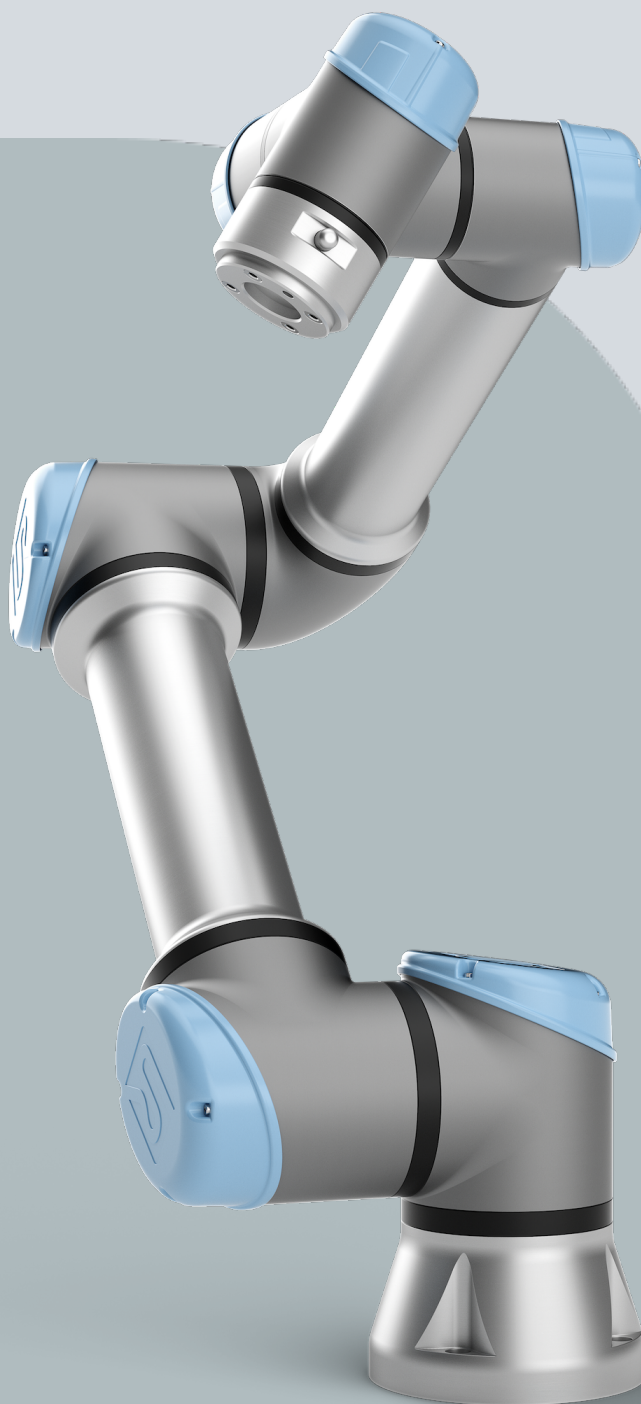




UNIVERSAL ROBOTS

# User Manual

UR5e PolyScope X









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# Contents

<b>1. Liability and Intended Use</b>	<b>11</b>
1.1. Limitation of Liability	11
1.2. Intended Use	11
<b>2. Your Robot</b>	<b>14</b>
2.1. Technical Specifications UR5e	18
2.2. Teach Pendant with 3-Position Enabling Device	19
2.2.1. 3PE Teach Pendant Button Functions	21
2.3. PolyScope X Overview	24
2.3.1. Touch Screen	26
2.3.2. Icons	27
<b>3. Safety</b>	<b>31</b>
3.1. General	31
3.2. Safety Message Types	32
3.3. General Warnings and Cautions	33
3.4. Integration and Responsibility	35
3.5. Stop Categories	35
<b>4. Lifting and Handling</b>	<b>36</b>
4.1. Robot Arm	36
4.2. Control Box and Teach Pendant	36
<b>5. Assembly and Mounting</b>	<b>37</b>
5.1. Securing the Robot Arm	38
5.2. Dimensioning the Stand	40
5.3. Mounting Description	42
5.3.1. Control Box Mounting	43
5.3.2. Control Box Clearance	44
5.4. Workspace and Operating Space	45
5.4.1. Singularity	46
5.4.2. Fixed and Movable Installation	47
5.5. Robot Connections: Base Flange Cable	48
5.6. Robot Connections: Robot Cable	49
5.7. Mains Connections	50
<b>6. Application Tab</b>	<b>52</b>
6.1. Communication	53
<b>7. First Boot</b>	<b>54</b>
7.1. Powering On the Robot	55





7.2. Inserting the Serial Number .....	55
7.3. Starting the Robot Arm .....	56
7.4. Powering Down the Robot .....	56
<b>8. Installation .....</b>	<b>57</b>
8.1. Electrical Warnings and Cautions .....	57
8.2. Control Box Connection Ports .....	59
8.3. Ethernet .....	60
8.4. 3PE Teach Pendant Installation .....	61
8.4.1. Hardware Installation .....	61
8.5. Controller I/O .....	64
8.5.1. Drive Power Indicator .....	68
8.6. Using I/O for Mode Selection .....	70
8.7. Safety I/O .....	72
8.7.1. Safety I/O Signals .....	76
8.8. Three Position Enabling Device .....	81
8.9. General Purpose Analog I/O .....	82
8.9.1. Analog Input: Communication Interface .....	83
8.10. General Purpose Digital I/O .....	84
8.10.1. Digital Output .....	85
8.11. Remote ON/OFF control .....	86
8.12. End Effector Integration .....	87
8.12.1. Tool I/O .....	88
8.12.2. Maximum Payload .....	90
8.12.3. Securing Tool .....	92
8.12.4. Set Payload .....	93
8.12.5. Tool I/O Installation Specifications .....	94
8.12.6. Tool Power Supply .....	95
8.12.7. Tool Digital Outputs .....	96
8.12.8. Tool Digital Inputs .....	97
8.12.9. Tool Analogue Inputs .....	97
8.12.10. Tool Communication I/O .....	98
<b>9. First Time Use .....</b>	<b>99</b>
9.1. Settings .....	99
9.1.1. Password .....	99
9.1.2. Secure Shell (SSH) Access .....	106
9.1.3. Permissions .....	106
9.1.4. Services .....	107
9.2. Safety Related Functions and Interfaces .....	107
9.2.1. Configurable Safety Functions .....	108
9.2.2. Safety Function .....	109



9.3. Safety Configuration .....	109
9.4. Setting a Safety Password .....	109
9.5. Software Safety Limits .....	109
9.5.1. Robot Limits .....	110
9.5.2. Safety Planes .....	112
<b>10. Cybersecurity Threat Assessment .....</b>	<b>114</b>
10.1. General Cybersecurity .....	114
10.2. Cybersecurity Requirements .....	114
10.3. Cybersecurity Hardening Guidelines .....	116
<b>11. Communication Networks .....</b>	<b>117</b>
11.1. Ethernet/IP .....	118
11.2. Profinet .....	119
11.3. UR Connect .....	122
<b>12. Emergency Events .....</b>	<b>126</b>
12.1. Emergency Stop .....	126
12.2. Movement Without Drive Power .....	127
12.3. Operational Mode .....	128
<b>13. Transportation .....</b>	<b>130</b>
13.1. Teach Pendant Storage .....	131
<b>14. Maintenance and Repair .....</b>	<b>132</b>
14.1. Testing Stopping Performance .....	133
14.2. Robot Arm Cleaning and Inspection .....	133
<b>15. Disposal and Environment .....</b>	<b>139</b>
<b>16. Risk Assessment .....</b>	<b>141</b>
16.1. Pinch Hazard .....	144
16.2. Stopping Time and Stopping Distance .....	145
<b>17. Declaration of Incorporation (original) .....</b>	<b>150</b>
<b>18. Declarations and Certificates .....</b>	<b>152</b>
<b>19. Certifications UR5e .....</b>	<b>154</b>
<b>20. Certificates UR5e .....</b>	<b>156</b>







# 1. Liability and Intended Use

## 1.1. Limitation of Liability

### Description

Any information provided in this manual must not be construed as a warranty, by UR, that the industrial robot will not cause injury or damage, even if the industrial robot complies with all safety instructions and information for use.

## 1.2. Intended Use

### Description



#### NOTICE

Universal Robots takes no responsibility and assumes no liability for unapproved uses of its robots or uses for which its robots are not intended and Universal Robots will provide no support for unintended uses.



#### READ MANUAL

Failure to use the robot in accordance with the intended use can result in hazardous situations.

- Read and follow the recommendations for intended use and the specifications provided in the User Manual.

Universal Robots robots are intended for industrial use, to handle tools/end effectors and fixtures, or to process or transfer components or products.

All UR robots are equipped with safety functions, which are purposely designed to enable collaborative applications, where the robot application operates together with a human. The safety function settings must be set to the appropriate values as determined by the robot application risk assessment.

The robot and Control Box are intended for inside use where, normally, only non-conductive pollution occurs i.e. Pollution degree 2 environments.

Collaborative applications are only intended for non-hazardous applications, where the complete application, including tool/end effector, work piece, obstacles and other machines, is low risk according to the risk assessment of the specific application.



**WARNING**

Using UR robots or UR products outside of the intended uses can result in injuries, death and/or property damage. Do not use the UR robot or products for any of the below unintended uses and applications:

- Medical use, i.e. uses relating to disease, injury or disability in humans including the following purposes:
  - Rehabilitation
  - Assessment
  - Compensation or alleviation
  - Diagnostic
  - Treatment
  - Surgical
  - Healthcare
  - Prosthetics and other aids for the physically impaired
  - Any use in proximity to patient/s
- Handling, lifting, or transporting people
- Any application requiring compliance with specific hygienic and/or sanitation standards, such as proximity or direct contact with food, beverage, pharmaceutical, and /or cosmetic products.
  - UR joint grease leaks, and can also be released as vapor into the air.
  - UR joint grease is not “food grade”.
  - UR robots do not meet any food, National Sanitization Foundation (NSF), Food and Drug Administration (FDA), or hygienic design standards.

Hygienic standards, for example ISO 14159 and EN 1672-2, require a hygiene risk assessment be conducted.

- Any use, or any application, deviating from the intended use, specifications, and certifications of UR robots or UR products.
- Misuse is prohibited as the result could be death, personal injury, and /or property damage

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**WARNING**

Failure to consider the added risks due to the reach, payloads, operating torques and speeds associated with robot application, can result in injury or death.

- Your application risk assessment shall include the risks associated with the application's reach, motion, payload and speed of the robot, end effector and workpiece.



**WARNING**

Do not modify or alter e-Series robots end caps. A modification can create unforeseen hazards. All authorized disassembling and reassembling shall be done at a UR service center, or can be done according to the newest version of all relevant service manuals by skilled persons.



## 2. Your Robot

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### Introduction

Congratulations on the purchase of your new Universal Robots robot, which consists of the robot arm (manipulator), Control Box and the Teach Pendant.

Originally designed to mimic the range of motion of a human arm, the robot arm is composed of aluminium tubes, articulated by six joints, allowing for a high range of flexibility in your automation installation.

The Universal Robots patented programming interface, PolyScope, allows you to create, load and run your automation applications.

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### In the boxes

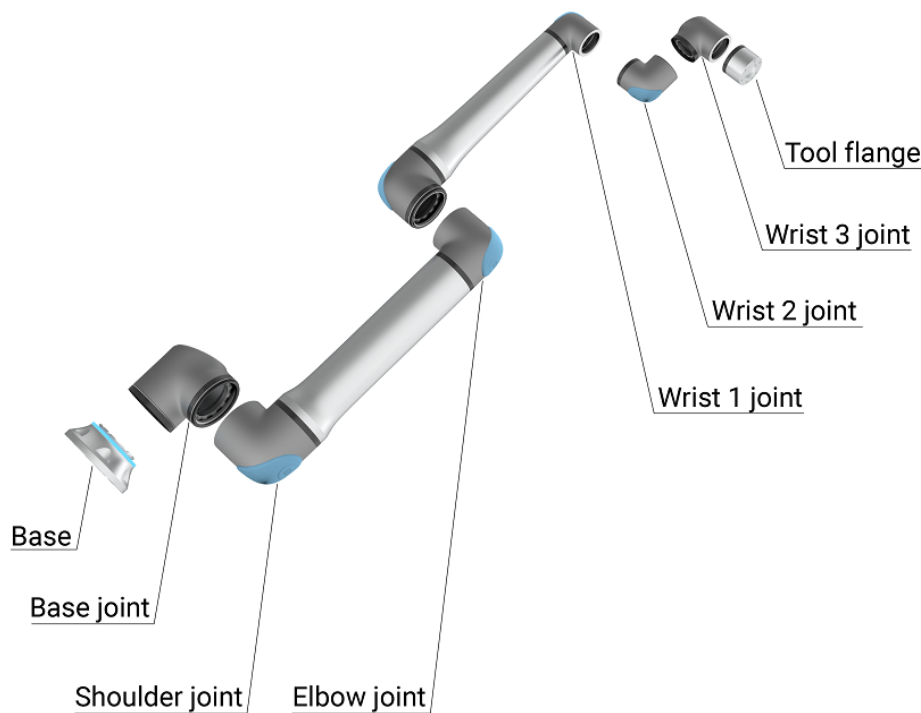
- Robot arm
- Control Box
- Teach Pendant or a 3PE Teach Pendant
- Mounting bracket for the Control Box
- Mounting bracket for the 3PE Teach Pendant
- Key for opening the Control Box
- Cable for connecting the robot arm and the Control Box (multiple options available depending on robot size)
- Mains cable or power cable compatible with your region
- Round sling or lifting sling (depending on robot size)
- Tool cable adapter (depending on robot version)
- This manual



**About the robot arm**

The Joints, Base and Tool Flange are the main components of the robot arm. The controller coordinates joint motion to move the robot arm.

Attaching an end effector (tool) to the Tool Flange at the end of the robot arm, allows the robot to manipulate a workpiece. Some tools have a specific purpose beyond manipulating a part, for example, QC inspection, applying adhesives and welding.



1.1: The main components of the robot arm.

- **Base:** where the robot arm is mounted.
- **Shoulder and Elbow:** make larger movements.
- **Wrist 1 and Wrist 2:** make finer movements.
- **Wrist 3:** where the tool is attached to the Tool Flange.

The robot is partly completed machinery, as such a Declaration of Incorporation is provided. A risk assessment is required for each robot application.

**About this manual**

This manual contains safety information, guidelines for safe use, and instructions to mount the robot arm, Control Box and Teach Pendant. You can also find instructions for how to begin to install and how to start programming the robot.

Read and adhere to the intended uses. Perform a risk assessment. Install and use in accordance with the electrical and mechanical specifications provided in this user manual.

Risk assessment requires an understanding of the hazards, risks and risk reduction measures for the robot application. Robot integration can require a basic level of mechanical and electrical training.



