ENG

USER HANDBOOK

PANDA

FRANKA EMIKA

ORIGINAL USER HANDBOOK

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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: 1st of October 2018

CONTENT OVERVIEW

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LEGAL FRAMEWORK

About this User Handbook

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.

Panda - CE out of the box solutions

This manual contains product descriptions for the Panda system components Arm, Control and Hand (hereinafter the system is also simply referred to as Panda).
If you have purchased a Panda – 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 user merely need to follow and confirm the steps in the CE check list. In this way, you can use Panda as an assembled machine according to the EU Machinery Directive 2006/42/EC. Find out more about CE out of the box solutions at:
www.franka.de/apps/

Notice of liability

The present Panda system is intended exclusively for use as described in this User Handbook.

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

Therefore:

- Panda may only be used in perfect 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 User Handbook
- Malfunctions that may impair safety need to be rectified immediately
- Modifications of Panda are not permissible

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

LEGAL FRAMEWORK

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 operating area of the Arm need to have read and understood this documentation, in particular the chapter on safety. 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 operator has to inform these persons explicitly about the limitations and restrictions of Panda.

Operator

The operator of Panda can be e.g. the entrepreneur, director of the institute, the employer or a delegate responsible for the use of Panda. The operator 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 operator must fulfill his monitoring obligations.
- The operator must ensure that all staff members working with Panda are suitably qualified to do so and have been informed about the possible dangers Panda may present.
- The operator must provide training and instructions in given intervals in order to create and consolidate risk awareness.

In this regard, we refer you to the Franka Academy, where appropriate training courses on the handling of Panda are offered.
https://www.franka.de/training/

Researcher

User of the Franka Control Interface (hereinafter also referred to as FCI) shall also take note of further product documentation on the use of the FCI https://www.github.com/frankaemika/

LEGAL FRAMEWORK

Intended purpose of Panda

The producer is not liable for damages caused by misuse. All the risk is borne by the operator alone.

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

Intended purpose - Panda

The Arm and its control system (hereinafter: Control) with/without mounted end-effector (e.g. Franka Emika's Hand) are intended exclusively for industrial use and use in research. The system may be applied only in the ambient and operating conditions described in this manual for the tasks of:

- testing and inspection
- handling
- mounting

Intended purpose - Panda research

When Panda is used for robotics research and the Franka Control Interface (FCI) is active, the intended purpose of Panda also 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, Panda may not be used for commercial purposes.

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

- 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

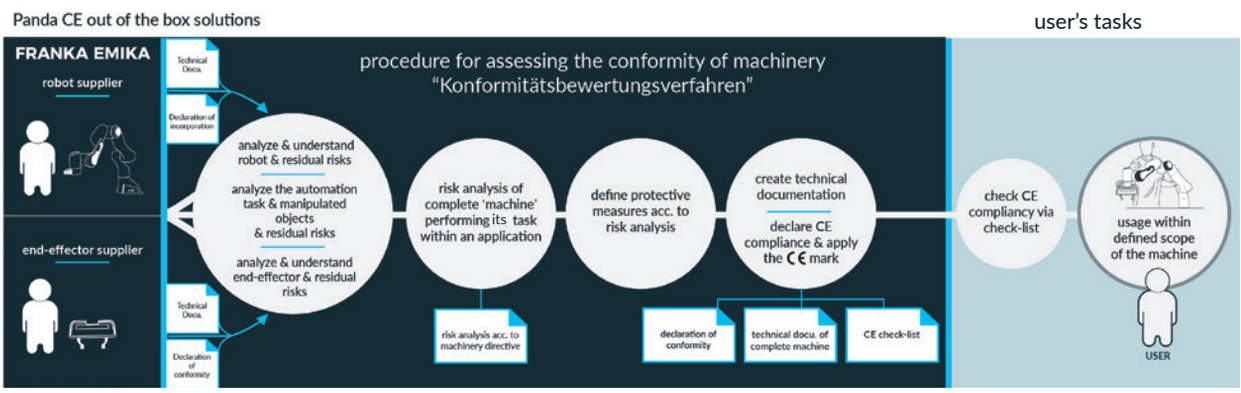
Modifications of Panda (e.g. fittings, creation of drill holes, etc.) may lead to damage to the system. This is considered misuse and will lead to the loss of warranty and liability claims.

LEGAL FRAMEWORK

Panda's conformities

EU Machinery Directive – Panda – CE out of the box solutions

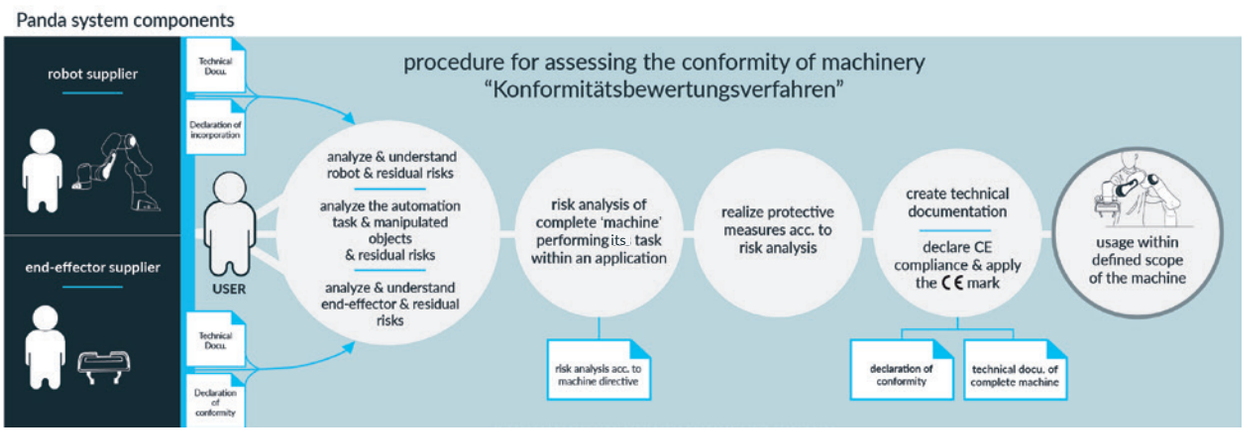
If you have purchased a Panda – CE out of the box solution you are now the proud owner of the first smart assistant of its kind! Similar to any power tool bought at a hardware store you can operate Panda after a short check as a complete machine according to the EU Machinery Directive 2006/42/EC. It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



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 user 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 Panda 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 Panda 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 Panda system components (Arm, Control, Hand) are to be assessed independently by the user as to their compliance with the Machinery Directive.
In this case the user needs to carry out a risk assessment independently based on the contents and correct application of the instructions in this manual. The user is responsible for implementing the necessary measures resulting from this assessment before operating the system and for declaring conformity with the Machinery Directive.

EU Machinery Directive – Panda System Components



The corresponding declaration of incorporation and the declarations of conformity are provided in the chapter: Product Conformity.

The operator is rsponsible for operating Panda and its possible integration into a larger installation or into a larger research apparatus.
The operator is furthermore solely responsible for carrying out a risk assessment based on the contents of this user handbook and implementing and ensuring appropriate or necessary measures (e.g. consturctional or oganizational measures) resulting from it.

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EMC Directive
Low-Voltage Directive

The system component Control in connection with the Arm is CE-compliant according to:

- to EMC Directive (2014/30/EC)
- and to the Low Voltage Directive (2014/35/EC).

The Hand is CE-compliant according to:

- to the Machinery Directive (2006/42/EC)
- and to EMC Directive (2014/30/EC)

For the declarations of conformity see chapter: Product Conformity

RoHS, REACH, WEEE

Control, Arm, Hand and accessory parts are exempt from regulations according to RoHs, REACH and WEE directives. Nevertheless, our products comply with the requirements according RoHS.
For the corresponding confirmation, see Chapter/Product Conformity/Further Declarations.

FCC

In addition to the European EMC Directive, Panda is also compliant to the US regulation FCC rule 47 CFR part 15 for electromagnetic compatibility.

OSHA

Within the United States of America, the operator is solely responsible to be compliant to the OSHA regulations (29 CFR part 1910) and to be compliant to public laws. Supporting the operator's evaluation we have added an additional statement of conformity.
Herein we declare for eaxample that our power supply is NRTL certified by UL, and the usage of international Standards.
For the corresponding confirmation, see chapter: Product Conformity/ Further Information.

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.

WARNING

Panda offers functionalities and features of various safety levels. They are described in the chapter “Safety Concept/ Operating modes of Panda”, 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. You may therefore NOT rely on the availability of these functionalities. When they are used, dangerous and uncontrolled movements 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 movements can lead to risks of crushing, shearing, impact, puncture or penetration and may cause severe injury. Therefore:

- When using these features the operator is solely responsible for conducting a 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 user is aware that the mentioned features could be not available.

Functionalities and Features of Various Safety Levels

LEGAL FRAMEWORK

Perfect condition

WARNING

Panda may only be used in perfect condition, according to its intended purpose and with possible dangers and risks in mind. Misuse can cause personal and material damage. The manufacturer is not liable for damages caused by misuse.

Modifications

WARNING

The Arm is equipped with an ISO end effector flange. Different end effectors can be mounted on it. In our risk assessment, we have only considered our own gripper (Hand). Should other end effectors be mounted, the operator is responsible for carrying out the appropriate risk assessment and implement the corresponding measures. We are not liable for damages caused by mounted equipment.

Apart from mounting end effectors, modifications to Panda are not allowed. 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 Panda indicates possible malfunctions or the user 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, the Control approx. 7kg, the Hand approx. 1kg. 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

NOTICE

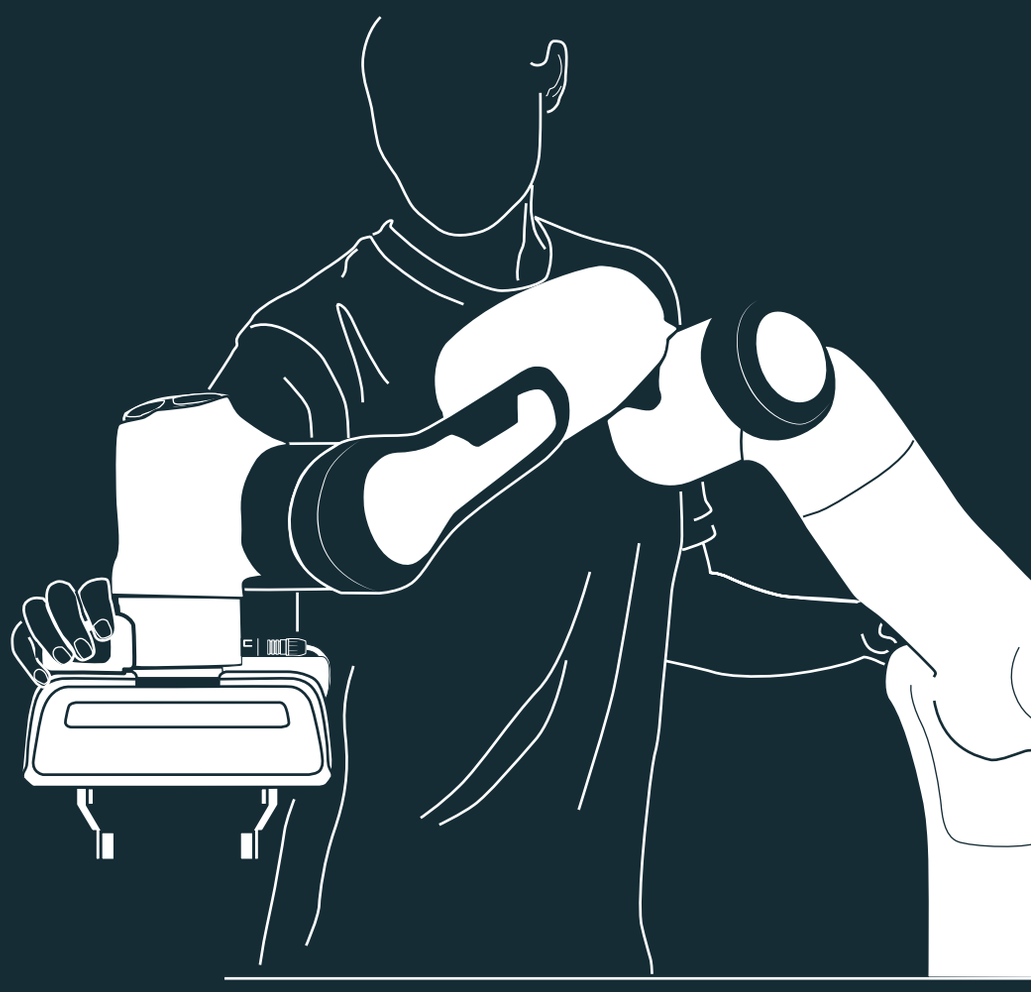
The Arm and Control contain sensitive electromechanical components. These can be decalibrated or damaged by shock!

Therefore:

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

INTRODUCTION

- Terms
- About us - Franka Emika GmbH
- This is Panda
    - The Panda Power Tool
    - Some features
    - Equipment overview
    - Scope of delivery and additionally required equipment



INTRODUCTION

Terms

German	English	Description
Franka Emika GmbH	Franka Emika GmbH	Franka Emika GmbH (abbreviated FE) is the company name. We produce Panda.
Panda	Panda	The system components: Arm, Control, Hand and Pilot compose the Panda System, hereafter simply called Panda.
Panda – CE out of the box solutions	Panda – 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. After carrying out a quick check, Panda - CE out of the box solutions can be used immediately without the need for further risk assessment.
Arm	Arm	The Arm is our sensitive robotic arm with 7 axes and is part of Panda. Hereinafter referred to as Arm or robotic arm.
Controller	Control	The Control is the main control computer and part of Panda.
Hand	Hand	The Hand is our electrical two-finger parallel gripper and part of Panda.
Franka Control Interface (FCI)	Franka Control Interface (FCI)	When the Franka Control Interface (FCI) is activated for research purposes it offers a software interface for controlling Panda in real-time.
Pilot	Pilot	The Pilot is the user interface on the Arm for guiding and operating Desk and Hand and is part of Panda.
Desk	Desk	Desk is our web-based, intuitive and graphical programming and user interface.

Bediengerät	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.
Workstation PC	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 Panda.
Web-browser	web browser	A web browser (Chrome, Chromium, Firefox) on the interface device serves as connection to Desk, and thereby to the intuitive, graphical user and programming interface.
Franka Academy	Franka Academy	Franka Academy (abbreviated FE Academy) is our training center
Franka World	Franka World	Franka World is our online platform, which provides access to all our products and services.
Franka Store	Franka Store	Via the Franka Store, you can online purchase Apps and hardware by Franka Emika. Under www.franka.de
App	App	Apps are modular robot programs, each representing a partial step of a robot task. They can be purchased from the Franka Store and can be parametrized in Desk to form entire automation Tasks.
Research App	Research App	Research Apps are apps specifically customized for research purposes
Task	Task	A Task in Desk represents an entire automation routine. A Task consists of one or several Apps

Betreiber	operator	The operator of Panda can be for example the entrepreneur, director of the institute, the employer or a delegate responsible for using Panda. For further information, see chapter: Legal Framework.
Anwender	user	The user can use Panda within the limits defined by the operator and the admin. See chapter: Safety Concept/ Staff.
Admin	admin	The admin has the authorization to edit IT and safety settings for Panda.
Griff	Grip	The Grip is part of the Pilot and is used for manual guiding.
Bedienfeld	Disc	The Disc is part of the Pilot and is used for interacting with the Arm and/or Desk.
Zustimmtaster	Enabling button	The enabling button is part of the Grip and thereby the Arm. It allows the activation of Arm movements.
externer Zustimmtaster	External Enabling Device	The external enabling device is plugged into the female connector X4 of the Arm. When the external enabling device is half pressed during “monitored stop” it is possible to run automatic robot programs, as long as the device remains half pressed.
Not-Halt Einrichtung	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 Panda in the case of an emergency. This will cause Panda to brake at maximum capacity and the locking bolts to mechanically lock the Arm.
externer Aktivierungsschalter	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.

Verbindungskabel	Connection cable	The connection cable connects the Arm with the Control.
Fail-safe Sicherheits-blockiersystem, bzw. Sicherheitsblockier-system	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. This way, the Arm stays in position even when turned off. Hereinafter also referred to as safety locking system.
Entriegelungswerk-zeug	Unlocking tool	The unlocking tool provided can be used for manually unlocking the safety locking system in case of emergency to move the Arm.
Notentriegelung	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.
Emergency unlock	Emergency unlock	The emergency unlock labels on the Arm indicate the three positions on the Arm where an emergency unlock can be carried out.
Achsen/Gelenke	Axes/joints	The robotic arm consists of 7 consecutive joints or axes. The movement is created in these joints.
Handführen/Guiding	Guiding	Guiding describes the procedure of taking the Arm by the hand and moving it manually, for example to teach a new pose.
Geste	Gesture	A gesture is a movement of the Arm similar to a human gesture (e.g. nodding to confirm a procedure).
Guiding Modus	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 Taster	Guiding Button	The guiding button is located on the grip of the Pilot. Using this button you can guide the Arm, as long as the enabling button is half-pressed too.

