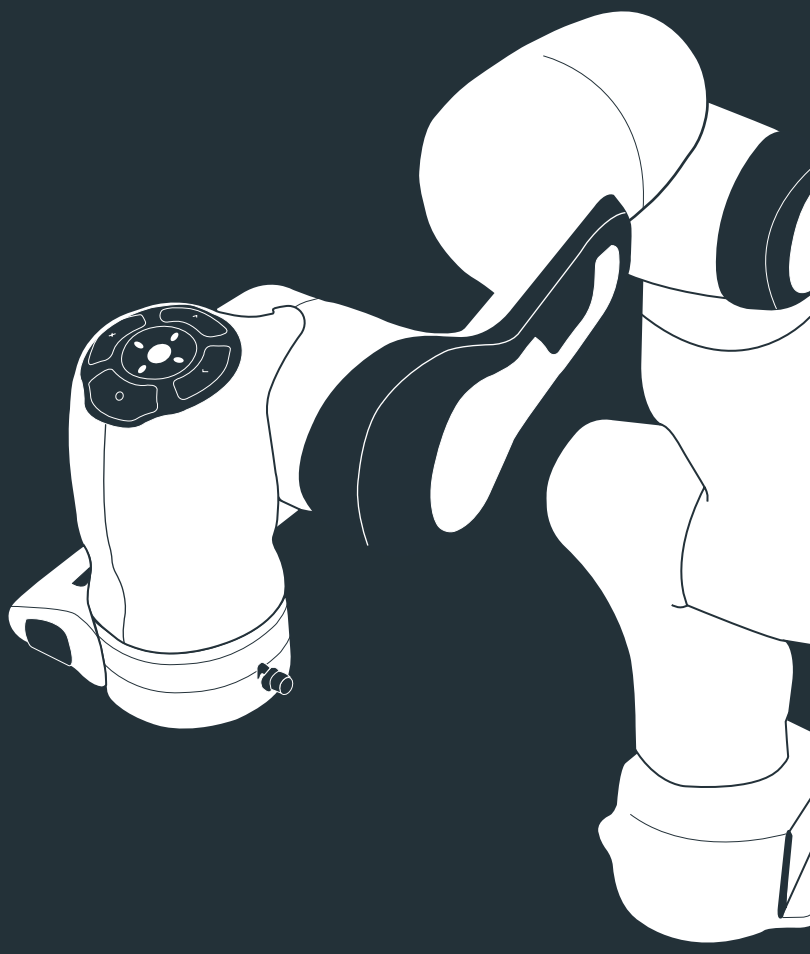
Name plate:
Emergency Stop Device

Safety label: Arm



THIS IS FRANKA EMIKA ROBOT

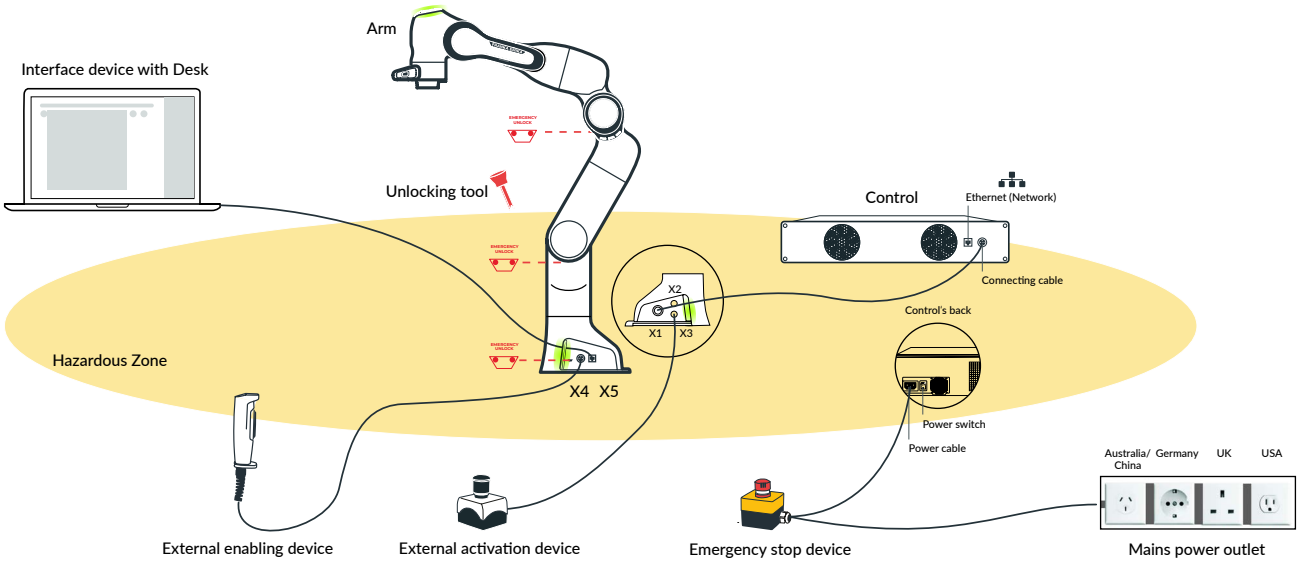
- Equipment overview
- Scope of delivery and additionally required equipment



THIS IS FRANKA EMIKA ROBOT

Equipment overview

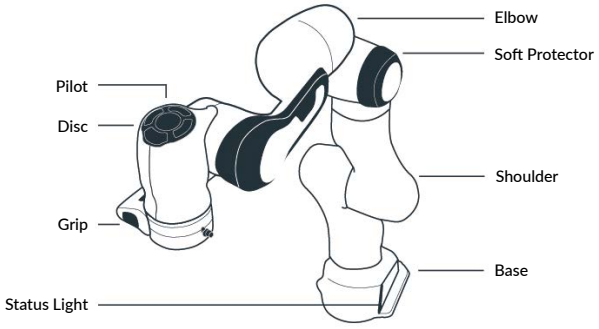
The following illustration represents a sample wiring to give an overview about the equipment.

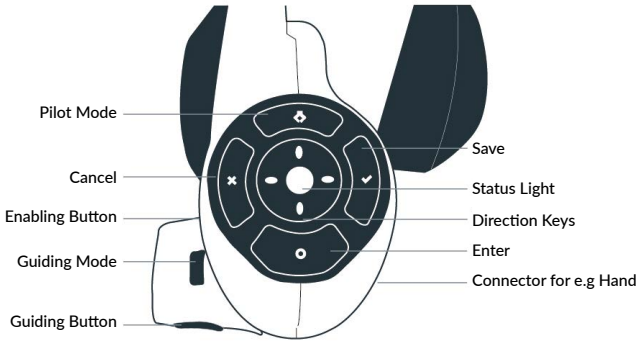


- If the emergency stop device delivered by Franka Emika is used, the emergency stop device is connected between the Control and the mains power outlet; when pressed, it cuts the supply to Franka Emika Robot.
- The 3-stage external enabling device is connected at the base of the Arm (connector X4). Half pressing it will enable Franka Emika Robot (Attention – always step out of the Hazardous Zone first) and programs can be started via Desk.
- If useds, the external activation device is connected at the base of the Arm (socket X3), in order to consciously authorize motion of the Arm from outside the Hazardous Zone. For information on alternative connections to the female connector X3, please consult chapter: Planning ahead/ Stopping mechanisms/ and chapter: Mounting and Installation/ Wiring and electrical installation.
- The Arm is connected via a connection cable to the Control
- At the base of the Arm (socket X5) the interface device is connected, with installed web browser in order to program via Desk.
- Socket X2 is not used in this current version.

The Arm

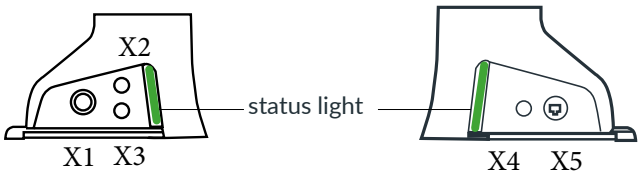
The Arm has the following components:



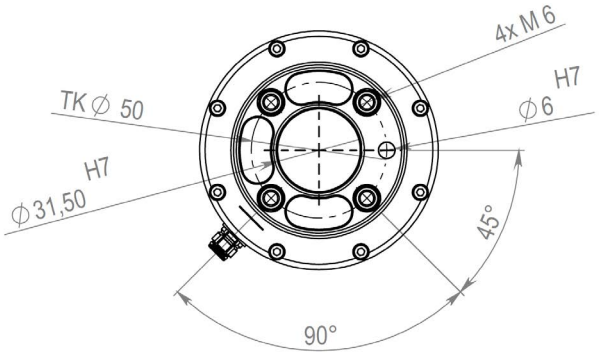


Top view

Via the Pilot the user interface Desk and integrated end effectors like Hand can be operated directly from the robotic arm.



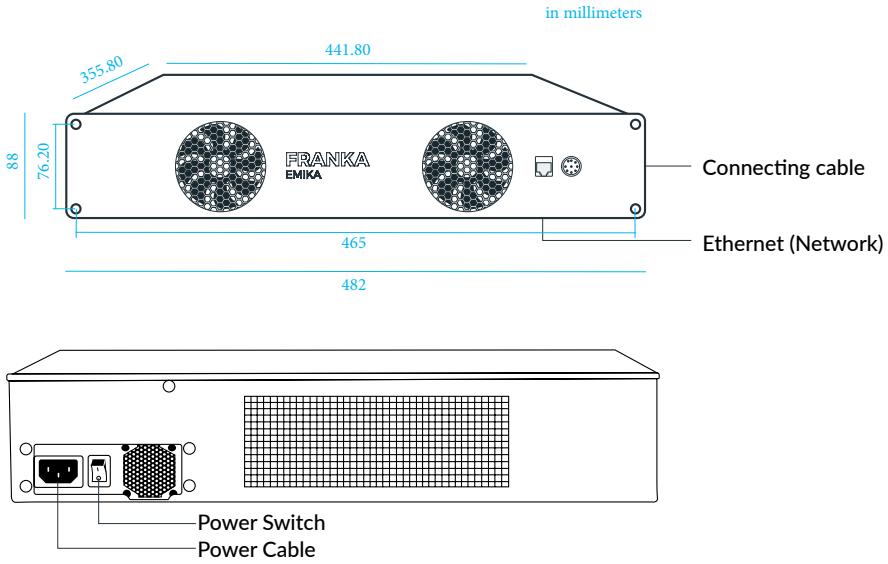
Base of the Arm



End effector flange

THIS IS FRANKA EMIKA ROBOT

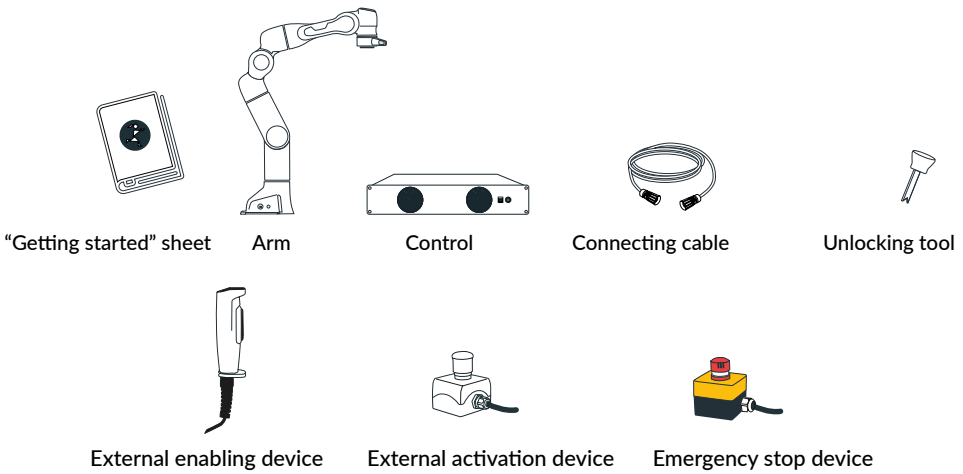
The Control



Ambient conditions	see chapter: Correct Site of Installation/ Ambient conditions.
Production standard	Arm and Control are manufactured in a production company certified according to EN ISO 9001 in Germany.

Scope of delivery and additionally required equipment

In the box



- Main components
  - Arm
  - Control
- Accessories
  - Connecting cable 2.5m (for connecting Arm and Control)
  - 2 x unlocking tool
  - External enabling device
  - External activation device
  - Emergency stop device
- “Getting started” sheet

Not included in delivery are: Additionally required

Interface device

- tablet/notebook/PC
  - with browser (Chrome, Chromium, Firefox)
  - with Ethernet port
  - ideally with Touch functionality

Material

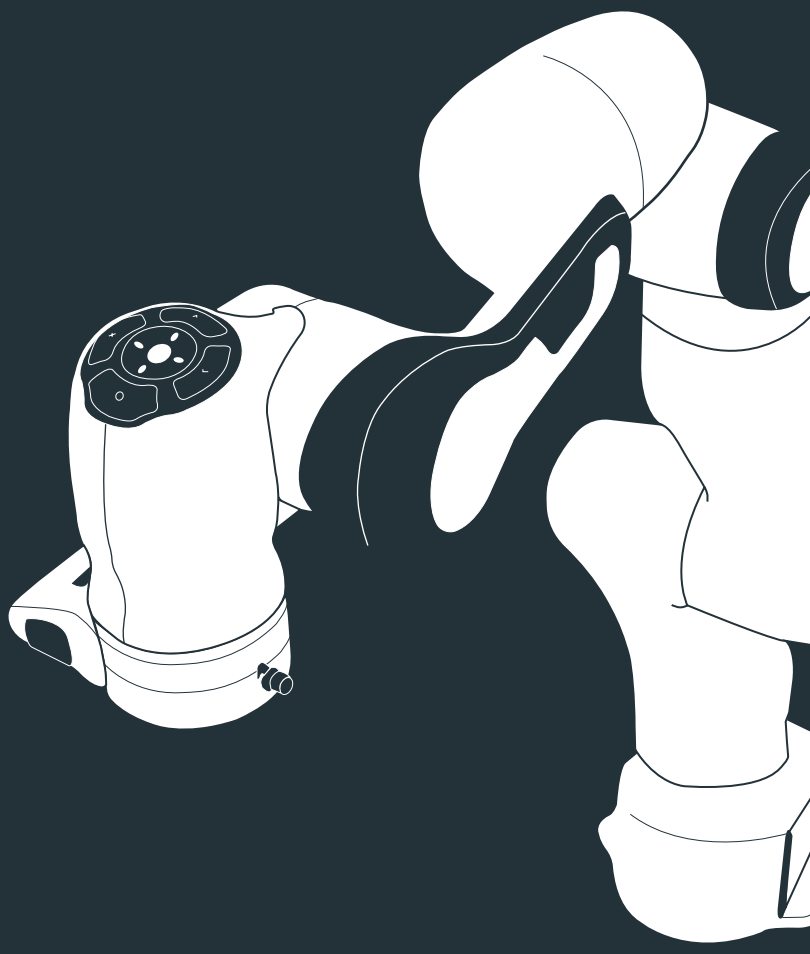
- Ethernet cable with RJ 45 connector for connecting the interface device to the Arm
- Ethernet cable with RJ 45 connector for optional connection of Control to the company network or PC workstation
- Mounting accessories for mounting the Arm on a stand, e.g. according to our suggestion:
  - 4x cylinder head screw with hexagon socket M8x25mm – strength class 8.8
  - 4x washers M8
  - 2x 6mm h8 pins for precise mounting, if applicable
- Functional earth cable with eye
- For attaching functional earth: screw M5x8 incl. lock washer

Tools

- Hex key for mounting the Arm on the base
- Screw driver for connecting the functional earth
- Level for ensuring the horizontal installation of the Arm

PLANNING AHEAD

- Hazardous Zone, Working & Safeguarded Spaces
- Operating modes of Franka Emika Robot
- Dangers that Franka Emika Robot may present
- Practical tips for usage and positioning of Franka Emika Robot
- Stopping mechanisms
- Emergency stop installation
- Prepaing the installation site

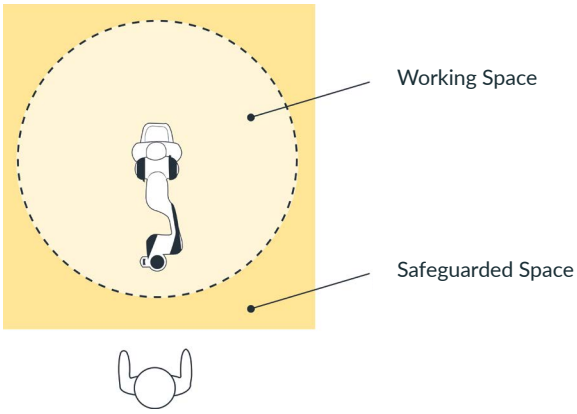


PLANNING AHEAD

In this present chapter, some illustrations of Franka Emika Robot include Franka Emika's end effector (i.e. Hand). Note that Hand is not of the scope of Franka Emika Robot as a partly completed machinery, and it is represented in some figures of this chapter for example purpose only. Also note that, upon connection of any end effector, the integrator is responsible for conducting appropriate hazard and risk assessment to identify residual risks so as not to compromise safety and health, and is responsible for the safety of the final application.

Hazardous Zone, Working & Safeguarded Spaces

Classification of spaces



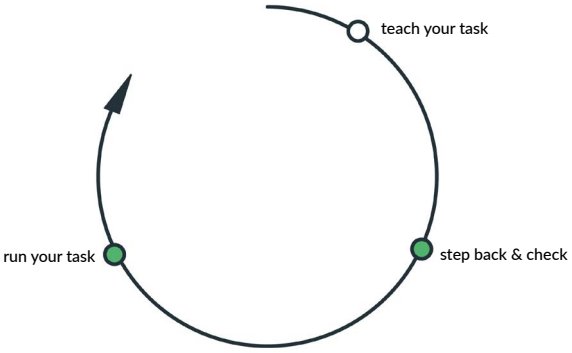
Distinction of the different areas:

- Hazardous or Danger Zone: any space with and/or around machinery in which a person can be exposed to a hazard.
- Working Space: space which can be swept by the wrist reference point increased by the range of rotation or translation of each joint in the wrist.
- Safeguarded Space: space defined by the perimeter safeguarding.

PLANNING AHEAD

Operating modes of Franka Emika Robot

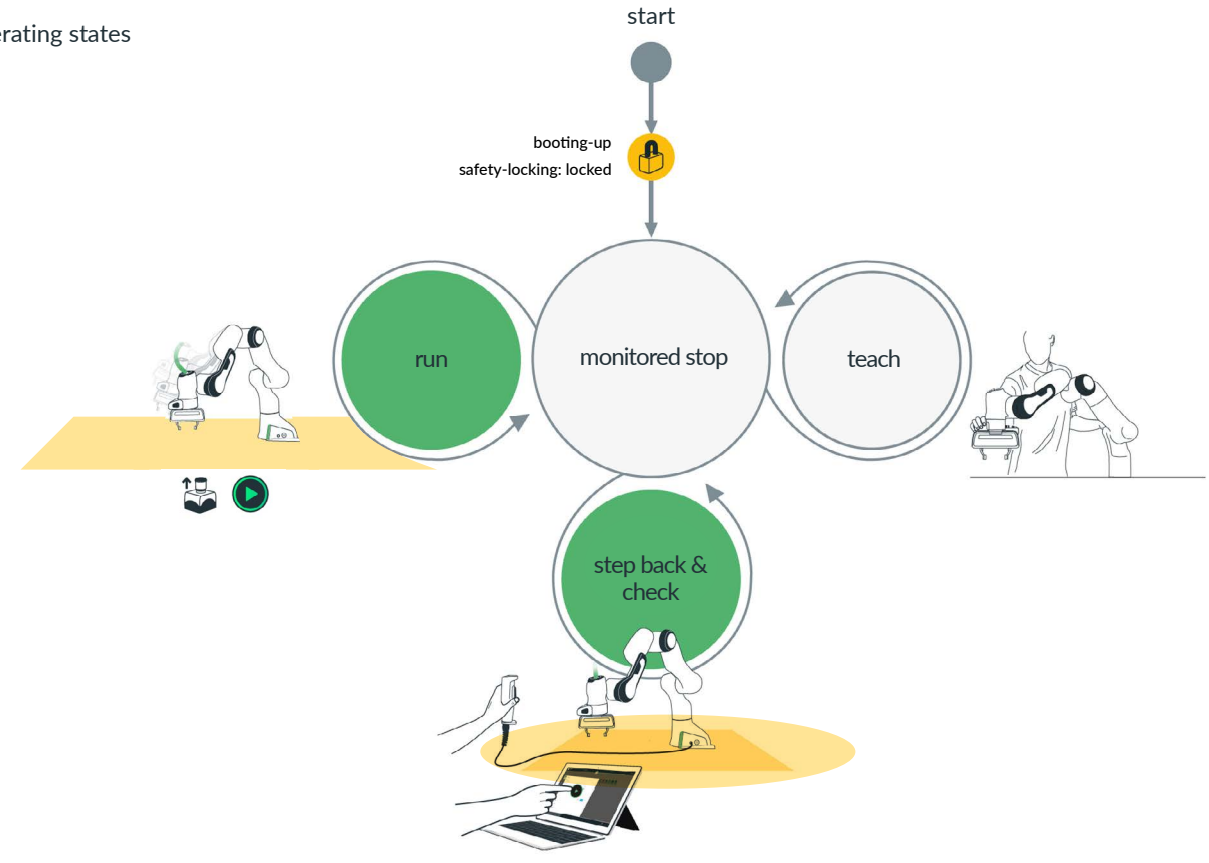
Our operating philosophy



Our operating philosophy consists of three main steps, that you may repeat as many times as you wish:

- teach your task: teach Franka Emika Robot a task, by taking the Arm by the hand
- step back & check: then step outside of the Hazardous Zone and check whether the taught task is correctly executed
- run your task: once the task has been learned, Franka Emika Robot can execute the task automatically

Operating states

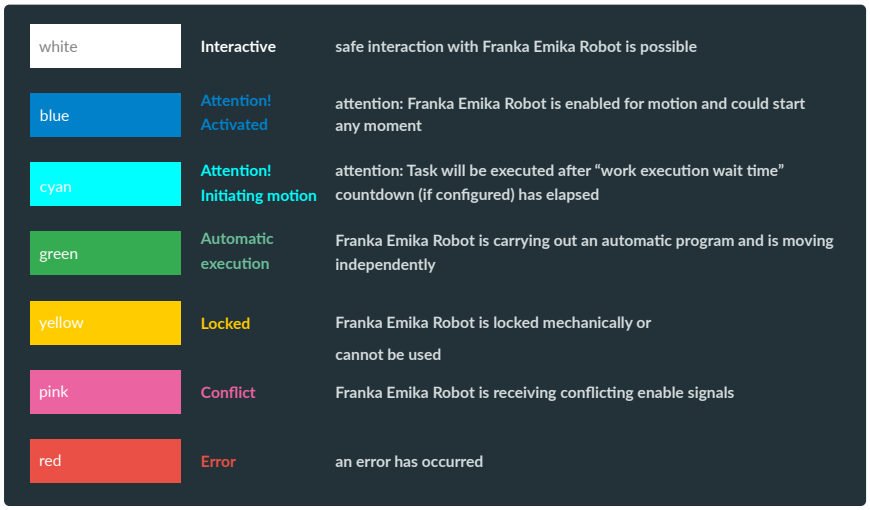


- With the external activation device pressed down, after the Control has been switched on, or supplied with energy, Franka Emika Robot boots up. In this process, the safety locking system is activated, motions are thus locked mechanically. The display lights on the base and the pilot flash yellow.
- As soon as Franka Emika Robot has booted up, the display lights are lit yellow continuously.
- At this point, the safety locking system can be opened with the button “unlock joints” in the sidebar of Desk. The display lights now are lit white continuously. Desks’s sidebar shows now “joints unlocked”. Franka Emika Robot is now in the “monitored stop” state.
- By simultaneous pressing of the enabling button and the guiding button at the Arm’s grip, the Arm allows itself to record (teach) positions, for example by guiding the Arm manually (teaching). During any Teaching, Franka Emika Robot is lit white continuously.
- Should the buttons be released, then Franka Emika Robot is once again in “monitored stop” condition and is lit white continuously.
- From here, the “step back & check” status can be entered by taking the external enabling device and possibly also the emergency stop device out of the Hazardous Zone. If the external enabling device is half-pressed now, Franka Emika Robot is activated and is lit blue. Now, the Play button in Desk can be pressed. If the “work execution wait time” is configured (see chapter: Working with Franka Emika Robot/ Desk/ Initiating Motion), the robot will be lit cyan until the countdown has elapsed. Afterwards, the task starts execution. During execution, Franka Emika Robot is lit green.
- In case of error, Franka Emika Robot turns red.
- If conflicting authorization signals are present (e.g. external activation device is activated and the external enabling device or the enabling button on the grip is activated), Franka Emika Robot signals with the color pink.
- In the following sections, it will be described that Franka Emika Robot is lit blue and the task can be executed without using the external enabling device, as long as the external enabling device is pulled up (open state), after the task itself has been carefully tested.