**Content disclaimer** Universal Robots A/S continues to improve the reliability and performance of its products, and as such reserves the right to upgrade products, and product documentation, without prior warning. Universal Robots A/S takes every care to ensure the content of the User Manual/s is precise and correct, but takes no responsibility for any errors or missing information.

This manual does not contain warranty information.

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**myUR** The myUR portal allows you to register all your robots, keep track of service cases and answer general support questions.

Sign into [myur.universal-robots.com](https://myur.universal-robots.com) to access the portal.

In the myUR portal, your cases are handled either by your preferred distributor, or escalated to Universal Robots Customer Service teams.

You can also subscribe to robot monitoring and manage additional user accounts in your company.

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**Support** The support site [www.universal-robots.com/support](https://www.universal-robots.com/support) contains other language versions of this manual

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**UR+** The online showroom UR+[www.universal-robots.com/plus](https://www.universal-robots.com/plus) provides cutting-edge products to customize your UR robot application. You can find everything you need in one place – from tools and accessories to software.

UR+ products connect to and work with UR robots to ensure simple set-up and an overall smooth user experience. All UR+ products are tested by UR.

You can also access the UR+ Partner Program via our software platform [plus.universal-robots.com](https://plus.universal-robots.com) to design more user-friendly products for UR robots.

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**UR forums** The UR Forum [forum.universal-robots.com](https://forum.universal-robots.com) allows robot enthusiasts of all skill levels to connect to UR and each other, to ask questions and to exchange information. While the UR Forum was created by UR+ and our admins are UR employees, the majority of the content is created by you, the UR Forum user.

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**Academy** The UR Academy site [academy.universal-robots.com](https://academy.universal-robots.com) offers a variety of training opportunities.

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**Developer suite** The UR Developer Suite [universal-robots.com/products/ur-developer-suite](https://universal-robots.com/products/ur-developer-suite) is a collection of all the tools needed to build an entire solution, including developing URCaps, adapting end-effectors, and integrating hardware.

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**Online  
manuals**

Manuals, guides and handbooks can be read online. We have gathered a large number of documents at <https://www.universal-robots.com/manuals>

- PolyScope Software Handbook with descriptions and instructions for the software
  - The Service Handbook with instructions for troubleshooting, maintenance and repair
  - The Script Directory with scripting for in depth programming
-



## 2.1. Technical Specifications UR5e

Robot type	UR5e
Maximum payload	5 kg / 11 lb
Reach	850 mm / 33.5 in
Degrees of freedom	6 rotating joints
Programming	PolyScope 5 GUI on 12" touchscreen. or PolyScope X GUI on 12" touchscreen.
Power consumption (average)	570 W (max.) Approx. 250 W using a typical program
Ambient temperature range	0-50 °C. At ambient temperatures above 35°C, the robot may operate at reduced speed and performance.
Safety functions	17 sophisticated safety functions. PLd Category 3 in accordance with: EN ISO 13849-1.
IP classification	IP54
Noise	Robot Arm: Less than 60 dB(A) Control Box: Less than 50 dB(A)
Tool I/O ports	2 digital in, 2 digital out, 2 analog in
Tool I/O power supply & voltage	1.5 A (Dual pin) 1 A (Single pin) & 12 V/24 V
Force Torque sensor accuracy	4 N
Speed	Joints: Max 180 °/s . Tool: Approx. 1 m/s / Approx. 39.4 in/s.
Pose repeatability	± 0.03 mm / ± 0.0011 in (1.1 mils) per ISO 9283
Joint ranges	± 360 ° for all joints except Elbow ± 160 °
Footprint	Ø151 mm / 5.9 in
Materials	Aluminium, PC/ASA plastic
Robot arm weight	20.7 kg / 45.7 lb
System update frequency	500 Hz
Control Box size (W × H × D)	460 mm × 449 mm × 254 mm / 18.2 in × 17.6 in × 10 in
Control Box I/O ports	16 digital in, 16 digital out, 2 analog in, 2 analog out
Control Box I/O power supply	24 V 2 A in Control Box
Communication	MODBUS TCP & Ethernet/IP adapter, PROFINET, USB 2.0, USB 3.0
Tool Communication	RS
Control Box power source	100-240 VAC, 47-440 Hz
Short-Circuit Current Rating (SCCR)	200A
TP cable: Teach Pendant to Control Box	4.5 m / 177 in
Robot Cable: Robot Arm to Control Box (options)	Standard (PVC) 6 m/236 in x 13.4 mm Standard (PVC) 12 m/472.4 in x 13.4 mm Hiflex (PUR) 6 m/236 in x 12.1 mm Hiflex (PUR) 12 m/472.4 in x 12.1 mm



## 2.2. Teach Pendant with 3-Position Enabling Device

### Description

Depending on the robot generation, your Teach Pendant can include a built-in 3PE device. This is called a 3-Position Enabling Teach Pendant (3PE TP). Higher payload robots can only use the 3PE TP.

If you are using a 3PE TP, the buttons are located on the underside of the Teach Pendant, as illustrated below. You can use either button, according to your preference.

If the Teach Pendant is disconnected, you are required to connect and configure an external 3PE device. The 3PE TP functionality extends to the PolyScope interface, where there are additional functions in the Header.

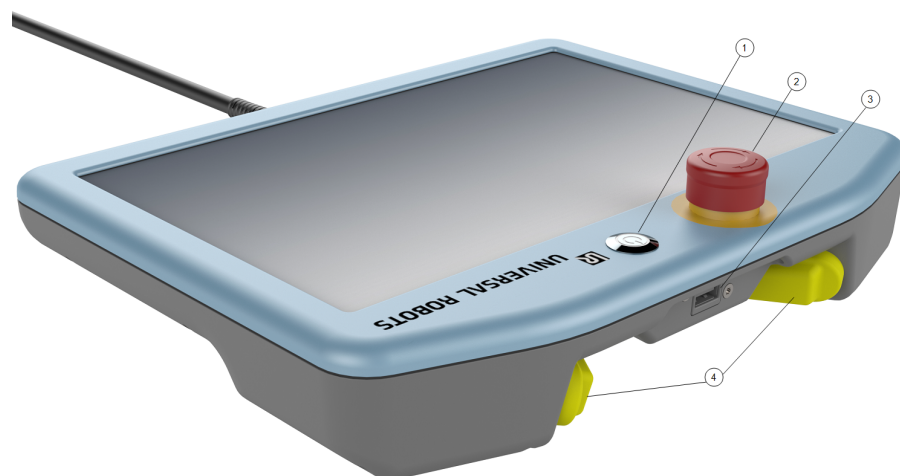


### NOTICE

- If you have bought a UR15, UR20 or UR30 robot, a Teach Pendant without the 3PE device will not work.
- Using a UR15, UR20, or UR30 robot requires an external enabling device or a 3PE Teach Pendant when programming, or teaching, within the reach of the robot application. See ISO 10218-2.
- The 3PE Teach Pendant is not included with the purchase of the OEM Control Box, so enabling device functionality is not provided.

### Overview of TP

1. Power button
2. Emergency Stop button
3. USB port (comes with a dust cover)
4. 3PE buttons





**Freedrive**

A Freedrive robot symbol is located under each 3PE button, as illustrated below.





## 2.2.1. 3PE Teach Pendant Button Functions

### Description



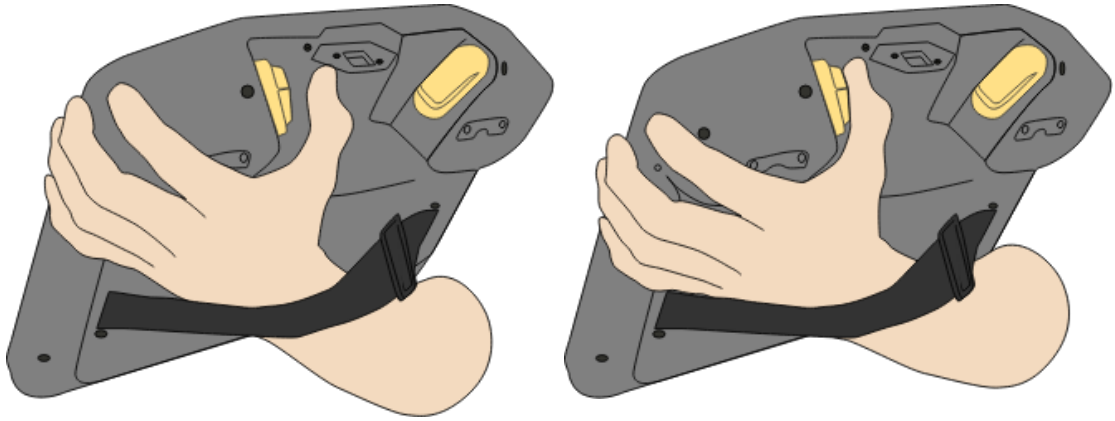
#### NOTICE

The 3PE buttons are only active in Manual mode. In Automatic mode, robot movement does not require 3PE button action.

The table below describes the functions of the 3PE buttons.

Position		Description	Action
1	Release	There is no pressure on the 3PE button. It is not pressed.	Robot movement is stopped in Manual mode. Power is not removed from the robot arm and the brakes remain released.
2	Light-press (Grip lightly)	There is some pressure on the 3PE button. It is pressed to a middle point.	Allows your program to play when the robot is in Manual mode.
3	Tight-press (Grip tightly)	There is full pressure on the 3PE button. It is pressed all the way down.	Robot movement is stopped in Manual mode. Robot is in 3PE Stop.





Button release

Button press







## 2.3. PolyScope X Overview

### Overview

PolyScope X is the graphical user interface (GUI) installed on the teach pendant that operates the robot arm via touch screen. The PolyScope X interface allows you to create, load, and execute programs.

### To view Main Screen



1. Tap the 3D icon on the left toolbar.

This gives you a three-dimensional view of the robot arm in X-Y-Z coordinates.

2. To maximize the 3D viewing area, collapse the right drawer using the right toolbar:

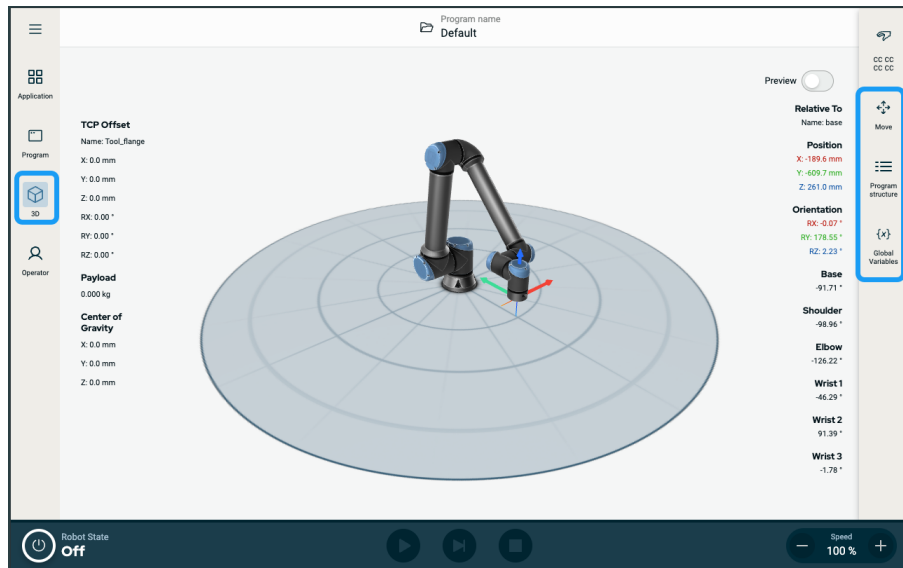
- tap once the Move icon



- tap twice the Program structure icon



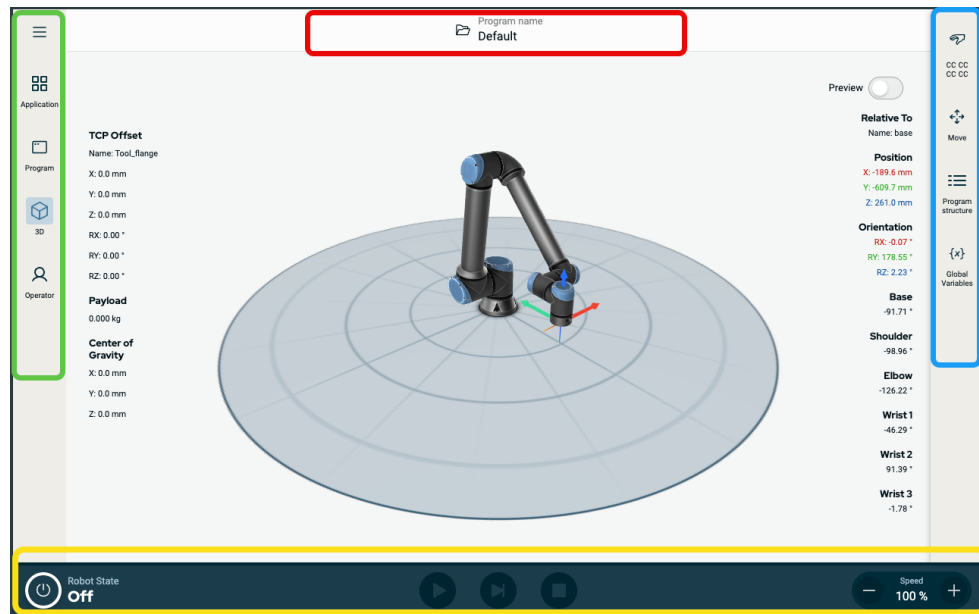
- tap twice the Global Variables icon





## Screen Layout

The PolyScope X GUI is divided as shown in the following illustration:



- **Header** - in red-border box. Also called **system manager**.  
Contains a folder to load, create, and edit programs and access URCaps.
- **Left Toolbar** - in green-border box. Also called **navigation hub**.  
Contains icon/fields to select a main screen:
  - Hamburger icon
  - Application
  - Program
  - 3D Viewer
  - Operator
- **Right Toolbar** - in blue-border box. Also called **multitasking panel**.  
Contains icon/fields to select a multitask screen:
  - Safety overview icon
  - Move
  - Program structure
  - Global Variables
- **Footer** - in yellow-border box. Also called **robot control bar**.  
Contains buttons to control robot state, speed, and program run/play.



## Screen Combinations

The main screen and the multitask screen make up the operating screen combination for the robot.

The multitask screen is independent of the main screen so you can do separate tasks. For example, you can configure a program in the main screen while moving the robot arm in the multitask screen. You also can hide the multitask screen if it is not needed.

- **Main screen**  
Contains fields and options to manage and monitor robot actions.
- **Multitask screen**  
Contains fields and options often relating to the main screen.