INTRODUCTION

Teaching	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 Fehler	Tracking Error	The actual motion of the Arm follows the target motion with a small deviation, a so-called tracking error.
Pose	Pose	A pose is the position of the Arm including its positioning and orientation in space.
Arbeitsbereich	Operating Area	The area, in which the Arm performs its Task is called operating area. For further information, see also the description in chapter: Safety Concept/ Hazardous and safe areas.
Gefährdungsbereich	Hazard Area	An area in which humans may be harmed. See also the description in chapter: Safety Concept/ Hazardous and safe areas.
Sicherheitsbereich	Safety Area	An area in which humans are separated from a hazardous area by protective measures (here e.g. safety fence). See also the description in chapter: Safety Concept/ Hazardous and safe areas.
Schutzeinrichtungen	Protective Measures	Protective measures are supplementary, often structural or technical measures such as safety fences, laser scanners etc., which serve to safely separate humans from a hazardous area.
Anhalteweg	Stopping Distance	The stopping distance is the distance the Arm will cover after activation of the emergency off until it comes to a full stop.
Stopping Time	Stopping Time	The Stopping Time is the time, which still elapses, after activation of the Emergency Stop until the arm comes to rest.
Cartesian	Cartesian	The Cartesian Space is the (mainly) three dimensional space in which all axes (x, y and z) are perpendicular to each other.

Anhaltezeit	Stopping Time	The stopping time is the time that passes after the emergency off has been activated until the Arm comes to a full stop.
Kartesisch	Cartesian	The Cartesian space is the three-dimensional space.
Kollaboration	Collaboration	Collaboration exists, when a person works directly together with a robot within a determined operating area. See also the description in chapter: Safety Concept/ Hazardous and safe Areas.
Interaktion	Interaction	Panda is designed to be easily and safely programmed and operated, and to be able to quickly learn and relearn new tasks. When Panda is in “monitored stop” mode or is being guided (teaching mode), Panda glows white to indicate that the Arm is ready for interaction.
Massenangriffspunkt	Center Of Mass	The center of mass is the center of gravity of an object. At this point, gravitational force comes into effect.
Maschinenrichtlinie (2006/42/EU)	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.
Niederspannungs-richtlinie 2014/35/EC	Low Voltage Directive 2014/35/EC	The Low Voltage Directive (2014/35/EC), hereinafter referred to as Low Voltage Directive, regulates the safety of electronically operated devices within the European Economic Area, Switzerland and Turkey.
EMV Richtlinie 2014/30/EU	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 Richtlinie 2011/65/EU	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 Verordnung (EU) No. 1907/2006	REACH 1907/2006	The REACH regulation (EG) No 1907/2006, hereinafter referred to as REACH, is a chemicals regulation.
FCC rule 47 CFR part 15	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	OSHA is the Occupational Safety and Health Administration. It is a US federal authority regulating occupational safety and health issues.
libfranka	libfranka	libfranka is our C++ program library, which can be accessed at https://www.github.com/frankaemika/ – libfranka is part of the Franka Control Interface (FCI) for researchers
franka_ros	franka_ros	franka_ros is our ROS interface with ROS control and MoveIt integration, which can be accessed at https://www.github.com/frankaemika/ – franka_ros is part of the Franka Control Interface (FCI) for researchers

INTRODUCTION

FRANKA EMIKA

The vision of a robot for everyone – sensitive, interconnected and adaptive

Even today, robotics remains a technology accessible only to few. The reasons for this are the high costs, difficult programming and the separation of humans and robots by safety fences. So how can this complex technology be made accessible to the general population?

We at Franka Emika GmbH, the high-tech company from Munich, want to solve this problem.

To us, the ideal robot of the future is a tool which can be used by anybody and which supports humans in carrying out unpleasant or even dangerous tasks. Panda is the first system of an entirely new generation of tools, which are developed with the following main objectives: first as a research robot, then as a colleague in a factory and finally as an assistant in daily life for elderly or sick people.

We presented the Panda “power tool” at the Hannover trade fair 2017. The system can be operated via Apps like a smartphone and be taught new Tasks within a few minutes, without requiring any programming skills. At the same time the system is sensitive to such an extent, that it can take over assembling, testing or inspecting tasks next to a human colleague without the need for a safety fence. The online platform Franka World represents the center of this ecosystem, in which the community can interact, developers and clients can be assigned and new solutions and applications are provided.

The system was developed based on the globally leading German robot technology, and is now produced in series in Allgäu, Bavaria. Panda research has been ready for use for the research community since August 2017; later in 2018 it became ready for use in industry, and this is only the beginning of a new generation of universal tools.

Panda – designed, developed and made in Germany.

THIS IS PANDA

The Panda Power Tool

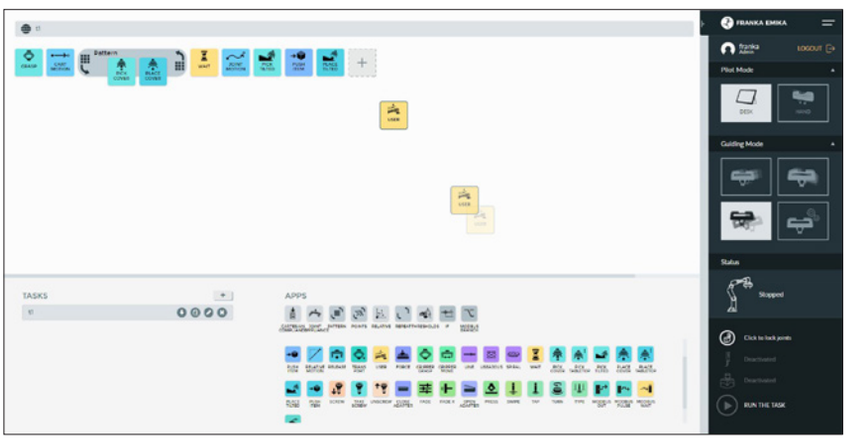
Panda

Panda is our sensitive and extremely versatile power tool. The torque sensors in all seven axes enable Panda to manipulate objects in a skillful and sensitive way. Yet they also enable the user to interact directly and intuitively with the Arm. By means of our in-house developed programing paradigm, this lightweight robot system, despite its myriad of highly-complex capabilities, is extraordinarily easy to assemble and use. In combination with apps, Panda can be implemented in a matter of minutes.

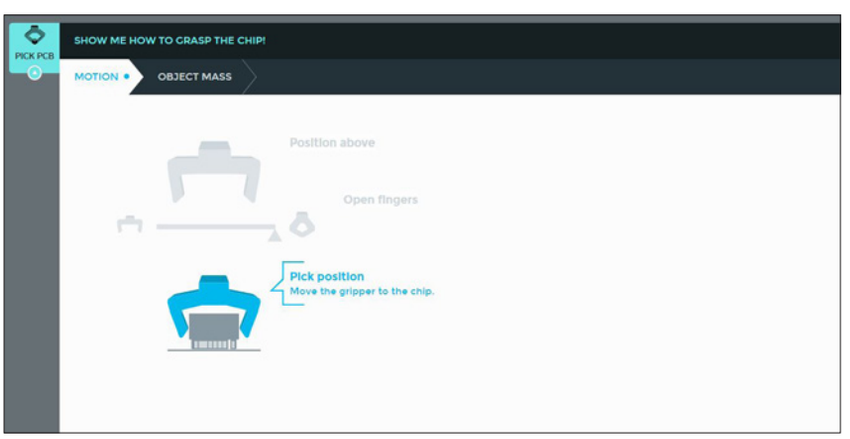
An app for everything

Apps are modular robotic programs, which represent respectively one partial step of a robotic task and which may be obtained from the Franka Store. These apps can encompass differing scopes from the highly complex to the very simple. When selected from Desk, each app can be opened and the user is prompted with a context menu that requests parameters by means of dia-logue-based interaction with the user.

Programming with one swipe



A Task can be composed in Desk by arranging Apps, which are then parametrized directly at the robot in the operating area.



Pilot is the interface integrated in the Arm, which allows for smooth interaction between Arm and Desk.

Teaching by demonstration

THIS IS PANDA

The FCI package - the bonus for researchers

The Panda research package allows for real-time, bidirectional connection between a workstation PC and the Arm. Also commanding the Hand is possible. This interface (FCI) enables the user to implement specially created controllers and applications with the robot. The package consists of libfranka, a C++ program library, and franka_ros, an ROS interface with ROS Control and MoveIt integration, which can be accessed at https://www.github.com/frankaemika/. Detailed information can be found in the corresponding API descriptions and quick start guides.

Some features

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. A certain pose can be uniquely identified with 7 values in units of degrees. 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 movement 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 movement of a robot always depends on the reference coordinate system, which can be configured for Panda 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 Panda 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.

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 a user reaches into the motion path of the robotic arm when it is moving, this 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 movement.

Generating forces

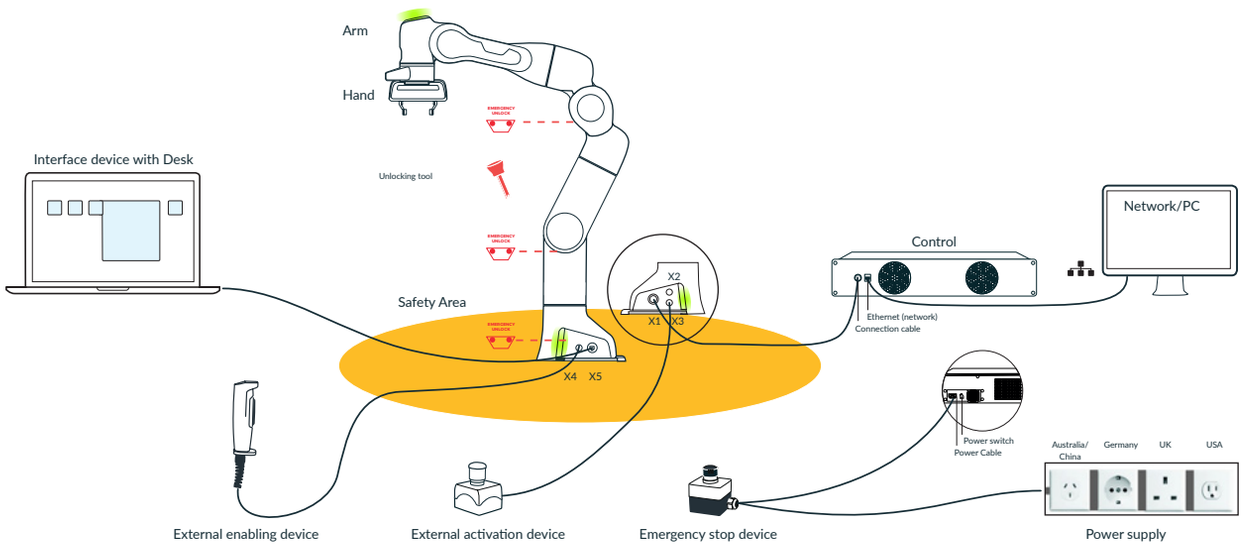
If the Arm is in intended contact with its surroundings, sensor signals of the seven torque sensors can be used to generate a defined force on the point of contact.

THIS IS PANDA

Equipment overview

Basic set-up

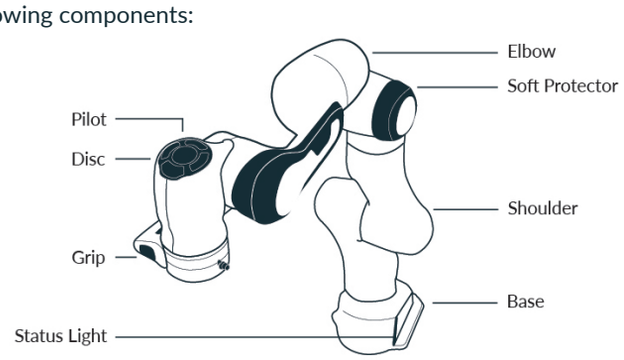
The basic set-up of Panda looks like this:



- between the controller and the net supply is situated an emergency stop device, which in cases of emergency safely removes the supply from Panda
- the 3-way external enabling device is connected at the base of the Arm (connector X4). Half pressing it will activate Panda (Attention – always step out of the safe area first) and programs can be started via Desk.
- The external activation device is connected at the base of the Arm (socket X3), in order to consciously authorize movements of the Arm from outside the Safety Area.
- 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.
- if you wish to program Panda via FCI, the shopfloor network ethernet interface on the front side of the Control should be used.

The Arm

The Arm has the following components:

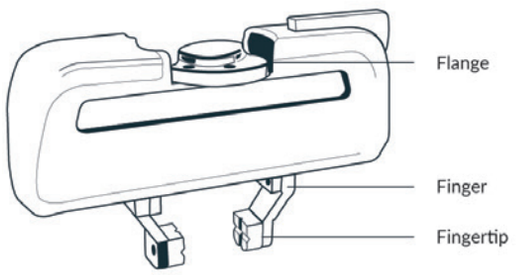


Top view

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

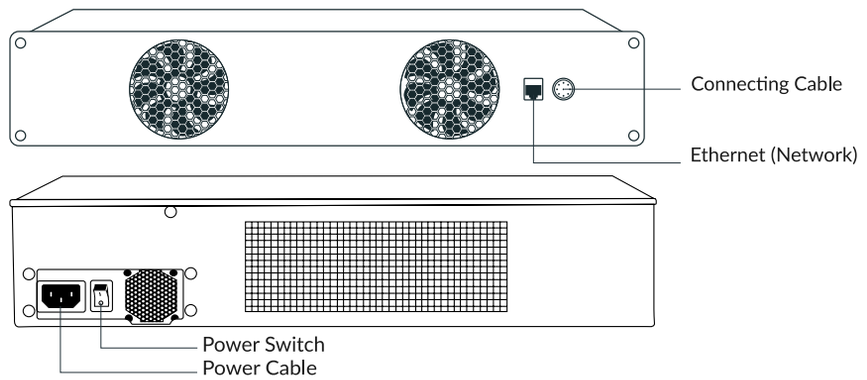
The Hand

The 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 gripped (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.

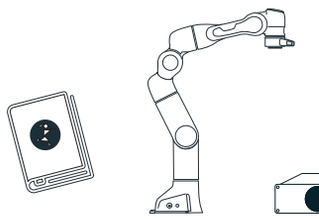
The Control



THIS IS PANDA

Scope of delivery and additionally required equipment

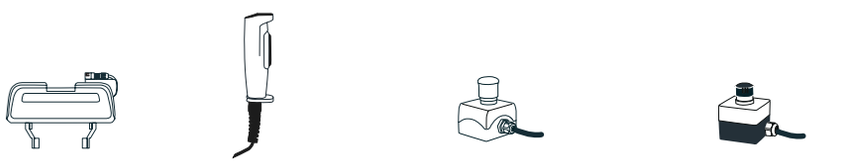
In the box



Quick guide | Arm | Control | Connection cable | Unlocking tool

- Main components
  - Arm
  - Control
- Accessories
  - Connection cable 2.5m (for connecting Arm and Control)
  - 2 x unlocking tool
- Quick guide

Optional accessories



Hand | ext. Enabling device | ext. Activation device | Emergency stop device

- Main components
  - Hand + 1 set of fingertips
- further accessories
  - External enabling device
  - External activation device
  - Emergency stop device
  - Hand assembly accessories:
    - 2 x DIN7984 M6X12 ST 8.8 Screws
    - 1 x ISO2338B 6X10 h8 A2 cylindrical pin

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

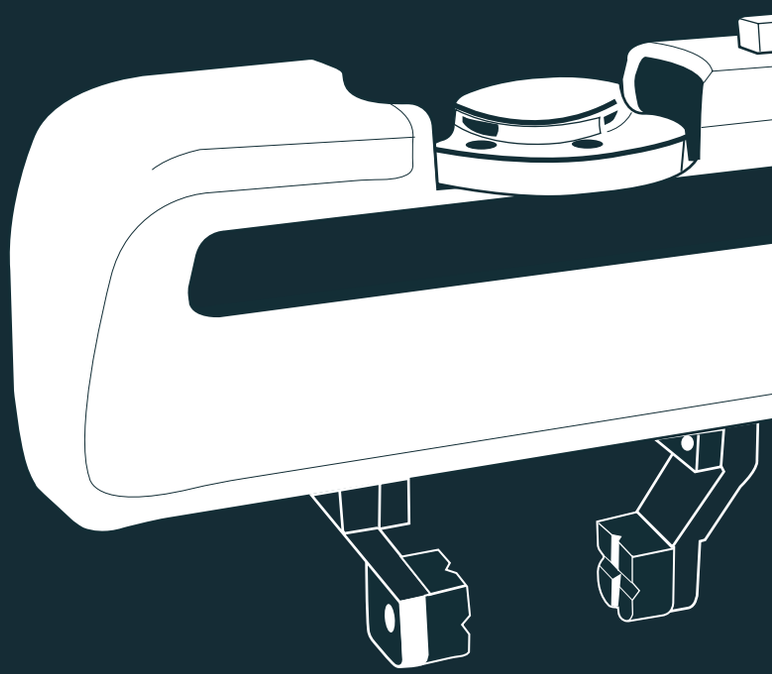
- Ethernet cable with RJ 45 connector for connecting the interface device to the Arm
- Ethernet cable with RJ 45 connector for optional connection of Control to the company network or PC workstation
- Mounting accessories for mounting the Arm on a stand, e.g. according to our suggestion:
  - 4x cylinder 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
- Hex key size 4 for attaching the Hand to the end effector flange of the Arm
- Level for ensuring the horizontal installation of the Arm