Overview of the status indicators

There are status lights on both sides of the base which take on the corresponding color, similar to a traffic light. These status lights will only flash during boot-up, whereas during other processes the lights will glow continuously in the corresponding color of the status Franka Emika Robot is in. In addition, there is a circular status light in the middle of the Pilot’s Disc. Its color also indicates Franka Emika Robot’s status. When a operator is interacting with the Arm the middle status light on the Pilot is
switched off to increase visibility and usability. In certain situations, in particular when Franka Emika Robot requires attention or an input by the operator, the Pilot will flash in the corresponding color.

PLANNING AHEAD



Emergency stop device

Activating the emergency stop device will, if installed correctly, cut the power supply to Franka Emika Robot. All motions of the robot are thereby locked mechanically.

Safety locking system

The fail-safe safety locking system safely locks all mechanical motions of the Arm, also and in particular in an unpowered state.

Monitored stop

Once the safety locking system has been unlocked Franka Emika Robot is in the mode “monitored stop”. A safety system will ensure that Franka Emika Robot does not move. Should an unexpected motion occur nevertheless, the safety locking system is activated and the Arm will be locked mechanically.

Teaching/Guiding

Enabling/disabling Franka Emika Robot using the two buttons on the grip will safely enable/disable Franka Emika Robot. Should an unexpected situation occur during teaching, the letting go or strongly pressing of the enabling button will lead to the immediate stop of the Arm (it will go into “monitored stop”).

Enabling during step back & check

The operator is responsible for stepping out of the Hazardous Zone. The system is enabled as soon as he keeps the external enabling device half pressed. Now the operator can trigger a robot motion by giving another command (e.g. the start command in Desk). Should an unexpected situation occur during step back and check, the letting go or strongly pressing of the external enabling device will lead to the immediate stop of the Arm (it will go into “monitored stop”).

External activation

The operator is responsible for stepping out of the Hazardous Zone. Franka Emika Robot is activated as soon as the operator brings the external activation device to the activated state. Now the operator can start a robot motion by giving a further command (e.g. the start command in Desk). If the activation signal is interrupted during automatic operation the Arm will stop immediately (and go into “monitored stop”). For information on alternative connections to the female connector X3, please consult chapter: Planning ahead/ Stopping mechanisms/ and chapter: Mounting and Installation/ Wiring and electrical installation.

Additional features

WARNING

The functionalities described below are mere features and are not classified as safety functions according to EN ISO 13849-1. You may therefore NOT rely on the availability of these functionalities. When they are used, dangerous and uncontrolled motion of the robotic arm are to be expected at any given moment! Such a malfunctioning is to be regarded as extremely rare and will only occur under very unfavorable conditions. Therefore, maintaining attention focused and alert for any malfunctioning presents a further challenge. The motion mentioned can lead to risks of crushing, shearing, impact, puncture or penetration and may cause severe injury.
Therefore:

- When using these features the responsible person/integrator is solely responsible for conducting a hazard and risk assessment based on the contents of this manual and subsequently implementing appropriate measures
- (constructional or organizational measures).
- The operator needs to be made aware that the features listed below might not be reliably available.

The operator can benefit from the following features, which e.g. help make applications more robust, and improve performance and task success.

- Self-collision avoidance
- Monitoring of joint angles
- Speed monitoring
- Force monitoring
- Torque monitoring
- Collision detection and reaction

Dangers that Franka Emika Robot may present

Abstract of possible dangers

WARNING

An extensive but not definitive list of dangers that generally may be presented by a robot system can be found under EN ISO 10218-1:2011 ANNEX A. respectively ANSI/RIA R15.06. Special attention will be drawn here to the following dangers that Franka Emika Robot may possibly present:

- Mechanical dangers
  - Crushing
    - by falling or tilting over of the robotic arm in particular or the control during transport and incorrect mounting
    - between robot/end effector and robot/end effector
    - between robot/end effector and environment (objects in the Working Space)
    - by objects falling out of the gripper
    - during manual unlocking of the fail-safe safety locking system
  - Shearing
    - between robot/end effector and object in the end effector and environment (objects in the Working Space)
    - during manual unlocking of the fail-safe safety locking system
  - Impact, puncture, penetration
    - between end effector/object in the end effector and humans
- Electrical hazards
  - electric shock when touching live part
    - when wiring the emergency off installation in particular
    - when operating Franka Emika Robot with damaged supply cables or incorrect electrical installation
- Environmental hazards
  - Crushing, shearing, impact, puncture, penetration
    - by falling caused by an earthquake
    - by unexpected motions of the robot caused by earthquakes
- Combined hazards
  - Crushing, shearing, impact, puncture, penetration
    - by unexpected motions of the robot

PLANNING AHEAD

Application related possible dangers

The following possibly safety-related aspects are to be taken into consideration when planning and designing the application and performing the hazard & risk assessment for a completed machinery.

Unexpected motion

Please considere that the robot arm can move unexpectedly for a human. To name some examples:

- The Arm's pathplanner could come up with a different trajectory, and thereby an unexpecteded motion for a human
- Also we are handling so called singularities by avoiding driving through such singularities, unexpected motions due to crossing a singularity cannot be fully avoided
- Tilted, not horizontal fundament of the robot arm
- Hanging robot arm
- Acceleration of the robot's fundament
- Malfunctions of the control

Depending on the application, the used end effector, the handled objects, surrounding objects, and so forth, unexpected motion of the Arm could result in different hazards. Those hazards need to be considered and adequately mitigated.

Trapping within a completed machinery

Please consider, among others, that by placing the Arm within an application constellations could occur in which a human could be trapped. Dependent on the concrete risks evaluated within the application, chapter "Emergency Operation Guideline/ Manually moving the Arm in case of emergency" offers mechanisms to move the robot arm (e.g. for releasing a clamped human) also when no power is available.

Wiring of end effectors

If an end effector is selected that cannot be connected to Franka Emika Robot's Pilot directly, please take into consideration that external wiring has an own dead weight and because of that the maximum attachable payload has to be reduced accordingly. Please also take into consideration that external wiring creates additional loads and torques to the arm which may have influence on Franka Emika Robot's control performance.

Please consider among others, the following aspects and possible hazards of a selected end effector:

- sharp edges or pointed design of an end effector and/or moving parts of the end effector (e.g. sharp edged gripper fingers)
- movement or rotation of sharp rotating end effectors
- unexpectedly moving robot arm leading to the end effector freely impacting or crushing a human
- malfunctions of the control leading to unexpectedly opening or closing of the end effector
- malfunction of the control that an initiated protective stop is not stopping the end effector opening or closing
- power-loss leading to un-powering the end effector and thereby to opening/ closing of the end effector
- initiated emergency stop (supply voltage is cut) also un-powers the end-effector

End effectors

Franka Emika Robot is, dependent on the configuration, installed Apps & services, capable of sending protocols to possibly connected machines (incl. starting motion), externally wired end-effectors, associated equipment, and so forth. Please consider possibly related risks.

Initiation of motion of externally wired end-effectors, associated equipment,...

Franka Emika Robot is generally controlled via a single Desk connection. Only one Desk can be connected to a Franka Emika Robot at a time to ensure single point of control. Franka Emika Robot only allows starting commands in the dedicated operating states “run (automatically)” or “step back & check”. Please consider potential risks like unexpectedly initiated motion when Franka Emika Robot is controlled by third party controls via field buses.

Single point of control

Please consider among others, the following aspects and possible hazards of objects intended to be handled:

- sharp edged or pointed objects
- movement or rotation of sharp rotating objects
- unexpectedly moving robot arm leading to the grasped object freely impacting or crushing a human

Objects to be handled

Task environment-dependend effects:
Surface temperature of the Arm (from Base until Axis 7, excluding Flange)

CAUTION

At extended ambient temperatures comprised between 25 and 45 °C – after intense task execution and once Franka Emika Robot is set to “monitored stop” state - the integrator shall evaluate risks and implement appropriate measures such that operators can e.g. prolongedly (< 60 s) touch the Arm’s segments without being subject to thermal burns (EN ISO 13732-1:2006). Measures might include allowing cool down time before the Arm can be guided again or even switching off the robot for a specific time, notifying the operator accordingly, marking the spots that are most likely to become hot, or even prohibiting access to the robot.

After intense task execution at maximum payload and once Franka Emika Robot is set to “monitored stop” state - at ambient temperatures comprised between 15 and 25 °C (typical temperature range) - the operator can prolongedly (< 60 s) touch the Arm’s segments, without being subject to thermal burns, as the surface temperature of the Arm’s uncoated metal segments does not reach a temperature >= 51° C, and plastic segments do not reach a temperature >= 60 °C (EN ISO 13732-1:2006).

Task environment-dependend effects:
Surface temperature of Flange and end-effectors

CAUTION

As soon as end-effectors are mounted to the Arm - independently of ambient temperature - the integrator needs to evaluate if issues concerning touching surfaces during hand guiding may arise, especially after intense task execution. The integrator shall evaluate risks and implement appropriate measures such that operators can touch the Arm, the end effector’s Flange and the end effector connected to it without being subject to thermal burns (EN ISO 13732-1:2006), as the end effector may generate heat itself, and/or limit heat dissipation of the Flange and the Arm. Measures might include allowing cool down time before the Arm can be guided again or even switching off the robot for a specific time, notifying the operator accordingly, marking the spots that are most likely to become hot, or even prohibiting access to the robot.

Task dependend effects: Lifetime

WARNING

When one or more parts of the Arm's drive chain reaches their maximum lifetime, the integrity of the drive chain is no longer ensured, as a break through of the drive chain can occur that may lead to uncontrolled motions of the Arm. This can cause severe injuries.
The robot must be taken out of operation to prevent any harm!

Franka Emika has performed lifetime tests at critical component level as well as at single joint and Franka Emika Robot Arm level. Although all critical components exceed 20000 hours in our lifetime tests even at 100% payload, the expected nominal lifetime is 20000 hours. Nominal lifetime is measured at conditions of continuous task execution with 66% payload and within a workspace of 0.4 x 0.4 x 0.4 m centered at [0.515, 0.0, 0.226] m, with the Z-Axis of the flange oriented parallel to earth-gravity and the elbow positioned upwards (based on Annex A of EN ISO 9283).

Nonetheless, the Arm's actual lifetime can obviously be highly variable, as it depends on the specific application. For this reason, Franka Emika Robot arm does not just estimate the end of life based on its time in operation, but it performs real-time measurements based on effective load in order to monitor the actual wear, thereby maximizing lifetime. As soon as one of the components' lifetime limits is reached, a message notification on Desk will inform the operator that one or more parts of the Arm's drive chain have reached their maximum lifetime. Franka Emika Robot is then to be taken out of operation.

PLANNING AHEAD

Practical tips for usage and positioning of Franka Emika Robot

The following information on how to use and place the Arm are practical tips and may not be exhaustive when it comes to concrete application. They do not replace a hazard and risk assessment but may suggest layout options.

Free space for retracting

WARNING

Humans instinctively retract from unexpected motions. This is why the area in which the operator stands should allow for sufficient space to retract or recoil. Furthermore, it is to be made sure that this space is free of obstacles (e.g. cables, objects) to prevent persons from tripping over these obstacles and harming themselves.

Greatest possible distance to the Arm

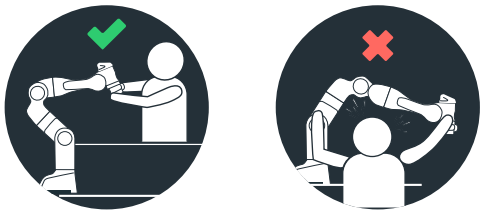
WARNING

The Arm should be kept at the greatest possible distance at any given time to allow the operator to react and recoil.

RIGHT WRONG

DO NOT operate the robotic arm while embracing it!

RIGHT WRONG



DO NOT place your head or other body parts between or underneath segments of the robotic arm!

RIGHT WRONG

NEVER place body parts (especially hands, fingers) between the robotic arm or its end effector and stationary objects.

Workspace design

WARNING

WRONG WRONG RIGHT

NO sharp edges in the Working Space and NO pointed objects!
NO unnecessary objects in the Working Space
Ergonomic position for teaching:

- Robotic arm is within easy reach
- The Arm is installed at an ergonomic height

Eye protection

WARNING

Dependent on what fingers are part of any end effector connected to the Arm and what objects are grapsed, protective goggles may have to be worn.

Clothing and jewelry

CAUTION

WRONG WRONG RIGHT

DO NOT wear loose clothing or clothing with ribbons!
NO loose jewelry such as necklaces or bracelets!

PLANNING AHEAD

Emergency stop installation

Franka Emika Robot has no digital input for an emergency-stop signal. The emergency-stop functionality needs to be realized externaly by the integrator by safely cutting the power to the Arm and/ or control. Franka Emika Robot is designed that way that cutting power will result in a safe emergency-stop state of the arm.

If FE's emergency stop device is used to cut the power to the Control, it must be activated at start-up and checked for function at least every 12 months.

NOTICE

Due to the technology of locking bolts, the position of the Arm cannot be held perfectly when the power is switched off. This means that Arm segments will sink some centimeters, in particular at those joints on which gravitational force comes into effect.

NOTICE

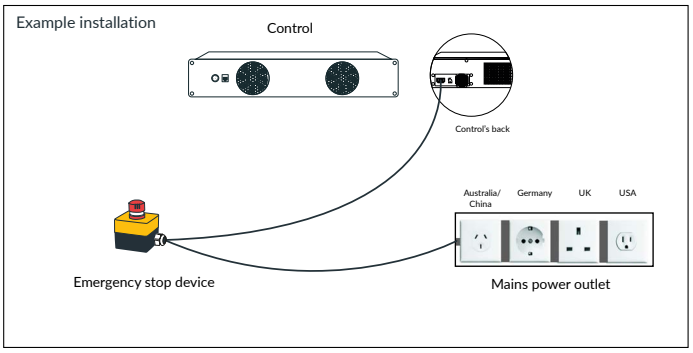
As soon as the Control is no longer supplied with power, Franka Emika Robot is safely stopped and mechanically locked by the fail-safe safety locking system. The emergency stop is designed for stopping the Arm as quickly as possible in case of emergency. This can damage the Arm or, when stopping at an unfavorable point in the process, also the end effector, work pieces or the surroundings.
Therefore:

- The emergency stop system should only be used in safety-critical situations.
- If possible, use the external activation device on X3 before activating the emergency stop. This will stop the robot motion more gently than the emergency stop system and will not activate the safety locking system.
- Any damages occurring to the Arm when the Emergency Stop is pressed will not cause harm to people, as the Arm will safely stop regardless of damages. If damages do occur, these will be notified to the User when the system is switched on again, after booting up.

Emergency stop installation

The emergency stop system is to be installed according to generally valid and accepted engineering standards (e.g. European standards EN 60204 and related).

The primary emergency stop system must safely separate the Arm and/ or the Control from the mains power supply. One potential version to safely cut the power to the Arm (while the Control is still energized) in TÜV Rheinland certified PId CAT3 is the optional equipment FEBB-1 safety box available via Franka World. Another potential versions is the emergency stop device (Franka Emika's article number: #78456374) contained in the optional Franka Emika Robot package. As soon as the power is disconnected, the fail-safe safety locking bolts of all 7 axes instantly block further motions of the Arm.



Disconnection from supply circuit

For ensuring that the system is/remains powered off and with the joints of the Arm locked in place (e.g. during unattended time intervals, maintenance works, implementation of applications), one option is to cut Franka Emika Robot off from the mains power supply by disconnecting the power cable (connecting mains and the control) and store it in a safe location.

Stopping time and distance

Stopping time (i.e. the time that passes by between activation of the emergency stop and complete stop of the Arm) and stopping distance (i.e. the distance covered by the Arm after activation of the emergency stop until it comes to a complete stop) were measured in accordance with EN ISO 10218-1, Annex B.
Under absolute worst case conditions (e.g. maximum payload of 3 kg and maximum velocity), the stopping distance for the Arm's main axes (i.e. A1, A3, A5, A7) is 141.71° (by cutting 110/230 V) and 116.5° (by cutting 48 V), and the stopping time is 652 ms (110/230 V) and 552 ms (48 V).

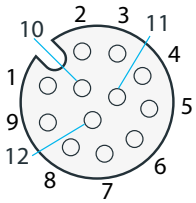
PLANNING AHEAD

Stopping mechanisms

Emergency stop - by cutting power to the Control	Stop Type: emergency stop Stop Category: 0 (acc. to IEC 60204-1) Safety-rating: up to PL d Cat. 3, dependent on the external device used realization: safely cutting the power supply to the Control example 1: FE's emergency-stop device (PL c Cat. 1) example 2: connecting an emergency-stop device to a safety-rated power switch (up to PL d Cat.3) result: power is cut to the Control and thereby also to the Arm. The Fail-Safe Safety-Locking system immediately locks all joints in a mechanical manner. The Control is also unpowered.
Emergency stop - by cutting power to the Arm	Stop Type: emergency stop Stop Category: 0 (acc. to IEC 60204-1) Safety-rating: up to PL d Cat. 3, dependent on the external device used realization: safely cutting the power supply to the Arm example: FEBB-1 (available on Franka World) is connected between Control and Arm and on request (e.g. by an emergency-stop device connected to the FEBB-1) cuts the power to the Arm with PL d Cat. 3. result: power is cut to the Arm. The Fail-Safe Safety-Locking system immediately locks all joints in a mechanical manner. The Control remains powered.
Protective stop – by cutting power the to Arm	Stop Type: protective stop Stop Category: 0 (acc. to IEC 60204-1) Safety-rating: up to PL d Cat. 3, dependent on the external device used. realization: safely cutting the power supply to the Arm example: FEBB-1 (available on Franka World) is connected between Control and Arm and on request (e.g. by a safeguard connected to the FEBB-1) cuts the power to the Arm with PLd Cat. 3. result: power is cut to the Arm. The Fail-Safe Safety-Locking system immediately locks all joints in a mechanical manner. The Control remains powered
Protective stop – as a result of changing operational modes – external device connected to X3.1A	Stop Type: protective stop Stop Category: 2 (acc. to IEC 60204-1) Safety-rating: no safety-rating realization: connecting an external device for changing operational modes to X3.1A example: FE's external activation device example: FEBB-1 (available on Franka World) with connected key-switch result: As soon as the input is opened, the system reacts with a protective stop of category stop 2 and remains in a "monitored stop" condition. The Fail-Safe Safety-Locking system is not locking the joints mechanically. The Control remains powered. As soon as the X3.1A input is closed, the system switches to automatic mode – and an additional command is needed to start robotic motion.

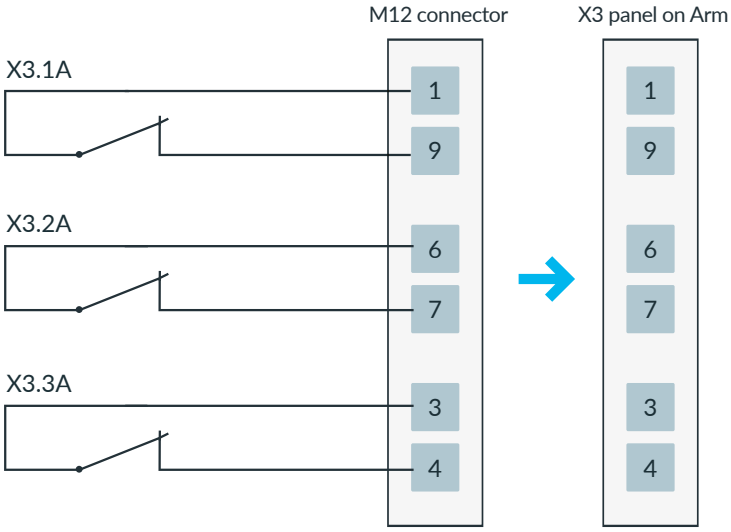
Protective stop – external device connected to X3.2A	Stop Type: protective stop Stop Category: 2 (acc. to IEC 60204-1) Safety-rating: no safety-rating realization: connecting an external device to X3.2A to request a protective stop of stop category 2 during automatic mode is active example: FEBB-1 (available on Franka World) with a 2-zones laser scanner connected. As soon as a person enters the outer zone controlled by the laser scanner, a protective stop of Cat 2 can be requested to stop the Arm in a controlled way result: a stop category 2 is executed when X3.2A is closed (not open). The Arm is stopped in a controlled way and remains in "monitored stop" condition. The Fail-Safe Safety-Locking system is not locking the joints mechanically. The Control remains powered.
Protective stop – external device connected to X3.3A	Stop Type: protective stop Stop Category: 1 (acc. to IEC 60204-1) Safety-rating: no safety-rating realization: connecting an external device to X3.3A to request a protective stop of category 1 result: a stop category 1 is executed when X3.3A is closed. The Arm is stopped in a controlled way and then all joints are mechanically locked. The Control remains powered.

Wiring for X3



M12, 12 PIN, male standard A-coding for Arm: X3

pin	signal
1	X3.1Ap
2	reserved
3	X3.3Ap
4	X3.3An
5	reserved
6	X3.2Ap
7	X3.2An
8	reserved
9	X3.1An
10	reserved
11	reserved
12	reserved



Preparing the installation site

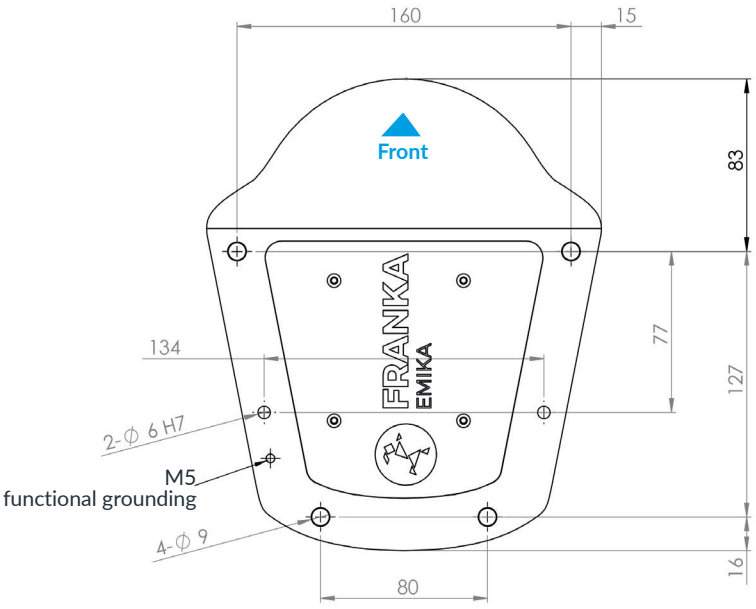
Correct site of installation

In the chapter: Correct Site of Installation/ the most important requirements for the installation site are summarized.

