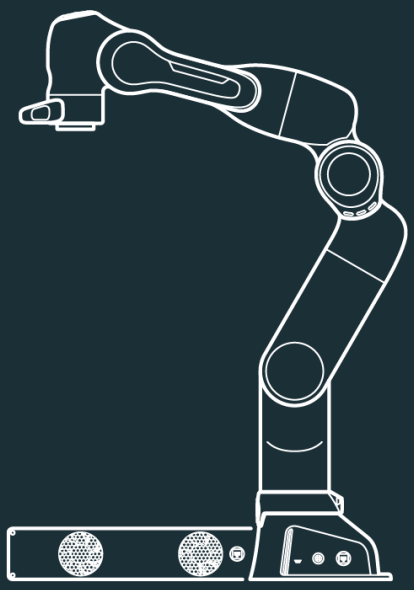
FRANKA EMIKA

FRANKA PRODUCTION 3

Product Manual



ORIGINAL PRODUCT MANUAL

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

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

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

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

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

Complementary documents to this product manual are:

- Datasheet Franka Production 3 (Document number: 110020)
- Getting Started guide (Document number: 110030)
- Labeling material for the integrator (Document number: 110040)
- Drilling template (Document number: 110050)

Document number: 110010 (110010/1.5/EN)

Release Version: 1.5 (Aug 2022), valid for Franka Production 3 with system version 5.

Get your manual and additional supporting material in English and other languages at www.franka.de/documents.

TABLE OF CONTENTS

1 ABOUT FRANKA EMIKA

Enabling industrial automation

Franka Emika (FE) is a German tactile robotics platform company.

Our mission is to provide robotics as production services, making it intuitive and universally accessible for everyone. With this mission in mind, we redefined robotics with cost-efficient and the most easy-to-use robot for industrial automation – the Franka Production 3 robot.

Our human-centered design in the technology with seven axes is tactile and safety certified, making it available for all kinds of use cases in the industry.

Our AI-enabled collective learning platform enables scalable software solutions and reduces learning time and resources to a minimum with intuitive and simple programming.

We provide an inclusive robotics platform with hardware and software – operating within one ecosystem.

Designed, developed, manufactured, and serviced in Germany.

Introducing Franka World – a digital robotics platform

After redefining robotics and establishing a community, we launched a novel digital robotics platform to interconnect the digital world with the physical world.

Franka World allows community interaction between researchers, partners, customers, developers, suppliers, and robots. In addition, all users can easily gain integrated access to products and services and manage their entire robot fleets, independent of their physical location.

We strive for a world where everyone can use a robot, and we can reach that by connecting the world. We treasure our community of robotics professionals, academics, and enthusiasts, from whom we learn every single day.

As members of the community ourselves, we commit to supporting each other and thriving together.
Franka Emika – a certified robotics platform with tactile intelligence

2 RIGHTS OF USE AND PROPERTY RIGHTS

2.1 General

Protected trademarks

This product manual refers to protected trademarks not explicitly designated in the continuing text. The absence of such indication may not imply that the corresponding product name is free of third-party rights. The following trademarks are protected trademarks:

- Franka and Franka Emika are registered trademarks.
- Microsoft is a registered trademark, and Windows is an indication of the Microsoft Corporation in the United States and other countries.
- GOOGLE, Mozilla, Firefox, CHROME, ITEM are registered trademarks.

Trademark rights

The responsible person is not granted any rights or claims to the trademark, logo, or trade names of Franka Emika.

Use of open-source codes

A complete list of all open-source licenses used by Franka Production 3 can be accessed via the Settings menu of the Franka UI.

2.2 Identification

Removal of identification

Copyright notices, serial numbers, and any other labeling that identifies the product or operating software may not be removed or modified.

3 DECLARATION OF INCORPORATION AND CERTIFICATES

3.1 Declaration of Incorporation

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

Description of the partly completed machinery:

Product identification: Franka Emika Production components: *Control*, *Arm*
Model/Type:
Control (#295341) in combination with *Arm* (#290101 and #290102)

We declare that the product complies with the following essential safety and health requirements set out in Annex I of the Machinery Directive 2006/42/EC:
1.1.2; 1.1.3; 1.1.5; 1.1.6; 1.2.1; 1.2.2; 1.2.3; 1.2.4.1; 1.2.4.2; 1.2.4.3; 1.2.4.4; 1.2.5; 1.2.6; 1.3.1; 1.3.2; 1.3.3; 1.3.4; 1.3.6; 1.3.7; 1.3.8; 1.3.8.1; 1.3.8.2; 1.3.9; 1.4.1; 1.4.2.1; 1.4.2.2; 1.4.3; 1.5.1; 1.5.2; 1.5.3; 1.5.4; 1.5.5; 1.5.6; 1.5.8; 1.5.9; 1.5.10: 1.5.11; 1.5.13; 1.5.14; 1.6.1; 1.6.3; 1.6.4; 1.7.1; 1.7.1.1; 1.7.1.2; 1.7.2; 1.7.3; 1.7.4; 1.7.4.1; 1.7.4.2; 2; 2.2.1; 2.2.1.1; 4; 4.1.2.3; 4.2.1; 4.3.3; 4.4.2

In addition, the partly complete machinery is in conformity with the following EU Directives:
Directive 2014/35/EU relating to electrical equipment (LVD)
Directive 2014/30/EU relating to electromagnetic compatibility (EMC)
Directive 2011/65/EU relating to hazardous substances in electrical and electronic equipment (RoHS)
Directive 94/62/EC relating to packaging and packaging waste

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 60204-1:2018 IEC 60204-1:2016	Safety of machinery – Electrical equipment of machines – Part 1: General requirements
EN 60664-1:2007 IEC 60664-1:2007	Insulation coordination for equipment within low-voltage systems – Part 1: Principles, requirements and tests
EN 60664-4:2006 IEC 60664-4:2005	Insulation coordination for equipment within low-voltage systems – Part 4: Consideration of high-frequency voltage stress
EN 60529:1991/A1:2000/A2:2013 IEC 60529:1989/AMD1:1999/A2:2013	Degrees of protection provided by enclosures (IP Code)
EN 61010-1:2010/A1:2019/AC:2019-04 IEC 61010-1:2010/AMD1:2016/COR1:2019	Safety requirements for electrical equipment for measurement, control, and laboratory use – Part 1: General requirements
EN IEC 61010-2-201:2018 IEC 61010-2-201:2017	Safety requirements for electrical equipment for measurement, control, and laboratory use – Part 2-201: Particular requirements for control equipment
EN 61800-5-1:2007/A1:2017-04 IEC 61800-5-1:2007 /AMD1:2016	Adjustable Speed Electrical Power Drive Systems – Part 5-1: Safety requirements – Electrical, thermal and energy

Machinery safety

Standard	**Name**
EN ISO 10218-1:2011 ISO 10218-1:2011	Robots and robotic devices – Safety requirements for industrial robots – Part 1: Robots
EN ISO 12100:2010 ISO 12100:2010	Safety of machinery – General principles for design – Risk assessment and risk reduction
EN ISO 13849-1:2015 ISO 13849-1:2015	Safety of machinery – Safety-related parts of control systems – Part 1: General principles for design

EN ISO 13849-2:2012 ISO 13849-2:2012	Safety of machinery – Safety-related parts of control systems – Part 2: Validation
EN ISO 13850:2015 ISO 13850:2015	Safety of machinery – Emergency stop function – Principles for design
EN ISO 14118:2018 ISO 14118:2017	Safety of machinery — Prevention of unexpected start-up
EN 61310-1:2008 IEC 61310-1:2007	Safety of machinery – Indication, marking and actuation – Part 1: Requirements for visual, acoustic and tactile signals
EN 61310-2:2008 IEC 61310-2:2007	Safety of machinery – Indication, marking and actuation – Part 2: Requirements for marking

EMC

Standard	Name
EN IEC 61000-6-1:2019 IEC 61000-6-1:2016	Electrical compatibility (EMC) – Part 6-1: Generic standards – Immunity standard for residential, commercial and light-industrial environments
EN IEC 61000-6-2:2019 IEC 61000-6-2:2016	Electrical compatibility (EMC) – Part 6-2: Generic standards – Immunity standard for industrial environments
EN 61000-6-3:2007 /A1:2011/AC:2012-08 IEC 61000-6-3:2020	Electrical compatibility (EMC) – Part 6-3: Generic standards – Emission standard for residential, commercial and light-industrial environments
EN IEC 61000-6-4:2019 IEC 61000-6-4:2018	Electrical compatibility (EMC) – Part 6-4: Generic standards – Emission standard for industrial environments
EN 61000-6-7:2015 IEC 61000-6-7:2014	Electrical compatibility (EMC) – Part 6-7: Generic standards – Immunity requirements for equipment intended to perform functions in a safety-related system (functional safety) in industrial locations
EN 61326-3-1:2017 IEC 61326-3-1:2017	Electrical equipment for measurement, control and laboratory use – EMC requirements – Part 3-1: Immunity requirements for safety-related systems and for equipment intended to perform safety-related functions (functional safety) – General industrial applications
CISPR 11:2015+AMD1:2016 +AMD2:2019 CSV	Industrial, scientific and medical equipment – Radio-frequency disturbance characteristics – Limits and methods of measurement

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.

Representative in EU, authorized to compile the relevant technical documentation:
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Manufacturer:
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Date, location
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Dr. Patrick Pfaff, CTO

3.2 Certificates

Certificates by TÜV SÜD RAIL and TÜV SÜD PS can be found under the following link:
www.franka.de/documents

3.3 Further Statements

Further Information
status: 01.04.2022 Franka Production 3

Restriction of Hazardous Substances (RoHS):

The components *Control and Arm* 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
7a: Lead in high melting temperature type solders (i.e., lead-based alloys containing 85 % by weight or more lead)
7c-I: Electrical and electronic components containing lead in a glass or ceramic other than dielectric ceramic in capacitors, e.g., piezo-electronic devices, or in a glass or ceramic matrix compound

REACH:

FRANKA EMIKA GmbH is a "downstream user" as defined in REACH. Our products are exclusively non-chemical products (manufactured items). In addition, no substances are released under normal conditions of use and conditions that can reasonably be predicted (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) unless covered by RoHS exceptions (see above). Extensions published by the ECHA candidate list are matched with our products, and if it is known that one of these newly added substances is contained in our products, we will inform you immediately.
This confirmation was created based on currently available information from our suppliers.

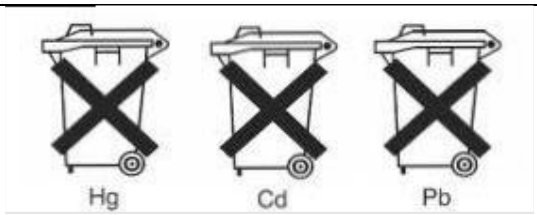
WEEE Directive:

The components *Control and Arm* 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 of them with consumer waste. Dispose of them according to statutory orders and bring 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).



3.4 Labeling on the Equipment

Arm

Type label

Figure 3.1

Emergency unlock label

Three Emergency Unlock Labels on the Arm point to the spots where the Emergency Unlocking Tool needs to be inserted to manually unlock the Fail-safe Locking System in case of an emergency.

Figure 3.2

WARNING

Falling heavy Arm when using Emergency Unlocking Tool

Risk of being trapped by the Arm when unlocking joints

- Make sure the Arm does not drop down when unlocking it.
- Do not place your head or other body parts between or underneath segments of the Arm.
- Do not place body parts (especially hands, fingers) between the Arm, the end effector, or stationary objects.
- Do not use the Emergency Unlocking Tool while the Arm is powered.
- Insert Emergency unlocking tool at the base of the robot
- Store Emergency Unlocking Tool near the Arm

Hot Surfaces label

Figure 3.3

WARNING

Hot Surfaces and Handguiding

At ambient temperatures above 30 °C the robot surface can become too hot to touch. Therefore, using the assist feature in automatic mode is not permitted above 30 °C.

Functional earth label

The functional earth label points to the spot where functional earth can be connected to the base of the Arm.

Figure 3.4

Grasping position label

Figure 3.5

Control

Type label

Figure 3.6

External Enabling Device

Type label

Figure 3.7

Emergency Stop Device

Type label

Figure 3.8

4 SAFETY

4.1 Safety Instructions and General Indications

Warning notices

Before installing, starting up, and operating the device, carefully read this manual and any additional documentation. Take note of the safety instructions as well as general indications.

Warning notices are posted as follows:

⚠ CAUTION

Type of hazard
Potential consequences of hazard
Evasive/avoidance actions to be taken

The following warning notices are used in this manual:

⚠ DANGER

DANGER indicates a hazardous situation that, if not avoided, will result in death or serious injury.

⚠ WARNING

WARNING indicates a hazardous situation that, if not avoided, could result in death or serious injury.

⚠ CAUTION

CAUTION indicates a hazardous situation that, if not avoided, could result in minor or moderate injury.

NOTICE

NOTICE indicates information considered important but not hazard related.

SAFETY-INSTRUCTION

SAFETY INSTRUCTION indicates processes that need to be strictly observed.

Indications

ⓘ

Indicates where further information can be obtained.

4.2 Notice of Liability

Franka Production 3 has been developed according to the relevant quality standards. A hazard and risk assessment according to EN ISO 12100 has been carried out through the course of development and is the basis for Franka Production 3 and this manual.

The Arm is equipped with an ISO end effector flange according to DIN ISO 9409-1-A50.

The present document includes assembly instructions for Franka Production 3 as a partly completed machinery. It contains descriptions of the conditions that must be met to correct incorporation in the final machinery not to compromise safety and health (e.g., Annex I of Machinery Directive 2006/42/EC).

4.3 Intended Use

Franka Production 3 is exclusively intended for industrial use. The system may be applied only in the ambient and operating conditions described in this document for the tasks of, e.g., testing and inspection, handling, or mounting.

Franka Production 3 may only be used in sound technical condition, for its intended purpose, and within the technical specifications and operating conditions, with awareness of safety and possible dangers.

The present Franka Production 3 system is intended exclusively for use as described in this manual.

For the normal and extended working conditions under which the robot should operate, see chapter 7 TECHNICAL SPECIFICATIONS.

4.4 Misuse

DANGER

Misuse of Franka Production 3

Risk of danger to life and limb, impairments, damage to the robot, and other material assets.

- Only use Franka Production 3 in sound technical condition.
- Only use Franka Production 3 in the ambient and operating conditions described in this document.

The misuse of Franka Production 3 voids the manufacturer's warranty and liability. Any application different from the intended purpose is considered misuse and is not permissible.

Misuse is any use that deviates from the warnings, notices, and instructions in this manual and the Getting Started guide, in particular, but not limited to, the following uses:

- Transport of people and animals
- Transport without packing pose and original packaging
- Use as climbing assistance
- Leaning against the Arm
- Use in potentially explosive areas
- Use below ground
- Use for the handling of radioactive objects
- Use outdoors
- Use as a medical product
- Use as a service Arm, e.g., for the care of the elderly
- Use in the vicinity of children
- Handling of liquids

- Use in any position other than upright
- Use outside of the specified operating limits

Modifications to Franka Production 3 that Franka Emika does not explicitly permit are not allowed and will lead to loss of warranty and liability claims. Not permitted modifications include but are not limited to the following:

- Any adaptation of the mechanical structure
- Varnishing
- Wrapping the robotic structure unless using FE certified equipment

Franka Emika grants only the following modifications to Franka Production 3:

- Installation of a cable guidance system (can impact the motion and control behavior of the system)
- Mounting equipment to the flange
- Covering screw holes

It is prohibited to open the Arm and the Control enclosure, and other equipment.

The robot may only be used in places where sufficient space and safe use can be ensured.

Franka Emika is not liable for damage caused by mounted equipment or damage caused by misuse.

4.5 General Possible Dangers and Safety Measures when Working with Robots

Abstract of possible dangers

An extensive but not definitive list of dangers that generally may be presented by a robot system can be found under EN ISO 10218-1:2011 ANNEX A.

Special attention is drawn here to the following dangers that the Franka Production 3 may present:

DANGER

Electrical or fire hazards and dangerous fumes

Fire and fumes may cause breathing difficulties, eye irritation, lung damage, poisoning, and may lead to death.

- Do not use the Franka Production 3 outside of its indicated specifications.

DANGER

Damaged wires or inadequate electrical installation

Risk of personal injury by electric shock, as well as material damage.

- Only use Franka Production 3 in sound technical condition.
- Only install the emergency stop system with qualified personnel.
- Check cables and electrical installations.

DANGER

Risk of smoldering fires

Too many devices connected to the power supply system may lead to an overload of the electrical installation and may result in smoldering fires, which may cause death or severe damage to persons.

- Connect the Franka Production 3 accordingly to avoid an overload of the electrical installation.
- Install the overload protection devices accordingly.

WARNING

Objects falling from end effectors due to a power supply cut off

Objects falling from the gripper lead to injuries to hands, fingers, feet, and toes.

- Always wear personal protective equipment (e.g., safety shoes).
- Use the appropriate type of grippers to prevent objects from falling.

WARNING

Falling and unexpected motions of the robot, especially in earthquake-prone areas

Risk of severe injuries such as crushing, tearing of the skin, and puncturing.

- Level the platform.
- Only install the Arm on even, unmoving, and stable platforms. Accelerations and vibrations are not permissible.
- Do not install the Arm on hanging, tilted, or uneven platforms.
- Level the platform in an upright position.
- Ensure a correctly laid out and tight screw connection.
- Tighten the screws after 100 hours of operation with the correct tightening torque.
- If operated in an earthquake-prone area, take the respective hazard and risk assessments into consideration.

WARNING

Dangerous and uncontrolled motions of the Arm

Risk of severe injury, such as crushing, tearing of the skin, and puncturing from the Arm and end effectors.

- Ensure that the end effector and/or the object mass and the Center of Mass (CoM) are parameterized correctly.
- Keep out of the working space during operation.

CAUTION

Damaged cables, plugs, mechanical housing, or oil leaks

Contact with leaking oil may cause eye or skin irritation.

Electrical risks may lead to severe injury.

- Only use Franka Production 3 in sound technical condition.
- Do not use damaged cables, plugs, and mechanical housing for operation. In cases of doubt, contact Franka Emika.

Sound condition

CAUTION

Leaking grease or oil through voids of structural elements of the robot

Irritation of skin and eyes.

- Stop operating the machine.
- Contact manufacturer.
- Use gloves.
- Seek medical attention after contact with eyes or skin.

Disruptions

NOTICE

The operator will be informed about possible malfunctions through Desk. Malfunctions need to be rectified before continuing the operation.

- To rectify the possible malfunctions, follow the instructions in the Franka UI. A reboot of the system may be required.

Overload of joints

NOTICE

An offline overload in all the robot's joints may lead to material damage to the robot.

- Perform a risk assessment with foreseeable misuse in mind.
- Adhere to the system’s warning to take the robot out of operation.

4.6 Application Related Possible Dangers and Safety Measures

The following possibly safety-related aspects are to be considered when planning and designing the application and performing the hazard & risk assessment for completed machinery. The integrator is obligated to perform a risk analysis.

Functionalities and features of various safety levels

Franka Production 3 offers functionalities and features of various safety levels. All safety functions and their corresponding safety ratings are described in section Safety Functions in chapter Safety Functionalities. All other functionality described throughout this chapter is not classified as safety-rated according to EN ISO 13849-1 or EN 62061. You may, therefore, not rely on the availability of these functionalities.

Please note that the integrator is obligated to perform a risk analysis.

Unexpected motion

⚠ CAUTION

Unexpected moving of Arm

The use of various applications, handled end effectors and surrounding objects, may cause crushing between arm segments and impact and collision.

- Ensure that the end effector and/or the object mass and the Center of Mass (CoM) are parameterized correctly.
- Keep out of the maximum space during operation.

Trapping within a completed machinery

⚠ WARNING

Risk of trapping body parts or person

Risk of severe injury, such as crushing, tearing of the skin, and puncturing from the Arm and end effectors.

- Do not place body parts between Arm segments.
- In case of acute mortal danger:
  1. Press the Emergency Stop Device to stop the robot from operating.
  2. Pull or push the Arm out of the dangerous position manually.

Please see section Emergency unlock in chapter Manually Moving the Arm for more information.

Wiring of end effectors

NOTICE

If an end effector is used with Franka Production 3, the maximum attachable payload is reduced by the weight of the end-effector and its external wiring.

NOTICE

External wiring adds additional loads and torques to the Arm which may influence Franka Production 3‘s control performance.

Initiation of motion of externally wired end effectors, associated equipment

NOTICE

Because of different configurations, installed apps and services, Franka Production 3 is able to send protocols to possibly connected machines (incl. starting motion), externally wired end effectors, and other associated equipment. Please be aware of possible related risks of using external equipment.

Please see section Initiating Motion in chapter Test & Jog for more information.

Single Point of Control

Franka Production 3 can be controlled via a single Franka UI connection or field bus. Single Point of Control (SPoC) mechanisms ensure control by one source only. For more information, see chapter Single Point of Control.

⚠ WARNING

Unexpected moving of Arm

Risk of severe injury, such as crushing, tearing of the skin, and puncturing from the Arm and end effectors.

- Ensure that the end effector and/or the object mass and the Center of Mass (CoM) are parameterized correctly.
- Keep out of the working space during operation.
- In case of acute mortal danger:
  1. Press the Emergency Stop Device to stop the robot from operating.
  2. Pull or push the Arm out of the dangerous position manually.
- In case of non-life-threatening danger:
  1. Use the Emergency Unlocking Tool to move the Arm.

Field buses are covered by SPoC as well. For more information about SPoC, refer to chapter Single Point of Control.

Task environment - dependent effects:

SAFETY-INSTRUCTION

At extended ambient temperatures between 25 °C and 45 °C (after intense task execution and once Franka Production 3 is set to “monitored stop” state), the integrator needs to implement measures and evaluate the risks of touching the Arm for a prolonged time (< 60 s) without being subjected to thermal burns (EN ISO 13732-1:2006). Measures include but are not limited to the following:

- Cool-down time for the robot.
- Switching off the robot for a certain amount of time.
- Notifying the operator.
- Marking the spots that are most likely to be hot.
- Prohibiting access to the robot.

Surface temperature of the Arm (from base until axis 7, excluding flange)

WARNING

Hot Surfaces

Handling of the Arm's metal or plastic segments for a prolonged time after intense task execution may cause thermal burns.

- Do not touch the Arm's segments for more than 60 seconds after stopping the Franka Production 3 after an intense task execution at maximum payload and extended temperature.

WARNING

Hot Surfaces and Handguiding

At ambient temperatures above 30 °C the robot surface can become too hot to touch. Therefore, using the assist feature in automatic mode is not permitted above 30 °C.

Task environment - dependent effects:

Safety instruction depends on risk assessment (regarding hot surfaces).

After mounting the end effectors to the Arm, the integrator needs to assess possible risks regarding the end effectors.

SAFETY-INSTRUCTION

The integrator needs to implement measures for touching the surfaces of the Arm, the end effector, and the end effector's flange regarding possible heating which may lead to thermal burns (EN ISO 13732-1:2006). Measures include but are not limited to the following:

- Cool-down time for the robot.
- Switching off the robot for a certain amount of time.
- Notifying the operator.
- Marking the spots that are most likely to be hot.
- Prohibiting access to the robot.

4.7 Installation of Safety Peripherals

Emergency stop installation

The Emergency Stop Device needs to be installed according to the generally valid and accepted engineering standards, e.g., European standards EN 60204 and related.

The Emergency Stop Device provided by Franka Emika needs to be connected to the X3.1 port. Other devices than the Emergency Stop Device provided by Franka Emika may also be connected to the X3 port.

The devices connected to the emergency stop signal must follow EN 60947-5-5 or EN 62061.

Store detached devices that no longer fulfill a safety function away from the device to prevent them from mistakenly being activated.

NOTICE

Place the connected Emergency Stop Device such that it is always reachable in case of an emergency but that an accidental use can be prevented.

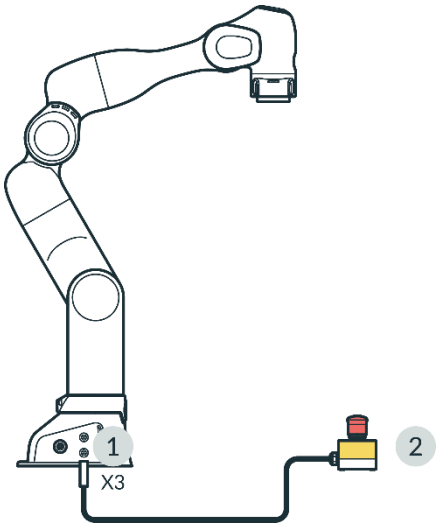


Figure 4.1

1	X3 - Safe inputs connector	2	Emergency Stop Device

Stopping time and distance

Stopping time (i.e., the time that passes between the request of an emergency stop and the complete stop of the Arm) and stopping distance (i.e., the distance covered by the Arm after activation of the emergency stop until it comes to a complete stop) were measured per EN ISO 10218-1, Annex B. Stopping time and distance can be found in the appendix.

4.8 Fail-safe Locking System

Fail-safe locking system

When the Arm is disconnected from the power supply, the locking bolts automatically lock all seven joints. The locking bolts mechanically lock any motion regarding the joints so that the Arm stays in position even when it is not supplied with power.

Due to the technology of these locking bolts, the exact position cannot be maintained when the power is cut off. The locking bolts lock with an audible click, causing the Arm to lower a few centimeters, particularly those joints in which gravitational force comes into effect.

Unlocking the safety locking system

Each axis will move slightly as soon as the safety locking system unlocks.

4.9 Manually Moving the Arm

Moving the Arm without electrical power

⚠ CAUTION

Moving Arm

Risk of severe injury, such as crushing, tearing of the skin, and puncturing

- Always wear personal protective equipment (e.g., safety goggles).
- The integrator needs to perform a risk analysis for any attached end effectors.
- Do not stand in the maximum space during operation.

If a person is trapped by the Arm, follow one of the three release options below to free them even when the power supply is cut off.

- Use the Emergency Unlocking Tool at respective positions to unlock and move the robot by hand.
- Unscrew the Arm base from its mounting place.
- Manually move the Arm.

In case of non-acute danger and jamming of the Arm, use the Emergency Unlocking Tool.

WARNING

Falling heavy Arm when using Emergency Unlocking Tool

Risk of being trapped by the Arm when unlocking joints

- Make sure the Arm does not drop down when unlocking it.
- Do not place your head or other body parts between or underneath segments of the Arm.
- Do not place body parts (especially hands, fingers) between the Arm, the end effector, or stationary objects.
- Do not use the Emergency Unlocking Tool while the Arm is powered.
- Insert Emergency unlocking tool at the base of the robot
- Store Emergency Unlocking Tool near the Arm

Action: Emergency unlock

SAFETY-INSTRUCTION

1. Press the Emergency Stop Device to stop the robot from operating.
2. Take the unlocking tool from the Pilot's base.
3. Hold the Arm's segments.
4. Insert the unlocking tool in the respective trapezoidal openings and unlock one or more joints one after another.
   The openings are marked with the "Emergency Unlock" label.

The Arm segment can now be moved manually.

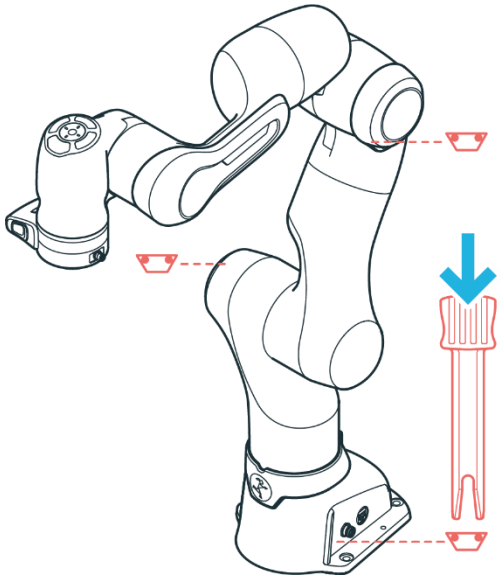


Figure 4.2

NOTICE

Be aware that as soon as the unlocking tool is inserted, the Arm segment towards the wrist of the Arm will fall down with gravity.

NOTICE

- The integrator needs to make sure that the unlocking tool is stored in a holder at the base of the robot.
- Do not remove the unlocking tool unless in an emergency.
- The unlocking tool must always be within reach.
- Only use the original unlocking tool.
- The unlocking tool should only be used in case of emergency.

NOTICE

Manually pulling or pushing the Arm will damage the Arm as the joints will be overloaded.

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

SAFETY-INSTRUCTION

In case of acute mortal danger:

1. Press the emergency stop device to stop the robot from operating.
2. Pull or push the Arm out of the dangerous position manually.
3. Secure the robot arm from falling down.

Action: Pushing away manually

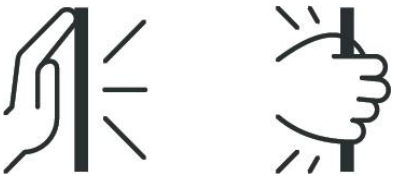


Figure 4.3

NOTICE

The integrator must evaluate the risk of a human being trapped. Remove the Emergency Unlocking Tool after use.

NOTICE

Manually pulling or pushing the Arm will damage the Arm as the joints will be overloaded.

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

4.10 Safety Concept

The safety concept of Franka Production 3 provides a simple approach to making the robotic system safe within its target application. The system provides a set of safety functions compliant with EN ISO 13849-1. For more information on safety functions, see chapter Safety Functionalities.

With the Franka UI tool Watchman, the safety operator can use those safety functions in so-called safety rules and scenarios to cover the risks identified in the risk analysis carried out for the robot cell and application.

The configuration of the safety system through Watchman is split into two parts:

- General safety-relevant settings are configured in the safety setup (e.g., defining the behavior of safe inputs).
- Safety scenarios allow covering different situations with suitable safety measures.

Each safety scenario can define one or more safety rules to cover a certain situation/state the robot can be in.

Each safety rule consists of a safety function, optional conditions (defining when the rule is active), and a reaction triggered when the safety function is violated.

With the safety setup and the safety scenarios, the safety operator can set up the safety system according to the needs revealed by the risk analysis. Franka Production 3 comes with a predefined and prevalidated set of scenarios. If they are suitable to cover the needs revealed by the risk analysis, this setup can be used out-of-the-box.

If more specific safety rules and scenarios are required, the safety operator can adjust predefined scenarios and rules using Watchman. Some safety scenarios are read-only or contain fixed rules to ensure a minimum set of safety measures common to most applications. In general, these presets are defined by ISO 10218-1.

The safety operator must validate all customized safety settings and scenarios before confirming and activating them on the robot.

The predefined safety scenarios cover the possible operation states of the system.

NOTICE

During recovery of violated safety functions, the system switches to the predefined recovery scenario to provide a safe recovery. The original scenario (e.g., Work), in which the violation happened, its rules, and especially the violated safety function, are not active during recovery. The system switches back to the original scenario as soon as the recovery has been completed. The integrator must consider the predefined recovery scenarios when performing the application-specific hazard & risk assessment for completed machinery.

Scenarios for states in Programming mode

Idle (read-only)

- The user might be close to the robot but not interact with it. The robot is at a safely monitored standstill.
- This is the default state in Programming mode if no other mode is active or if conflicting inputs are present.

Teach (customizable)

- The user can hand-guide the robot.
- Safe activation signal: Pressing the Enabling Button located on the Pilot-Grip.
- The safety operator can customize the pre-defined velocity limit.

Test & Jog (customizable)

- The user watches and verifies the execution of a created task and inches the robot via Franka UI.
- Safe activation signal: External Enabling Device (X4).
- The safety operator can customize the pre-defined velocity limit.

Scenarios for states in execution mode

Work (customizable)

- The robot works independently by executing a task.
- This scenario is pre-filled with rules activating the safely monitored standstill (SMSS) safety function stopping the robot when the inputs X3.2 or X3.3 are opened. A rule to trigger the “Safely Monitored Standstill” within “Work” to allow a switch to the “Assist” mode must be set.
- The safety operator can customize all rules within this scenario.

Assist (customizable)

- Collaborative operation “hand-guiding” as defined by ISO 10218-1 while in execution mode.
- Safe activation signal: Pressing the Enabling Button located on the Pilot-Grip while the robot is in Safely Monitored Standstill.
- The safety operator can customize the velocity limit for this mode and/or add custom rules.

Opening/closing brakes (read-only)

- Active while the brakes are opened or closed.
- Extend of motion and speed is safely limited.

Error/Violation states

The following states are not active in the normal operation of the robot. They only become active when safety functions in the other states are violated, or safety-relevant errors occur.

Work invalid (read-only)

If there is no valid safety scenario available for the Work mode, the “Work invalid” scenario is activated as a backup to prevent the robot from moving.

Violation idle (read-only)

This state is active after any safety function is violated and the respective reaction has been carried out.

Recovery (position error, joint limit violation, or space violation) (read-only)

This state is active while the robot is recovering from a violated safety function or an error.

Safe activation signal: Depending on the type of violation or error.

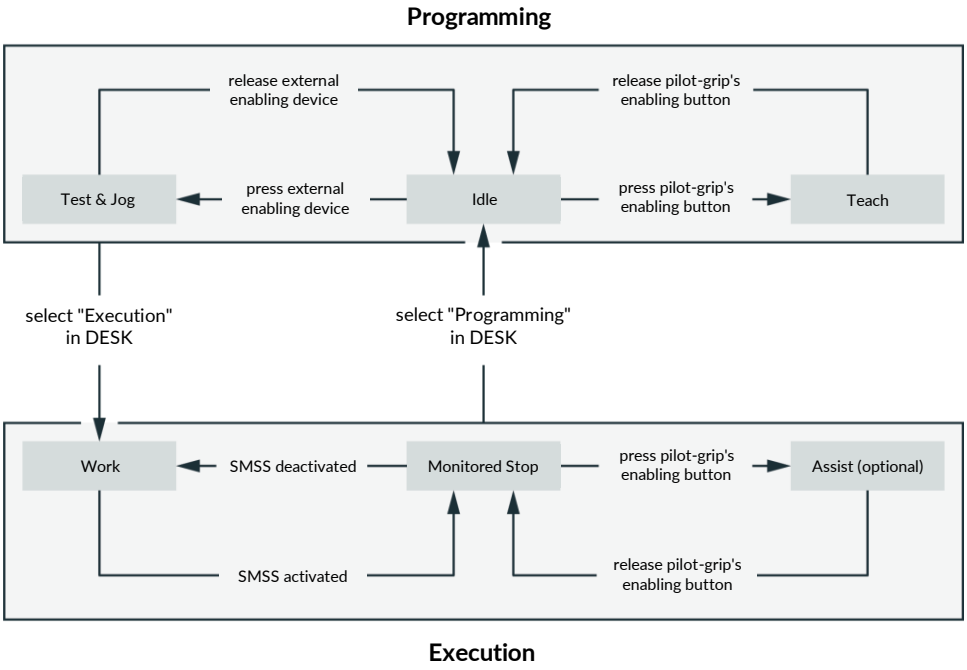

Programming
release external enabling device
release pilot-grip's enabling button
Test & Jog
press external enabling device
Idle
press pilot-grip's enabling button
Teach
select "Execution" in DESK
select "Programming" in DESK
Work
SMSS deactivated
Monitored Stop
press pilot-grip's enabling button
Assist (optional)
SMSS activated
release pilot-grip's enabling button
Execution

Figure 4.4

4.11 Safety Functionalities

⚠ WARNING

Hot Surfaces and Handguiding during Recovery

At ambient temperatures above 30 °C the robot surface can become too hot to touch. Therefore, in case of occurence of a safety function violation which requires hand-guiding during recovery, the following must be observed:

- Recovery may be performed only by personnel specifically trained for this situation.
- Before recovery, surface temperatures must be evaluated to be below touchable limits. Cooldown times depend on previously executed motion and ambient temperatures.
- Wearing of heat resistant safety gloves for this procedure is advised.

NOTICE

Franka Production 3 distinguishes between two safety functions: limiting functions and monitoring functions.

Limiting functions guarantee that limits are not breached, e.g., stopping times, distances, and tolerances.

Monitoring functions are only triggered upon a violation. It is the safety integrator's obligation to consider stopping times, distances, and tolerances.

NOTICE

Connecting external devices with a separate power supply may jeopardize the system's safety function if the electrical ratings are not complied with.

In addition, the voltages in the connected devices must either be SELV or suitably isolated from system-connected signals.

Safe inputs

Name	Description	Safety Rating	Stop Reaction
Emergency Stop (X3.1)	The X3 connector in the robot base provides one safe input to connect an emergency stop.	PL d / Cat.3	Category 1 stop
External Enabling Device (X4)	The X4 connector at the robot base provides one safe input dedicated to a 3-position External Enabling Device.	PL d / Cat.3	Releasing or fully pressing the Enabling Button activates the SMSS safety function. The reaction in case of a violation of SMSS depends on the active safety scenario. Operating mode “Programming”: Category 1 stop (see predefined scenario “Idle”) Operating mode “Execution”: Reaction depending on SMSS configuration in scenario “Work.” During safety function violation or error recoveries, fully pressing or releasing the Enabling Button triggers a Category 1 stop.
Enabling Button	A 3-position Enabling Button is provided near the flange on the Pilot-Grip of the robot.	PL d / Cat.3	
Two configurable safe inputs (X3.2, X3.3)	The X3 connector on the robot base provides two additional safe inputs. The behavior of those two inputs can be configured in the safety setup.	PL d / Cat.3	Depends on the configuration in safety scenarios.

Safety functions

Name	Abbreviation	Description	Safety Rating	Recovery in case of violation Note: The operator can recover all violations.

Safely limited Cartesian Position	SLP-C	Monitoring of the Cartesian position of certain points on the robot. The position is checked against user-defined cartesian spaces.
		The following points are monitored:
		• Flange
		• Elbow
		• Wrist
		• Customer defined tool spheres
		The monitoring can be configured to signal violation either when one or more points are inside the defined space or when one or more points are outside the defined limits.
		Parameterization:
		• Tool model (up to five spheres)
		  ○ Radius of each sphere
		  ○ Position of each sphere center relative to the flange
		Hint: This is a general setting and will affect all safety functions using this tool model.
		• Monitored Cartesian space (box)
		• Violation if inside/outside
		This is a monitoring function.
			PL d / Cat.3	Violated position or orientation limits will be shown in Desk.
				• Unlock brakes of robot.
				• Guide robot out of Cartesian position limit. Desk shows if position limits are not violated anymore.
				• Finish recovery by pressing Confirm in Desk.

Name	Abbreviation	Description	Safety Rating	Recovery in case of violation Note: The operator can recover all violations.
Safely limited end-effector orientation	SLO	Monitoring of the orientation of the flange coordinate system. The reference orientation is defined in the base coordinate system. SLO monitors the difference between flange orientation and reference orientation. The safety function is violated if the difference is greater than the defined limits. The monitoring can be configured to signal violation either when the orientation is inside the defined limits or outside the defined limits. Parameterization: • Permitted flange orientation range in all three directions of the reference orientation • Reference orientation with respect to the base frame • Tool orientation with respect to the flange frame. This is a monitoring function.	PL d / Cat.3	
Safely limited Cartesian speed	SLS-C	Monitoring the Cartesian speed of certain points on the robot structure. The following points are monitored: • Flange • Elbow • Wrist • Centers of customer-defined tool spheres Parameterization: • Limit for Cartesian speed This is a monitoring function.	PL d / Cat.3	A violation of the speed limit is shown in a dialog in the Franka UI. • Confirm violation by pressing the button. No further recovery procedure is necessary.
Safely monitored standstill	SMSS	Monitoring the standstill in Cartesian space of certain points on the robot structure. The following points are monitored: • Flange • Elbow • Wrist • Centers of customer-defined tool spheres The user cannot change the parameters of this safety function. This is a monitoring function.	PL d / Cat.3	A violation dialog is shown in the Franka UI. • Confirm violation by pressing the button. No further recovery procedure is necessary.
Safe End Effector Power off	SEEPO	Safely switch off the power provided to the end effector (48 V power line). The behavior of SEEPO can be configured in the safety setup. E.g., it can be configured that SEEPO switches off the power when an emergency stop is triggered. Parameterization: • General configuration, whether SEEPO is active or not • Switch-off triggers of SEEPO	PL b / Cat. b	The power of the end effector can be switched on again in Settings or the sidebar of Desk.

Internal safety functions (not parametrizable and configurable in safety rules)

Name	Abbreviation	Description	Safety Rating	Reaction	Recovery in case of violation Note: The operator can recover all violations.
Safely limited joint angle	SLP-J	Monitoring the position of each joint in joint space. This safety function is only used internally to protect the joint limits of the robot, prevent self-collisions and local clamping. It is not available in user-defined scenarios. This is a limiting function.	PL d / Cat.3	-	Dialog within Desk informs the user about the violation and allows recovery. • To enable recovery motion, press the External Enabling Device. • Unlock the joint that shall be moved by clicking the unlock icon in the recovery dialog. • Move the joint by pressing the +/- buttons in the recovery dialog. Hint: Joints in a violated state can only be moved in a non-violated direction. All other joints can be moved in both directions to move the robot into a more convenient pose.
Safely limited joint speed	SLS-J	Monitoring the speed of a single joint in joint space. This internal safety function is used, e.g., to prevent fast motions during joint position recovery. This is a monitoring function.	PL d, Cat. 3	Cat. 1 Stop	A violation dialog is shown in the Franka UI. 1. Confirm violation by pressing the button. No further recovery procedure is necessary.
Safely limited distance	SLD	SLD monitors a single joint to stay within a permitted position window. This internal safety function is used, e.g., to prevent excessive motion during the brake opening procedure. This is a monitoring function.	PL d, Cat. 3	Cat. 1 Stop	A violation dialog is shown in the Franka UI. 1. Confirm violation by pressing the button. No further recovery procedure is necessary.

Stopping functions

Name	Description	Safety Rating
Category 0 stop	Robot is stopped immediately by removing power from the motors and applying the brakes.	PL d / Cat.3
Category 1 stop	Robot is stopped in a controlled manner using the normal control of the motors until the standstill of each joint. The brakes are safely applied, and the power is safely removed from the inverters upon standstill. The Cartesian speed deceleration is monitored.	PL d / Cat.3
Category 2 stop	Robot is stopped in a controlled manner using the normal control of the motors until the standstill of each joint. Upon standstill, the standstill is safely monitored. The Cartesian speed deceleration is monitored.	PL d / Cat.3

Safe outputs

Name	Description	Safety Rating
Safe End Effector Power Off	Switch the power provided to the end effector (48 V power line) off.	PL b / Cat.b

Further safety ratings

- The 3-position Enabling Button near the robot's flange is realized in compliance with IEC 60204-1:2016 and IEC 60947-5-8:2006.
- The 3-position External Enabling Device provided by Franka Emika is realized in compliance with IEC 60204-1:2016 and [60947-5-8].

- The emergency stop provided by Franka Emika complies with IEC 60204-1:2016 and EN ISO 13850:2015.

Other safety-related recoveries (in case of safety errors)

Joint position error recovery

Only safety operators can recover joint position sensor errors.

A dialog within Desk informs the user about the error and allows recovery.

Use the external enabling device to enable recovery motion.

Unlock the joint that shows the position error by clicking the unlock icon in the recovery dialog.

Move the joint by pressing the “move to reference” button in the recovery dialog.

All other joints that do not have an error can be moved in both directions via +/- buttons to bring the robot into a more convenient pose.

Visually check that the affected joint moved into the correct reference position. If correct, confirm recovery. The robot can be used again. If not correct, contact support.

Safe input error recovery

Safe input errors are recoverable by confirming the respective dialog in the Franka UI if confirmation for those inputs is configured in Watchman.

Other safety errors

Other safety errors are typically not recoverable. Please try to restart the system to recover from such errors. If the error persists, contact your vendor or Franka Emika.

General info for all cases

In case of a safety violation, the robot does not allow motion until the recovery has been accomplished.

In case of a safety violation, the base flashes slowly in red.

Desk will show a recovery wizard to perform the recovery procedure.

Only the safety operator can recover joint position errors.

The operator can perform all other recoveries.

4.12 Safety Settings and Watchman

Draft and committed settings

The “committed safety settings” are the settings currently active on the robot (A). To change safety settings, switch to “Draft” mode in Watchman. In “Draft” mode, new settings can be created and validated before committing them as the new active settings.

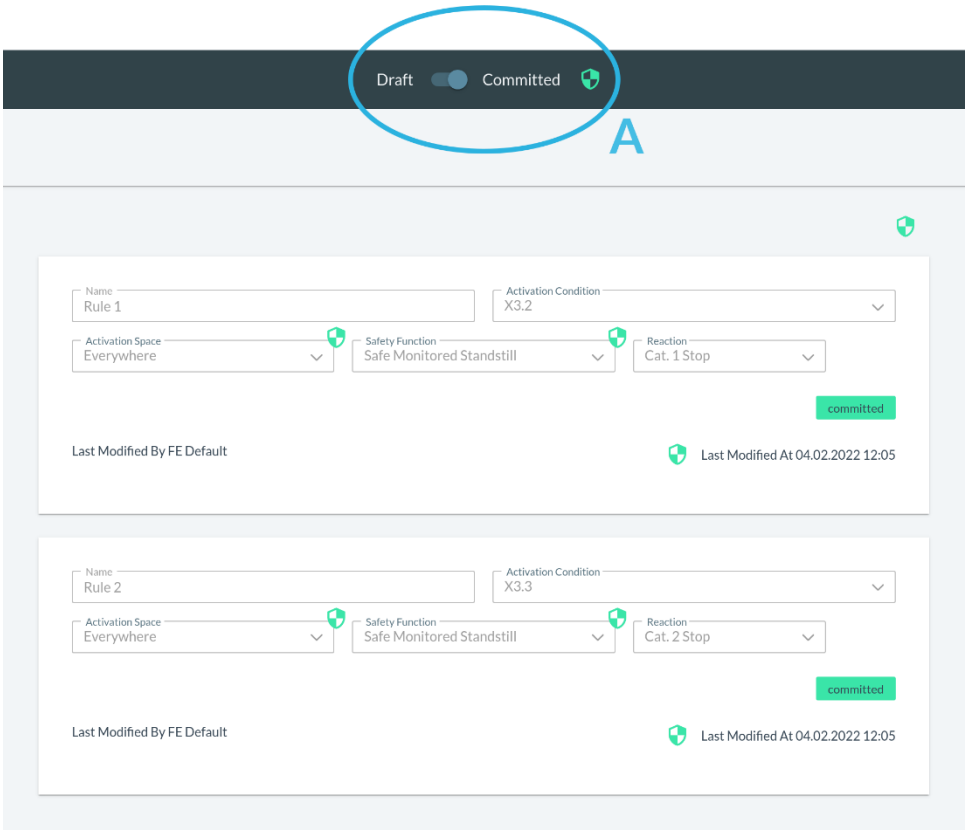


Figure 4.5

Editing in “Draft” mode is divided into the Safety setup and the Safety scenarios.