SPECIFICATION

- Technical specification



SPECIFICATION

Technical specification

Panda

TECHNICAL DATA [1, 2]

Arm	
degrees of freedom	7 DOF
payload	3 kg
sensitivity	torque sensors in all 7 axes
maximum reach	855 mm
joint position limits [°]	A1: -166/166, A2: -101/101, A3: -166/166, A4: -176/-4, A5: -166/166, A6: -1/215, A7: -166/166
joint velocity limits [°/s]	A1: 150, A2: 150, A3: 150, A4: 150, A5: 180, A6: 180, A7: 180
Cartesian velocity limits	Up to 2 m/s end effector speed
repeatability	+/- 0.1 mm (ISO 9283)
interfaces	▪ Ethernet (TCP/IP) for visual intuitive programming with Desk ▪ input for external enabling device ▪ input for external activation device or a safeguard ▪ Control connector ▪ Hand connector
interaction	enabling and guiding button, selection of guiding mode, Pilot user interface
mounting flange	DIN ISO 9409-1-A50
installation position	upright
weight	~ 18 kg
protection rating	IP30
ambient temperature	▪ +15°C to 25°C (typical) ▪ +5°C to + 45°C (extended) [3]
air humidity	20% to 80% non-condensing
Control	
interfaces	▪ Ethernet (TCP/IP) for Internet and/or shop-floor connection ▪ power connector IEC 60320-C14 (V-Lock) ▪ Arm connector
controller size (19”)	355 x 483 x 89 mm (D x W x H)
supply voltage	100 V_{AC} - 240 V_{AC}
mains frequency	47- 63 Hz
power consumption	▪ max. 600 W ▪ average ~ 300 W
active power factor correction (PFC)	yes
weight	~ 7 kg
protection rating	IP20
ambient temperature	▪ +15°C to 25°C (typical) ▪ +5°C to + 45°C (extended) [3]
air humidity	20% to 80% non-condensing

Hand	
parallel gripper	with exchangeable fingers
grasping force	continuous force: 70 N maximum force: 140 N
travel (travel speed)	80 mm (50 mm/s per finger)
weight	~ 0.7 kg
Desk	
platform	via modern web browser
programming	visual & intuitive, dialog-based
Apps	can be composed into complex workflows to create Tasks and Solutions
CE out of the box solutions	

Check www.franka.de to see if for your application a CE out of the box solution is available already. If so, you only have to go through an enclosed CE-checklist and you can start using Panda out of the box without performing an additional risk analysis.

[1] **technical data is subject to change**

[2] if you have not purchased a Panda - CE out of the box solution, or don’t comply with the CE-checklist the operator is responsible for the performance of a risk analysis and safe operation of the robot in accordance to its intended use and applicable standards and laws.

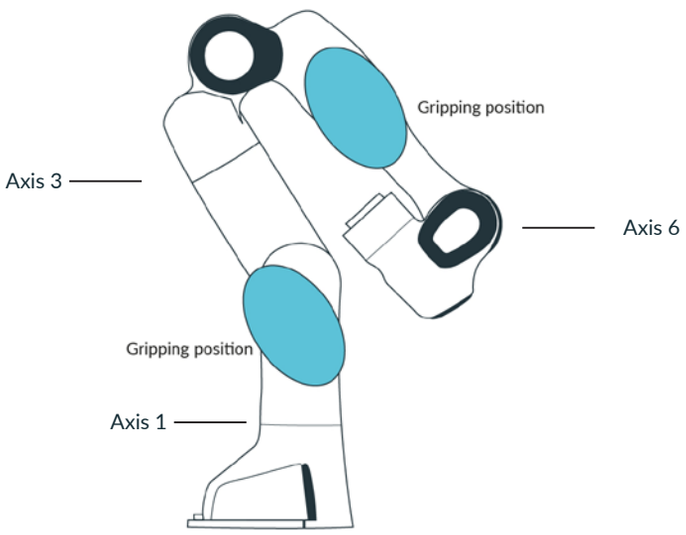
[3] performance can be reduced when operating outside the typical temperature range

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

Transportation pose of the Arm and marking of gripping positions



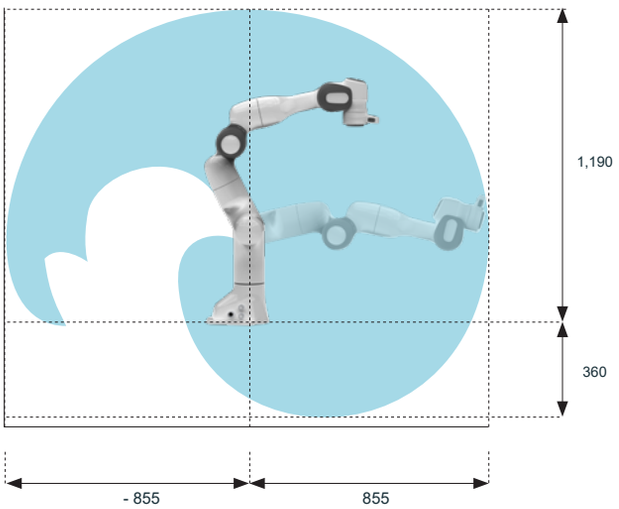
- The transportation pose can be described by the following joint angles of axis 1 to axis 7: [0°, -32.08°, 0°, -170.17°, 0°, 0°, 45°]
- The Arm must only be handled at the positions marked in the picture.

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

SPECIFICATION

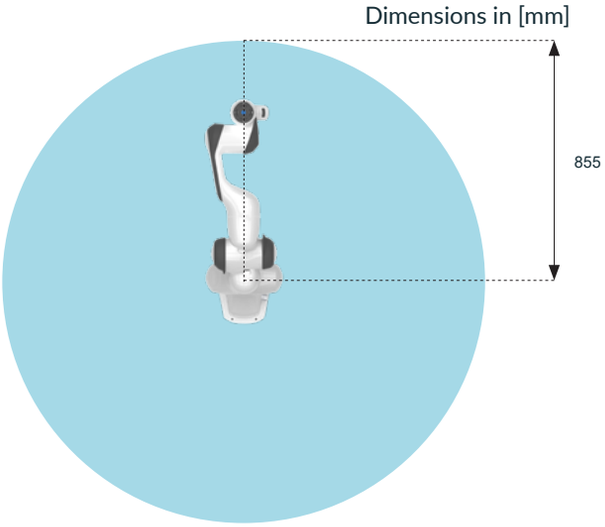
Operating space
Side view of motion range

Dimensions in [mm]

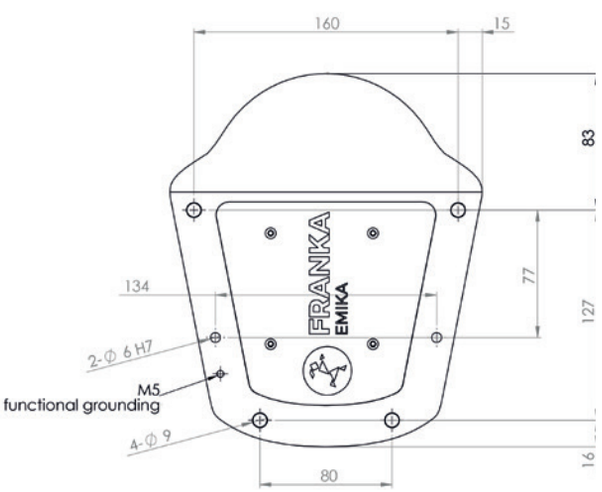


View from above

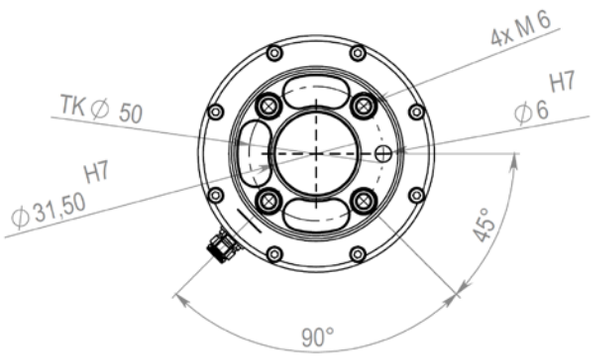
Dimensions in [mm]



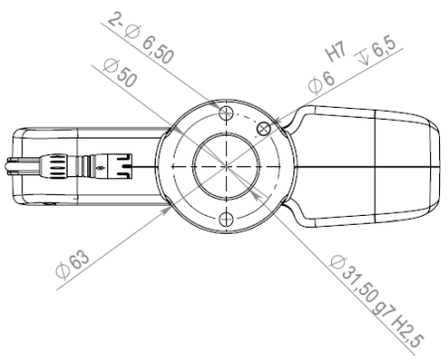
Footprint
View from below



Base of the Arm

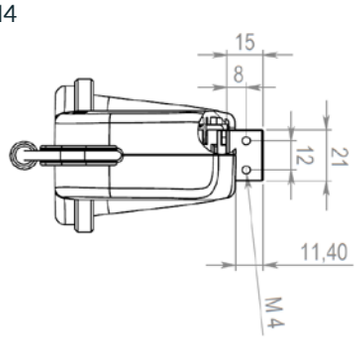


End effector flange



For optional mounting of the Hand to the end effector flange the following tools are required:

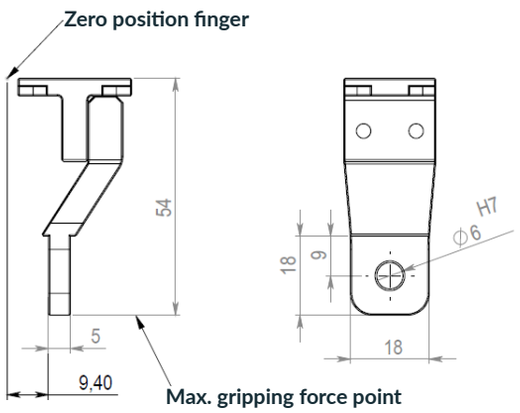
- Assembly material (included in scope of delivery of the Hand)
  - 2 x DIN7984 M6X12 ST 8.8 screw
  - 1 x ISO2338B 6X10 H8 A2 cylindrical pin
- Tools (not included in scope of delivery of the Hand):
  - Hex key, size M4



Interface Hand to fingers

SPECIFICATION

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.

Mechanical data of Hand

The following 4 data sets are to be set in Desk, as soon as the Hand has been attached to the Arm.

e.g. at the Arm's start up: for more information, see chapter: Start-up

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]

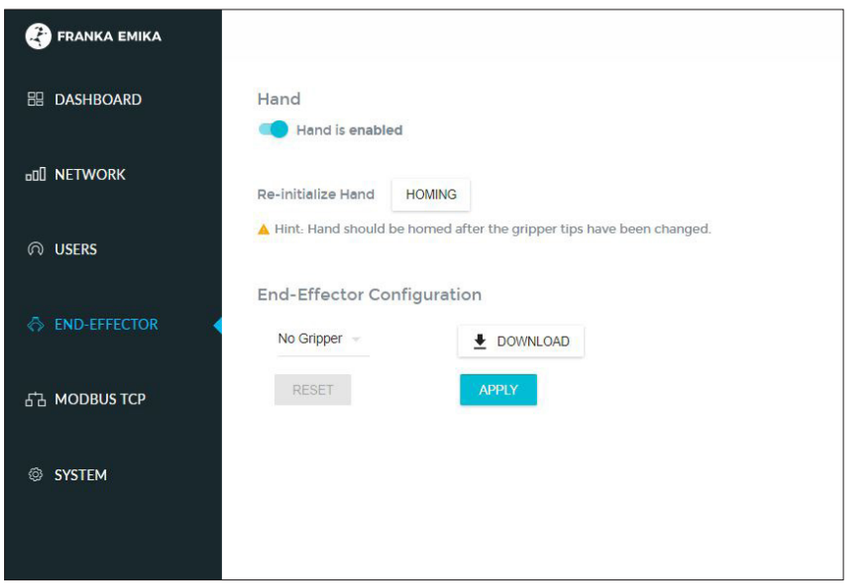
0.001	0	0
0	0.0025	0
0	0	0.0017

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

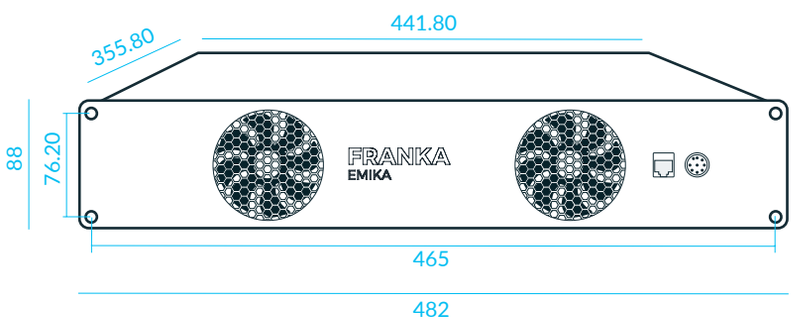
If no end effector is used, “No Gripper” is to be selected.

System settings without use of end effector



in millimeters

Control dimensions



see chapter: Correct Site of Installation/ Ambient conditions.

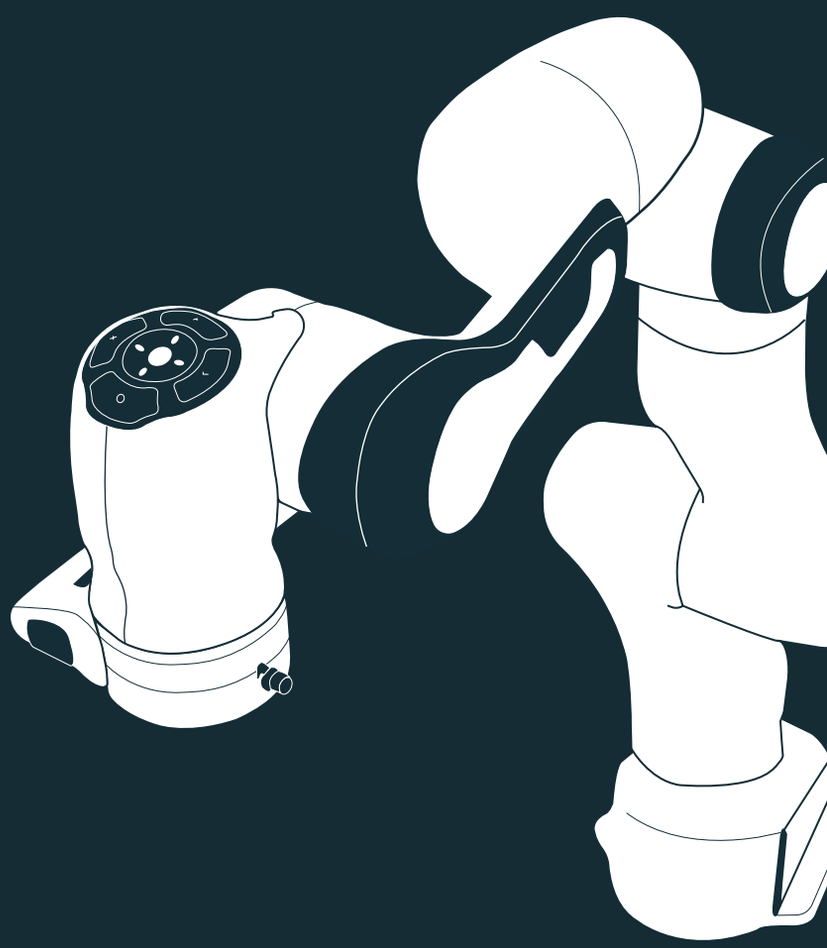
Ambient conditions

Arm, Control and Hand are manufactured in a production company certified according to ISO 9001 in Germany

Production standard

PRODUCT CONFORMITY

- Declaration of Incorporation
  - Control with Arm
- Declaration of Conformity
  - Hand
- Further statements



PRODUCT CONFORMITY

Declaration of Incorporation

Control with Arm

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: *Controller*, *Arm*, *Emergency-Stop Device*
Modell/Type:
Controller (#75674215) in combination with *Arm* (#73681342) and *Emergency-Stop Device* (#78456374)

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; 1.2.5; 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

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 1037:1995+A1:2008	Safety of machinery - Prevention of unexpected start-up
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 12100:2010 ISO 12100:2010	Safety of machinery - General principles for design - Risk assessment and risk reduction
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
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
01.06.2018

Dr. Simon Haddadin, CEO

Declaration of Conformity

Hand

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!