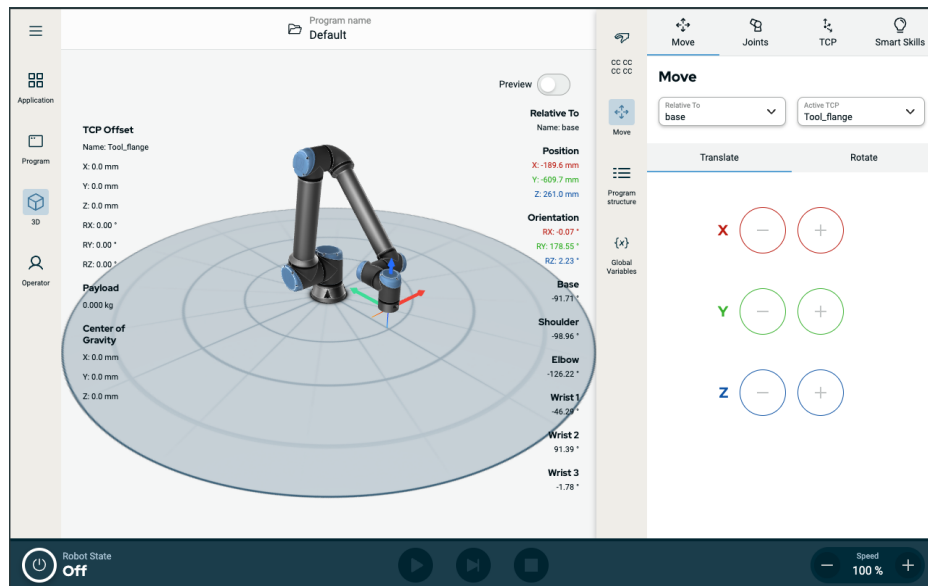


Figure 1.2: Main screen and multitask screen

### To show/hide the Multitask Screen

1. In the right toolbar, tap any field to show the multitask screen.  
The right toolbar expands to the middle of the screen so the multitask screen becomes visible.
2. Tap the currently selected field in the right toolbar to hide the multitask screen.

## 2.3.1. Touch Screen

### Description

The Teach Pendant touch screen is optimised for use in industrial environments. Unlike consumer electronics, Teach Pendant touch screen sensitivity is, by design, more resistant to environmental factors such as:

- Water droplets and/or machine coolant droplets
- Radio wave emissions
- Other conducted noise from the operating environment



Using the  
Touch Screen


The touch sensitivity is designed to avoid false selections on PolyScope X, and to prevent unexpected motion of the robot.

For best results, use the tip of your finger to make a selection on the screen. In this manual, this is referred to as a "tap". A commercially available stylus may be used to make selections on the screen if desired. The following section lists and defines the icons/tabs and buttons in the PolyScope X interface.






The following section lists and defines the icons/tabs and buttons in the PolyScope X interface.

2.3.2. Icons

Header Icon

Icon	Title	Description
	Program name	Gives access to System Manager. Enables you to create, modify, add program, and URCaps files.

Left Toolbar Icons

Icon	Title	Description
	More	Access to information of robot version, serial number, and settings.
	Application	Configures and sets up the robot arm settings and safety, including end effectors and communication.
	Program	Access to basic and advanced robot programs.
	3D	Enables control and regulation of robot movement in X, Y, Z coordinates.
	Operator	Operates the robot using prewritten programs and shows the status of the robot.

Icons Inside the More/Hamburger Icon

Icon	Title	Description
------	-------	-------------





System Manager

Gives access to System Manager.  
Enables you to create, modify, add program, and URCaps files.



About

Displays information about robot version and serial number.



Settings

Configures system settings, such as language, units, password, and security.



Reload





A safe function to apply the default settings defined in the application.



Shutdown












To restart, power on and off the robot.

## Right Toolbar Icons

Icon	Title	Description
	Safety Overview	Access to the active safety checksum and detailed parameters of each robot arm parts, and changes the operational mode.
	Move	Comprehensive function for robot movement, detailing the joints, TCP, flange, base.
	Program structure	Provides an orderly structure of created program(s). Access to add modules.
	Global Variables	Access to created program names and values.



## Footer Icons/Buttons

Icon	Title	Description
		
	Initialize	<p>Manages the robot state. When RED, press it to make the robot operational.</p> <ul style="list-style-type: none"> <li>• Black, Power off. The robot arm is in a stopped state.</li> <li>• Orange, Idle. The robot arm is on, but not ready for normal operation.</li> <li>• Orange, Locked. The robot arm is locked.</li> <li>• Green, Normal. The robot arm is on and ready for normal operation.</li> <li>• Red, Error. The robot is in a fault state, such as e-stop.</li> <li>• Blue, Transition. The robot is changing state, such as brake releasing.</li> </ul>
		
		
		
		
		
	Play	Starts the current loaded program.
	Step	Allows a program to be run single-stepped.
	Stop	Halts the current loaded program.
	Speed slider	Manages the robot state. When RED, press it to make the robot operational.

## Main Screen Icons

Icon	Title	Description
------	-------	-------------





Move up

To move up a command node in a program tree.



Move down

To move down a command node in a program tree.



Revert

To revert a recent move of a command node in a program tree.



Undo revert

To undo revert a recent move of a command node in a program tree.



Suppress/Unsuppress

To suppress and unsuppress a command node in a program tree.



Copy

To copy a command node to another program tree.



Paste

To paste a command node to another program tree.



Cut

To cut a command node from a program tree.



Delete

To delete a command node in a program tree.



## 3. Safety

**Description** Read the safety information here to understand key safety guidelines, important safety messages and your responsibilities when working with the robot. System design and installation are not covered here.

### 3.1. General

**Description** Read the general safety information and the instructions and guidance pertaining to risk assessment and the intended use. Subsequent sections describe and define safety-related functions particularly relevant for collaborative applications.



#### **WARNING**

An application risk assessment must be performed for the safety of personnel and equipment.

Read and understand the specific engineering data relevant to mounting and installation, in order to understand the integration of UR robots before the robot is powered on for the first time.

It is essential to observe and follow all assembly instructions in the following sections of this manual.



#### **NOTICE**

Universal Robots disclaims any and all liability if the robot (arm Control Box with or without Teach Pendant) is damaged, changed or modified in any way. Universal Robots cannot be held responsible for any damages caused to the robot or any other equipment due to programming errors, unauthorized access to the UR robot and its contents, or malfunctioning of the robot.



## 3.2. Safety Message Types

### Description

Safety messages are used to emphasize important information. Read all the messages to help ensure safety and to prevent injury to personnel and product damage. The safety message types are defined below.



#### **WARNING**

Indicates a hazardous situation that, if not avoided, can result in death or serious injury.



#### **WARNING: ELECTRICITY**

Indicates a hazardous electrical situation that, if not avoided, can result in death or serious injury.



#### **WARNING: HOT SURFACE**

Indicates a hazardous hot surface where injury can result from contact and non-contact proximity.



#### **CAUTION**

Indicates a hazardous situation that, if not avoided, can result in injury.



#### **GROUND**

Indicates grounding.



#### **PROTECTIVE GROUND**

Indicates protective grounding.



#### **NOTICE**

Indicates the risk of damage to equipment and/or information to be noted.



#### **READ MANUAL**

Indicates more detailed information that should be consulted in the manual.



## 3.3. General Warnings and Cautions

**Description** The following warnings messages can be repeated, explained or detailed in subsequent sections.



### WARNING

Failure to adhere to the general safety practices, listed below, can result in injury or death.

- Verify the robot arm and tool/end effector are properly and securely bolted in place.
- Verify the robot application has ample space to operate freely.
- Verify the personnel are protected during the lifetime of the robot application including transport, installation, commissioning, programming/ teaching, operation and use, dismantling and disposing.
- Verify robot safety configuration parameters are set to protect personnel, including those who can be within reach of the robot application.
- Avoid using the robot if it is damaged.
- Avoid wearing loose clothing or jewelry when working with the robot. Tie back long hair.
- Avoid placing any fingers behind the internal cover of the Control Box.
- Inform users of any hazardous situations and the protection that is provided, explain any limitations of the protection and the residual risks.
- Inform users of the location of the emergency stop button(s) and how to activate the emergency stop in case of an emergency or an abnormal situation.
- Warn people to keep outside the reach of the robot, including when the robot application is about to start-up.
- Be aware of robot orientation to understand the direction of movement when using the Teach Pendant.
- Adhere to the requirements in ISO 10218-2.



### WARNING

Handling tools/end effectors with sharp edges and/or pinch points can result in injury.

- Make sure tools/end effectors have no sharp edges or pinch points.
- Protective gloves and/or protective eyeglasses could be required.



**WARNING: HOT SURFACE**

Prolonged contact with the heat generated by the robot arm and the Control Box, during operation, can lead to discomfort resulting in injury.

- Do not handle or touch the robot while in operation or immediately after operation.
- Check the temperature on the log screen before handling or touching the robot.
- Allow the robot to cool down by powering it off and waiting one hour.

**CAUTION**

Failure to perform a risk assessment prior to integration and operation can increase risk of injury.

- Perform a risk assessment and reduce risks prior to operation.
- If determined by the risk assessment, do not enter the range of the robot movement or touch the robot application during operation. Install safeguarding.
- Read the risk assessment information.

**CAUTION**

Using the robot with untested external machinery, or in an untested application, can increase the risk of injury to personnel.

- Test all functions and the robot program separately.
- Read the commissioning information.

**NOTICE**

Very strong magnetic fields can damage the robot.

- Do not expose the robot to permanent magnetic fields.

**READ MANUAL**

Verify all mechanical and electrical equipment is installed according to relevant specifications and warnings.



## 3.4. Integration and Responsibility

### Description

The information in this manual does not cover designing, installing, integrating and operating a robot application, nor does it cover all peripheral equipment that can influence the safety of the robot application. The robot application must be designed and installed in accordance with the safety requirements set forth in the relevant standards and regulations of the country where the robot is installed.

The person/s integrating the UR robot are responsible for ensuring that the applicable regulations in the country concerned are observed and that any risks in the robot application are adequately reduced. This includes, but is not limited to:

- Performing a risk assessment for the complete robot system
- Interfacing other machines and additional safeguarding if required by the risk assessment
- Setting the correct safety settings in the software
- Ensuring safety measures are not modified
- Validating the robot application is designed, and installed and integrated
- Specifying instructions for use
- Marking the robot installation with relevant signs and contact information of the integrator
- Retaining all documentation; including the application risk assessment, this manual and additional relevant documentation.

## 3.5. Stop Categories

### Description

Depending on the circumstances, the robot can initiate three types of stop categories defined according to IEC 60204-1. These categories are defined in the following table.

Stop Category	Description
0	Stop the robot by immediate removal of power.
1	Stop the robot in an orderly, controlled manner. Power is removed once the robot is stopped.
2	*Stop the robot with power available to the drives, while maintaining the trajectory. Drive power is maintained after the robot is stopped.

\*Universal Robots robots' Category 2 stops are further described as SS1 or as SS2 type stops according to IEC 61800-5-2.





## 4. Lifting and Handling

---

<b>Description</b>	The robot arms come in different sizes and weights, so it is important to use the appropriate lifting and handling techniques for each model. Here you can find information on how to safely lift and handle the robot.
--------------------	---

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### 4.1. Robot Arm

---

<b>Description</b>	The robot arm, depending upon weight, can be carried by one or two people unless the sling is provided. If the sling is provided, equipment for lifting and transport is required.
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### 4.2. Control Box and Teach Pendant

---

<b>Description</b>	The Control Box and the Teach Pendant can each be carried by one person. While in use, all cables are to be coiled and held to prevent tripping hazards.
--------------------	--

---



## 5. Assembly and Mounting

---

<b>Description</b>	Install and power on the robot arm and Control Box to start using PolyScope.
--------------------	--

---

<b>Assemble the robot</b>	You have to assemble the robot arm, Control Box and Teach Pendant to be able to continue.
---------------------------	---

1. Unpack the robot arm and the Control Box.
2. Mount the robot arm on a sturdy, vibration-free surface.  
Verify the surface can withstand at least 10 times the full torque of the base joint and at least 5 times the weight of the robot arm.
3. Place the Control Box on its Foot.
4. Connect the robot cable to the robot arm and the Control Box.
5. Plug in the mains, or main power cable, of the Control Box.

**WARNING**

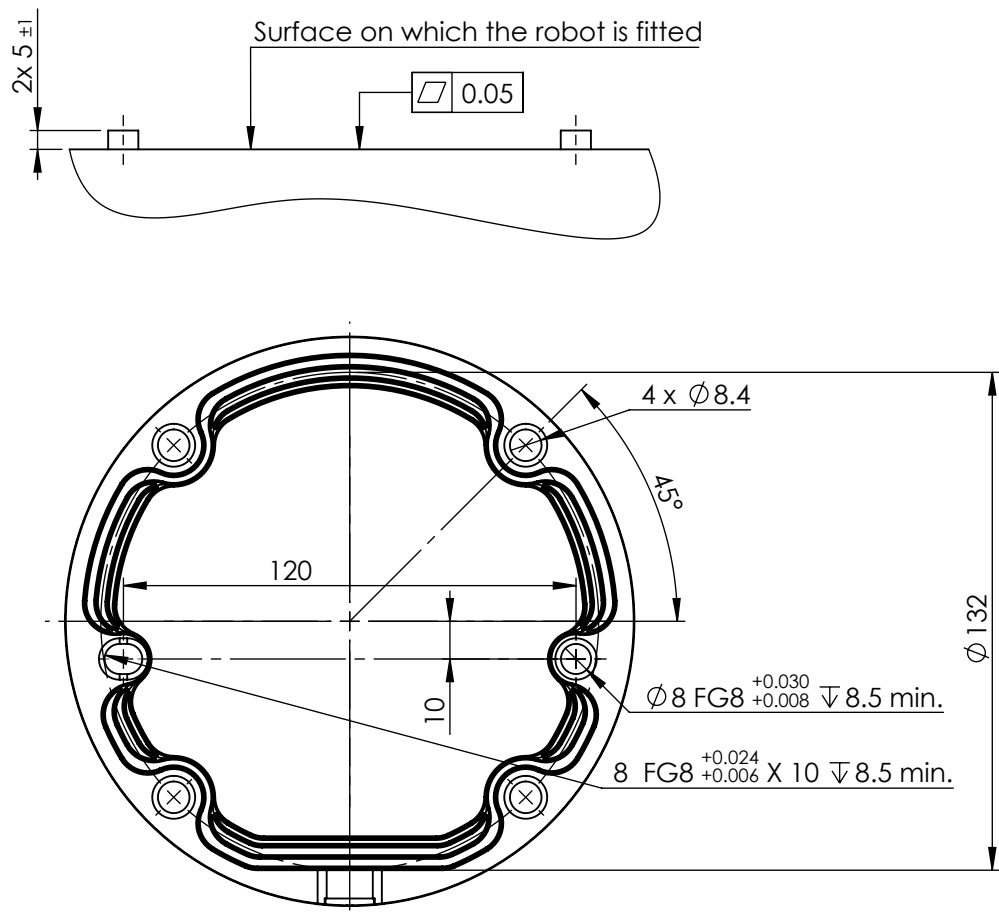
Failure to secure the robot arm to a sturdy surface can lead to injury caused by the robot falling.