Safety setup

The safety setup contains all general settings regarding the safety system.

Enable Assist

Assist allows the user to hand-guide the robot in execution mode. Depending on the risk analysis requirements, this mode can be enabled or disabled in the safety setup.

Safe input confirmation

For every safe input, the user can configure whether a confirmation is required or not. For example, a confirmation could be needed for a door switch, but it could be unnecessary when using a laser scanner. The appropriate settings must be derived from the cell safety concept and analysis.

End effector

Model of the end effector

- The model of the end effector is used in all spatial safety functions (e.g., the Safely limited Cartesian space and velocity). The user can model the end effector by five spheres placed relative to the flange. The surfaces of the spheres are considered during the spatial safety function SLP-C. The center of the sphere is used for SLS-C.
- For more information on SLP-C and SLS-C, see chapter Safety Functionalities.

SEEPO Behavior

- Defines when the power to the end effector is safely switched off.

End effector power

- Defines when the end effector power (corresponding to the Safe End Effector Power OFF function) is supplied to the end effector.

Safety scenario configuration

The safety operator can customize some of the pre-defined safety scenarios using Watchman, see chapter Safety Concept. It is not possible to create new safety scenarios.

To customize a safety scenario, safety rules can be added to or deleted from it.

Not all scenarios are fully editable. If customization is restricted, e.g., no button to create further rules or delete certain rules is shown.

Each safety rule consists of a safety function, optional conditions defining when the rule is active, and a reaction triggered when the safety function is violated.

Some safety functions require setting additional parameters (e.g., the monitoring space of an SLP-C function).

All safety rules can have a custom title/summary to simplify keeping track of the single rules and finding the respective rules when they are violated.

Procedure

1. Edit safety scenarios (B).

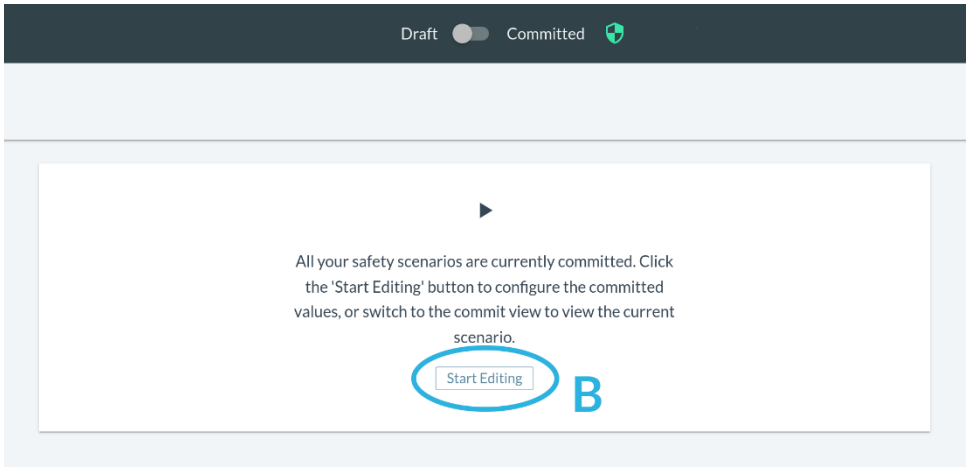


Figure 4.6

2. Create (C) or delete (D) rules.

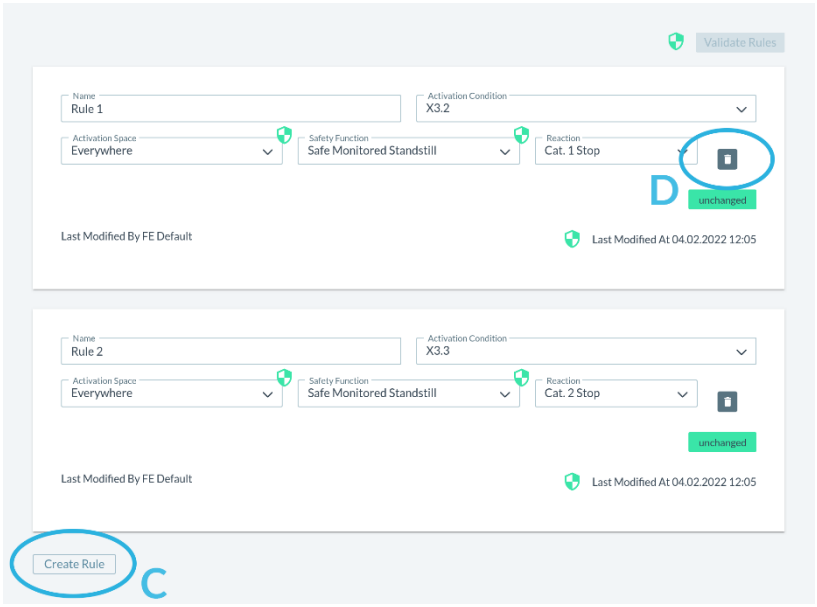


Figure 4.7

3. Modify a rule. The input for the activation condition (E) can be selected, as well as the activation space (F), the safety function (G), and the reaction (H) in case of a violated safety function.

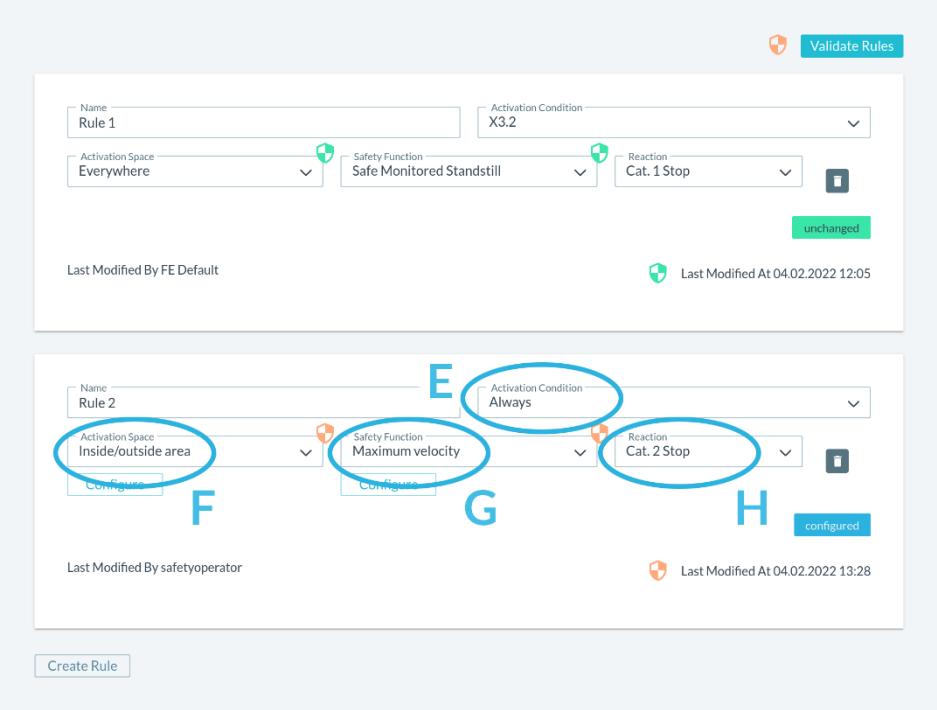


Figure 4.8

Validation of safety setup and customized scenarios

When a safety setting is changed, the system needs to be validated before committing it as an active setting. The validation process starts at the safety function parameters and is followed by the validation rule, scenarios, and the overall validation:

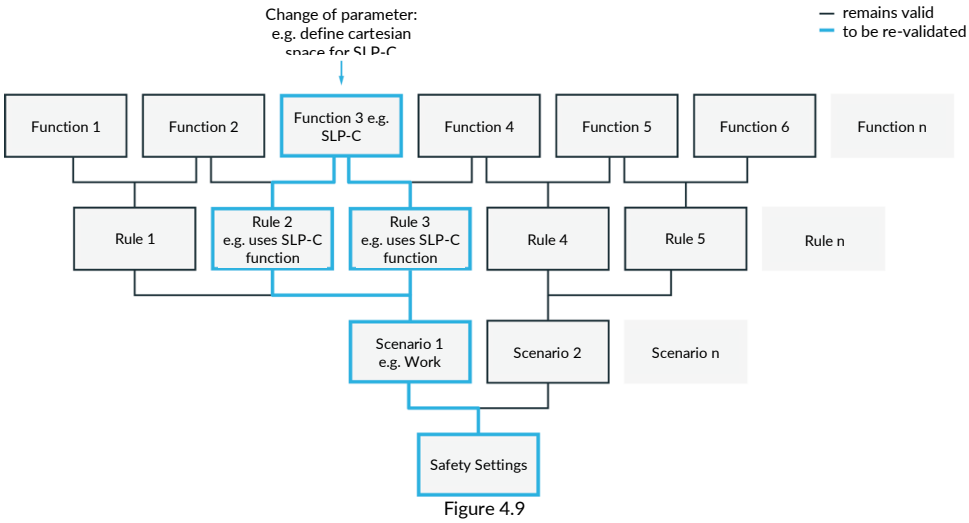


Figure 4.9

Any change to a safety function invalidates the function itself, its contained rule, and the respective scenario. All other functions, rules, or scenarios depending on the change are also invalid. All functions, rules, and scenarios not affected by the change remain valid. In Watchman, the safety operator can always check what part of the safety settings needs revalidation.

To validate a part of the safety settings, the safety operator needs to check whether all parameters, functions, rules, and scenarios are set correctly according to the risk analysis results. To check whether the settings execute the correct behavior, perform a test run and validate the draft settings in Programming mode before finally executing them.

Validation of safe inputs

- Check whether the activation condition matches the safety concept defined by the risk analysis
- Connect peripherals to the safe input.
- Check whether the status shown in the Franka UI changes upon triggering the input.

Validation of SLP-C and SLO

- Check whether parameters of the safety functions match the safety concept defined by the risk analysis.

Validation of SLS-C

- Guide the robot in Programming mode to violate the defined rules.
- Check violation of the rules at the expected positions/orientations with the violation status shown next to the safety function in the Franka UI.

Validation of SEEPO

- Check whether the parameters of the safety function match the safety concept defined by the risk analysis.

Validation of whole rules, scenarios, and overall configuration

- Check whether end-effector power is turned off in all expected situations.
- Check on each level whether the combination of activation triggers, safety functions, reactions, rules, and scenarios matches the safety concept defined by the risk analysis.

While in draft mode, non-validated safety settings are indicated by orange validation markers:

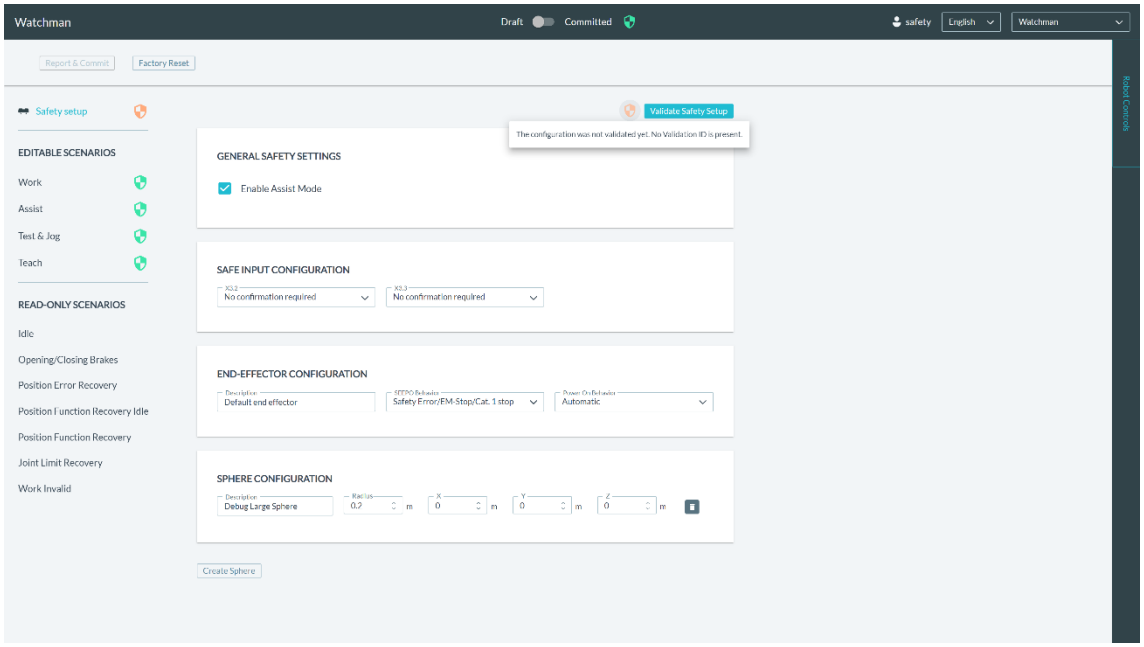


Figure 4.10

After everything has been validated all markers are green, indicating that the settings are ready to be committed by clicking the "Report & Commit" button.

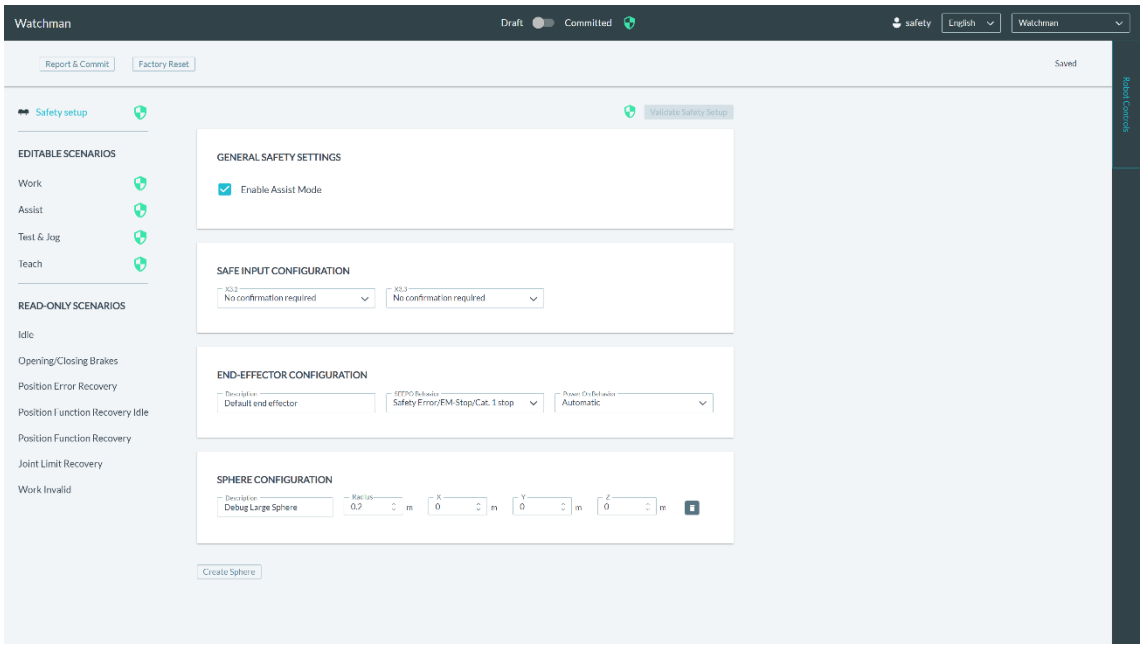


Figure 4.11

Clicking this button leads to the commit report which can be printed/saved for documentation purposes. This dialog can be downloaded again for the committed settings at any time.

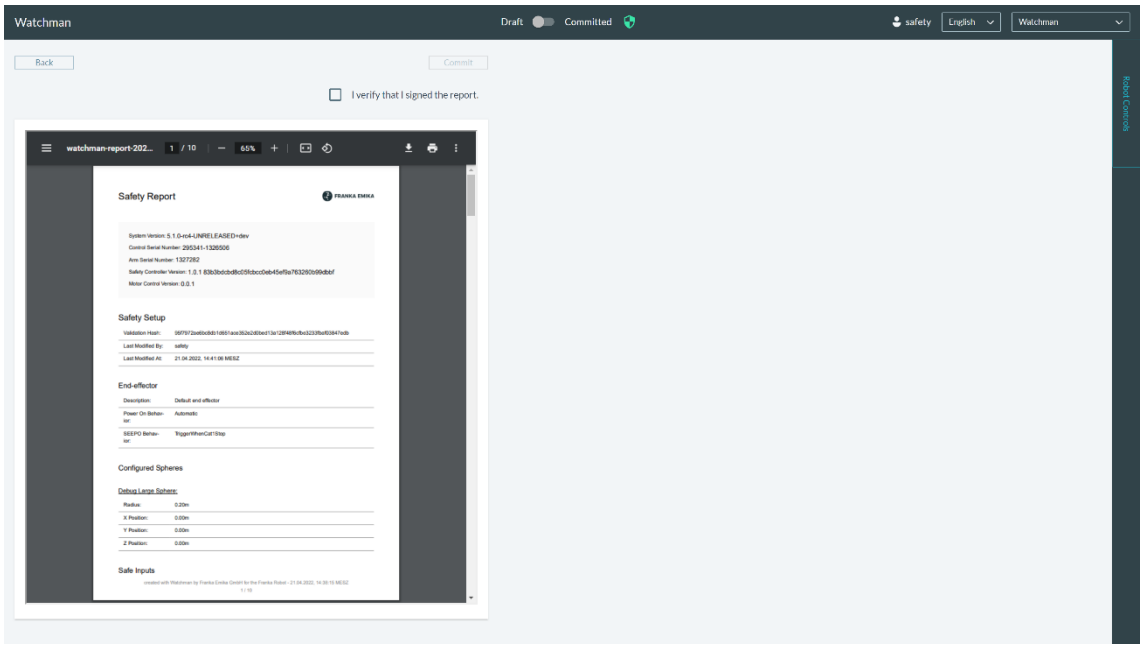


Figure 4.12

Committed (or unchanged draft) settings can be compared to the report by looking at the validation hashes generated for rules and scenarios:

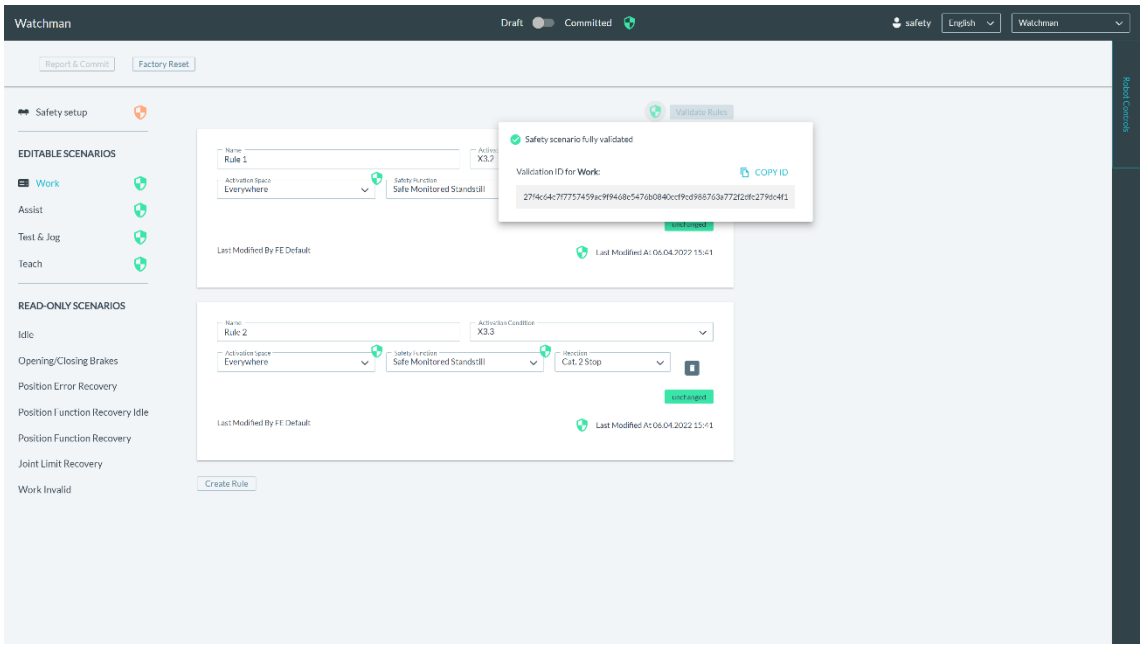


Figure 4.13

Wiring for X3

Safe inputs (X3.n) always have two separate channels, designated A and B. Each channel is implemented via its p- and n-pins which have to be connected via a floating switch. During regular operation, both channels must be in the same state (open/closed) and not be connected; any other state will be considered a failure by the safety system.

The safe inputs are galvanically isolated from the robot system and other interfaces at the robot, although all safe inputs share a common electrical domain, regardless of their interface connector.

Safe Inputs electrical domain characteristics for X3:

- signal voltage 24 V
- signal current 30mA

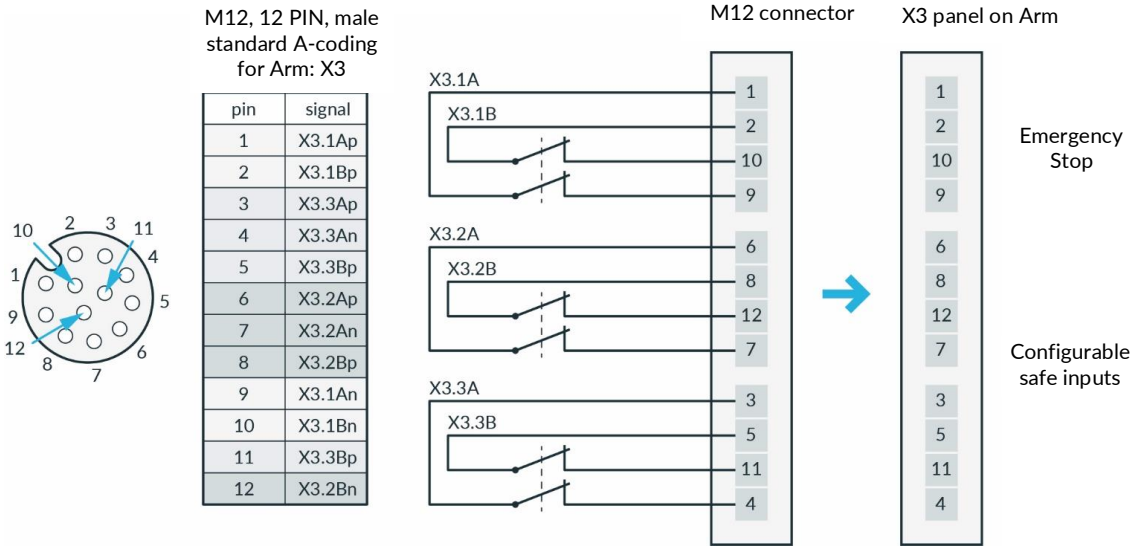


Figure 4.14

5 ROLES AND PERSONAE

⚠ WARNING

Insufficiently qualified personnel

Insufficiently qualified personnel may cause severe injuries to themselves or others.

- Read the manual thoroughly and resolve any questions.
  All persons entering the maximum space must use their knowledge and experience, be aware of potential risks regarding the robot system, and be adequately prudent in their behavior.
- The responsible person must explicitly inform the users about the limitations and restrictions of Franka Production 3.

NOTICE

Intoxicated personnel

Intoxicated personnel may cause material damage to machinery and equipment.

- Do not operate Franka Production 3 under the influence of drugs, alcohol, or medication impacting reactions.

NOTICE

User roles should only be assumed by qualified or sufficiently trained personnel. They should be instructed on the conduct in emergency or abnormal situations. The operating entity must choose the personnel based on experience, training, or similar existing duties in robotics, automation, safety, or risk of injury.

Creating user roles

Creating an administrator

When logging in for the first time, creating an administrator user is compulsory.

1. Enter a username.
2. Enter a password.
3. Confirm the password.

Administrator login information should be kept safely and securely. The only way to access the role without a password is to perform a factory reset that deletes all prior information.

NOTICE

Only qualified or sufficiently trained personnel that possess adequate technical skills are permitted to operate the robot. The qualification of said personnel includes but is not limited to professional technical education, a university degree in engineering, or professional experience in the field of robotics or automation.

FE suggests a product specific training performed by FE, partners, and affiliates.

NOTICE

Always use secure passwords to prevent unauthorized persons from accessing the system.

Creating and editing users

Procedure

1. Log into the Franka UI. For information on the Franka UI, see chapter Franka UI.
2. Go to Settings.
3. Click on the Users tab.
4. Add new users or edit existing ones.

There must always be one administrator defined. This means that the last administrator cannot be deleted. Every user must be assigned a role, and several users can have the same role. The current version of Franka Production 3 supports the roles described in the following passages.

Responsible person

The responsible person is responsible for compliance with occupational health regulations and the operational safety ordinance. The responsible person for Franka Production 3 includes but is not limited to the entrepreneur, the director of the institute, the employer, or a delegate responsible for the use of Franka Production 3.

The responsible person is responsible for the following:

- The responsible person must fulfill the monitoring obligations.
- The responsible person must ensure that all staff members working with Franka Production 3 are suitably qualified to do so and have been informed about the possible dangers Franka Production 3 may present.
- The responsible person must provide training and instructions in given intervals to create and consolidate risk awareness.

Administrator

The administrator has all the rights that the operator has. An administrator is a person authorized by the responsible person to set up and access the robotic system and to utilize the user interface Franka UI as follows:

- Set and change roles, access rights, and passwords
- Set and change non-safety-related parameters of the system (e.g., change end effector settings)
- Program and teach the robot system
- Install system updates, features, and apps
- Edit system configuration
- Create, edit, and set parameters for tasks

Safety operator

The safety operator has the same rights as the operator, plus the rights to set up and confirm safety settings. The safety operator can utilize the user interface Franka UI as follows:

- Edit safety configurations
- Program and teach the robot system
- Create, edit, and set parameters for tasks

Operator

An operator can access Franka Production 3 and utilize the user interface Franka UI to use Franka Production 3 within the limits defined by the responsible person, the administrator, and the safety operator. The operator can utilize the user interface Franka UI as follows:

- Start, monitor, and stop the intended operation of Franka Production 3
- Download and select tasks
- View Tasks and App settings
- View status of the system (network, robot, end effector)
- View safety settings
- Lock/unlock joints
- Start/stop a task
- Guiding (no saving of poses possible)
- Switch Pilot-Mode button
- Move to transport pose for packing
- Download log files from the system
- Shutdown and reboot the system

The operator only has limited access to Franka UI.

Integrator

The integrator is responsible for assembling the partly completed machinery into the final machinery by combining the robot with other equipment or another machine, including other robots, to form a machine system.

The integrator also conducts an appropriate risk assessment to identify residual risks and eliminate and minimize them.

The integrator is responsible for the safety of the final application.

For further information on liability-related topics, see chapter Notice of Liability.

6 SCOPE OF DELIVERY AND ACCESSORIES

6.1 Equipment Overview

The following illustration represents a sample wiring and gives an overview of the equipment.

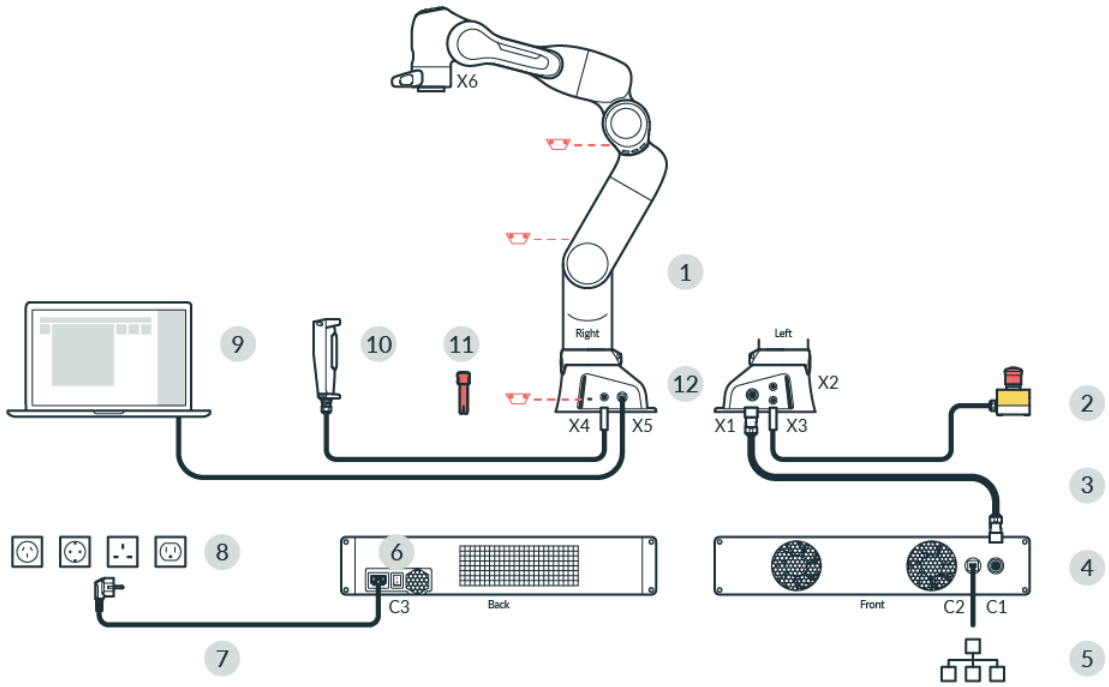


Figure 6.1

1	Arm	7	Power cable
2	Emergency Stop Device	8	Mains power outlet
3	Connecting cable	9	Interface device (not included) with Franka UI
4	Control	10	External Enabling Device
5	Ethernet (Network)	11	Emergency Unlocking System
6	Power switch	12	Connection to functional earth

6.1.1 The Arm

The Arm has the following components:

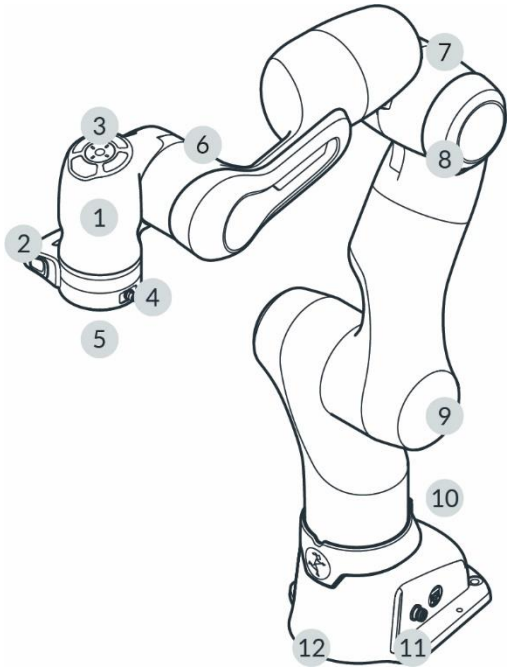


Figure 6.2

1	Pilot	7	Elbow
2	Pilot-Grip	8	Soft protector
3	Pilot-Disc	9	Shoulder
4	X6 - End effector connector	10	Holder for Emergency Unlocking Tool
5	Flange for end effector	11	Status light
6	Wrist	12	Base

Pilot top view

The user interface Desk and the integrated end effectors can be operated directly from the robotic Arm via the Pilot-Disc.

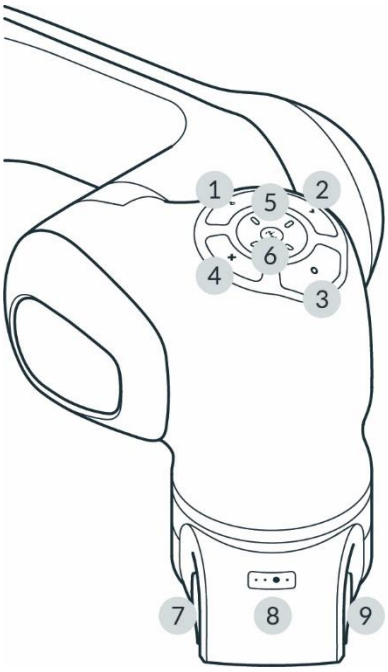


Figure 6.3

1	Pilot-Mode button	6	Status light
2	Confirm button	7	Enabling Button
3	Teach button	8	Guiding-Mode Button
4	Delete button	9	Guiding Button
5	Arrow keys		

Pilot

The Pilot is the user interface integrated directly into the Arm for the guiding (also referred to as hand-guiding) of the robot and the smooth interaction with end effectors and Desk. The Pilot consists of Pilot-Disc (1-6) and Pilot-Grip (7-9).

For more information on Desk, see section Desk in chapter Franka UI.

Pilot-Disc (1-6)

The Pilot-Disc is located on top of the Pilot and is used for interacting with the robot system. Navigate to Desk by pressing the Pilot-Mode button (1) on the Pilot-Disc. Select individual apps, parameterize them or enter poses by manually guiding the Arm to the desired pose and pressing the Teach button (3).

Pilot-Grip (7-9)

The Pilot-Grip is located near the robot's tip as part of the robot structure. The Pilot-Grip provides a Guiding Button, an Enabling Button, and a Guiding-Mode Button.

Pilot-Mode button (1)

By pressing the Pilot-Mode button (1), the user switches between using the arrow keys of the Pilot-Disc to navigate Desk or to control the integrated end effectors (e.g., Franka Hand).

Confirm button (2)

If illuminated, pressing the Confirm button confirms any changes made in a context menu section and skips to the next section. The Confirm button saves any selections made.

Teach button (3)

Teach a component value (i.e., a robot pose or gripper width) by bringing the system to the desired configuration and pressing the Teach button.

Delete button (4)

If illuminated, pressing the Delete button deletes a selected component value or section.

Arrow keys (5)

The Arrow keys can either navigate Desk or control integrated end-effectors depending on the Pilot-Mode. In end-effector mode, the key assignment depends on the selected end-effector.

Enabling Button (7)

The Enabling Button is located on the left side of the Pilot-Grip and enables robot motions if pressed to the middle position. To move the robot, half-press the Enabling Button while pressing the Guiding Button simultaneously. The Enabling Button is safety rated per the requirements in EN ISO 10218-1. The three positions of the Enabling Button either stop, re-enable, or move the robot. To immediately stop the robot, release or fully press the Enabling Button. After stopping, release it first completely and then press it again to its middle position to re-enable the robot.

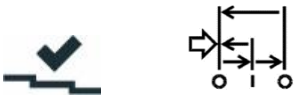


Figure 6.4

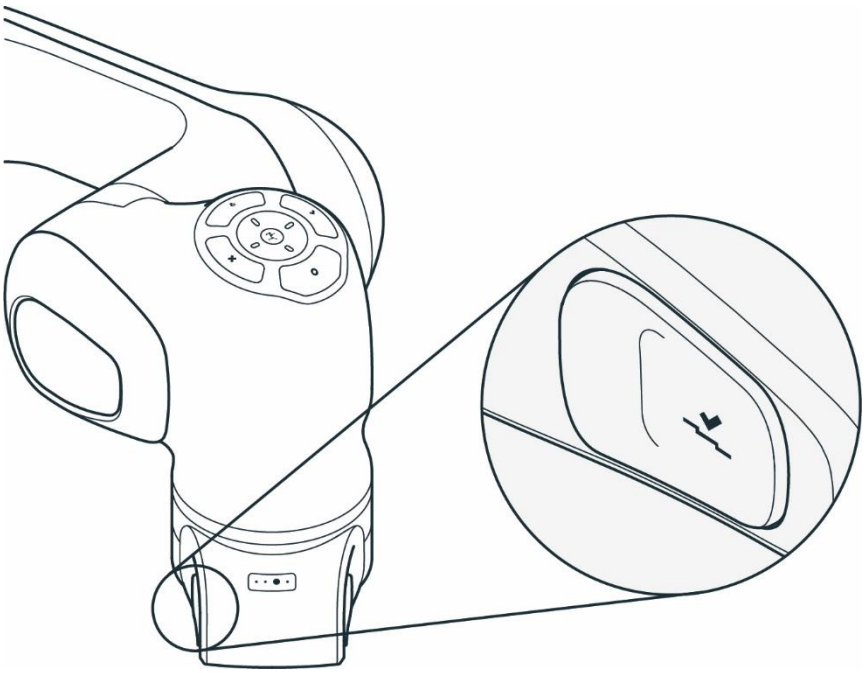


Figure 6.5

Guiding-Mode Button (8)

Figure 6.6

The Guiding-Mode Button switches between different robot hand-guiding modalities: translation only, rotation only, free moves, and user-defined. The Guiding-Mode Button is located on the top of the Pilot-Grip and allows the user to change between different Guiding Modes. You can switch between different robot hand-guiding modalities by pressing the Guiding-Mode Button twice or more.

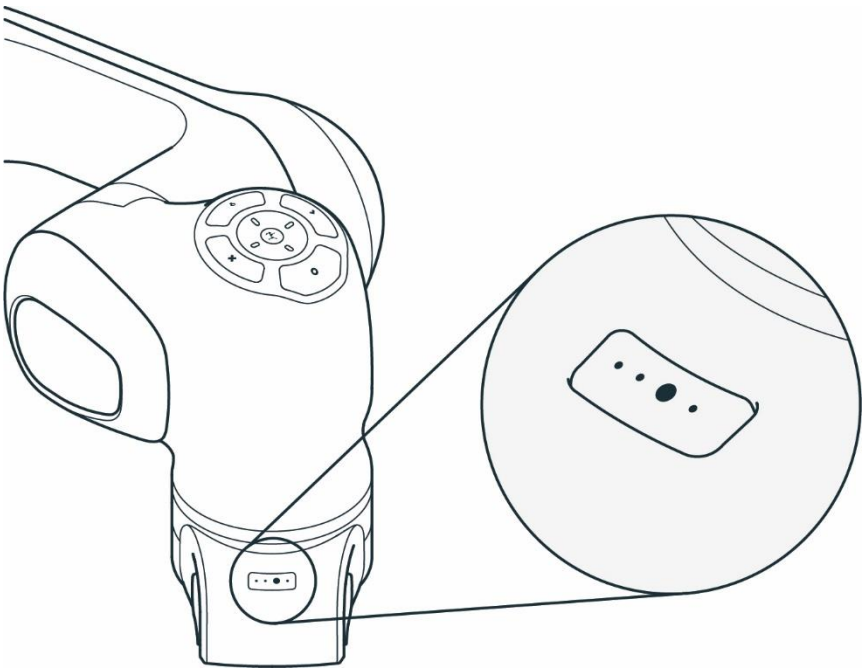


Figure 6.7

Guiding Button (9)

Figure 6.8

The Guiding Button is located on the right of the Pilot-Grip. Press the Guiding Button while half-pressing the Enabling Button (7) simultaneously to move the robot.

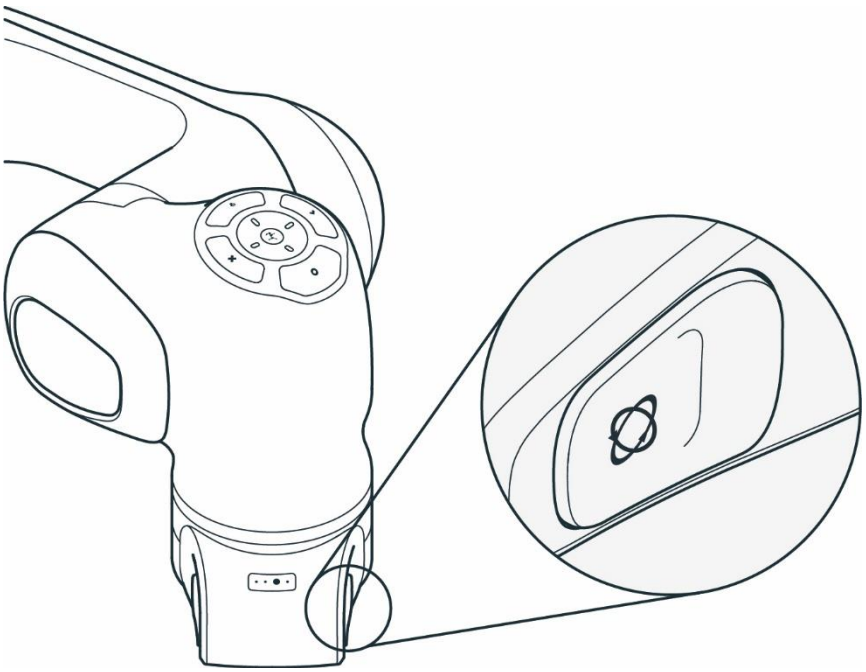


Figure 6.9

Base of the Arm

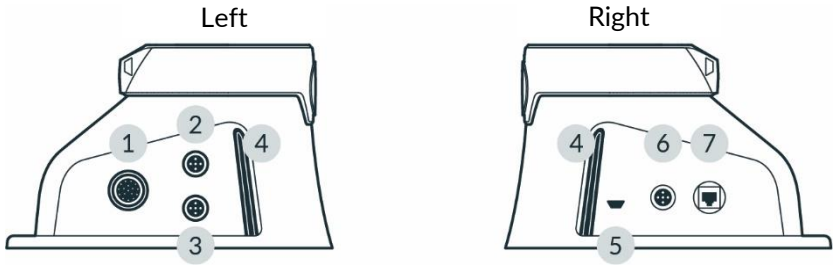


Figure 6.10

1	X1 - Connection to Control connector	5	Insertion point for Emergency Unlocking Tool
2	X2 - Digital IOs connector	6	X4 - External enabling connector
3	X3 - Safe inputs connector	7	X5 - Robot network connector
4	Status light		

The base of the robot has several ports to connect and support various equipment:

- X1 - Connection to Control
- X2 - Digital IOs
  The Data Input-Output carries two non-safe digital inputs and outputs each. The inputs and outputs and the 24 V power supply are galvanically isolated from the robot system and other interfaces at the robot. The functionality of the physical ports depends on the particular software version.

- X3 - Safe inputs
  - X3.1 - Emergency stop: A category 1 stop command will be triggered to stop the robot and optionally cut the power to the end effector by pressing the Emergency Stop Device. This behavior can be configured in Watchman. Watchman is a web browser accessible user interface to set and visually validate safety-related parameters of Franka Production 3, e.g., safety-related monitored speed or safety-related monitored spaces. It is part of the Franka UI. For more information on Watchman, see section Watchman in chapter Franka UI.
  - X3.2, X3.3 - (configurable) Safe inputs: The X3 port allows two additional safe inputs. Their behavior can be configured in Watchman. For more information on Watchman, see section Watchman in Franka UI.
    Per default, X3.2 and X3.3 are configured to a safely monitored standstill and a category 1 stop. The default configuration is only applied to the "Work" scenario.
- X4 - External enabling
  The 3-position External Enabling Device will enable “Test & Jog” when the system is in Programming mode. It allows Franka Production 3 to move. Programs can be started via Desk.
- X5 - Robot network
  The interface device running the browser-based Franka UI is connected to the X5 Ethernet port.

NOTICE

A custom connector with the corresponding safety signals must be assembled to utilize the configurable Safe inputs (X3.2, X3.3). When doing so, the existing Emergency stop can no longer be used. Therefore, the Emergency stop functionality must be integrated for channel X3.1 in the custom connector.

NOTICE

By default, the Safe input channels X3.2 and X3.3 are assigned to the SMSS safety function in the "Work" scenario in Watchman. Suppose no external safety devices are connected to X3.2 and X3.3 (only Franka Emika emergency stop is connected to X3.1). Those inputs will be considered “activated,” meaning it will not be possible to move the robot with the default "Work" scenario rules. Depending on the application-specific risk & hazard analysis, the default rules may be changed to allow robot movements regardless of X3.2 and X3.3.

End effector flange

End effectors, such as Franka Hand, can be connected via the end effector flange. The end effector flange has been developed according to the relevant quality standards of DIN ISO 9409-1-A50. For more information, see the chapter Mounting End Effectors.

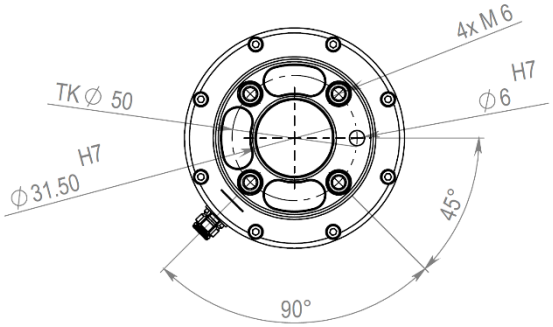


Figure 6.11

NOTICE

Franka Hand is not part of the certified machinery.

6.1.2 Control

NOTICE

The operation of the Arm is only permitted with the Control provided by Franka Emika.

The Control is the main control unit and is part of Franka Production 3. The main control unit allows monitoring and control of the mechanical structure of the robot.