Further statements

Further Information

status: 04.05.2018 Panda

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.

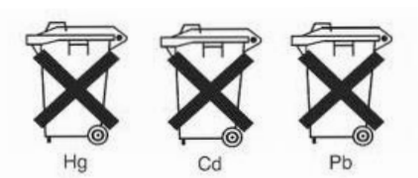
WEEE Directive:

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:

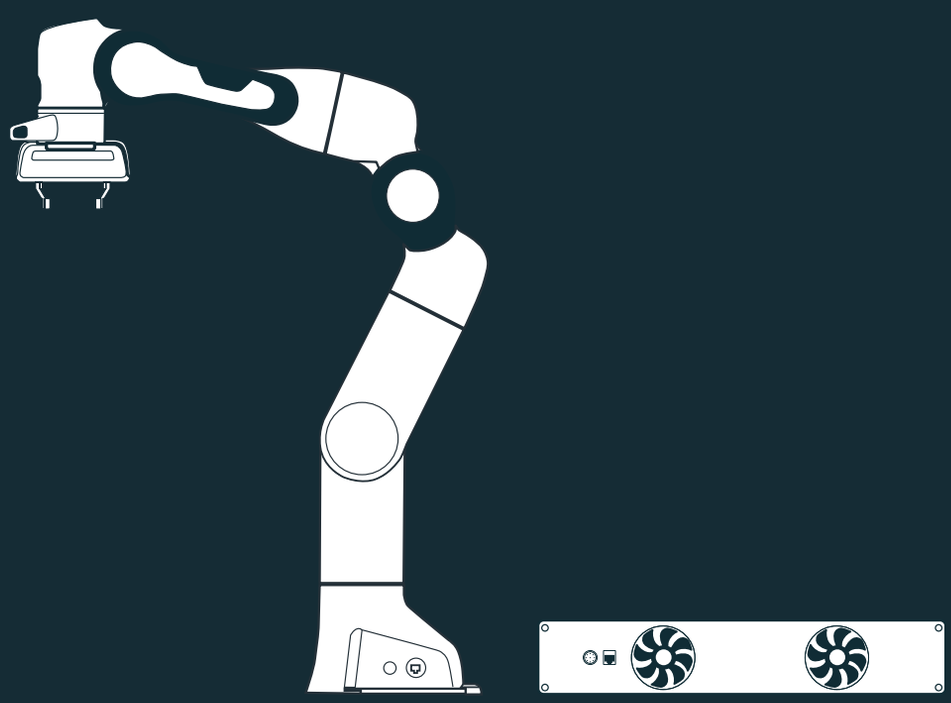
The product *Control* contains a BIOS battery.

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
  - Arm and Hand
  - Control



CORRECT SITE OF INSTALLATION

Ambient conditions: Arm and Hand

Permissible conditions at site of installation

Site of installation

- indoors, in enclosed buildings
- not exposed to direct sunlight
- no vibrations
- no magnetic fields

Type of installation

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

Protection class

- Arm: 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
- Hand: 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

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

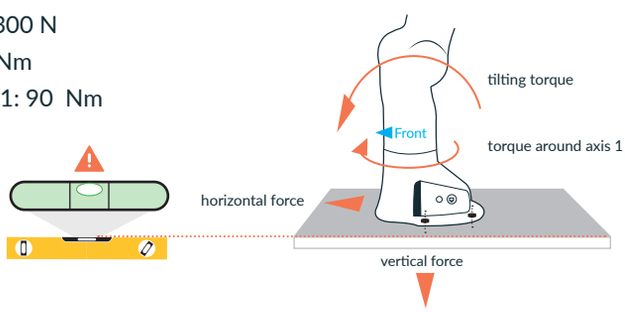
- <= 2000 m above sea level

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
- horizontal 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!

WARNING

If the Arm is installed on moving, instable ground, this may cause malfunctions and unexpected movements of the robotic arm or cause it to fall. This may lead to severe injuries.

Therefore:

- 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, vibrations are not permissible
- When used in earthquake-prone areas this needs to be considered during the 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!

CORRECT SITE OF INSTALLATION

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 magnetic fields

Type of installation

- device can be installed vertically and horizontally to the earth's surface
- 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

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:

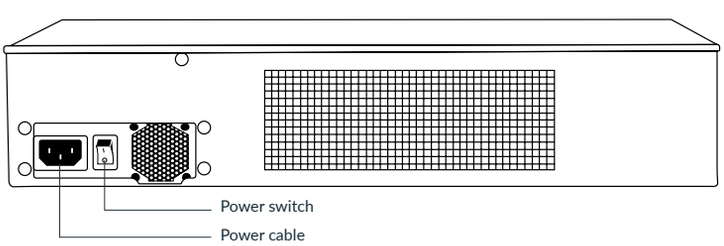
- <= 2000 m above sea level

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 emergnecy stop device (#78456374), mains needs to be protected with a max. 10A fuse.

Switch for disconnecting from the power supply

The power switch for disconnecting Panda from the mains supply is located at the back of the Control next to the connector port for a power cable.



Energy consumption

Panda requires on average < 300 W for standard operation. Temporarily, electrical power of up to 600 W can be drawn from the mains.

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 Panda will not lead to an overload of the electrical installation
- make sure that overload protection devices are installed accordingly

CORRECT SITE OF INSTALLATION

NOTICE

If a fuse in the upstream power supply of the Control blows, Panda is disconnected from the power supply. The Arm reacts with braking as much as possible before the fail-safe locking bolts catch in the 7 axes. If the residual energy is not sufficient to bring the Arm to a full stop, the locking bolts may damage the Arm.

Therefore:

- the mains fuse is to be selected accordingly

Adequate ventilation

NOTICE

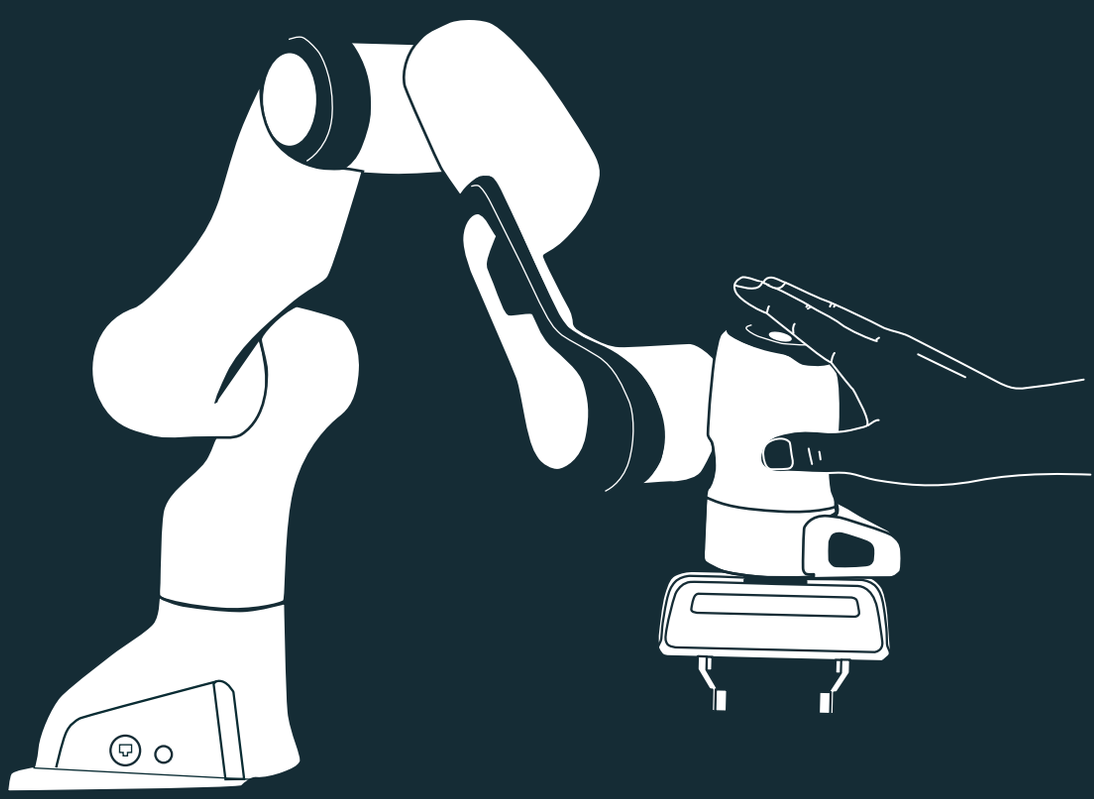
The Control contains power electronic components and modules (electric drives, CPUs, etc.) which heat up depending on the stress the device is subject to. An internal, active ventilation system sucks in air from the environment and channels it through the casing of the Control.

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

SAFETY CONCEPT

- Staff
- Dangers that Panda may present
- Hazardous and safe areas
- Emergency stop installation
- Stopping mechanisms
- Fail-safe safety locking system
  - Manually moving the Arm in case of emergency
- Operating modes of Panda
  - Teach Panda a task
  - Step back & check - Check whether the task is being executed correctly
  - Let Panda run a task
    - Run your task - automatically
    - Run your task - collaboratively
- Carrying out a risk analysis
- Practical tips for usage and positioning of Panda
- Labeling on the equipment



SAFETY CONCEPT

Staff

All persons working with Panda have to have read and understood the documentation, in particular the chapters on safety. Users need to be able to comprehend any risks the robotic system may present and be prudent in their behavior. Furthermore, it is to be ensured that users always pay attention and are aware of potential dangers.

WARNING

Persons using Panda 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 Panda under the influence of drugs, alcohol or medication impacting your reactions.

Operator	see chapter: Legal Framework

Persons handling Panda or parts of it need to have received: • Training for handling sensitive devices	Transport and logistics
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 User Handbook	Installation
Cleaning may only be carried out by trained users. For information on the correct cleaning, see chapter: Maintenance, Service & Support	Cleaning staff

In this regard, we refer you to the Franka Academy where relevant courses are offered.
https://www.franka.de/training

SAFETY CONCEPT

Dangers that Panda may present

Abstract of possible dangers

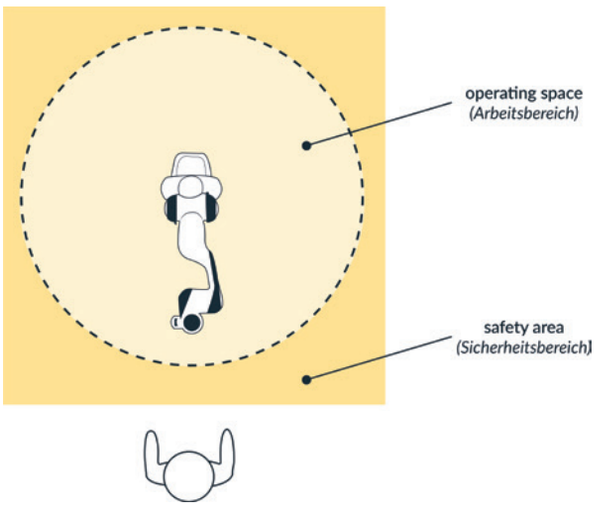
WARNING

An extensive but not definitive list of dangers that generally may be presented by a robot system can be found under ISO 10218-1:2011 ANNEX A. respectively ANSI/RIA R15.06. Special attention will be drawn here to the following dangers that Panda 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 (operating area, objects in the operating area)
    - 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 (operating area, objects in the operating area)
    - 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 Panda with damaged supply cables or incorrect electrical installation
- Environmental hazards
  - Crushing, shearing, impact, puncture, penetration
    - by falling caused by an earthquake
    - by unexpected movements of the robot caused by earthquakes
- Combined hazards
  - Crushing, shearing, impact, puncture, penetration
    - by unexpected movements of the robot

Hazardous and safe areas

Classification of areas



Distinction of the different areas:

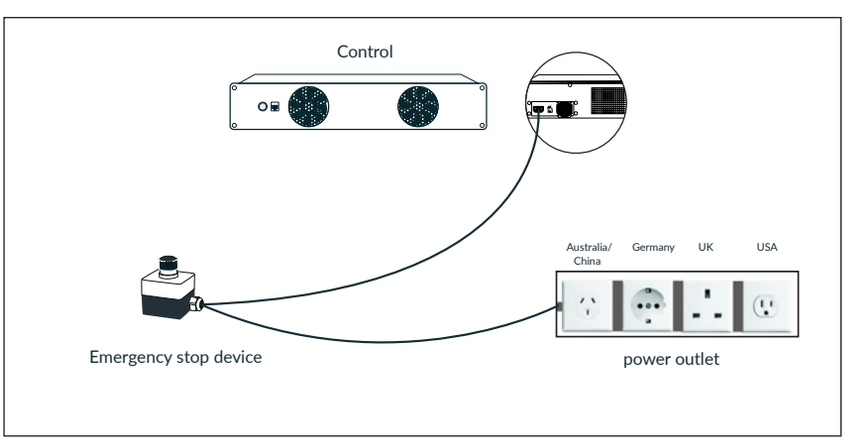
- Operating Area: the area in which the Arm executes its task. The Operating Area in this case corresponds to the Hazardous Area.
- Safety Area: an area in which humans are separated from a hazardous area by constructive or protective measures (e.g. by a safety fence).

Emergency stop installation

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, EN 418 and related).

The primary emergency stop system must safely separate the Control from the mains power supply. One potential version is the Emergency Stop Device contained in the optional Panda package. As soon as the power is disconnected, the fail-safe safety locking bolts of all 7 axes instantly block further movements of the Arm.



SAFETY CONCEPT

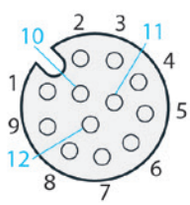
Stopping mechanisms

The emergency stop is designed for emergencies and should not be used as the habitual on/off switch for the machine. The emergency stop device must be activated at start-up and checked for function at least every 12 months.
In order to avoid damage being caused to Panda, the emergency stop system must always be tested while at standstill. It should be noted, that when disconnecting from the power supply the safety bolts will catch in all 7 joints and the robot will sink a little due to gravitational force.

There are three ways of bringing Panda into a stopped condition:

- If constructional measures have been implemented to prevent persons from entering Panda's Saftey Area the external activation device (connected to X3 at the base) is used for activating and deactivating Panda. Deactivation means here that the Arm is decelerated and brought to a full stop in the condition of "monitored stop" (stop category 2 according to IEC 60204-1). Then Panda will glow white and the Safety Area can be entered.
- If Panda is to be brought into "monitored stop" upon deactivation of a safeguard (e.g. opening of a safety fence), this safeguard is to be connected to the female connector X3 instead of the external activation device (stop category 2 according to IEC 60204-1).
- If Panda is to be stopped as quickly as possible, with the power to the axes being cut off and the locking bolts locking the Arm mechanically, the safeguard can be integrated between Panda's Control and the mains power supply. This will ensure that a deactivation of the safeguard (e.g. opening of a safety fence) will cut off the power supply to the Control (stop category 0 according to IEC 60204-1).

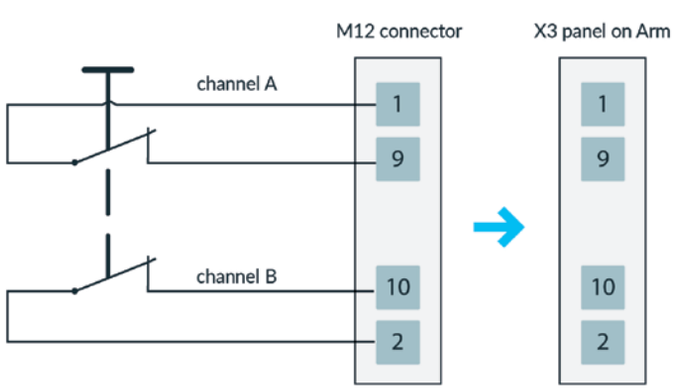
Wiring example for X3



Pinning of the X3 socket using wiring example:

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

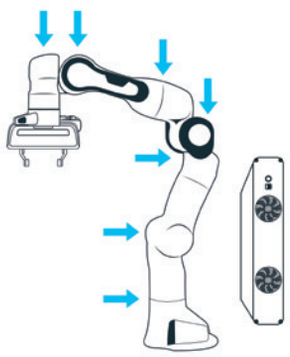
pin	signal
1	Ap
2	Bp
...	...
9	An
10	Bn



Fail-safe safety locking system

When the Arm is disconnected from the power supply locking bolts automatically catch in all 7 axes of the Arm. They mechanically lock any movement 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 particular at those joints on which gravitational force comes into effect. This should be taken into consideration.