Preparing the baseplate

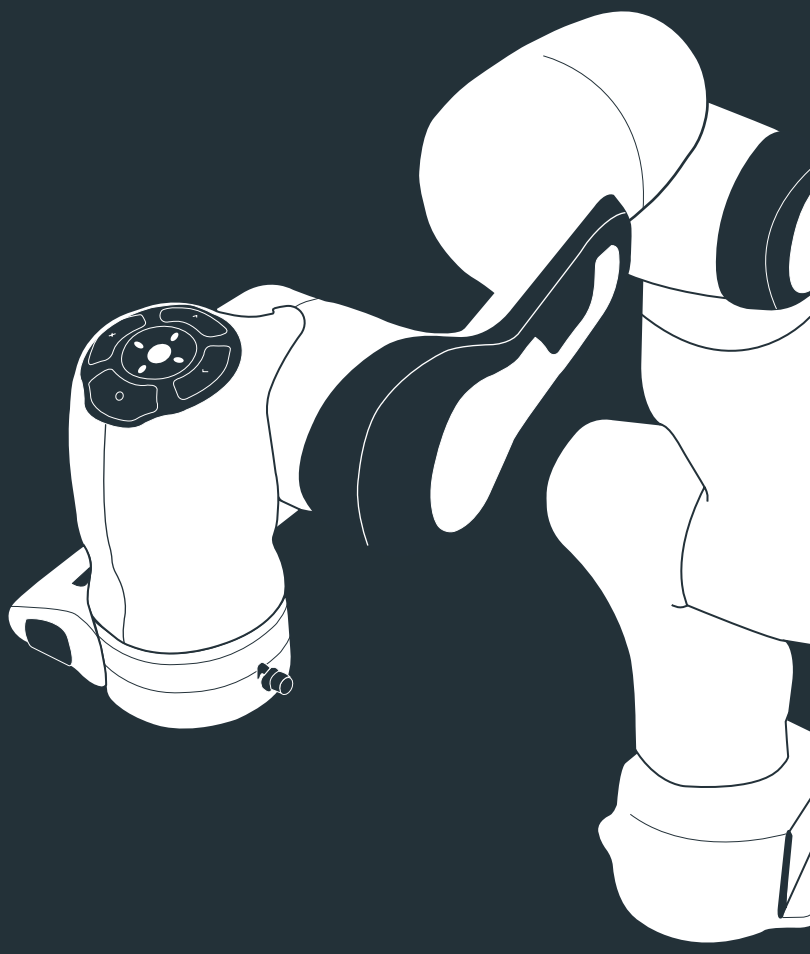
Prepare positions for screws in baseplate:

- The Arm has 4 drill holes with a diameter of 9mm in its mounting flange
- For fixing the corresponding screws, threaded holes need to be made in the baseplate, or the corresponding lock nuts need to be used
- Use the technical drawing provided to position the holes
- Also note the indication for the front of the Arm
- The hole spacing is designed to be compatible with flexible assembly parts by ITEM
- Two holes for dowel pins (diameter 6mm H7) in the mounting flange allow for accurate repeatable assembly of the Arm using 2 x 6mm H8 pins
- A detailed mounting layout for the baseplate is described in chapter: Correct Site of Installation/.



DELIVERY AND TRANSPORT

- Delivery & Transport
- Handling & Lifting
- Re-packing the Arm



DELIVERY AND TRANSPORT

Delivery & Transport

Franka Emika Robot is delivered in original packaging. The delivery scope is described in chapter: This is Franka Emika Robot/ Scope of delivery and additionally required equipment.

WARNING

The Arm weighs approx. 18kg and the Control approx. 7kg.
Due to the dead weight and partly geometric design (e.g. mounting flanges), lifting and handling the device can lead to back injury, and, if it falls down, to serious injury to fingers, hands, toes and feet.

Therefore:

- Always wear personal protective equipment (e.g. safety shoes), when transporting, mounting or demounting these devices
- The devices must be placed such as to prevent tilting or sliding
- If applicable, existing company regulations regarding e.g. the lifting of loads and personal protective equipment are to be observed.

The Arm and Control contain sensitive electromechanical components.
These can be decalibrated or damaged by shock. Cables need to be in sound condition. Damaged components can, for example, cause electrical risks and may lead to severe injury.

Therefore:

- Check if the packaging is in sound condition and fulfils its protective function
- Cables or plugs must be free of damages
- If damages are found, the devices are to be taken out of operation immediately (e.g. 'disabled' label). In cases of doubt, contact the manufacturer.

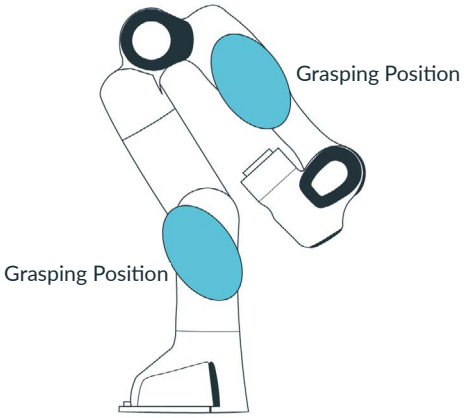
Transport pose

Since both the Arm and Control contain sensitive electromechanical components, we recommend storing and transporting them in their original packaging at all times. The transport position is described in chapter: Delivery and Transport/ Re-packing the Arm/ Transportation pose of the Arm.

- Furthermore, we offer a function in Desk for bringing the Arm in transport position with one click. There, you can find this option under Settings/System/Move to pack pose.
- Before the function can be used, the end effector must be removed.
- It is to be ensured that the robot can move freely to adopt the transport position and is not encumbered by obstacles.

Handling & Lifting

Always lift the Arm in the positions intended for lifting, as not to overstress the joints of the Arm during handling and lifting. In particular, the Arm may never be carried in extended position with one person holding each end of the Arm!



NOTICE

The Arm contains sensitive mechanical and mechatronic components. These can be decalibrated or damaged due to wrong handling or misuse!

Therefore:

- The Arm may only be handled, lifted and transported at the points indicated in this manual in order to avoid overstressing the joints of the Arm
- The Arm is to be handled gently even when set-up and switched on or off. If, for example, the arm is moved by force when in stopped and locked state, an internal safety system is triggered and will cause a momentary slipping of internal parts. This slipping causes decalibration and damage to the Arm, which will be detected during next start-up of Franka Emika Robot and the operator will be notified by Desk to take Franka Emika Robot out of operation.

DELIVERY AND TRANSPORT

NOTICE

The Arm and Control contain sensitive electromechanical components. These can be decalibrated or damaged by mechanical shock!

Therefore:

- Avoid shocks or setting the device down roughly.
- Always store and transport devices in their original packing, even during transport inside buildings

NOTICE

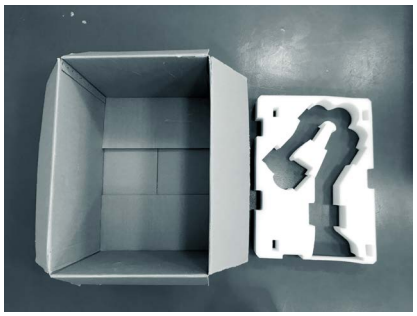
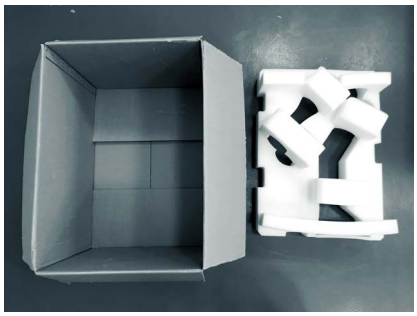
The Arm, and most likely any end effector connected to it (after appropriate application-specific hazard and risk assessment performed by the integrator) contain sensitive electromechanical components. These can be damaged if the Arm is moved to adopt the transport position while the end effector is still attached! Furthermore, when moving into transport position, objects in the Working Space of the Arm may be damaged.

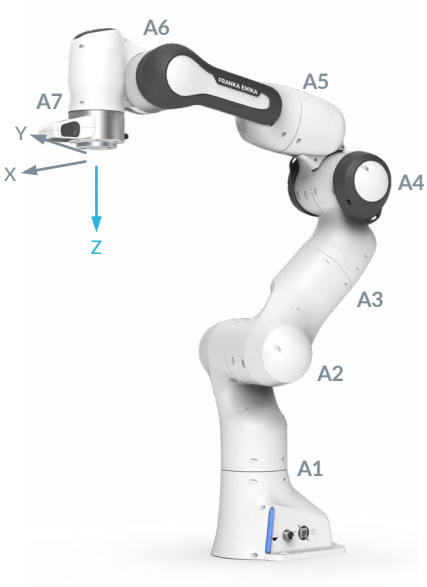
Therefore:

- Make sure that the end effector has been dismounted before bringing the Arm into the transport position.
- Make sure that the Working Space allows to bring the Arm into transport position safely.

Re-packing the Arm

- Move the Arm to its tranport pose, as described in chapter: Delivery and Transport/ Delivery & Transport/ Transport pose.
- Empty the box and position the foam layer such that the side that will surround the Pilot points leftward.
- Slot in the packaging elements that will support the Arm's weight.
- Flip over the foam layer with the inserted packaging elements, and fit it into the box. The Arm can now be packed in. We recommend doing this together with another person to help you, because the Arm weighs approx. 18 kg.

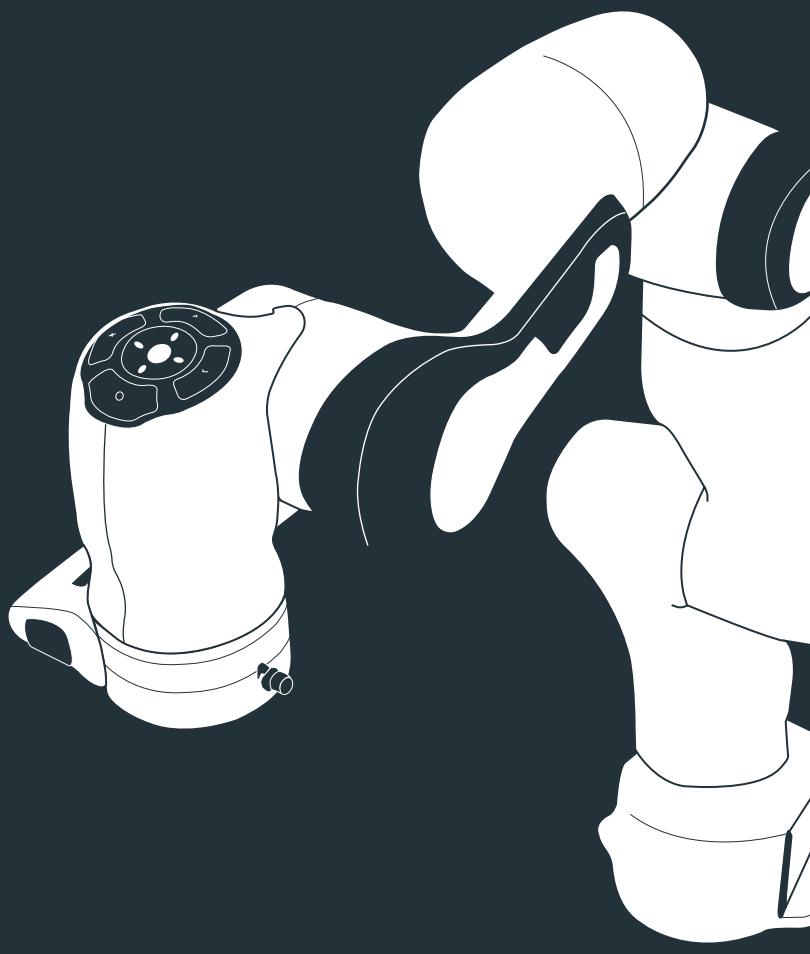



Transportation pose of the Arm

- The transportation pose can be described by the following joint angles of axis 1 to axis 7: [0°, -32.08°, 0°, -170.17°, 0°, 0°, 45°]

MOUNTING AND INSTALLATION

- Unpacking Franka Emika Robot
- Mounting the Arm
- End effectors
- Unpacking and mounting the Control
- Wiring and electrical installation



MOUNTING AND INSTALLATION

Unpacking Franka Emika Robot

Before proceeding

Before mounting and installing the system, make sure to have consulted chapter: Planning ahead/ Preparing the installation site/, chapter: Correct site of installation/, and chapter: Delivery and Transport

Dead weight

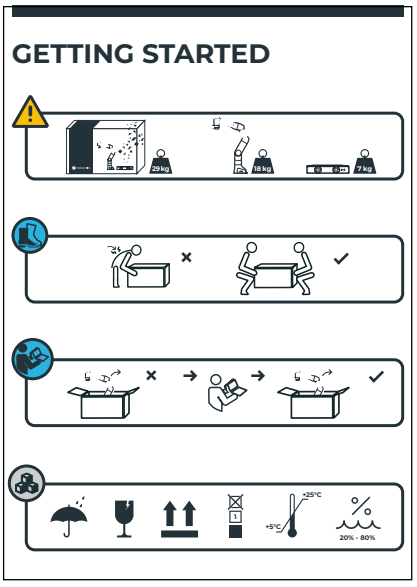
WARNING

The Arm weighs approx. 18kg and the Control approx. 7kg.
Due to the dead weight and partly geometric design (e.g. mounting flanges), lifting and handling the device can lead to back injury, and, should it fall down, to serious injury to fingers, hands, toes and feet.

Therefore:

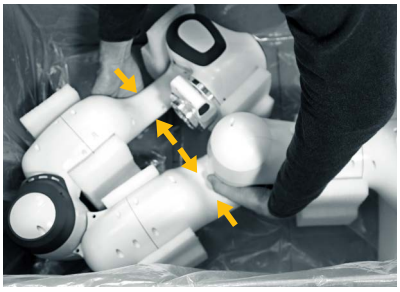
- Always wear personal protective equipment (e.g. safety shoes), when transporting mounting or demounting these devices
- The devices must be placed such as to prevent tilting or sliding
- When lifting and handling the equipment, always ensure correct lifting (from the knees and not from the back)

- Carefully open the box by removing the sealing adhesive strips on top of the cardboard box.
- Open the foil coating.
- Take out the “Getting started“ sheet and read it carefully.
- First take out the accessories and cables and set them aside.
- Then take out the Control by grasping it with one hand on each side of the casing and set it aside as well.



MOUNTING AND INSTALLATION

- First carefully remove the foam layer that is surrounding the Arm.
- Then grasp the Arm at the indicated grasping position and carefully lift it out of the box. We recommend doing this together with another person to help you, because the Arm weighs approx. 18kg.



NOTICE

The Arm contains sensitive mechanical and mechatronic components. These can be decalibrated or damaged due to wrong handling or misuse!

Therefore:

- The Arm may only be handled, lifted and transported at the points indicated in this manual in order to avoid overstressing the joints of the Arm
- The Arm is to be handled gently even when set-up and switched on or off. If, for example, the arm is moved by force when in stopped and locked state, an internal safety system is triggered and will cause a momentary slipping of internal parts. This slipping causes decalibration and damage to the Arm, which will be detected during next start-up of Franka Emika Robot and the operator will be notified by Desk to take Franka Emika Robot out of operation.

NOTICE

The Arm and Control contain sensitive electromechanical components. These can be decalibrated or damaged by mechanical shock!

Therefore:

- Avoid shocks or setting the device down roughly.
- Always store and transport devices in their original packing, even during transport inside buildings

Mounting the Arm

WARNING

The Arm weighs approx. 18kg and the Control approx. 7kg.
Due to the dead weight and partly geometric design (e.g. mounting flanges), lifting and handling the device can lead to back injury, and, should it fall down, to serious injury to fingers, hands, toes and feet.

Therefore:

- Make sure the Arm is stable and placed such as to prevent it from tilting.
- Keep holding the Arm until all four screws are securely fastened to the fundament.

Mounting

- Work in twos to place the Arm in its target position
- Make sure that the front of the Arm points in the right direction
- One person holds the Arm in position, while the other mounts it to the base-plate, using 4 screws that have to be prepared beforehand.
- An example with screws and tightening torque is given in chapter: Correct Site of Installation/.
- After 100 hours of operation the screws are to be tightened again with the nominal torque!

Adequate ventilation

NOTICE

The Arm contains power electronic components and modules (electric drives, CPUs, etc.) which heat up depending on the load the device is subject to. The Arm does not contain active cooling systems, meaning that the produced heat is given off via the Arm's surface.
Therefore:

- Make sure that the Arm is adequately ventilated
- Make sure the Arm is not exposed to direct sunlight
- Make sure that the Arm is not painted, pasted up with something or enwrapped

MOUNTING & INSTALLATION

End effectors

Find details about fixing end effectors within the end effector's assembly instructions.

Mounting of end effectors

WARNING

Please ensure that no tools employed to connect any end effectors remain inserted on the robot! They could become projectiles during later motions of the Arm and lead to injuries.

The Arm is equipped with a flange for mechanical connection of end effectors (see chapter: This is Franka Emika Robot/ Equipment overview), as well as a connector at the Pilot for direct connection (i.e. for power and communication) of integrated end effectors like Hand. If any end effector is to be coupled that cannot be connected directly to such connector, external cabling can be appropriately designed and implemented to power and control the end effector.

Unpacking and mounting the Control

Unwrapping

- Work in twos to remove the foam packaging of the Control, one person holding the Control and the other removing the foam packaging.

Positioning

- Place the Control in its designated position or attach it in a rack designed for 19 inch units (the control has 2 HUs - hight units). Please refer to chapter: Correct site of installation/ Ambient conditions: Control/ for information on how to install the Control.
- Note that the standard length of the connecting cable is 2.5m!

NOTICE

Adequate ventilation

The Control contains power electronic components and modules (electric drives, CPUs, etc.) which heat up depending on the load the device is subject to. An internal active ventilation system sucks in air from the environment and channels it through the casing of the Control.
Therefore:

- Make sure that the Control is adequately ventilated
- Make sure there is enough distance between the front ventilators and covering components
- Make sure there is enough distance between the back ventilators and covering components
- Make sure that the ventilators are not blocked by pollution
- Make sure the Control is not exposed to direct sunlight

Wiring and electrical installation

WARNING

Sound condition

Damaged or inadequate wires and electrical installations can cause serious personal injury by electric shock, as well as material damage

Therefore:

- Only use Franka Emika Robot when in sound technical condition
- The installation of the emergency stop system may only be carried out by qualified personnel.
- Live cables and electrical installations need to be in sound condition.

WARNING

Risk of falling

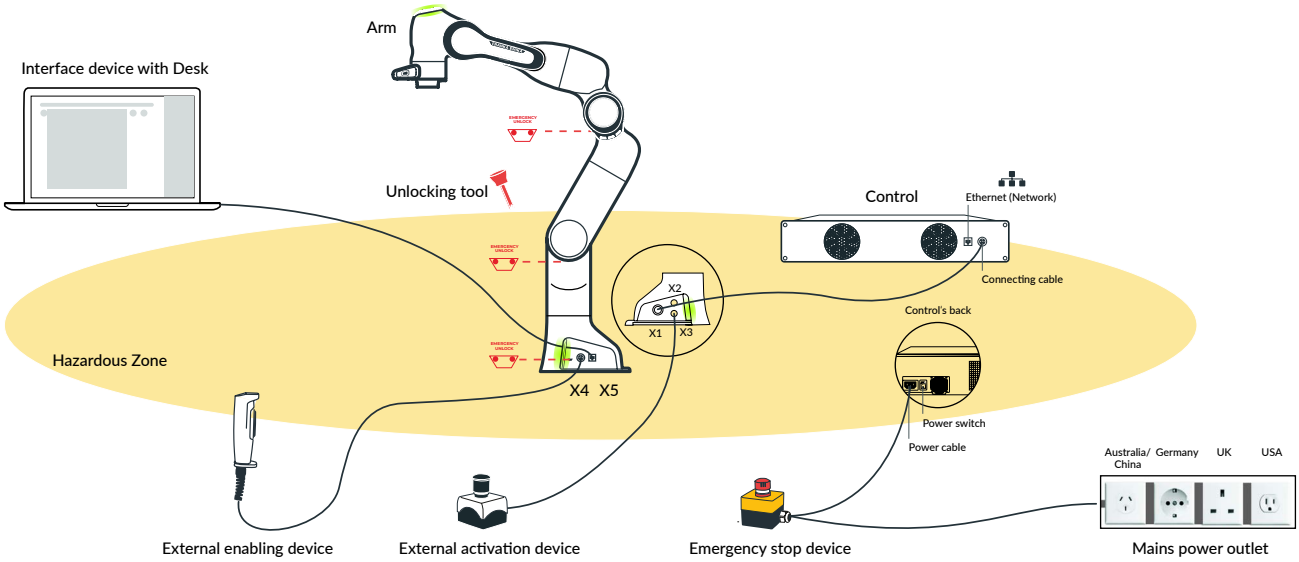
Badly laid wires and cables can present obstacles in the area around a robot installation and cause operators to trip and fall.
Therefore:

- Always lay cables safely

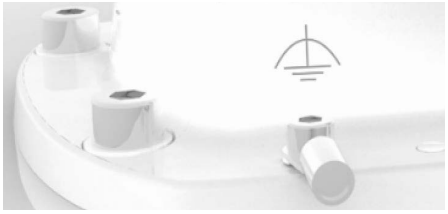
MOUNTING & INSTALLATION

Wiring diagram

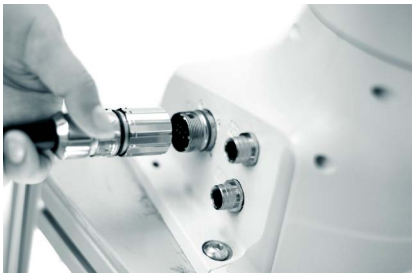
The following illustration represents a sample wiring with Franka Emika's emergency stop device, the external enabling device, the external activation device and the additional workfloor Ethernet connection.



Connecting the functional earth



- Connect the functional earth to the M5 thread of the Arm's base (at the indicated position) on one side and to a nearby, well-grounded part (e.g. a solid metal grounding bar) on the other end.
- For this purpose, an M5 screw thread is available – the corresponding grounding cable with end sleeve and an M5x8 screw with lock washer are not included.
- We recommend using a 1.5 mm² diameter grounding cable, with a maximum length of 5 m.



Connecting Arm and Control

- Carefully place the connector port onto the connector X1, the triangular marking pointing upward.
- By turning the movable front part of the connector port, the plug itself is pulled into the connector. Turn hand-tight.

- Apply the same principle to connect the other end of the connection cable with the connector on the front of the Control.

External enabling device & external activation device

- Connect the external enabling device to the X4 connector and the external activation device to the X3 connector on the Arm
  - Make sure that the guide pins are pointing in the right direction.
  - By turning the movable front part of the connector port, the plug itself is pulled into the connector. Turn hand-tight.
- Place the external activation device within easy reach of the operator.
- Make sure that the external activation device is closed.

Connecting your operating device (for operation via Desk)

To operate Franka Emika Robot via the intuitive programming interface Desk and using Apps:

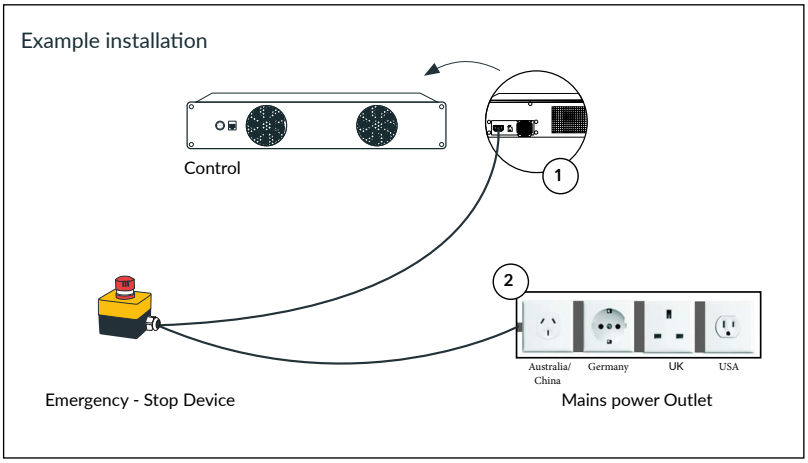
- Connect your interface device (tablet, notebook, PC, etc.) with a network cable (RJ45) to the connector X5 on the base of the Arm

MOUNTING & INSTALLATION

Emergency Stop Installation

For installation of emergency stop installations, please refer to the chapter: Planning ahead/ Stopping mechanisms.