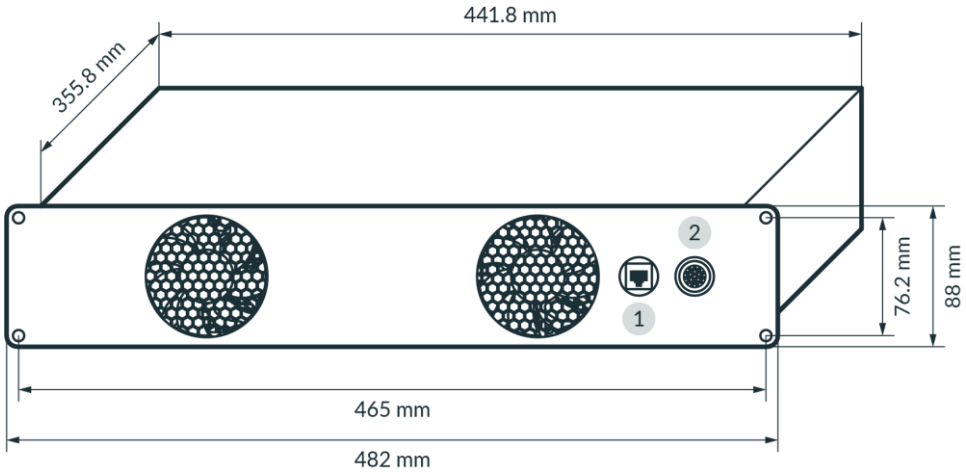


Figure 6.12

1	C2 - Shop floor network connector	2	C1 - Connection to Arm connector

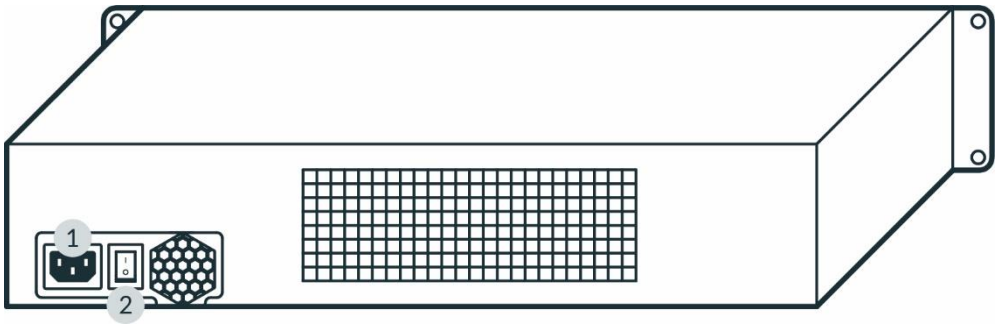


Figure 6.13

1	C3 – Power connector	2	Power switch

Installation

The Control fits in a 2RU 19” rack.

6.2 Scope of Delivery and Additional Equipment

Included in the box

Arm

- 1x Arm
- 1x Emergency Unlocking Tool
- 4x screw (ISO 4762, M8x20, ST 10.9 A2K)
- 4x washer (ISO 7089, M8, ST HV300 A2K)
- 1x screw (ISO 4762, M5x8, ST 8.8 A2K)
- 1x tooth washer (DIN 6797-A, M5, ST A2K)
- 1x Getting Started guide (Document number: 110030)
- 1x Labeling material for the integrator (Document number: 110040)
- 1x Drilling template (Document number: 110050)
- 1x Reference pager for multilingual documentation (Document number: 110060)

Figure 6.14

Control

- 1x Control
- 1x country-specific power cable

Figure 6.15

Devices

- 1x External Enabling Device
- 1x Emergency Stop Device

Figure 6.16

Accessories

- 1x Connecting cable

Figure 6.17

Not included in the box

For additional accessories, e.g., cobot pump, visit https://franka.world/.

The following equipment is not included:

- Interface device
  - Tablet/notebook/PC
    The interface device should be equipped with a browser (Chrome, Chromium, or Firefox), an Ethernet port, and 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 the Control to the company network or PC workstation
  - Mounting accessories (recommended by Franka Emika): 2x 6 mm h8 pins for precise mounting of the Arm, if applicable
  - Baseplate to mount the Arm (depending on the baseplate, different screws and washers may be needed, see table in chapter 9.4 Mounting the Arm)
  - Functional earth cable with eye
  - Thread
- Tools
  - Hex key for mounting the Arm on the baseplate
  - Screwdriver for connecting the functional earth cable
  - Level for ensuring the horizontal installation of the Arm
  - Torque spanners to tighten screws with 30 Nm

6.3 Available Spare Parts and Accessories

The spare parts for Franka Production 3 include but are not limited to:

- Arm
- Control incl. country-specific power cable
- External Enabling Device
- Emergency Stop Device
- Connecting cable (2.5 m, 5 m, or 10 m)
- Emergency Unlocking Tool
- Franka Hand (Not part of the certified machinery)
- Cobot pump (Not part of the certified machinery)

7 TECHNICAL SPECIFICATIONS

FRANKA EMIKA

Franka Production 3
Release Version: 1.3 (August 2022)
Document number: 110020

Datasheet [1]
Arm & Control

ARM			
Degrees of freedom	7	Interfaces	• ethernet (TCP/IP) for visual intuitive programming with Desk • safety-rated input for external enabling device • 2 configurable safety-rated inputs for emergency stop devices, safeguards or other protective devices (OSSD devices via external OSSD converter connectable) • hardware prepared for: 2x DI & 2x DO (24V, isolated, EN 61131-2 type 3 characteristics, 100 Hz sampling rate) • Control connector • connector for end effector
Payload	3 kg		
Maximum reach	855 mm		
Force/Torque sensing	link-side torque sensor in all 7 axes		
Joint position limits	A1, A3: -166/166 deg A2: -105/105 deg A4: -176/-7 deg A5: -165/165 deg A6: 25/265 deg A7: -175/175 deg		
Mounting flange	DIN ISO 9409-1-A50		
Installation position	upright	User Interfaces at the Arm's Pilot Grip	• integrated safety-rated guiding enabling switch • guiding button • guiding mode selector
Weight	~ 17.8 kg		
Protection rating	IP40		
Ambient temperature [2]	+5 °C to +45 °C		
Air humidity	20 – 80 % non-condensing	User Interfaces at the Arm's Pilot Disc	• status light • Pilot mode selector • arrow keys, teach, confirm, delete

CONTROL	
Controller size (19")	355 x 483 x 89 mm (D x W x H)
Supply voltage	100 – 240 V_{AC}
Mains frequency	50– 60 Hz
Power consumption	~ 80 W
Active power factor correction (PFC)	yes
Weight	~ 7 kg
Protection rating	IP20
Ambient temperature [2]	+5 °C to +45 °C
Air humidity	20 – 80 % non-condensing
Permitted mounting orientation	horizontal
Interfaces	• ethernet (TCP/IP) for internet and/or shop-floor connection • power connector IEC 60320C14 (V-Lock) • Arm connector

PERFORMANCE	
Motion	
Joint velocity limits	A1-A4: 150 °/s A5-A7: 301 °/s
Cartesian velocity limits	up to 2 m/s end effector speed
Pose repeatability [3]	<+/- 0.1 mm (ISO 9283)
Interaction	
Guiding force	~ 2.5 N
Adjustable translational stiffness	10 – 3000 N/m
Adjustable rotational stiffness	1 – 300 Nm/rad
Monitored signals	joint position, velocity, torque cartesian position, force

ADD-ONS	
Fully integrated end effectors	• 2-finger gripper • Vacuum gripper
Fieldbuses	• Modbus/TCP • OPC UA

FRANKA EMIKA

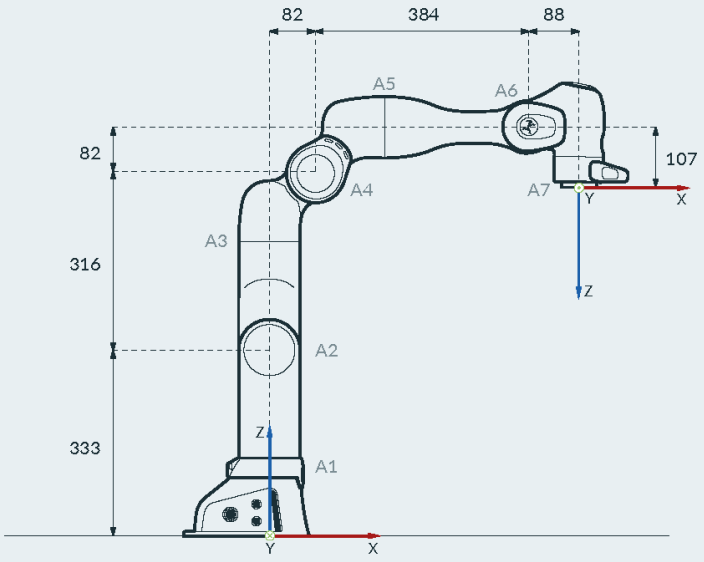
Franka Production 3
Release Version: 1.3 (August 2022)
Document number: 110020

SAFETY

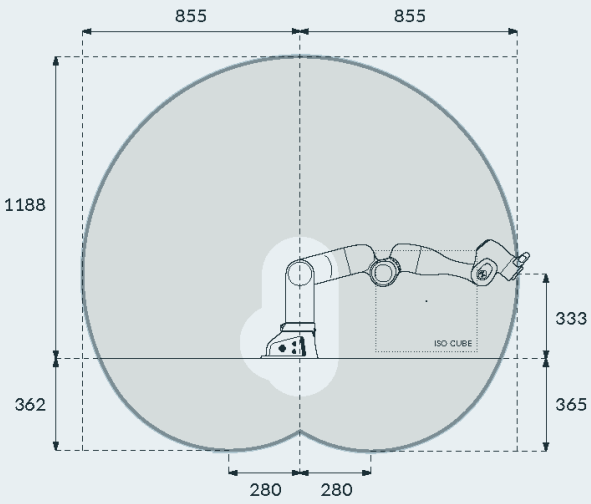
Certifications	
EN ISO 10218-1:2011 Robots and robotic devices - safety requirements for industrial robots Part 1: Robots	certified by TÜV SÜD Product Service
EN ISO 13849-1:2015 safety of machinery - safety-related parts of control systems	certified by TÜV SÜD RAIL
Collaborative operation modes	
Safety-rated monitored stop	fully integrated in PL d Cat. 3
Hand-guiding	fully integrated in PL d Cat. 3
Safety-rated speed and separation monitoring	realizable in combination with external protective devices up to PL d Cat. 3
Safety parametrization & validation	
Watchman	user interface to set and validate safety-related parameters
User management	role based access management
Safety Functions	
Emergency Stop (X3.1)	PL d / Cat. 3
External Enabling Device (X4)	PL d / Cat. 3
Enabling Button	PL d / Cat. 3
Two configurable safe inputs (X3.2 and X3.3)	PL d / Cat. 3
SLP-C: Safely limited Cartesian position	PL d / Cat. 3
SLS-C: Safely limited Cartesian speed	PL d / Cat. 3
SLP-J: Safely limited joint angle	PL d / Cat. 3
SLS-J: Safely limited joint speed	PL d / Cat. 3
SLD: Safely limited distance	PL d / Cat. 3
SEEPO: Safe End Effector Power off	PL b / Cat. b
Stopping Functions	
Category 0 stop	PL d / Cat. 3
Category 1 stop	PL d / Cat. 3
Category 2 stop	PL d / Cat. 3
Worst case safe Cartesian position accuracy for stopping functions	50 mm
Safety values according to EN ISO 13849-1	
PFH of PL d / Cat. 3 safety functions (Probability of Failures per Hour)	$< 1 \times 10^{-7}$
PFH of PL b / Cat. b safety functions (Probability of Failures per Hour)	$< 1 \times 10^{-7}$

1. Technical data are subject to change.
2. For more details see Product Manual Franka Production 3.
3. Based on ISO 9283 (Annex A), specified values refer to a workspace of 0.4 x 0.4 x 0.4 m centered at [0.498, 0.0, 0.226] m, with the Z-Axis of the flange oriented parallel to earth-gravity and the elbow positioned upwards.

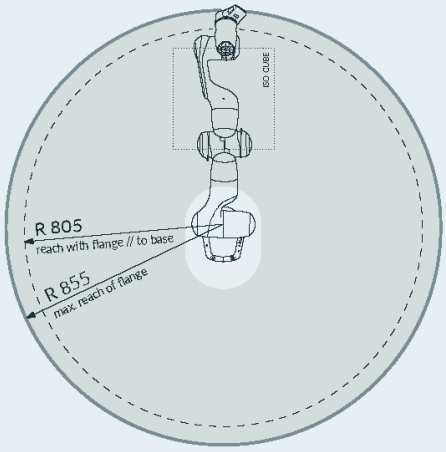
DIMENSIONS & WORKSPACE



Axes names with joint lengths [mm]



Workspace | side view [mm]



Workspace | top view [mm]

NOTICE

The probability of failure per hour was evaluated at 40 °C. However, the safety rating holds for all functions within the temperature range, including the extended temperature range.

If the system probability of failure per hour values are used for calculation, take the temperature into account.

For more information on the probability of failure per hour, contact Franka Emika at support@franka.de.

8 TRANSPORT AND HANDLING

⚠ WARNING

Heavy equipment

Due to the dead weight and geometric design, lifting and handling the equipment may cause back injury, and, if it falls, serious injury to fingers, hands, toes, and feet.

- Always wear personal protective equipment (e.g., safety shoes) when transporting, mounting, or demounting the equipment.
- The equipment must be placed on even surfaces to prevent it from tilting or sliding.
- Follow the company regulations on lifting loads and personal protective equipment.

⚠ WARNING

Damaged components

Electrical risks may lead to severe injury.

- Check if the packaging is in sound condition and fulfils its protective function.
- Check the cables, plugs, and mechanical housing for cracks and broken insulations.
- Do not use damaged cables, plugs, and mechanical housing for operation. In cases of doubt, contact Franka Emika.

NOTICE

Material damage to Arm and Control

Mechanical shock may cause damage or loss of calibration of sensitive electromechanical components in the Arm and the Control.

- Avoid shock.
- Carefully set down the devices.
- Always store and transport the devices in their original packing, even for short-distance transport.

NOTICE

Material damage to Arm, end effectors, and objects in the maximum space

Sensitive electromechanical components in the Arm and end effectors may be damaged if end effectors are connected to the Arm while bringing it into transport position.

- Dismount any end effector before bringing the Arm into transport position.
- Do not leave loose objects in the maximum space.

8.1 Ambient Conditions for Delivery and Transport

The system can be stored and transported within the temperature range of -25 °C to +70 °C.

Handling and Lifting

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

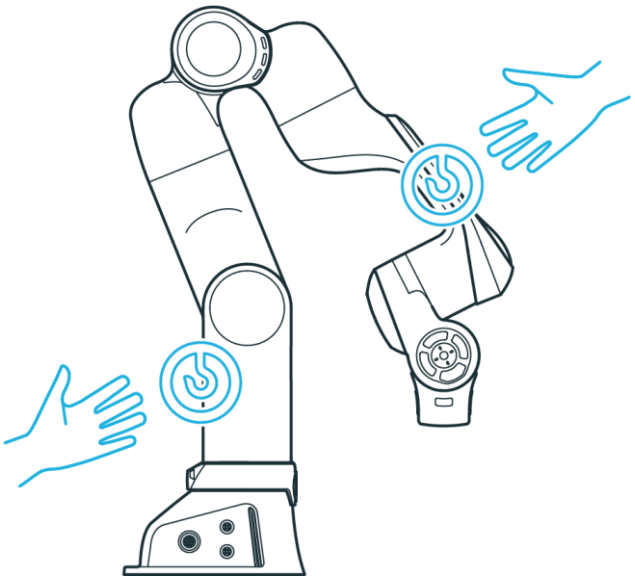


Figure 8.1

NOTICE

Material damage to the Arm

Moving the Arm by force in a locked state will lead to a momentary slipping of internal parts which causes loss of calibration and damage to the Arm.

- Handle, lift, and transport the Arm only at the points indicated in this manual to avoid overstressing the joints of the Arm.
- The Arm is to be handled gently even when set-up and switched on or off.

NOTICE

Do not step or lean on the Arm.

NOTICE

Pay attention to the weight.

The weight of the Arm is approx 17,8 kg

9 MOUNTING AND INSTALLATION

WARNING

Heavy equipment

Due to the dead weight and geometric design, lifting and handling the equipment may cause back injury, and, if it falls down, serious injury to fingers, hands, toes, and feet.

- Always wear personal protective equipment (e.g., safety shoes) when transporting, mounting, or demounting the equipment.
- Always lift the equipment with the help of a second person.
- The equipment must be placed on even surfaces to prevent it from tilting or sliding.
- Follow the company regulations on lifting loads and personal protective equipment.

NOTICE

Before mounting and installing the system, read chapters SAFETY and TRANSPORT AND HANDLING carefully.

NOTICE

Arm does not stand stable without being screwed at the base.

Overview of interfaces provided by Control and Arm

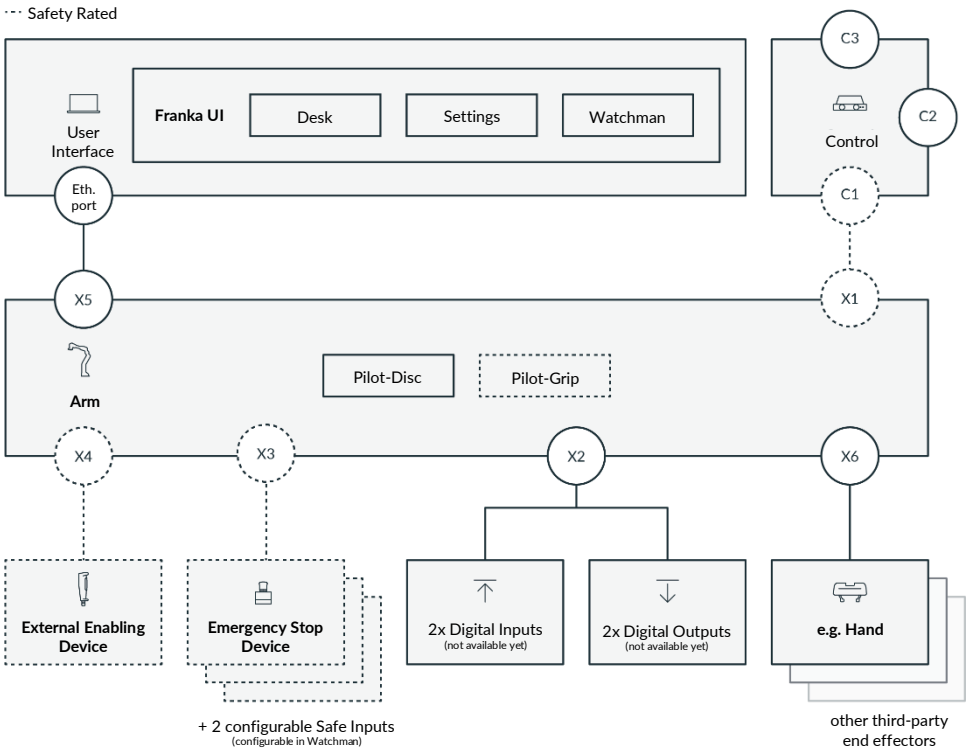


Figure 9.1

9.1 Unpacking the Equipment

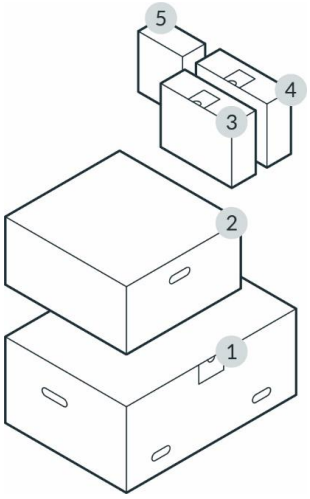


Figure 9.2

1	Arm	4	Emergency Stop Device & External Enabling Device
2	Control	5	Optional (e.g. Franka Hand)
3	Connecting cable		

NOTICE

Always keep the original packaging in case of relocating the robot.

NOTICE

Franka Hand is not part of the certified machinery.

Unboxing

Procedure

1. Take off the top lid of the outer box.

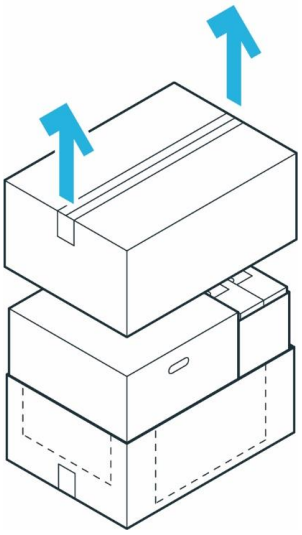


Figure 9.3

2. Lift the top inner boxes and put them aside.

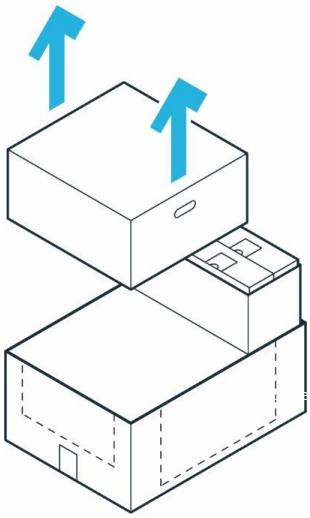


Figure 9.4

3. Pull the outer box apart to access the bottom inner box.

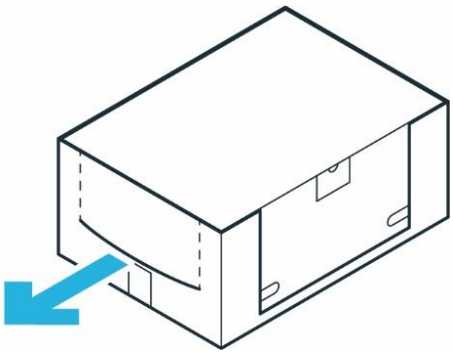


Figure 9.5

Unpacking the Arm

Procedure

1. Carefully open the box by removing the sealing adhesive strips on top of the cardboard box.
2. Open the foil coating.
3. Remove the top protective layer.

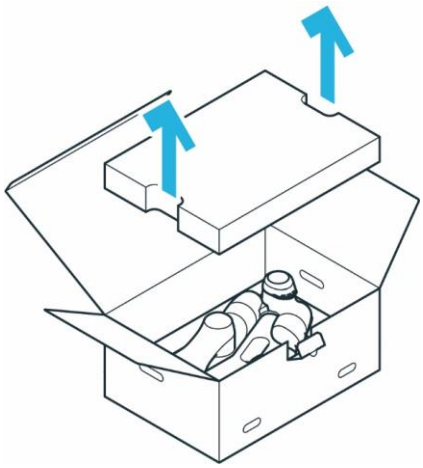


Figure 9.6

4. Remove the middle protective layer.

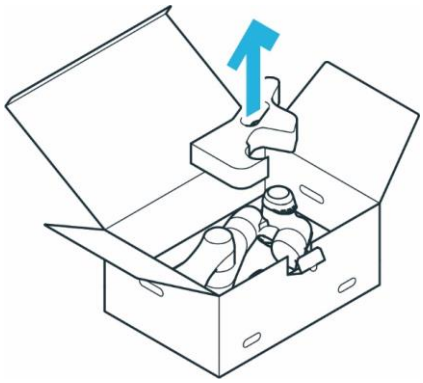


Figure 9.7

5. Grasp the Arm at the indicated grasping positions carefully, lift it out of the bottom protective layer, and set it aside.

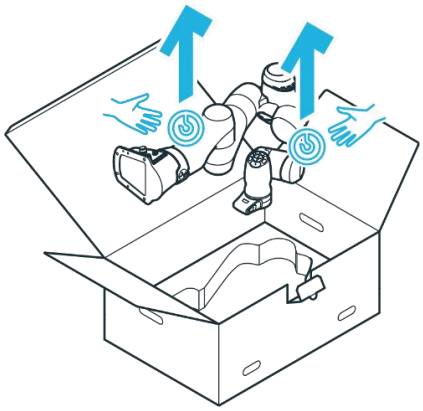


Figure 9.8

Unpacking the Control

Procedure

1. Carefully open the box by removing the sealing adhesive strips on top of the cardboard box.
2. Open the foil coating.
3. Remove the power cable and the top lid.

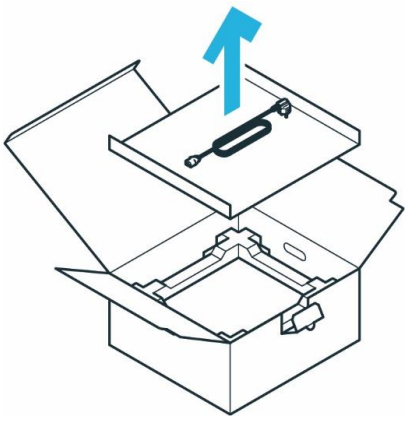


Figure 9.9

4. Remove the top protective layer.

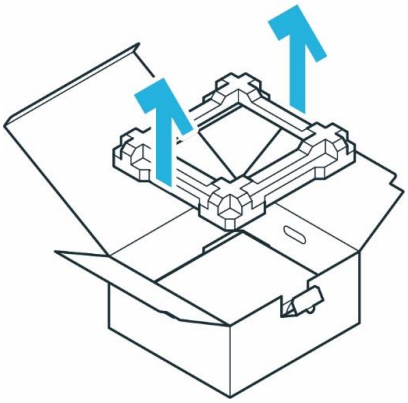


Figure 9.10

5. Grasp the Control at the indicated grasping positions, carefully lift it out of the bottom protective layer, and set it aside.

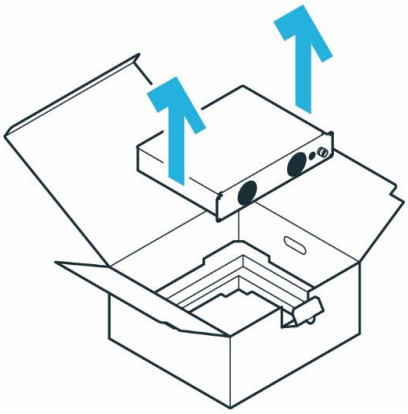


Figure 9.11

9.2 Correct Installation Site

9.2.1 Maximum-and safeguarded space

Classification of spaces

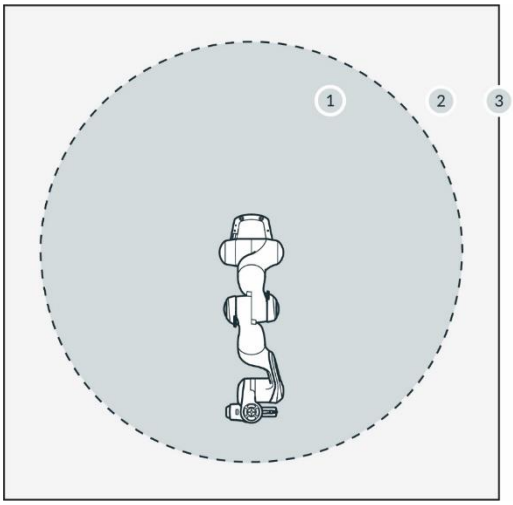


Figure 9.12

1	Maximum space	3	Perimeter safeguarding
2	Safeguarded space		

- Maximum space
  Space that can be swept by the robot's moving parts plus the space which the end-effector and the workpiece can sweep.
- Safeguarded space
  Defined by the perimeter safeguarding (see graphic)

NOTICE

Utilize the provided safety functions to mitigate any risks of accidental collisions from an unexpectedly moving Arm. Monitoring functions are only triggered upon violation. The safety integrator must consider stopping times, distances, and tolerances.

NOTICE

Application-specific risk analysis may define a hazardous zone larger than the maximum space in some applications.

9.2.2 Ambient conditions: Arm

Permissible conditions at the site of installation

Ambient temperature

- +15 °C to +25 °C (normal)
- +5 °C to +45 °C (extended)

Relative air humidity

- 20 % to 80 %, non-condensing

Site of installation

- Indoors, in enclosed buildings
- Not exposed to direct sunlight
- No vibrations, no accelerating fundaments
- Magnetic fields are only permissible in the stated specification range. See chapter Notice of Liability

Orientation of installation

- Arm may only be installed vertically (base horizontal to the earth's surface, no hanging Arm)

Ambient medium

- Air
- Free from flammable substances (dust, gas, liquid)
- Free from aggressive media
- Free from corrosive substances
- Free from flying objects
- Free from spraying liquids
- Free from pressurized air streams

Pollution degree

- Degree 2 (according to EN 60664)
- Only dry, non-conductive pollution occurs; occasionally, temporary conductibility caused by condensation may occur

Setup altitude

- ≤ 2,000 m above sea level

Electromagnetic compatibility

- Environment conditions must adhere to general industrial equipment according to EN 61000-6-4 as the system is designed for respective emission tolerance according to EN 61000-6-2

NOTICE

In order not to endanger the safety functionality of the system, ensure pollution degree 2 according to EN 60664.

Adequate ventilation

NOTICE

The heat produced by power electronic components and modules inside the Arm is dissipated via the Arm's surface.

- Install the Arm in an adequately ventilated place.
- Do not expose the Arm to direct sunlight.
- Do not repaint, paste up, or wrap up the Arm.

Ergonomic consideration

NOTICE

To avoid overheating, the system will stop working when it exceeds the extended temperature range. The user will be informed through Desk.

Follow further instructions in Desk.

NOTICE

To avoid overheating of the motors, the system will stop working, if the internal sensors detect excess temperatures in the windings. The user will be informed through Desk.

Follow further instructions in Desk.

NOTICE

Install the Arm in an ergonomic teaching position.

9.2.3 Ambient conditions: Control

Permissible conditions at site of installation

Ambient temperature

- +15 °C to +25 °C (normal)
- +5 °C to +45 °C (extended)

Relative air humidity

- 20 % to 80 %, non-condensing

Site of installation

- Indoors, in enclosed buildings
- Not exposed to direct sunlight
- No vibrations
- Magnetic fields are only permissible in the stated specification range. See chapter Notice of Liability
- Enclosure needs a minimum degree of protection corresponding to IP4X or IPXXD if located in places open to all persons

Orientation of installation

- Device may only be installed horizontally on the earth's surface
- Mounting in angle brackets, e.g., under tables
- Mounting in control cabinets (2U, 4HP)

Ambient medium

- Air
- Free from flammable substances (dust, gas, liquid)
- Free from aggressive media
- Free from corrosive substances
- Free from flying objects
- Free from spraying liquids
- Free from pressurized air streams

Pollution degree

- Degree 2 (according to EN 60664)
- Only dry, non-conductive pollution occurs; occasionally, temporary conductibility caused by condensation may occur

Setup altitude:

- ≤ 2,000 m above sea level

NOTICE

If it is not open to all persons, only pollution degree 2 is relevant and needs to be ensured.

NOTICE

In order not to endanger the safety functionality of the system, ensure pollution degree 2 according to EN 60664.

The enclosure mentioned above is not suitable to protect from higher pollution degrees. Here, an even higher IP is needed.

9.3 Preparing the Installation Site

Correct installation site

Before installation, prepare the installation site. See chapter Correct Installation.

WARNING

Malfunctions and unexpected motions due to improper installation

Risk of severe injury, such as crushing of fingers, hands, upper body, head.

- Only switch on the robot when the Arm is properly installed on the platform.
- Only install the Arm on even, unmoving, and stable platforms. Accelerations and vibrations induced by the platform are not permissible.
- Do not install the Arm hanging or on tilted or uneven platforms.
- Level the platform and install the robot in an upright position.
- Tighten the screws after 100 hours of operation with the correct tightening torque.

9.3.1 Arm

Derating

When operating Franka Production 3 within the extended temperature range, the user may need to reduce the dynamic parameters (acceleration, maximum velocity, etc.) to avoid overheating the system and its components. Otherwise, Franka Production 3 stops its operation.

Stable platform

The Arm is equipped with highly sensitive sensor technology and fine-tuned control algorithms. The control algorithm requires installation on a stable, leveled, non-moving, and non-vibrating platform in an upright position. The maximum permitted tilt angle is 0.1°.

The following maximum forces must be supported during static and dynamic operation:

- tilting torque: 280 Nm
- torque around axis: 190 Nm
- horizontally force: 300 N
- vertical force: 410 N

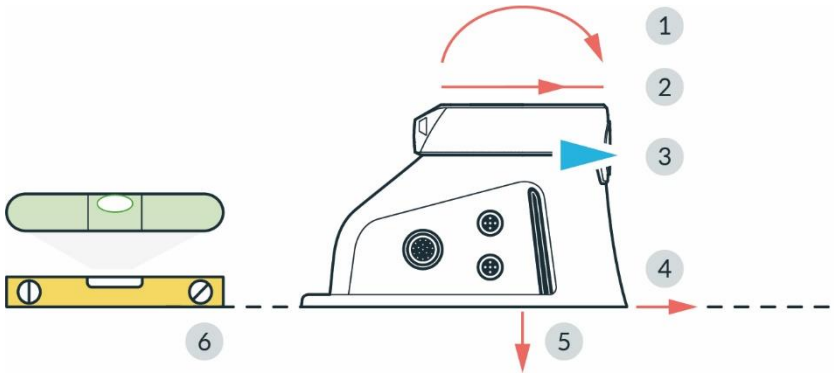


Figure 9.13

1	Tilting torque	4	Horizontal force
2	Torque around axis	5	Vertical force
3	Front	6	Leveled surface

Preparing the baseplate

Required material

- Detailed mounting layout for baseplate

Procedure

1. Use the technical drawing for positioning the holes.

NOTICE

Note the position of the Arm in the technical drawing and align it on the baseplate accordingly.

The hole spacing is designed to be compatible with flexible assembly parts by ITEM. Two holes (Ø 6 mm H7) for dowel pins in the mounting flange allow for accurate, repeatable assembly of the Arm using 2 x Ø6 h8 pins (see table in chapter 9.4 Mounting the Arm).

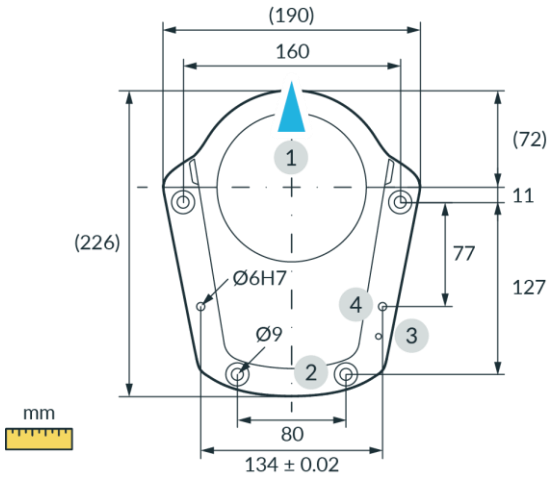


Figure 9.14

1	Front	3	Thread for functional earth M5
2	Holes for M8 screws	4	Holes for alignment pins Ø6H7

9.3.2 Control

NOTICE

The power supply connection must be established via suitable equipment, e.g., by using the supplied country-specific cable.

Adequate ventilation

NOTICE

Make sure that the main supply and main switch are easily accessible.

NOTICE

he heat produced by power electronic components and modules inside the Control is dissipated through an internal ventilation system.

- Install the Control in an adequately ventilated place.
- Do not expose the Control to direct sunlight.
- Place the Control at a sufficient distance between the front/back fans and covering components (40 mm on both sides).
- Make sure that the Control's fans are not covered with dirt.

⚠ WARNING

Heavy equipment

Due to the dead weight and partly due to the geometric design, lifting and handling the equipment may cause back injury and, if it falls, serious injury to fingers, hands, toes, and feet.

- Always wear personal protective equipment (e.g., safety shoes), when transporting, mounting, or demounting the equipment.
- Always lift the equipment with the help of a second person.
- The equipment must be placed on even surfaces to prevent it from tilting or sliding.
- Follow the company regulations on lifting loads and personal protective equipment.

9.4 Mounting the Arm

The Arm must be connected securely to the baseplate with four suitable-sized screws. For this purpose, four drill holes with a diameter of 9 mm are provided in the base flange of the Arm.

Use only the designated lifting points to lift the Arm.

Required tools and material

- Washers and screws depend on the surface the robot is mounted on. Please check the table below for details.
- 1x cylindrical head screw with hexagon socket M5x8 (strength class 8.8 A2K)
- 1x tooth washer M5 (strength class A2K)
- Torque spanners to tighten screws with 30 Nm

	Robot on aluminum table	Robot on steel table	Robot on ITEM aluminum profiles
Screws	ISO 4762 - M8x25 - 10.9	ISO 4762 - M8x20 - 10.9 (included in the scope of delivery)	
Washers	ISO 7089-8,4-HV300 Washers (included in the scope of delivery)		
Minimal thread length	16 mm	11 mm	Line 8 construction profiles
Tightening torque	30 Nm		
Other			Only use ITEM 0.0.420.83 Heavy Duty T-Slot M8 Nuts.

NOTICE

Material damage to the Arm

Moving the Arm by force in a locked state will lead to a momentary slipping of internal parts which causes loss of calibration and damage to the Arm.

- Handle, lift, and transport the Arm only at the points indicated in this manual to avoid overstressing the joints of the Arm.
- The Arm is to be handled gently even when set up and switched on or off.

NOTICE

Make sure that the maximum forces and torques are supported during static and dynamic operation. For more information, see section Stable platform in Preparing the Installation Site

Precondition

- Two people are required for mounting the Arm.
- Prepared baseplate. See section Preparing the Baseplate in chapter Preparing the Installation Site.

Procedure

1. Lift the Arm.
2. Carry the Arm to its designated position.
3. Align the Arm accordingly to the pre-fixed holes on the baseplate.
4. Person 1: Hold the Arm.
   Person 2: Use the four screws to mount it to the baseplate with a tightening torque of 30 Nm.

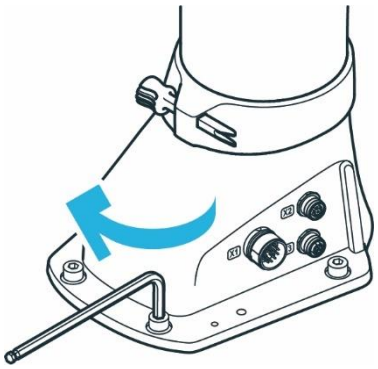


Figure 9.15

5. Connect the functional earth to the base of the Arm.

The Arm is successfully mounted to the baseplate.

NOTICE

The Arm should not be powered until correct mounting is confirmed.

NOTICE

After 100 hours of operation, tighten the screws with the correct tightening torque.

9.5 Positioning the Control

WARNING

Heavy equipment

Due to the dead weight and partly due to the geometric design, lifting and handling the equipment may cause back injury and, if it falls, serious injury to fingers, hands, toes, and feet.

- Always wear personal protective equipment (e.g., safety shoes), when transporting, mounting, or demounting the equipment.
- Always lift the equipment with the help of a second person.
- The equipment must be placed on even surfaces to prevent it from tilting or sliding.
- Follow the company regulations on lifting loads and personal protective equipment.

NOTICE

Material damage to Arm and Control

Moving the Arm by force in a locked state will lead to a momentary slipping of internal parts which causes loss of calibration and damage to the Arm.

- Avoid shocks.
- Carefully set down the devices.
- Always store and transport the devices in their original packing, even inside buildings.

Positioning

Precondition

- Two people are required for positioning the Control.
- Prepared baseplate. See section Preparing the Baseplate in chapter Preparing the Installation Site.

Procedure

1. Person 1: Grasp the Control at the indicated grasping positions.
2. Person 2: Remove the foam packaging from the Control.
3. Place the Control horizontally in its designated position and ensure that proper ventilation is provided.
   Alternative option:
   Attach the Control in a rack designed for 19-inch units. For more information, see chapter Correct Installation.

9.6 Wiring and Electrical Installation

Sound condition

DANGER

Damaged wires or inadequate electrical installation

Risk of personal injury by electric shock, as well as material damage

- Only use Franka Production 3 in sound technical condition.
- Only install the emergency stop system with qualified personnel.
- Check cables and electrical installations.

CAUTION

Exposed wires and cables

Operators may trip and fall due to exposed wires and cables in the maximum space. Therefore:

- Always lay cables safely.

NOTICE

Only devices with galvanic isolation up to 60 V in the Ethernet port may be connected to the system.

NOTICE

Do not swap the connected Arm while the Control is powered on.

Wiring diagram

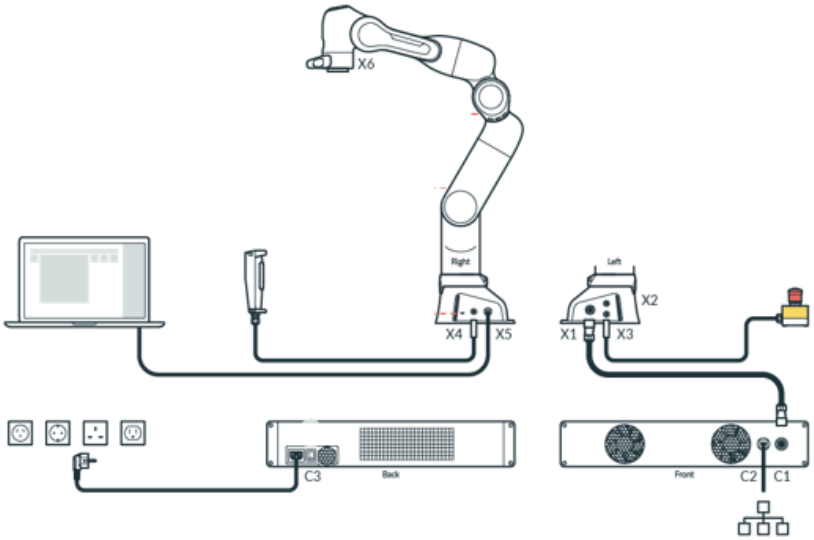


Figure 9.16

X2 - Digital IOs

Interface X2 is located at the robot's base and carries non-safe digital inputs and outputs. The inputs and outputs and the 24 V power supply provided on X2 are galvanically isolated from the robot system and other interfaces at the robot.

The connector is a female 8-pin M12 connector with A coding.

The 24V power supply is driven by the robot. Feeding power into these pins is neither necessary nor permitted. The maximum total output current for the 24 V pins and the digital outputs is 500 mA.

Input characteristics

- 24 V input according to IEC 61131-2 type 3
- 15 kHz low-pass input filter
- Sampling frequency 1 kHz

Output characteristics

- Output high level 24 V DC; Output current per output max. 250 mA
- Update frequency 1 kHz

pin	signal
1	X2.3
2	+24V
3	X2.4
4	+24V
5	X2.1
6	GND
7	X2.2
8	GND

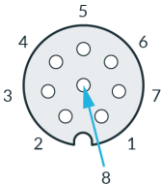


Figure 9.17

X3 - Safe inputs

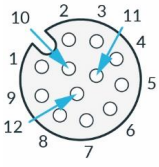
Interface X3 is located at the base of the robot arm and carries three safe input signals. The connector is a female 12-pin M12 connector with A coding.

Safe Inputs electrical domain characteristics for X3:

- signal voltage 24 V; signal current 30mA

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

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



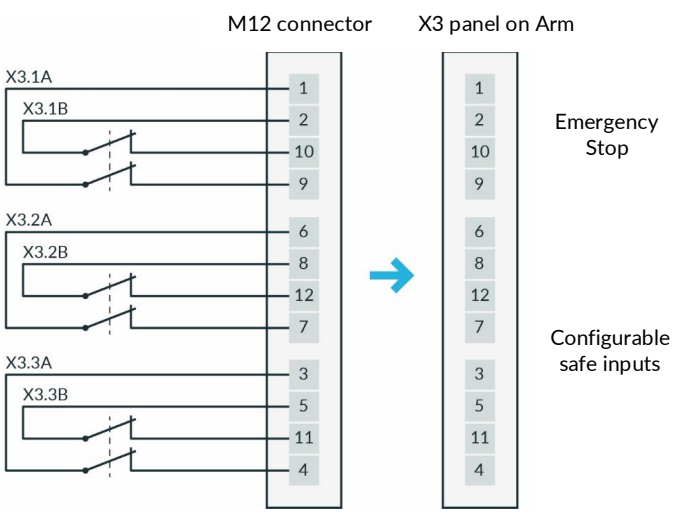


Figure 9.18

For more information on wiring, see section Wiring for X3 in chapter Safety Settings and Watchman.

X4 - External enabling

Interface X4 is located at the base of the robot arm and carries one safe input signal. The connector is a female 4-pin M12 connector with A coding. This connector is intended for the temporary connection of the External Enabling Device during operating phases when this is required. Therefore, safe input 1 is permanently assigned to the external enabling functionality.

X5 - Robot network

The pins of the Ethernet cable are isolated from the metal section and shielded by an air gap. The metal surface surrounding the Ethernet connections is connected to the shielding indirectly through the flaps. The shielding is, in turn, connected to the shell.

X6 - End effector

Interface X6 is located at the wrist of the robot arm and carries signals from the robot connecting to the end effector. The connector is a Binder 8-pin female Snap-in IP67 Series 620.

pin	signal
1	48V
2	CAN_H
3	CAN_L
4	reserved
5	reserved
6	reserved
7	reserved
8	GND

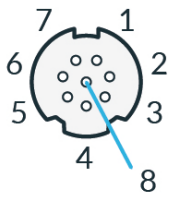


Figure 9.19

Nominal voltage 48 ± 3 VDC.

Nominal hold current 0.5 A at 25°C.

Maximal capacitive load 220 µF.

The End effector interface does not exchange any safety-related information. No discrete nor protocol-based means of safe data transfer is provided. No 48 V power supply is available on this interface if SEEPO is active. No earthing is provided in the end-effector supply.

If additional devices are connected, please test whether the intended function works as expected.