Safety locking system



Manually moving the Arm in case of emergency

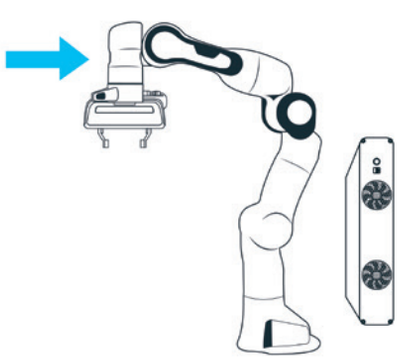
There are several possibilities to move the Arm even without a power supply in case of emergency. They are listed below in order of criticality of the hazardous situation:

- 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: loosen the screws attaching the Arm to the base

Moving the Arm without electrical power

SAFETY INSTRUCTION

In case of acute mortal danger, the Arm needs to be immediately pushed or pulled out of the dangerous position manually.



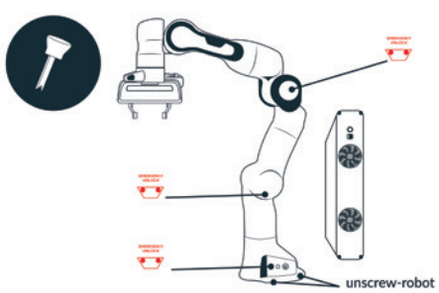
Action:
Pushing away manually

SAFETY CONCEPT

Action: Emergency unlock

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. 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 segments below it can be moved manually.

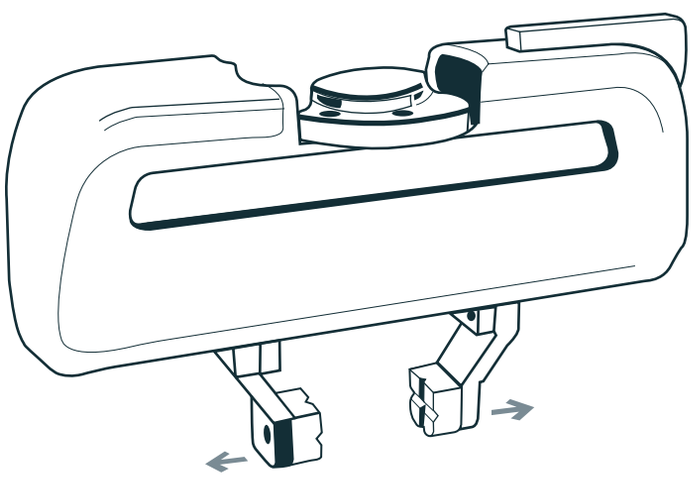


Action: unscrewing of the manipulator from the fundament

Jamming of the Arm can also be remediated by loosening the screws attaching the Arm to the fundament.

Moving of fingers without electrical power

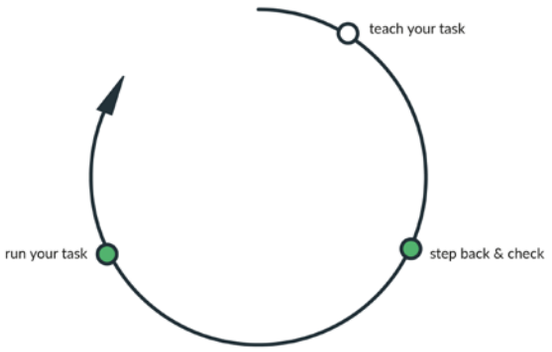
When the device is turned off, the Hand is not supplied with power either. A jamming between the fingers of the Hand can be loosened by simply pulling the finger open.



SAFETY CONCEPT

Operating modes of Panda

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 Panda a task, by taking the Arm by the hand
- step back & check: then step outside of the Safety Area and check whether the taught task is correctly executed
- run your task: once the task has been learned, Panda can execute the task autonomously

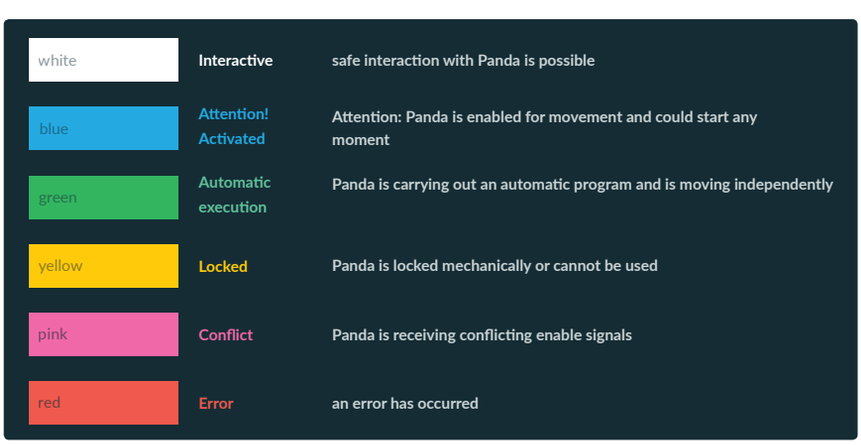
Operating states

- After the Control has been switched on, or supplied with energy, Panda boots up. In this process, the safety locking system is activated, movements are thus locked mechanically. The display lights on the base and the pilot flash yellow.
- As soon as Panda 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”. Panda 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, Panda is lit white continuously.
- Should the buttons be released, then Panda 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 Safety Area. If the external enabling device is half-pressed now, Panda is activated and is lit blue. Now, the Play button in Desk can be pressed, for example, and an automated program started. As a rule, during this Panda is lit green.
- In case of error, Panda turns red.

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, during other processes the lights will glow continuously in the corresponding color of the status Panda is in. In addition, there is a circular status light in the middle of the Pilot’s Disc. Its color also indicates Panda’s status. When a user 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 Panda requires attention or a user input, the Pilot will flash in the corresponding color.



SAFETY CONCEPT

Teach Panda 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 conditions:

- Emergency Stop device must always be installed within easy reach

Preconditions for operations:

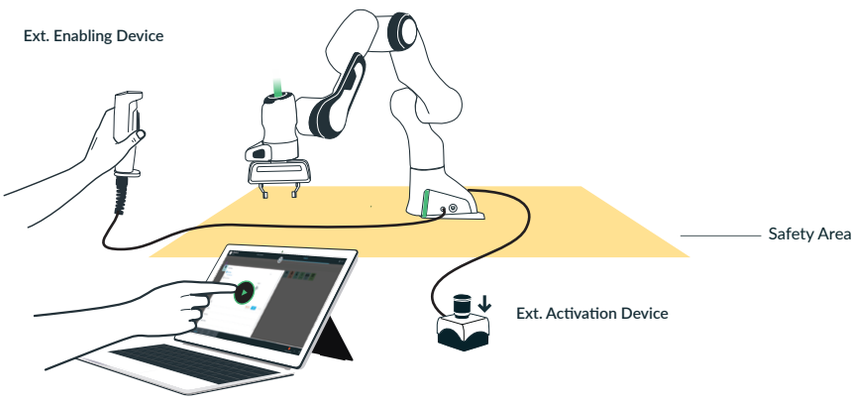
- the Control must be switched on and booted up
- the safety locking system must be unlocked (by clicking “unlock joints” in Desk)
- Emergency Stop must be in open position
- X3 – inputs
  - In this status no device needs to be connected to X3
  - The external activation device can however be connected 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: De-activation of the Arm
  - half pressed down: Arm activation
  - completely pressed down: De-activation of the Arm
- in addition, the guiding button must be pressed continuously.

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

Step back & check - Check whether the task is being executed correctly

Brief description

After teaching a robot movement you usually want to check the learned movement. To do this, step back outside the Safety Area. Using the external enabling device, you can activate the robot for movements. Do this only if your full attention is directed to the pending robot movement (awareness). If you determine any abnormal behavior during the running of the automatic robotic movement, then use the external enabling device to stop the robot's movement. 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.



Safety operation:

Preconditions

- Emergency Stop must always be installed within easy reach
- The user has left the Safety Area (step back)
- the user must check, that no other persons are in the Safety Area.
- the user must direct his full attention to the pending robotic movement (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 movements
- X3 – Inputs
  - in this state no device needs to be connected to X3
  - the external activation device can, however, be connected to X3. 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 movement of the Arm be executed, e.g. using the play button in Desk.

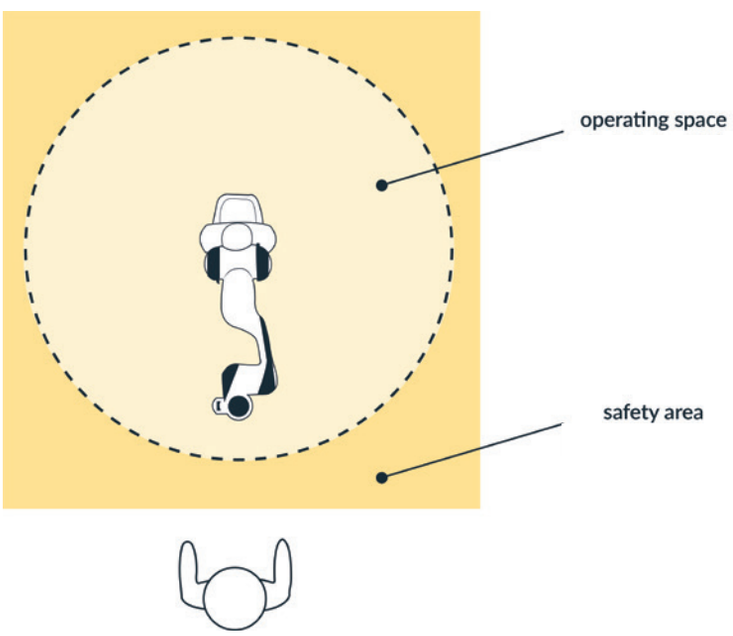
SAFETY CONCEPT

Let Panda run a task

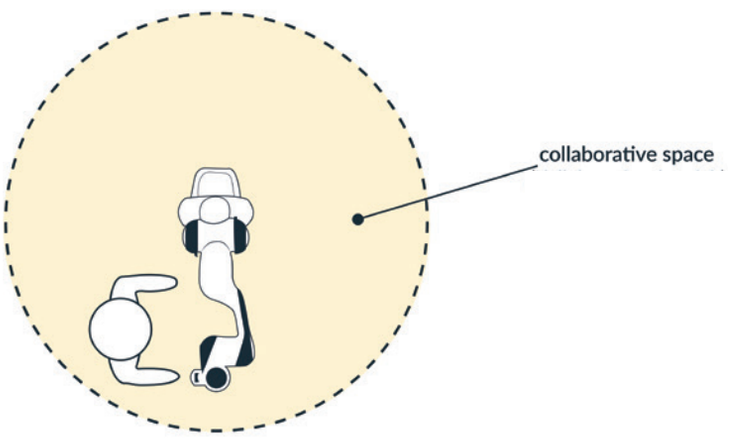
Brief description

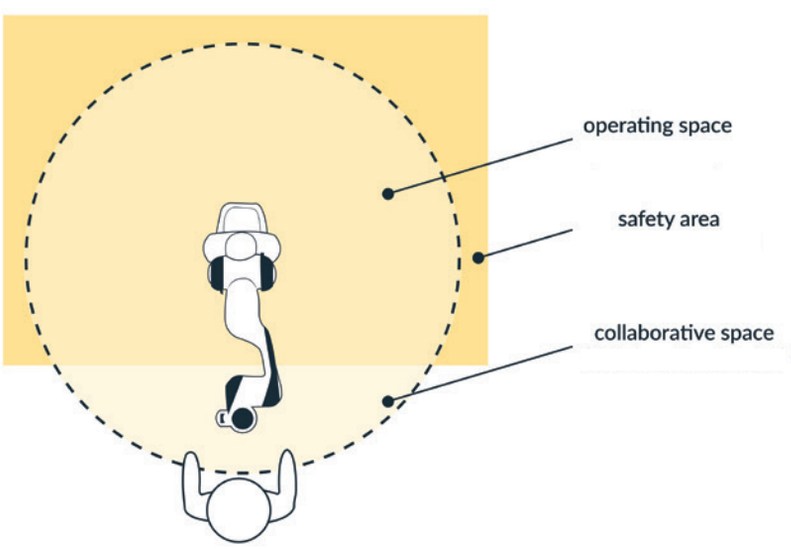
After Panda has learned and mastered its Tasks, they shall be executed autonomously. This can be done in two ways:

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



- interactively/collaboratively
  The risk assessment has shown that the Task can safely be executed collaboratively. Collaboratively means that there is a shared operating area, which both the Arm and a person can enter. During collaboration the entire operating area or the larger part of it is only very rarely used by the robotic arm and a person at the same time. This means that only a small part of the operating area is shared. In addition, this common operating area is usually rarely used by human and robotic arm at the same time. In this case any danger presented by the Arm is limited and therefore easier to take into account.





SAFETY CONCEPT

Run your task - automatically

Brief description

As soon as the system performs a Task repeatedly it needs to be ensured that no persons enter the Safety Area of the robot arm and are harmed as a result. Safeguards can be installed around Panda to prevent access to the hazardous area (e.g. a safety fence with access monitoring, safe laser scanners or similar safeguards). This operating mode corresponds to “automatic mode” as described in EN ISO 10218-1:2012 respectively ANSI/RIA 15.06.

Preconditions

Safety conditions:

- the operator must ensure by means of adequate installation, that no person lingers in the hazardous area of the robotic arm
- installation of safeguards (e.g. safety fence with access monitoring, safe laser scanners,...) must be so configured and connected to the base (X3), that any entry of the Safety Area is safely recognized. Panda then switches to “monitored stop” status and can again be guided by hand (taught).
- the Safety Area 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 External activation device must be connected and activated - OR: an external safeguard (e.g. a safety fence with access monitoring, safe laser scanner or similar) has to be connected to X3 at the base and activated

--> only then, for example, can a movement 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 Safety Area.

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), Panda signals with the color pink.

Run your task - interactively

Brief description

Panda makes safe functionalities and additional features available. These may be used in order to create interactive working situations, if this is allowed by the risk analysis run by the customer.

Safe functionalities:

Emergency stop device

Activating the emergency stop device will, if installed correctly, cut the power supply to Panda. All movements of the robot are thereby locked mechanically.

Safety locking system

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

Monitored stop

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

Teaching/Guiding

Enabling/deactivating Panda using the two buttons on the grip will safely activate/deactivate Panda. 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”).

Activation during step back & check

The user is responsible for stepping out of the Safety Area. The system is activated as soon as he keeps the external enabling device half pressed. Now the user can trigger a robot movement 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

You can either connect the external activation device or a safeguard to the female connector X3. The user is responsible for stepping out of the Safety Area. Panda is activated as soon as the user brings the external activation device to the activated state. Now the user can start a robot movement 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”).

SAFETY CONCEPT

Preconditions

Safety preconditions:

- Emergency Stop must always be installed within easy reach
- a risk analysis must have been carried out on the part of the customer - and the results must enable interactive/collaborative work
- the user must direct his full attention to the pending robotic movement (awareness)

Operating preconditions:

- the controller must be switched on and booted up
- the safety locking system must be unlocked (by clicking “unlock joints” on Desk)
- Emergency Stop must be in the up position
- the external activation device must be connected and in the up-position
  --> only then may the robotic Arm be operated interactively/collaboratively

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 movements 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 movements mentioned can lead to risks of crushing, shearing, impact, puncture or penetration and may cause severe injury.
Therefore:

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

Additional features

Franka Emika is continuously working on developing Panda further. The features listed below have not yet been entirely assessed as to their safety. You can therefore not rely on their availability and functioning. This needs to be taken into consideration during a risk assessment carried out by the customer. The features listed below are either preconfigured by default or can be selected additionally.

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

Carrying out a risk analysis

If you can answer all questions on the CE check list with “yes”, you can start using Panda straight away without performing an own risk assessment. Please use the delivered quick guide for installing Panda. Then you can start using Panda straight away.
If you have not purchased a Panda CE out of the box solution or have answered some questions on the CE check list with “no”, our CE assessment according to the Machinery Directive is not valid. You will therefore have to carry out the risk assessment yourself and implement the necessary measures before being able to use Panda.

In this case the operator is responsible for carrying out a risk assessment based on the contents of this manual according to the corresponding standards before using Panda.
Franka Emika recommends carrying out a risk analysis in accordance with the Machinery Directive and thereby take into consideration the hazards list from ISO 10218-1:2011 ANNEX A (the C standard for robots), in addition to the measures of 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.

Practical tips for usage and positioning of Panda

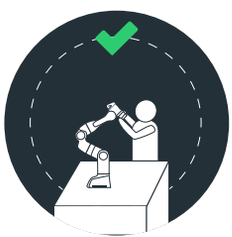
The following information on how to use and place the Arm are practical tips and may not be exhausitive when it comes to concrete application. They do not replace a risk assessment but may suggest layout options.

SAFETY CONCEPT

Free space for retracting

WARNING

Humans instinctively retract from unexpected movements. This is why the area in which the user 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.