- Ensure the robot arm is secured to a sturdy surface
-



## 5.1. Securing the Robot Arm

### Description



*Dimensions and hole pattern for mounting the robot.*

### To power down the robot arm



#### WARNING

Unexpected start-up and/or movement can lead to injury

- Power down the robot arm to prevent unexpected start-up during mounting and dismounting.

1. At the bottom left of the screen, tap the Initialize button to turn off the robot arm. The button changes from green to red.
2. Press the power button on the Teach Pendant to turn off the Control Box.
3. If a Shutdown dialog box displays, tap **Power Off**.

At this point, you can continue to:

- Unplug the mains cable / power cord from the wall socket.
- Allow 30 seconds for the robot to discharge any stored energy.



**To secure  
the robot  
arm**

1. Place the robot arm on the surface on which it is to be mounted. The surface must be even and clean.
  2. Tighten the four 8.8 strength, M8 bolts to a torque of 20 Nm.  
(Torque values have been updated SW 5.18. Earlier printed version will show different values)
  3. If accurate re-mounting of the robot is required, use the Ø8 mm. hole and Ø8x13 mm. slot with corresponding ISO 2338 Ø8 h6 positioning pins in the mounting plate.
-



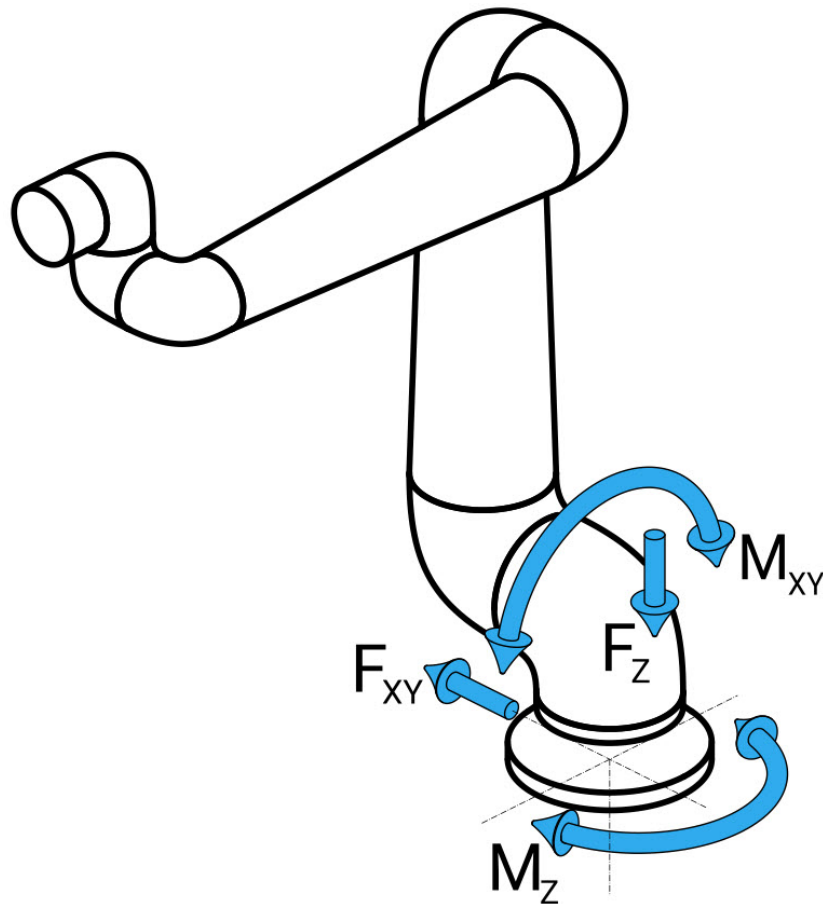
## 5.2. Dimensioning the Stand

### Description

The structure (stand) on which the robot arm is mounted is a crucial part of the robot installation. The stand must be sturdy and free of any vibrations from external sources.

Each robot joint produces a torque that moves and stops the robot arm. During normal uninterrupted operation and during stopping motion, the joint torques are transferred to the robot stand as:

- $M_z$ : Torque around the base z axis.
- $F_z$ : Forces along base z axis.
- $M_{xy}$ : Tilting torque in any direction of the base xy plane.
- $F_{xy}$ : Force in any direction in the base xy plane.



*Force and moment at base flange definition.*



**Dimensioning the Stand** The magnitude of the loads depends on robot model, program and multiple other factors. Dimensioning of the stand shall account for the loads that the robot arm generates during normal uninterrupted operation and during category 0, 1 and 2 stopping motion.

During stopping motion, the joints are allowed to exceed the maximum nominal operating torque. The load during stopping motion is independent of the stop category type. The values stated in the following tables are maximum nominal loads in worst-case movements multiplied with a safety factor of 2.5. The actual loads will not exceed these values.

Robot Model	Mz [Nm]	Fz[N]	Mxy[Nm]	Fxy [N]
UR5e	450	1090	750	910

*Maximum joint torques during category 0, 1 and 2 stops.*

Robot Model	Mz [Nm]	Fz[N]	Mxy[Nm]	Fxy [N]
UR5e	380	950	630	750

*Maximum joint torques during normal operation.*

The normal operating loads can generally be reduced by lowering the acceleration limits of the joints. Actual operating loads are dependent on the application and robot program. You can use URSim to evaluate the expected loads in your specific application.

**Safety margins** You can incorporate added safety margins, factoring in the following design considerations:

- **Static stiffness:** A stand that is not sufficiently stiff will deflect during robot motion, resulting in the robot arm not hitting the intended waypoint or path. Lack of static stiffness can also result in a poor freedrive teaching experience or protective stops.
- **Dynamic stiffness:** If the frequency of the stand matches the movement frequency of the robot arm, the entire system can resonate, creating the impression that the robot arm is vibrating. Lack of dynamic stiffness can also result in protective stops. The stand should have a minimum resonance frequency of 45 Hz.
- **Fatigue:** The stand shall be dimensioned to match the expected operating lifetime and load cycles of the complete system.



#### WARNING

- Potential for tip-over Hazards.
- The robot arm's operational loads can cause movable platforms, such as tables or mobile robots, to tip over, resulting in possible accidents.
- Prioritize safety by implementing adequate measures to prevent the tipping of movable platforms at all times.



#### CAUTION

- If the robot is mounted on an external axis, the accelerations of this axis must not be too high.  
You can let the robot software compensate for the acceleration of external axes by using script command:  
`set_base_acceleration()`
- High accelerations can cause the robot to make safety stops.



## 5.3. Mounting Description

### Description

Tool Flange	Uses four M6 thread holes for attaching a tool to the tool flange. The M6 strength class 8.8 bolts shall be tightened with 8 Nm. For accurate tool repositioning, use a pin in the Ø6 hole provided.
Control Box	The Control Box can be hung on a wall or placed on the ground.
Teach Pendant	The Teach Pendant is wall mounted or placed onto the Control Box. Verify the cable does not cause tripping hazard. You can buy extra brackets for mounting the Control Box and Teach Pendant.



#### WARNING

Mounting and operating the robot in environments exceeding the recommended IP rating can result in injury.

- Mount the robot in an environment suited to the IP rating. The robot must not be operated in environments that exceed those corresponding to the IP ratings of the robot (IP54), Teach Pendant (IP54) and Control Box (IP44)



#### WARNING

Unstable mounting can result in injury.

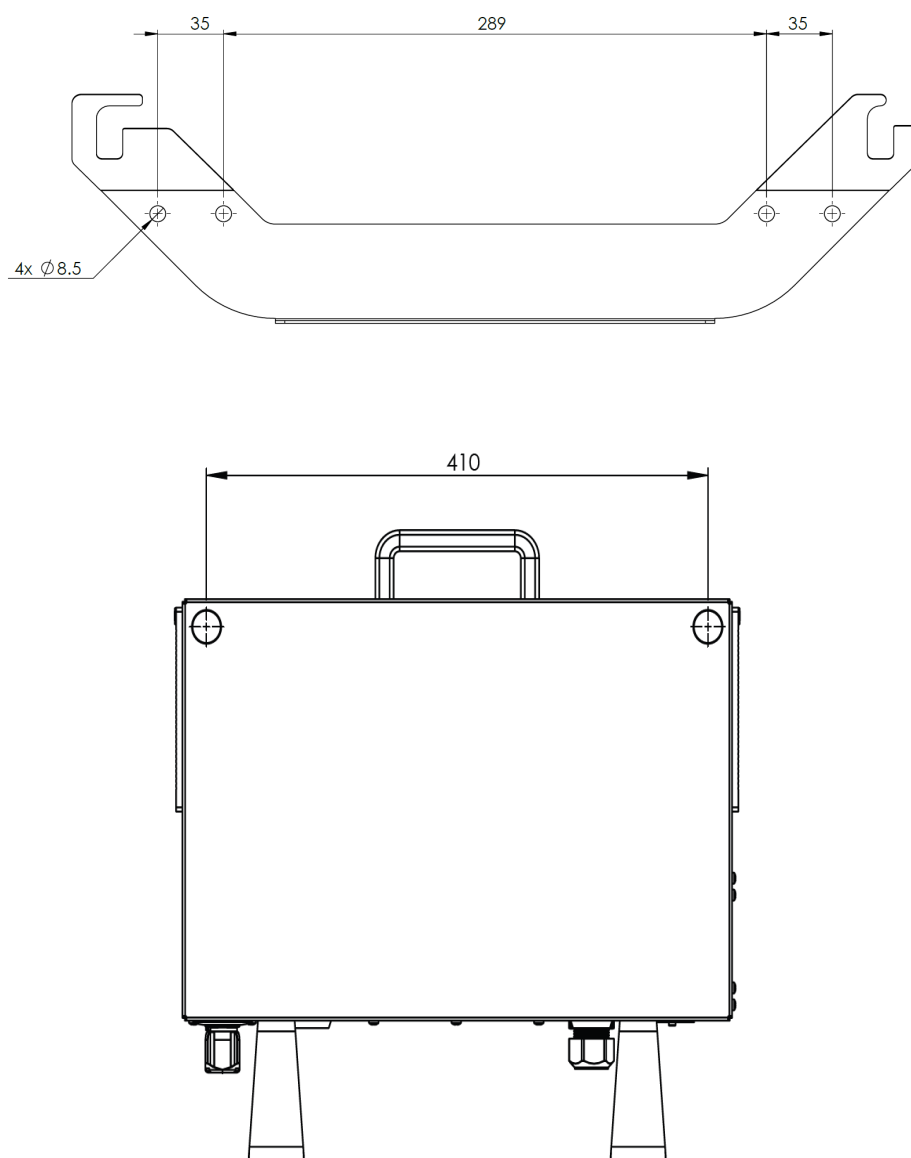
- Always make sure the robot parts are properly and securely mounted and bolted in place.



### 5.3.1. Control Box Mounting

**To mount a  
CB to a wall**

Use the bracket, shown below, included with the robot to mount the Control Box. Mount the bracket to a wall, then hang the Control Box on the bracket via the mounting pegs.

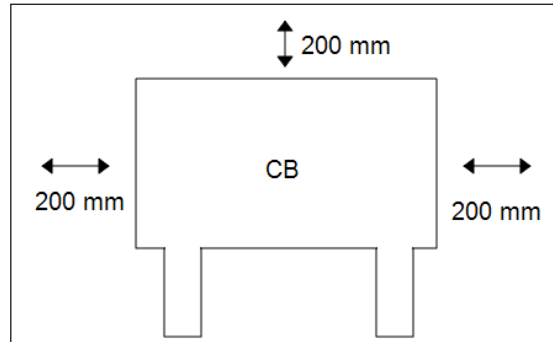




### 5.3.2. Control Box Clearance

**Description**

The flow of hot air in the Control Box can result in equipment malfunction. The recommended Control Box clearance is 200 mm on each side for sufficient cool airflow.


**WARNING**

A wet Control Box can cause fatal injury.

- Make sure the Control Box and cables do not come into contact with liquids.
- Place the Control Box (IP44) in an environment suited for the IP rating.



## 5.4. Workspace and Operating Space

### Description

The workspace is the range of the fully extended robot arm, horizontally and vertically. The operating space is the location where the robot is expected to function.



#### NOTICE

Disregard for the robot workspace and operating space can result in the damage to property.

It is important to consider the cylindrical volume directly above and directly below the robot base when choosing location to mount the robot. Moving the tool close to the cylindrical volume should be avoided because it causes the joints to move fast even when the tool is moving slowly. This can cause the robot to work inefficiently and can make it difficult to conduct a risk assessment.



#### NOTICE

Moving the tool close to the cylindrical volume can cause the joints to move too fast, leading to loss of functionality and damage to property.

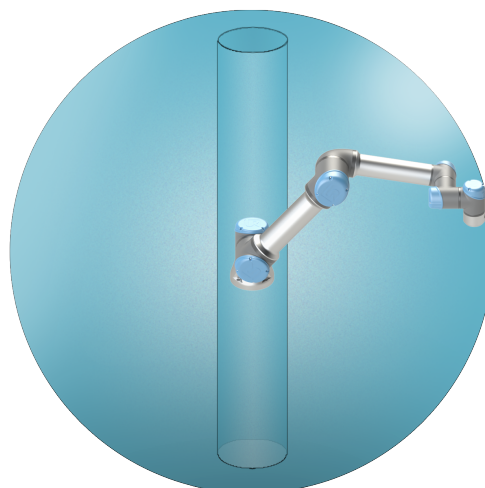
- Do not move the tool close to the cylindrical volume, even when the tool is moving slowly.

### Workspace

The cylindrical volume is both directly above and directly below the robot base. The robot extends 850 mm from the base joint.



Front



Tilted



## 5.4.1. Singularity

### Description

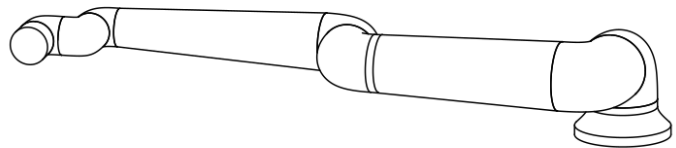
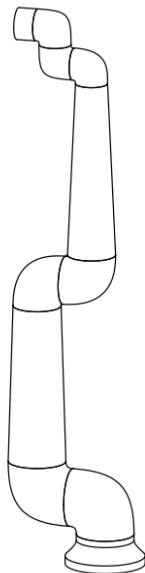
A singularity is a pose that restricts the motion and the ability to position the robot. The robot arm can stop moving or have very sudden and fast movements when approaching and leaving singularity.