Connecting the functional earth

NOTICE

It is required to connect the functional earth to meet the stated EMC levels.

Required material

- M5 screw thread
- 1x tooth washers M5
- Functional earth cable

We recommend using a minimum 1.5 mm^2 section Cu cable, with a maximum length of 5 m.

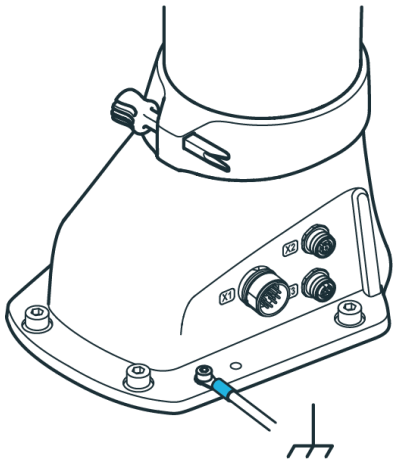


Figure 9.20

Procedure

1. Connect the functional earth to the M5 thread of the Arm's base at the indicated position on one side and to a nearby, well-grounded part (e.g., a solid metal grounding bar) on the other side.
2. Position the tooth washer M5 at the indicated position at the Arm's base for the functional earth.
3. Secure the cable lug of the functional earth cable with the M5 screw.
4. Connect the other side of the cable to a nearby, well-grounded part (e.g., a solid metal grounding bar).

NOTICE

The electrical safety of the system does not depend on a functional earth connection. A functional earth connection is not suited to propagate protective bonding to attached equipment like end effectors. All equipment in the vicinity of the robot must be installed in accordance with their respective electrical requirements, including protective bonding, if applicable.

NOTICE

The Arm connection cable, emergency stop cable, External Enabling Device cable, and user specific cabling shall not be extraordinarily subjected to the following:

- Mechanical handling and dragging across rough surfaces (abrasion)
- Operation without guides (kinking)
- Guide rollers and forced guiding, being wound and re-wound on cable drums (stress)
- High tensile stress, small radii, bending into another plane and/or frequent duty cycles

Connecting Arm to Control

Required material:

- Connecting cable

NOTICE

Only connecting cables provided by Franka Emika shall be used for electrical connection between Arm and Control.

Procedure

1. Carefully place the connector port onto the connector X1 and ensure that the triangular marking points upward.

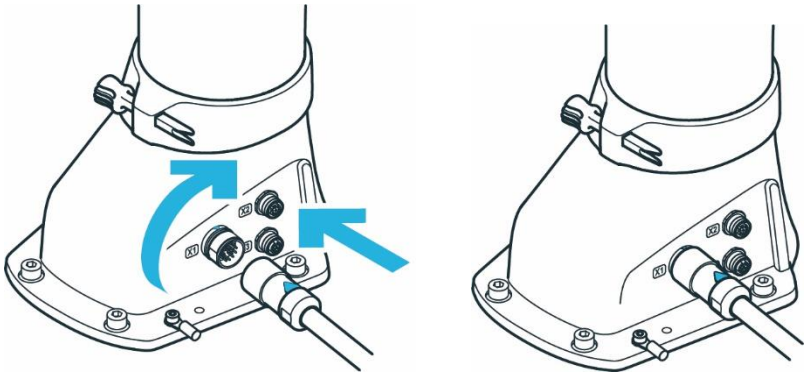


Figure 9.21

2. The plug itself is pulled into the connector port by turning the movable front part of the connector.
3. Turn hand-tight and test correct fit by slightly pulling the plug.
4. Apply the same principle to connect the other end of the connecting cable with the connector C1 on the front of the Control.

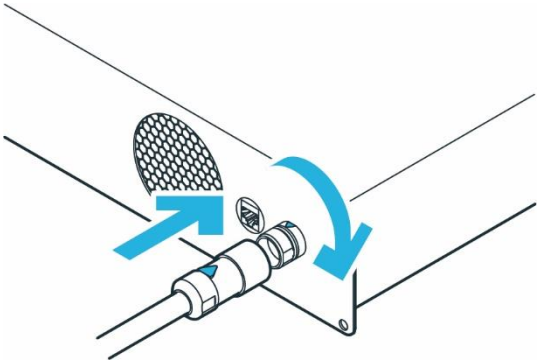


Figure 9.22

Connecting External Enabling Device

Required material:

- External Enabling Device

Procedure

1. Make sure that the guide pin is pointing in the right direction.
2. External Enabling Device to the X4 connector.

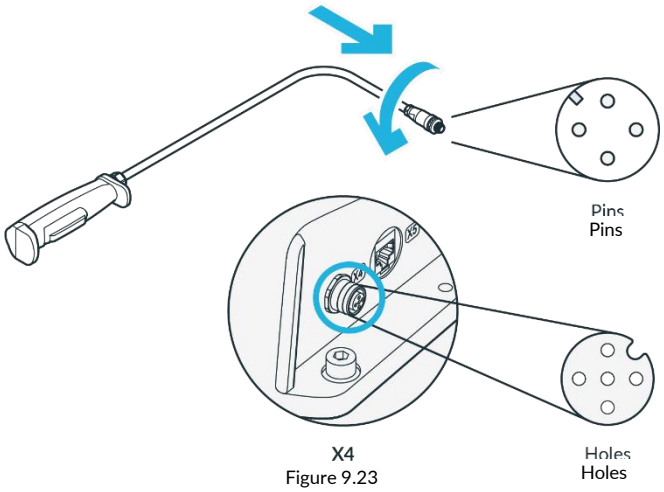


Figure 9.23

3. The plug itself is pulled into the connector port by turning the movable front part of the connector.
4. Turn hand-tight.

NOTICE

The External Enabling Device must comply with IEC 60204-1 and DIN EN 60947-5-8.

Connecting your operating device (for operation via Desk)

Required material:

- Interface device
- Ethernet cable with RJ 45 connector (not included)

Procedure

1. Connect your interface device and the connector X5 at the Arm base with the Ethernet cable.

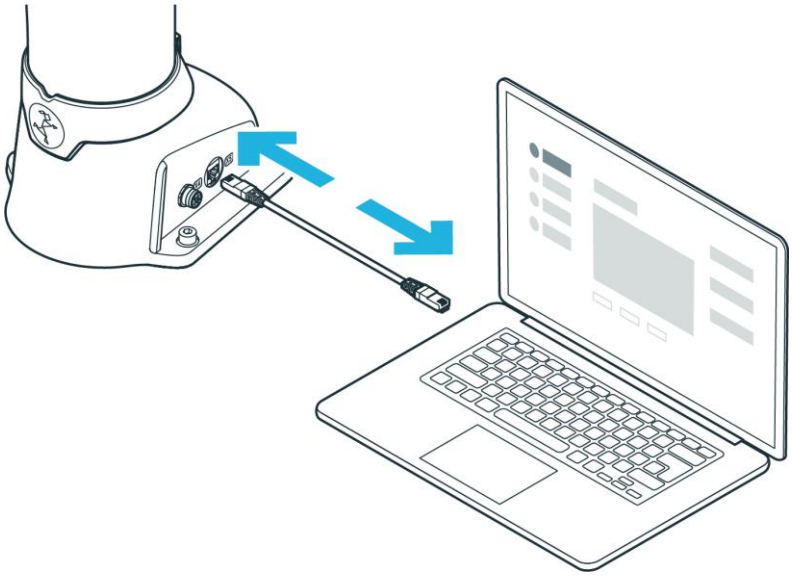


Figure 9.24

Emergency stop installation

To install the Emergency Stop System, see chapter Installation of Safety Peripherals.

Connecting the Control with the power supply

NOTICE

Make sure to connect the mandatory locking mechanism to the C14 connector on the power supply cable.

NOTICE

Allowed supply frequency: 50 – 60 Hz

Supply voltage: 100 - 240 VAC

Earth leakage: < 10 mA

Required material:

- Country-specific power cable

Procedure

1. Connect the power cable to the Control.
2. Connect the power cable to the power supply.

Connecting protective devices

WARNING

Risk of injuries

Connecting external devices with a separate power supply may jeopardize the system safety functionality.

Risk of severe injury, such as crushing, tearing of the skin, and puncturing from the Arm and end effectors.

- Ensure that the voltages in the connected devices are either SELV or suitably isolated to system-connected signals.

Required material

- Protective device (not included)
- Cable (not included)

Procedure

1. Assemble the custom configuration of the mating connector to the X3 interface and the protective devices to be connected (parts not included with delivery).

NOTICE

Material damage

Connecting external devices with a separate power supply may cause system damage if not adhering to electrical ratings.

- Voltages in connected devices must either be SELV or suitably isolated to system-connected signals.

NOTICE

Material damage of cables

Improper handling of cables leads to damage to the cables.

- Do not bend, fold, or roll the connection cable.
- Lay the connection cable such that it will not be overstressed.

NOTICE

Material damage of Arm or end effectors

Unsafe connection or disconnection of live cables or end effectors during operation leads to equipment damage.

- Do not connect or disconnect cables when Franka Production 3 is connected to the power supply.
- Do not connect or disconnect end effectors when Franka Production 3 is connected to the power supply.

2. Connect the protective device to the X3 connector.

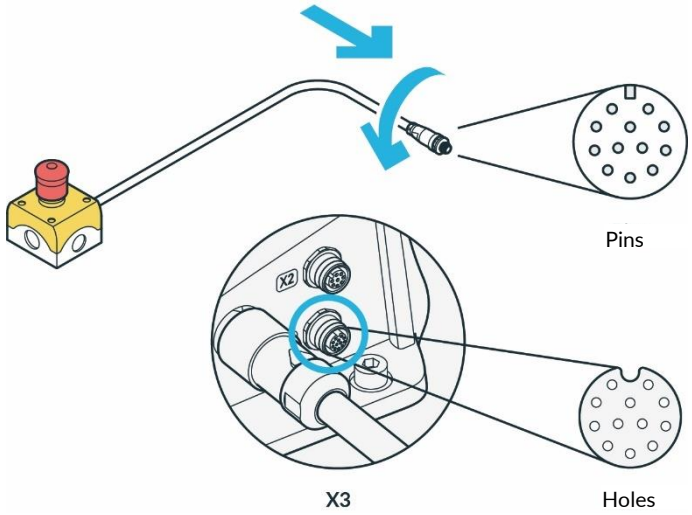


Figure 9.25

3. The plug itself is pulled into the connector port by turning the movable front part of the connector.
4. Turn hand-tight

Should you wish to connect external protective devices to decelerate the Arm and bring it to a full stop using a Cat. 1 or Cat. 2 Stop (according to IEC 60204-1), see chapter Installation of Safety Peripherals.

See chapter Safety Settings and Watchman or Franka UI for further information on the Watchman.

See section Safe input in chapter Safety Functionalities for further information on safe input.

For further information on safety functions, see chapter Safety Functionalities.

For further information on safety settings, see chapter Safety Settings and Watchman.

For further information on the equipment, see chapter Equipment Overview.

NOTICE

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

9.7 Mounting End Effectors

⚠ WARNING

Falling and/or flying tools from the end effectors

Tools that remain inserted in the end effector may turn into projectiles during later motions of the Arm and lead to injuries.

- Do not leave any tools inside the robot.

⚠ CAUTION

Sharp-edged, pointed designs and moving parts

Attached end effectors may cause injuries to hands, fingers, upper body, and head.

- Always wear personal protective equipment (e.g., safety goggles).
- The integrator needs to perform a risk assessment of any attached end effector.
- Do not stand in the maximum space during operation.

NOTICE

Connecting external devices with a separate power supply may jeopardize the system's safety function if it does not adhere to electrical ratings.

In addition, the voltages in the connected devices must either be SELV or suitably isolated from system-connected signals.

The Arm provides a flange for mechanically connecting an end effector. Furthermore, the electrical interface X6 can provide power and communication to the end effector if required. It should be noted that the X6 Interface connector has been configured specifically for the Franka Hand, and other devices may not be compatible with this connector. Suppose any end effector sould be coupled that cannot be connected directly to such connector. In that case, external cabling can be appropriately designed and implemented to power and control the end effector.

Interface X6 - End effector

Interface X6 is located at the head of the flange of the robot arm. The following figure and table show the Binder 8-pin female Snap-in IP67 Series 620 pinout and signals.

For detailed description of the wiring of interface X6 see chapter 9.6 Wiring and Electrical Installation.

The end effector interface does not exchange any safety-related information. No discrete nor protocol-based means of safe data transfer is provided. No 48 V power supply is available on this interface if SEEPO is active.

⚠ CAUTION

Opening and closing end effectors

Malfunctions of the Control may lead to an unexpected opening and closing of end effectors.

- Always wear personal protective equipment (e.g., safety goggles).
- The integrator must perform a risk assessment on any attached end effector.
- Do not stand in the maximum space during operation.

⚠ CAUTION

Moving Arm

Risk of severe injury, such as crushing, tearing of the skin, and puncturing

- Always wear personal protective equipment (e.g., safety goggles).
- The integrator must perform a risk assessment on any attached end effector.
- Do not stand in the maximum space during operation.

NOTICE

After connecting an end effector, a risk assessment needs to be performed. The risk assessment depends on the end effector and includes but is not limited to the following:

- Sharp-edged or pointed end effectors
- Movement or rotation of sharp rotating end effectors
- Unexpectedly moving Arm leading to the end effector impacting or crushing a human

An additional risk assessment is required for risks of a possible end effector failure. The failure risk assessment depends on the end effector and includes but is not limited to the following:

- Malfunction of the protective stop signal leading to not stopping of the end effector opening/closing
- Evaluation of power-loss of the end effector and its functions
- Control failures leading to unexpectedly opening/closing of the end effector

For information on mounting and de-mounting the end effector, please see the respective end effector manual.

9.8 Practical Tips for Usage and Positioning of Franka Production 3

Energy consumption

For standard operation, Franka Production 3 requires an average electrical power of 140–350 W. Temporarily, electrical power of up to 600 W can be drawn from the power supply.

NOTICE

In case of an unexpected power loss, Franka Production 3 attempts a Cat. 1 Stop. If the stored energy does not suffice, a Cat. 0 Stop will be performed.

After an emergency stop, the Arm could have lost calibration or been damaged. If malfunctions are detected at the next start-up, the user will be informed and should follow the instructions in Desk.

ESD limits

NOTICE

It is required to connect functional earth to meet stated EMC levels.

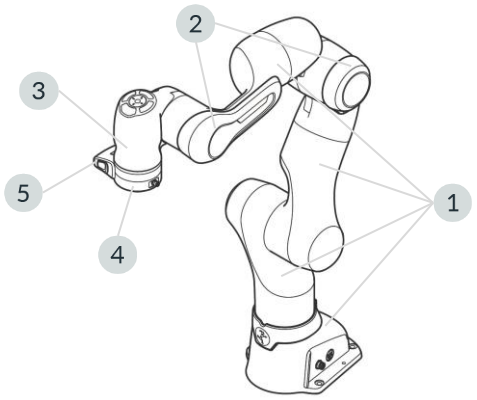


Figure 9.26

The values in the table were measured at a temperature of 24.2 °C and relative humidity of 44 %.

	Resistance to ground R_G [Ohm]	Surface voltage [V]	Distance to ESDS [mm]
Coating robot (1)	$15{,}5 \times 10^9$	13	0
Forearm bumper (2)	$20{,}3 \times 10^9$	30	0
Wrist shell incl. Bumper (3)	$24{,}3 \times 10^9$	850	25
Flange (4)	$50{,}0 \times 10^3$	0	0
Pilot-Grip (5)	$25{,}7 \times 10^9$	279	25
Franka Hand (without fingertip) (6)	$38{,}1 \times 10^9$	615	25

The specified distances correspond to the DIN EN 61340-5-1 standard. Above 125 V to 2.000 V require 25mm spacing.

NOTICE

It is recommended to check the distances according to the application requirement and the DIN EN 61340-5-1 standard.

Free space for retracting

NOTICE

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

Humans instinctively retract from unexpected motions. Therefore, the area where the operator or other persons stand should allow for sufficient space to retract or recoil.

Furthermore, ensure that this space is free of obstacles (e.g., cables, objects) to prevent people from tripping over them and harming themselves.

Greatest possible distance to the Arm

⚠ WARNING

Moving Arm

Risk of being trapped by the Arm.

- Keep the Arm at the greatest possible distance at any given time to allow the operator to react and retract.
- Do not operate the Arm while embracing it.
- Do not place your head or other body parts between or underneath segments of the Arm.
- Do not place body parts (especially hands, fingers) between the Arm, the end effector, or stationary objects.
- In case of acute mortal danger:
  1. Press the Emergency Stop Device to stop the robot from operating.
  2. Pull or push the Arm out of the dangerous position manually.

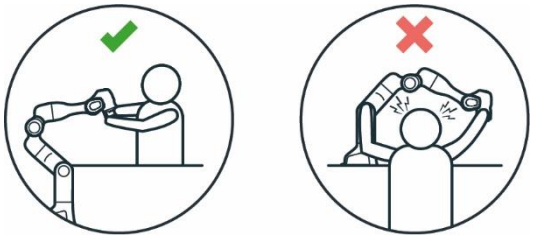


Figure 9.27

Figure 9.28

Figure 9.29

Workspace design

WARNING

Unexpectedly moving Arm

Risk of severe injury, such as crushing of fingers, hands, upper body, head.

- Do not have sharp edges in the maximum space.
- Do not keep any pointed objects in the maximum space.
- Install the Arm in an ergonomic teaching position.

Figure 9.30

Eye protection

WARNING

Unexpected moving of Arm and leaking oil

Contact with leaking oil may cause eye or skin irritation.

The use of various applications, the handled end effectors, and surrounding objects may lead to crushing, tearing of the skin, and puncturing.

- Always wear protective goggles.

Clothing and jewelry

CAUTION

Loose clothing or jewelry getting caught in Arm

Caught clothing or jewelry may cause imbalance and the risk of falling personnel.

- Do not wear loose clothing or clothing with ribbons
- Do not wear loose jewelry, e.g., necklaces or bracelets.

Figure 9.31

Further information

Corrosion might appear on visible surfaces. This does not affect the functionality of the robot.

NOTICE

The following information is practical and may not be exhaustive when it comes to preventing rust. In the event of rust, Franka Emika assumes no warranty or liability, since rust does not impair the function.

- Ensure compliance with humidity and temperature ranges during use, transport, and storage.
- Store the robot in moisture-reducing materials, for example with drybags.
- Only work with clean and dry hands especially during handling, installation, and when teaching a task.

9.9 Re-packing the Arm

WARNING

Heavy equipment

Due to the dead weight and partly due to the geometric design, lifting and handling the equipment may cause back injury and, if it falls, serious injury to fingers, hands, toes, and feet.

- Always wear personal protective equipment (e.g., safety shoes), when transporting, mounting, or demounting the equipment.
- Always lift the equipment with the help of a second person.
- The equipment must be placed on even surfaces to prevent it from tilting or sliding.
- Follow the existing company regulations on lifting loads and personal protective equipment.

NOTICE

Material damage to Arm, end effectors, and objects in the maximum space

Sensitive electromechanical components in the Arm and end effectors may be damaged if end effectors are connected to the Arm while bringing it into transport position.

- Dismount any end effector before bringing the Arm into transport position.
- Do not leave loose objects in the maximum space.

NOTICE

Material damage to Arm and Control

Mechanical shock may cause damage or loss of calibration of sensitive electromechanical components in the Arm and Control. Avoid shock.

- Do not set down the devices roughly.
- Always store and transport the devices in their original packing, even inside buildings.

Transportation pose of the Arm

To bring Franka Production 3 into transport mode, use the Move to pack pose function in the Settings interface of the Franka UI.

Precondition

- The end effector must be removed from the Arm.
- The robot needs to move freely without being encumbered by obstacles to adopt the transport pose. In case of obstacles in the robot cell, consider moving the robot closer to the transport pose via hand-guiding.

To remove the end effectors from the Arm, see the instructions in the product manual of the end effector.

Procedure

1. Log onto the Franka UI.
2. Click on Settings.
3. Navigate to System.
4. Click and hold the “Move to pack pose” button.

The Arm will automatically move to the transport pose while the button is pressed. If the robot is in Programming mode, pressing the enabling device is also necessary to move the robot.

NOTICE

The system monitors the connection of the Franka UI hold-to-run control with a maximum timeout of 1 s. If a connection loss is detected while a hold-to-run control is pressed, the system is stopped.

Re-packing the Arm

Precondition

- The robot needs to be in the transport pose.

Procedure

1. Open the box.
2. Grasp the Arm at the indicated grasping positions in twos and carefully put it inside the bottom protective layer.

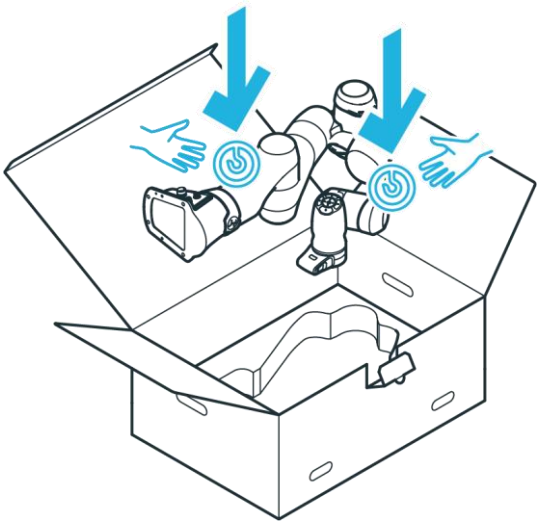


Figure 9.32

3. Insert the middle protective layer.

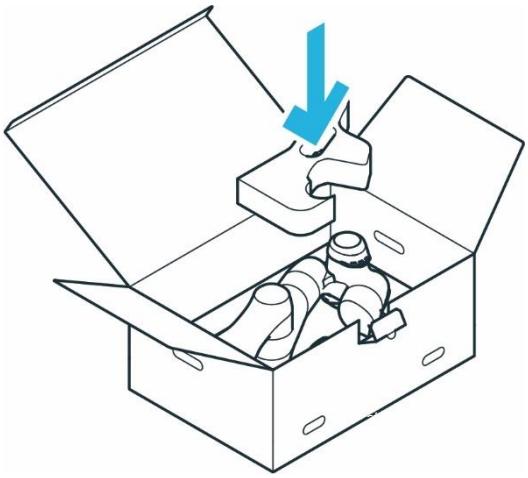


Figure 9.33

4. Insert the top protective layer.

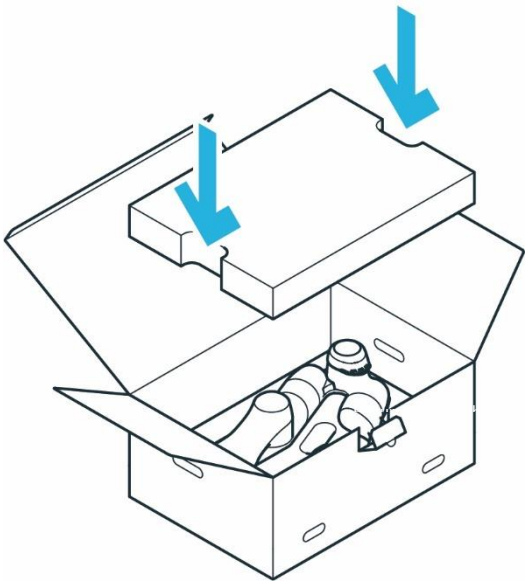


Figure 9.34

5. Close the foil coating.
6. Close the box by sealing it with adhesive strips

10 OPERATION

10.1 Switching On

Switching on

DANGER

Short circuit due to developed condensation when the device is transported from colder to warmer and more humid surroundings

Risk of life-threatening injuries due to electrical shock.

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

Precondition

- Cables need to be plugged in correctly.
- The external power supply must be connected.
- Leave the maximum space.

Procedure

1. Switch on the Control.

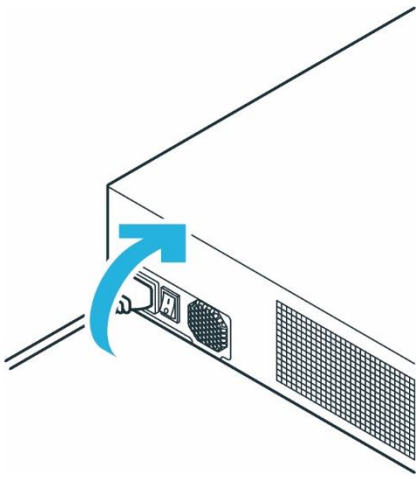


Figure 10.1

The Control is now switched on.

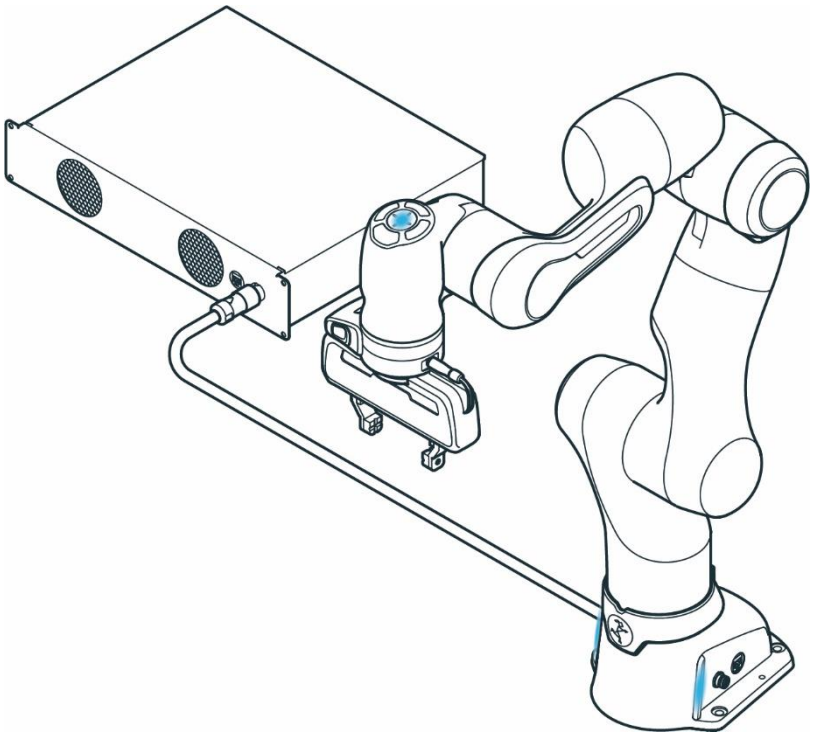


Figure 10.2

The following scenarios may occur:

- The cooling system will be activated.
- Ventilation will be visible and audible.
- The status lights on the Pilot and both sides of the base will start to flash.
- Booting up may take approximately 1 minute.
- Booting up is completed once the status light continuously glows blue.
- The fail-safe locking system is active. The axes are still mechanically locked. For information on unlocking the fail-safe locking system, see section Pre-guiding in Chapter Teach a Task.
- In case of malfunction, see chapters Maintenance, SERVICE AND SUPPORT, and Troubleshooting.

Overview of the status indicators

The visual indicators indicate the current state of the robot. The base LEDs are always active, while the LEDs on the Pilot are only active during programming.

When switching on the robot, always check the functionality of the indicators and their visibility from the operator's perspective. The following color schemes represent the following states:

Colour	Category	Explanation	Approaching the robot*
White	Not active; ready to start execution	Franka Production 3 is running but not in an active state (either in TEACH or IDLE). It is ready to start execution or interaction.	The robot is inactive and can be approached.
White (slow flashing)	Not active; booting or shutting down	Franka Production 3 is booting or shutting down. Do not interrupt the process.	
White (fast flashing)	Not active; updating	Franka Production 3 is updating. Do not interrupt the process or disconnect Franka Production 3 from its power source.	
Blue	Brakes engaged	Franka Production 3's brakes are locked.	The robot is in a stopped state, but the safety system allows to start motion at any time. Approach with care.
Blue	Ready to execute task	Operator can now start a task in Execution or Test & Jog mode.	
Blue (slow flashing)	Opening brakes	Franka Production 3 is opening its brakes. It might move slowly while doing this.	
Blue (slow flashing)	Collaborative operation (no task active)	Franka Production 3 is in collaborative mode while no task is active.	
Green	Automatic execution	Franka Production 3 is currently running an automatic program and is moving independently.	The robot is executing a task. Do not approach.
Green (slow flashing)	Collaborative operation (task active)	Franka Production 3 is in collaborative mode while a task is active (e.g., to hand-guide in Assist mode).	The robot is executing a task, but ready for collaboration in ASSIST mode. Approach with care and in accordance with the application-specific safety measures defined for ASSIST mode.
Green (fast flashing)	Attention: Automatic execution starting	Franka Production 3 will start task execution after "work execution wait time" countdown (if configured) has elapsed.	The robot will soon be executing a task. Do not approach.
Yellow	Warning	Franka Production 3 is in a warning state. If safety violations or errors are present, the status light will be red instead.	The system is in a warning state. Do not approach the robot.
Yellow (slow flashing)	Warning; user interaction needed	Franka Production 3 is in a warning state that needs to be acknowledged by the user. If safety violations or errors are present, the status light will be red instead.	
Pink (slow flashing)	Conflicting inputs	Franka Production 3 encountered conflicting input signals.	Do not approach the robot.
Red	Error	An error has occurred (e.g., Safety Error, System Error, or loss of communication).	Do not approach the robot.
Red (slow flashing)	Safety Violation / application error	A safety violation or application error is preventing task execution.	The robot can be approached depending on the violation/error shown in the Franka UI and the steps required for recovering a safety violation. Approach with care depending on the situation and actual violation.

(*) In general, it depends on the application specific risk & hazard analysis and on the specific configuration of the safety scenarios whether it is safe to approach the robot in a specific situation or state. The visual color indicators can help identify the situation or state the system is in. However, the visual indicators are not a safety function, so the user must always be careful when approaching the robot based on such information. If in doubt, use appropriate safety measures to prevent injuries before approaching the robot (e.g., press emergency stop or activate protective stop).

Generally, slow flashing (0.6 Hz, twice per 3 seconds) signals that the system is in transition between states or is used to attract attention to get support. The fast-flashing scheme (2 Hz, twice per second) warns the user that motion is initiating, the robot is moving very slowly, or the system is updating.

If a visual indicator or its controlling device detects a loss of communication, it will signal the error.

The visual indicators will always signal the most important event or state. The color scheme with the higher significance is signaled. Within one significance level, only one color scheme is shown.

10.2 Safety Relevant Tests of Franka Production 3

Self-test of the robotic system

The self-tests of the Control are executed while the system is running. The Arm is power cycled once to execute the self-tests of the Arm.

⚠ WARNING

Risk of injury due to falling objects

During the power cycle of the Arm, the power to the end effector is removed. Objects may fall from the end effector which could lead to injury.

- Remove all objects from the end effector.
- Move out of the hazard zone.

NOTICE

Every 24 hours, the user must initiate an online safety diagnostic to detect potentially dangerous failures during operation. In the sidebar, the system will warn the user 2 hours before the time is exceeded. If the time is exceeded, the robot will stop all operations and request the user to initiate the self-test.

Procedure

1. Go to Franka UI.
2. Go to Settings.
3. Click on Button “EXECUTE”

⚠ WARNING

Falling objects from end effectors due to a power supply cut off when SEEPO configuration is active

Risk of severe injury, such as crushing, tearing of the skin, and puncturing from the Arm and end effectors.

- Always wear personal protective equipment (e.g., safety shoes).
- Use the appropriate type of end effector to prevent objects from falling.
- Consider the shape, texture, and weight of the grasped objects in the risk assessment according to 10218-2. Using lightweight and/or round objects may reduce risks significantly.

Regular testing of safety functions

The function of some safety functions must be tested regularly. This applies to the following safety functions:

Safety function	Test
Emergency Stop Device	1. Press the Emergency Stop Device while the robot is not active. 2. Check whether the brakes are locked.
Guiding Enabling Device	1. Release the Pilot-Grip´s Enabling Button while guiding. *The robot must stop.* 2. Fully press the Pilot-Grip´s Enabling Button while guiding. *The robot must stop.*
External Enabling Device	1. Release the enabling button of the External Enabling Device while testing a task. *The robot must stop.* 2. Fully press the enabling button of the External Enabling Device while testing a task. *The robot must stop.*
Any switch connected to X3.2 or X3.3	1. Activate switch. 2. Check if configured safety function is triggered accordingly.

NOTICE

- Activate the emergency stop system during start-up every 12 months.
- Reconnect the emergency stop system during start-up every 12 months.
- Check all safety installations, e.g., emergency stop system, for function every 12 months.
- Check any additional safety measures that have been taken to secure safe operation.

For more information on the emergency stop system, see chapter Installation of Safety Peripherals.

Testing the emergency stop

WARNING

Risk of severe injury due to a non-operating Emergency Stop Device

Using a non-operational Emergency Stop Device to stop an operation in case of an emergency may lead to staying trapped which leads to severe injuries, such as crushing, tearing of the skin, and puncturing from the Arm and end effectors.

- Store the Emergency Stop Device in a safe place.

NOTICE

Material damage

The end effector, workpieces, or the surroundings can be damaged, when the device is stopped at an unfavorable point in the process.

- Only use the emergency stop in safety-critical situations.

NOTICE

Any damage occurring to the Arm when the emergency stop is pressed will not cause harm to persons, as the Arm will safely stop regardless of damage.

NOTICE

After an emergency stop, the Arm could have lost calibration or been damaged. If malfunctions are detected at the next start-up, the user will be informed.

NOTICE

Take other installed devices apart from Franka Production 3 into account that will be switched off by the emergency stop as well.

SAFETY-INSTRUCTION

Precondition

- Franka Production 3 must be at standstill with no task running.
- The locking bolts of the fail-safe locking system must be open.
- The Arm may not move.

Procedure

1. Clear the space around the Arm to avoid any damage to grasped objects or surroundings.
2. Use the guiding to bring the Arm into a position that is free from obstacles, e.g., 200 mm above stationary objects.
3. Activate the emergency stop.

The Arm will slightly lower with a clicking noise when falling into the mechanical locking bolts.

10.3 Connecting a User Interface Device

Precondition

- Access to a browser, e.g., Chrome, Chromium, or Firefox.

Procedure

Connect the interface device to the X5 connector on the Arm base via Ethernet cable to open the initial configuration interface.
For more information, see chapter MOUNTING AND INSTALLATION.

1. To automatically obtain the IP address via DHCP, configure the interface device.
   The IP address will automatically be assigned once Franka Production 3 has been switched on.
2. Go to your preferred web browser.
3. Enter the following URL: robot.franka.de
4. Press Enter.

The website showing the Franka UI opens up.

10.4 Software Setup

Procedure

1. Start Franka Production 3.
2. Enter the URL “robot.franka.de.”

The initial configuration is shown in the web browser. The same initial configuration will be shown after resetting the Control to factory default settings.

3. Configure the network.

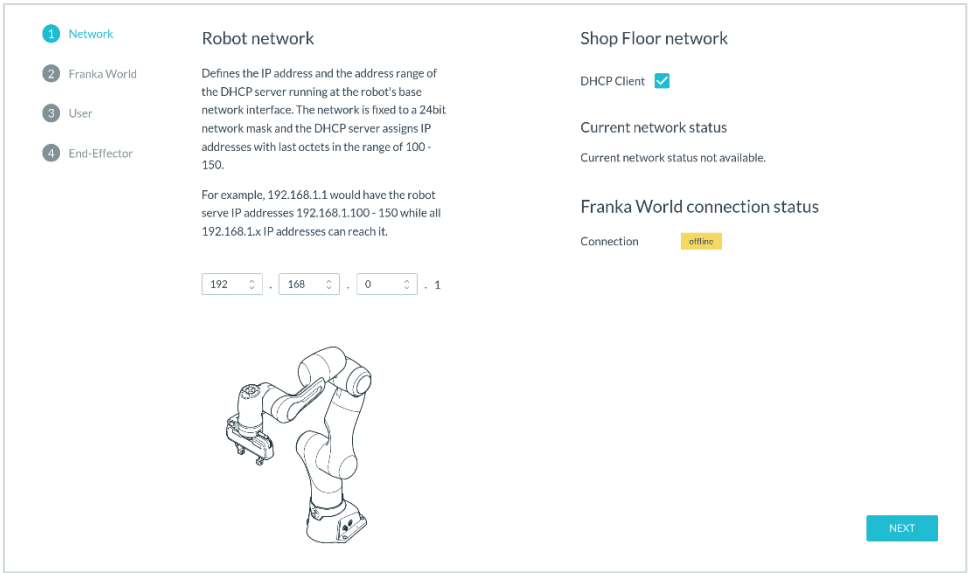


Figure 10.3

4. Connect to Franka World and get the latest system updates.

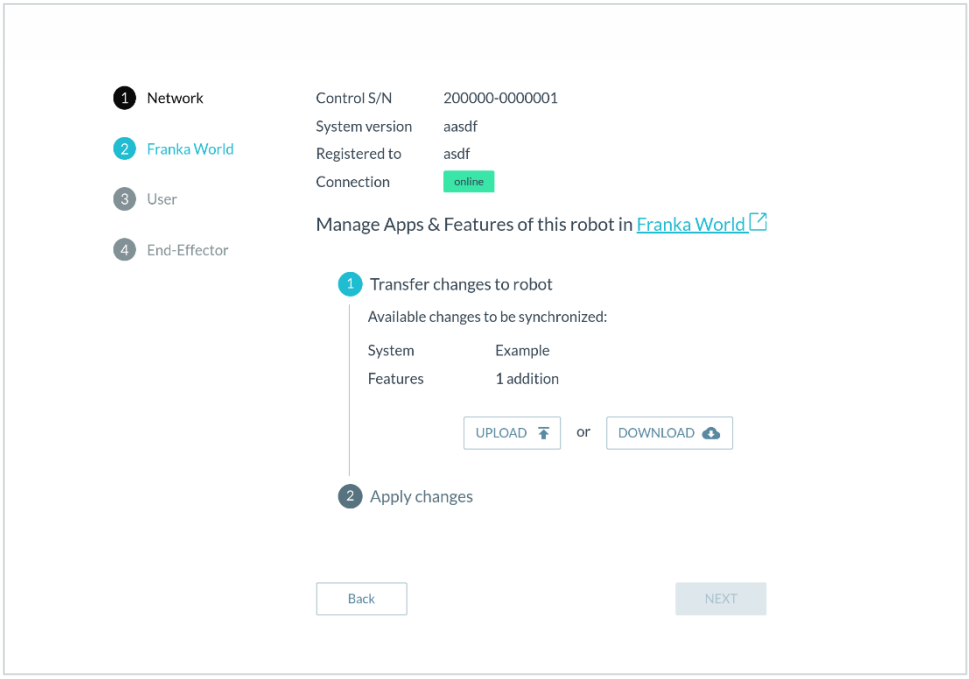


Figure 10.4

For more information on Franka World, see chapter Franka World.

Robot registration and update

A Franka World account is required to install system updates and apps. See chapter Managing Apps and Updates.

The easiest way to get the latest updates is by having the robot connected to the internet and Franka World.
Suppose an internet connection cannot be established. In that case, it is possible to update the device manually by downloading an update file from Franka World and uploading it to the robot via the Franka UI.

For more information on system updates and apps, see chapter Managing Apps and Updates.

5. Create a first administrator user.
   This user can later set further configurations and create more system users. See the section Creating an administrator in chapter ROLES AND PERSONAE for further information on roles.

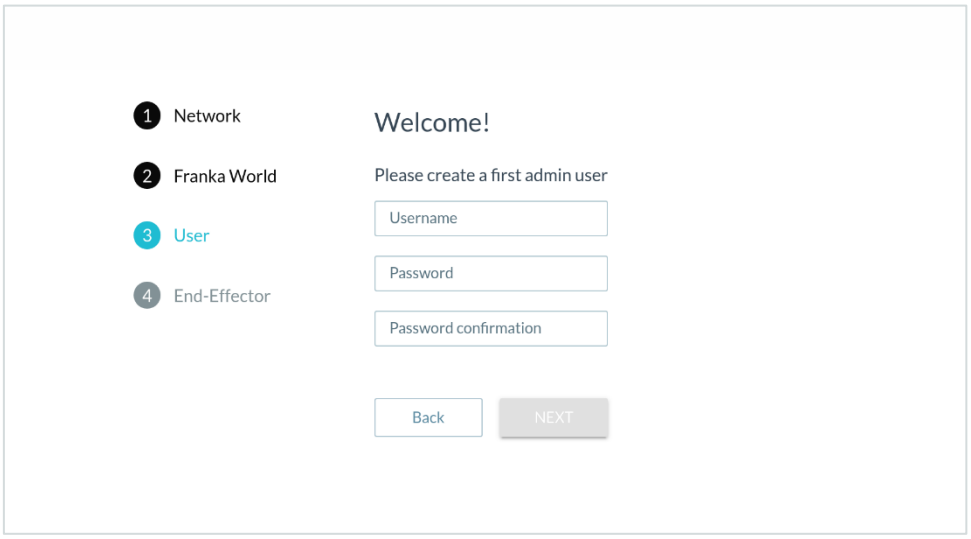


Figure 10.5

WARNING

Unexpected motions during guiding due to incorrectly configured end effectors

Incorrectly configured end effector mass and inertia may lead to not entirely compensated gravitational forces. The resulting and unexpected behavior of the robot including end effector may lead to injuries such as crushing, tearing of the skin, and puncturing.

- Always check the configuration of the end effector.
- When copying an already parametrized App or Task to another Franka Production 3 system, ensure that the end effector configuration remains identical to the original one.

6. Configure which end effector is used on the robot.

If you do not have an end effector mounted, select “None“ from the drop-down menu.

NOTICE

When copying an already parameterized App or Task to another Franka Production 3 system, ensure that the end effector configuration (incl. TCP setting) remains identical to the original one.

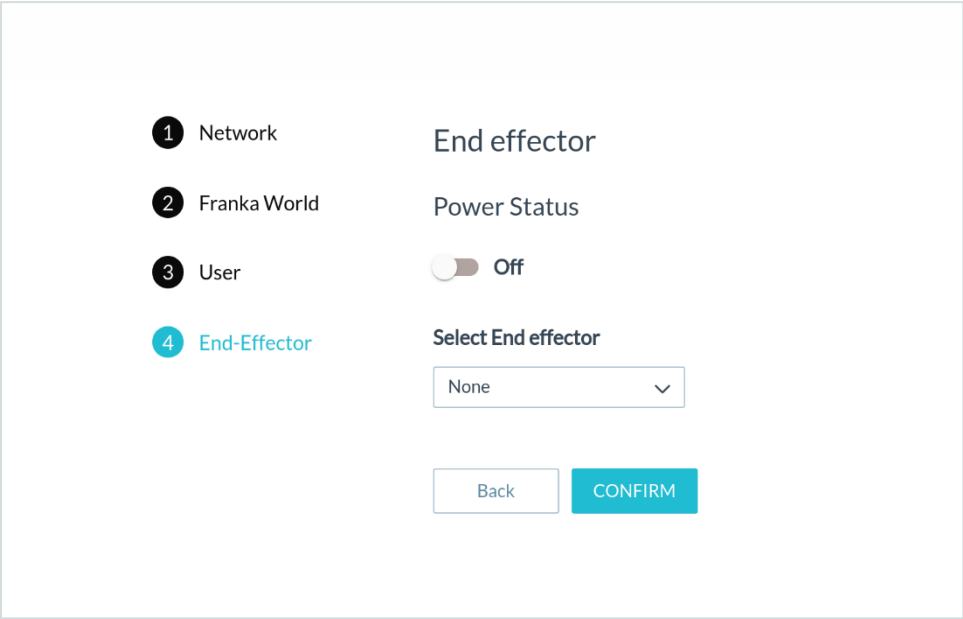


Figure 10.6

If you have mounted Franka Hand as an end effector, select “Hand“ from the drop-down menu.

NOTICE

Franka Hand is not part of the certified machinery.

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

NOTICE

You will be able to reedit the end effector settings later on.

End effector configuration

⚠ WARNING

Unexpected motions during guiding due to incorrectly configured end effectors

Incorrectly configured end effector mass and inertia may lead to not entirely compensated gravitational forces. The resulting and unexpected behavior of the robot including end effector may lead to injuries such as crushing, tearing of the skin, and puncturing.

- Always check the configuration of the end effector.
- When copying an already parametrized App or Task to another Franka Production 3 system, ensure that the end effector configuration remains identical to the original one.

CAUTION

Falling objects from end effectors during initial installation

Objects falling from the gripper lead to injuries to hands, fingers, feet, and toes.

- Always wear personal protective equipment (e.g., safety shoes).
- Use the appropriate type of grippers to prevent objects from falling.
- Consider the shape, texture, and weight of the grasped objects in the risk assessment according to 10218-2. Using lightweight and/or round objects may reduce risks significantly.
- Do not place your hands between grasped and solid objects (e.g., table).
- Do not load the end effector before start-up, since depending on the installed end effector, the 'homing' motions may be executed automatically upon restoration of power.

NOTICE

When copying an already parameterized App or Task to another Franka Production 3 system, ensure that the end effector configuration (incl. TCP setting) remains identical to the original one.

Robot synchronization with Franka World

A Franka World account is required to install system updates and apps. See chapter Managing Apps and Updates. It is possible to register the device even if the robot is not connected to the internet. In this case, the process is manual and will require downloading and uploading update and status files.

Completing configuration set up

Once the initial configuration has been completed and confirmed, a final preparation step will be performed. The programming interface Desk is displayed in the web browser, and the status light at the Arm continuously glows blue to indicate that the brakes are still engaged.

10.5 Switching Off and Restarting

WARNING

Falling objects from end effectors due to a power supply cut off

Objects falling from the gripper lead to injuries to hands, fingers, feet, and toes.