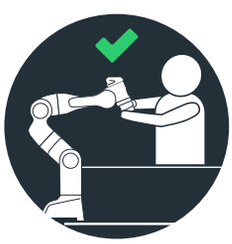


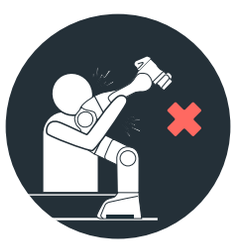
Greatest possible distance to the Arm

WARNING

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

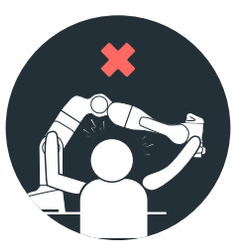
RIGHT WRONG





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 operating area and NO pointed objects!

NO unnecessary objects in the operating area

Ergonomic position for teaching:

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

Clothing, hair and jewelry

WARNING

WRONG WRONG RIGHT

WRONG WRONG RIGHT

DO NOT wear long hair loose, tie it up!

DO NOT wear loose clothing or clothing with ribbons!

NO loose jewelry such as necklaces or bracelets!

Eye protection

WARNING

Dependent on the fingers in use on the Hand and those objects for grasping, the following applies: if the fingers or the objects have a diameter of less than 5cm (and thus be able to injure the eyes), during interactions with Panda (teaching, interactive work) protective goggles are to be worn.

SAFETY CONCEPT

Labeling on the equipment

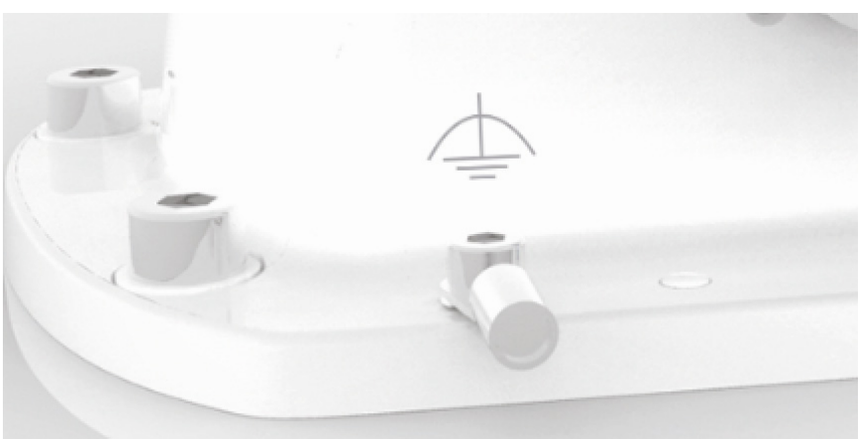
Name plate: Arm

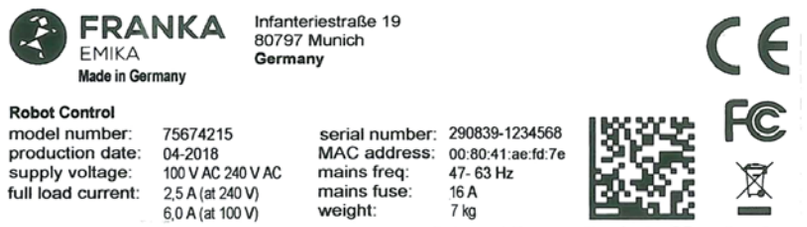
Emergency unlock label on Arm

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 safety locking manually in case of emergency.

Functional earth label on Arm

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

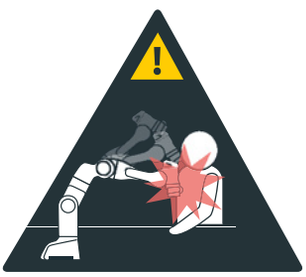




Name plate: Control

Name plate: Hand

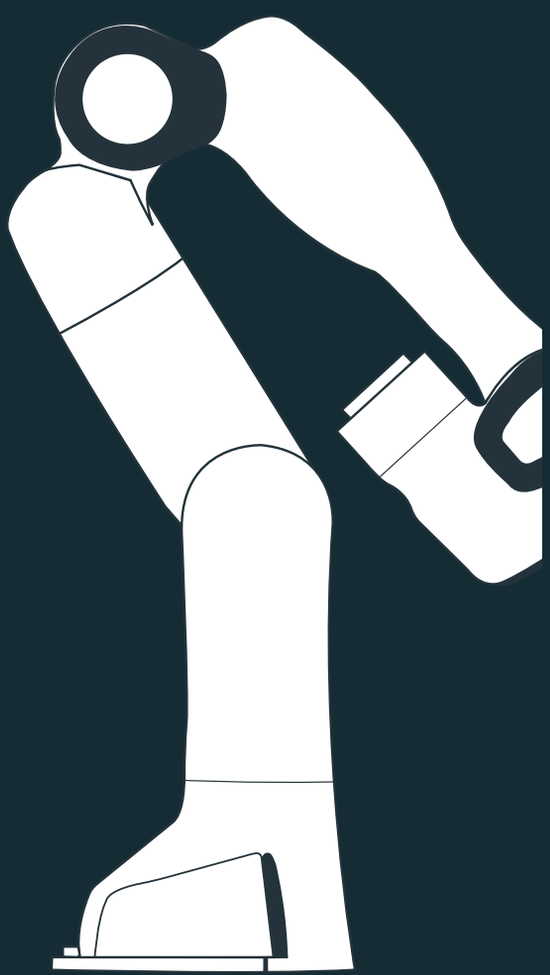
Name plate:
Emergency Stop Device



Safety label: Arm

DELIVERY AND TRANSPORT

- Delivery & transport
- Handling & lifting



DELIVERY AND TRANSPORT

WARNING

The Arm weighs approx. 18kg, the Control approx. 7kg, the Hand approx. 1kg. 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 perfect condition. Damaged components can, for example, cause electrical risks and may lead to severe injury.

Therefore:

- Check if the packaging is in perfect 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 (e.g. 'disabled' label). In cases of doubt, contact the manufacturer.

Delivery

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

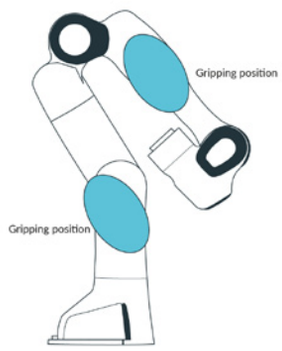
Transport pose

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: Specifications/ Technical Specification.

- Furthermore, we offer a function in Desk for bringing the Arm in transport position with one click.
- 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 mounted 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 components. This slipping causes decalibration and damage to the Arm.

NOTICE

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

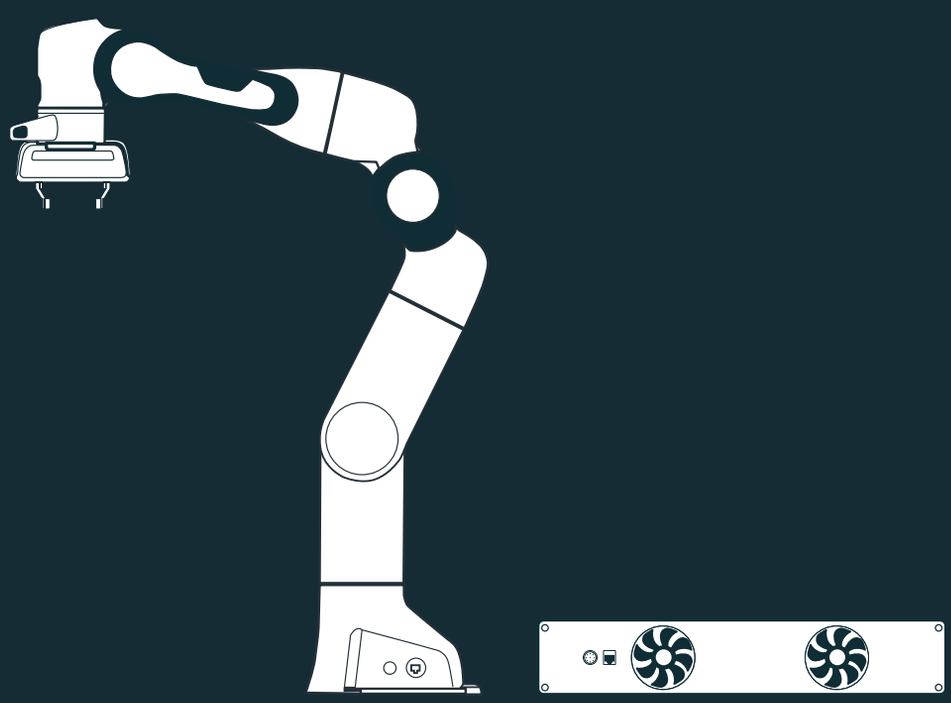
The Arm and Hand contain sensitive electromechanical components. These can be damaged if the Arm is moved to adopt the transport position while the end effector is still attached! Furthermore, when moving into transport position, objects in the operating area of the Arm may be damaged.

Therefore:

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

MOUNTING & INSTALLATION

- Preparing the installation site
- Unpacking Panda
- Mounting the Arm
- Mounting the Hand
- Unpacking and mounting the Control
- Wiring and electrical installation



MOUNTING & INSTALLATION

Preparing the installation site

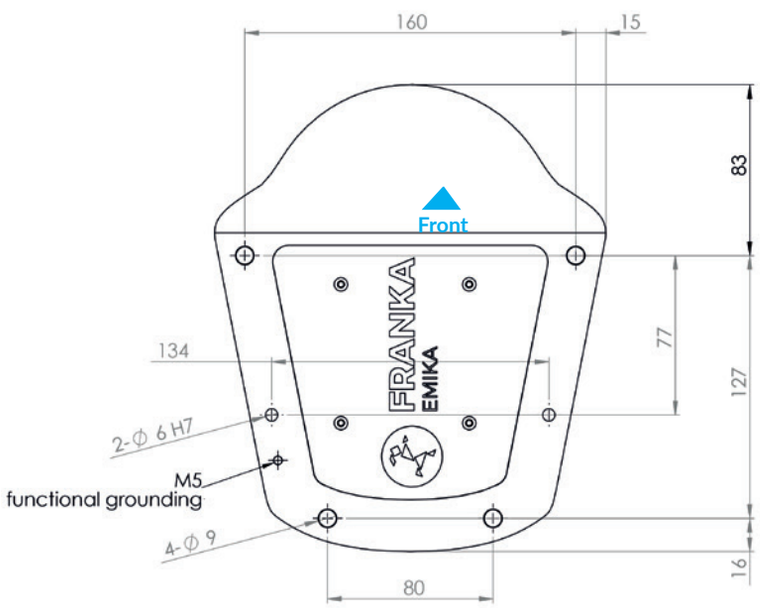
Correct site of installation

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 drilling template 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.



Unpacking Panda

Dead weight

WARNING

The Arm weighs approx. 18kg, the Control approx. 7kg, the Hand approx. 1kg. 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:

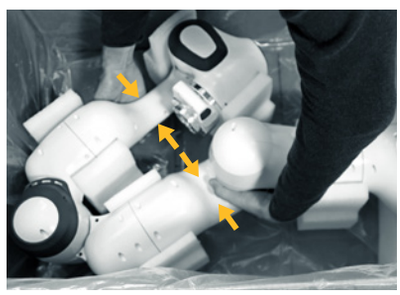
- Always wear personal protective equipment (e.g. safety shoes), when transporting mounting or demounting these devices
- The devices must be placed such as to prevent tilting or sliding
- When lifting and handling the equipment, always ensure correct lifting (from the knees and not from the back)

Unpacking

- Carefully open the box by removing the sealing adhesive strips on top of the cardboard box.
- Open the foil coating.
- Take out the quick guide 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 & INSTALLATION

- First carefully remove the foam layer that is surrounding the Arm.
- Than 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 mounted 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 components.
  This slipping causes decalibration and damage to the Arm.

NOTICE

The Arm and Control contain sensitive electromechanical components. These can be decalibrated or damaged by 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, the Control approx. 7kg, the Hand approx. 1kg. 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, e.g. using 4 previously prepared screws
- 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

Mounting the Hand

Mounting of gripper

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!)
- with the above noted screws the screw depth is 8mm. This must not be exceeded!

Notice: fix the hand with the 2 x M6x12 screws (never use any other type of screw!) and use 5Nm of torque

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

WARNING

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

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)
- Note that the standard length of the connection cable is 2.5m!

NOTICE

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

Adequate ventilation

Wiring and electrical installation

WARNING

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

Therefore:

- Only use Panda when in perfect 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.

Perfect condition

WARNING

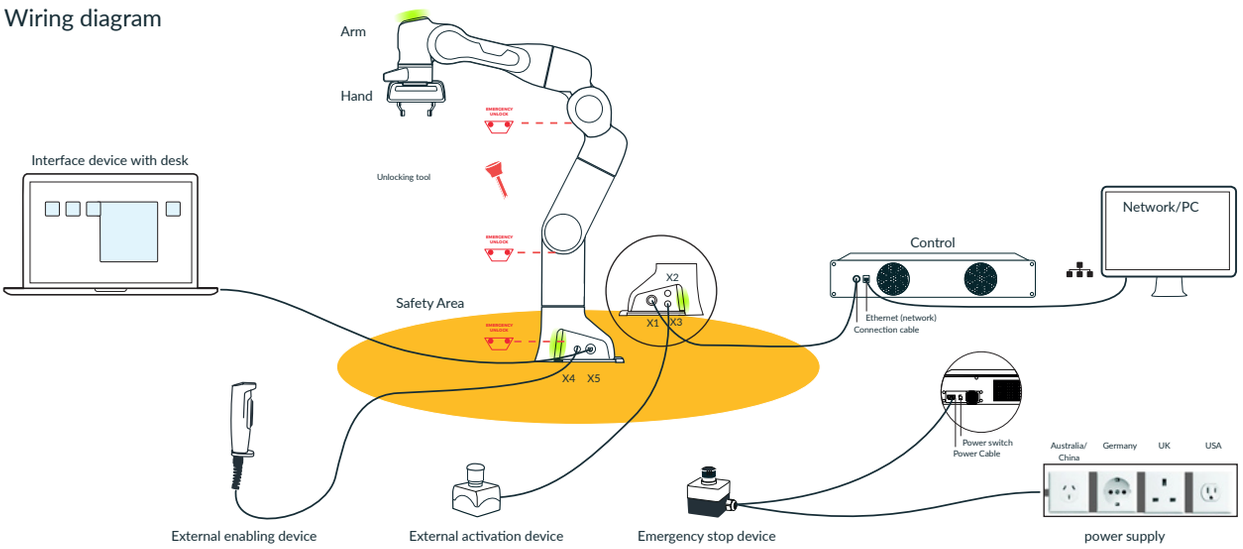
Badly laid wires and cables can present obstacles in the operating area and cause a user to trip and fall.
Therefore:

- Always lay cables safely

Risk of falling

MOUNTING & INSTALLATION

Wiring diagram



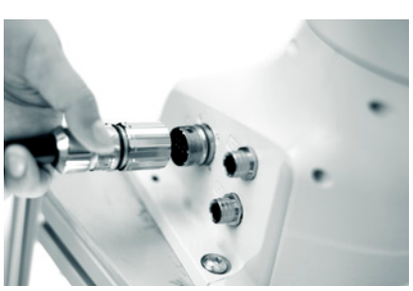
Connecting the functional earth

- Connect the functional earth to the base of the Arm at the indicated position.
- 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.

Connecting the Hand to the power supply

- 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!

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 user.
- Make sure that the external activation device is closed.

Connecting your operating device (for operation via Desk)

To operate Panda 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

Connecting to network - optional (e.g. for use of the FCI)

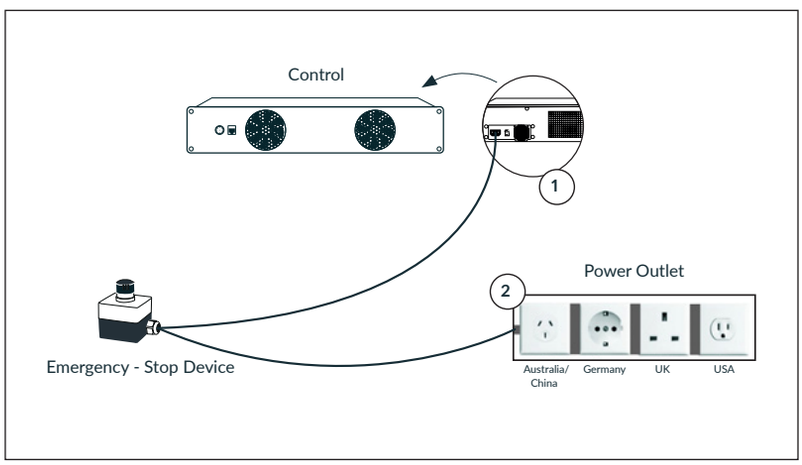
Optionally:

- 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 Panda via the FCI programming interface

MOUNTING & INSTALLATION

Emergency Stop Device

- The emergency stop system is to be installed according to the relevant rules of the technology (e.g. European standards EN 60204, EN 418 and related)
- The emergency stop system must safely disconnect the supply from Control
  - One possibility of using the emergency stop system is the installation of an emergency stop device, as it is included in the scope of delivery in some Panda packages. This device is installed between Panda's Control and the power supply.