- The emergency stop system must safely disconnect the supply from Control
  - One possibility is Franka Emika's emergency stop device, as it is included in the scope of the Franka Emika Robot delivery. This device is installed between Franka Emika Robot's Control and the power supply.



- In this process, ensure that the power switch at the Control is switched off (position 0)
- Insert the Emergency Stop device with the cold-device plug first into the Control and then connect the Control with the power supply (100-240V/47-63Hz frequency)

Protective devices

- Should you wish to connect external protective devices to decelerate the Arm and bring it to a full stop by means of a stop category 0, 1 or 2 (according to IEC 60204-1), please refer to the chapter: Planning ahead/ Stopping mechanisms.

Safety devices need to be checked for proper functioning before initial operation and after at regular intervals.

NOTICE

Live cables or connectors may never be connected or disconnected during operation (in particular rubber connectors, connection cable, connection cable to end effectors, etc.). This can lead to damaging the Arm or end effectors.
Therefore:

- never connect or disconnect cables before safely disconnecting Franka Emika Robot from the mains power supply
- never connect or disconnect end effectors while Franka Emika Robot is not safely disconnected from the mains power supply

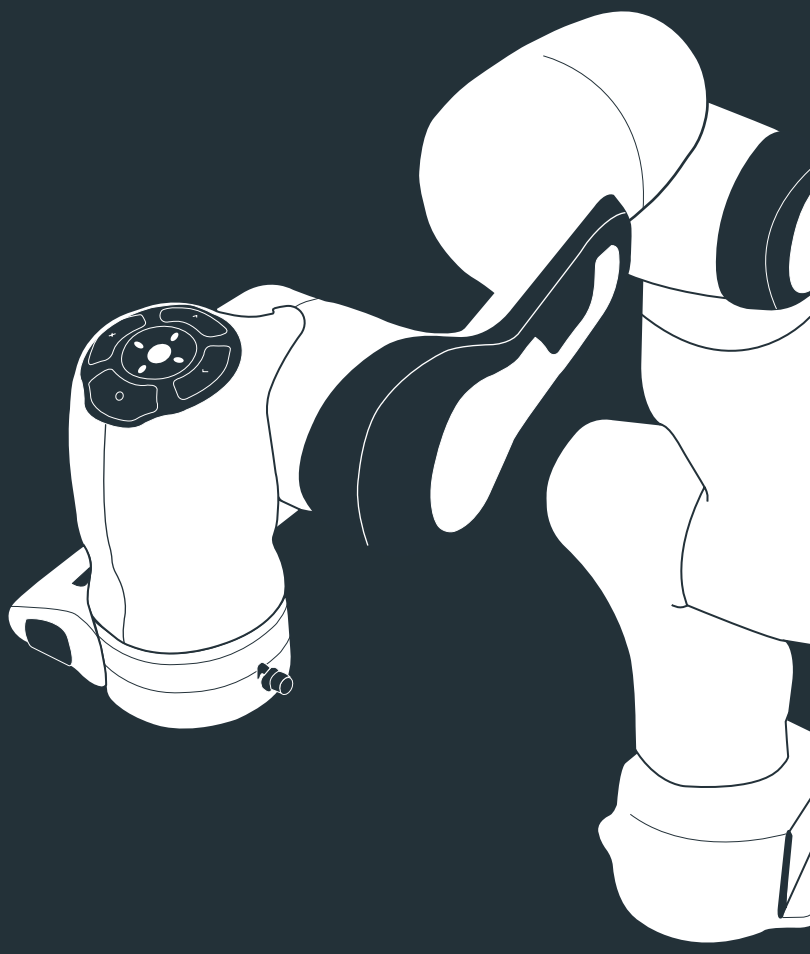
NOTICE

The connection cable does not support being folded, rolled over or stepped on.
Therefore:

- Lay the connection cable in such a way that it will not be overstressed (no bending, rolling over it).

EMERGENCY OPERATION GUIDELINES

- Fail-safe locking system
- Manually moving the Arm in case of emergency



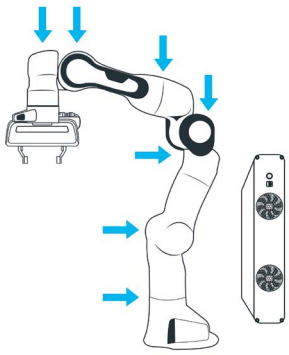
EMERGENCY OPERATION GUIDELINES

Fail-safe safety locking system

In this present chapter, some illustrations of Franka Emika Robot include Franka Emika's end effector (i.e. Hand). Note that Hand is not of the scope of Franka Emika Robot as a partly completed machinery, and it is represented in some figures of this chapter for example purpose only. Also note that, upon connection of any end effector, the integrator is responsible for conducting appropriate hazard and risk assessment to identify residual risks so as not to compromise safety and health, and is responsible for the safety of the final application.

Safety locking system

When the Arm is disconnected from the mains power supply locking bolts automatically catch in all 7 axes of the Arm. They mechanically lock any motion of the joints so that the Arm stays in position even when not supplied with power. Due to the technology of these locking bolts, the position of the Arm cannot be held perfectly when the power is switched off. The locking bolts catch with an audible click and let the Arm sink in the order of some centimeters, in particular at those joints on which gravitational force comes into effect. This should be taken into consideration.



Manually moving the Arm in case of emergency

Moving the Arm without electrical power

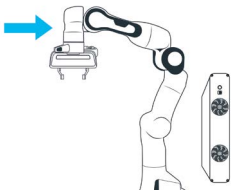
There are two possible ways to move the Arm even without a power supply in case of emergency. They are listed below in order of criticality of the hazardous situation:

- In case of acute mortal danger (e.g. person is severely crushed or can no longer breathe)
  - action: immediately push the Arm away manually
- In case of non-acute mortal danger and jamming of the Arm itself
  - action: unlock safety locking system with the use of the unlocking tool

Action:
Pushing away manually

SAFETY INSTRUCTION

In case of acute mortal danger, the Arm needs to be immediately pushed or pulled out of the dangerous position manually.
Check first that Franka Emika Robot is not energize
(e.g. by pressing the emergency stop button).
Then push or pull the arm manually.



NOTICE

Manully pulling or pushing the Arm can damage the Arm, as the joints are likely to be overloaded.

Therefore:

- The Arm should only be manually pulled or pushed away in safety-critical situations.

EMERGENCY OPERATION GUIDELINES

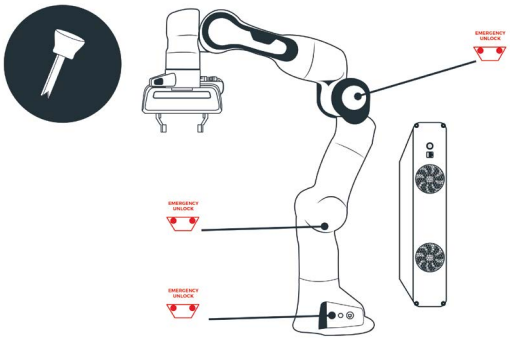
Action: Emergency unlock

If this method for emergency unlocking shall be used, integrator needs to make sure that the unlocking tool is stored closeby the application and that only the original unlocking tool is used.

SAFETY INSTRUCTION

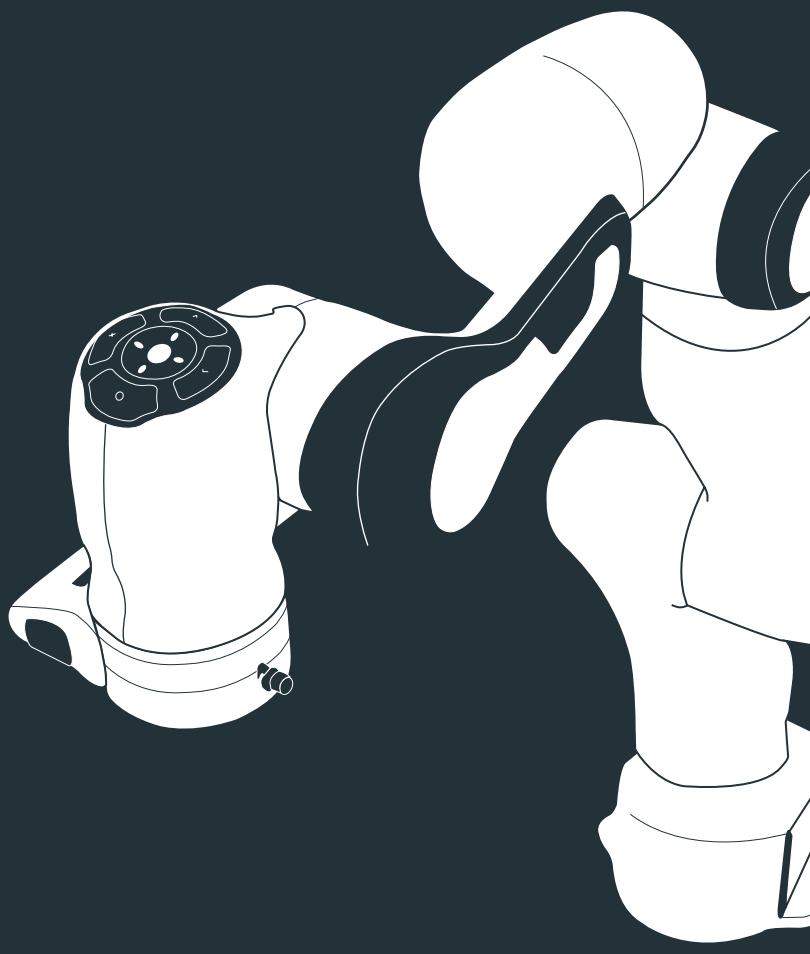
When the Arm is to be moved in a non-powered condition, (e.g. when it is jammed between surrounding objects), the emergency unlocking system is to be used. First of all, check that Franka Emika Robot is definitely unpowered (e.g. press the external emergency stop device). Then unlock one or more joints one after another. For this purpose, trapezoidal openings are available at three joints of the Arm. These are marked with the label emergency unlock. By gently inserting the unlocking tool, the joint is unlocked and the Arm segment can be moved manually. Be aware that as soon as the unlocking tool is inserted, the Arm segment towards the head of the Arm will fall down with gravity. So this Arm segment needs to be held before inserting the unlocking tool. The location of the three openings were identified - upon both mechanical and interaction design considerations - as the points/joints along the Arm that are best likely to support prompt and successful unlocking of the Arm, independently of the specific joint configuration in place at the moment of the unlocking.

Don‘t forget to remove the unlocking tool after manually moving the arm!



START-UP

- Switching on
- Testing the emergency stop system
- Connecting a user interface device
- Software setup
- Teach Franka Emika Robot a Task
- Teach Franka Emika Robot a Task: details about Guiding
- Step back & check
- Let Franka Emika Robot run a Task
- Switching off



START-UP

Switching on

In this present chapter, some illustrations of Franka Emika Robot include Franka Emika's end effector (i.e. Hand). Note that Hand is not of the scope of Franka Emika Robot as a partly completed machinery, and it is represented in some figures of this chapter for example purpose only. Also note that, upon connection of any end effector, the integrator is responsible for conducting appropriate hazard and risk assessment to identify residual risks so as not to compromise safety and health, and is responsible for the safety of the final application.

WARNING

Devices can be very cold after transport and may develop condensation when being placed in warmer surroundings with higher humidity. Wet devices can lead to a short circuit and may present the risk of electric shock.
Therefore:

- Leave devices to acclimatize after transport
- Do not switch on wet devices

WARNING

The system may only be used in sound technical condition and as intended, in a safety-conscious manner and aware of any dangers, while observing the instructions in the present documentation. Malfunctions compromising safety must be eliminated immediately.

NOTICE

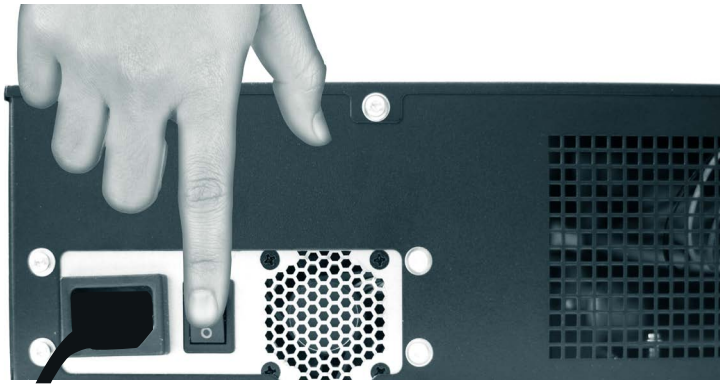
Switching on wet devices can not only lead to life-threatening injuries, but can also cause material damage.
Therefore:

- Leave devices to acclimatize after transport
- Do not switch on wet devices

SAFETY INSTRUCTION

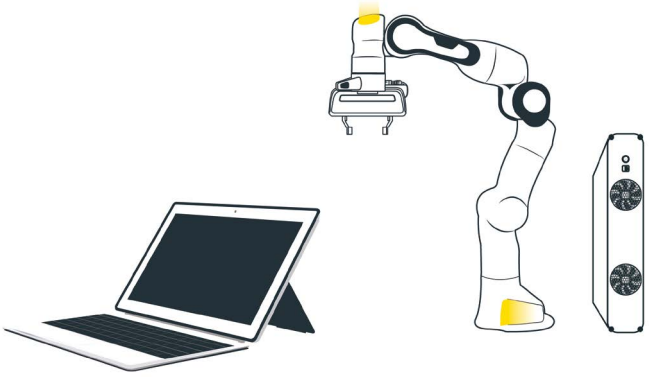
Be outside the Hazardous Zone while system boots up.

Now you may switch on Franka Emika Robot for the first time:



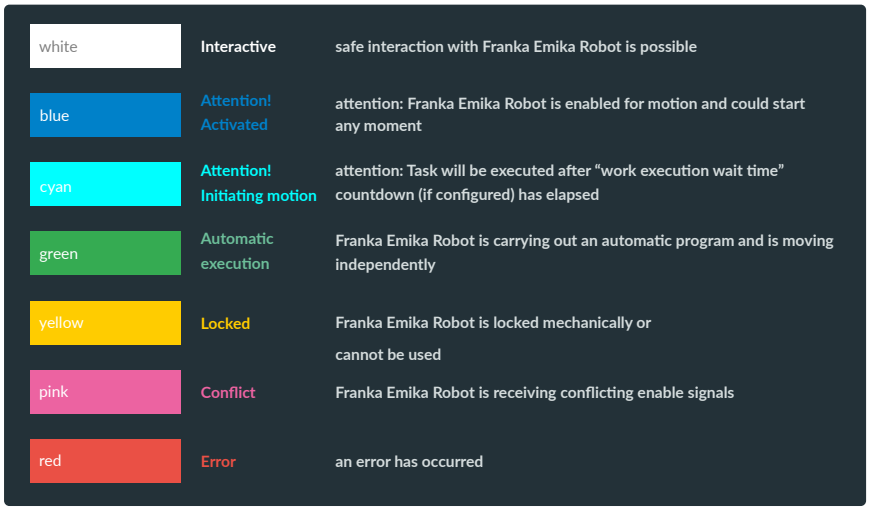
- Make sure that the external power supply is provided.
- Now switch on the Control. The power switch is located on the back of the Control.

The following behavior is to be expected:



- The Control will boot up and the cooling system is activated, so that you will hear and see the ventilation working.
- The status lights on the Pilot and on both sides of the base will start to flash yellow.
- Should you notice any malfunction, see chapter: Maintenance, Service & Support/ Troubleshooting.
- Booting up may take a short while (approx. 1 minute).
- Booting up is completed once the status light glows continuously yellow.
- The safety locking system is still active, meaning that the axes are still mechanically locked in this condition (how to unlock the safety locking system is described in the sections to follow).

Overview of the status indicators



Testing the emergency stop system

The emergency stop system must be activated at start-up and checked for function at least every 12 months. In this regard, please note the chapter: Planning ahead/ Emergency Stop Installation.

WARNING

The emergency stop also cuts off power supply to any end effectors directly connected and power supplied to/by the Arm. This means that objects can fall out of the gripper and cause injuries, in particular to hands or fingers on a table or to the toes.

Therefore:

- Make sure that objects cannot fall out of the gripper when de-energized (e.g. by using most appropriate type of gripper, by designing form-fit grasping).
- Alternatively, make sure that objects falling out of the gripper cannot cause any injuries (e.g. by using lightweight and/or rounded objects, by wearing safety shoes).

SAFETY INSTRUCTION

Please carry out the following SAFETY INSTRUCTIONS exactly as described below:

- Franka Emika Robot must be in the state of “monitored stop”. The locking bolts of the safety locking system need to be open and the Arm may not move.
- Activate the emergency stop
- By activating it, the Arm will slightly sink with a clacking noise when falling into the mechanical locking bolts. Make sure that there is enough space for the Arm to sink to avoid causing damages to grasped objects or the environment. Bring the Arm into a position that is free from obstacles, e.g. 200mm above stationary objects. Use guiding to do so.
- If the emergency stop is installed as to additionally switch off other devices apart from Franka Emika Robot, this needs to be taken into account during testing.

NOTICE

Due to the technology of locking bolts, the position of the Arm cannot be held perfectly when the power is switched off. This means that Arm segments will sink, in particular at those joints on which gravitational force comes into effect. Due to this sinking, workpieces or sensitive objects in the proximity of the device can be damaged.
Therefore:

- Take the sinking movement of the axes into account when switching off Franka Emika Robot. Place the Arm in a clear position (e.g. 200mm above stationary objects) before switching it off.

NOTICE

As soon as the Control is no longer supplied with power, Franka Emika Robot is safely stopped and mechanically locked by the fail-safe safety locking system. The emergency stop is designed for stopping the Arm as quickly as possible in case of emergency. This can damage the Arm or, when stopping at an unfavorable point in the process, also the end effector, work pieces or the surroundings.
Therefore:

- The emergency stop system should only be used in safety-critical situations.
- If possible, use e.g. the external activation device on X3 before activating the emergency stop. This will stop the robot motions more gently than the emergency stop system and will not activate the safety locking system.
- Any damages occurring to the Arm when the Emergency Stop is pressed will not cause harm to people, as the Arm will safely stop regardless of damages. If damages do occur, these will be notified to the operator when the system is switched on again, after booting up.

START-UP

Connecting a user interface device

The configuration and programming environment of Franka Emika Robot runs on all modern browsers. However, we recommend using Chrome, Chromium or Firefox. No further software is necessary:

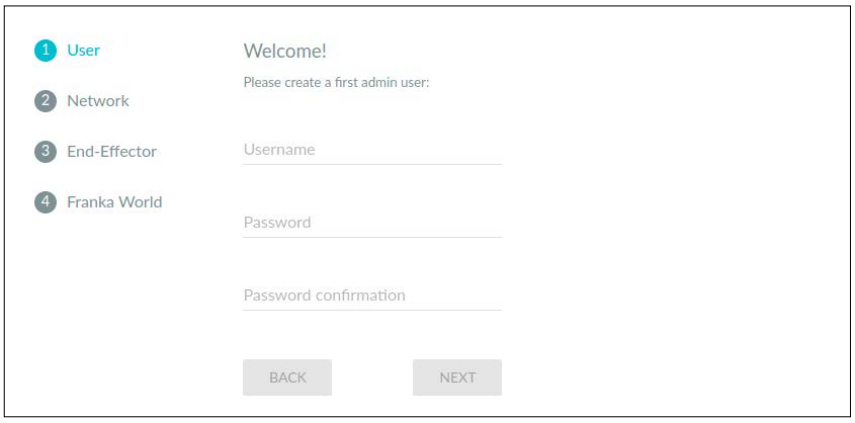
- To open the initial configuration interface, an interface device must be connected via Ethernet cable to the X5 connector on the base of the Arm (see chapter: Mounting & Installation/).
- The interface device must be configured to obtain the IP address automatically via DHCP.
- Once Franka Emika Robot has been switched on, the interface device will automatically be assigned an IP address.
- Then the URL "robot.franka.de" can be entered and opened in a web browser.

Software setup

All persons working with Franka Emika Robot must have read and understood the documentation (in particular the chapter: Planning ahead/ and chapter: Emergency operation guidelines/), be able to comprehend any risks associated with the robotic system and act with adequate care.

Configuring Franka Emika Robot

When first starting Franka Emika Robot or after resetting the Control to default settings, the initial configuration is shown in the web browser when you enter the URL "robot.franka.de":



Creating an admin user is mandatory. To create an admin, enter the user name and password and confirm the password. Always use secure passwords to prevent unauthorized persons from accessing the system!

Creating user roles

NOTICE

You can create or edit (other) users by carrying out the following steps:

- In Desk, access the tab Users from Settings.
- There, new users can be added or existing ones edited.

There must always be one admin defined; this means that the last admin cannot be deleted. Every user must be assigned a role, several users can have the same role. The current version of Franka Emika Robot supports the following roles:

- Admin: no restrictions to authorizations. The admin can edit all parameters and create new Tasks.
- Operator: the operator has the following access rights:
  - download & select Tasks
  - view Tasks & App settings
  - view status of the system (network, robot, end-effector)
  - lock/ unlock brakes
  - start/ stop a Task
  - guiding (no saving of poses possible)
  - switch pilot mode
  - move to transport pose for packing
  - download log files from system
  - shutdown and reboot the system

End effector configuration

⚠ WARNING

If the end effector is configured incorrectly, Franka Emika Robot will operate based on the wrong masses and mass inertia ratios of the end effector. This means that Franka Emika Robot will regulate to the wrong parameters and gravitational forces will not be entirely compensated. This can lead to unexpected motions during guiding, which may subsequently lead to injuries caused by the motion itself or by the operator flinching.

Therefore:

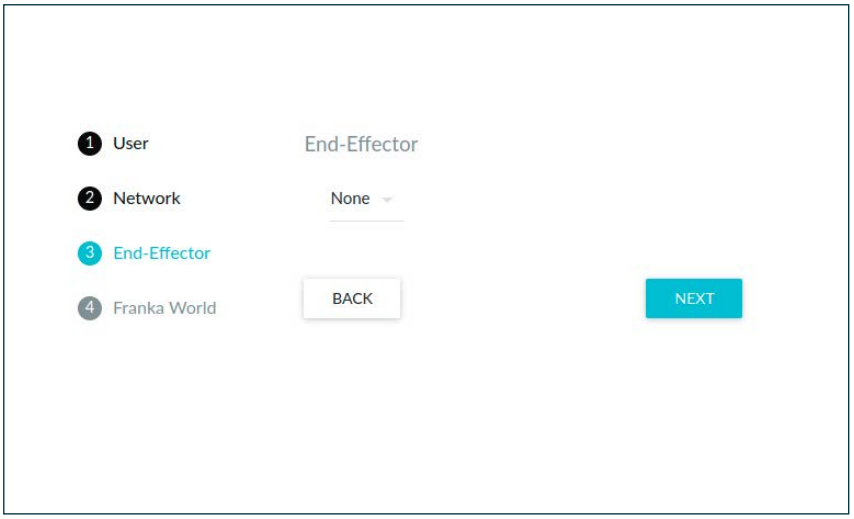
- Always check the configuration of the end effector
- When copying an already parametrized app or task to another Franka Emika Robot system, also make sure that the end effector configuration still is identical to the original one

WARNING

When the “Homing” button is pressed or during initial installation, grasped objects may fall out of the end effector and cause severe injuries.
Therefore:
- wear personal protective gear (e.g. safety footwear)
- never place your hands between grasped objects and solid objects (e.g. table).
- never load the end effector before startup, as “homing” has to happen after each time brakes are unlocked upon power up

Upon connection of any end effector, the integrator is responsible for conducting appropriate hazard and risk assessment to identify residual risks so as not to compromise safety and health, and is responsible for the safety of the final application.