- Always wear personal protective equipment (e.g., safety shoes).
- Use the appropriate type of grippers to prevent objects from falling.
- Consider the shape, texture, and weight of the grasped objects in the risk assessment according to 10218-2. Using lightweight and/or round objects may reduce risks significantly.

Shutting down

NOTICE

The system is only completely shut down when the fans stopped running.

Still running fans indicate that Franka Production 3 has not been completely shut down yet.

- Repeat the Safety Instructions of Shutting down Franka Production 3.

SAFETY-INSTRUCTION

Procedure

1. Move out of the hazard zone.
2. In Desk, navigate to “Shut-down” in the sidebar and click on it.

The fail-safe locking system is activated.

Franka Production 3 will shut down.

Restarting

Turn off the system in Desk and wait for the fans to power down. Switch off the power switch on the Control. Wait one minute before restarting Franka Production 3 again. To restart Franka Production 3, switch on the power switch on the back of the Control. Franka Production 3 will start to reboot again.

Disconnecting Franka Production 3 from the power supply

Procedure

NOTICE

For isolation (Safe disconnection) of electrical energy sources, either the power to the Control can be disconnected/ safely cut, or the connection cable between the Control and the Arm can be disconnected/ safely cut.

1. Move out of the maximum space.
2. Go to Desk.
3. Click on “Shut-down.”

The system shuts down.

4. Switch off the power switch on the backside of the Control.
5. Pull the cable from the backside of the Control.

NOTICE

To avoid unintentional repowering of the system, secure the connecting cable in a safe place.

Franka Production 3 is disconnected from the power supply.

NOTICE

Wait one minute before switching on the Control again.

11 WORKING WITH FRANKA PRODUCTION 3

11.1 Robotic Basics

Joint space

In joint space, a robot pose is described using the rotation angles of each of the robot's joints. In contrast to most industrial robots, which have six joints, Franka Production 3 has seven joints. This allows for extremely high flexibility. Movements in the joint space move all joints simultaneously from the current position to a defined target joint pose. The motion of the end effector results from the rotation of the joints and does not follow a specific path (e.g., a line in Cartesian space).

Cartesian space

In Cartesian space, a robot pose is described using alternative rotation angles of each of the robot’s joints. Here, the position and orientation of the end effector are the main focus. The three-dimensional space representation of a Cartesian pose usually consists of three values of lengths (in meters) for determining the position and three values (in degrees) for orienting the end effector.

For more information on robot poses, see section Redundancy in this chapter.

Movements in Cartesian space allow the precise tracking of predefined paths in space, such as straight lines. The changing of position is called translation, while the changing of orientation is called rotation. The Cartesian motion of a robot always depends on the reference coordinate system, which can be configured for Franka Production 3 via the configuration of the end effector in the administration section of Desk.

Redundancy

As Franka Production 3 has seven joints, the Arm can reach a certain Cartesian pose with various joint configurations. This capability is called redundancy. The part of the robot that can still be moved while keeping the end effector pose the same is often called 'elbow' because it matches the motion capability of the elbow in a human arm. The redundancy of the Arm allows for greater flexibility when teaching or executing tasks, e.g., using it to circumnavigate an obstacle to grip an object located behind it. The behavior of the robot’s elbow can be changed and adapted to each situation. It can be set to freely movable or immovable.

Sensitivity

The Arm has torque sensors in all seven joints. The torque sensors enable, among other things, to recognize and react to even the smallest forces acting on the Arm. This sensitivity facilitates numerous functionalities and capabilities, such as impedance or sensitive collision detection. For achieving maximum sensitivity, it is necessary to best possibly compensate for additional forces acting on the robot, e.g., a mounted end effector. For this reason, the end effector must be configured as precisely as possible in Settings in the Franka UI.

Impedance

Impedance is a robot's behavior that imitates the ability of a mechanical spring. Impedance can interact gently with the environment, e.g., to not damage fragile objects. The ability to change impedance can be seen as similar to that of a human arm, which tenses the muscles to change rigidity and can adapt depending on the situation to increase robustness when executing a task.

Collision detection and reaction

Torque sensors have been incorporated into all seven axes. These provide information on the currently applied torques per axis at any given time. In combination with our model-based Control of Franka Production 3, deviations between the expected and actual torque can be identified. The Arm can respond, e.g., if the Arm touches an unexpected object while moving, the contact will be recognized in real-time by one or several torque sensors. Such a torque magnification is classified as a collision and can, for example, stop the robot’s motion.

NOTICE

The robot's reaction to collisions depends on the user programming and is not a safety feature.

Generating forces

The Arm is in intended contact with its surroundings. With the help of the torque sensor signals, a defined force on the point of contact can be generated by the motors. To achieve this, suitable apps or programming are required.

NOTICE

External wiring adds additional loads and torques to the Arm which may influence the Franka Production 3's control performance.

11.2 Franka UI

Settings interface

The Settings interface offers the following functions for administrators:

- System status overview
- Managing network configurations
- Managing users
- End effector configuration
- Configuring Modbus
- Downloading system logs
- Factory reset
- Move to pack pose
- Installing apps and software updates from Franka World
- Downloading safety log
- Configuring initiating motion
- Configuring SPoC token force timeout
- Accessing manuals

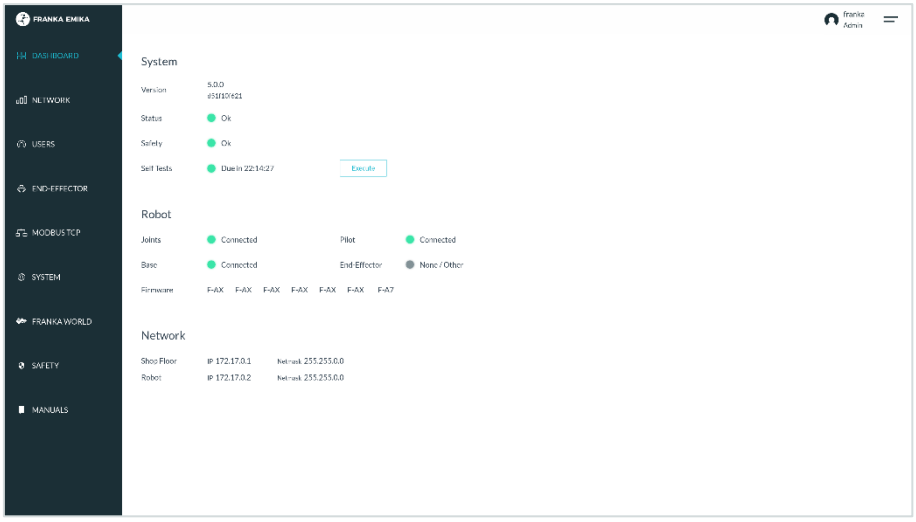


Figure 11.1

Watchman

The web application Watchman allows the safety operator to edit, validate, and integrate safety settings. However, every user can use Watchman to view the current safety settings.

To view the current safety settings in Watchman, go to https://robot.franka.de/watchman.

For more information on the safety configuration, see chapter Safety Functionalities.

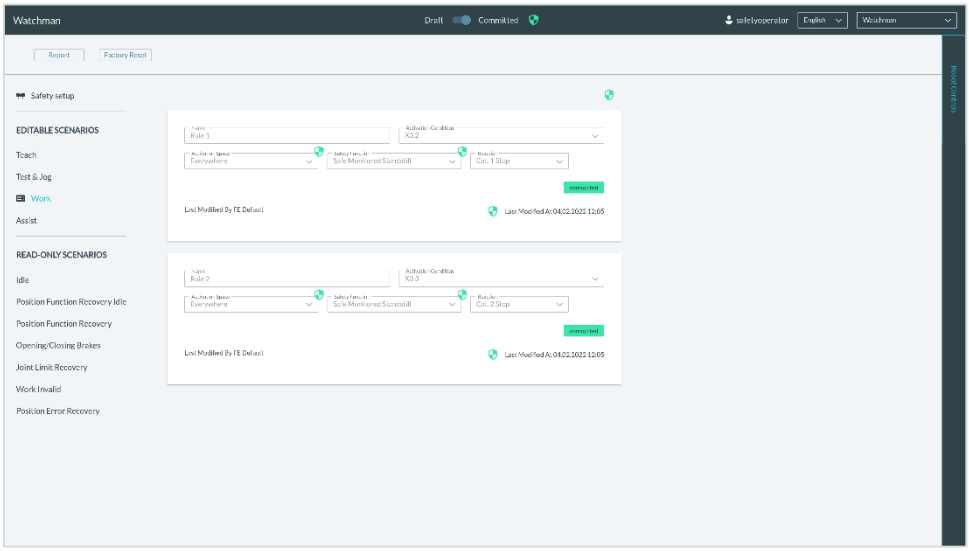


Figure 11.2

Desk

Overview

Desk is the user interface to configure the robot's Tasks. To open Desk, enter the following URL in the browser: https://robot.franka.de

Desk allows you to create Tasks. Tasks are chronological sequences of Apps. Apps are the building blocks of a Task and describe the basic capabilities of Franka Production 3, e.g., gripping, putting something down, or pushing a button.

Figure 11.3

1	Timeline	3	Tasks
2	Apps	4	Sidebar

Timeline (1)

Line up your Apps in the Timeline to program your Task. The Timeline represents the chronological sequence of a Task.

Apps (2)

All installed Apps from Franka World can be viewed here. The Apps in this section of Desk are ready to be used in the Tasks area. Drag and drop the Apps to the Timeline area to use and configure them

Tasks (3)

The Tasks area lists all configured Tasks of the robot. Here, you can access already existing Tasks and perform Task administration. In addition, you can create, download, clone, rename, or delete Tasks. Import a Task by dragging & dropping a Task file downloaded from the current or another robot to the Tasks area.

Tasks from a different Franka Emika robot system are not supported by Franka Production 3.

NOTICE

Make sure to always backup system logs, safety logs, and created Tasks.

Sidebar (4)

The sidebar allows the user to control the robot by selecting the Pilot Mode, selecting a Guiding Mode, locking/unlocking the joints, or powering the end effector on/off. It shows the robot's current status along with important messages. It also allows to change the operating mode and start Tasks for execution or testing.

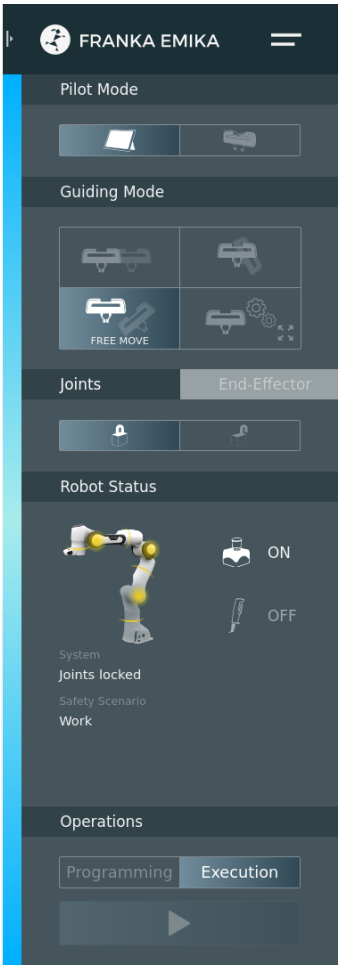


Figure 11.4

11.3 Apps

Apps incorporate the entire complexity of the Franka Production 3 system and represent modular building blocks of a production process such as grasping, plugging, insertion, and screwing. Using Desk, Apps can be arranged to create entire Tasks in no time. The created Tasks can quickly be adapted, reused, or deployed on multiple robots to reduce set-up costs remarkably. Individual Apps and Tasks can be parameterized by showing Franka Production 3 poses by demonstration or adding context-relevant parameters such as speed, duration, forces, and triggering actions.

Visit our Store on https://franka.world to browse our continuously growing portfolio of Apps and solutions.

11.4 Operating Modes

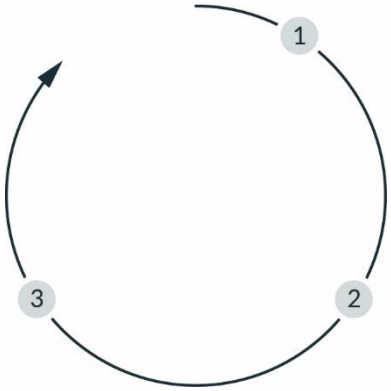


Figure 11.5

Operating steps

1	Teach a Task	3	Run a Task
2	Test & Jog		

Follow the process below when working with Franka Production 3:

Teach a Task (1)

Teach Franka Production 3 a Task.

Test & Jog (2)

Step out of the maximum space and check whether the taught Task is correctly executed. For this, the velocity can be limited, and the execution can be stopped at any time.

Run a Task (3)

Once the Task has been taught, Franka Production 3 executes the Task automatically.

Operating states

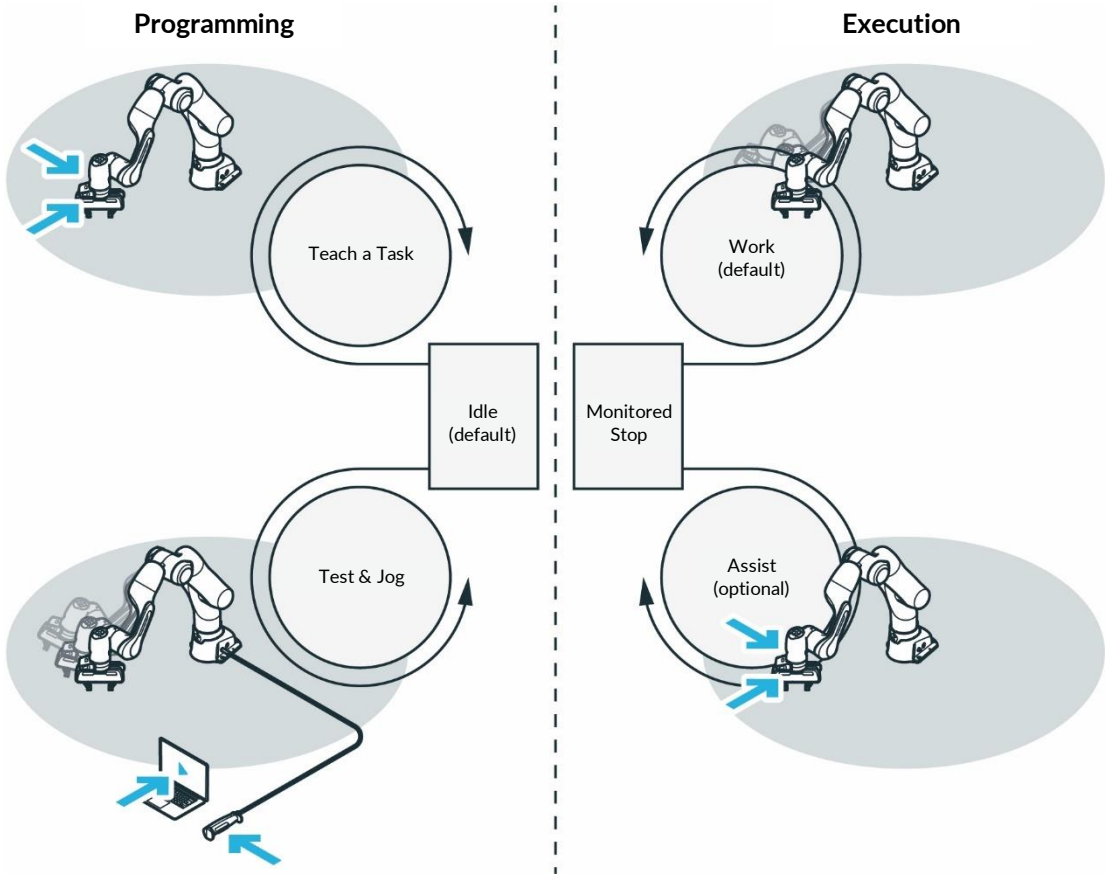


Figure 11.6

Franka Production 3 offers the following operating modes:

1. Programming
   - Idle (default)
   - Teach a Task (Enabling Button, Guiding Button)
   - Test & Jog (External Enabling Device, Hold-to-run button in Desk)
2. Execution
   - Work (default)
   - Monitored stop
   - Assist (Enabling Button, Guiding Button)

Switching

Switch between the general "Programming" and "Execution" modes using the toggle button in the Desk sidebar. Certain user interactions select all other modes implicitly within the general modes, e.g., pressing the External Enabling Device in "Programming."

The general operating modes can also be switched via Fieldbus control.

11.4.1 Programming

Programming mode is an operating mode in which the robot can be programmed to execute certain Tasks.

Teach a Task (Guiding Enabling Device)

The administrator teaches the robot by parameterizing the Task and its Apps. This is done by hand-guiding the robot with the Enabling and Guiding Buttons at the Pilot-Grip. See chapter Teach a Task.

Test & Jog (External Enabling Device)

The administrator tests and monitors the execution while standing back from the robot. The External Enabling Device connected to the robot via the dedicated X4 port is used. For more information, see chapter Test & Jog.

11.4.2 Execution

Execution mode is an operating mode in which the robot executes the previously taught Tasks.

Work

In Work mode, automatic execution of Tasks without the requirement of safe External Enabling Devices is activated. For more information, see chapter Work.

Monitored stop

The robot is at a supervised standstill. This mode is present in the following cases:

A safety sensor connected to a safe input configured in a dedicated safety rule using the SMSS safety function detects the presence of a human.

A transition mode to offer Assist mode to the user.

Assist

This mode can be used during execution if hand-guiding is part of the application. This mode is only permitted within the collaboration space defined.

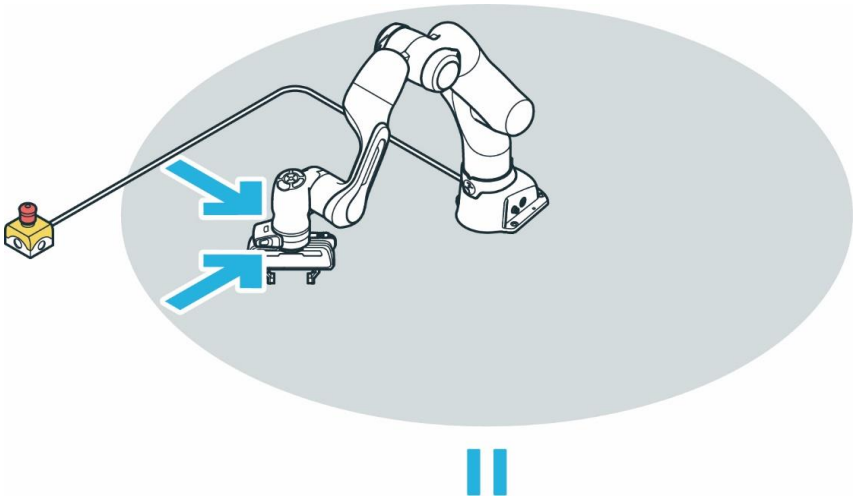


Figure 11.7

WARNING

Hot Surfaces and Handguiding

At ambient temperatures above 30 °C the robot surface can become too hot to touch. Therefore, using the assist feature in automatic mode is not permitted above 30 °C.

11.4.3 Overview of the status indicators

Status lights on both sides of the base take on the corresponding color, similar to a traffic light. The status lights will flash slowly during boot-up, when Franka Production 3 requires attention, or when the user enters values. The lights are lit in the corresponding color of the Franka Production 3 status during other processes. A circular status light in the middle of the Pilot-Disc indicates Franka Production 3's status as well.

When the operator is interacting with the Arm, the status light on the Pilot-Disc is switched off.

For more information on the color behavior, see chapter Switching On.

⚠ WARNING

Dangerous and uncontrolled motions of the Arm

Risk of severe injury, such as crushing, tearing of the skin, and puncturing from the Arm and end effectors.

- Ensure that the end effector and/or the object mass and the Center of Mass (CoM) are parameterized correctly.
- Keep out of the working space during operation.

NOTICE

The motion speed in Teach or Hand-Guiding Mode is pre-set. The speed can be reduced according to the risk evaluation of the Arm within its application.

11.4.4 Step-by-step overview of operating modes and corresponding status indicators

1. Switch on the Control.

The fail-safe locking system is activated, and motions are locked mechanically.

During boot up, the lights flash slowly white.

When booted up, lights are lit blue continuously, indicating brakes are still engaged.

2. To open the fail-safe locking system, click "unlock joints" in the sidebar of Desk.

The display lights are lit white continuously.

During unlocking, lights are slowly flashing blue.

After unlocking, the lights are again blue continuously.

The Desk sidebar shows "joints unlocked."

Franka Production 3 is in Work mode.

3. Switch to "Programming" mode in Desk.

Franka Production 3 is in "idle" mode.

The lights are lit white continuously.

4. To guide the Arm manually for teaching, press the Guiding Button while half-pressing the Enabling Button at the same time.

The lights are lit white continuously.

5. Release the Buttons.

Franka Production 3 is in "idle."

The light is lit white continuously.

6. Leave the maximum space and take the External Enabling Device and the Emergency Stop Device with you to perform Test & Jog.

7. Press the External Enabling Device.

Franka Production 3 is in "Test & Jog" mode.

The light is lit blue continuously.

8. Press the Play button in Desk.

If a countdown was configured (see section Initiating motion in chapter Franka UI), the robot light lights up fast-flashing green until the countdown expires.

Afterward, the Task starts execution.

During execution, the robot light is lit green.

In case of error or safety violation, the light turns red.

If conflicting safe inputs are present, the light turns pink (flashing slowly).

9. Switch to "Execution" mode in Desk.

Franka Production 3 enters "Work" mode.

The light is lit blue.

Tasks can be executed without External Enabling Device.

During execution, the light is lit green.

By triggering a safely monitored standstill from the safety configuration (e.g., from safe input), Franka Production 3 enters "monitored stop mode."

10. Press the Guiding Button and the Enabling Button.

Franka Production 3 goes into "Assist" mode and can be guided as part of the Task.

11.5 Single Point of Control

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

SPoC also applies to Fieldbuses. See section Fieldbus control in this chapter.

NOTICE

Even without the SPoC token, it is still possible to trigger uncritical actions like stopping a running Task or locking the robot brakes.

Take control

When connecting to the robot with an available token, take control by accepting the dialog displayed after login. The token is now assigned to you. Other users cannot control the robot without your consent.

Request control

When connecting to the robot with a token already taken by another user, request control by accepting the dialog displayed after login. The controlling user will be shown a control request dialog on the screen. The token is reassigned to the requesting user if the controlling user grants access. If the controlling user denies access, the token will remain with the controlling user.

NOTICE

For improved traceability, it is recommended to set up named profiles for each user in the system settings. That way, the system is able to inform newly connected users about who is currently controlling the robot.

A user requests control:

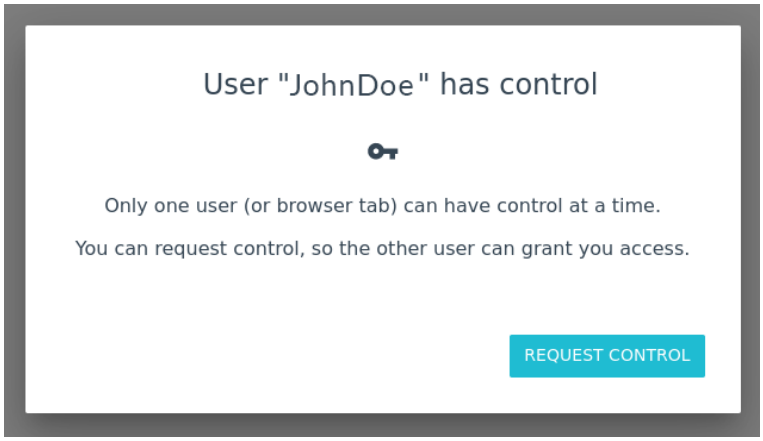


Figure 11.8

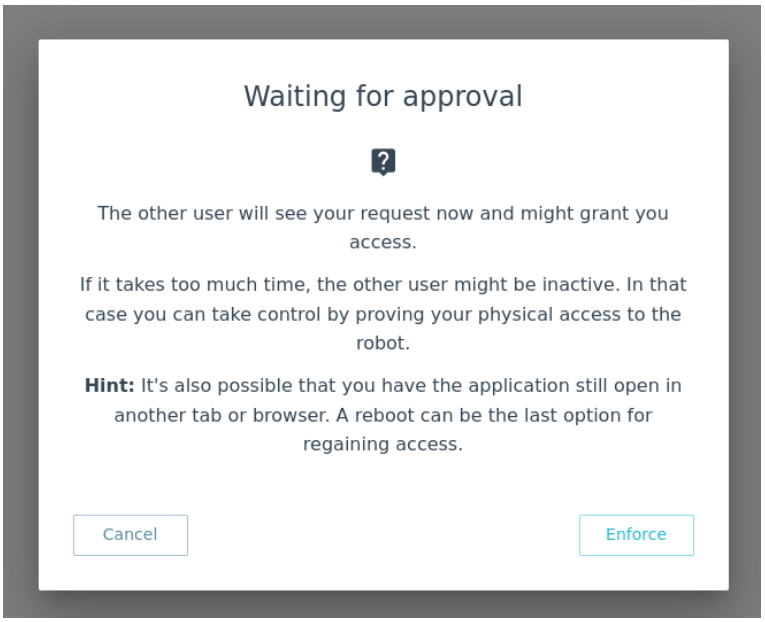


Figure 11.9

The user who has the SPoC token receives the control request:

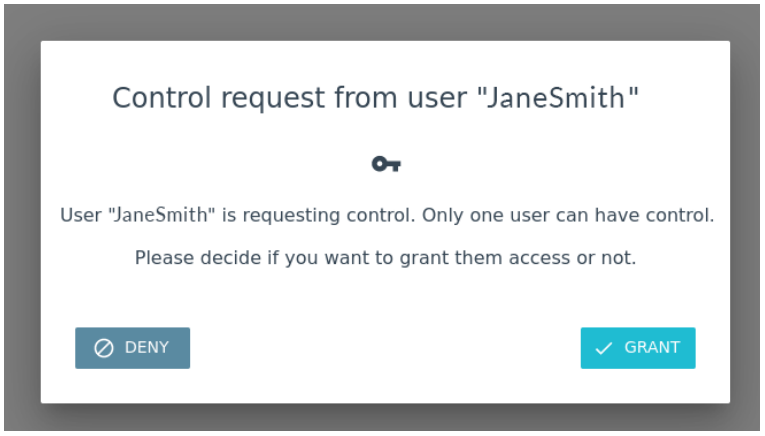


Figure 11.10

Enforce control

It is possible to enforce control if the user has physical access to the robot. Instead of requesting control, the user chooses to enforce control in the dialog displayed after login. After choosing enforced control, the requesting user has a time window in which he can press the blue circle on the robot's Pilot to take control. The controlling user is notified about the enforcement attempt during this time frame. The controlling user is then able to confirm or deny control.

NOTICE

Adjust the time window for control enforcement in the system settings. By default, the time window is set to 30 seconds.

Release control

New user enforces control

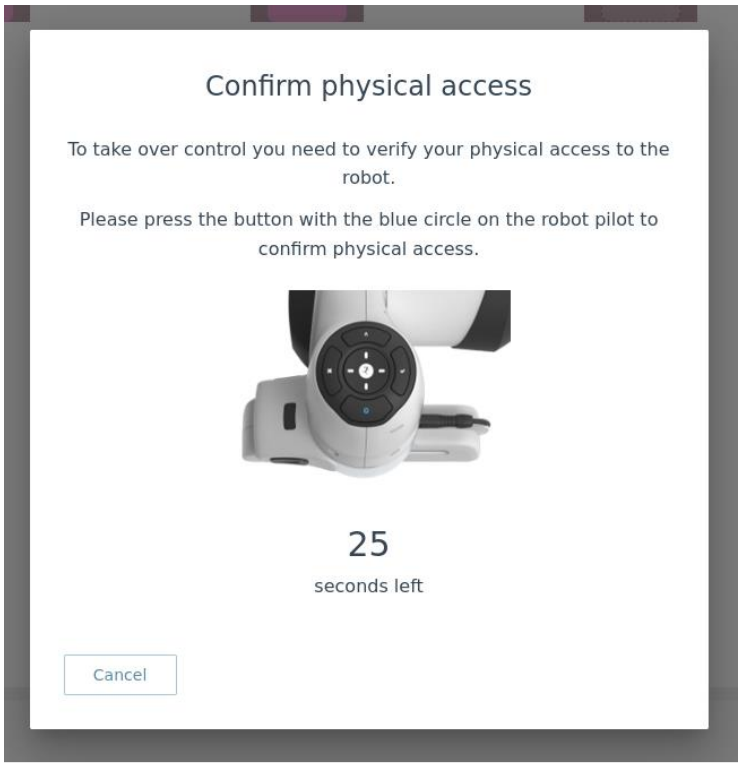


Figure 11.11

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

Fieldbus control

It is also possible to control the robot through Fieldbus interfaces. Single-Point-of-Control also applies to Fieldbus interfaces. The required functionalities are provided for the supported Fieldbus protocols but must be considered during connection implementation. Data access and uncritical actions are possible via Fieldbuses regardless of the token status.

Franka Production 3 implements OPC UA server functionality.

NOTICE

All Fieldbuses have the same rights as the operator role.

NOTICE

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

For more information on how to use Modbus OPC UA, see the respective manual at Franka World.

11.6 Teach a Task

WARNING

Risk of injuries during guiding

Risk of tearing the skin or puncturing during guiding.

- Do not have sharp edges in the maximum space.
- Do not keep any pointed objects in the maximum space.
- For more information, read chapter Practical Tips for Usage and Positioning of Franka Production 3.

NOTICE

Before executing any Task with Franka Production 3, make sure to read chapter OPERATION first.

11.6.1 Creating a Task

Procedure

1. To create and select a new Task, click on the “+”-symbol in Tasks.

A new Task is created with an empty Timeline.

2. Drag and drop the respective Apps from Apps to Timeline to program an individual Task.
   Alternatively, double click on the respective Apps.
3. Arrange them in the desired sequence by dragging and dropping the Apps.
   The programmed Tasks are executed from left to right.
4. To remove Apps from a Task, drag and drop the respective Apps from Timeline to Apps.

   Alternatively, right-click on the App to open a drop-down menu from which you can activate, deactivate, or delete individual Apps.
5. To change Task-level settings, e.g., the execution speed, click on the Task name in Timeline.

11.6.2 Task settings

Procedure

1. Click on the Task’s name in the top left corner of Desk.
2. Set the parameters for robot speed, compliance/stiffness, and sensitivity thresholds.

NOTICE

Navigation and parameterization can also be done via buttons on the Pilot.

11.6.3 Parameterization of Apps

WARNING

Falling objects from end effectors during initial installation

Objects falling from the gripper lead to injuries to hands, fingers, feet, and toes.

- Always wear personal protective equipment (e.g., safety shoes).
- Use the appropriate type of grippers to prevent objects from falling.
- Consider the shape, texture, and weight of the grasped objects in the risk assessment according to 10218-2. Using lightweight and/or round objects may reduce risks significantly.
- Do not place your hands between grasped objects and solid objects (e.g., table).
- Do not load the end effector before start-up, as “homing” might happen after each time brakes are unlocked upon power-up.

After the administrator creates a Task and adds at least one App, the App parameters can be configured.

Precondition

- A Task has been created and selected to be shown in the Timeline.
- An App has been added to the Task.

Procedure

1. Select an App in the App library and drag it to the Task Timeline.
2. To open an App in the created Task, click on it.
   A corresponding context menu appears to set the parameters.
3. Follow the instructions in the App context menu to teach poses.
4. Hand-guide the robot to the desired pose.
5. Press the Teach button on the Pilot-Disc to confirm the pose.

For further information on the Pilot-Disc and its buttons, see chapter Equipment Overview.

For further information on guiding, see section Guiding configuration in chapter Teach a Task.

The context menus of the Apps vary and contain one or more steps for entering parameters, e.g., teaching poses or entering execution speed.

Only activated Apps are executed and need to be taught.

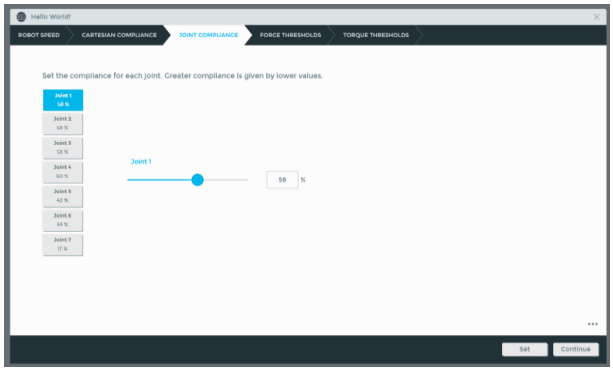


Figure 11.12

NOTICE

The Pilot (buttons) can also be used for navigation and parameterization.

11.6.4 Pose teaching

CAUTION

Unexpected moving of Arm

Incorrect set mass and center of gravity values may lead to injuries, such as crushing.

- Check the mass and center of gravity for any end effector and the objects grasped by it.
- Correct the values if necessary.

Precondition

An App with pose parameters has been added to the Task.

Procedure

1. Open App by clicking on it.

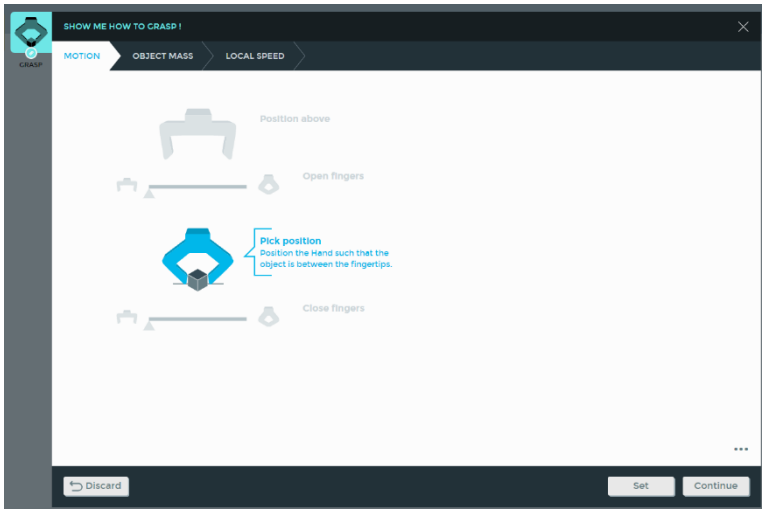


Figure 11.13

2. Click on necessary Step in the App

Guide the Arm as described in chapter Guiding

3. Stop guiding the Arm.
4. Release the buttons when the correct pose is reached.
5. Confirm the pose by pressing the Teach button.

Teaching a pose in the App is now finalized.

11.6.5 Pose fine adjustment

Procedure

1. Click on the App.
   The context menu appears.
2. In the context menu, right-click on the pose that needs to be adjusted.
3. Adjust the Cartesian position and/or the rotation of the end effector.
   The pose is adjusted.

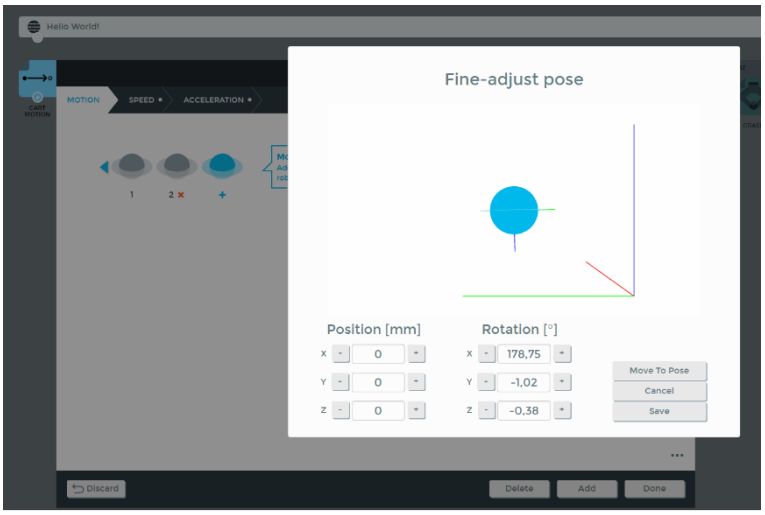


Figure 11.14

11.6.6 Guiding configurations

In Guiding mode, the motion of the Arm follows the corresponding guiding configuration, which is displayed in the sidebar. The guiding configuration can be changed by pressing the Guiding-Mode Button on top of the Pilot-Grip. The desired configuration can also be selected from the sidebar. The following configurations can be selected:

- Translation
  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
  The Arm can only be moved to change the Cartesian orientation of the end effector. Its position remains as it was before entering the Guiding mode. The reference coordinate system for this rotation is the predefined coordinate system of the end effector.
- Free
  The Arm can be moved freely. All seven joints can be moved.
- User
  The user can define the guiding behavior for each Cartesian translation and rotation axis. The elbow can be movable or fixed.

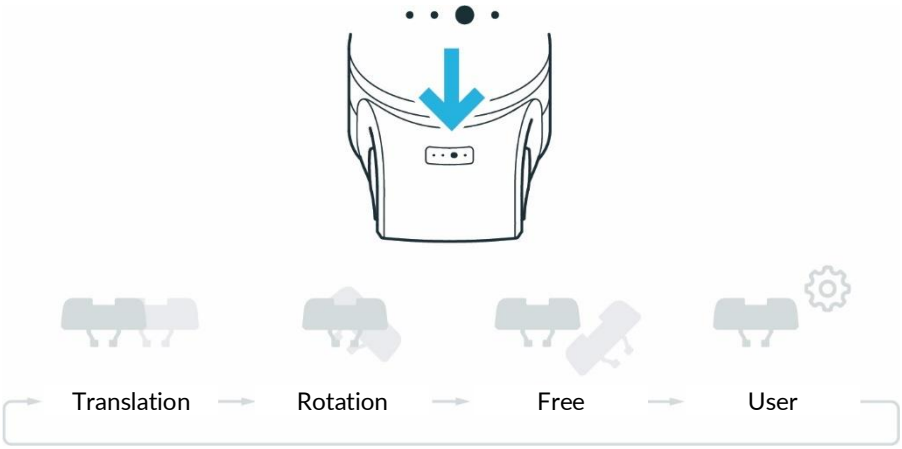


Figure 11.15

Figure 11.16

Figure 11.17

If “User mode” is selected, the user can select constraints for guiding:

Necessary guiding components

To guide the Arm, use the Pilot.

NOTICE

Operate Desk directly via the touchscreen or using your mouse/keyboard.

NOTICE

The motion speed in Teach or Hand Guiding-Mode is pre-set. The speed can be reduced according to the risk evaluation of the Arm within its application.

SAFETY-INSTRUCTION

Precondition

1. The Control must be switched on and booted up.
2. All external devices connected to X3 must be allowed to move.
3. Emergency stop is released.

Procedure

- Leave the maximum space and make sure that no other persons are within the maximum space.
- On Desk, click on “Unlock joints”.

Each of the seven axes makes a small movement and seven clicking noises can be heard.

The Arm is now in idle mode or monitored stop.

- Step back into the maximum space to start the guiding.

For more information on the Pilot, see chapter Equipment Overview

For more information, see chapter Practical Tips for Usage and Positioning of Franka Production.

11.6.7 Guiding

CAUTION

Unexpected moving of Arm

Incorrect set mass and center of gravity values may lead to injuries, such as crushing.

- Check the mass and center of gravity for any end effector and the objects grasped by it.
- Correct the values if necessary.

Procedure

1. Press the Guiding Button and half-press the Enabling Button.

Guiding is now enabled.

The base of the robot turns white.

Pre-guiding

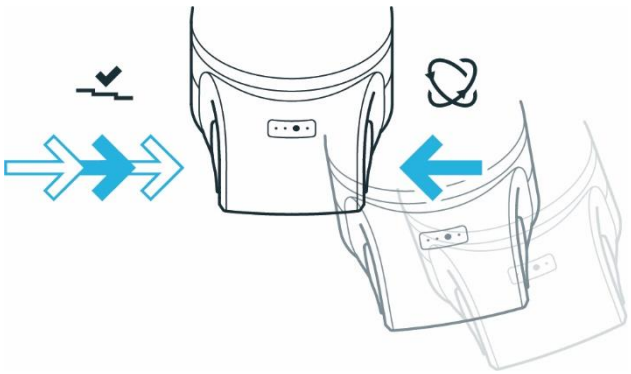


Figure 11.18

NOTICE

Do not use the external Enabling Button to guide the robot as it will lead to an error.

NOTICE

Do not guide the Arm when locked.

NOTICE

The vibration transmitted during hand-guiding is below 2.5 m/s^2. It was tested according to the test methods defined in DIN EN 1032:2009-02.

11.6.8 Editing end effector settings

A correct configuration is essential for operating Franka Production 3. When configured incorrectly, gravitational forces are not entirely compensated, and the Arm controls to the wrong target values.

Procedure

1. Go to Desk.
2. Click on Settings.
3. Select the end effector sub-menu.
   The input mask opens.
4. Enter the respective technical data, e.g., mass or mass inertia matrix.

In case of incorrect configuration, the following behavior might occur:

- The Arm may pull in certain directions in guiding mode.
- The control 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.

As soon as the Task is taught and the correct end effector settings are set, switch to Test & Jog to test the Task at a reasonable execution speed. Make sure that there are no collisions and that everything works fine while being able to stop at any time by releasing the External Enabling Device.

11.7 Test & Jog

NOTICE

Before executing any Task with Franka Production 3, make sure to read chapter OPERATION first.

Initiating motion

An optional countdown for Task execution can be configured and edited in Settings.

When starting a Task in either Test & Jog or Work mode, the countdown is displayed before executing the Task. During the countdown, the LEDs on the robot base will indicate the started Task by fast-flashing in green.

NOTICE

After a system reboot, the token is being reset.

NOTICE

Adjust the waiting time in the system settings. By default, the waiting time is set to 0 seconds.

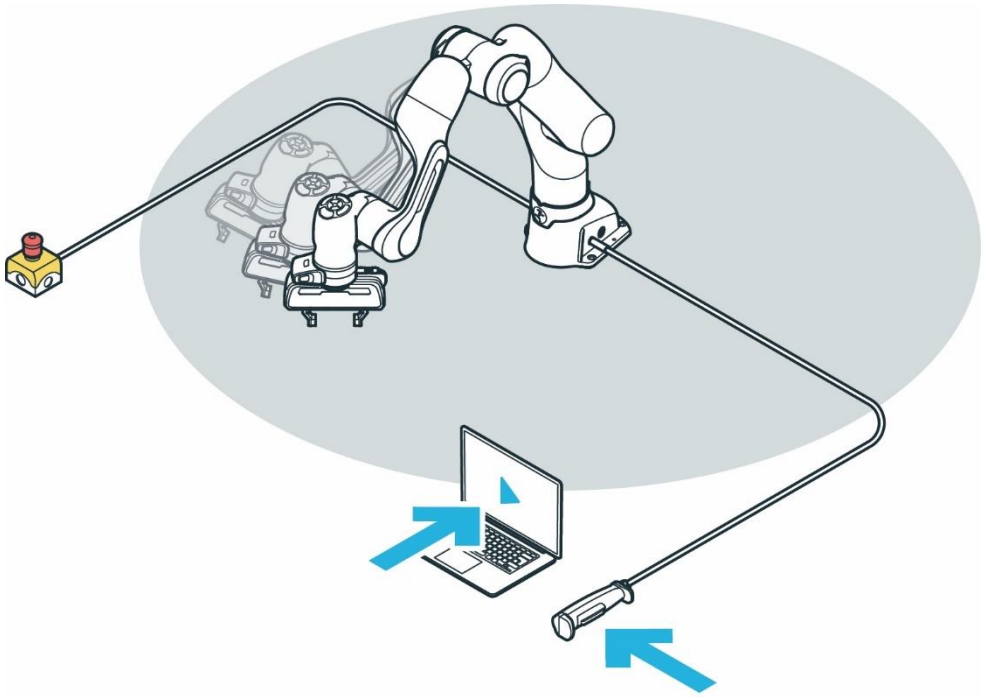


Figure 11.19

Testing

SAFETY-INSTRUCTION

Precondition

- The robot has learned a Task.
- The External Enabling Device must be connected to X4.
- The operator must have left the maximum space.
- The operator must check that all other persons have left the safety zone.
- The operator must direct his full attention to the pending robotic motion.

Procedure

To enable the robot, press the button on the External Enabling Device.Optional: Select an appropriate execution speed in the “Operation” section of the sidebar.
Default speed is 0.25m/s

Press and hold the Test&Jog play button in the “Operation” section of the sidebar.

Task execution will be terminated if either the Play button or the External Enabling Device is released.

If a countdown for Task execution has been configured, a confirmation dialog is shown as well. During the countdown, the execution can still be canceled. Robot lights are flashing green quickly during the countdown.

If the robot executes the task as intended, proceed to chapter Work.

If adjustments need to be made, go back to chapter Teach a Task.

NOTICE

The system monitors the connection of the Franka UI hold-to-run control with a maximum timeout of 1 s. If a connection loss is detected while a hold-to-run control is pressed, the system is stopped.

11.8 Work

In Work mode, the robot executes its task autonomously. Compared to Test & Jog, there is no External Enabling Device as a safeguard, i.e., the operator needs to be safely separated from dangers presented by the Arm (acc. to EN ISO 10218-1:2011 and ISO 10218-2).

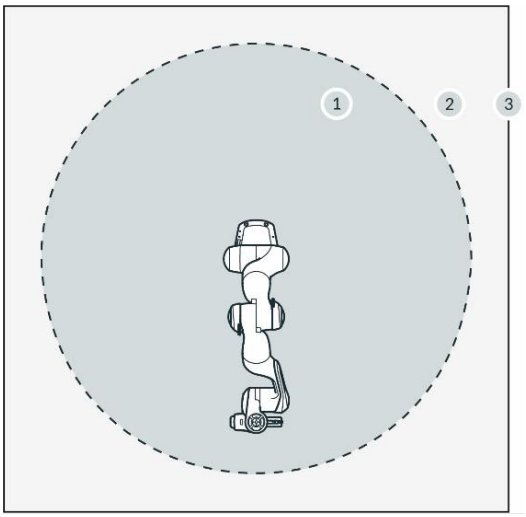


Figure 11.20

1	Maximum space	3	Perimeter safeguarding
2	Safeguarded space		

Precondition

- A Task has been created in Teach a Task
- The Task has been successfully tested in Test & Jog.
- The safety system is running without violations and errors.