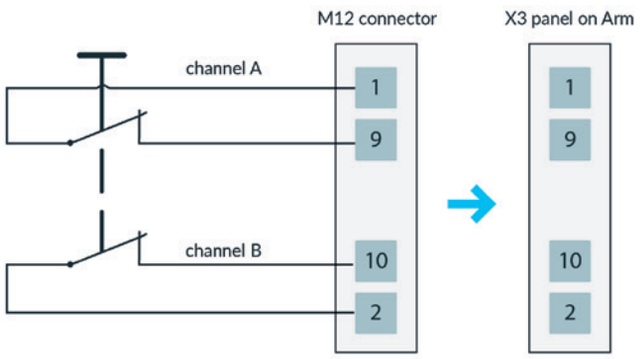
- In this process, ensure that the power switch at the Control is switched off (position 0)
- Insert the Emergency Stop device with the cold-device plug first into the Control and then connect the Control with the power supply (100-240V/47-63Hz frequency)

If Franka Emika's emergency stop device (#78456374) is used to take the power from the system (e.g. to do installation work within the Safety Area), always check in addition that the fail-safe safety locking system is activated (the Arm can be slightly moved within the safety bolts by sensitive motions), or disconnect the connection cable between the Arm and the Control.

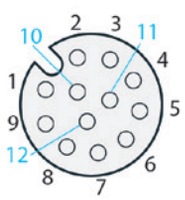
Protective devices

- Should you wish to connect an external protective device (such as, for example, a protective screen with access monitoring), then instead of the external activation device at X3, connect this as shown in the following section
- Should the activation signal be interrupted during automatic operation this will lead to an immediate stop of the Arm (it will then go into "monitored stop")

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



Connecting an external safety device to the Arm



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

pin	signal
1	Ap
2	Bp
...	...
9	An
10	Bn

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 cables before safely disconnecting Panda from the mains power supply
- never connect or disconnect the Hand, while Panda is not safely disconnected from the mains power supply

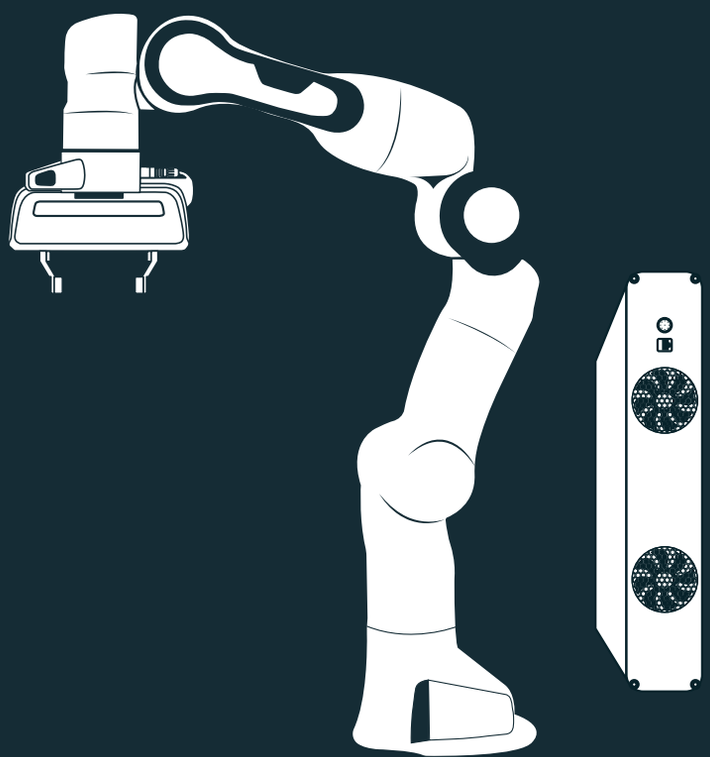
NOTICE

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).

START-UP

- Switching on
- Connecting a user interface device
- Software setup
- Guiding
- Testing the emergency stop system
- Switching off



START-UP

Switching on

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 perfect 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.

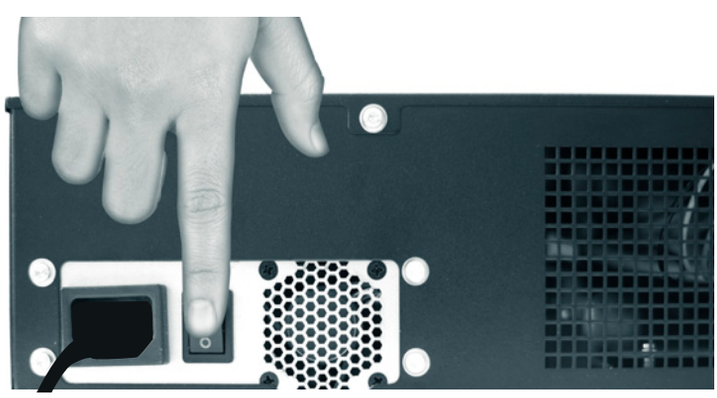
NOTICE

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

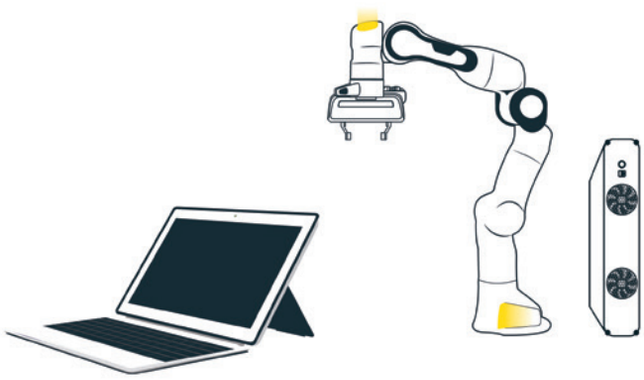
Switching on

Now you may switch on Panda 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).

white	Interactive	safe interaction with Panda is possible
blue	Attention! Activated	Attention: Panda is enabled for movement and could start any moment
green	Automatic execution	Panda is carrying out an automatic program and is moving independently
yellow	Locked	Panda is locked mechanically or cannot be used
pink	Conflict	Panda is receiving conflicting enable signals
red	Error	an error has occurred

Overview of the status indicators

START-UP

Connecting a user interface device

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

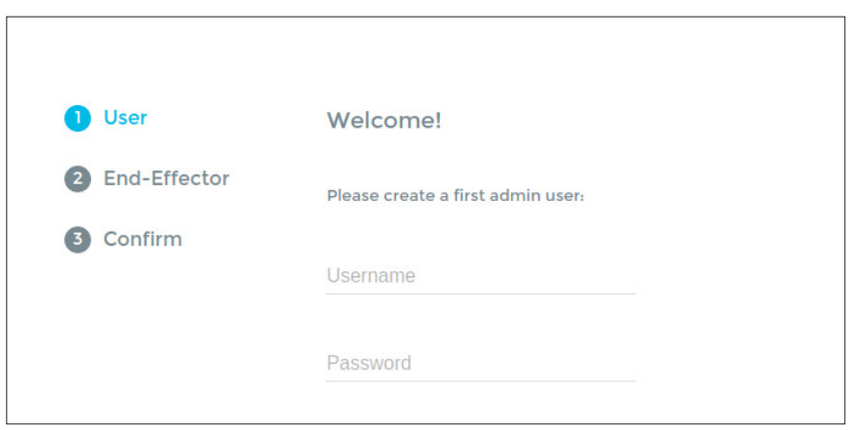
- To open the initial configuration interface, an interface device must be connected via Ethernet cable to the X5 connector on the base of the Arm (see in chapter: Mounting & Installation).
- The interface device must obtain the IP address automatically via DHCP.
- Once Panda has been switched on, the 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 Panda must have read and understood the documentation (in particular the chapters on safety), be able to comprehend any risks associated with the robotic system and act with adequate care. In contrast to a regular user, the admin has extensive rights to edit IT and safety settings of Panda! Please refer to chapter: Safety Concept/ Staff.

Configuring Panda

When first starting Panda 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

Procedure:

- Initially, an admin user must be created
- This step 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!

NOTE: You can also complete this step at a later point in time by carrying out the following steps:

- To create an admin: In Desk, click on the user name on the right-hand side of the header in order to open the administrator's interface.
- Then click "admin". In the submenu "users", 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 Panda only supports the following one:
    - **Admin:** no restrictions to authorizations. The admin can edit all parameters and create new Tasks.

WARNING

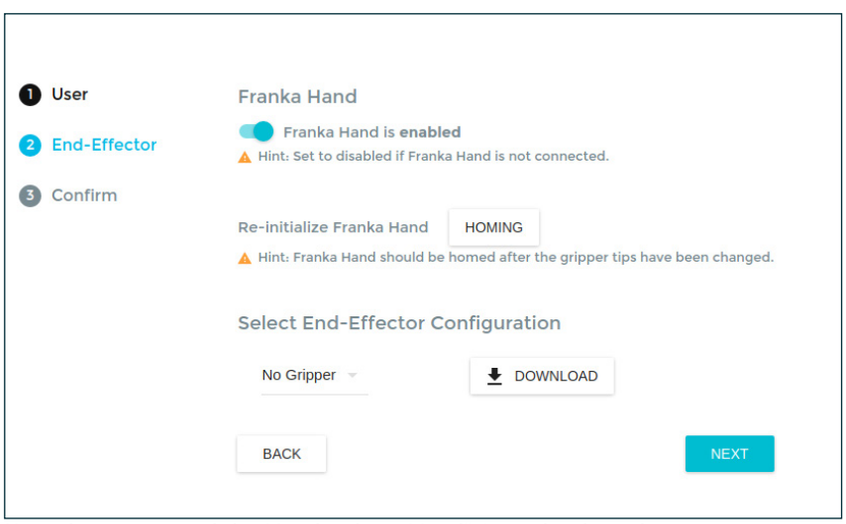
If the end effector is configured incorrectly, Panda will operate based on the wrong masses and mass inertia ratios of the end effector. This means that Panda will regulate to the wrong parameters and gravitational forces will not be entirely compensated. This can lead to unexpected movements during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

Therefore:

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

End effector configuration

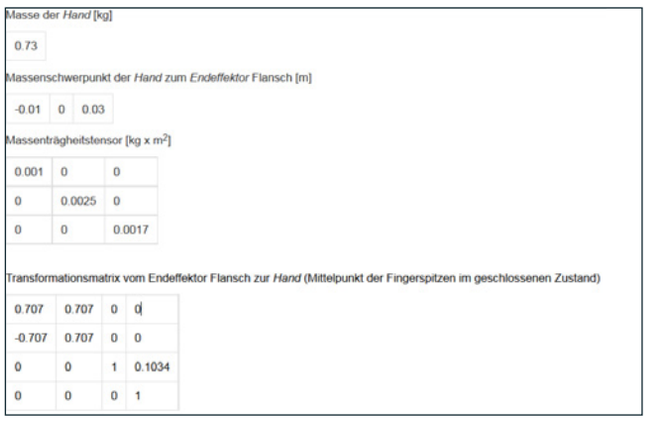
If you do not have a gripper, select „No Gripper“ from the drop-down. Keep the following DEFAULT setting:



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

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

The default settings of the Hand are as follows:



NOTE: 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 administrator'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 Panda. 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

Caution - when the "Homing" button is pressed or during initial installation, the gripper fingers open! Thereby grasped objects fall out of the gripper and may 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 gripper before startup, as "homing" has to happen after each time brakes are unlocked upon power up

Completing configuration setup

Once initial configuration has been completed and confirmed, Panda 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.

START-UP

Guiding

Please read the chapters: Safety Concept/ + /Interaction/Programming/ 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

SAFETY INSTRUCTION

Before you can move Panda, you must unlock the Safety Locking System.
Proceed in this case as before:

- ensure that the Emergency Stop is within easy reach for you
- If the external activation device is connected to X3 of the robot's base, then please bring it to deactivated status (pressed down)/correspondingly a connected Safetyguard must be on (e.g. opened protective screen).
    - Notice: if X3 is nevertheless activated during the unlocking, Panda will be enabled immediately after unlocking in automatic mode
- be now out of the Safety Area and make sure that also no other persons are within the Safety Area.
- click in Desk 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 Panda is now lit white.
    - Notice: if X3 is already activated, Panda is now lit blue and thereby signals, that an automatic program can be started.

WARNING

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

- Avoid sharp-edged or pointed objects whenever possible
- Please also read the chapter: Safety Concept/ Practical tips for usage and positioning of Panda.

CAUTION

Before entering guiding mode, check that the correct mass and center of gravity are set for the end effector, respectively the correct masses are set for other objects. If Panda 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 movement which makes the user 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.

Guiding

Now the Arm can be guided. To guide the Arm:

- half-press the Enabling Button on the grip and additionally press the guiding button. Panda 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 movements of the Arm to facilitate easy operation.

NOTICE

Panda allows you to switch guiding modes. They are used for limiting predefined movements 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 user by force, this can damage Panda.
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 Panda is lit, for example, “pink”, then Panda is receiving conflicting release signals and therefore does not allow itself to be led by hand.

START-UP

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: Safety Concept/ Emergency Stop Installation.

WARNING

The emergency stop also cuts off power supply to the Hand. 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 falling out of the gripper cannot cause any injuries (e.g. by wearing safety shoes)

Testing Emergency Stop

SAFETY INSTRUCTION

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

- Panda 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. Make sure that there is enough space for the Arm to sink to avoid causing damages. 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 Panda, 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 Panda. 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, Panda 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 Hand, 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 before activating the emergency stop. This will stop the robot movements more gently than the emergency stop system and will not activate the safety locking system.

Switching off

Shutting down

For switching off, be outside the Safety Area. Via the option “shut-down” in the sidebar of Desk the safety locking system is activated and Panda will be shut down.

Switching off

Disconnect Panda 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, Panda 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 Panda. Then simply reconnect it to a power supply and Panda will start to reboot again.

WARNING

The energy supply is also disconnected from the Hand. 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:

- it must be ensured that falling objects cause no injuries (e.g. wearing of protective footwear, etc.)

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 Panda. Place the Arm in a clear position (e.g. 200mm above stationary objects) before switching it off.

INTERACTING & PROGRAMMING

- Direct human-robot interaction
- Creating a task in Desk
  - Desk overview
  - An app for everything
  - Configuring apps
- Executing the task
  - Manual unlocking of Arm and Hand in cases of emergency

INTERACTING & PROGRAMMING

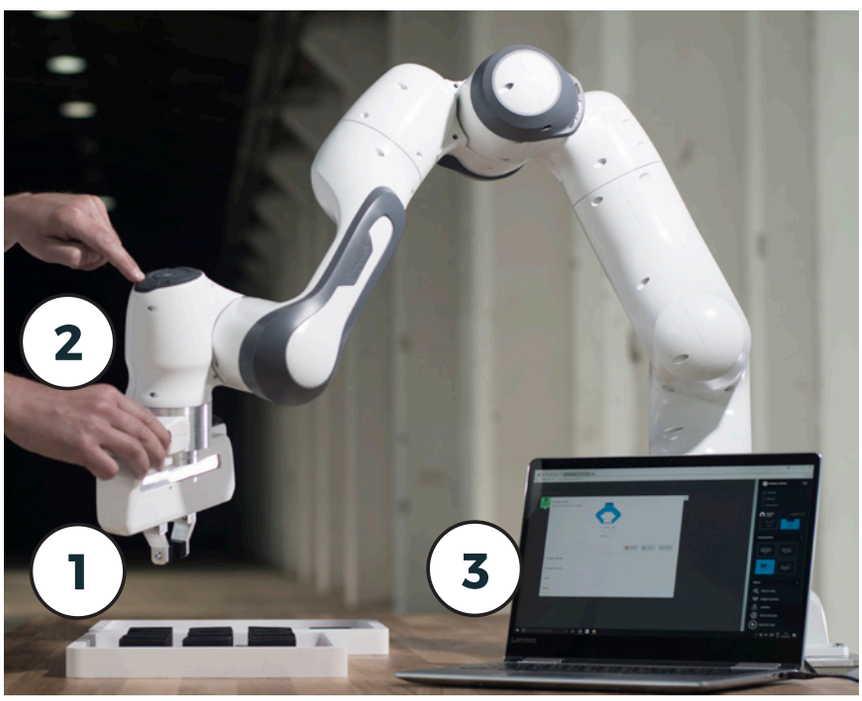
Direct human-robot interaction

Interaction concept

We provide several software and hardware components that interact smoothly with each other to offer you intuitive and effective usability for Panda. You can purchase robot apps in the Franka Store and arrange them in Desk to form Tasks. These Tasks can then be saved and archived. You can operate Desk directly on the computer or from the Pilot disc on the Arm.

Pilot

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



1. On the grip of the Pilot there are two grey buttons, one on each side. By pressing them, the guiding mode is activated. Once the buttons are released the Arm can no longer be moved.