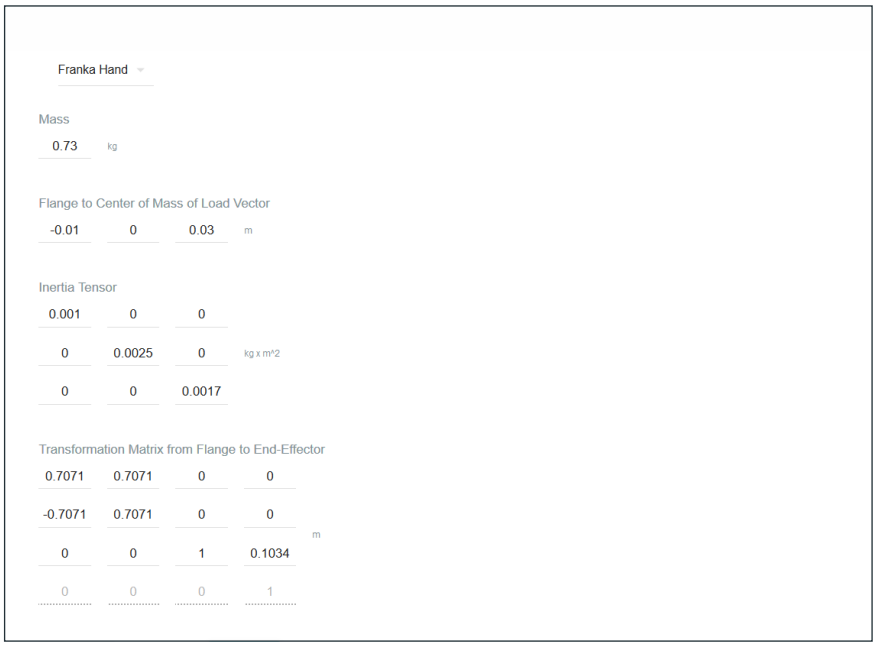
If you do not have a gripper, select „No Gripper“ from the drop-down.



If you have mounted the Hand, select „Hand“ from the drop-down.

If you want to use another end effector or adjust the configuration of Hand, select “User Defined” from the dropdown and enter the corresponding values into the text fields. The appropriate values are usually found in your end effector’s manual.

The default settings of „User Defined“ are as follows (and they match those of Hand):



NOTICE

You can edit the end effector settings at a later point in time.

To edit the end effector settings:

- In Desk, click on the user name on the right-hand side of the header in order to open the admin's interface.
- Then click “admin” and select the submenu “end effector”.
- The input mask opens and technical data such as mass, mass inertia matrix etc. can be entered.

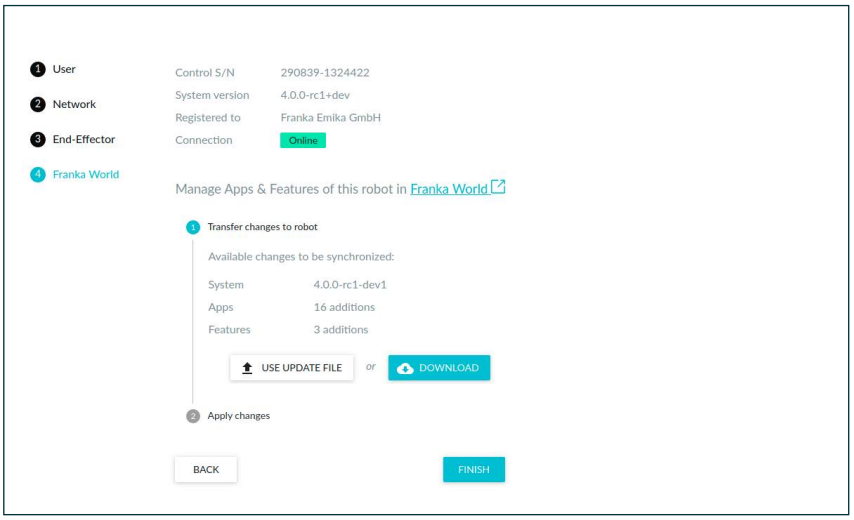
A correct configuration is essential for operating Franka Emika Robot. When configured incorrectly, gravitational forces are not entirely compensated and the Arm regulates to the wrong target values.

When configured incorrectly:

- The Arm may pull towards certain directions in guiding mode
- The regulation in operating mode may be affected so that the expected sensitivity of the Arm for collision detection is reduced
- The tracking behavior may be affected

Robot registration

A last configuration step involves registering the robot to Franka World (see chapter: Working with Franka Emika Robot/ Franka World of Section 3). A Franka World account is required in order to install system updates and apps (see chapter: Working with Franka Emika Robot/ Manage Apps and Updates of Section 3). It will be possible to register the device also in case the robot is not connected to the internet, although in such case the process is manual and will require downloading and uploading update and status files.



Completing configuration setup

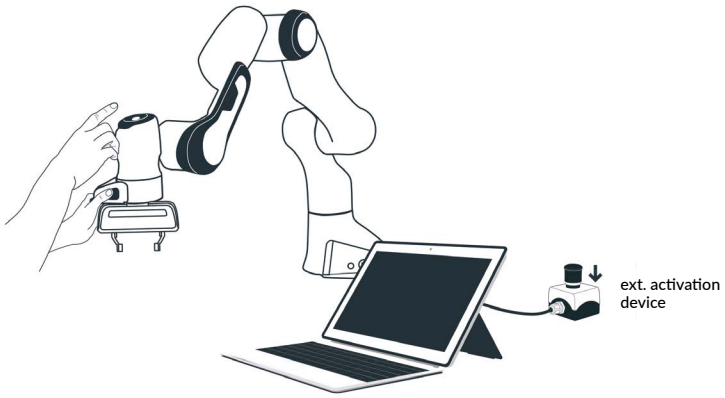
Once initial configuration has been completed and confirmed, a final preparation step will be performed, after which the programming interface Desk is displayed in the web browser and the Arm glows continuously yellow.

START-UP

Teach Franka Emika Robot a Task

Brief description

Keep both buttons on the grip of the Arm pressed (enabling & guiding buttons) and the Arm can be moved freely (but limited according to the corresponding guiding mode) by guiding it. This mode is used for teaching new poses or for manually moving the Arm to another pose.



Preconditions

SAFETY INSTRUCTION

Safety conditions:

- Emergency Stop device must always be installed within easy reach

Preconditions for operations:

- the Control must be switched on and booted up
- the safety locking system must be unlocked (by clicking “unlock joints” in Desk)
- Emergency Stop must be in open position
- X3 – inputs
  - In this status no device needs to be connected to X3
  - The external activation device can however be connected to X3. If it is connected, it needs to be “closed”, i.e. pressed.
  - If a safeguard is connected to X3 it cannot be active
- the enabling button on the grip must be half-pressed down and held. The enabling button has three states:
  - not pressed down: Arm is not enabled for any motion
  - half pressed down: Arm is enabled for motion
  - completely pressed down: Arm is not enabled for any motion
- in addition, the guiding button must be pressed continuously.

--> Only now can the Arm be moved manually and freely in guiding mode

Teach Franka Emika Robot a Task: details about Guiding

Please read chapter: Planning ahead/ and chapter: Emergency operation guidelines/ before using guiding mode for the first time. Not using it correctly may cause serious injury and/or material damage!

Unlocking the Safety Locking System

WARNING

Sharp-edged or pointed objects near the end effector or in the Working Space can lead to injuries during guiding. Therefore:

- Avoid sharp-edged or pointed objects whenever possible
- Please also read the chapter: Planning ahead/ Practical tips for usage and positioning of Franka Emika Robot.

WARNING

Objects or tools could fall at any time (e.g. due to loose couplings or malfunctions that can cause any end effectors to release objects). Should they fall, the objects or tools - which can weigh up to approx. 3 kg (from the robot's maximum payload of 3kg, the mass of any connected end effector shall be subtracted to determine the permissible weight of the object) - could lead to injury to fingers, hands, toes and feet.

Therefore:

- always wear personal protective equipment (e.g. safety shoes) whenever in the Operating Space, also during guiding mode and monitored stop state.
- never place your hands between grasped objects and solid objects (e.g. table) whenever in the Operating Space, also during guiding mode and monitored stop state.

CAUTION

Before entering guiding mode, check that the correct mass and center of gravity are set for any connected end effector and for any object grasped by it. If Franka Emika Robot operates assuming a lower mass, the Arm will sink when the guiding button is pushed, whereas if it operates assuming a higher mass, it will rise. This can lead to an unexpected motion which makes the operator flinch and may lead to injury such as crushing.
Therefore:

- always set the correct mass for the end effector and/or mass on the end effector before guiding.

SAFETY INSTRUCTION

Before you can move Franka Emika Robot, you must unlock the Safety Locking System.

- Ensure that the Emergency Stop is within easy reach for you.
- If e.g. the external activation device is connected to X3.1A of the robot's base, then please bring it to deactivated status (pressed down). Correspondingly, other external devices connected to X3 must allow motion.
- Note, that if the operation mode selection on digital input X3.1A is switched to automatic mode, Franka Emika Robot is enabled to start a Task - without the use of the external enabling device - immediately after unlocking (see chapter Planning ahead/ Operating modes of Franka Emika Robot).
- Be now out of the Hazardous Zone and make sure that also no other persons are within the Hazardous Zone.
- In Desk, click on "unlock joints".

Expect the following behavior:

- In order to release the locking pins, each of the 7 axes makes a small movement.
- In addition, you will hear 7 clicking noises.
- The Arm will now be held in position by its control and find itself in "monitored stop" status and Franka Emika Robot is now lit white or blue*

* In Desk, click „lock joints" again to verify correct locking of all joints in standstill. Click „unlock joints" again. The Arm needs to lit white before you can start guiding.

During guiding:

- Please pay attention to the practial tips of chapter Planning Ahead/Practical tips for usage and positioning of Franka Emika Robot.
- Note that, if the operation mode selection on digital input X3.1A is switched to automatic mode, Franka Emika Robot is lit blue and thereby signals that Franka Emika Robot is enabled to start a Task - without the use of the external enabling device - immediately after unlocking (see chapter Planning ahead/ Operating modes of Franka Emika Robot). In such case, press down the external activation device or turn off any safeguard connected to X3. By doing so, you will also allow the Arm to be hand guided.

Guiding

As long as the preconditions described in chapter: Start-up/ Teach Franka Emika Robot a Task/ are met, the Arm can be guided. To guide the Arm:

- half-press the Enabling Button on the grip and additionally press the guiding button. Franka Emika Robot from now on is lit continuously white. For improved usability, we turn off the middle status light of the Pilot.
- as soon as you release any of the two buttons, the Arm remains still
- as soon as you press the enabling button too hard, the Arm equally remains still (panic function of the enabling button)
- try this out for yourself now!

Switching between guiding modes

The guiding mode button is located on the top of the grip. With this button, or directly in Desk, different guiding modes can be selected. Which mode is currently selected is indicated in the sidebar of Desk. A guiding mode limits certain motions of the Arm to facilitate easy operation.

NOTICE

Franka Emika Robot allows you to switch guiding modes. They are used for limiting predefined motions during guiding. A guiding mode can for example only allow the Cartesian directions X, Y and Z, while rotations around these axes are locked. If the locked directions and rotations are overstressed by the operator by force, this can damage Franka Emika Robot.
Therefore:

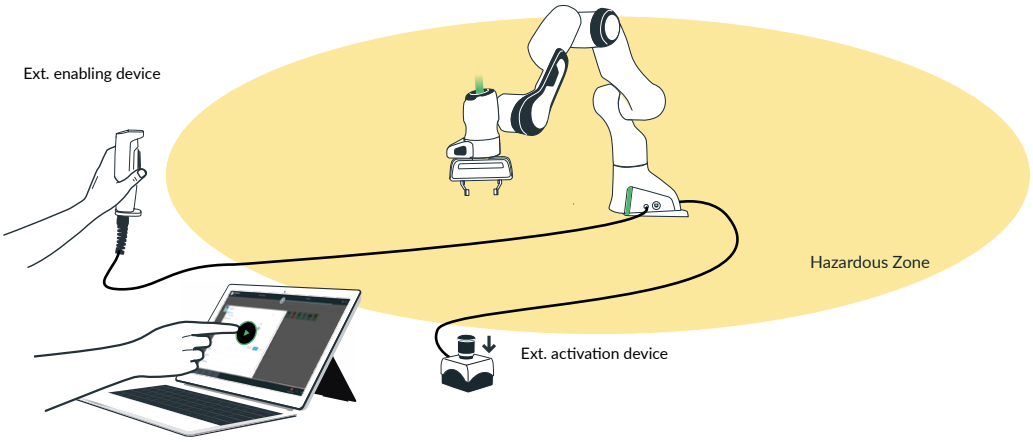
- if, during guiding by hand, one direction feels as if it is locked and the base is lit white, it should be checked, if the correct guiding mode has been configured. Any forcing of locked directions is to be avoided.
- if Franka Emika Robot is lit, for example, “pink”, then Franka Emika Robot is receiving conflicting release signals and therefore does not allow itself to be led by hand.

START-UP

Step back & check

Brief description

After teaching a robot motion you usually want to check the learned motion. To do this, step back outside the Hazardous Zone. Using the external enabling device, you can enable the robot for motion. Do this only if your full attention is directed to the pending robot motion (awareness). If you determine any abnormal behavior during the running of the automatic robotic motion, then use the external enabling device to stop the robot's motion. In addition, the Emergency Stop device is always available, to turn off all energy supply to the system, should this be necessary in case of emergency.



Preconditions

SAFETY INSTRUCTION

Safety operation:

- Emergency Stop must always be installed within easy reach
- The operator has left the Safety Zone (step back)
- the operator must check, that no other persons are in the Safety Zone.
- the operator must direct his full attention to the pending robotic motion (awareness)

Preconditions for operation:

- the Control must be switched on and booted up
- the safety locking system has to be unlocked (via the button “Unlock joints“ in Desk)
- Emergency stop must be in the open position
- The external enabling device has to be connected to X4 and half pressed in order to activate the automatic execution of robot programs and enable robot motion
- X3 – Inputs
  - in this state no device needs to be connected to X3
  - the external activation device can, however, be connected to X3.1A. If it is connected, it must be in “closed” state, therefore pressed down.
  - If a safeguard is connected to X3, then this should not be in active state

In addition the emergency stop device could be used in order to cut off the power supply completely, should this become necessary in an emergency.

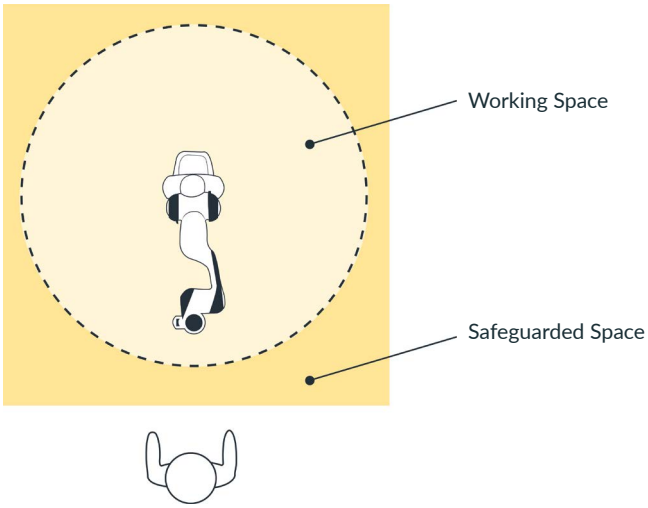
--> Only now can a motion of the Arm be executed, e.g. using the play button in Desk.

Let Franka Emika Robot run a task

Brief description

After Franka Emika Robot has learned and mastered its Tasks, they shall be executed automatically:

- The person is safely separated from dangers presented by the Arm (in EN ISO 10218-1, respectively ANSI/RIA R15.06 this is referred to as “automatic mode”):



START-UP

Preconditions

SAFETY INSTRUCTION

Safety conditions:

- the resposible person/integrator must ensure by means of adequate installation, that no person lingers in the Hazardous Zone of the robotic arm
- installation of safeguards (e.g. safety fence with access monitoring, safe laser scanners) must be so configured and connected, that any entry of the Safeguarded Space is safely recognized. Franka Emika Robot then switches to “monitored stop” status and can again be guided by hand (taught).
- the Safeguarded Space must be set up sufficiently large, such that the maximum time of stopping and the maximum stopping path of the Arm have been considered
- Emergency Stop must always be installed within easy reach

Operating conditions:

- the Control must be switched on and booted up
- the Safety locking system must be unlocked (by clicking “unlock joints” in Desk)
- Emergency stop must be in the open position
- The digital input X3.1A for changing the operation mode must be switched to automatic mode (if FE‘s external activation device is connected, it would need to be in up position for example). If X3.2A and/or X3.3.A are used they must allow motion and do not trigger protective stops.

--> only then, for example, can a motion of the Arm be carried out via the “Play” button in Desk

Before start-up, the operator must check that no persons are in the Hazardous Zone.

NOTICE

If conflicting authorization signals are present (e.g. external activation device is activated and the external enabling device or the enabling button on the grip is activated), Franka Emika Robot signals with the color pink.

Switching off

WARNING

The energy supply is also disconnected from any end effectors directly connected and power supplied to/by the Arm. In this way, grasped objects may fall out of the gripper and injuries, particularly of hands and fingers on a table or toes may be caused. Therefore:

- Make sure that objects cannot fall out of the gripper when de-energized (e.g. by using most appropriate type of gripper, by designing form-fit grasping)
- Alternatively, make sure that objects falling out of the gripper cannot cause any injuries (e.g. by using lightweight and/or rounded objects, by wearing safety shoes)

SAFETY INSTRUCTION

Shutting down

For switching off, be outside the Hazardous Zone. Via the option “shut-down” in the sidebar of Desk the safety locking system is activated and Franka Emika Robot will shut down.

Switching off

Disconnect Franka Emika Robot from the mains after shutting down the system (e.g. using the power switch on the back of the Control). Once the front ventilators stand still, Franka Emika Robot has been shut down and can be switched off. Otherwise the ventilators on the back will remain active.

Restarting

You need to wait 1 minute before restarting Franka Emika Robot. Then simply reconnect it to a power supply and Franka Emika Robot will start to reboot again.

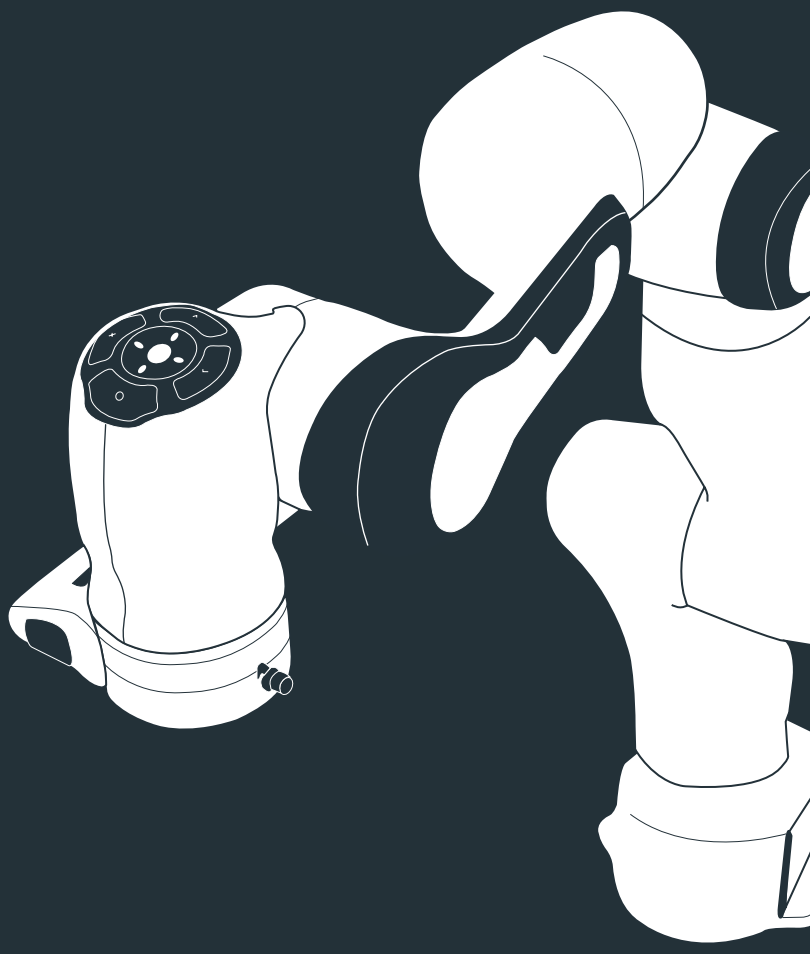
NOTICE

Due to the technology of locking bolts, the position of the Arm cannot be held perfectly when the power is switched off. The locking bolts catch with an audible click and let the Arm sink, in particular at those joints on which gravitational force comes into effect. This can cause to damages to work pieces in the proximity. Therefore:

- Take the sinking movement of the axes into account when switching off Franka Emika Robot. Place the Arm in a clear position (e.g. 200mm above stationary objects) before switching it off.

MAINTENANCE, SERVICE & SUPPORT

- Cleaning
- Updates
- Service & Support
- Troubleshooting
- Disposal



MAINTENANCE, SERVICE & SUPPORT

Cleaning

WARNING

Improper use of liquid cleaning agents and devices that are not correctly disconnected from the mains supply before cleaning can cause fatal accidents by electric shock.
Therefore:

- never clean devices that have not been safely disconnected from the mains supply
- never use liquid cleaning agents for cleaning the devices
- do not switch on devices that have not fully dried

The following things need to be kept in mind while cleaning:

- Cleaning may only be carried out by qualified persons.
- Cleaning of components is only permissible when Franka Emika Robot is safely disconnected from the power supply (control disconnected from the mains)
- Switching off and unplugging the device is to be carried out by qualified persons
- Do not spray any liquids directly onto the device
- Do not use any cleaning chemicals
- The components may only be cleaned using a damp, entirely wrung out cloth or using a dry cloth. Make sure that no moisture enters the devices.
- Do not apply great force to the Arm. The parts to be cleaned are to be supported manually, as not to overload and possibly damage the Arm.
- Restarting is only permitted when all surfaces have dried completely.

NOTICE

Improper cleaning may cause material damage to the devices.

Updates

System updates

Updates for the operating system, apps and features can be downloaded conveniently from within Desk Settings > Franka World, or manually using an update file from the Franka World device management page for your robot. Note that the system is also updated, if required, when new apps or features are to be installed from Franka World (see chapter: Working with Franka Emika Robot/ Franka World and chapter: Working with Franka Emika Robot/ Manage Apps and Updates, of Section 3). After confirmation of updating the system, it will reboot. The system restarts and the electricity supply to the robot must not be disconnected.

Service & Support

For any requests regarding service & support please contact us at support@franka.de. A ticket for your request will be issued in our service & support center and our experts will respond as soon as possible.

Troubleshooting

Teaching/Guiding is not functioning

Franka Emika Robot is lit white: Possibly one of the two buttons on the grip has not been pressed properly. Release both buttons and press them again. Make sure that you do not completely press down the enabling button, otherwise the Arm's motion is stopped!

If Franka Emika Robot changes to color pink, this means that the system is receiving conflicting enabling signals. This may occur when e.g. the external activation device is open (pulled up) and - simultaneously - the two guiding buttons on the grip are being pressed.All inputs must be closed, before the robot can be moved again. The opened inputs are shown - highlighted in pink - in Desk.

Franka Emika Robot is lit or flashes yellow: The Safety Locking System is still active. In Desk, this can be released via "Unlock Joints".

Franka Emika Robot flashes red: The safety system has identified a problem. The Safety Locking System can be released again from Desk.

Franka Emika Robot is lit red: There is a problem. If this cannot be rectified by restarting the system, please contact us at: support@franka.de.