NOTICE

Always evaluate the remote start of the execution and realize the safety concept within the safety design (e.g., external safety means) and the safety settings of the robotic system.

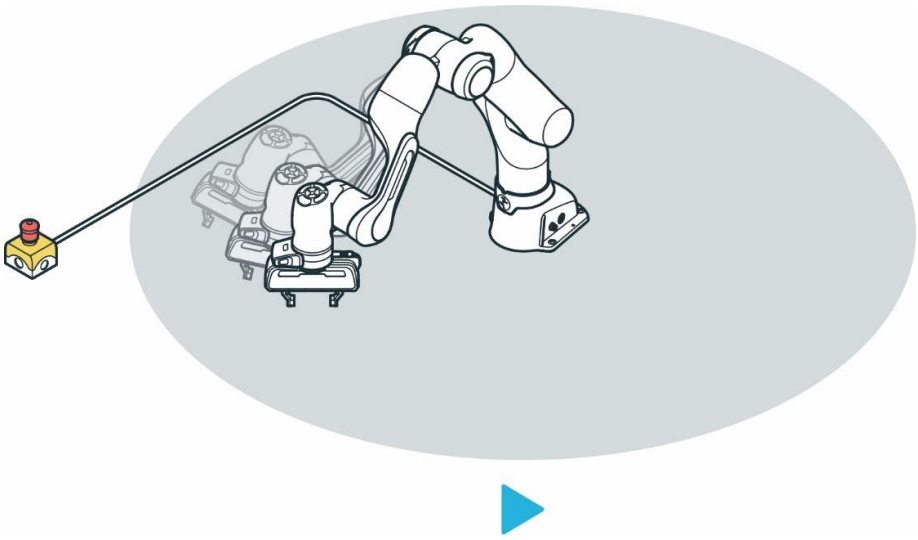


Figure 11.21

NOTICE

Noise levels during operation < 70 dB (A)

Procedure

1. Press the Play button in Desk.

A confirmation dialog is shown.

2. Confirm the dialog.

The robot executes the learned task.

NOTICE

If a collision occurs, the execution is stopped. The failed App is highlighted, and an error description is displayed. In this mode, the Arm can be moved using guiding and any causes of error can be eliminated.

NOTICE

Any error message is displayed in the sidebar. There, information on the error and how to eliminate it can be viewed.

1. To continue with the execution, press the Play button for one of the Apps.
2. To end the Task, press the Stop button.

NOTICE

The remote execution start must be evaluated during the realization of the specific cell safety concept.

11.9 Troubleshooting

Recoverable errors

For a list of recoverable safety errors, see chapter Safety Functionalities.

Error	Solution
Franka Production 3 indicator is lit white	Possibly one of the two buttons on the Pilot-Grip has not been pressed properly. Release both buttons and half-press the Enabling Button while simultaneously pressing the Guiding Button again. Make sure that you do not completely press down the Enabling Button, otherwise the Arm's motion is stopped.
Franka Production 3 indicator changes to color pink	The system is receiving conflicting enabling signals. Close all inputs before moving the robot again. The opened inputs X3.1 (emergency stop) and X4 (External Enabling Device) are highlighted in pink in Desk.
Franka Production 3 indicator is lit or flashes yellow	The system has identified a warning in the system. The system might work with the active warning or not, depending on the type of warning.
Franka Production 3 indicator flashes red	An application error or safety violation has occurred. The error or violation must be fixed before the system Fail-safe Locking System can be released again from Desk.
Franka Production 3 indicator is lit red	There is a problem. If this cannot be rectified by restarting the system, please contact a contact partner, a service provider or us directly at: support@franka.de.

Arm pulls strongly in one direction during teaching

Immediately check the settings for the end effector and make sure that the correct end effector has been selected and configured. Make sure Franka Production 3 is mounted on a plain surface within the permitted tilt tolerance.

If you connect to a third party or custom-made end effector, ensure that you have compensated it correctly by updating the transformation matrix. To set the correct tool center point, adjust the weight, set the center of mass relative to the flange.

NOTICE

If a third party or custom-made end effector has been installed, check the following:

1. Update the transformation matrix to set the correct tool center point.
2. Adjust the weight of the end effector.
3. Set the center of mass relative to the flange.
4. Update the inertia matrix.

If the problem persists, please contact your service partner or customer support at support@franka.de. Do not operate the system until the issue is solved.

In the case of heavy external cabling, a drift cannot be prevented as that cannot be compensated with Franka Production 3 settings for all poses.

Loud clicking at switch-off

The clicking results from the deployment of the Fail-safe Locking System and is normal. Locking pins are deployed in the joints to lock them mechanically.

Joint position error

If a joint position error occurs, the system cannot guarantee that previously taught poses are still correct.

NOTICE

While using the “Test & Jog” mode with the External Enabling Device, make sure that you are outside of the hazard zone when checking the Task execution from a safe distance.

To recover from a joint position error, follow the instructions in chapter Safety Functionalities.

If the recovery cannot be completed successfully, the robot hardware has been compromised. Shut down the system and take the robot out of operation.

For more information on joint position errors, see chapter Safety Functionalities

Failed to unlock joints

If the joint unlocking process fails, follow the following steps:

1. Shut down the robot, unplug it from its power source, and remove the connecting cable between the Arm and Control. For information on how to safely shut down Franka Production 3, see section Disconnecting Franka Production 3 from the power supply in chapter Preparing the Installation Site.
2. Check the pins for potential damage.
   If no damage can be observed, carefully but firmly reattach the cable and make sure it sits tight.
   Power up the robot and try to unlock the joints.
3. If the issue should persist, contact your service partner or customer support at support@franka.de by providing the serial number of the Arm and the log files of the robot. You can find the log files in Desk – Settings – System – Download log files.

Robot does not finish booting

Procedure

1. Turn off the Control.
2. Unplug the system from its power source.
   For information on how to safely shut down Franka Production 3, see section Disconnecting Franka Production 3 from the power supply in chapter Preparing the Installation Site.
3. Remove the connecting cable between the Arm and Control.
4. Check the pins for potential damage.
5. If no damage can be observed, carefully but firmly reattach the cable and make sure it sits tight.
6. Power up the robot.

If the issue persists, contact your service partner or support@franka.de by providing the serial number of the Arm.

Lifetime exceeded

As the load on Franka Production 3 can vary between different Tasks, Franka Production 3 performs real-time measurements based on the effective load to monitor the actual wear of the most critical drive-chain elements. As soon as the wear of such a drive chain component exceeds its specification, a notification in Desk will inform you that the robot needs to be replaced.

For more information, see chapter System Lifetime.

Desk continuously displays “Shutting down the system”

You have shut down the system. As soon as the front fans of the Control 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.

Robot does not boot after turning on the Control

Occurs when the system has been turned off via Desk, but the Control power button was not turned off.
Solution: Turn off the Control and wait for a few seconds. Turn on again. Control should now boot.

Restarting after an unexpected stop

For restarting after an unexpected stop, refer to subchapter Restarting in chapter Switching Off and Restarting.

12 MANAGING FRANKA PRODUCTION 3

12.1 Franka World

Franka World is an online platform that interconnects customers, partners, and software and hardware developers, whose activity revolves around Franka Emika's products and services. Franka World provides tools for managing Franka Production 3, access to an online store that features a continuously growing portfolio of software and hardware products, and the possibility of becoming part of an active and passionate community.

Visit https://franka.world/ to make use of all the benefits.

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

12.2 Managing Apps and Updates

System updates and Apps purchased over the Franka World store can be retrieved and installed on the robot via the Franka World tab in the Settings interface. Synchronization between the robot and a Franka World account is easy and fast when the robot is online. An alternative manual option is presented to the operator via the same interface if the robot is offline.

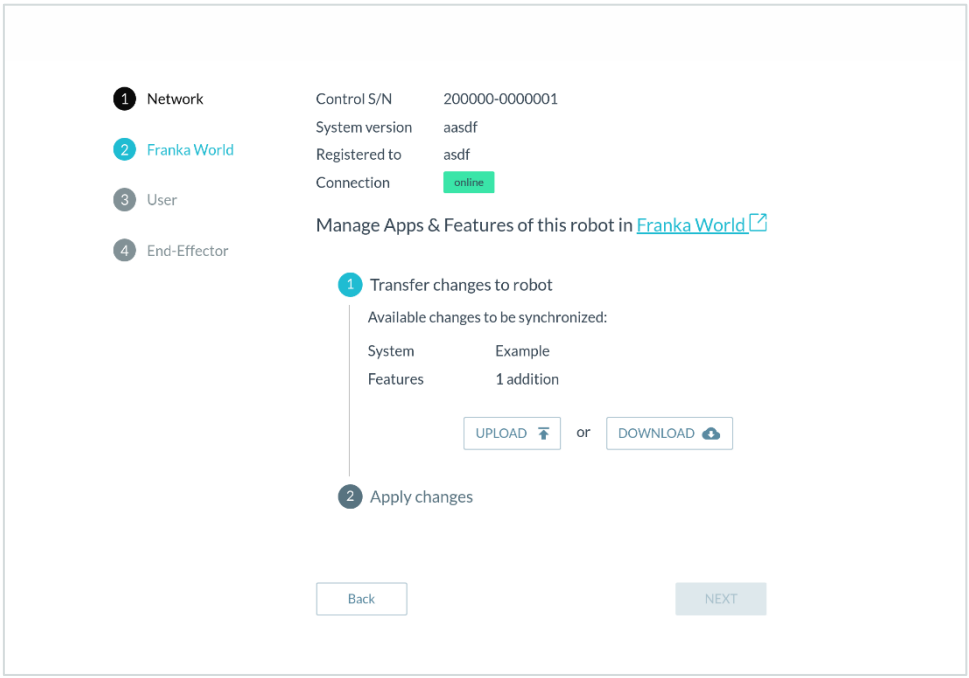


Figure 12.1

Registering

Precondition

- The robot must be online.
- You must be logged in to Franka World.

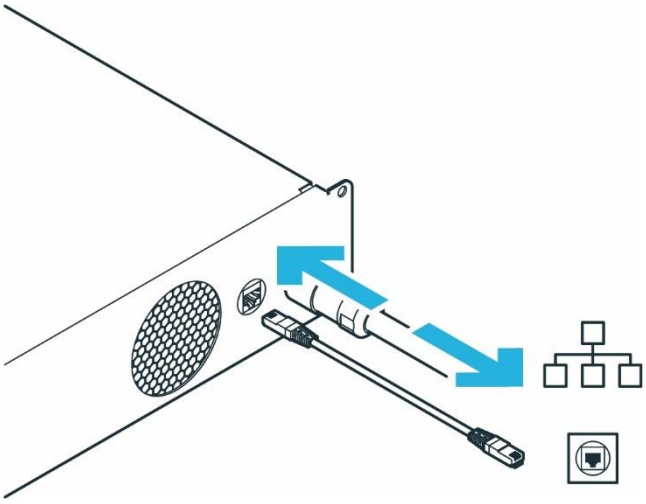


Figure 12.2

Procedure

1. Navigate to Settings.
2. Click on REGISTER DEVICE.

You will be redirected to a different site that states your robot's serial number and other proof of ownership.

3. If required, enter your e-mail and password and log in.

You will be redirected to another site.

4. Choose an account for registering your robot.
5. Click REGISTER.

The robot is now registered.

6. Navigate to Manage.
7. To see all registered robots, click on Devices.

12.3 Hub

Hub is the central knowledge section within Franka World. It provides access to documentation, tutorials, codes, and updates about our Franka Emika robot and its interfaces. Find more information on https://franka.world/.

12.4 Updates

System updates

Updates for the operating system, Apps, and features can be downloaded conveniently from the Franka World tab in the Settings interface. It is also possible to use an update file from the Franka World device management page and install it manually on your robot.

After updating, the operating system will reboot. The power supply to the robot must not be disconnected.

NOTICE

If required, the operating system will update when new Apps or features need to be installed from Franka World.

13 MAINTENANCE AND DISPOSAL

13.1 Maintenance

There is no maintenance needed for the Arm or Control during their lifetime.

NOTICE

- Activate the emergency stop system during start-up every 12 months.
- Reconnect the emergency stop system during start-up every 12 months.
- Check all safety installations, e.g., emergency stop system, for function every 12 months.
- Check any additional safety measures that have been taken to secure safe operation.

13.2 Cleaning

DANGER

Risk of electric shock

Improper use of liquid cleaning agents, as well as incorrectly disconnected devices from the power supply, can lead to fatal accidents.

- Do not clean devices that have not been safely disconnected from the power supply.
- Do not use liquid cleaning agents for cleaning the devices.

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

- Only qualified persons may carry out cleaning.
- Cleaning is only permissible when Franka Production 3 is safely stopped and disconnected from the power supply.
- Switching off and disconnecting the device must be carried out by qualified persons only.
- Do not use any liquids to clean the device.
- Do not use any cleaning chemicals.
- The components may only be cleaned with a dry cloth.
- Moisture must not enter the device.
- Do not apply great force to the Arm. The parts to be cleaned must be supported manually to not overload and possibly damage the Arm.

NOTICE

Material damage to the devices

- Do not use liquid cleaning agents for cleaning the devices.

13.3 System Lifetime

The expected lifetime of Franka Production 3 in normal operating conditions is 20,000 hours. Normal operating conditions are derived from various representative use cases of the robotic system. This was

verified by analysis and test. If a customer application differs from these normal operating conditions, the lifetime of Franka Production 3 might not reach 20,000 hours.

As the load on Franka Production 3 can vary between different Tasks, Franka Production 3 performs real-time measurements based on the effective load to monitor the actual wear of the most critical drive-chain elements. As soon as the wear of such a drive chain component exceeds its specification, a notification in Desk will inform you that the robot needs to be replaced.

To allow the customer to prepare for the robot reaching its end of life, Franka Production 3 informs the operator upfront that the wear of one or more parts of the Arm's drive chain is reaching its allowed maximum.

⚠ CAUTION

The wear shown in the Settings UI is an estimate of the wear of the robot. It covers the most critical components of the Franka Production 3 system and is an indicator of when the robot needs to be replaced.

A wear estimate below 100 % cannot guarantee that

- the integrity of the most critical components is still given.
- other components or the overall structure of the robot are not damaged.

If any damage to the structure of the robot is detected by visual inspection, the robot must be taken out of operation regardless of the wear shown in the Settings UI.

13.4 Disposal

Disposal

Disposal of Franka Production 3 must comply with the relevant country-specific laws, standards, and regulations.

Battery

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

To remove the battery, open the Control.

NOTICE

Opening the Control is only allowed for the purpose of removing the coin cell battery when disposing of it.

Return of waste of packaging

Please contact Franka Emika to return any used packaging.

14 SERVICE AND SUPPORT

NOTICE

If you have purchased your Franka Production 3 at one of our sales partners or if you have cooperated with a service provider, please get in contact with them first. Our partners can consolidate information and reach out to Franka Emika for troubleshooting and further support.

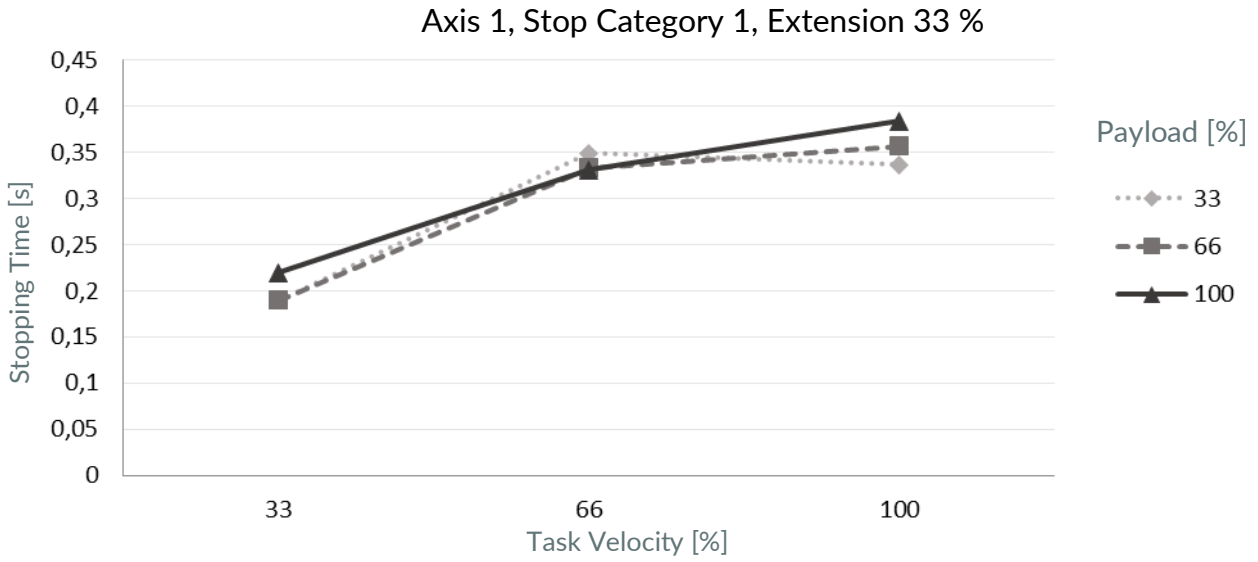
Please visit www.franka.world for supplemental material and additional information on our robot.

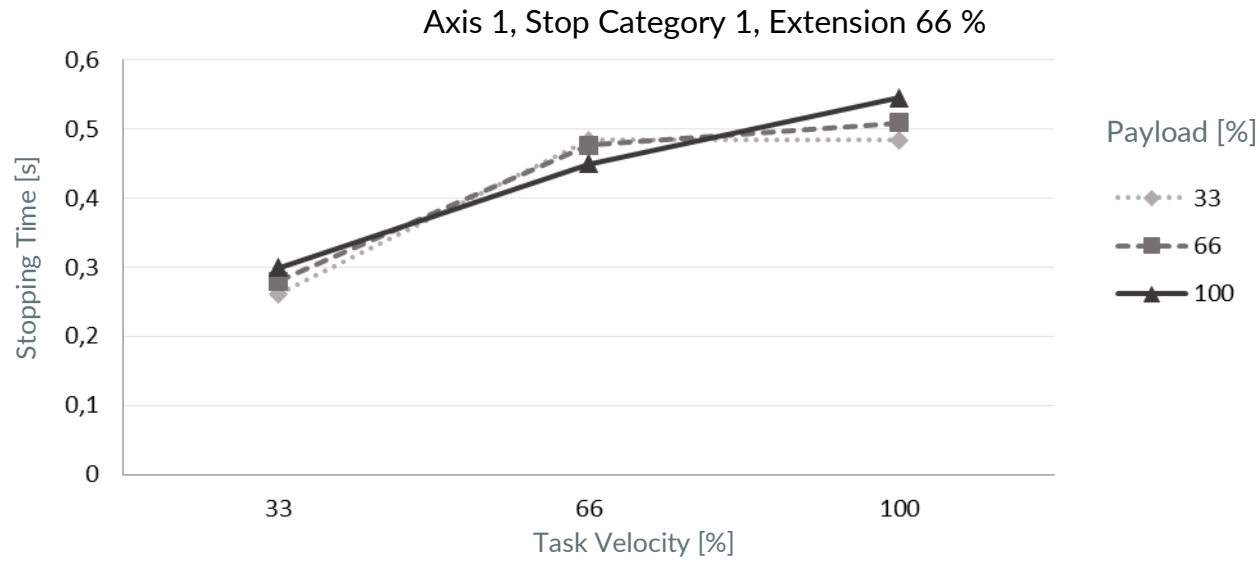
For any other requests regarding service and support please contact us at support@franka.de. We will issue a ticket regarding your request in our service and support center and our experts will respond as soon as possible.

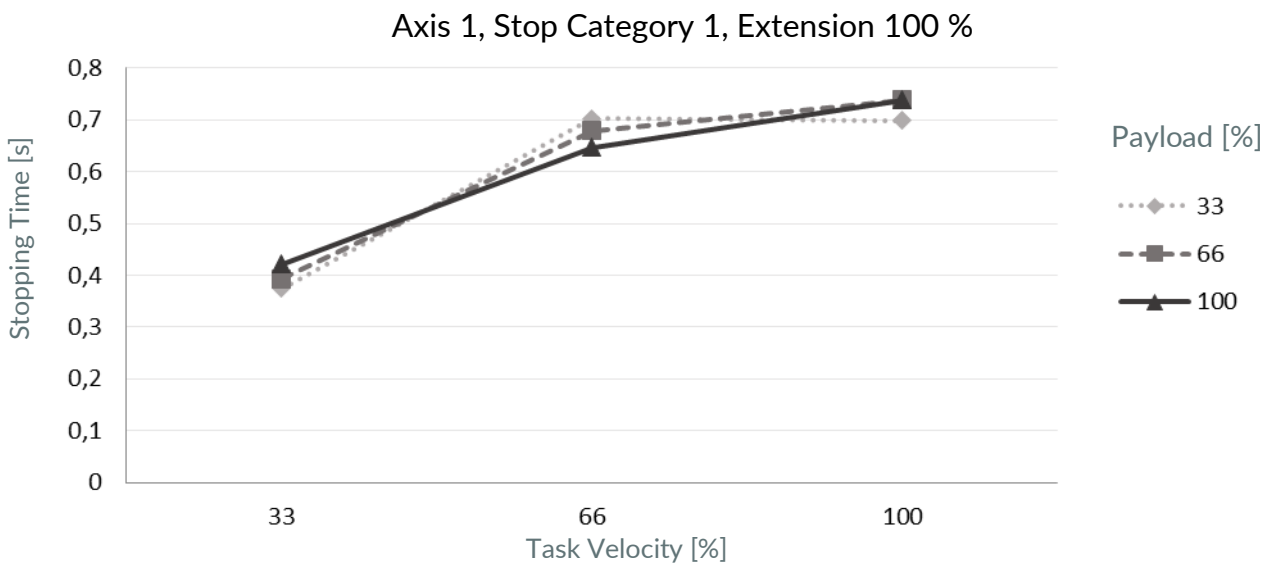
15 APPENDIX

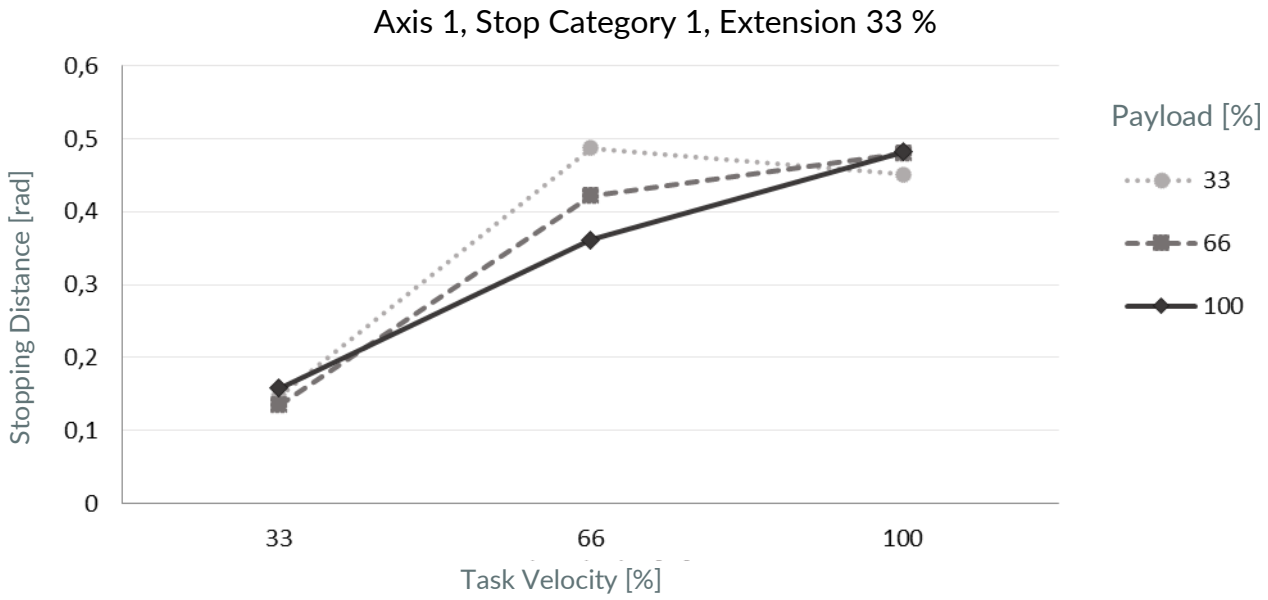
15.1 Stopping Times and Distances

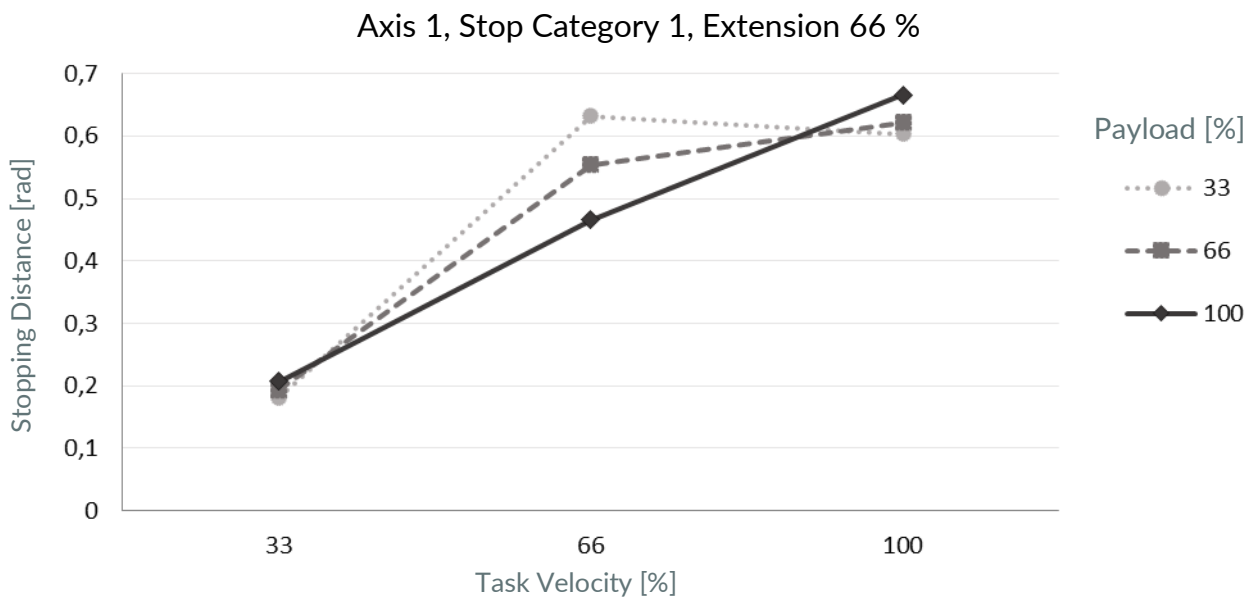
Stopping times and stopping distances as a function of task velocity for different axes, stop categories and extensions.

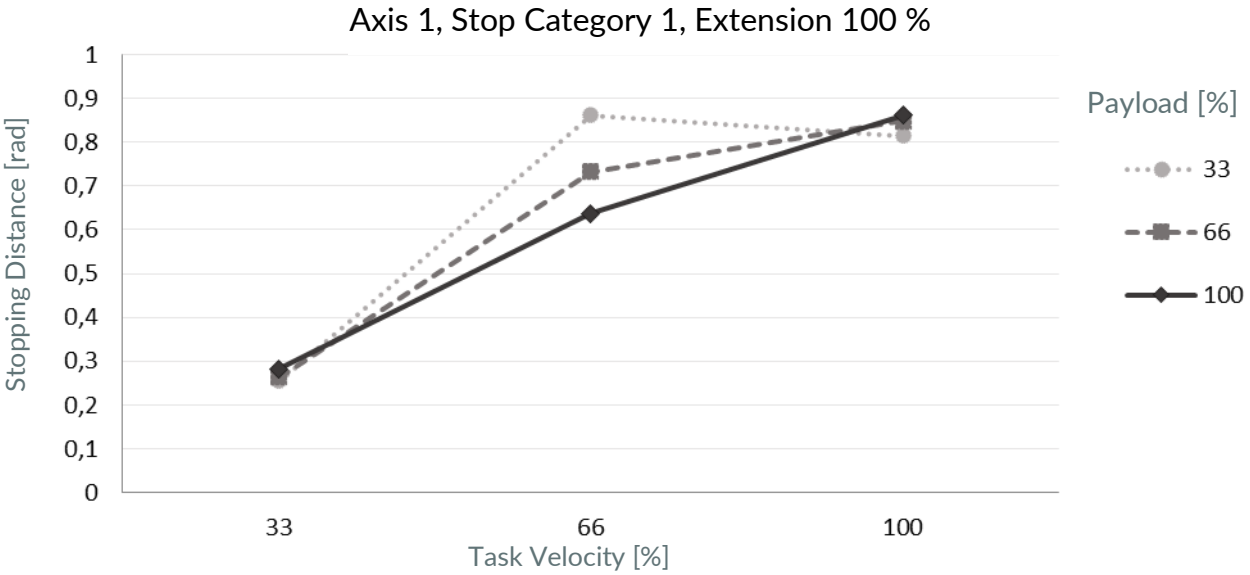


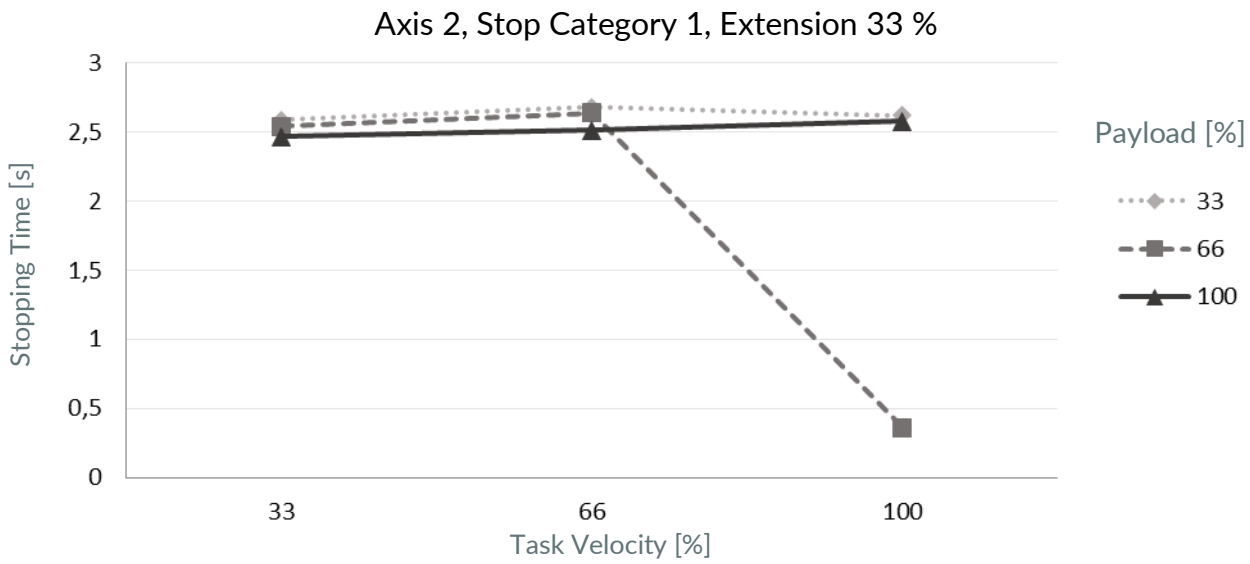


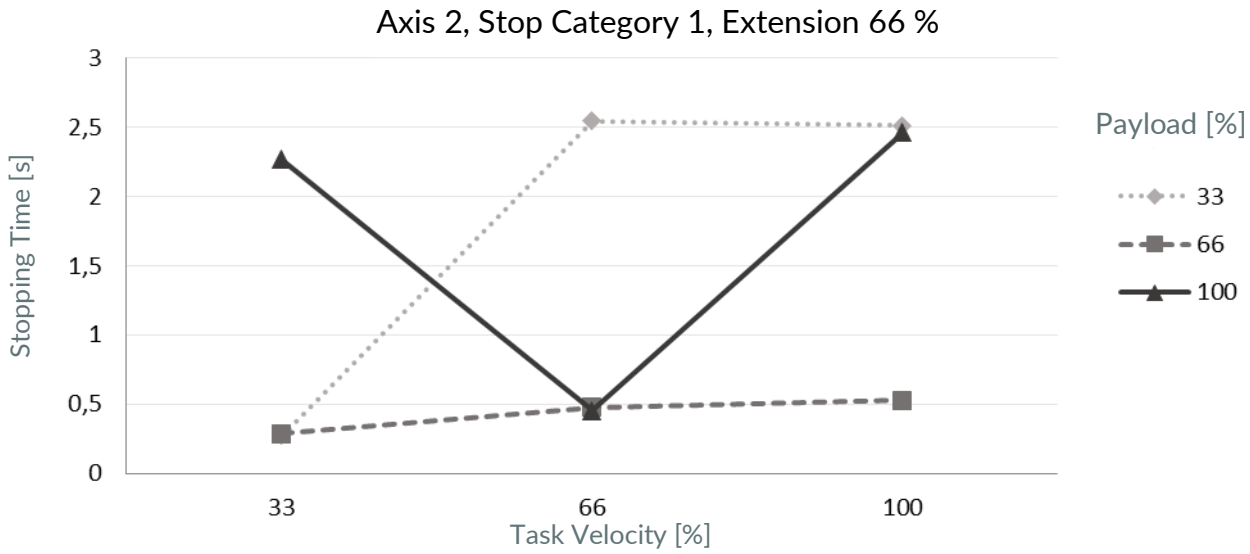

Axis 1, Stop Category 1, Extension 100 %
Stopping Time [s]
0,8
0,7
0,6
0,5
0,4
0,3
0,2
0,1
0
33
66
100
Task Velocity [%]
Payload [%]
33
66
100

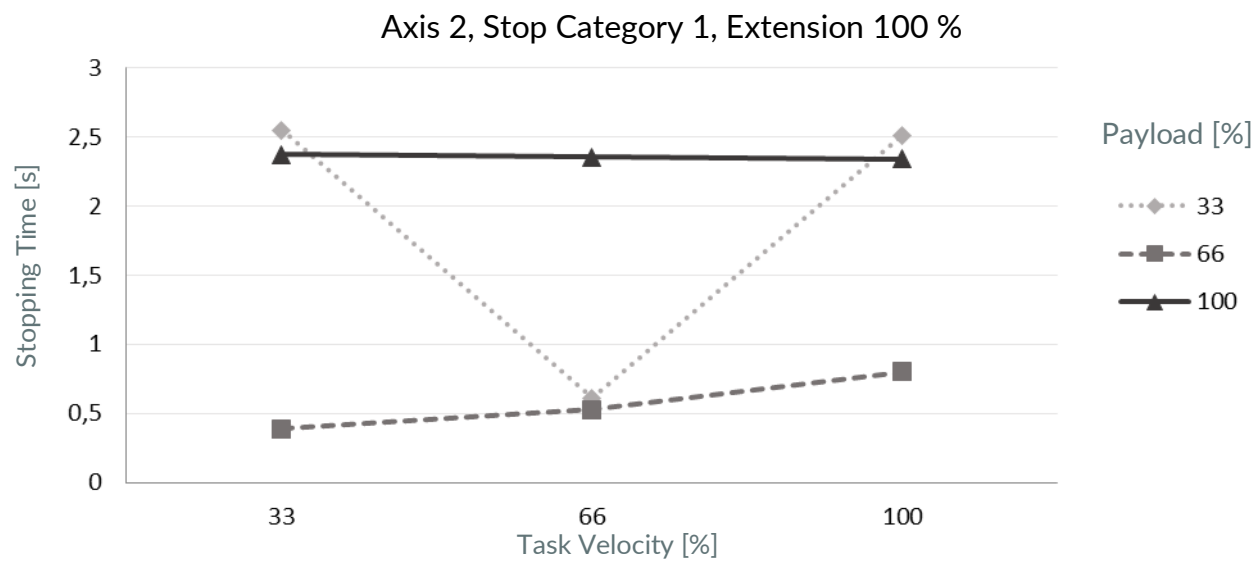

Axis 1, Stop Category 1, Extension 33 %
Stopping Distance [rad]
0,6
0,5
0,4
0,3
0,2
0,1
0
33
66
100
Task Velocity [%]
Payload [%]
33
66
100

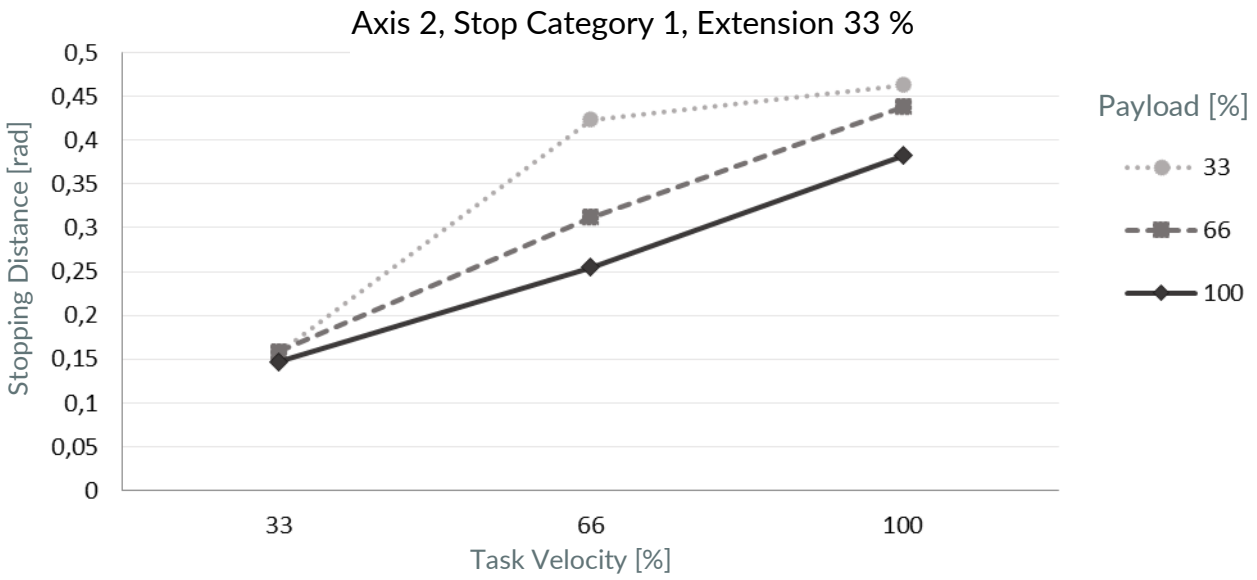

Axis 1, Stop Category 1, Extension 66 %
Stopping Distance [rad]
0,7
0,6
0,5
0,4
0,3
0,2
0,1
0
33
66
100
Task Velocity [%]
Payload [%]
33
66
100

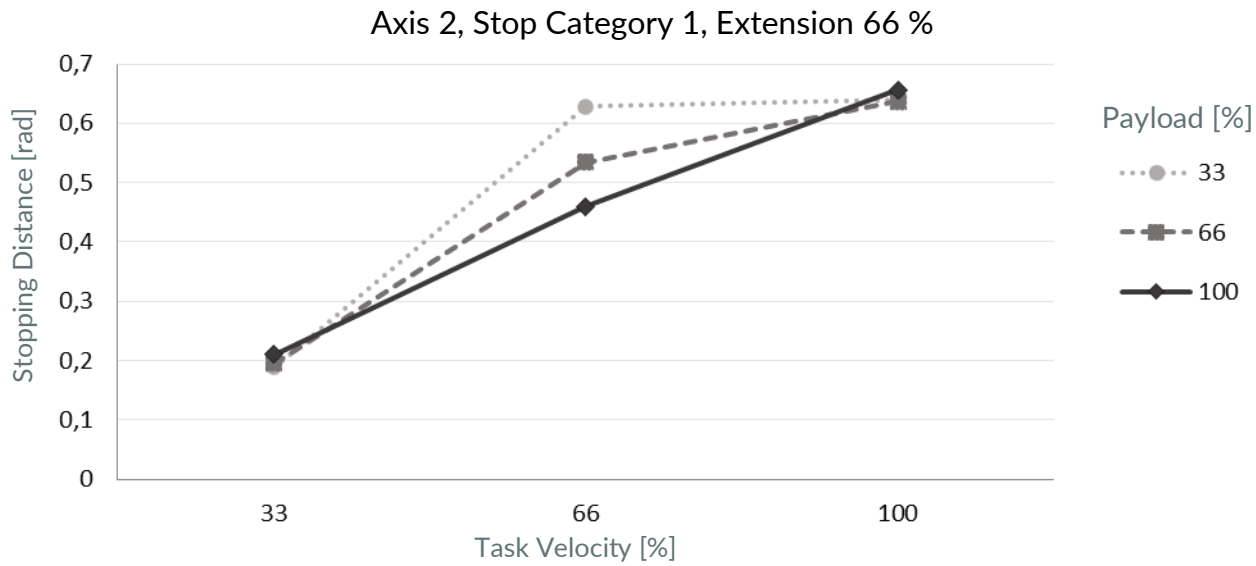

Axis 1, Stop Category 1, Extension 100 %
Stopping Distance [rad]
1
0,9
0,8
0,7
0,6
0,5
0,4
0,3
0,2
0,1
0
33
66
100
Task Velocity [%]
Payload [%]
33
66
100


Axis 2, Stop Category 1, Extension 33 %
Stopping Time [s]
3
2,5
2
1,5
1
0,5
0
33
66
100
Task Velocity [%]
Payload [%]
33
66
100


Axis 2, Stop Category 1, Extension 66 %
Stopping Time [s]
3
2,5
2
1,5
1
0,5
0
33
66
100
Task Velocity [%]
Payload [%]
33
66
100


Axis 2, Stop Category 1, Extension 100 %
Stopping Time [s]
3
2,5
2
1,5
1
0,5
0
33
66
100
Task Velocity [%]
Payload [%]
33
66
100


Axis 2, Stop Category 1, Extension 33 %
Stopping Distance [rad]
0,5
0,45
0,4
0,35
0,3
0,25
0,2
0,15
0,1
0,05
0
33
66
100
Task Velocity [%]
Payload [%]
33
66
100