#### WARNING

Make sure that robot motion near a singularity does not create hazards to anyone within the range of the robot arm, end effector, and workpiece.

- Set safety limits for the speed and acceleration of the elbow joint.



The following causes singularity in the robot arm:

- Outer workspace limit
- Inner workspace limit
- Wrist alignment

### Outer workspace limit

The singularity occurs because the robot cannot reach far enough or it reaches outside of the maximum working area.

To avoid: Arrange the equipment around the robot to avoid it reaching outside of the recommended workspace.



**Inner  
workspace  
limit**

The singularity occurs because the movements are directly above or directly below the robot base. This causes many positions/orientations to be unreachable.

To avoid: Program the robot task in such a way that it is not necessary to work in or close to the central cylinder. You can also consider mounting the robot base on a horizontal surface to rotate the central cylinder from a vertical to horizontal orientation, potentially moving it away from the critical areas of the task.

---

**Wrist  
alignment**

This singularity occurs because wrist joint 2 rotates on the same plane as the shoulder, elbow and wrist joint 1. This limits the range of movement of the robot arm, regardless of workspace.

To avoid: Layout the robot task in such a way that it is not necessary to align the robot wrist joints in this manner. You can also offset the direction of the tool, so that the tool can point horizontally without the problematic wrist alignment.

---

## 5.4.2. Fixed and Movable Installation

---

**Description**

Whether the robot arm is fixed (mounted to a stand, wall or floor) or in a movable installation (linear axis, push cart, or mobile robot base), it must be installed securely to ensure stability through all motions.

The design of the mounting must ensure stability when there are movements of:

- the robot arm
  - the robot base
  - both robot arm and robot base
-



## 5.5. Robot Connections: Base Flange Cable

**Description** This subsection describes the connection for a robot arm configured with a Base Flange Cable connector.

**Base Flange Cable connector** The Base Flange Cable establishes the robot connection to the robot arm to the Control Box. The Robot Cable connects to the Base Flange Cable connector on one end, and to the Control Box connector on the other end.  
You can lock each connector when robot connection is established.



### CAUTION

Improper robot connection can result in loss of power to the robot arm.

- Do not use one Robot Cable to extend another Robot Cable.



### NOTICE

Connecting the Base Flange Cable directly to any Control Box can result in equipment or property damage.

- Do not connect the Base Flange Cable directly to the Control Box.



## 5.6. Robot Connections: Robot Cable

**Description** This subsection describes the connection for a robot arm configured with a fixed 6 meter Robot Cable.

**To connect the arm and Control box** You can turn the connector to the right to make it easier to lock after the cable is plugged in.

- Establish the robot connection by connecting the robot arm to the Control Box with the Robot Cable.
- Plug and lock the cable from the robot into the connector at the bottom of the Control Box shown below.
- Twist the connector twice to ensure it is properly locked before turning on the robot arm.



### CAUTION

Improper robot connection can result in loss of power to the robot arm.

- Do not disconnect the Robot Cable when the robot arm is turned on.
- Do not extend or modify the original Robot Cable.



## 5.7. Mains Connections

### Description

The mains cable from the Control Box has a standard IEC plug at the end. Connect a country specific mains plug, or cable, to the IEC plug.



#### NOTICE

- IEC 61000-6-4:Chapter 1 scope: “This part of IEC 61000 for emission requirement applies to electrical and electronic equipment intended for use within the environment of existing at industrial (see 3.1.12) locations.”
- IEC 61000-6-4:Chapter 3.1.12 industrial location: “Locations characterized by a separate power network, supplied from a high- or medium-voltage transformer, dedicated for the supply of the installation”

### Mains connections

To power the robot, the Control Box shall be connected to the mains via the supplied power cord. The IEC C13 connector on the power cord connects to the IEC C14 appliance inlet at the bottom of the Control Box.



#### WARNING: ELECTRICITY

Failure to correctly place the mains connection can result in injury.

- The power plug for the mains connection shall be placed outside the reach of the robot, such that power can be removed without exposing personnel to potential hazards.
- If additional safeguarding is implemented, the power plug for the mains connection shall also be placed outside the safeguarded space such that power can be removed without exposure to any potential hazards.



#### NOTICE

Always use a power cord with a country specific wall plug when connecting to the Control Box. Do not use an adapter.

As a part of the electrical installation, provide the following:

- Connection to ground
- Main fuse
- Residual current device
- A lockable (in the OFF position) switch

A main switch shall be installed to power off all equipment in the robot application as an easy means for lockout. The electrical specifications are shown in the table below.



Parameter	Min	Typ	Max	Unit
Input voltage	90	-	264	VAC
External mains fuse (90-200V)	8	-	16	A
External mains fuse (200-264V)	8	-	16	A
Input frequency	47	-	440	Hz
Stand-by power	-	-	<1.5	W
Nominal operating power	90	150	325	W

**WARNING: ELECTRICITY**

Failure to follow any of the below can result in serious injury or death due to electrical hazards.

- Ensure the robot is grounded correctly (electrical connection to ground). Use the unused bolts associated with grounding symbols inside the Control Box to create common grounding of all equipment in the system. The grounding conductor shall have at least the current rating of the highest current in the system.
- Ensure the input power to the Control Box is protected with a Residual Current Device (RCD) and a correct fuse.
- Lockout all power for the complete robot installation during service.
- Ensure other equipment shall not supply power to the robot I/O when the robot is locked out.
- Ensure all cables are connected correctly before the Control Box is powered. Always use the original power cord.



## 6. Application Tab

The Application tab allows you to configure the settings which affect the overall performance of the robot and PolyScope X.

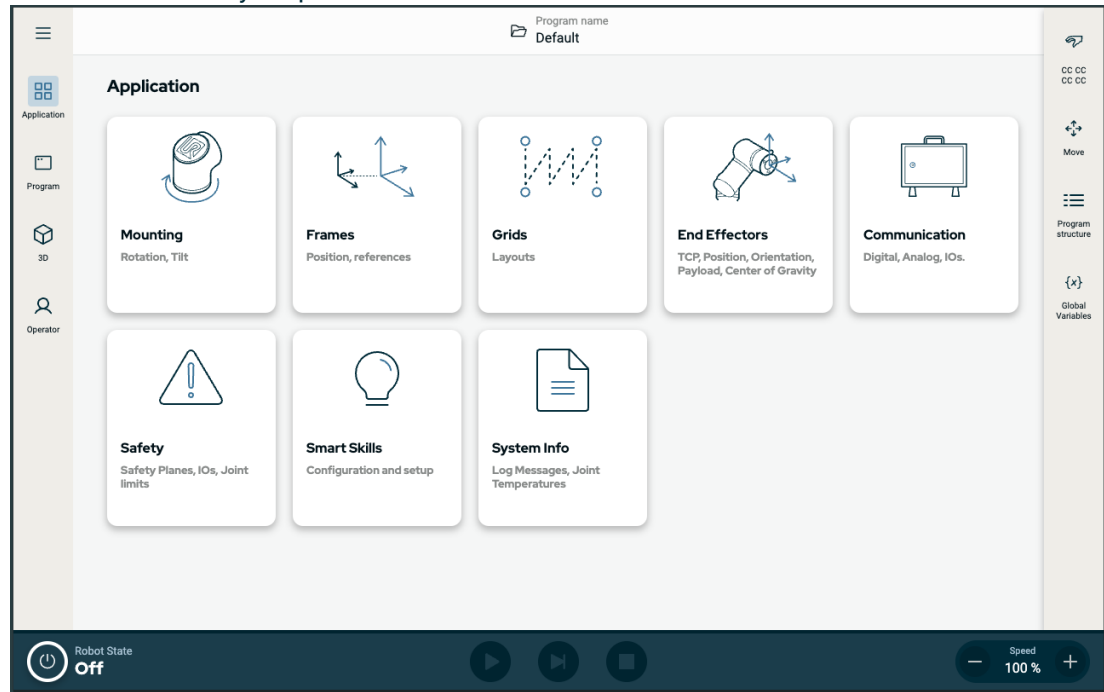


Figure 1.1: Application screen displaying application buttons.

Use the Application tab to access to the following configuration screens:

- Mounting
- Frames
- Grids
- End Effectors
- Communication
- Safety
- Smart Skills
- System Info



## 6.1. Communication

### Description

The Communication screen allows you to monitor and set the live I/O signals from/to the robot control box. The screen displays the current state of the I/O, including during program execution. If anything is changed during program execution, the program stops. At program stop, all output signals retain their states.

The Communication screen updates at 10Hz, so very fast signals may not display properly. You can reserve configurable I/Os for special safety settings defined in [8.7.1 Safety I/O Signals on page 76](#). Those which are reserved will have the name of the safety function in place of the default or user defined name. Configurable outputs reserved for safety settings cannot be selected, they are displayed as LEDs only.

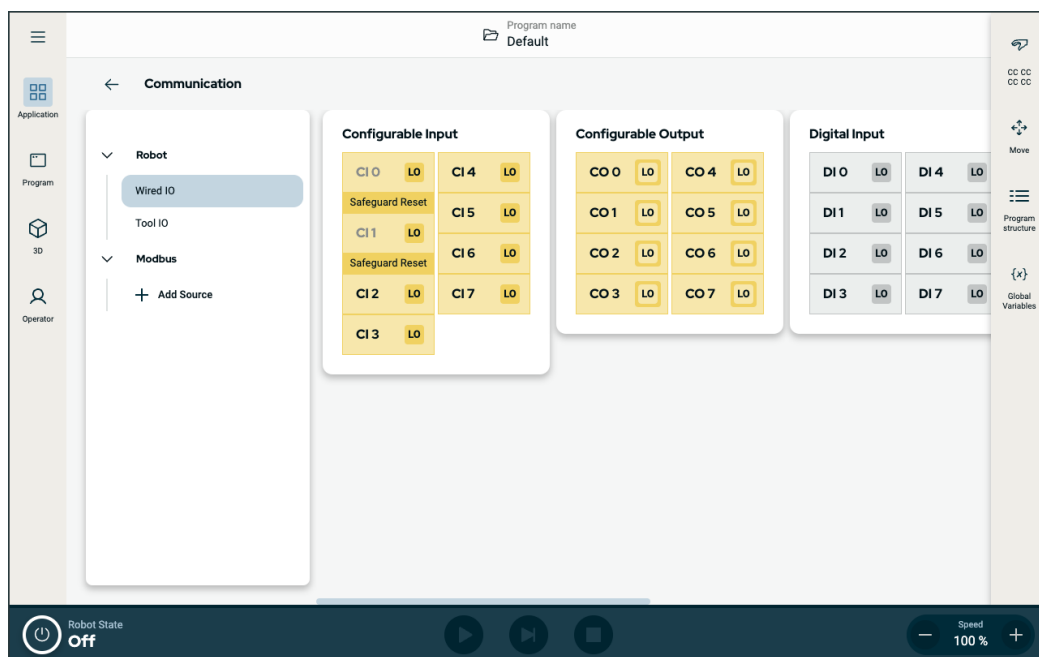


Figure 1.2: Communication screen displaying I/Os.



## 7. First Boot

### Description

The first boot is the initial sequence of actions you can take with the robot after assembly. This initial sequence requires you to:

- Power on the robot
- Insert the serial number
- Initialize the robot arm
- Power down the robot



#### CAUTION

Failure to verify the payload and installation before starting up the robot arm can lead to injury to personnel and/or property damage.

- Always verify the actual payload and installation are correct before starting up the robot arm.



#### CAUTION

Incorrect payload and installation settings prevent the robot arm and Control Box functioning correctly.

- Always verify the payload and installation setting are correct.



#### NOTICE

Starting up the robot in lower temperatures can result in lower performance, or stops, due to temperature dependent oil and grease viscosity.

- Starting up the robot in low temperatures can require a warmup phase.



## 7.1. Powering On the Robot

### To power on the robot

Powering on the robot turns on the Control Box and loads the display on the TP screen.

1. Press the power button on the Teach Pendant to power on the robot.

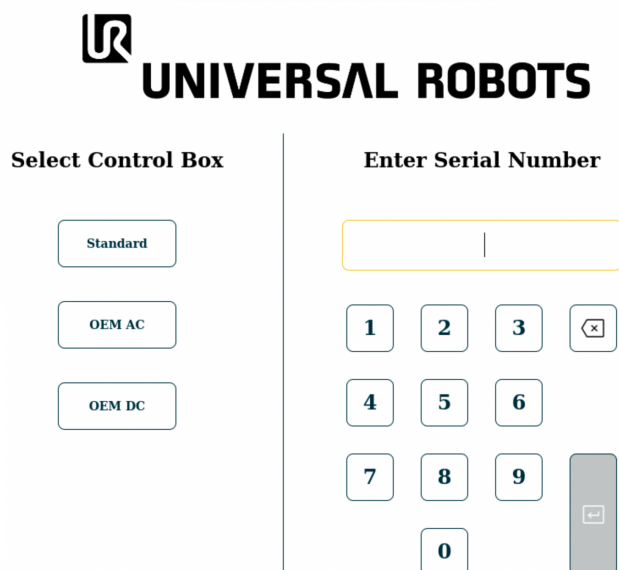
## 7.2. Inserting the Serial Number

### To insert the serial number

Installing your robot for the first time requires you to enter the serial number on the robot arm. This procedure is also required when you re-install the software, for example when you install a software update.

1. Select your Control Box.
2. Add the serial number as it is written on the robot arm.
3. Tap **OK** to end.

It can take a few minutes for the start screen to load.



The screenshot shows the Universal Robots start screen. At the top is the Universal Robots logo. Below it, the screen is divided into two main sections. The left section is titled 'Select Control Box' and contains three buttons: 'Standard', 'OEM AC', and 'OEM DC'. The right section is titled 'Enter Serial Number' and features a large empty text input field at the top. Below this field is a numeric keypad with buttons for digits 1 through 9, 0, and a backspace button (X). To the right of the numeric keypad is a large grey button with a right-pointing arrow, labeled 'OK'.



## 7.3. Starting the Robot Arm

### To start the robot

Starting the robot arm disengages the braking system, allowing you to start moving the robot arm and to start using PolyScope.

1. In the bottom left of the screen, tap power button. The robot arm state is **Off**.
2. When the Initialize box displays, tap **Power On**. The robot arm state is **Booting**.
3. Tap **Unlock** to release the brakes.

Robot arm initialization is accompanied by sound and slight movements as the joint brakes are released.

The robot arm state is now **Active** and you can start to use the interface.

4. You can tap an **OFF** to turn off the robot arm.

When the robot arm state changes from **Idle** to **Normal**, sensor data is checked against the configured mounting of the robot arm.

If the mounting is verified, tap **START** to continue releasing all joint brakes, preparing the robot arm for operation.