Arm pulls strongly in one direction during Teaching	Immediately check the settings for the end effector. Has the correct end effector been selected and configured? For this purpose, please see the chapter: Start-up/ Software Setup. If the problem persists, please contact support, and do not operate the system until the issue is solved.
There is a loud clicking at switching-off	The clicking is a result of the deployment of the Safety Locking system and is normal. Locking pins in the joints are here deployed in the joints, in order to lock them mechanically.
Shutdown position data error	A shutdown position error can happen in the following cases: • The emergency stop was used, or the Arm lost its power (i.e. joints were not locked from Desk). • The unlocking tool has been used to unlock one or more joints. • A problem with the hardware or with the Arm‘s internal sensors occurred. If a shutdown position error occurred, the system can not guarantee that previously taught poses are still correct. To handle such situations, the system provides the following options: • Use the recovery dialog to automatically move the robot to a pre-defined reference pose and inspect it visually to assess correct positioning. • Temporarily ignore the error to verify positioning correctness by (carefully) running a previously taught task.  Be outside the Hazardous Zone while checking the task execution from a safe distance - using the “step back and check” mode with the external enabling device. • Acknowledge the shutdown position error and continue. This option must only be used if positioning correctness has been previously assessed by the operator. • If the robot hardware is compromised, the system must be shut down and the robot shall be taken out of operation.
Lifetime exceeded	As the load on Franka Emika Robot can vary between different tasks, Franka Emika Robot does not just estimate the end of life based on its time in operation, but it performs real-time measurements based on effective load in order to monitor the actual wear, thereby maximizing lifetime. As soon as one of the components’ lifetime limits is reached, a message notification on Desk will inform you that one or more parts of the Arm’s drive chain have reached their maximum lifetime. Franka Emika Robot is then to be taken out of operation.
Desk continuously displays “Shutting down the system”	You have presumably shut down the system. As soon as the front fans of the controller have stopped turning, the Control can be turned off using the switch on the rear side. Then the browser window of Desk can be closed.

Disposal

Disposal

Disposal of Franka Emika Robot may only take place according to the relevant country-specific laws, standards and regulations.

Battery

The Control contains a coin cell battery. This battery is to be disposed of separately according to the relevant country-specific laws, standards and regulations.

Return of waste

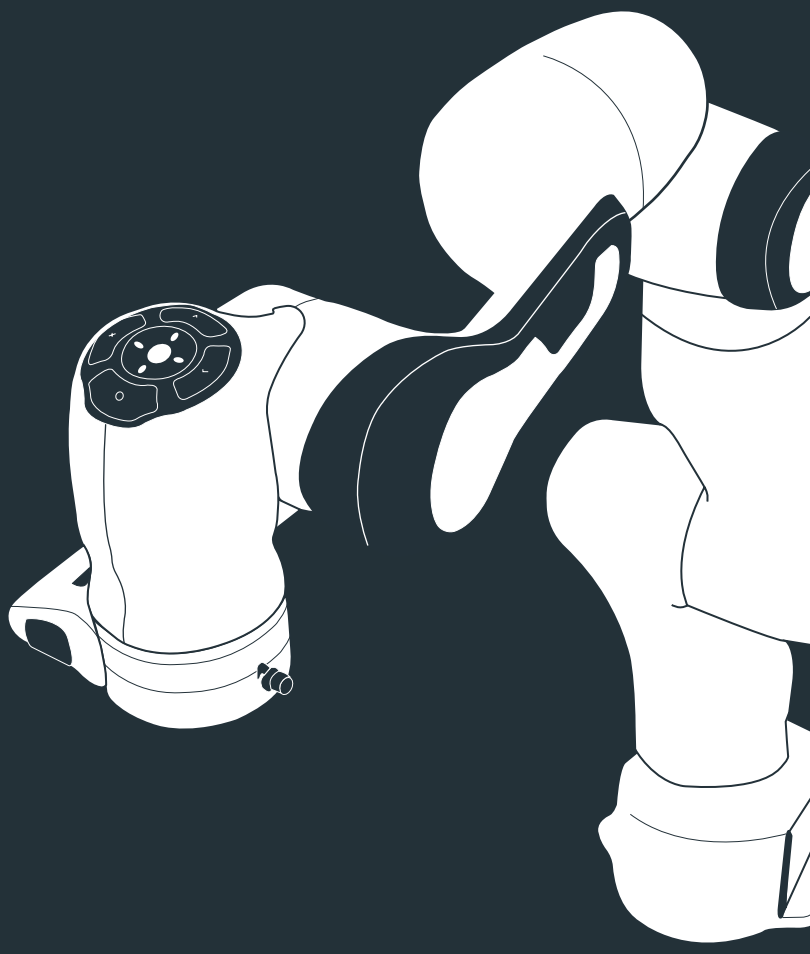
Please contact us to process any returns of waste.

SECTION 3

Further user instructions for Franka Emika Robot system

WORKING WITH FRANKA EMIKA ROBOT

- Franka Emika Robot Powertool
- Robotics tips
- Desk
- Apps
- Franka World
- Manage Apps and Updates
- Teaching
- Execution
- Hub



WORKING WITH FRANKA EMIKA ROBOT

Franka Emika Robot Powertool

Groundbreaking innovation

Franka Emika redefined robotics with the world's most advanced robotic system Franka Emika Robot, the fastest selling industry-suited robotic system. Our customers – from SMBs to global enterprises – profit from this novel easy-to-use, flexible, cost-efficient and scalable solution. Franka Emika Robot has been designed to be lightweight and manufactured in large quantities. It incorporates the highest mechatronic integration and is equipped with more than a hundred sensors. Our payload to moving mass ratio of 1 to 4 was achieved by diligent mechanical design and development all the way from system to component level. As a global product with local roots, Bavaria is home to Franka Emika Robot's manufacturing site and our supply chain is nearly 90% European.

Soft-robot performance

Motion

Franka Emika Robot incorporates the features of a classical stiff industrial robot with a pose repeatability of +/- 0.1 mm and a negligible path deviation even at high velocities of up to 2 m/s. This allows precise, robust and fast execution of manufacturing processes.

Force Sensing

Inspired by the human sense of touch, Franka Emika Robot is equipped with link-side torque sensors in all 7 axes. Outstanding resolution, accuracy and repeatability allow the robot to dynamically sense the surrounding environment, even exceeding the performance of most purpose-made force sensors. Our sophisticated sensors, control algorithms and internal model allow prompt detection and reaction upon unwanted collisions within milliseconds. Besides that, Franka Emika Robot's flexible torque-controlled joints can act compliant or stiff in the same way humans contract or relax their muscles to adapt to a task or the environment.

1 kHz Force Control

Franka Emika Robot can be used to apply forces with a minimum of 0.05N in order to conduct delicate tasks, for instance pressing, insertion, and screwing. Continuous and accurate fine-tuning of forces is also a prerequisite for applications such as contour tracking, polishing and grinding.

Interaction

Franka Emika Robot features adjustable guiding modes that compensate gravity and friction to reduce the perceived weight up to a factor of 60, ensuring smooth and elegant physical interaction between human and machine.

Robotics tips

Joint space

A joint space is the description of a robot pose using the rotation angles of the robot's individual joints. In contrast to most industrial robots, which have 6 joints, our Arm has 7. This allows for an extremely high flexibility. Movements in the joint space move all joints simultaneously from the current position to a defined target joint pose. Here it is important to notice that the motion of the end effector results from the rotation of the joints and does not follow a specific path (e.g. a line).

Cartesian space

The Cartesian space allows an alternative description of the robot pose. Here, the position and orientation of the end effector are the main focus. The representation of Cartesian poses in three-dimensional space usually consists of three values (in meters) for determining the position and three values (in degrees) for orientating the end effector. For a robot with 7 joints this representation is not complete for defining a certain robot pose. For more information, see the section "Redundancy". Movements in Cartesian space allow the exact tracking of predefined paths in space, such as straight lines. The changing of position is called translation, while the changing of orientation is called rotation. The Cartesian motion of a robot always depends on the reference coordinate system, which can be configured for Franka Emika Robot via the configuration of the end effector in the admin section of Desk.

Redundancy

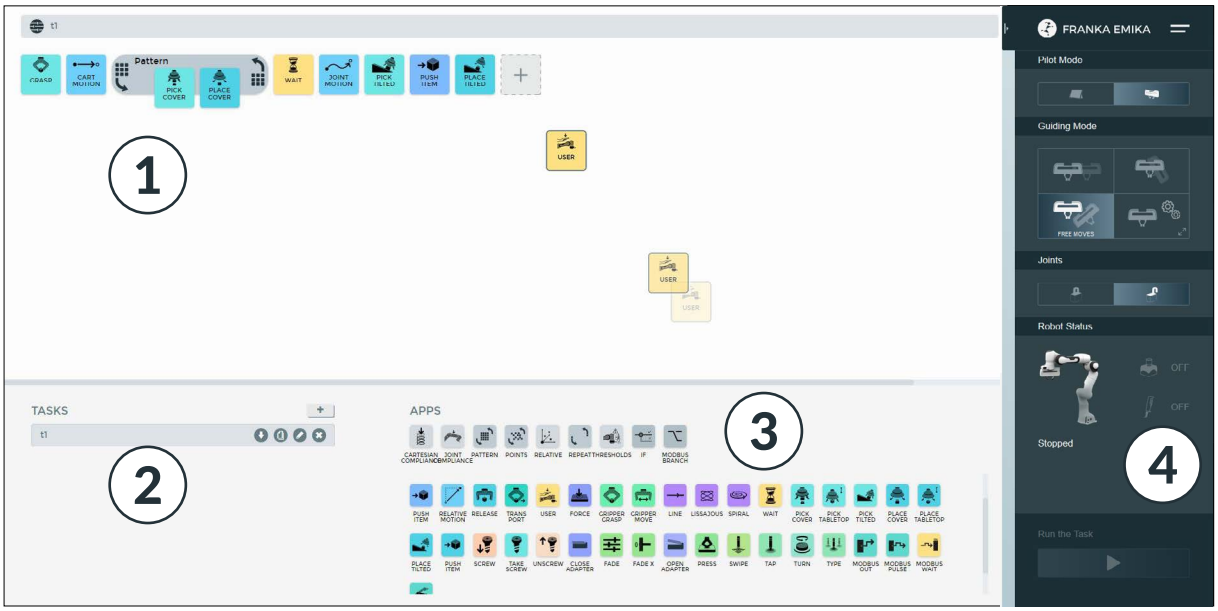
The Arm can reach a certain Cartesian pose with various joint configurations. This capability is called redundancy. In Franka Emika Robot this additional motion capability is often called elbow, because it matches the motion capability of the elbow in a human arm. The redundancy of the Arm allows for a greater flexibility when teaching or executing Tasks. For example, it can be used to circumnavigate an obstacle in order to grip an object located behind it. The behavior of the elbow can be changed and adapted to each situation. It can be set to freely movable or immovable.

WORKING WITH FRANKA EMIKA ROBOT

Sensitivity	The Arm has real torque sensors in all 7 joints. These enable, among other things, to recognize and react to even the smallest forces acting on the Arm. This sensitivity facilitates numerous functionalities and capabilities, which are not possible with conventional industrial robots, such as impedance, guiding of the robot or collision detection. It should be noted that for achieving maximum sensitivity it is absolutely necessary to best possibly compensate additional forces acting on the robot (e.g. a mounted end effector). This is why the end effector to be used should be configured as precisely as possible in the admin section of Desk.
Impedance	Impedance is a behavior of the robot, which imitates the ability of a mechanical spring. This behavior can be used to interact gently with the environment, for example as not to damage fragile objects. The ability of changing impedance can be seen as similar to that of a human arm, which tenses the muscles in order to change rigidity and can adapt depending on the situation, in order to increase robustness when executing a task.
Collision detection and reaction	We have incorporated torque sensors in all seven axes. These provide information on the currently applied torques per axis at any given time. In combination with our model-based control, deviation between the expected torque and the actual torque can be identified and the Arm can respond to it. For example, if the Arm touches an unexpected object when it is moving, the contact will be recognized in real-time by one or several torque sensors. Such a torque magnification is classified as a collision and can for example stop the robot's motion.
Generating forces	If the Arm is in intended contact with its surroundings, sensor signals of the seven torque sensors can be used to generate a defined force on the point of contact.

Desk

Overview	Franka Emika Robot is programmed using the web application Desk. This is opened by entering the https://robot.franka.de. Desk allows you to create tasks. Tasks are program sequences and consist of a chronological sequence of apps. Apps are the building blocks of a Task and describe the basic capabilities of Franka Emika Robot, such as "grip", "put down", "push button".



1. The timeline is the area in which you can line up your apps in order to program your task.

2. In the task area, you can store your programed tasks, perform administration, or click on already-programed tasks, in order to access them.

3. The app area is to be found here, i.e. the collection of installed apps available to you for programming. You can simply drag them onto the timeline via drag-and-drop, in order to configure them for the next step.

4. In the side bar you can see which guiding mode Franka Emika Robot is in. In other words, whether, for example, translational or rotational motion is enabled in guiding Franka Emika Robot. Thereunder are situated important notices on Franka Emika Robot's status, such as, for example, whether the external activation switch is on or off, or whether there is an error.

Task

By clicking on the "+" symbol in the task area, a new task is created and selected. A new task is created with an empty timeline. The program procedure will then be created, in which apps are moved using drag-and-drop from the app area (3) into the timeline area (2) to the desired position. The execution takes place from left to right. Apps may be removed from the timeline by dragging an app from the timeline area back into the app area. Re-arrangement of the task using drag-and-drop is equally possible.

You can change the speed and other task-level settings for the task execution by clicking on the task name in the timeline.

Single Point of Control

In order to comply with safety regulations, the system provides Single-Point-of-Control (SPoC) functionality. This means that only one user at a time can trigger critical actions i.e. edit system settings and programs or trigger active robot actions like unlocking brakes and running tasks. The user in control gets assigned the SPoC software token.

NOTICE

Even without the SPoC token, it is always possible to trigger uncritical actions like stopping a running task and locking the robot brakes.

Take control

When connecting to the robot with the token being available, you can simply take control by accepting the dialog displayed after login. The token is now assigned to you and other users can not control the robot without your consent.

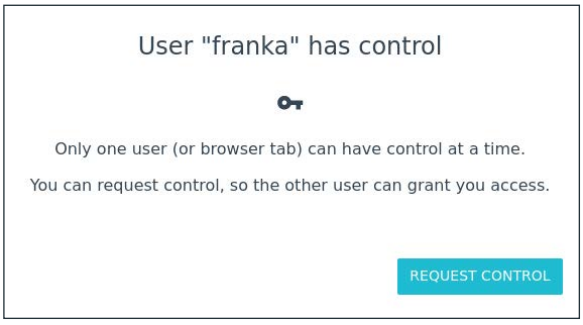
Request control

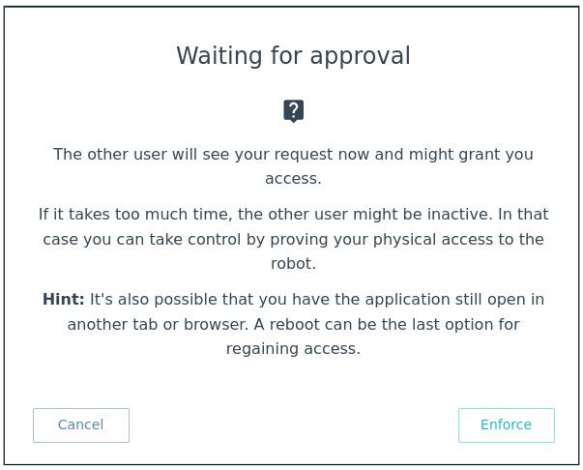
When connecting to the robot with the token being taken by another user, you can request control by accepting the dialog displayed after login. The controlling user will now have a control request dialog displayed on his screen. If the controlling user grants access, the token is reassigned to the requesting user. If the controlling user denies access, the token will remain with the controlling user.

NOTICE

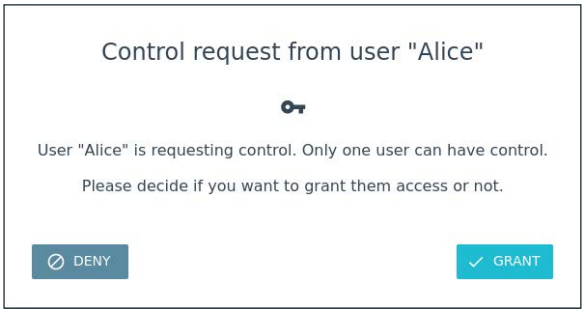
For improved traceability, we recommend setting up named profiles for each robot user in the system settings (see chapter: Start-up/ Software setup). In this case the system will inform you which user is currently controlling the robot.

A user requests control:





The user which has the SPoC token gets the control request:



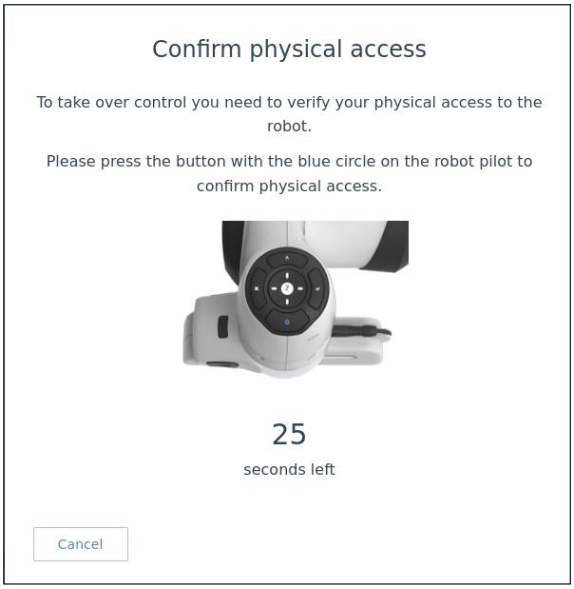
Enforce control

You can enforce control if you have physical access to the robot. Instead of requesting control, you can choose to enforce control in the dialog displayed after login. After choosing to do so, you have a time window in which you can press the blue circle on the robot pilot to take control. During this time frame the controlling user is notified about the enforcement attempt and is also able to confirm or deny control.

NOTICE

You can adjust the time window for control enforcement in the system settings. By default, the time window is 30s.

New user enforces control:



Release control

After you are done working with the robot, you can release control in the robot menu. This will lock access for you and free the token. Other users can now connect to the robot and take control directly. Control is also released if the controlling user logs out.

Fieldbus control

The robot can also be controlled through fieldbus interfaces. Single-Point-of-Control also applies to fieldbus interfaces. The required functionalities are provided for the supported fieldbus protocols but need to be considered during connection implementation. Data access and uncritical actions are possible via fieldbusses unrelated to the token status.

NOTICE

If the robot is controlled via a fieldbus protocol, there is no request procedure for other users trying to take control via Desk. When a Desk user takes control the token is automatically reassigned from the fieldbus protocol towards the user.

NOTICE

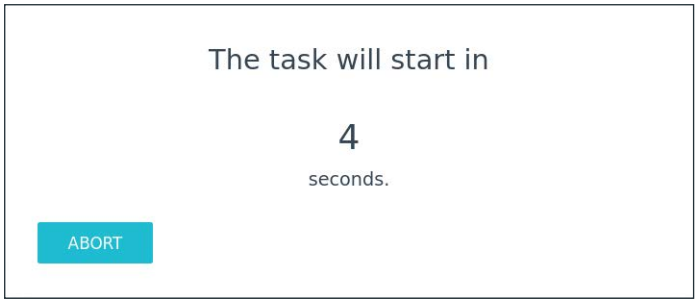
After a system reboot the token is being reset.

When starting a task, a countdown is displayed before the task is finally being executed. During this time the LEDs on the robot base indicate a starting task by indicating a constant cyan color.

NOTICE

You can adjust the “work execution wait time“ in the system settings. By default, the waiting time is 0s.

User is asked to confirm task execution and informed about the configured wait time.



After confirmation, the countdown starts. The task execution will start after the countdown finishes.

WORKING WITH FRANKA EMIKA ROBOT

Apps

Apps incorporate the entire complexity of Franka Emika Robot system and represent modular building blocks of a production process such as grasping, plugging, insertion and screwing. Using Desk, apps can be arranged to create entire tasks in no time. These tasks can quickly be adapted, reused or deployed on multiple robots to remarkably reduce setup costs. Individual apps and tasks can be parameterized by means of showing Franka Emika Robot poses by demonstration, or adding context relevant parameters such as speed, duration, forces, and triggering actions.

Visit our Store on https://world.franka.de/products to browse our continuously growing portfolio of apps and app packages!

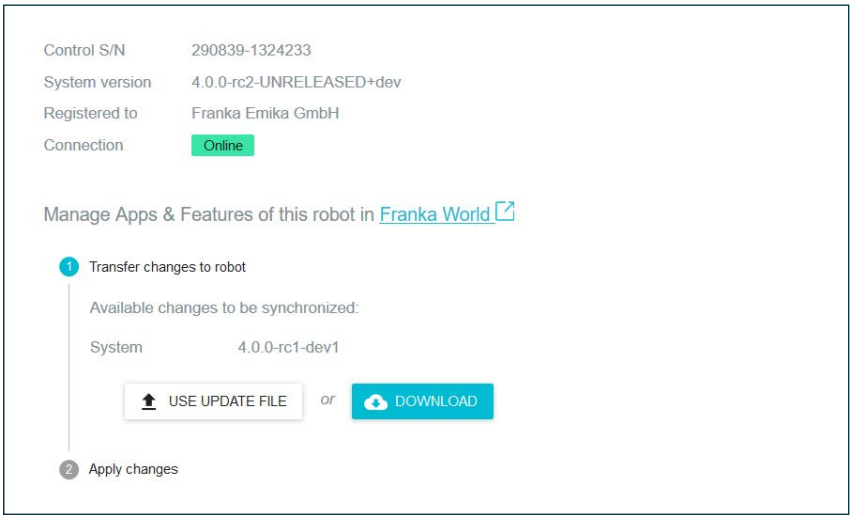
FRANKA WORLD

Franka World - https://world.franka.de/ - is an online platform that interconnects Franka Emika's customers, partners, developers and robots. By bringing Franka Emika Robots into the cloud, all parties can mutually benefit from each other's interaction, and gain integrated access to the products and services provided by Franka Emika and our network of qualified partners. Franka World provides customers with centralized and remote management of their fleets of Franka Emika robots, and the possibility to access the Store, to browse a continuously growing portfolio of accredited software and hardware extensions.

Access the user manual to get an overview of all Franka World features and how to benefit from them: https://download.franka.de/franka-world-manual/

Manage Apps and Updates

System updates as well as apps purchased over the Store of Franka World can be retrieved and installed into robots via Settings > Franka World. Synchronization between robot and Franka World account is swift when the robot is connected online. Should the robot be offline, an alternative manual option is presented to the operator via the same interface.



Teaching

Relevant chapters (in particular chapter: Planning ahead/ and chapter: Emergency operation guidelines/) need to be taken into account before teaching/guiding can be carried out.

Pilot

The Pilot is the user interface integrated directly into the Arm for smooth interaction with end effectors and Desk.

1. On the grip of the Pilot there are two grey buttons (guiding and enabling buttons), one on each side. By pressing them, the guiding mode is activated as long as the external activation device is pressed down – and the Arm can be hand-guided by the operator to show Franka Emika Robot desired poses. Once the buttons are released the Arm can no longer be moved.

NOTICE

One of the two buttons is a three-stage enabling button and needs to be half-pressedfor guiding. When pressed all the way Franka Emika Robot will stop the guiding mode andmake the Arm immovable.

2. By pressing the disc's buttons on top of the Pilot, you can navigate in Desk to select individual Apps, parameterize them (e.g. by adjusting sliders or activating/deactivating certain functionalities). In addition, poses can be entered by manually guiding the Arm to the desired pose and pressing the set button.

NOTICE

You can also operate Desk directly via the touchscreen or using your mouse/keyboard.