Axis 2, Stop Category 1, Extension 66 %
Stopping Distance [rad]
0,7
0,6
0,5
0,4
0,3
0,2
0,1
0
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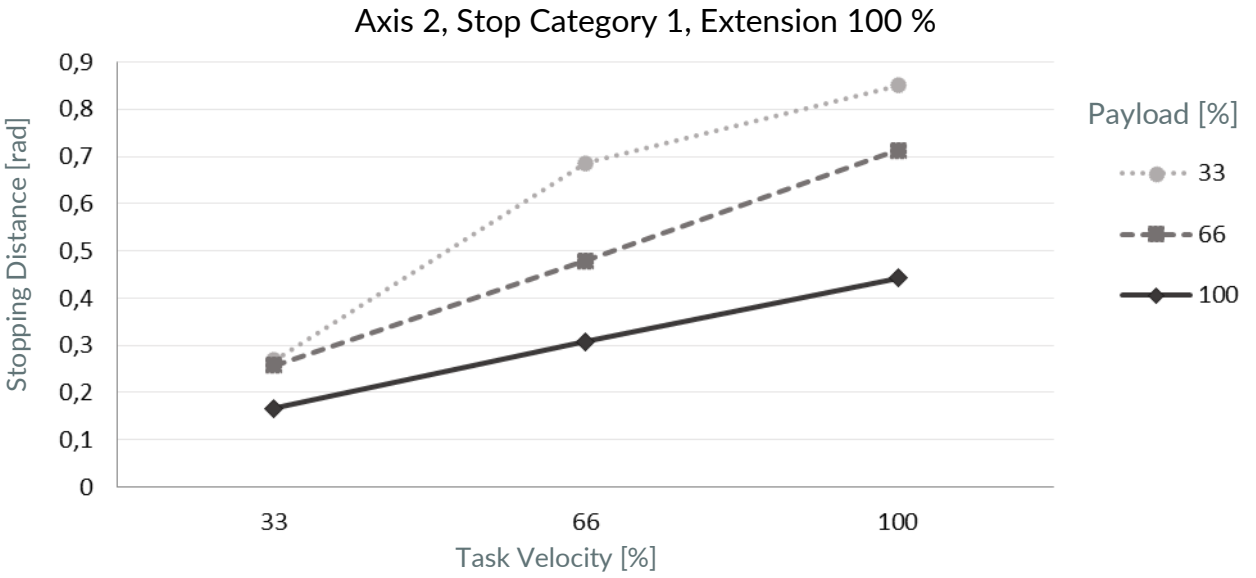
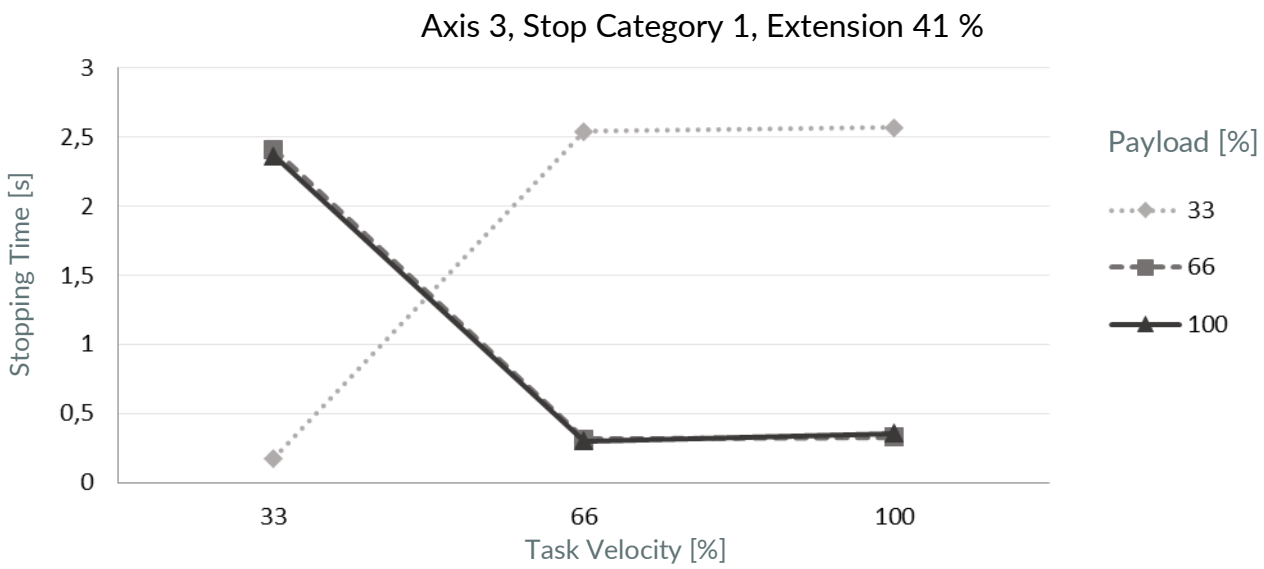
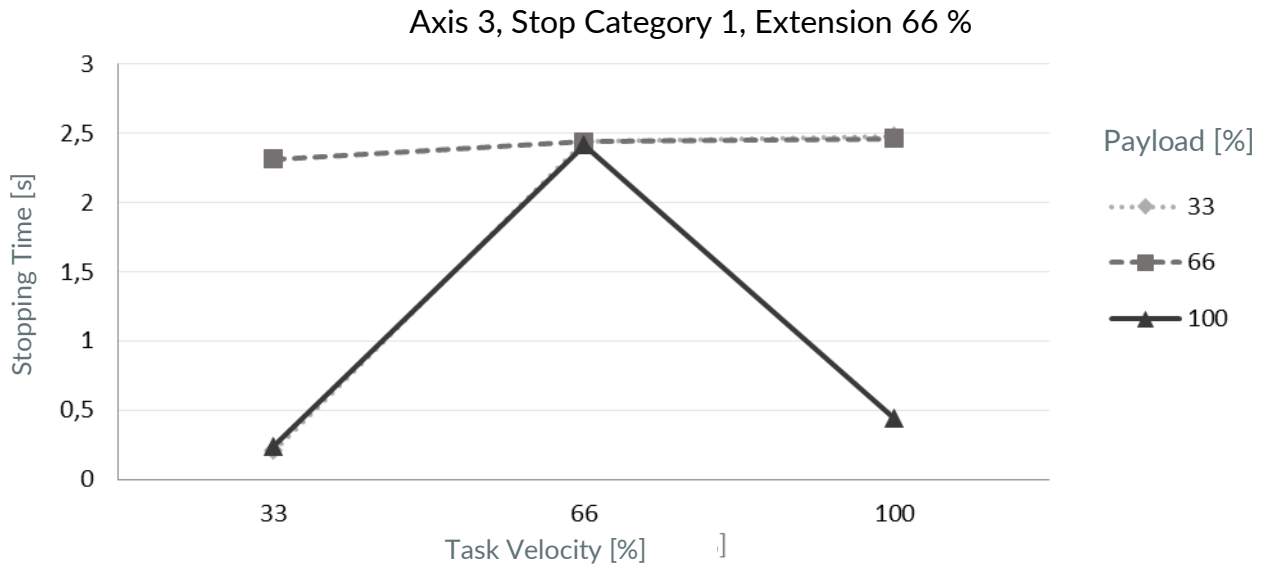
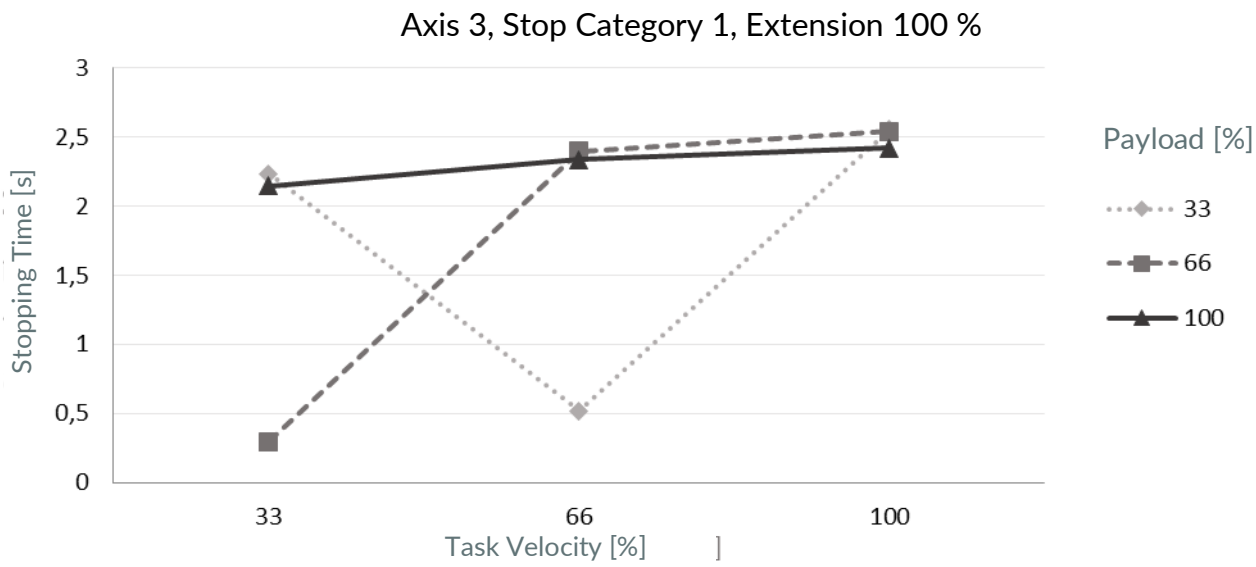
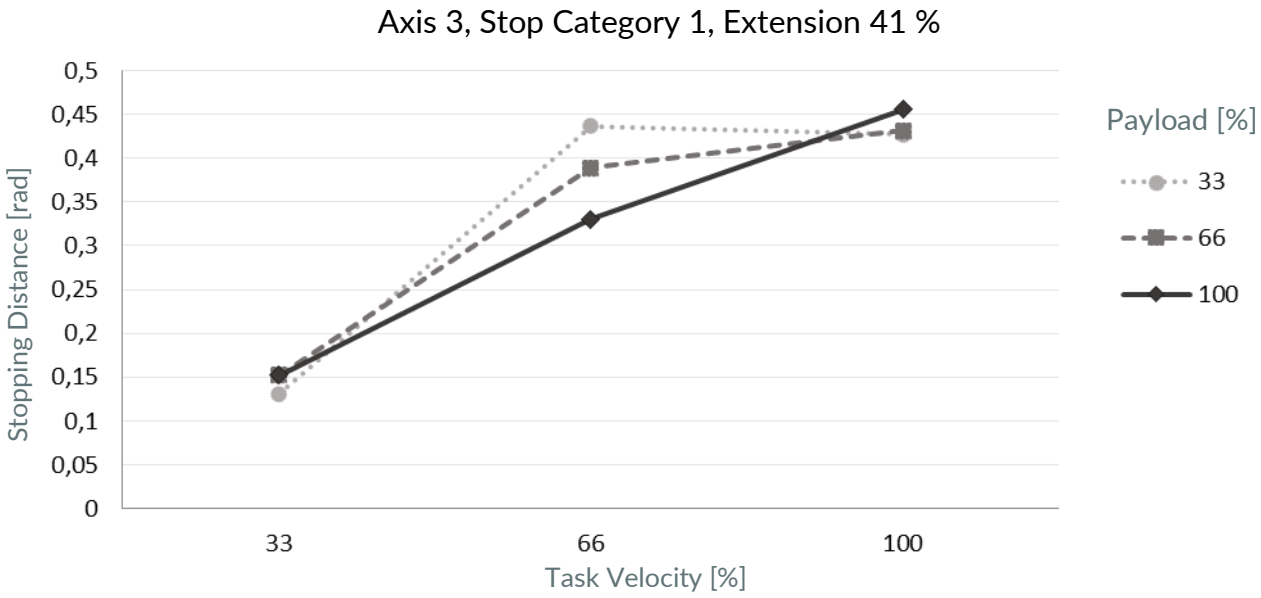
66
100
Task Velocity [%]
Payload [%]
33
66
100

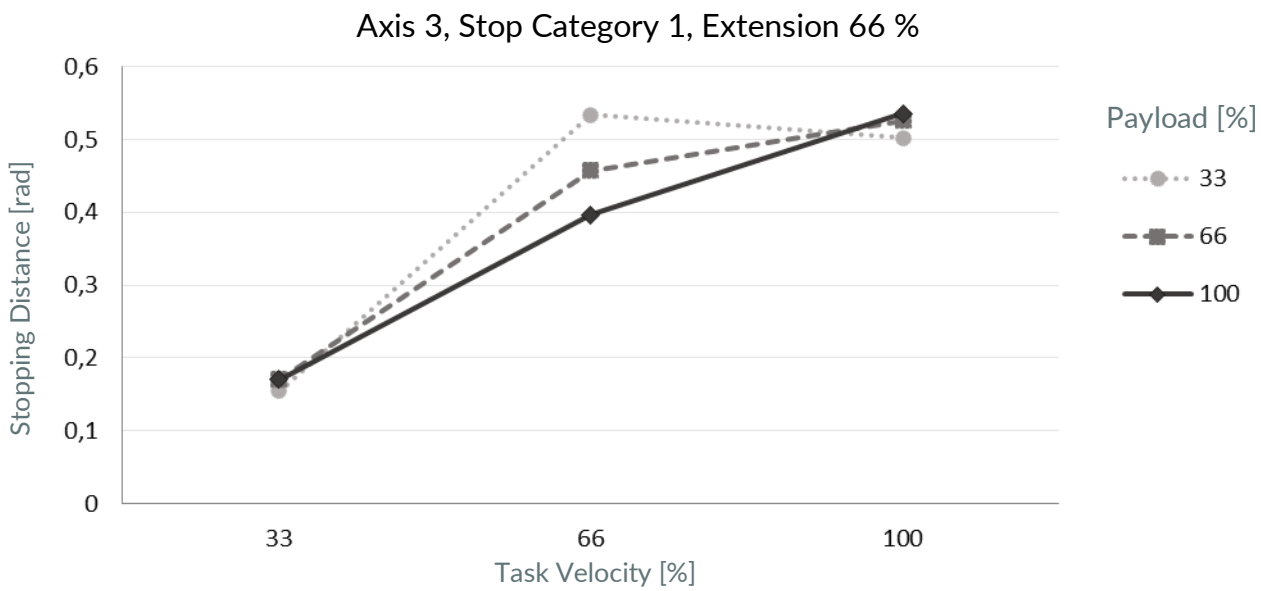

Axis 2, Stop Category 1, Extension 100 %
Stopping Distance [rad]
0,9
0,8
0,7
0,6
0,5
0,4
0,3
0,2
0,1
0
33
66
100
Task Velocity [%]
Payload [%]
33
66
100


Axis 3, Stop Category 1, Extension 41 %
Stopping Time [s]
3
2,5
2
1,5
1
0,5
0
33
66
100
Task Velocity [%]
Payload [%]
33
66
100


Axis 3, Stop Category 1, Extension 66 %
Stopping Time [s]
3
2,5
2
1,5
1
0,5
0
33
66
100
Task Velocity [%]
Payload [%]
33
66
100


Axis 3, Stop Category 1, Extension 100 %
Stopping Time [s]
3
2,5
2
1,5
1
0,5
0
33
66
100
Task Velocity [%]
Payload [%]
33
66
100


Axis 3, Stop Category 1, Extension 41 %
Stopping Distance [rad]
0,5
0,45
0,4
0,35
0,3
0,25
0,2
0,15
0,1
0,05
0
33
66
100
Task Velocity [%]
Payload [%]
33
66
100


Axis 3, Stop Category 1, Extension 66 %
Stopping Distance [rad]
0,6
0,5
0,4
0,3
0,2
0,1
0
33
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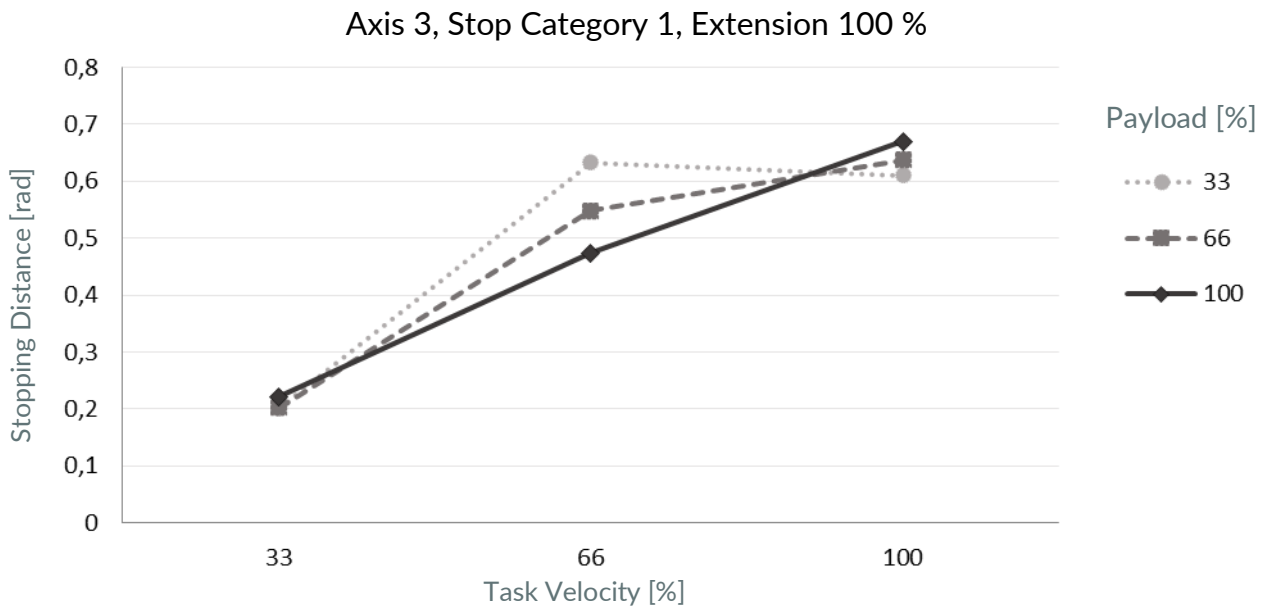
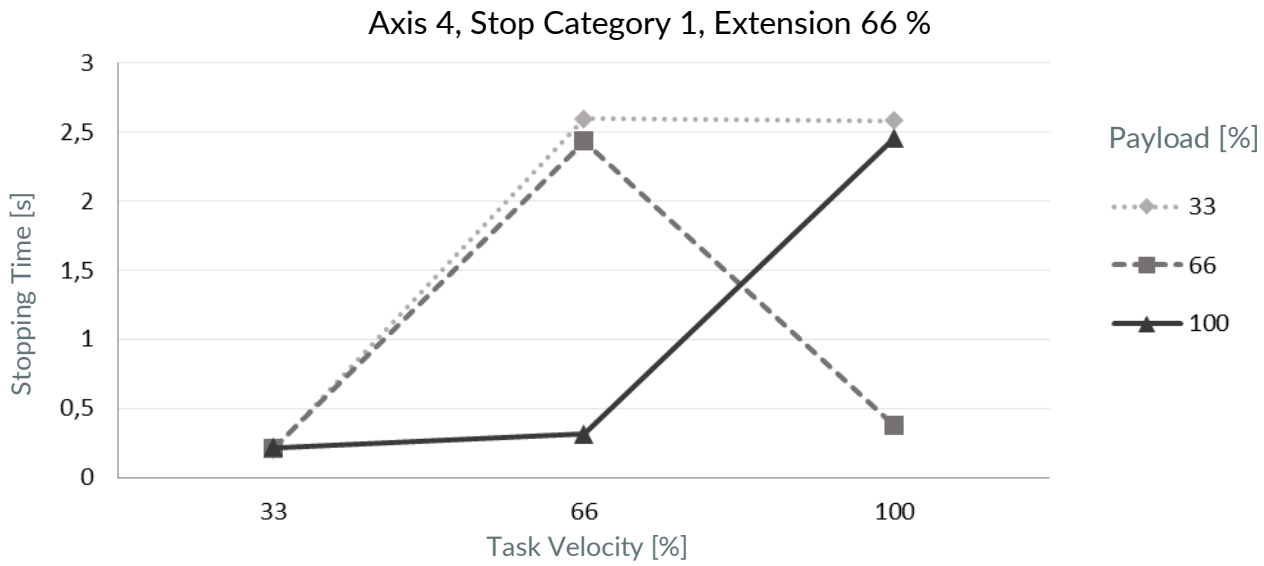
100
Task Velocity [%]
Payload [%]
33
66
100


Axis 3, Stop Category 1, Extension 100 %
Stopping Distance [rad]
0,8
0,7
0,6
0,5
0,4
0,3
0,2
0,1
0
33
66
100
Task Velocity [%]
Payload [%]
33
66
100


Axis 4, Stop Category 1, Extension 66 %
Stopping Time [s]
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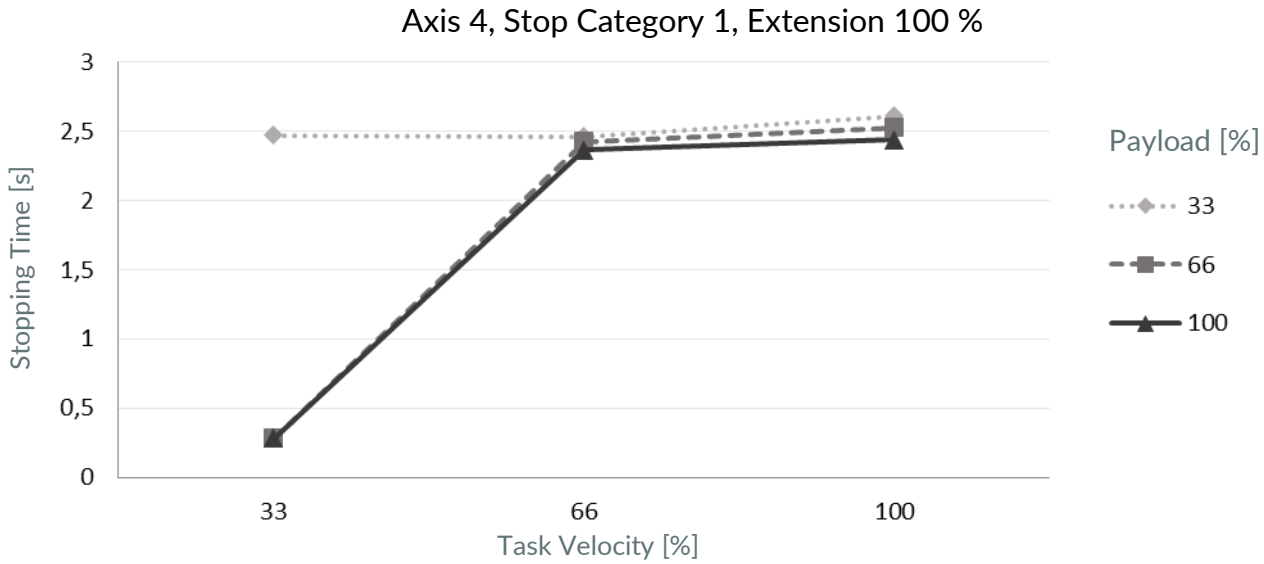
2
1,5
1
0,5
0
33
66
100
Task Velocity [%]
Payload [%]
33
66
100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Stopping Time [s]
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2,5
2
1,5
1
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0
33
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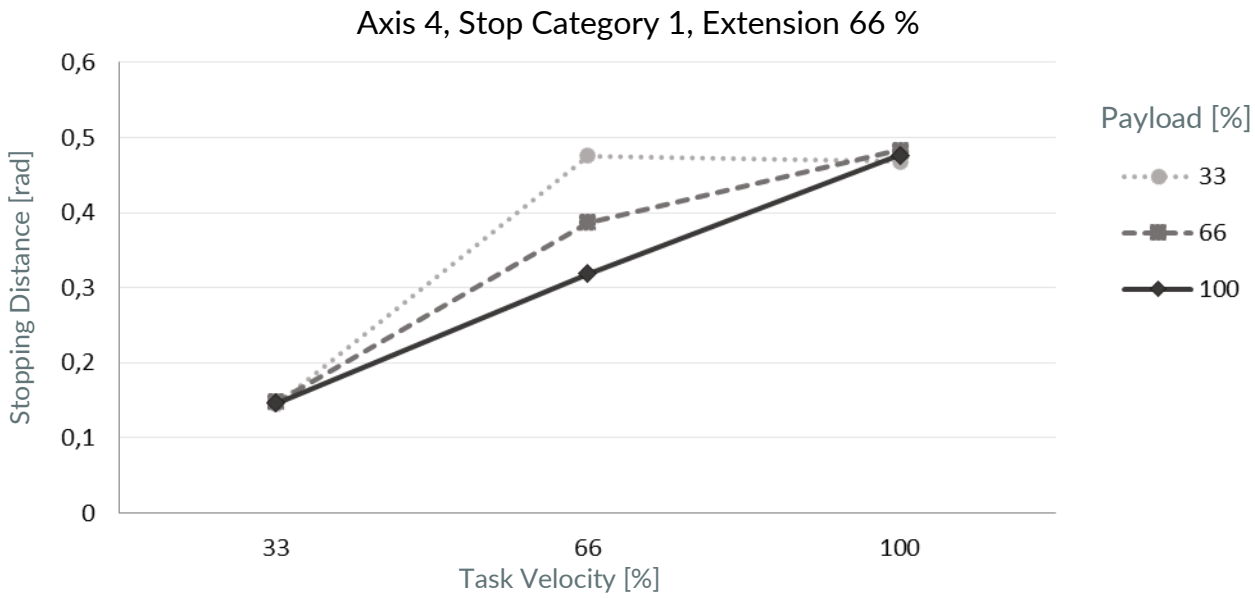
Task Velocity [%]
Payload [%]
33
66
100


Axis 4, Stop Category 1, Extension 66 %
Stopping Distance [rad]
0,6
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0,4
0,3
0,2
0,1
0
33
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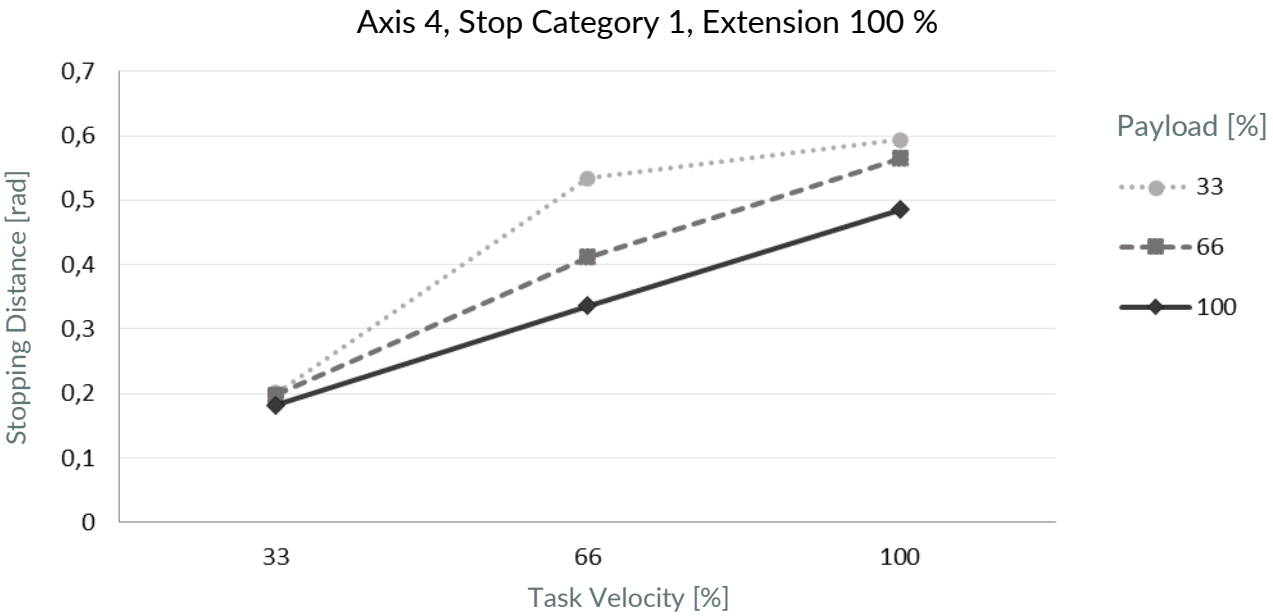
Payload [%]
33
66
100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Stopping Distance [rad]
0,7
0,6
0,5
0,4
0,3
0,2
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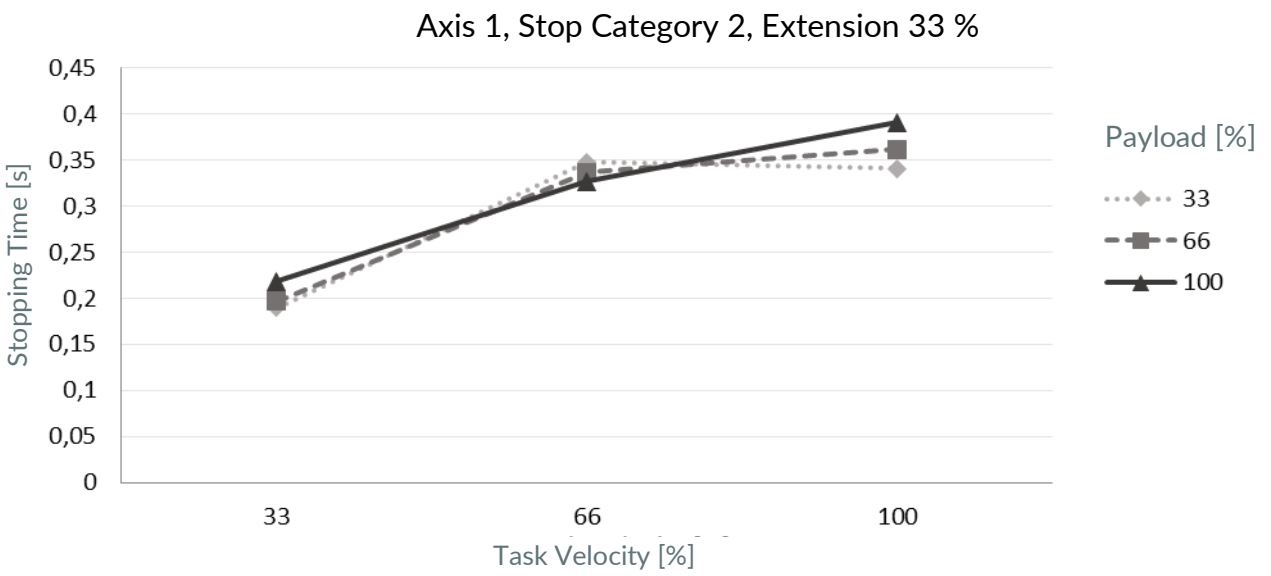
0
33
66
100
Task Velocity [%]
Payload [%]
33
66
100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0,4
0,35
0,3
0,25
0,2
0,15
0,1
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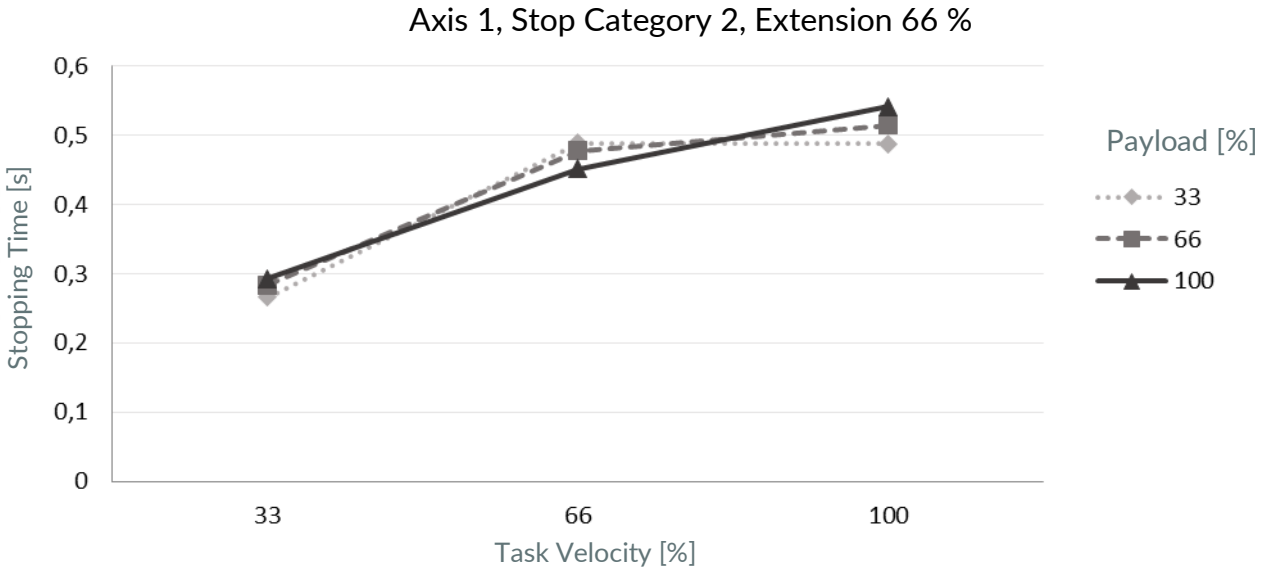
Payload [%]
33
66
100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Stopping Time [s]
0,6
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0,4
0,3
0,2
0,1
0
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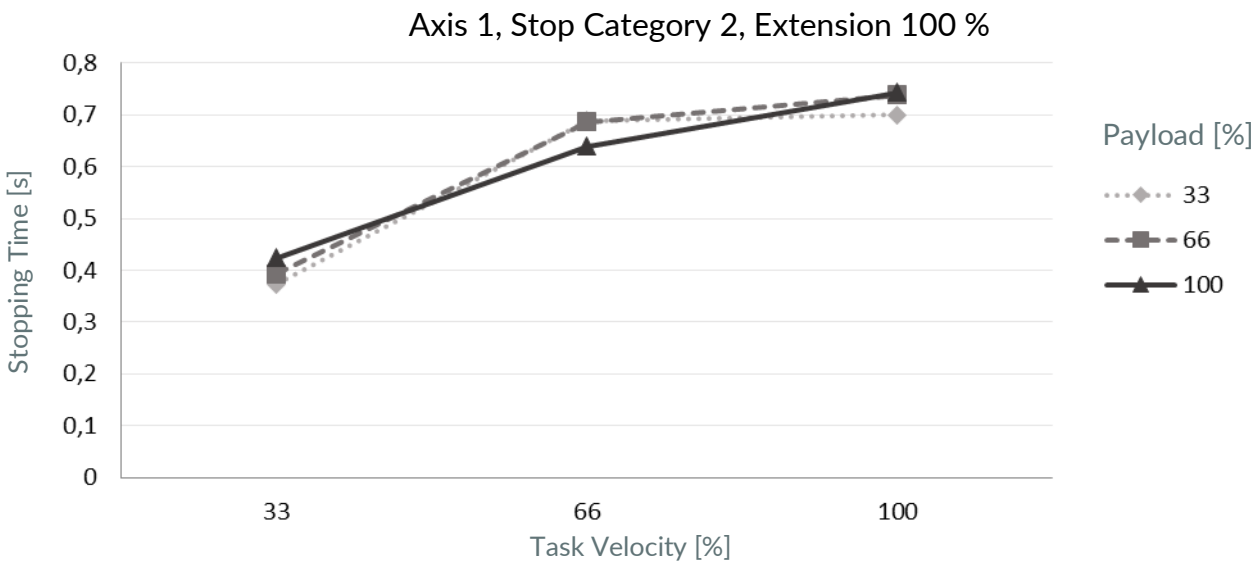
Payload [%]
33
66
100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Stopping Time [s]
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0,7
0,6
0,5
0,4
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0,2
0,1
0
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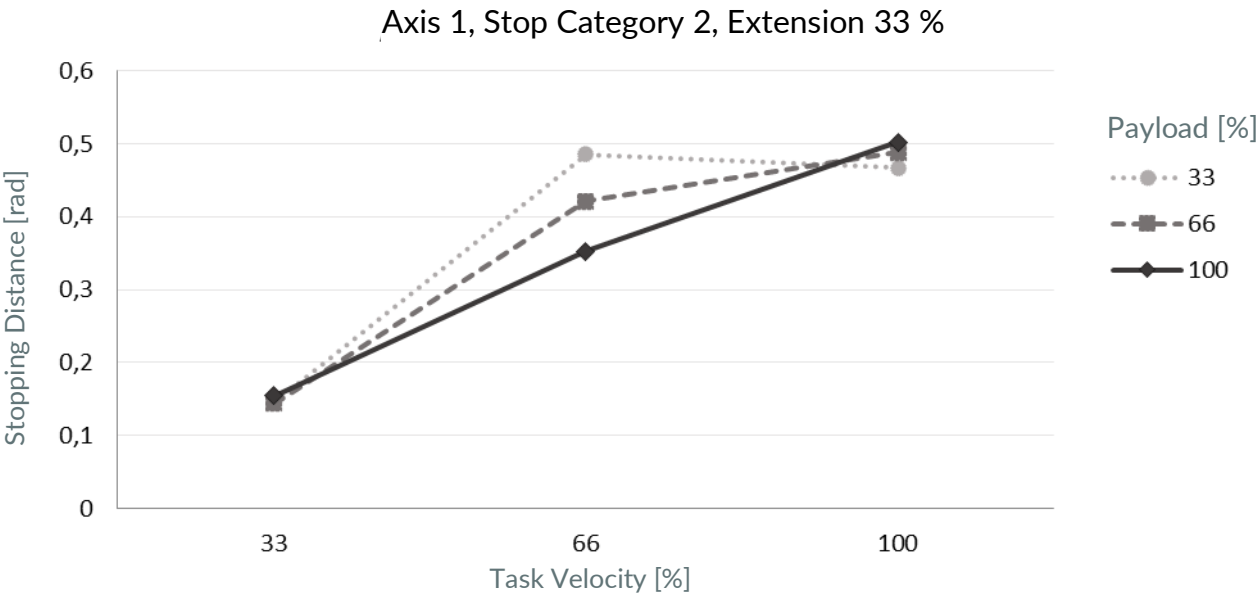
66
100
Task Velocity [%]
Payload [%]
33
66
100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Stopping Distance [rad]
0,6
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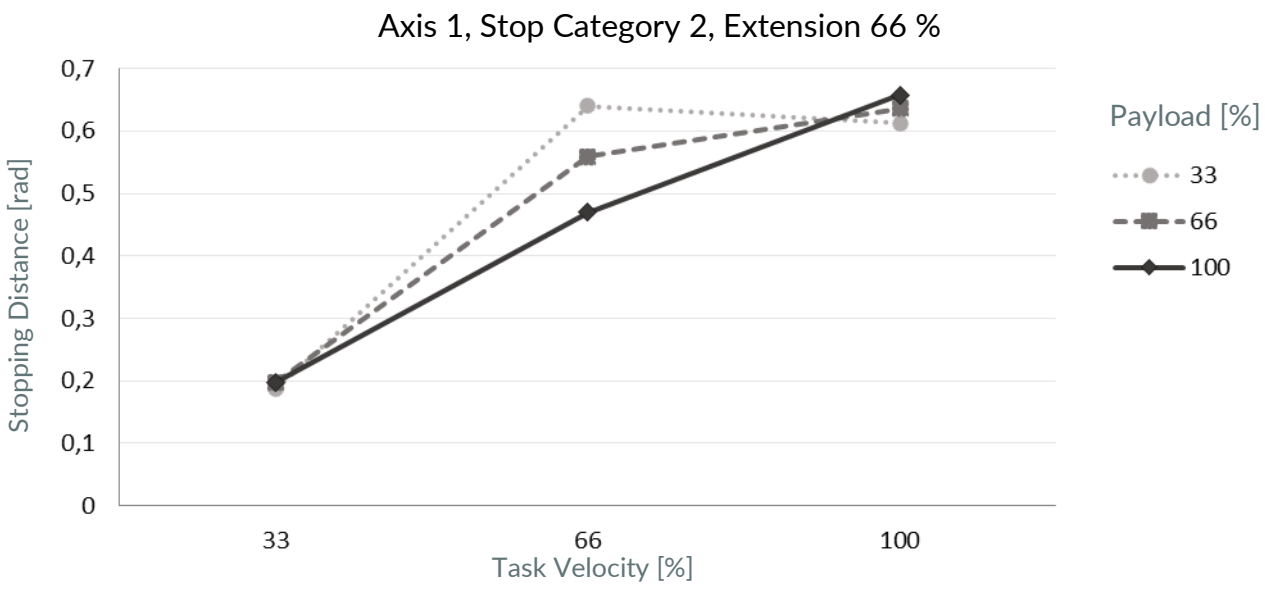
Payload [%]
33
66
100


Axis 1, Stop Category 2, Extension 66 %
Stopping Distance [rad]
0,7
0,6
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0,4
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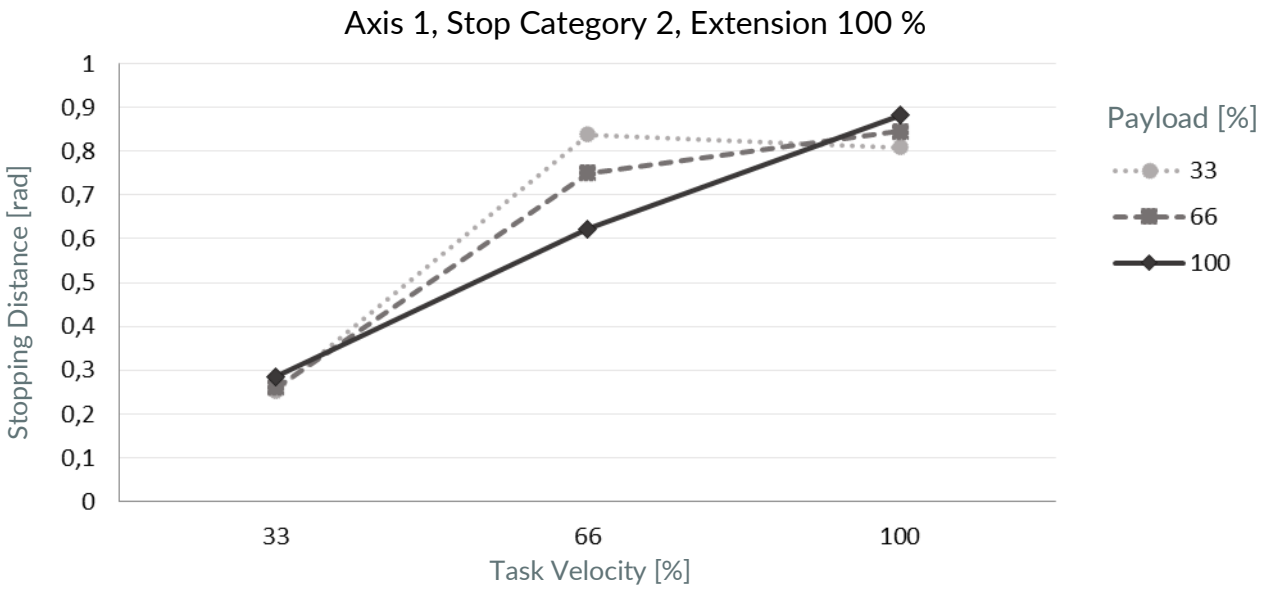
Task Velocity [%]
Payload [%]
33
66
100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0,9
0,8
0,7
0,6
0,5
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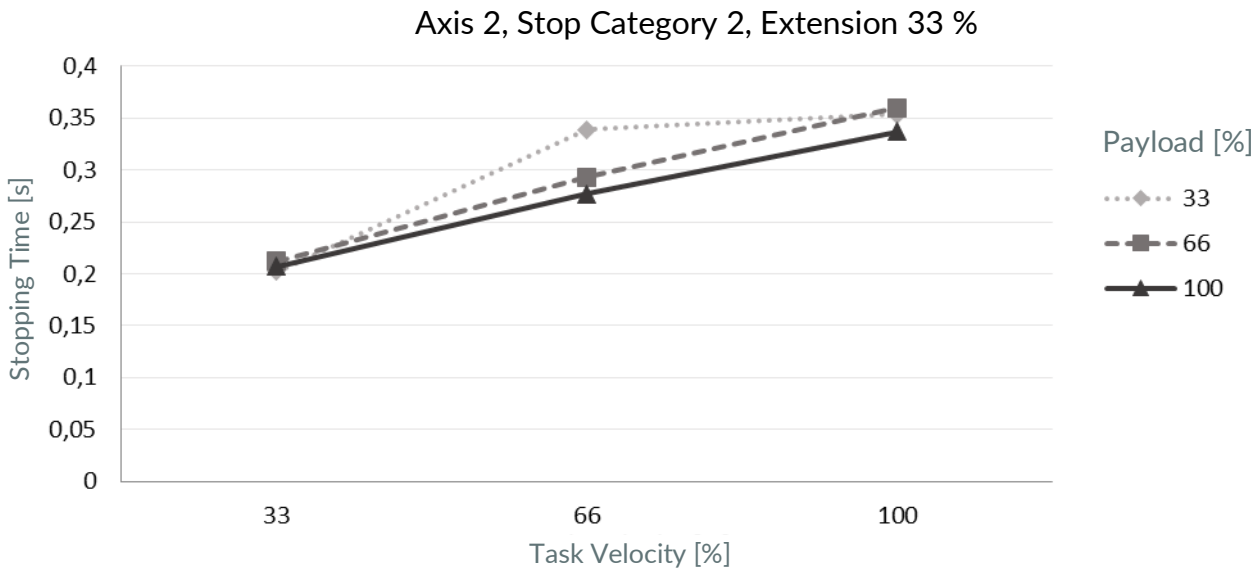
66
100
Task Velocity [%]
Payload [%]
33
66
100


Axis 2, Stop Category 2, Extension 33 %
Stopping Time [s]
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0,35
0,3
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0,2
0,15
0,1
0,05
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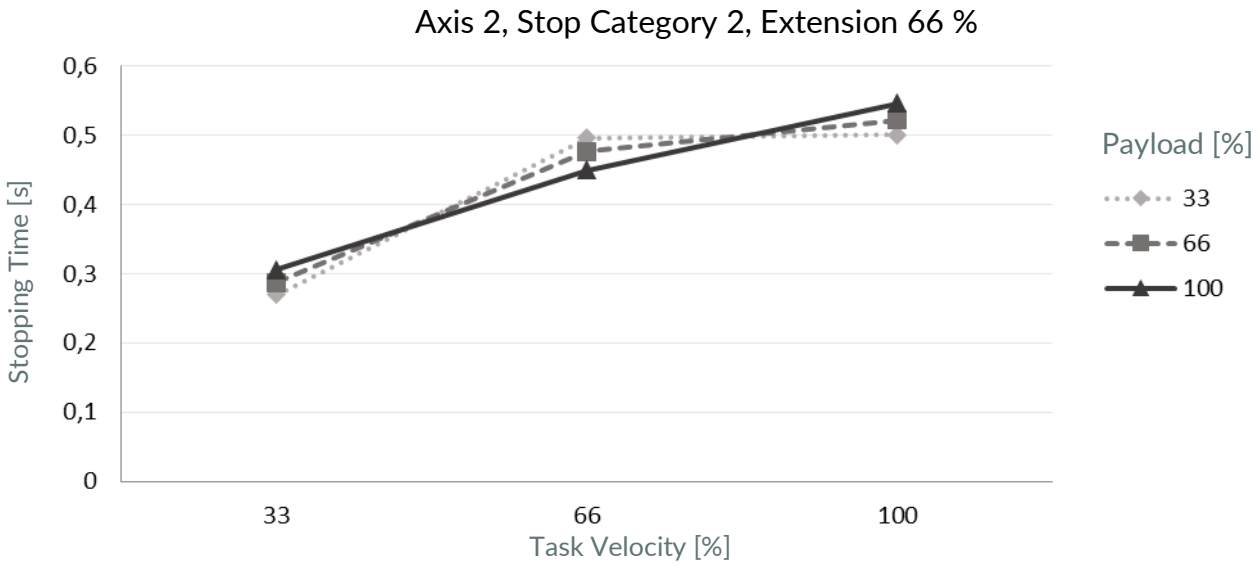
Payload [%]
33
66
100