## 7.4. Powering Down the Robot

### To power down the robot arm



#### WARNING

Unexpected start-up and/or movement can lead to injury

- Power down the robot arm to prevent unexpected start-up during mounting and dismounting.

1. At the bottom left of the screen, tap the Initialize button to turn off the robot arm.  
The button changes from green to red.
2. Press the power button on the Teach Pendant to turn off the Control Box.
3. If a Shutdown dialog box displays, tap **Power Off**.

At this point, you can continue to:

- Unplug the mains cable / power cord from the wall socket.
- Allow 30 seconds for the robot to discharge any stored energy.



## 8. Installation

**Description** Installing the robot can require the configuration and use of input and output signals (I/Os). These different types of I/Os and their uses are described in the following sections.

### 8.1. Electrical Warnings and Cautions

**Warnings** Observe the following warnings for all the interface groups, including when you design and install an application.



#### **WARNING**

Failure to follow any of the below can result in serious injury or death, as the safety functions could be overridden.

- Never connect safety signals to a PLC that is not a safety PLC with the correct safety level. It is important to keep safety interface signals separated from the normal I/O interface signals.
- All safety-related signals shall be constructed redundantly (two independent channels).
- Keep the two independent channels separate so a single fault cannot lead to loss of the safety function.



#### **WARNING: ELECTRICITY**

Failure to follow any of the below can result in serious injury or death due to electrical hazards.

- Make sure all equipment not rated for water exposure remain dry. If water is allowed to enter the product, lockout-tagout all power and then contact your local Universal Robots service provider for assistance.
- Only use the original cables supplied with the robot only. Do not use the robot for applications where the cables are subject to flexing.
- Use caution when installing interface cables to the robot I/O. The metal plate in the bottom is intended for interface cables and connectors. Remove the plate before drilling holes. Make sure that all shavings are removed before reinstalling the plate. Remember to use correct gland sizes.



**CAUTION**

Disturbing signals with levels higher than those defined in the specific IEC standards can cause unexpected behaviors from the robot. Be aware of the following:

- The robot has been tested according to international IEC standards for **ElectroMagnetic Compatibility (EMC)**. Very high signal levels or excessive exposure can damage the robot permanently. EMC problems are found to happen usually in welding processes and are normally prompted by error messages in the log. Universal Robots cannot be held responsible for any damages caused by EMC problems.
- I/O cables going from the Control Box to other machinery and factory equipment may not be longer than 30m, unless additional tests are performed.

**GROUND**

Negative connections are referred to as Ground (GND) and are connected to the casing of the robot and the Control Box. All mentioned GND connections are only for powering and signalling. For PE (Protective Earth) use the M6-size screw connections marked with earth symbols inside the Control Box. The grounding conductor shall have at least the current rating of the highest current in the system.

**READ MANUAL**

Some I/Os inside the Control Box can be configured for either normal or safety-related I/O. Read and understand the complete Electrical Interface chapter.



## 8.2. Control Box Connection Ports

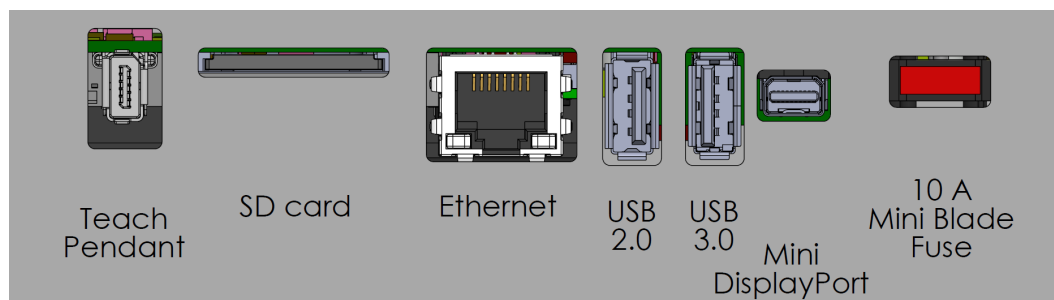
### Description

The underside of the I/O interface groups in the Control Box is equipped with external connection ports and a fuse, described below. There are capped openings at the base of the Control Box cabinet to run external connector cables to access the connection ports.

### External connection ports

The ports for external connections are as follows:

- Teach Pendant port to use the Teach Pendant to control or program the robot arm.
- SD card port to insert an SD card.
- Ethernet port to allow ethernet type connections.
- Mini DisplayPort to support monitors using DisplayPort. This requires an active Mini Display to a DVI or HDMI converter. Passive converters do not work with DVI/HDMI ports.
- The Mini Blade Fuse is used when an external power supply is connected.



#### NOTICE

Connecting or disconnecting a Teach Pendant while the Control Box is powered on can cause equipment damage .

- Do not connect a Teach Pendant while the Control Box is on.
- Power off the Control Box before you connect a Teach Pendant.



#### NOTICE

Failure to plug in the active adapter before powering on the Control Box can hinder the display output.

- Plug in the active adapter before powering on the Control Box.
- In some cases the external monitor must be powered on before the Control Box.
- Use an active adapter that supports revision 1.2 as not all adapters function out-of-the-box.



## 8.3. Ethernet

### Description

The Ethernet interface can be used for:

- MODBUS, EtherNet/IP and PROFINET.
- Remote access and control.

To connect the Ethernet cable by passing it through the hole at the base of the Control Box, and plugging it into the Ethernet port on the underside of the bracket. Replace the cap at the base of the Control Box with an appropriate cable gland to connect the cable to the Ethernet port.



The electrical specifications are shown in the table below.

Parameter	Min	Typ	Max	Unit
Communication speed	10	-	1000	Mb/s



## 8.4. 3PE Teach Pendant Installation

### 8.4.1. Hardware Installation

#### To remove a Teach Pendant



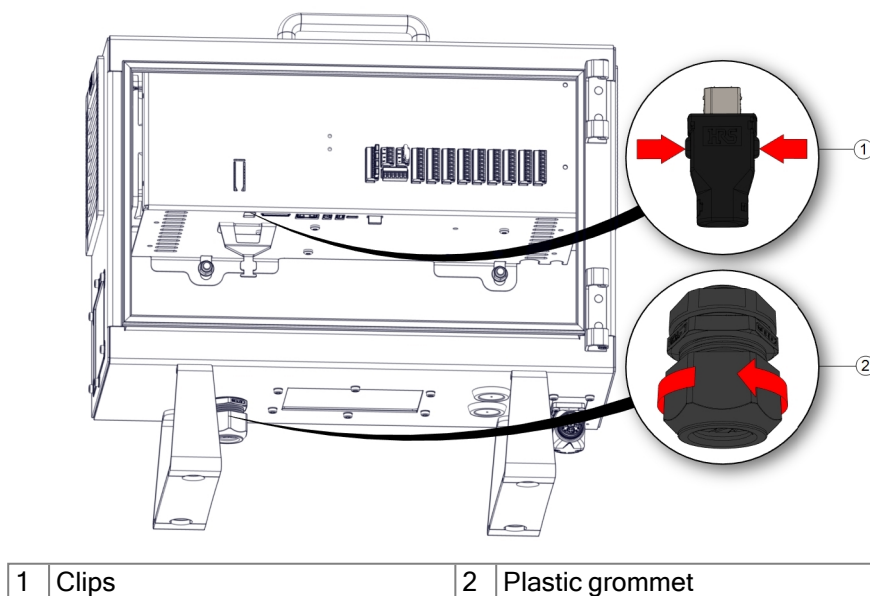
#### NOTICE

Replacing the Teach Pendant can result in the system reporting a fault on start-up.

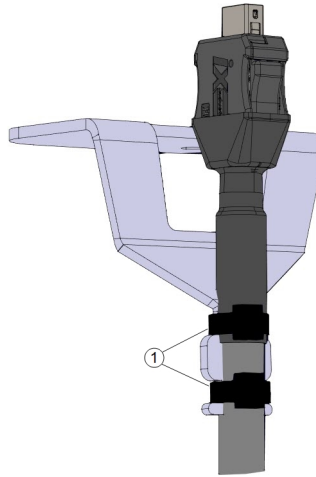
- Always select the correct configuration for the type of Teach Pendant.

To remove the standard Teach Pendant:

1. Power down the control box and disconnect the main power cable from the power source.
2. Remove and discard the two cable ties used for mounting the Teach Pendant cables.
3. Press in the clips on both sides of the Teach Pendant plug as illustrated, and pull down to disconnect from the Teach Pendant port.
4. Fully open/loosen the plastic grommet at the bottom of the control box and remove the Teach Pendant plug and cable.
5. Gently remove the Teach Pendant cable and Teach Pendant.







1	Cable ties
---	------------

### To install a 3PE Teach Pendant

1. Place the Teach Pendant plug and cable in through the bottom of the control box and fully close/tighten the plastic grommet.
2. Push the Teach Pendant plug into the Teach Pendant port to connect.
3. Use two new cable ties to mount the Teach Pendant cables.
4. Connect the main power cable to the power source and power on the control box.

There is always a length of cable with the Teach Pendant that can present a tripping hazard if it is not stored properly.

- Always store the Teach Pendant and the cable properly to avoid tripping hazards.





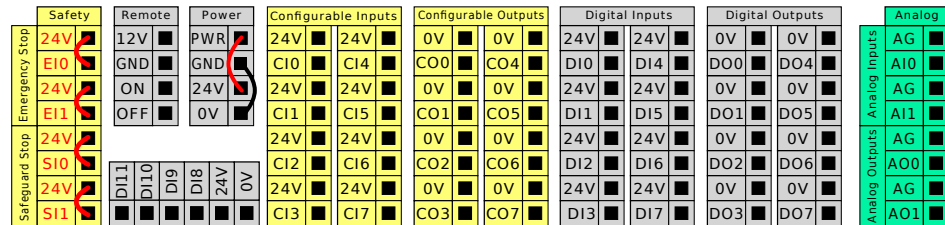


## 8.5. Controller I/O

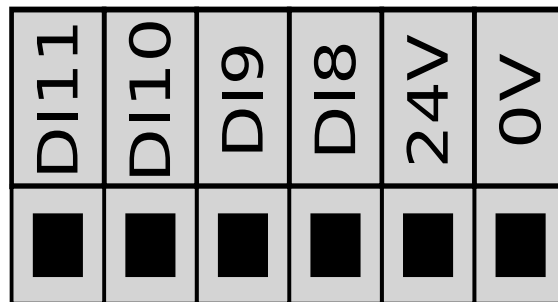
### Description

You can use the I/O inside the Control Box for a wide range of equipment including pneumatic relays, PLCs and emergency stop buttons.

The illustration below shows the layout of electrical interface groups inside the Control Box.



You can use the horizontal Digital Inputs block (DI8-DI11), illustrated below, for quadrature encoding Conveyor Tracking.



The meaning of the color schemes listed below must be observed and maintained.

Yellow with red text	Dedicated safety signals
Yellow with black text	Configurable for safety
Gray with black text	General purpose digital I/O
Green with black text	General purpose analog I/O

In the GUI, you can set up **configurable** I/O as either **safety-related** I/O or **general purpose** I/O.



**Common specifications for all digital I/O**

This section defines electrical specifications for the following 24V digital I/O of the Control Box.

- Safety I/O.
- Configurable I/O.
- General purpose I/O.

**NOTICE**

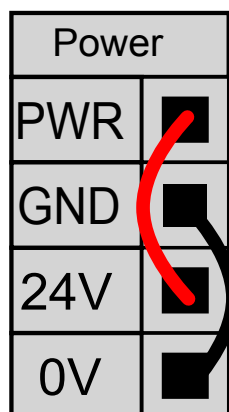
The word **configurable** is used for I/O configured as either safety-related I/O or normal I/O. These are the yellow terminals with black text.

Install the robot according to the electrical specifications which are the same for all three inputs.

It is possible to power the digital I/O from an internal 24V power supply or from an external power source by configuring the terminal block called **Power**. This block consists of four terminals. The upper two (PWR and GND) are 24V and ground from the internal 24V supply. The lower two terminals (24V and 0V) in the block are the 24V input to supply the I/O. The default configuration uses the internal power supply.

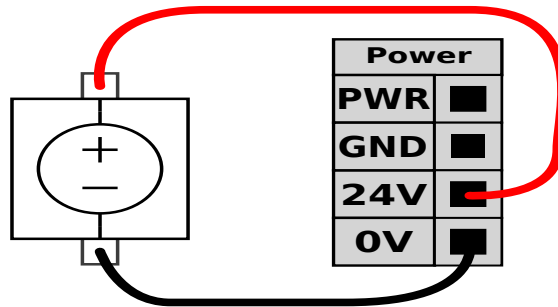
**Power supply default**

In this example the default configuration uses the internal power supply





**External power supply** If more current is needed, you can connect an external power supply as shown below. The fuse is Mini Blade type with maximum current rating of 10 A and a minimum voltage rating of 32 V. The fuse must be UL marked. If the fuse is overloaded, it must be replaced.



In this example the configuration uses an external power supply for more current.

**Specification** The electrical specifications for both the internal and external power supply are shown below.

Terminals	Parameter	Min	Typ	Max	Unit
<i>Internal 24V power supply</i>					
[ PWR - GND ]	Voltage	23	24	25	V
[ PWR - GND ]	Current	0	-	2*	A
<i>External 24V input requirements</i>					
[ 24V - 0V ]	Voltage	20	24	29	V
[ 24V - 0V ]	Current	0	-	6	A

\*3.5A for 500ms or 33% duty cycle.



**Digital I/Os**

The digital I/O are constructed in compliance with IEC 61131-2. The electrical specifications are shown below.

Terminals	Parameter	Min	Typ	Max	Unit
<b>Digital Outputs</b>					
[COx / DOx]	Current*	0	-	1	A
[COx / DOx]	Voltage drop	0	-	0.5	V
[COx / DOx]	Leakage current	0	-	0.1	mA
[COx / DOx]	Function	-	PNP	-	Type
[COx / DOx]	IEC 61131-2	-	1A	-	Type
<b>Digital Inputs</b>					
[EIx/SIx/CIx/DIx]	Voltage	-3	-	30	V
[EIx/SIx/CIx/DIx]	OFF region	-3	-	5	V
[EIx/SIx/CIx/DIx]	ON region	11	-	30	V
[EIx/SIx/CIx/DIx]	Current (11-30V)	2	-	15	mA
[EIx/SIx/CIx/DIx]	Function	-	PNP +	-	Type
[EIx/SIx/CIx/DIx]	IEC 61131-2	-	3	-	Type

\*For resistive loads or inductive loads of maximum 1H.



## 8.5.1. Drive Power Indicator

### Description

The drive power indicator is a light that turns on when the robot arm is powered on, or when there is power to the robot cable. When the robot arm is powered off, the drive power indicator turns off.

The drive power indicator is connected via the Digital Outputs. It is not a safety feature and does not use safety I/Os.