Guiding

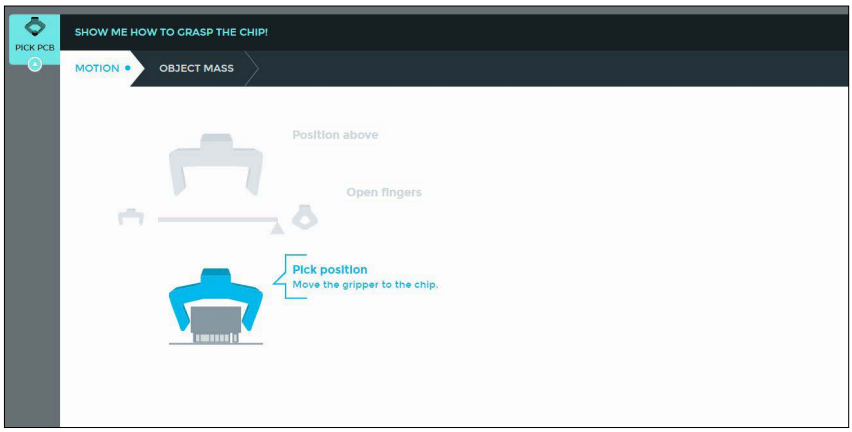
When the guiding button and the enabling button are pressed on the grip, the Arm is in guiding mode and can be moved manually.

In guiding mode, motion of the Arm follows the corresponding guiding configuration, which is displayed in the sidebar. The guiding configuration can be changed by pressing the guiding mode button on top of the grip. You can also select the desired configuration from the sidebar.

- Translation: in this guiding mode, the Arm can only be moved to change the Cartesian position of the end effector; its orientation remains as it was before entering the guiding mode.
- Rotation: in this guiding mode, the Arm can only be moved to change the Cartesian orientation of the end effector; its position remains as it was before entering guiding mode. The reference coordinate system for this rotation is the predefined coordinate system of the end effector.
- Free: the Arm can be moved freely, all 7 joints can be moved.
- User: the user can define the guiding behavior in this guiding mode, meaning that it is possible to define for each Cartesian translation and rotation axis if the Arm is movable or immovable.

Parameterization

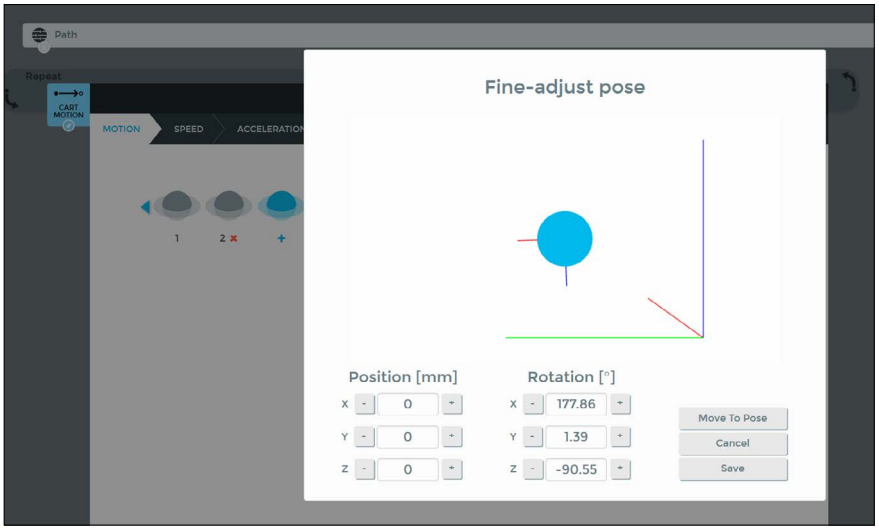
After creating a task, all apps need to be taught. This means that all necessary parameters of the apps need to be configured so that Franka Emika Robot knows how to
execute them. Clicking on an app will open the corresponding context menu, where the parameters can be set. The rest of the timeline moves to the background and the context menu of the selected app opens. The context menu of an app comprises one or several steps where dialogs ask the user to enter the parameters required for app configuration, step by step. This can be a request to teach one or several poses or to enter parameters such as speed and duration of execution.



Right-clicking on one or several apps opens a menu, from which you can activate, deactivate or delete individual apps. Only activated apps are executed and need to be taught.

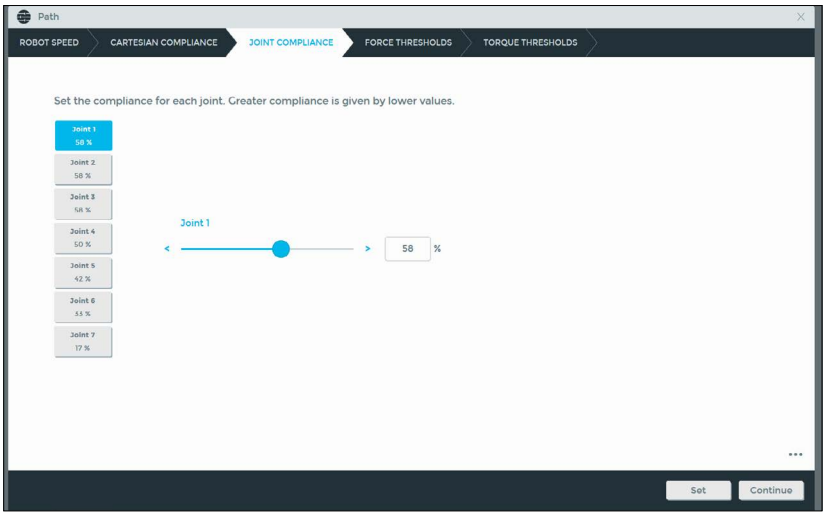
Pose fine-adjustment

Poses can be fine-adjusted by right-clicking the pose to be adjusted within the context menu. The cartesian position as well as the rotation of the end effector can be adjusted.



Task settings

At a Task level, parameters about robot speed, compliance/stiffness and sensitivity thresholds, can be set by clicking the Settings icon on the top left corner of Desk.



Execution

- Before letting Franka Emika Robot execute a task by way of trial, take note of the instructions in chapter: Planning ahead/, and chapter: Start-up/ (in particular: /Step Back and check).
- In addition, the unlocking tool (see chapter: Emergency operation guidelines/) must be within immediate reach of the Arm. However, by no means may it stay inserted into the emergency unlock openings of the Arm!

If all activated apps for a task have been taught completely, it can be executed out by pressing the “Play” button (please take note of the instructions in chapter: Planning ahead/, and chapter: Start-up/ (in particular: /Step Back and check).

If an error occurs, such as a collision, program execution is stopped. The failed app is bordered in blue and an error description is displayed. In this mode, the Arm can be moved using guiding and any causes of error can be eliminated.

If an error stops program execution, further information on the error and how to eliminate it is displayed in the robot “traffic light” in the sidebar. By pressing the “Play” symbol on one of the apps, the task execution can carry on with the corresponding app, or the task ended by pressing the “Stop” button.

Hub

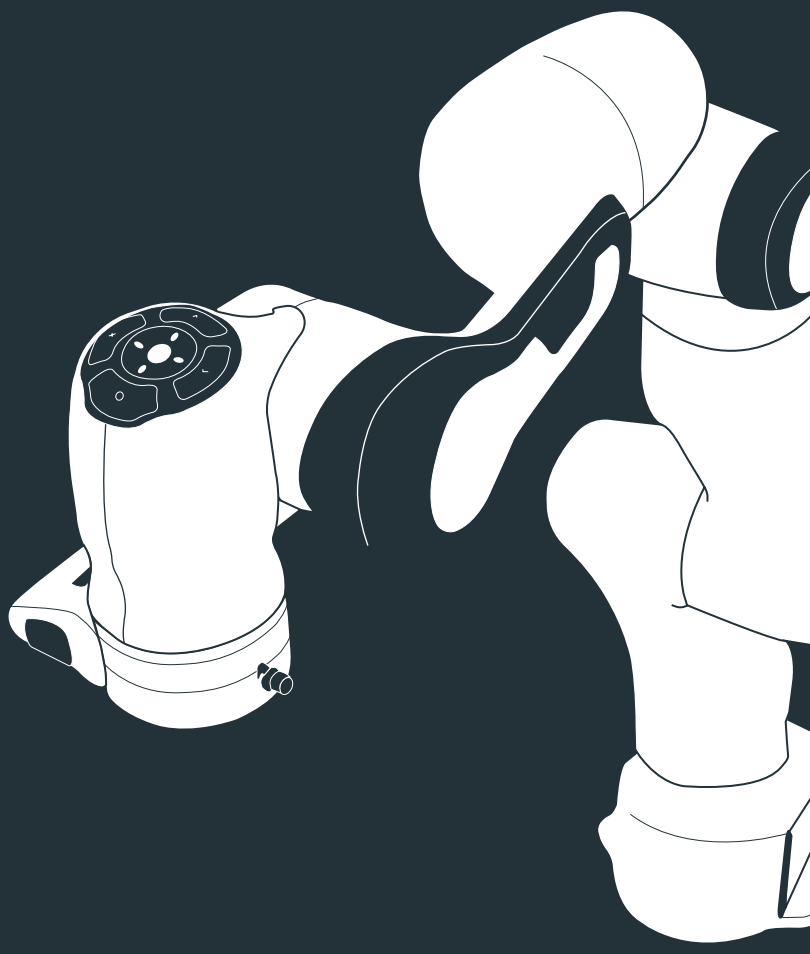
Find much more information on Hub (https://world.franka.de/resources) – the new section of Franka World – where you can access documentation, tutorials and code!

SECTION 4

Other products (Hand, Franka Emika Robot for Researchers, and CE out of the box solutions)

FRANKA EMIKA ROBOT HAND

- Introduction
- Specification
- Product conformity
- Correct site of installation
- Mounting & Operation

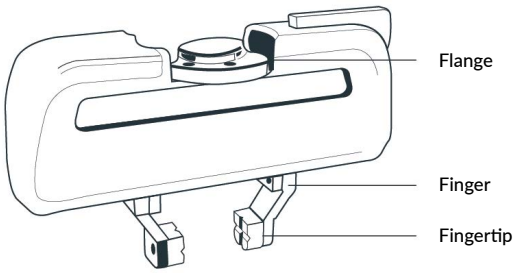


FRANKA EMIKA ROBOT HAND

Introduction

This is Hand

Hand is an electrical two-finger parallel gripper produced by Franka Emika. Hand communicates directly via the connection in the Arm and is also supplied with power from the Arm. No cumbersome external wiring and integration is necessary!



- The fingertips can easily be changed and adapted to the objects to be grasped (e.g. using 3D-printed fingertips).
- The fingers can also be simply mounted differently in order to increase the span length of the gripper.
- The plug is simply plugged into the connector port on the grip of the Arm.

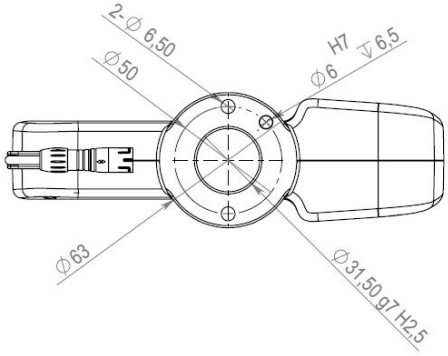
Scope of delivery and additionally required equipment

- Main components:
  - Hand
- Also included:
  - 1 set of fingertips
  - 2 x DIN7984 M6X12 ST 8.8 Screws
  - 1 x ISO2338B 6X10 h8 A2 cylindrical pin
- Additional required equipment
  - Hex key size 4 ready for use.

Labeling

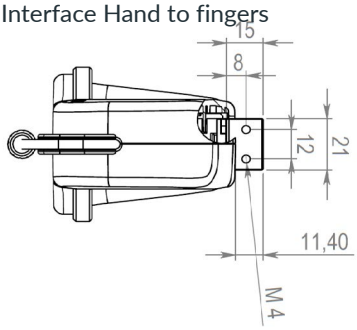
Specification

Interface flange of Hand

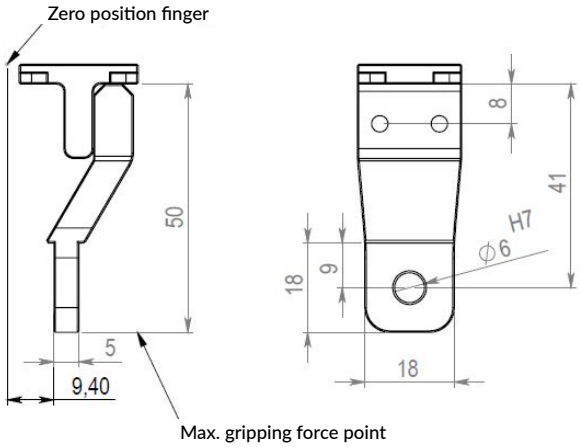


Technical drawings

Interface Hand to fingers



Interface finger to fingertips



- These fingers are included in the scope of delivery of the Hand and are suitable for being mounted to the Hand
- Should you design and mount other fingers to the Hand, the following needs to be noted:
  - Carry out a risk assessment and implement the measures resulting from it
  - Gripping of an object at a distance of the finger to the Hand will lead to tilting loads. The Hand is designed and tested for a finger length of 54mm.

FRANKA EMIKA ROBOT HAND

Mechanical data

Weight of Hand [kg]
0.73

center of mass of Hand to end effector flange [m]

-0.01	0	0.03

Inertia sensor [kg x m2]

0.001	0	0
0	0.0025	0
0	0	0.0017

Transformation matrix of end effector flange to Hand (center point of finger tips when closed)

0.707	0.707	0	0
-0.707	0.707	0	0
0	0	1	0.1034
0	0	0	1

Grasping (continuous) force [N]
70

Maximum grasping force [N]
140

Travel span [mm]
80

Travel speed (per finger) [mm/s]
50

Production standard

Hand is manufactured in a production company certified according to EN ISO 9001 in Germany.

Product conformity

Declaration of Conformity

Declaration of Conformity
according to directive 2006/42/EC on machinery

CE

Description of the machinery:

Product identification: Panda system component: Hand

Modell/Type:
Hand (#73912449)

We declare that the product complies with the essential requirements of the Machinery Directive2006/42/EC.

In addition, the machinery is in conformity with the following EC Directives:
EC Directives 2014/30/EC relating to electromagnetic compatibility (EMC)

We declare that the relevant technical documentation is compiled in accordance with part A of Annex VII.

Applied harmonized standards

Machinery safety

Standard	Name
EN ISO 12100:2010 ISO 12100:2010	Safety of machinery - General principles for design - Risk assessment and risk reduction
EN 60204-1:2006/A1:2009/ AC:2010 IEC 60204-1:2005/A1:2008	Safety of machinery - Electrical equipment of machines - Part 1: General requirements

EMC

Standard	**Name**
EN 61000-6-1:2007 IEC 61000-6-1:2005	Electromagnetic compatibility (EMC) - Part 6-1: Generic standards - Immunity for residential, commercial and light-industrial environments
EN 61000-6-2:2005/ AC:2005 IEC 61000-6-2:2005	Electromagnetic compatibility (EMC) - Part 6-2: Generic standards - Immunity for industrial environments
EN 61000-6-3:2007/ A1:2011/AC:2012 IEC 61000-6-3:2006/ A1:2010	Electromagnetic compatibility (EMC) - Part 6-3: Generic standards - Emission standard for residential, commercial and light-industrial environments
EN 61000-6-4:2007/ A1:2011 IEC 61000-6-4:2006/ A1:2010	Electromagnetic compatibility (EMC) - Part 6-4: Generic standards - Emission standard for industrial environments

We commit to transmit, in response to a reasoned request by the market surveillance authorities, relevant documents on the partly completed machinery. The industrial property rights remain unaffected!

Manufacturer:
Franka Emika GmbH
Infanteriestr. 19
80797 München
Deutschland

Representative in EU, authorized to compile the relevant technical documentation:
Johannes Schmid
Franka Emika GmbH
Infanteriestr. 19
80797 München
Deutschland

Datum
04.05.2018

Dr. Simon Haddadin, CEO

Further statements

Further Information

status: 04.05.2018 Franka Emika Robot

Restriction of Hazardous Substances (RoHS):

The products *Control*, *Arm* and *Hand* do not fall within the scope of EU RoHS Directive 2011/65/EU, but still meet the requirements of the restricted substances and maximum concentration values that are allowed in homogenous materials:

- Lead (0.1%)
- Mercury (0.1%)
- Cadmium (0.01%)
- Hexavalent chromium (0.1%)
- Polybrominated biphenyls (PBB) (0.1%)
- Polybrominated diphenyl ethers (PBDE) (0.1%)

The following exceptions are also applied:
6a: Lead as an alloying element in steel for machining purposes and in galvanized steel containing up to 0,35 % lead by weight
6b: Lead as an alloying element in aluminum containing up to 0,4 % lead by weight
6c: Copper alloy containing up to 4 % lead by weight

REACH:

FRANKA EMIKA GmbH is a "downstream user" as defined in REACH. Our products are exclusively non-chemical products (manufactured items). In addition, under normal conditions of use and the conditions which can reasonably be predicted, no substances are released (Article 7, REACH).
We confirm that our products do not contain more than 0.1 percent by mass of any of the listed substances on the published ECHA candidate list (SVHC). Extensions published by the ECHA candidate list are matched with our products and if it is known that one of these newly added substances contained in our products, we will inform you immediately.
This confirmation was created based on currently available information of our suppliers.

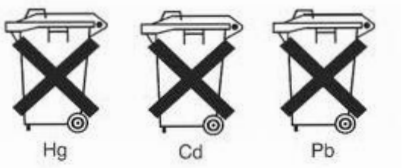
WEEE Directive:

The products *Control*, *Arm* and *Hand* are not subject to the WEEE Directive 2002/96/EC for collection, recycling and recovery for electrical goods.

Battery Directive:

The product *Control* contains a BIOS battery.

Disposal of batteries:
There is an obligation to return rechargeable and non-rechargeable batteries by Battery Directive 2006/66/EC; do not dispose them with consumer waste. Dispose them according to statutory orders and lead them to a recycler. Batteries will be recycled.
The signs below the crossed out trashcan indicate the substances lead (Pb), cadmium (Cd), or mercury (Hg).



Correct site of installation

Ambient conditions

Site of installation

- indoors, in enclosed buildings
- not exposed to direct sunlight
- no vibrations
- external magnetic fields are allowed in the magnitude of the earth magnetic field only

Type of installation

- screwing connection to Franka Emika Robot's end effector flange

Protection class

- IP 20 (according to EN 60529:1991)
  - IP 2x: protected against ingress of solid bodies with a dimeter >=12.5mm
  - IP x0: no protection against water

Ambient medium

- air
  - free from flammable substances (dust, gas, liquid)
  - free from aggressive media
  - free from corrosive substances
  - free from "flying parts"
  - free from spraying liquids
  - free from pressurized airstreams

Pollution degree

- degree 2 (according to IEC 60664)
  - "only dry, non-conductive pollution occurs; occasionally temporary conductibility caused by condensation may occur"

Ambient temperature

- +15°C to 25°C (typical)
- +5°C to + 45°C (extended)
- -10°C to + 60°C (transport)
- +5°C to + 25°C (storage)

Relative air humidity

- 20 % - 80 %, non-condensing

Set-up altitude

- <= 2000 m above sea level

FRANKA EMIKA ROBOT HAND

Mounting & Operation

Mounting

WARNING

Hand needs to be correctly mounted. Otherwise the Hand could fall off during later operation.

CAUTION

Please ensure that the tool (hex key) does not remain inserted on the robot! This could become a projectile during later motions of the Arm and lead to injuries.

The Arm needs to be safely disconnected from the mains power supply before the Hand is allowed to be mounted.

The following materials are included in the scope of delivery of the Hand:

- 2 x DIN7984 M6X12 ST 8.8 screw
- 1 x ISO2338B 6X10 H8 A2 cylindrical pin

Have an Hex key size 4 ready for use.

Mounting:

- If desired, insert the cylindrical pin in the H7 fit of the flange of the Hand.
- Position the Hand with its flange on the end effector flange on the Arm. Should you not use the cylindrical pin, make sure that the side of the Hand with the cable is attached on the side of the grip where the connector port is located.
- Attach the Hand with 2 x M6x12 screws (do not use other types of screws!) and use 5 Nm of torque.
- with the above noted screws the screw depth is 8mm. This must not be exceeded!

Insert the connector port of the Hand into the designated connector on the grip of the Arm. It has to be simply pushed and not screwed!

NOTICE

Fix the Hand with the 2 x M6x12 screws (never use any other type of screw!) and use 5Nm of torque

NOTICE

Live cables or connectors may never be connected or disconnected during operation (in particular rubber connectors, connection cable, connection cable to Hand, etc.). This can lead to damaging the Arm or the Hand.
Therefore:

- never connect or disconnect the Hand, while Franka Emika Robot is not safely disconnected from the mains power supply

NOTICE

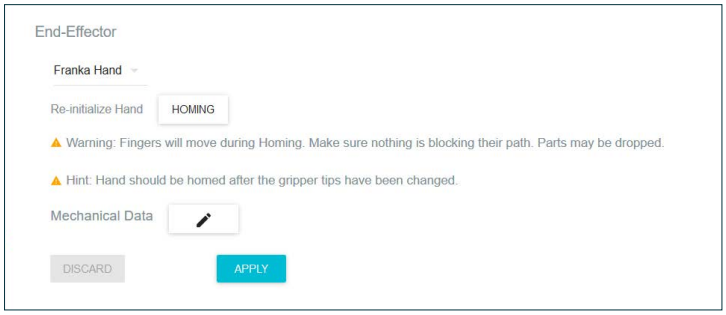
Using the above-mentioned screws, the screw-in depth is 8mm. This should never be exceeded!

WARNING

If the end effector is configured incorrectly, Franka Emika Robot will operate based on the wrong masses and mass inertia ratios of the end effector. This means that Franka Emika Robot will regulate to the wrong parameters and gravitational forces will not be entirely compensated. This can lead to unexpected motions during guiding, which may subsequently lead to injuries caused by the motion itself or by the operator flinching.

Therefore:

- Always check the configuration of the end effector
- When copying an already parametrized app or task to another Franka Emika Robot system, also make sure that the end effector configuration still is identical to the original one

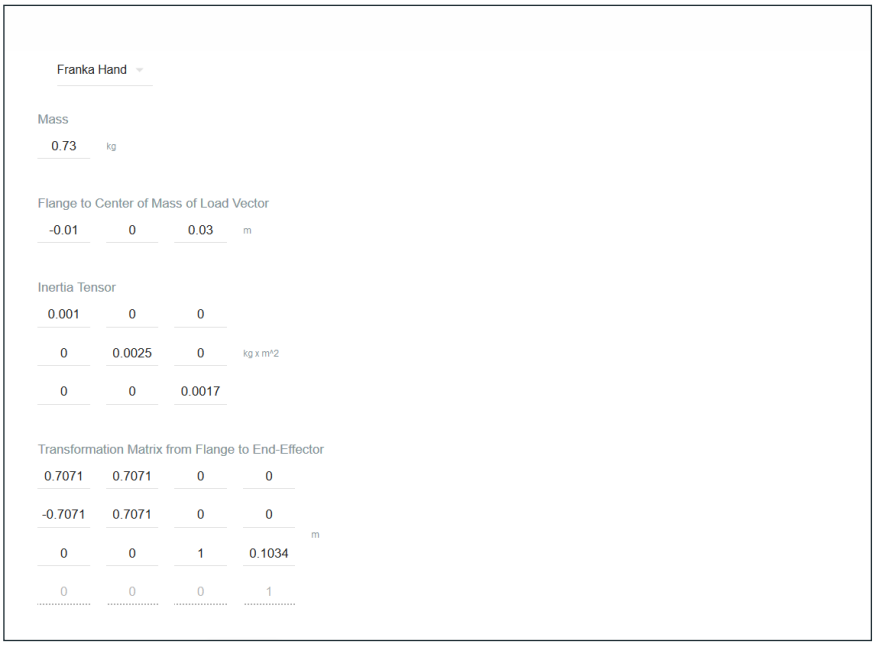


When first starting Franka Emika Robot - by means of the initial configuration – or at a later point in time by accessing the end-effector settings, Hand can be selected from a dedicated dropdown menu.