Note: The left button is a three-stage enabling button and needs to be half-pressed for guiding. When pressed all the way Panda will stop the guiding mode and make the Arm immovable.

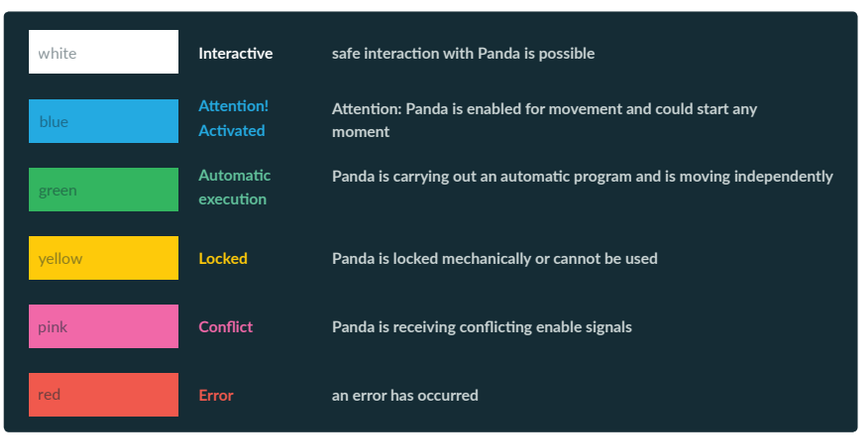
2. Using the disc on top of the Pilot, different entries for programming can be made. Disc can be used to navigate in Desk (3), select individual Apps and parametrize, e.g. by adjusting the slider or activating/deactivating certain functionalities. In addition, robot poses can be entered by manually guiding the Arm using the set button.

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

3. Desk is the software used for progamming and operating Panda.

When the guiding button and the enabling button are pressed on the grip, Panda is in guiding mode and can be moved manually. Once the buttons are released, guiding mode is deactivated and Panda can no longer be moved.

Guiding



Overview of the status indicators

INTERACTING & PROGRAMMING

Creating a task in Desk

Desk overview

Panda is programed using the web application Desk. This is opened by entering the URL 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 Panda, such as “grip”, “put down”, “push button”. The Apps within a Task need to be parametrized, meaning that parameters such as poses, orientations, speeds etc. need to be set. This process is called “teaching”.

List of available apps, app packages and solutions

A list with a brief description of apps, app packages and solutions can be found at: https://www.franka.de/apps/

First steps

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 activate 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 Panda is in. In other words, whether, for example, translational or rotational movements are enabled in guiding Panda. Thereunder are situated important notices on Panda’s status, such as, for example, whether the external activation switch is on or off, or whether there is an error.

Configuring a Task

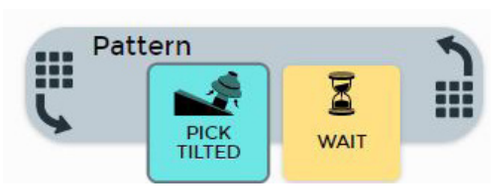
By clicking on the “+” symbol in the task area, a new task is created and selected. A new task is created with an empty timeline.

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 areas back into the app area. Re-arrangement of the task using Drag-and-Drop is equally possible.

Groups

One particular variant of apps are so-called Groups, such as, for example, Pattern, Repeat or Relative. In contrast to normal apps, which implement certain functionalities, Groups modify the execution and teaching behavior of those apps contained within them. Firstly, a Group is dragged into the timeline area. Thereafter, other apps may be dragged into these. The “Repeat” Group executes, for example, all the apps contained in them repeatedly according to the Group configuration. Groups such as “Pattern” or “Points” allow the execution of the same app repeatedly at different points.



Functionalities of Pilot’s Disc

Hand mode: In this mode, the fingers of the Hand can be steered via the directional buttons of the Pilot’s Disc:

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

Desk mode: using the direction buttons on the disc of the Pilot you can navigate in Desk and the context menus of Apps in the timeline.

INTERACTING & PROGRAMMING

Guiding mode

In guiding mode, movements of the Arm follow 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 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 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 completely freely, all 7 joints can be moved freely
- User: the user can freely define the guiding behavior in this mode, meaning that it is possible to define for each Cartesian translation and rotation axis if it is movable or immovable

An app for everything

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. These apps can encompass differing scopes from the highly complex to the very simple. When selected in Desk, each App opens a context menu in which the user is interactively lead through the process parameters.

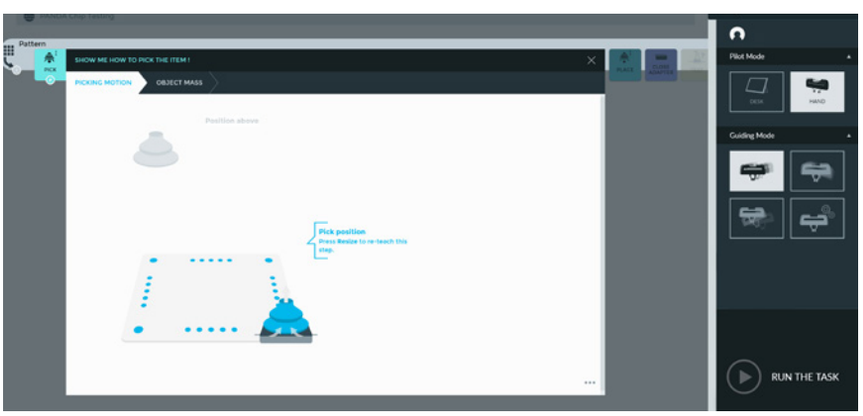
Configuring apps

Teaching

After creating a Task in Desk, all Apps need to be taught, this means that all necessary parameters of the Apps need to be configured so that Panda knows how to execute the App.
If not all Apps of a Task have not yet been fully parametrized.

App dialog window

You can set the parameters for individual Apps in the context menu. The context menu of an App comprises one or several steps. Each step can be divided into sub-steps. For example, for many Apps where a pose is needed, usually two poses are taught. The actual pose for carrying out an activity and a transitional pose, which is used for assuring movement in the operating area without risk of collision. These two poses are normally taught in one step, yet they are individual sub-steps.



INTERACTING & PROGRAMMING

Executing the task

- Before letting Panda execute a task by way of trial, take note of the safety instructions in chapter: Safety concept/ (in particular: Step Back and check).
- In addition, the unlocking tool must be within immediate reach of the Arm. By no means may it stay inserted into the emergency unlock openings of the Arm!

WARNING

The philosophy of step back and check ensures the safety of the user during execution of root movements by way of trial. It is based on the principle that humans are safely separated from possibly dangerous movements.

Therefore:

- The user has to leave the hazardous area during the execution of a robot movement and needs to also make sure that no other persons are within the Safety Area.
- The robot movement is to be triggered only when paying full attention to the movement.

Testing the settings (step back & check)

If all activated apps for a task have been taught completely, it can be executed out by pressing the “Play” button. This is only possible if the robot has been released via the external enabling device for movement (X4). The robot is lit blue if it has been enabled. After starting the task Panda starts to be lit green. The currently executable app is displayed with a green frame.

Speed

Change the speed for the Task execution by clicking on the Task name in the timeline.

Activating/ de-activating apps

Right-clicking on one or several Apps opens a select menu, from wich you can activate, deactivate or delete individual Apps. Only activated Apps are executed and need to have been taught.

Optimization and troubleshooting

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 Group, or the task ended by pressing the “Stop” button.

Manual unlocking of Arm and Hand in case of emergency

WARNING

The Arm weighs approx. 18kg. With mounted end effector and objects in the end effector, the total weight can amount to 21kg. If unscrewed, the manipulator may tilt or fall, causing severe injury by crushing or cutting, in particular of hands, fingers and toes.

Therefore:

- Make sure that the Arm is held in place and cannot tilt or fall while unscrewing the Arm

CAUTION

When unlocking the safety locking system, the dead weight of the Arm segment below the lock will lead to movement (especially sinking and dropping of the Arm). This movement may cause injuries by crushing or penetrating body parts.
Therefore:

- Arm segments below locks are to be supported manually before carrying out the emergency unlock.
- Never carry out an emergency unlock when the Arm is switched on – Panda must always be safely disconnected from the power supply before an emergency unlock

Manually moving the Arm in cases of emergency

There are several possibilities 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 remove Arm 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 key
  - --> Action: loosen the screws attaching the Arm to its base

See also chapter: Safety concept/ Manually moving the Arm in case of emergency

NOTICE

The Arm is equipped with an integrated safety mechanism, which allows it to be moved manually in emergency situations (by pushing away etc.). If this safety mechansim has been activated, the system is to be shut down afterwards and replaced.

NOTICE

The emergency unlock may only be used in exceptional circumstances. The unlocking tool included in the delivery is designed such as not to damage the mechatronics inside of the Arm. Inappropriate handling may damage the Arm.

Therefore:

- Only use the unlocking tool provided for an emergency unlock. The unlocking tool is to be inserted gently into the opening as not to damage the mechatronics.
- The safety locking system should unlock upon slight moderate pressure.

⚠ CAUTION

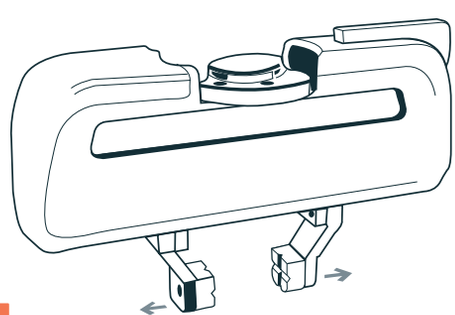
When unlocking the safety locking system, the dead weight of the Arm segment below the lock will lead to movement (especially sinking and dropping of the Arm). This movement may cause injuries by crushing or penetrating body parts.

Therefore:

- Arm segments below locks are to be supported manually before carrying out the emergency unlock.
- Never carry out an emergency unlock when the Arm is switched on – Panda must always be safely disconnected from the power supply before an emergency unlock.

Moving the fingers of the Hand without a power supply

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



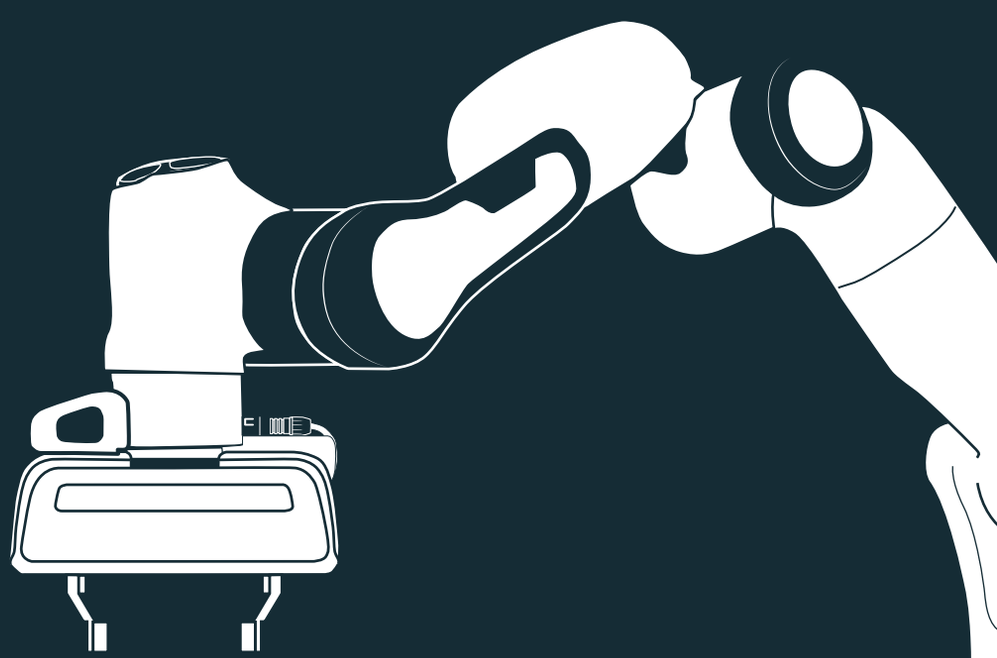
⚠ WARNING

With manual opening of the gripper, grasped objects will fall out. These may fall on your hands/fingers or feet and thus cause severe injuries.
Therefore:

- support the object in the gripper, before the gripper is opened manually
- wear personal protective gear (safety footwear, etc.)

MAINTENANCE, SERVICE & SUPPORT

- Cleaning
- Updates
- Service & Support
  - Troubleshooting
- Shut-down, storage and 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 users.
- Arm, Control and Hand
  - Cleaning of components is only permissible when Panda 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 users
  - 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.

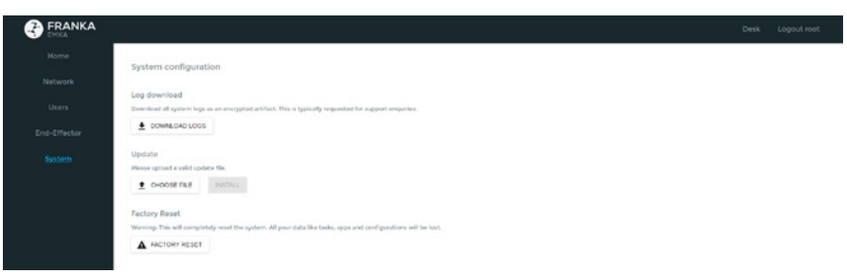
NOTICE

Improper cleaning may cause material damage to the devices.

Updates

System updates

System updates are imported via the admin interface under “System”. Click on the ‘Upload’ button to select an update file. After the file has been successfully uploaded, the update can be installed by clicking the ‘Install’ button. For this purpose, the system 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

Panda is lit white: Possibly one of the two buttons on the grip has not been pressed properly. Release both buttons once again and press them again. Pay attention, that the Enabling Button has not been completely pressed down, otherwise all movement is stopped!
Panda flashes white: The robot finds itself just before the joint angle limit. More information may be found in the Desk sidebar. Guiding out of the limit is required.

If Panda changes to color pink, this means that it, meaning that it has received conflicting enable signals for the Arm. This may occur when e.g. the activation device is open and simultaneously the two buttons for guiding on the grip are being pressed. Make sure that only one of the following signals enables movement:

- pressing both buttons on the grip of the Arm at the same time (enabling switch and guiding button)
- OR: the external enabling switch
- OR: the external activation device
- OR: an external safety device alternatively connected to X3

All inputs must be closed, before the robot can be moved again. The opened inputs in Desk are highlighted in pink.

Panda is lit or flashes yellow: The Safety Locking System is still active. In Desk, this can be released via “Unlock Joints”.

Panda flashes red: The safety system has determined a problem. The Safety Locking System can be de-activated again on the desk.

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

MAINTENANCE, SERVICE & SUPPORT

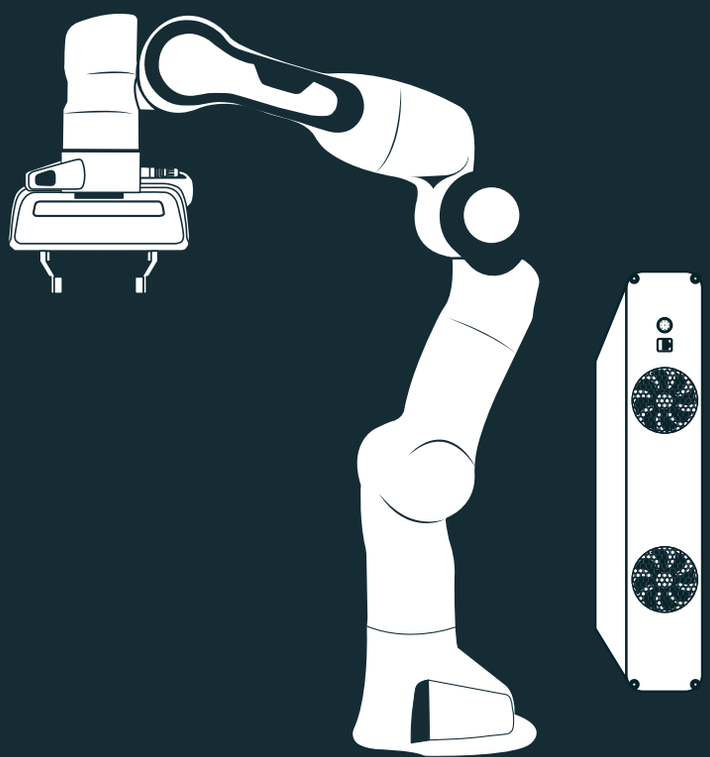
Arm pulls strongly in one direction during Teaching	Immediately check the settings for the end effector. Has the correct end effector been selected and configured? For this purpose, please see the chapter: Start-up/ Software Setup
There is a loud clicking at switching-off	The clicking is a result of 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.
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.

Shut-down, storage an disposal

Disposal	Shut-down, storage and disposal of Panda 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.

RIGHTS OF USE AND PROPERTY RIGHTS

- Identification
- Rights of use and property rights



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