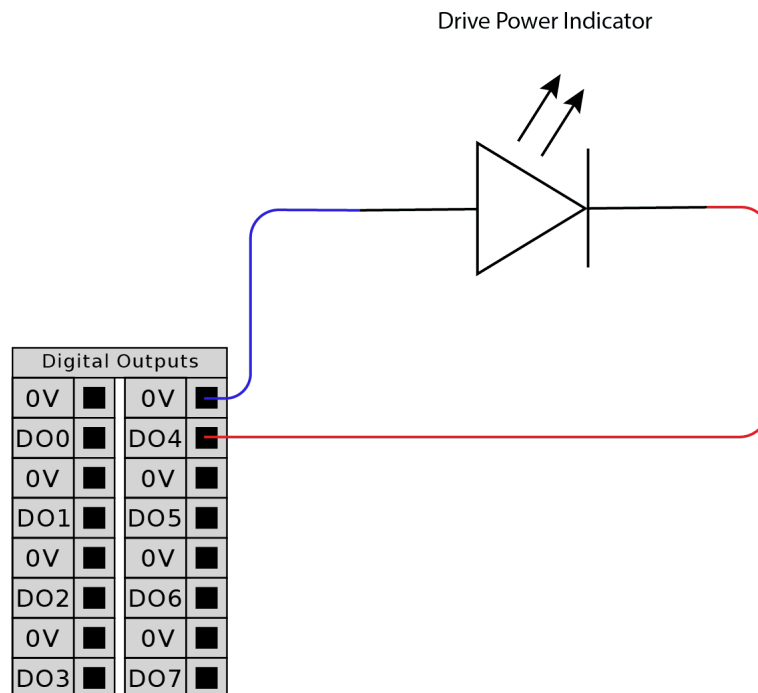
### Indicator

The drive power indicator can be a light that can work at 24VDC.

### To set up the indicator

Setting up the indicator requires a light and wiring for the outputs.

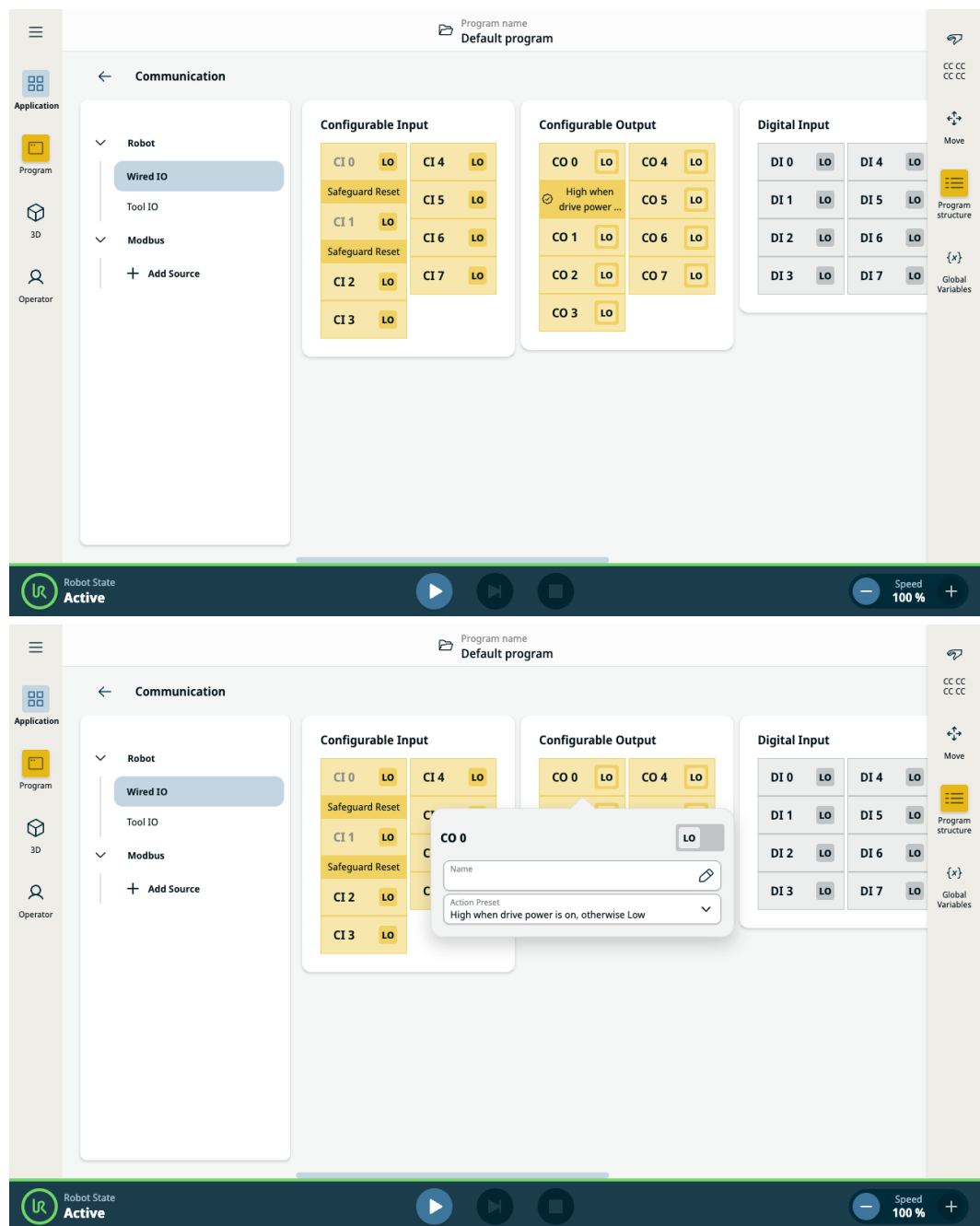
1. Connect your drive power indicator to the Digital Outputs as shown in the image below.
2. Verify the drive power indicator is correctly connected.
  - You can power on the robot arm and verify the light turns on.
  - You can power off the robot arm and verify the light turns off.





### To configure the indicator

1. In the Navigation menu, tap **Application**.
2. Select **Communication**.
3. In the side menu, select **Wired IO**.
4. Scroll to your desired output type and tap to select one of the following:
  - Configurable Output
  - Digital Output
  - Analog Output
5. Select **Action Preset**  
You can name the selected output
6. In the dropdown select **High when drive power is on, otherwise Low**.





## 8.6. Using I/O for Mode Selection

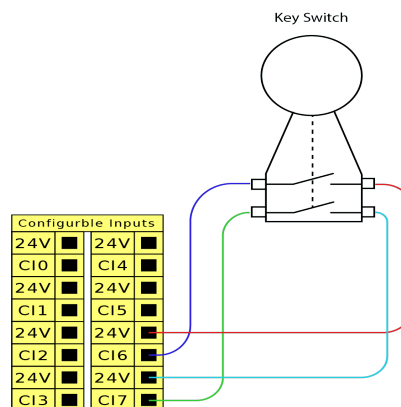
**Description** The robot can be configured to switch between operational modes without using the Teach Pendant. This means using the TP is prohibited when switching from Automatic mode to Manual mode and from Manual mode to Automatic mode.

Switching modes without the use of the Teach Pendant requires safety I/O configuration and a secondary device as a mode selector.

**Mode selector** The mode selector can be a key switch with a redundant electrical layout or with signals from a dedicated safety PLC.

**To use the mode selector** Using the mode selector, such as a key switch, prevents the TP from being used to switch between the modes.

1. Connect your mode selector to the inputs as shown in the image below.
2. Verify the mode selector is correctly connected and configured.





**To configure the connected safety inputs**

Configuring the safety inputs for the secondary device connection requires unlocking the safety I/O screen.

1. In the Navigation menu, tap **Application**.
2. Select **Safety**.
3. At the bottom of the screen, tap **Unlock**.

When prompted, input your password to unlock the Safety screen.

If you have not previously defined a password, use the default password: `ursafe`.

4. Under Safety I/O select **Inputs**.
5. Select one of the input signals by tapping one of the Input dropdown options.
6. In the dropdown list, select **Operational Mode**.
7. Tap **Apply** and allow the robot restart.
8. Tap **Confirm Safety Configuration**.

You can now only use the secondary device to select and/or switch between operational modes.

Once the input is assigned to the secondary device, switching modes via the TP is disabled. If an attempt is made to use the TP to switch modes, a message appears confirming the TP cannot be used to change the operational mode.



## 8.7. Safety I/O

**Safety I/O** This section describes dedicated safety input (Yellow terminal with red text) and configurable I/O (Yellow terminals with black text) when configured as safety I/O. Safety devices and equipment must be installed according to the safety instructions and the risk assessment in chapter Safety. All safety I/O are paired (redundant), so a single fault does not cause loss of the safety function. However, the safety I/O must be kept as two separate branches.

The permanent safety input types are:

- **Robot Emergency Stop** for emergency stop equipment only
- **Safeguard Stop** for protective devices
- **3PE Stop** for protective devices

**Table** The functional difference is shown below.

	Emergency Stop	Safeguard Stop	3PE Stop
Robot stops moving	Yes	Yes	Yes
Program execution	Pauses	Pauses	Pauses
Drive power	Off	On	On
Reset	Manual	Automatic or manual	Automatic or manual
Frequency of use	Infrequent	Every cycle to infrequent	Every cycle to infrequent
Requires re-initialization	Brake release only	No	No
Stop Category (IEC 60204-1)	1	2	2
Performance level of monitoring function (ISO 13849-1)	PLd	PLd	PLd

**Safety caution** Use the configurable I/O to set up additional safety I/O functionality, e.g. Emergency Stop Output. Use the PolyScope interface to define a set of configurable I/O for safety functions.



### CAUTION

Failure to verify and test the safety functions regularly can lead to hazardous situations.

- Safety functions shall be verified before putting the robot into operation.
- Safety functions shall be tested regularly.



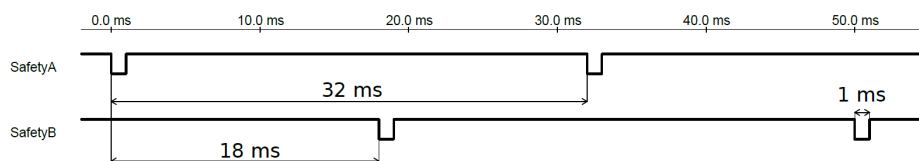
### OSSD signals

All configured and permanent safety inputs are filtered to allow the use of OSSD safety equipment with pulse lengths under 3ms. The safety input is sampled every millisecond and the state of the input is determined by the most frequently seen input signal over the last 7 milliseconds.

### OSSD Safety Signals

You can configure the Control Box to output OSSD pulses when a safety output is inactive/high. OSSD pulses detect the ability of the Control Box to make safety outputs active/low. When OSSD pulses are enabled for an output, a 1ms low pulse is generated on the safety output once every 32ms. The safety system detects when an output is connected to a supply and shuts down the robot.

The illustration below shows: the time between pulses on a channel (32ms), the pulse length (1ms) and the time from a pulse on one channel to a pulse on the other channel (18ms)



To enable OSSD for Safety Output

1. In the Header, tap **Installation** and select **Safety**.
2. Under **Safety**, select **I/O**.
3. On the I/O screen, under Output Signal, select the desired OSSD checkbox. You must assign the output signal to enable the OSSD checkboxes.

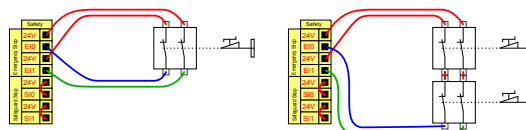
### Default safety configuration

The robot is delivered with a default configuration, which enables operation without any additional safety equipment.

Safety	
Emergency Stop	24V
	EI0
	24V
	EI1
Safeguard Stop	24V
	SI0
	SI1

### Connecting emergency stop buttons

Most applications require one or more extra emergency stop buttons. The illustration below shows how one or more emergency stop buttons can be connected.



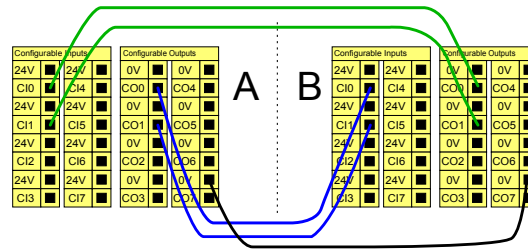


### Sharing the Emergency Stop with other machines

You can set up a shared emergency stop function between the robot and other machines by configuring the following I/O functions via the GUI. The Robot Emergency Stop Input cannot be used for sharing purposes. If more than two UR robots or other machines need to be connected, a safety PLC must be used to control the emergency stop signals.

- Configurable input pair: External Emergency Stop.
- Configurable output pair: System Stop.

The illustration below shows how two UR robots share their emergency stop functions. In this example the configured I/Os used are CI0-CI1 and CO0-CO1.



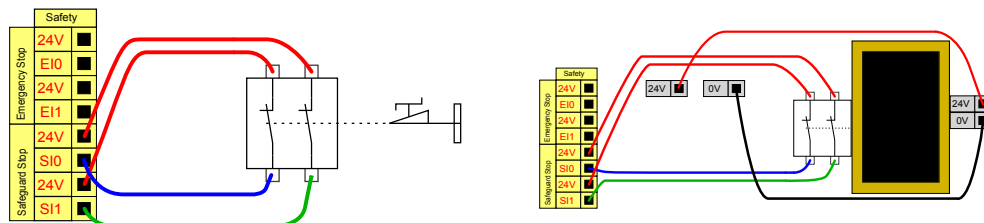
### Safeguard stop with automatic resume

This configuration is only intended for applications where the operator cannot go through the door and close it behind him. The configurable I/O is used to setup a reset button outside the door to reactivate robot motion. The robot resumes movement automatically when the signal is re-established.



#### WARNING

Do not use this configuration if signal can be re-established from the inside of the safety perimeter.



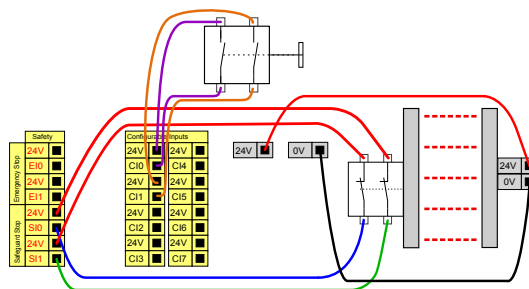
In this example a door switch is a basic safeguard device where the robot is stopped when the door is opened.

In this example a safety mat is a safety device where automatic resume is appropriate. This example is also valid for a safety laser scanner.



**Safeguard  
Stop with  
reset button**

If the safeguard interface is used to interact with a light curtain, a reset outside the safety perimeter is required. The reset button must be a two channel type. In this example the I/O configured for reset is CI0-CI1.





## 8.7.1. Safety I/O Signals

### Description

The I/O are divided between inputs and outputs and are paired up so that each function provides a Category 3 PLd capability.