If you want to use another gripper or adjust the configuration of Hand, select “User Defined” from the dropdown and enter the corresponding values into the text fields.

FRANKA EMIKA ROBOT HAND

The default settings of the Hand are as follows:



A correct configuration is essential for operating Franka Emika Robot. When configured incorrectly, gravitational forces are not entirely compensated and the Arm regulates to the wrong target values.

When configured incorrectly:

- The Arm may pull towards certain directions in guiding mode
- The regulation in operating mode may be affected so that the expected sensitivity of the Arm for collision detection is reduced
- The tracking behavior may be affected

WARNING

Once configuration has been completed and confirmed, a final preparation step will be performed, after which the programming interface Desk is displayed in the web browser and the Arm glows continuously yellow.

Once configuration has been completed and confirmed, Franka Emika Robot will restart and is then ready for operation. After successful restart the programming interface Desk is displayed in the web browser and the Arm glows continuously yellow.

WARNING

Objects or tools could fall at any time (e.g. due to loose couplings, malfunctions that can cause Hand to open or when Franka Emika Robot is switched off, or the power to Franka Emika Robot system is cut). Should they fall, the objects or tools (which can weigh up to approx. 2.3 kg when Hand is installed, as the robot's maximum payload is 3kg, and the 0.73 kg mass of Hand shall be subtracted from it) could lead to injury to fingers, hands, toes and feet.

Therefore:

- take this into consideration while performing a hazard and risk assessment

By setting the Pilot mode to control the end effector, the fingers of Hand can be steered via the directional buttons of the Pilot's Disc:

- keep the "left" button pressed to slowly open Hand
- keep the "right" button pressed to slowly close Hand
- press the "down" button once to open Hand to full width
- press the "up" button once to make Hand grasp something, meaning that it closes around a grasped object and holds it with its holding force.

NOTICE

Hand contains sensitive electromechanical components. These can be damaged if the Arm is moved to adopt the transport position while Hand is still attached! Furthermore, when moving into transport position, objects in the Working Space of the Arm may be damaged.

Therefore:

- Make sure that Hand has been dismounted before bringing the Arm into the transport position.
- Make sure that the Working Space allows to bring the Arm into transport position safely.

When the device is turned off, Hand is not supplied with power either.
A jamming between the fingers of Hand can be loosened by simply pulling the fingers open.

Cleaning

⚠ CAUTION

Improper use of liquid cleaning agents and devices that are not correctly disconnected from the mains supply before cleaning can cause accidents by electric shock (e.g. by being freightened and falling due to retracting).
Therefore:

- never clean devices that have not been safely disconnected from the mains supply
- never use liquid cleaning agents for cleaning the devices
- do not switch on devices that have not fully dried

The following things need to be kept in mind while cleaning:

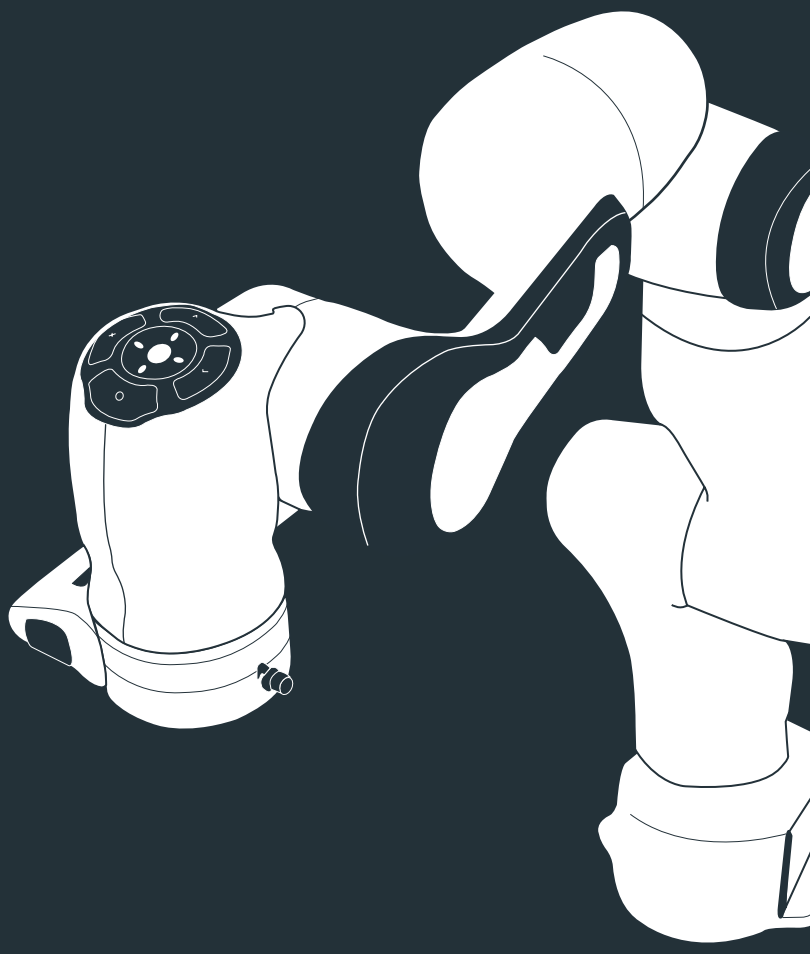
- Cleaning may only be carried out by qualified persons.
- Cleaning of components is only permissible when Franka Emika Robot is safely disconnected from the power supply (control disconnected from the mains)
- Switching off and unplugging the device is to be carried out by qualified persons
- Do not spray any liquids directly onto the device
- Do not use any cleaning chemicals
- The components may only be cleaned using a damp, entirely wrung out cloth or using a dry cloth. Make sure that no moisture enters the devices.
- Do not apply great force to the Arm. The parts to be cleaned are to be supported manually, as not to overload and possibly damage the Arm.
- Restarting is only permitted when all surfaces have dried completely.

NOTICE

Improper cleaning may cause material damage to the devices.

FRANKA EMIKA ROBOT FOR RESEARCHERS

- Introduction
- Additional conformities
- Franka Control Interface (FCI)
- Wiring & Installation



FRANKA EMIKA ROBOT FOR RESEARCHERS

Introduction

The following sections within the chapter: Franka Emika Robot for Researchers/ are an extension to Section 1: Introduction/ and Section 2: Assembly instructions for Franka Emika Robot as a partly completed machinery/. Those sections need to be read and taken into account before setting up and using Franka Emika Robot for research purposes.

The ideal platform for research

Franka Emika Robot is the ideal platform to conduct research on and test e.g. control and motion algorithms, grasping strategies, interaction scenarios and machine learning, as it features the add-on Franka Control Interface (FCI). FCI allows a fast low-level bidirectional connection to the robot's Arm and Hand.

Intended use

When Franka Control Interface (FCI) is active, the intended purpose of Franka Emika Robot includes:

- researching and testing path planning algorithms
- researching and testing control algorithms
- researching and testing gripping strategies
- researching and testing interaction scenarios
- researching and testing machine learning algorithms

As long as the FCI is active, Franka Emika Robot may not be used for commercial purposes.

Research operator

As Franka Emika Robot for Researchers with activated FCI interface allows to access Franka Emika Robot's low level sensor and actuator signals, the Research operator need to be highly-skilled. They need to be able to use their knowledge and experience to understand any risks the robot system may present and be adequately prudent in their behavior.

Additional conformities

FCC

Franka Emika Robot for Researchers is compliant to the US regulation FCC rule 47 CFR part 15 for electromagnetic compatibility.

OSHA

Within the United States of America, the responsible person/integrator is solely responsible to be compliant to the OSHA regulations (29 CFR part 1910) and to be compliant to public laws. Supporting the responsible person/integrator's evaluation we have added an additional statement of conformity.
Herein we declare for example that our power supply is NRTL certified by UL, and the usage of international Standards.

Declaration of Conformity

Statement of Conformity
supporting operator's OSHA 29CFR part 1910 evaluation

Description of the PARTLY COMPLETED MACHINERY:

Product identification:
Panda Research system components: *Control*, *Arm*
Model/Type:
Control (#75674215) in combination with *Arm* (#73681342)

We declare that the product complies with the following essential requirements of the European Machinery Directive2006/42/EC:
1.1.2; 1.1.3; 1.1.5; 1.1.6; 1.2.1; 1.2.2; 1.2.3; 1.2.4.1; 1.2.4.2; 1.2.4.4; 1.2.5; 1.2.6; 1.3.1; 1.3.2; 1.3.3; 1.3.4; 1.3.6; 1.3.7; 1.3.9; 1.5.1; 1.5.2; 1.5.4; 1.5.5; 1.5.6; 1.5.7; 1.5.8; 1.5.9; 1.5.10; 1.5.11; 1.5.13; 1.5.14; 1.5.16; 1.6.1; 1.6.2; 1.6.3; 1.6.4; 1.6.5; 1.7.1; 1.7.2; 1.7.3; 1.7.4; 4.1.2.1; 4.1.2.3; 4.2.1; 4.4.2

In addition, the partly completed machinery is in conformity with the following European Directives:
EC Directives 2014/35/EC relating to electrical equipment (LVD)
EC Directives 2014/30/EC relating to electromagnetic compatibility (EMC)

We declare that the relevant technical documentation is compiled in accordance with part B of Annex VII of the European Machinery Directive 2006/42/EC.

For supporting customers in the USA for OSHA 29CFR part 1910 evaluation, we can in addition give the following information:

List of NRTL certified components:

Main Power Supply	UL-certified: Ref. Cert. No. DK-58634-UL Input: 110V-240V; 8.5-3.5A; 50/60Hz Output: DC 48V/6.25A; 12V12.5A Reinforced insulation between the input and output circuit – SELV outputs Supplier: DELTA ELECTRONICS (THAILAND) PUBLIC CO LTD 909 SOI 9, MOO 4, PATTANA 1RD BANGPOO INDUSTRIAL ESTATE (E P Z) TAMBOL PHRAKS AMPHUR MUANG SAMUTPRAKARN 10280 THAILAND

Applied harmonized standards
Electrical safety

Standard	Name
EN 61010-1:2010 IEC 61010-1:2010 + Cor. :2011	Safety requirements for electrical equipment for measurement, control and laboratory use - Part 1: General requirements
EN 61010-2-201:2013 + AC:2013 IEC 61010-2-201:2013	Safety requirements for electrical equipment for measurement, control and laboratory use - Part 2-201: Particular requirements for control equipment
EN 60204-1:2006/A1:2009/ AC:2010 IEC 60204-1:2005/A1:2008	Safety of machinery - Electrical equipment of machines - Part 1: General requirements
EN 61800-5-1:2007 IEC 61800-5-1:2007	Adjustable speed electrical power drive systems - Part 5-1: Safety requirements - Electrical, thermal and energy

Machinery safety

Standard	Name
ANSI ISO 12100:2010 ISO 12100:2010	Safety of machinery - General principles for design - Risk assessment and risk reduction
EN ISO 13857:2008 ISO 13857:2008	Safety of machinery - Safety distances to prevent hazard zones being reached by upper and lower limbs
EN ISO 13732-1:2006	Ergonomics of the thermal environment - Methods for the assessment of human responses to contact with surfaces - Part 1: Hot surfaces
EN ISO 13850:2015 ISO 13850:2015	Safety of machinery - Emergency stop - Principles for design
EN 61800-5-2:2007 IEC 61800-5-2:2007	Adjustable speed electrical power drive systems - Part 5-2: Safety requirements - Functional IEC 61800-5-2:2007

EMC

Standard	Name
	FCC part 15 – radio frequency devices. Acc. to class A digital device.
FCC rule 47 CFR part 15	"This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation."
EN 61000-6-1:2007 IEC 61000-6-1:2005	Electromagnetic compatibility (EMC) - Part 6-1: Generic standards - Immunity for residential, commercial and light-industrial environments
EN 61000-6-2:2005/ AC:2005 IEC 61000-6-2:2005	Electromagnetic compatibility (EMC) - Part 6-2: Generic standards - Immunity for industrial environments
EN 61000-6-3:2007/ A1:2011/AC:2012 IEC 61000-6-3:2006/ A1:2010	Electromagnetic compatibility (EMC) - Part 6-3: Generic standards - Emission standard for residential, commercial and light-industrial environments
EN 61000-6-4:2007/ A1:2011 IEC 61000-6-4:2006/ A1:2010	Electromagnetic compatibility (EMC) - Part 6-4: Generic standards - Emission standard for industrial environments
EN 61000-6-1:2007 IEC 61000-6-1:2005	Electromagnetic compatibility (EMC) - Part 6-1: Generic standards - Immunity for residential, commercial and light-industrial environments

Important Information!

The partly completed machinery must not be put into service until the final machinery into which it is to be incorporated has been declared to comply with all applicable federal, state, and local laws and regulations (especially to OSHA requirements).

Manufacturer:
Franka Emika GmbH
Frei-Otto-Straße 20
80797 Munich
Germany

Date
03.04.2020
Munich, Germany

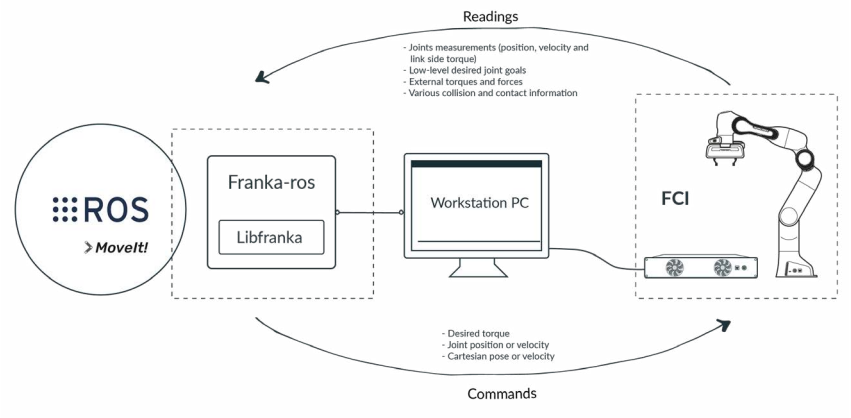
Dr. Simon Haddadin, CEO & MD **Dirk Engelmann, Managing Director**

FRANKA EMIKA ROBOT FOR RESEARCHERS

Franka Control Interface (FCI)

FCI in a nutshell

Activating the FCI unlocks the possibility to connect your workstation PC to the Franka Emika Robot system, using a fast and direct low-level bidirectional communication. It provides the current status of the robot and enables its direct control (1 kHz).



Documentation about Franka Control Interface and how to use it can be found at https://support.franka.de, which also includes source code and documentation of the open source packages libfranka and franka_ros.

libfranka provides a C++ interface which can run on a workstation PC. It enables you to connect your own applications via standard Ethernet to a Franka Emika Robot with activated FCI. franka_ros connects Franka Emika Robot with the entire ROS ecosystem. It integrates libfranka into ROS Control, and includes URDF models and detailed 3D meshes of our robots and end effectors, which allows visualization (e.g. RViz) and kinematic simulations. Additionally, MoveIt! integration makes it easy to move the robot and control the gripper.

Wiring & Installation

Connecting to network

- Connect the Control to the network (optional) via an RJ 45 Ethernet cable (not included)
- or connect the Control directly with a PC workstation, in order to access Franka Emika Robot via the FCI programming interface

Documentation

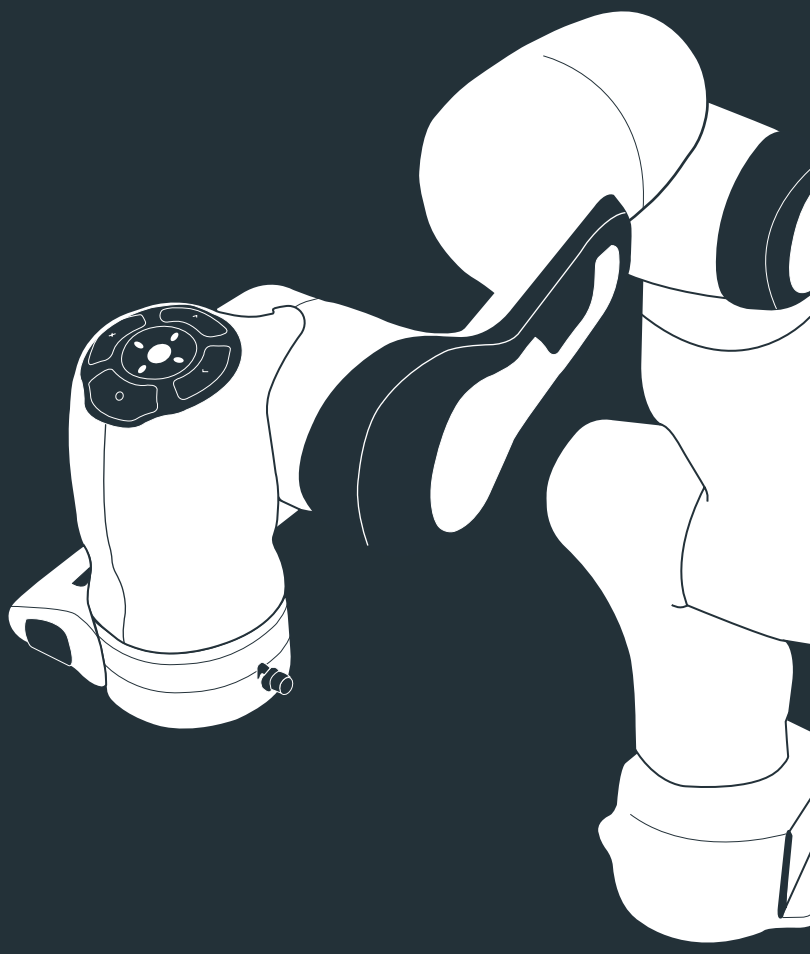
For other information on FCI, such as network requirements, installation tips, description of libraries, troubleshooting and FAQs, please access our comprehensive documentation from https://frankaemika.github.io/docs/.

Community

Register and contribute to our community of researchers and enthusiasts who use Franka Emika Robot (https://www.franka-community.de) to mutually benefit from each other's interaction!

CE OUT OF THE BOX SOLUTIONS

- Introduction
- Legal framework



CE OUT OF THE BOX SOLUTIONS

Introduction

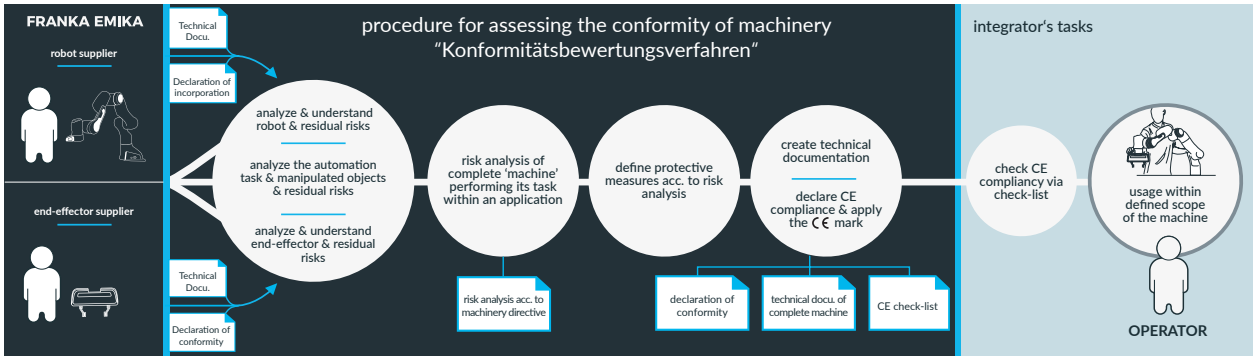
If you have purchased a Franka Emika Robot – CE out of the box solution, please be sure to take account of the supplementary documentation including the CE check list provided, in addition to the present basic documentation. The CE out of the box solutions have already been assessed by Franka Emika as to their compliance with the Machinery Directive so that you as a responsible person/integrator merely need to follow and confirm the steps in the CE check list. In this way, you can use Franka Emika Robot as a completed machinery according to the EU Machinery Directive 2006/42/EC.

Legal Framework

EU Machinery Directive – CE out of the box solutions

If you have purchased a Franka Emika Robot – CE out of the box solution you are now the proud owner of the first smart assistant of its kind! Similar to any power tool bought at a hardware store you can operate Franka Emika Robot after a short check as a completed machinery according to the EU Machinery Directive 2006/42/EC. It has the corresponding CE marking and there is no need for a risk assessment, you can get started straight away.

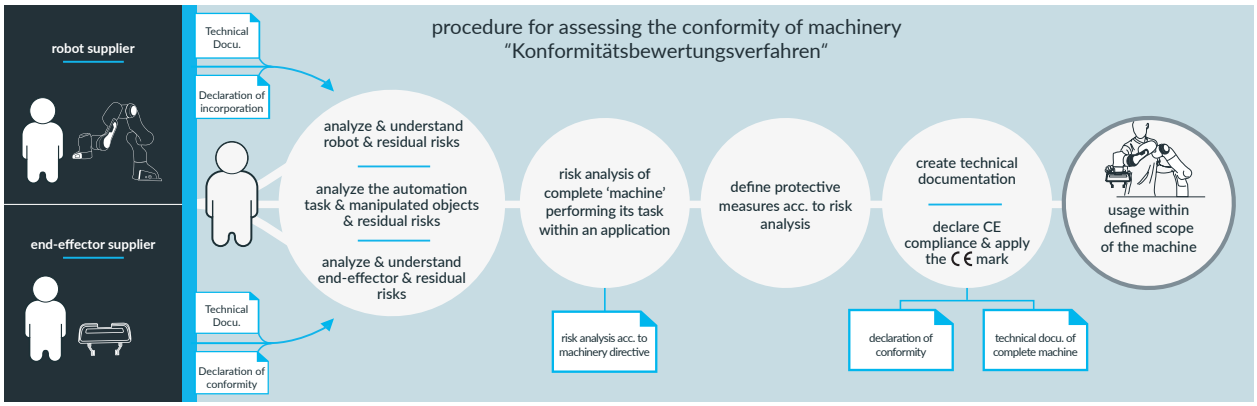
Franka Emika Robot CE out of the box solutions



For CE out of the box solutions Franka Emika has already carried out the conformity assessment procedure according to the Machinery Directive. As long as the responsible person/integrator operates the CE out of the box solution according to the intended purpose, Franka Emika's conformity assessment will remain valid. In order to verify that Franka Emika Robot is being operated under the ambient and operating conditions defined in the manual, every CE out of the box solution contains a CE check list. If all questions can be answered with "yes", the enclosed declaration of conformity is valid and Franka Emika Robot can be used straight away.

If one or several of the questions on the CE check list for the CE out of the box solution have been answered with “no” or if you have not purchased a CE out of the box solution, the Franka Emika Robot system components (Arm, Control, Hand) are to be assessed independently by the integrator as to their compliance with the Machinery Directive. In this case the integrator needs to carry out a hazard and risk assessment independently based on the contents and correct application of the instructions in this Handbook, and is also responsible for implementing the necessary measures resulting from this assessment before operating the system and for declaring conformity with the Machinery Directive.

Franka Emika Robot system components



The corresponding declaration of incorporation is provided in the chapter: Franka Emika Robot’s conformities/.

In this case the integrator is responsible for carrying out a hazard and risk assessment based on the contents of this handbook according to the corresponding standards before using Franka Emika Robot.
Franka Emika recommends carrying out a hazard and risk assessment in accordance with EN ISO 12100 and the Machinery Directive and thereby take into consideration the hazards list from EN ISO 10218-1:2011 ANNEX A (the C standard for robots), in addition to the measures of EN ISO 10218-2:2011.
Any measures emerging from it, whether suitable or necessary (e.g. constructional or organizational measures) are to be introduced and assured.

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