Axis 2, Stop Category 2, Extension 66 %
Stopping Time [s]
0,6
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Task Velocity [%]
Payload [%]
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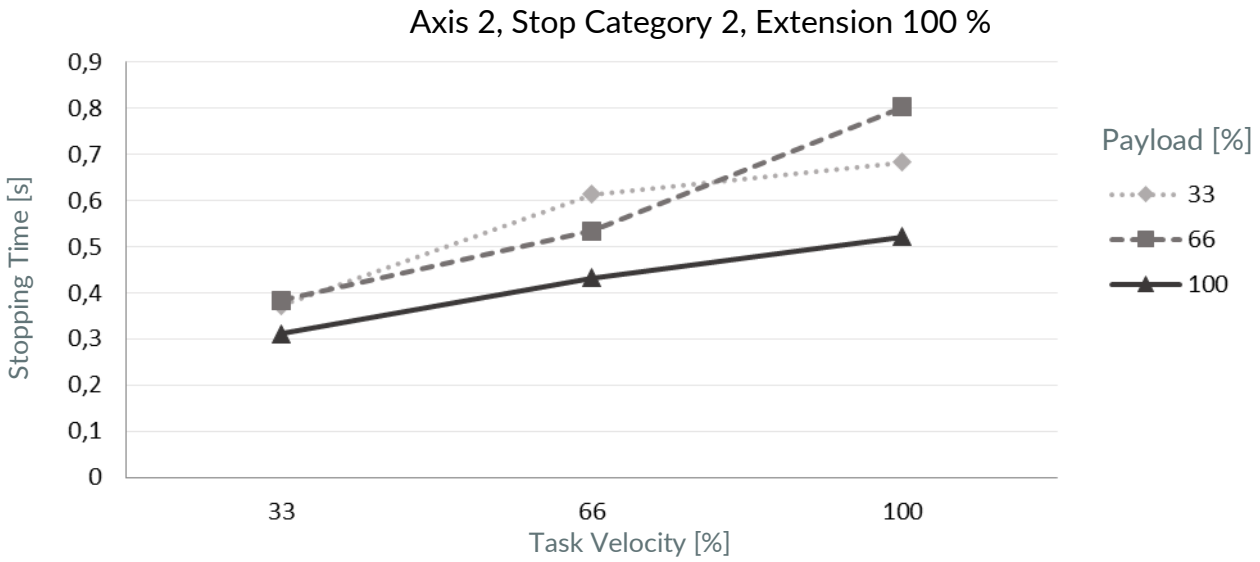
100


Axis 2, Stop Category 2, Extension 100 %
Stopping Time [s]
0,9
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Task Velocity [%]
Payload [%]
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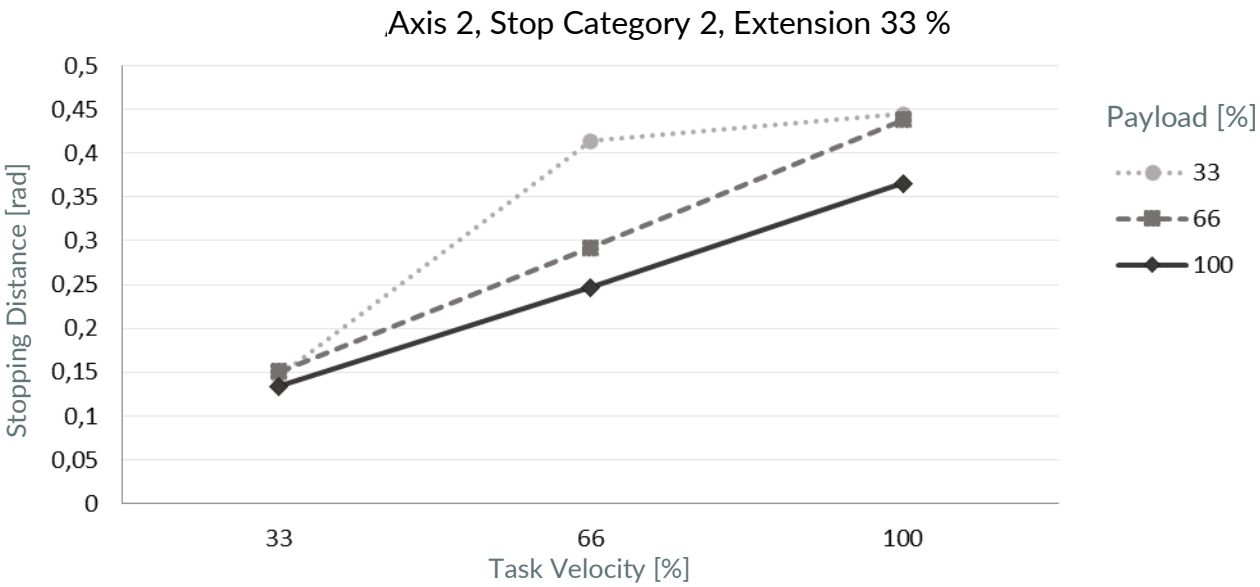
100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Stopping Distance [rad]
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0,45
0,4
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0,3
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Task Velocity [%]
Payload [%]
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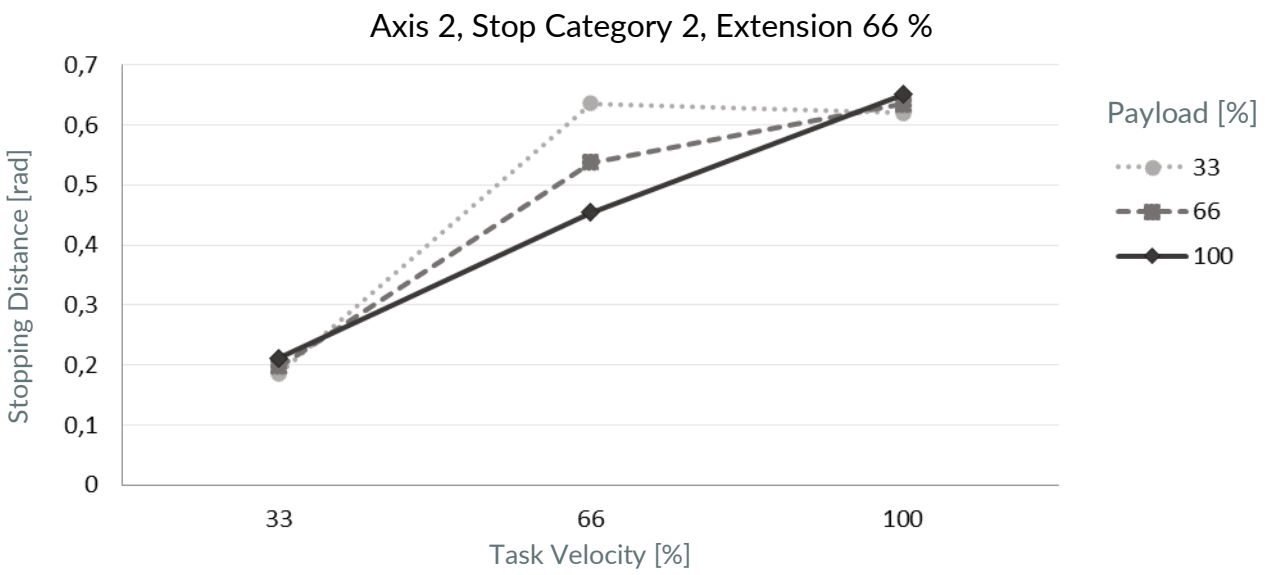
100


Axis 2, Stop Category 2, Extension 66 %
Stopping Distance [rad]
0,7
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Payload [%]
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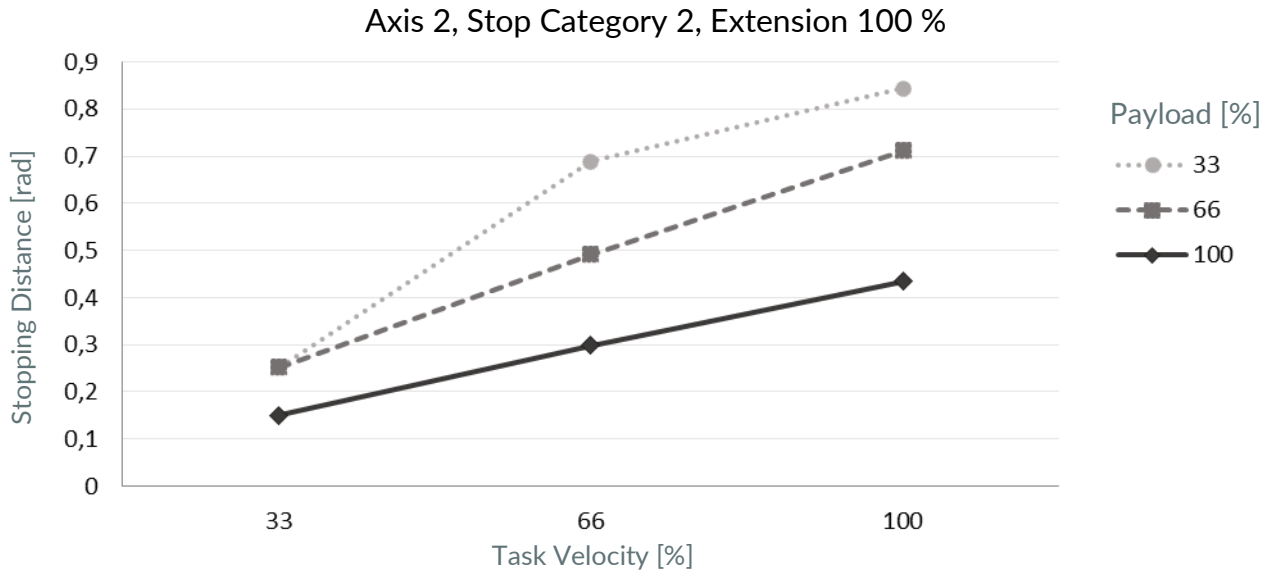
Axis 2, Stop Category 2, Extension 100 %
Stopping Distance [rad]
0,9
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Task Velocity [%]
Payload [%]
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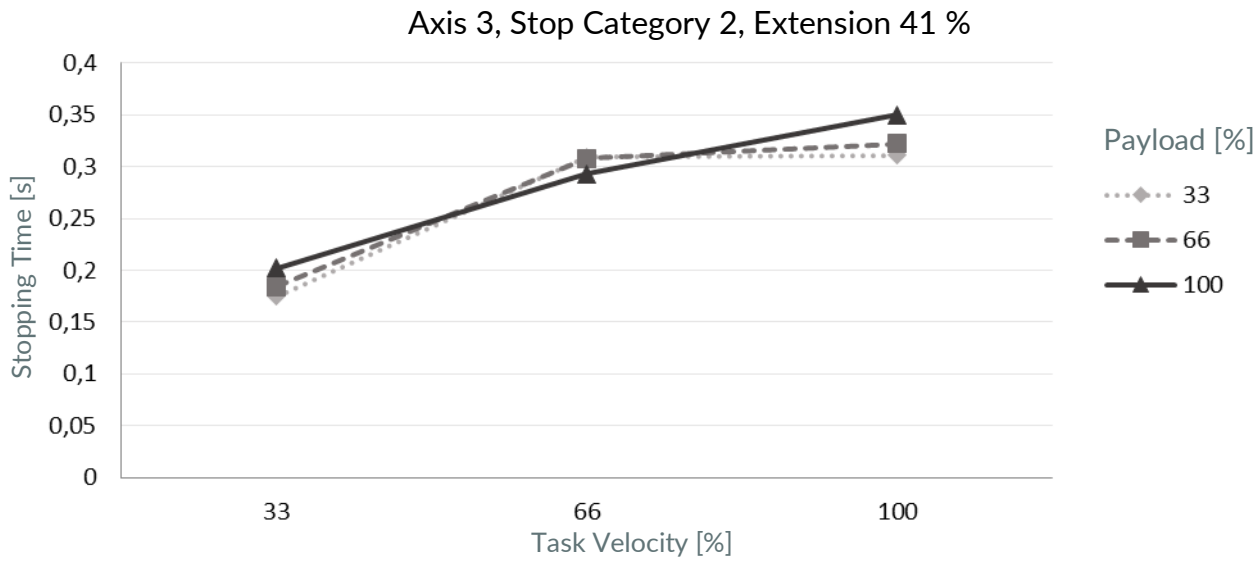
Axis 3, Stop Category 2, Extension 41 %
Stopping Time [s]
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0,3
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0,05
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Task Velocity [%]
Payload [%]
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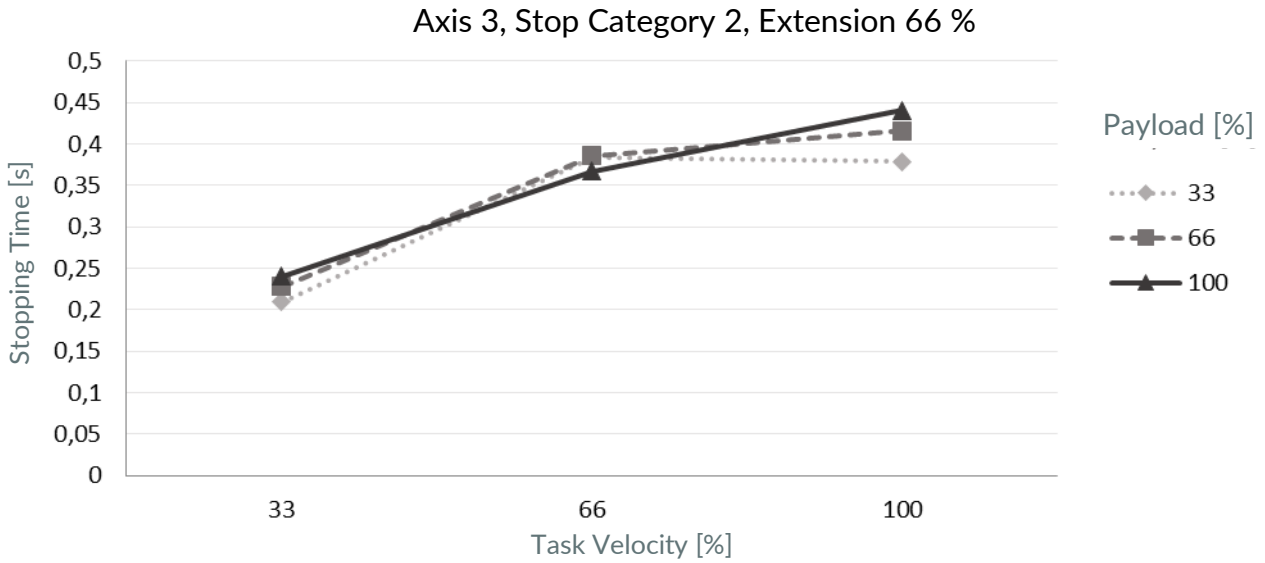
Axis 3, Stop Category 2, Extension 66 %
Stopping Time [s]
0,5
0,45
0,4
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Task Velocity [%]
Payload [%]
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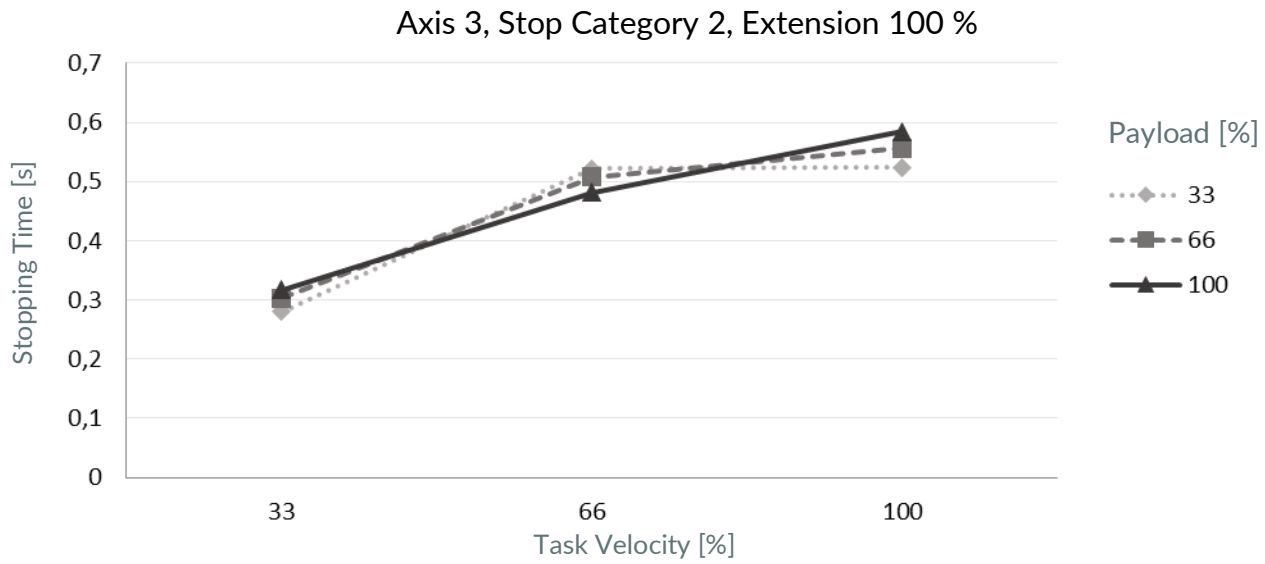
100


Axis 3, Stop Category 2, Extension 100 %
Stopping Time [s]
0,7
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Task Velocity [%]
Payload [%]
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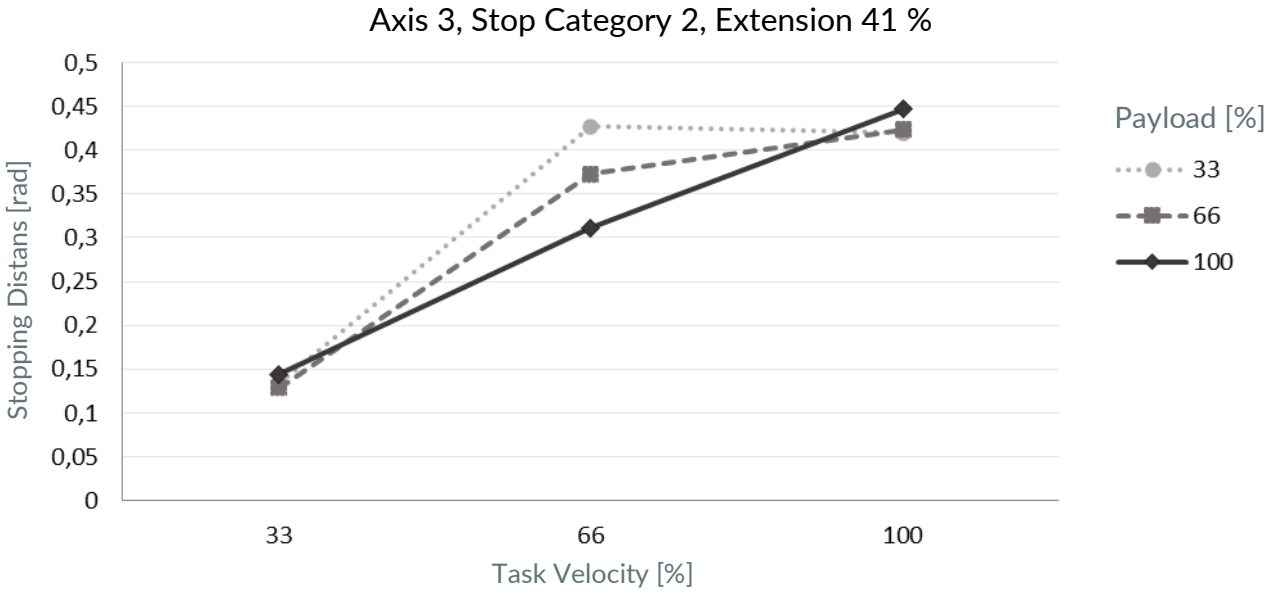
Axis 3, Stop Category 2, Extension 41 %
Stopping Distans [rad]
0,5
0,45
0,4
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33
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Task Velocity [%]
Payload [%]
33
66
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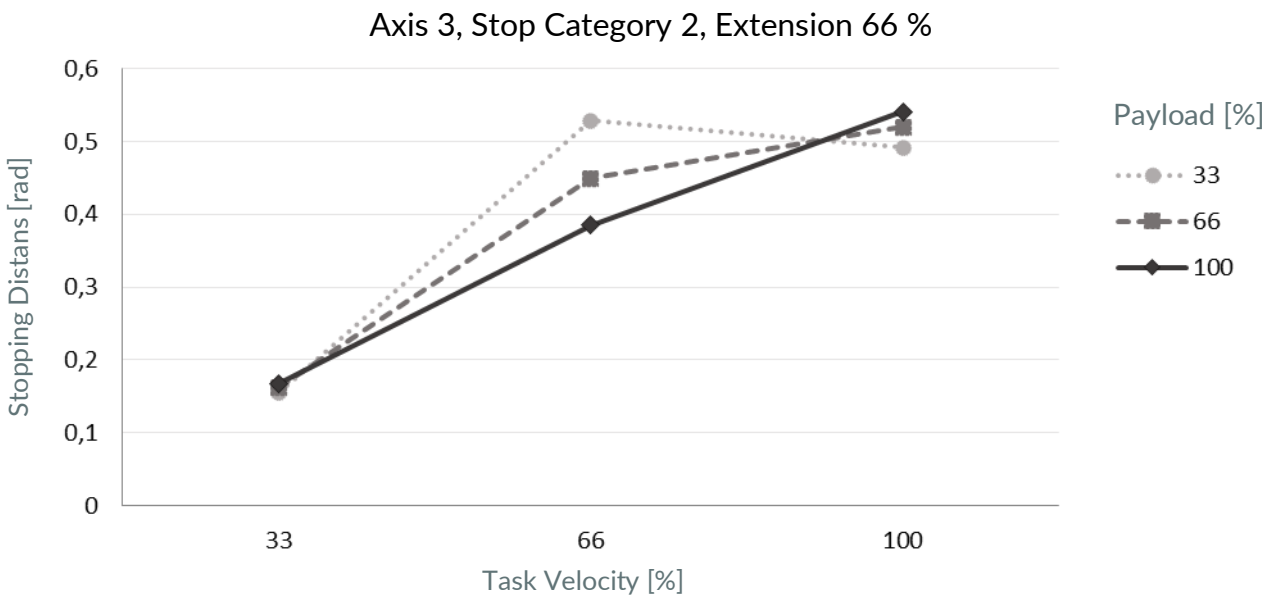
Axis 3, Stop Category 2, Extension 66 %
Stopping Distans [rad]
0,6
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0,4
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Task Velocity [%]
Payload [%]
33
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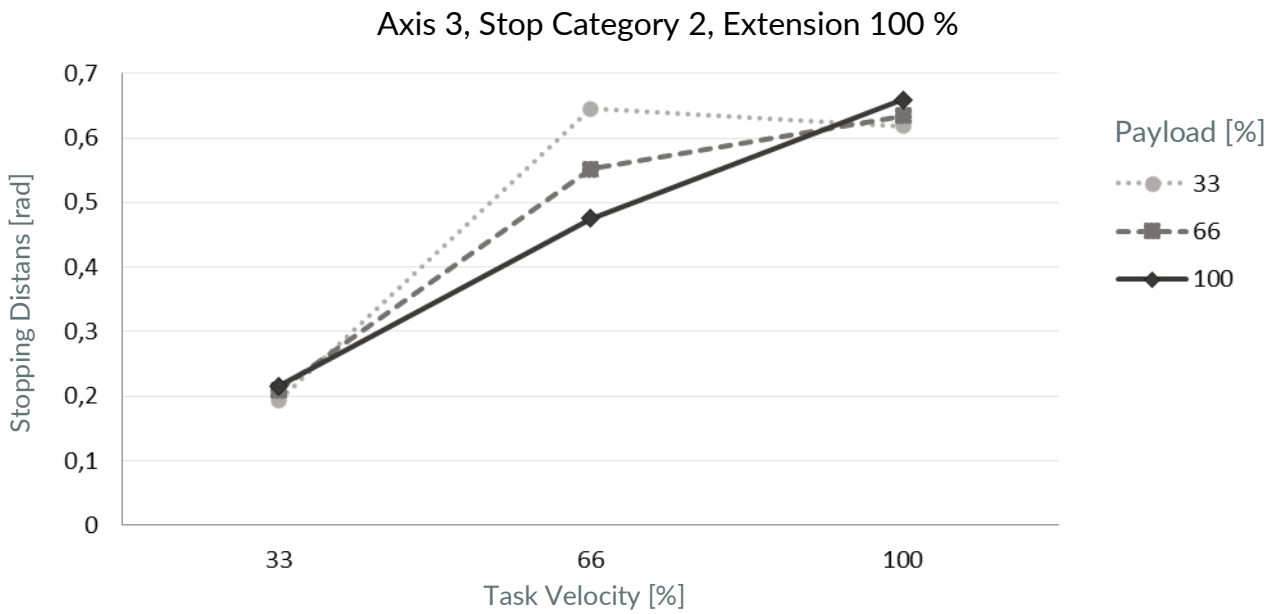
100


Axis 3, Stop Category 2, Extension 100 %
Stopping Distans [rad]
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Task Velocity [%]
Payload [%]
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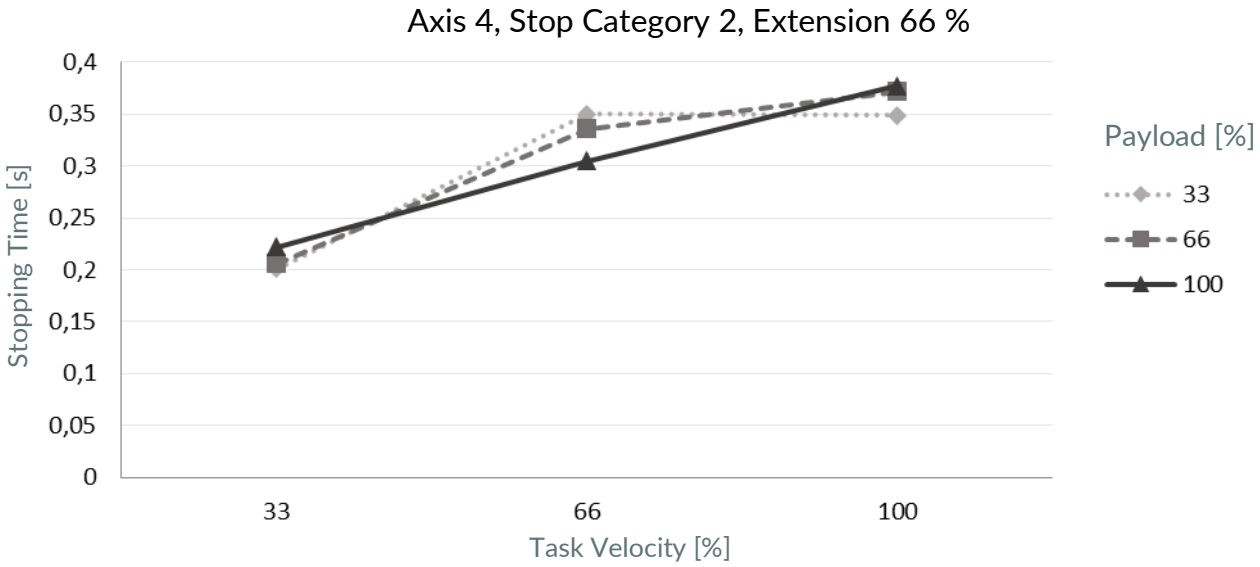
100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Stopping Time [s]
0,4
0,35
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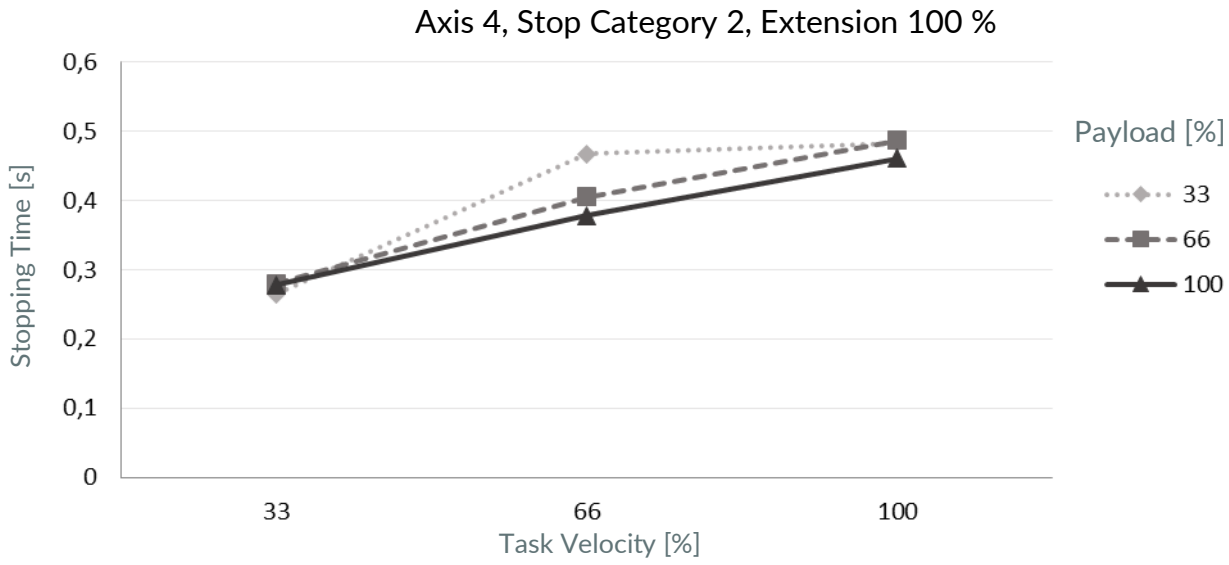
100
Task Velocity [%]
Payload [%]
33
66
100


Axis 4, Stop Category 2, Extension 100 %
Stopping Time [s]
0,6
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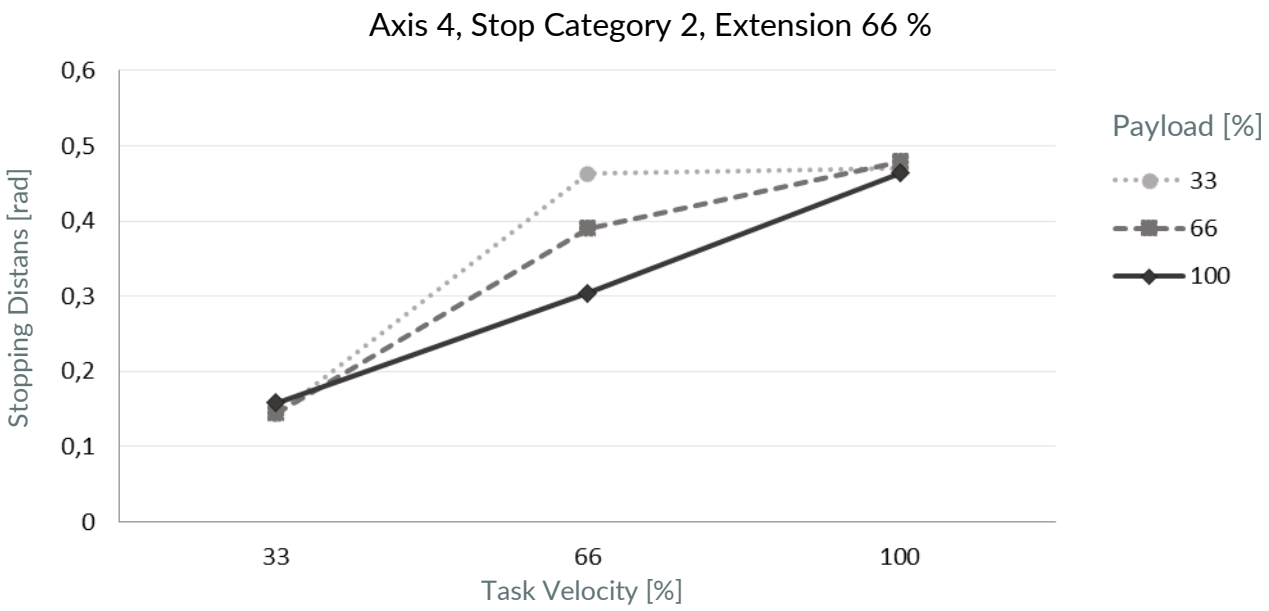
100
Task Velocity [%]
Payload [%]
33
66
100


Axis 4, Stop Category 2, Extension 66 %
Stopping Distans [rad]
0,6
0,5
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Task Velocity [%]
Payload [%]
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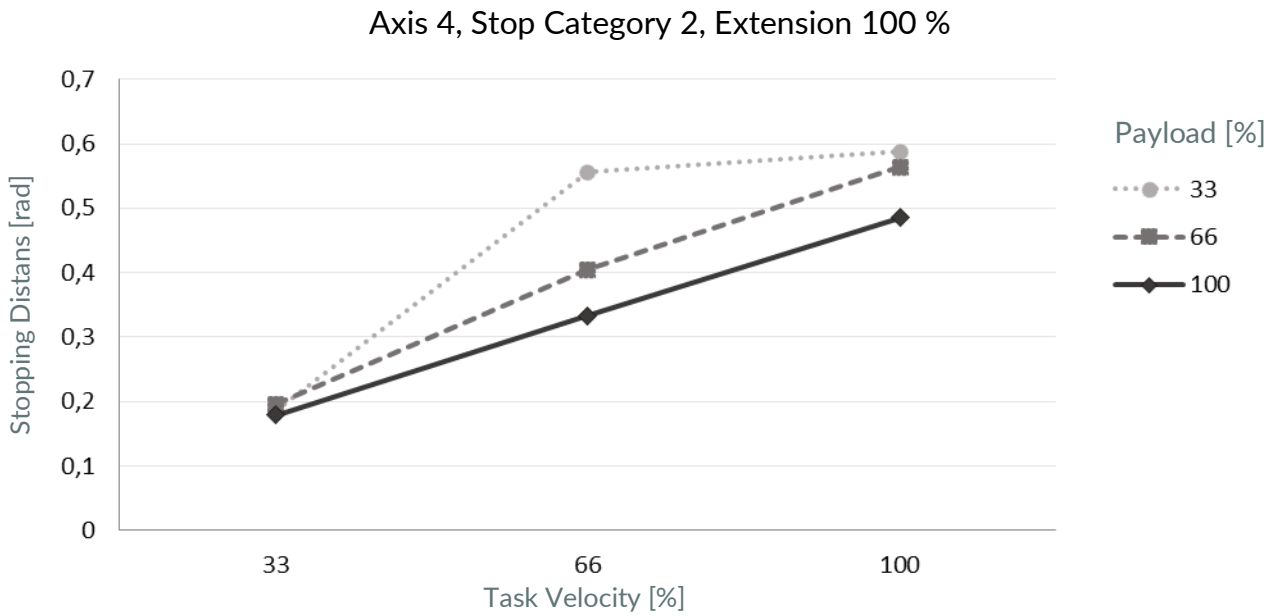
Axis 4, Stop Category 2, Extension 100 %
Stopping Distans [rad]
0,7
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0,4
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0,1
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33
66
100
Task Velocity [%]
Payload [%]
33
66
100

15.2 Response times

Input	Reaction time motor	Reaction time Safe Output grip
User input	42 ms	48 ms
Safety function violation	36 ms	42 ms
Central reaction – joint error	42 ms	48 ms
Central reaction – subordinate error	42 ms	48 ms
Local reaction – joint error	10 ms	-
Local reaction – subordinate error	10 ms	-
Reaction – Master Controller error	30 ms	36 ms

15.3 Safe Position Accuracy

If any safety function, that is based on safe position measurement is used, a limited accuracy needs to be taken into account.

Main contributing factors to be considered include, but are not limited to structural elasticity, mechanical tolerances, assembly tolerances, signal processing, sensor accuracy.

The effect on the accuracy of these factors is strongly influenced by external forces, payload, dynamic state such as velocity and kinematic configuration (pose).

Safe position accuracy needs to be considered while parameterizing the safety functions to be used in an application. How much of a margin needs to be used is highly dependent on the aforementioned factors, and therefore needs to be evaluated and validated individually.

16 GLOSSARY

Naming	Description
Administrator	An administrator is a person authorized by the responsible person to access the robotic system and utilize the user interface Desk as follows: The administrator sets and changes roles, access rights, and passwords. The administrator sets and changes non-safety-related parameters of the system (e.g., when changing the end effector settings). The administrator programs and teaches the robot system.
App	Apps are modular robot programs, each representing a partial step of a robot Task. They can be purchased in the Franka Store and be parametrized in Desk to form entire automation tasks.
Arm	The Arm is a tactile robotic arm with seven axes. It is part of Franka Production 3.
Axes	The Arm consists of seven consecutive axes. The motion is created in the axes.
Cartesian	The Cartesian space is the three-dimensional space where all axes (X, Y, and Z) are perpendicular.
Category 0 Stop	A Category 0 Stop is the stopping by immediate removal of power to the machine actuators (acc. to EN 60204:2019).
Category 1 Stop	A Category 1 Stop is a controlled stop with power available to the machine actuators to achieve the stop and then the removal of power when the stop is achieved (acc. to EN 60204:2019).
Category 2 Stop	A Category 2 Stop is a controlled stop with power available to the machine actuators (acc. to EN 60204:2019).
Center of Mass (CoM)	The center of mass is the center of gravity of an object. At this point, the gravitational force comes into effect.
Collaboration space	Space accessible by both the operator and the robot during the execution of Tasks.
Connecting cable	The connecting cable connects the Arm with the Control.
Control	The Control is the main control unit and is part of Franka Production 3. The main control unit allows monitoring and control of the mechanical structure of the robot.
Desk	Desk is Franka Emika‘s web-based, intuitive, and graphical programming and user interface to exchange information and issue commands. It is part of the Franka UI.
Emergency Stop Device	The Emergency Stop Device must be connected to the system to stop Franka Production 3 and execute a Cat. 1 Stop in case of an emergency. This will cause Franka Production 3 to brake at maximum capacity and the locking bolts to mechanically lock the Arm. The Emergency Stop Device is connected to the X3 connector at the Arm’s base.

Naming	Description
Emergency Unlock Labels	The Emergency Unlock Labels can be found in three different areas on the Arm. They show where to use the Emergency Unlocking Tool to move the robot manually in case of an emergency.
Emergency unlocking	Using the Emergency Unlocking Tool to unlock the Fail-safe Locking System to move the Arm manually is called emergency unlocking.
Emergency Unlocking Tool	The Emergency Unlocking Tool is a tool to manually unlock the Fail-safe Locking System in case of an emergency. Using the tool, the Arm can be moved even when the Arm has no power.
EMI Directive 2014/30/EU	The EMI Directive (2014/30/EC), referred to as EMI Directive, regulates the electromagnetic compatibility of devices within the European Economic Area, Switzerland, and Turkey.
Enabling Button	The Enabling Button is part of the Pilot-Grip and the Pilot. It allows the activation of the Arm's motion.
External Enabling Device	The External Enabling Device is connected to the X4 connector into the Arm‘s base. While half-pressing the External Enabling Device, it is possible to test and run automatic robot programs as long as the device remains half-pressed.
Fail-Safe Locking System	The Fail-safe Locking System locks all seven axes of the Arm. The Arm maintains its position, even when the power is turned off.
FCC rule 47 CFR part 15	FCC is the Federal Communications Commission. It is an independent US agency regulating radio, satellite, and cable communications. It regulates issues regarding the electromagnetic compatibility of devices.
Franka Emika GmbH	Franka Emika GmbH (abbreviated FE) is the company name. We have developed and now produce Franka Production 3.
Franka Production 3/ Franka Production 3 System	The Arm and Control system components compose the Franka Production 3 System, simply called Franka Production 3.
Franka Store	Franka Store is Franka Emika‘s online store, offering apps, bundles, and hardware for easy online ordering. It is part of Franka World: https://franka.world/
Franka UI	The Franka UI is the software framework for the web browser accessible user interface for Franka Production 3. It contains "Desk," "Watchman," and the “Settings” interface.
Franka World	Franka World is an online platform that interconnects customers, partners, and software and hardware developers, whose activity revolves around Franka Emika's products and services. Franka World provides tools for managing Franka Production 3, access to an online store that features a continuously growing portfolio of software and hardware products, and the possibility of becoming part of an active and passionate community. Visit https://franka.world/ to make use of all the benefits.
Guiding / Hand-guiding	Guiding describes moving the robot by haptic interaction, e.g., to teach a new pose.

Naming	Description
Guiding Button	The Guiding Button is located on the right of the Pilot-Grip. The Arm can be moved by pressing the Guiding Button and half-pressing the Enabling Button.
Guiding Mode	Guiding modes ease guiding by locking or unlocking different directions or rotations in space, e.g., moving the Arm in three directions. One can switch between guiding modes using the Guiding-Mode Button on the Pilot-Grip or directly from Desk.
Hand/ Franka Hand	The Hand is an electrical two-finger parallel gripper and is optionally available. The Hand can be used for Franka Emika Robot, Franka Production 3, and mountings according to the ISO flange design. The Hand is an end effector. It is not part of the certified machinery.
Integrator	The integrator is responsible for assembling the partly completed machinery into the final machinery by combining the robot with other equipment or another machine, including additional robots to form a machine system. The integrator also conducts appropriate risk assessments to identify residual risks and to eliminate and minimize them according to ISO 12100. The integrator is responsible for the safety of the final application.
Interaction	Franka Production 3 is designed to be easily programmed and operated, and to learn and relearn new Tasks quickly. When Franka Production 3 is in “monitored stop” mode or is being guided (teaching mode), Franka Production 3’s base is white to indicate that the Arm is ready for interaction.
Interface device	The interface device, a commercially available PC, tablet, or notebook with a web browser, is connected to the Arm base via an Ethernet cable. The Franka UI can be accessed in a web browser via the interface device.
Low Voltage Directive 2014/35/EC	The Low Voltage Directive (2014/35/EC), hereinafter referred to as Low Voltage Directive (LVD), regulates the safety of electronically operated devices within the European Economic Area, Switzerland, and Turkey.
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 to prevent accidents for machinery and partly completed machinery within the European Economic Area, Switzerland, and Turkey.
Maximum space	Space that can be swept by the robot's moving parts plus the space that the end-effector and the workpiece can sweep. For further information, see section Maximum-and safeguarded space in chapter Correct Installation.
Operator	An operator is authorized to access Franka Production 3 and utilize the user interface Desk to use Franka Production 3 within the limits defined by the responsible person and the administrator. The operator is allowed to start, monitor, and stop the intended operation of Franka Production 3. Within Desk, the “operator” role can be assigned to users. Operators only have limited access to Desk.
Pilot	The Pilot is the user interface on the Arm for guiding and operating the Arm and/or Desk. It includes the Pilot-Grip and the Pilot-Disc.
Pilot-Disc	The Pilot-Disc is part of the Pilot and is used for interacting with the Arm and/or Desk.
Pilot-Grip	The Pilot-Grip is part of the Pilot and is used for manual guiding.
Pose	A pose is a combination of position and orientation in space.

Naming	Description
Protective Measures	Protective measures achieve risk reduction according to 3.19 of ISO 12100. They are implemented and assessed by the following persons: Designer and/or Integrator (inherently safe design, safeguarding, and complementary protective measures, information for use) Responsible person/Integrator (organization: safe working procedures, supervision, permit-to-work systems; provision and use of additional safeguards; use of personal protective equipment; training)
Responsible person	The responsible person is responsible for compliance with occupational health regulations and the operational safety ordinance. The responsible person for Franka Production 3 includes but is not limited to the entrepreneur, the director of the institute, the employer, or a delegate responsible for the use of Franka Production 3.
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.
Safeguarded space	The perimeter safeguarding defines the safeguarded space. For further information, see section Classification of spaces in chapter Correct Installation.
Safety rules	A safety rule consists of a parameterized safety function, optional activation conditions, and a reaction to be carried out when the safety function is violated.
Safety scenarios	A set of safety rules defined in Watchman covering a specific risk situation, e.g., the "Test & Jog" scenario covering all rules for the Test & Jog mode.
Safety set-up	Definition of general safety-relevant settings such as safe input behavior or an end effector collision model.
SEEPO	Safety function “Safe End Effector Power Off.” See chapter Safety functionalities for details.
Settings interface	The Settings interface is a web browser accessible user interface to set non-safety-related parameters of Franka Production 3, e.g., network settings, user roles, or passwords. It is part of the software framework Franka UI.
Single Point of Control (SPoC)	Single Point of Control (SPoC) is a functionality that allows only one user at a time to trigger critical actions, i.e., edit system settings and Tasks or trigger active robot actions like unlocking joints and running tasks.
SLD	Safety function “Safely limited distance.” See chapter Safety functionalities for details.
SLO	Safety function “Safely limited end-effector orientation.” See chapter Safety functionalities for details.
SLP-C	Safety function “Safely limited Cartesian Position.” See chapter Safety functionalities for details.
SLP-J	Safety function “Safely limited joint angle.” See chapter Safety functionalities for details.
SLS-C	Safety function “Safely limited Cartesian speed.” See chapter Safety functionalities for details.
SLS-J	Safety function “Safely limited joint speed.” See chapter Safety functionalities for details.
SMSS	Safety function “Safely monitored standstill.” See chapter Safety functionalities for details.

Naming	Description
Stopping Distance	The stopping distance is the distance the Arm covers after a stop demand is received until the Arm comes to a full stop.
Stopping Time	The stopping time is the time that passes after the stop demand is received, e.g., by the emergency device, until the Arm comes to a full stop.
Task	A Task in Desk represents an entire automation routine. A Task consists of one or several Apps.
Teaching	Teaching describes the process of parameterizing a Task and the contained Apps by manually guiding the robot or end effector. This includes, among others, the teaching of "poses" by guiding the robot to that poses.
Tracking Error	The actual motion of the Arm follows the target motion with a small deviation, a so-called tracking error.
Watchman	Watchman is a web browser accessible user interface to set and visually validate safety-related parameters of Franka Production 3, e.g., safety-related monitored speed or safety-related monitored spaces. It is part of the Franka UI.
Web browser	A software application running on an interface device, serving as the Franka UI connection. A web browser provides the environment for Desk, Watchman, and the Settings interface. Examples include the following: Chrome, Edge, and Firefox.

17 INDEX

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