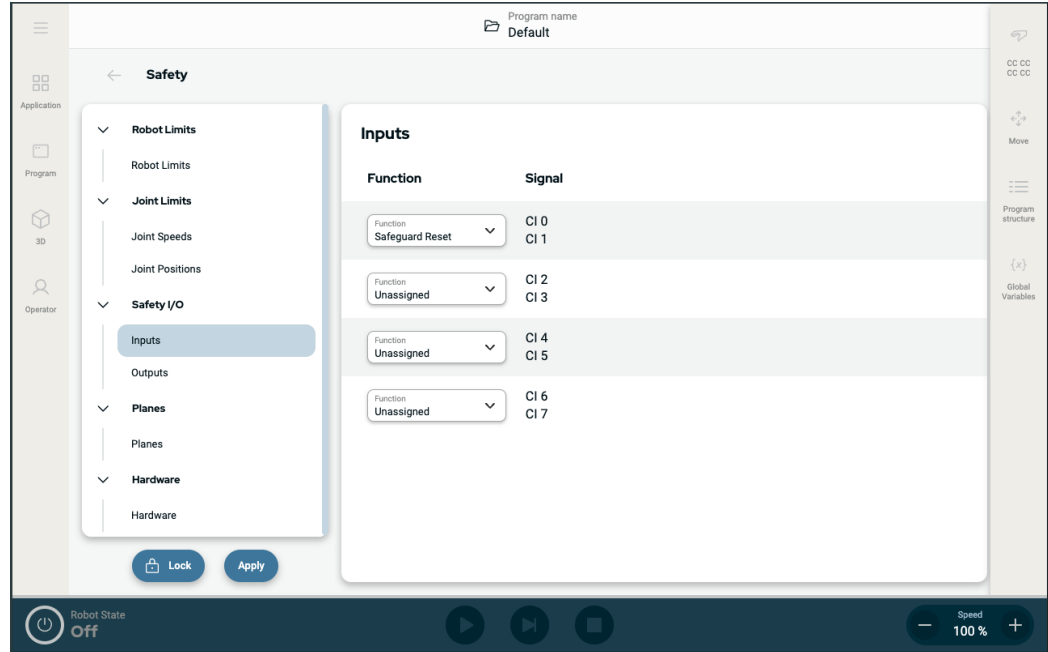
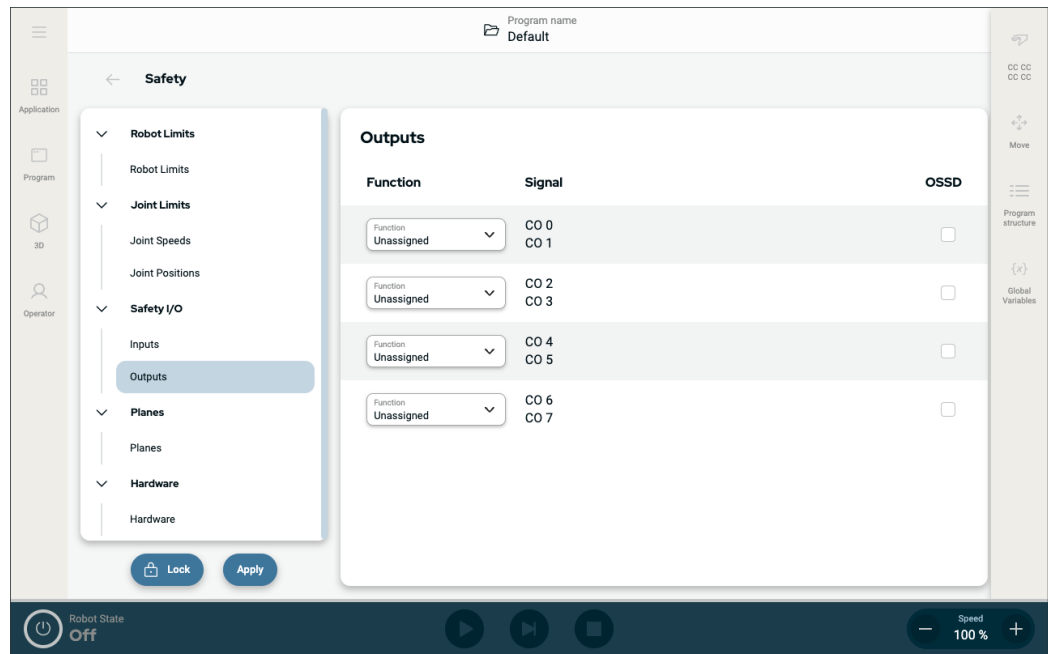


Figure 1.3: PolyScope X screen displaying the Input signals.





## Input Signals

The inputs are described in the tables below:

Emergency Stop Button	Performs a Stop Category 1 (IEC 60204-1) informing other machines using the System Stop output if that output is defined. A stop is initiated in anything connected to the output.
Robot Emergency Stop	Performs a Stop Category 1 (IEC 60204-1) via Control Box input, informing other machines using the System Emergency Stop Output if that output is defined.
External Emergency Stop	Performs a Stop Category 1 (IEC 60204-1) on robot only.
Reduced	<p>All safety limits can be applied while the robot is using a <b>Normal</b> configuration, or a <b>Reduced</b> configuration.</p> <p>When configured, a low signal sent to the inputs causes the safety system to transition to the reduced configuration. The robot arm decelerates to satisfy the reduced parameters.</p> <p>The safety system guarantees the robot is within reduced limits less than 0.5s after the input is triggered. If the robot arm continues to violate any of the reduced limits, a Stop Category 0 is triggered. Trigger planes can also cause a transition to the reduced configuration. The safety system transitions to the normal configuration in the same way.</p>



**Input  
Signals**

The inputs are described in the table below

Operational Mode	When an external mode selection is used it switches between <b>Automatic Mode</b> and <b>Manual Mode</b> . The robot is in Automatic mode when input is <i>low</i> and Manual mode when the input is <i>high</i> .
Safeguard Reset	Returns from the Safeguard Stop state, when a rising edge on the Safeguard Reset input occurs. When a Safeguard Stop occurs, this input ensures that the Safeguard Stop state continues until a reset is triggered.
Safeguard	A stop triggered by a safeguard input. Performs a Stop Category 2 (IEC 60204-1) in all modes, when triggered by a Safeguard.
Automatic Mode Safeguard Stop	Performs a Stop Category 2 (IEC 60204-1) in Automatic mode ONLY. Automatic Mode Safeguard Stop can only be selected when a Three-Position Enabling Device is configured and installed.
Automatic Mode Safeguard Reset	Returns from the Automatic Mode Safeguard Stop state when a rising edge on the Automatic Mode Safeguard Reset input occurs.
Freedrive on robot	You can configure the Freedrive input to enable and use Freedrive without pressing the Freedrive button on a standard TP, or without having to press-and-hold any of the buttons on the 3PE TP in the light-press position.

**WARNING**

When the default Safeguard Reset is disabled, an automatic reset happens when the safeguard no longer triggers a stop.

This can happen if a person passes through the field of the safeguard.

If a person is not detected by the safeguard and the person is exposed to hazards, automatic reset is forbidden by standards.

- Use the external reset to ensure resetting only when a person is not exposed to hazards.

**WARNING**

When Automatic Mode Safeguard stop is enabled, a safeguard Stop is not triggered in Manual Mode.



**Output  
Signals**

All safety outputs go low in the event of a safety system violation or fault. This means the System Stop output initiates a stop even when an E-stop is not triggered. You can use the following Safety functions output signals. All signals return to low when the state which triggered the high signal has ended:

<sup>1</sup> System Stop	Signal is <i>Low</i> when the safety system has been triggered into a stopped state including by the Robot Emergency Stop input or the Emergency Stop Button. To avoid deadlocks, if the Emergency Stopped state is triggered by the System Stop input, low signal will not be given.
Robot Moving	Signal is <i>Low</i> if the robot is moving, otherwise high.
Robot Not Stopping	Signal is <i>High</i> when the robot is stopped or in the process of stopping due to an emergency stop or safeguard stop. Otherwise it will be logic low.
Reduced	Signal is <i>Low</i> when reduced parameters are active or if the safety input is configured with a reduced input and the signal is currently low. Otherwise the signal is high.
Not Reduced	This is the inverse of Reduced, defined above.
3-Position Enabling Device	In Manual Mode, an external 3-Position Enabling Device must be pressed and held in the center-on position to move the robot. If you are using a built-in 3-Position Enabling Device, the button must be pressed and held in the mid position to move the robot.
Safe Home	Signal is <i>High</i> if the robot arm is stopped and is located in the configured Safe Home Position. Otherwise, the signal is <i>Low</i> . This is often used when UR robots are integrated with mobile robots.


**NOTICE**

Any external machinery receiving its Emergency Stop state from the robot through the System Stop output must comply with ISO 13850. This is particularly necessary in setups where the Robot Emergency Stop input is connected to an external Emergency Stop device. In such cases, the System Stop output becomes high when the external Emergency Stop device is released. This implies that the emergency stop state at the external machinery will be reset with no manual action needed from the robot's operator. Hence, to comply with safety standards, the external machinery must require manual action in order to resume.

<sup>1</sup>System Stop was previously known as "System Emergency Stop" for Universal Robots robots. PolyScope can display "System Emergency Stop".







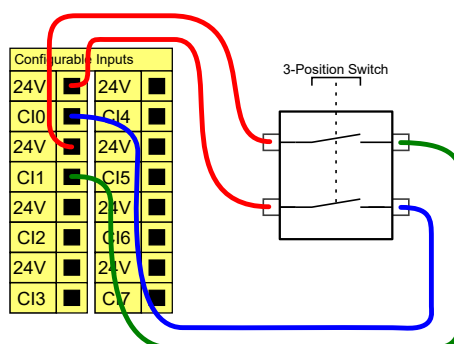
## 8.8. Three Position Enabling Device

### Description

The robot arm is equipped with an enabling device in the form of the 3PE Teach Pendant. The Control Box supports the following enabling device configurations:

- 3PE Teach Pendant
- External Three-Position Enabling device
- External Three-Position device and 3PE Teach Pendant

The illustration below shows how to connect a Three-Position Enabling device.



Note: The two input channels for the Three-Position Enabling Device input have a disagreement tolerance of 1 second.



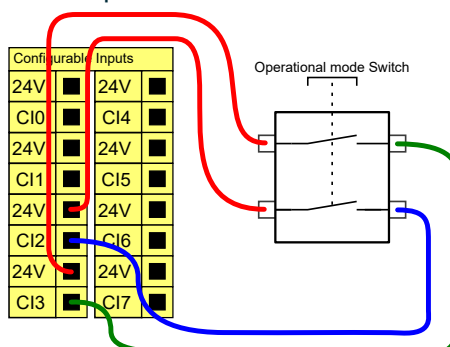
### NOTICE

The UR robot safety system does not support multiple external Three-Position Enabling Devices.

### Operational Mode Switch

Using a Three-Position Enabling device requires the use of an Operational Mode switch.

The illustration below shows an Operational Mode switch.





## 8.9. General Purpose Analog I/O

### Description

The analog I/O interface is the green terminal. It is used to set or measure voltage (0-10V) or current (4-20mA) to and from other equipment.

The following directions is recommended to achieve the highest accuracy.

- Use the AG terminal closest to the I/O. The pair share a common mode filter.
- Use the same GND (0V) for equipment and Control Box. The analog I/O is not galvanically isolated from the Control Box.
- Use a shielded cable or twisted pairs. Connect the shield to the GND terminal at the terminal called **Power**.
- Use equipment that works in current mode. Current signals are less sensitive to interferences.

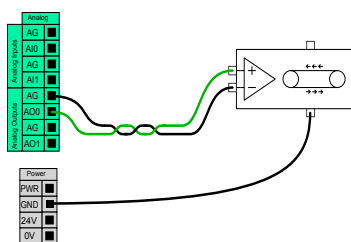
### Electrical Specifications

In the GUI you can select input modes. The electrical specifications are shown below.

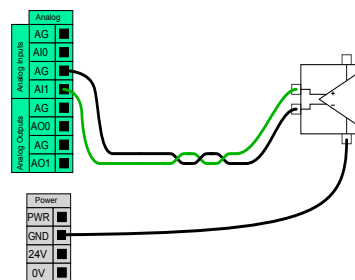
Terminals	Parameter	Min	Typ	Max	Unit
<i>Analog Input in current mode</i>					
[AIx - AG]	Current	4	-	20	mA
[AIx - AG]	Resistance	-	20	-	ohm
[AIx - AG]	Resolution	-	12	-	bit
<i>Analog Input in voltage mode</i>					
[AIx - AG]	Voltage	0	-	10	V
[AIx - AG]	Resistance	-	10	-	Kohm
[AIx - AG]	Resolution	-	12	-	bit
<i>Analog Output in current mode</i>					
[AOx - AG]	Current	4	-	20	mA
[AOx - AG]	Voltage	0	-	24	V
[AOx - AG]	Resolution	-	12	-	bit
<i>Analog Output in voltage mode</i>					
[AOx - AG]	Voltage	0	-	10	V
[AOx - AG]	Current	-20	-	20	mA
[AOx - AG]	Resistance	-	1	-	ohm
[AOx - AG]	Resolution	-	12	-	bit



### Analog Output and Analog Input



This example illustrates controlling a conveyor belt with an analog speed control input.



This example illustrates connecting an analog sensor.

## 8.9.1. Analog Input: Communication Interface

### Description

The Tool Communication Interface (TCI) enables the robot to communicate with an attached tool via the robot tool analog input. This removes the need for external cabling. Once the Tool Communication Interface is enabled, all tool analog inputs are unavailable.

### Tool Communication Interface

1. Tap the Installation tab and under General tap Tool I/O.
2. Select Communication Interface to edit TCI settings.  
Once the TCI is enabled, the tool analog input is unavailable for the I/O Setup of the Installation and does not appear in the input list. Tool analog input is also unavailable for programs as Wait For options and expressions.
3. In the drop-down menus under Communication Interface, select required values. Any changes in values are immediately sent to the tool. If any installation values differ from what the tool is using, a warning appears.



## 8.10. General Purpose Digital I/O

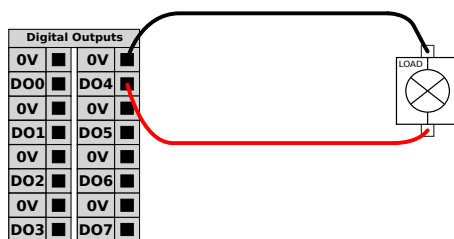
**Description** The Startup screen contains settings for automatically loading and starting a default program, and for auto-initializing the Robot arm during power up.

**General purpose digital I/O** This section describes the general purpose 24V I/O (Gray terminals) and the configurable I/O (Yellow terminals with black text) when not configured as safety I/O.

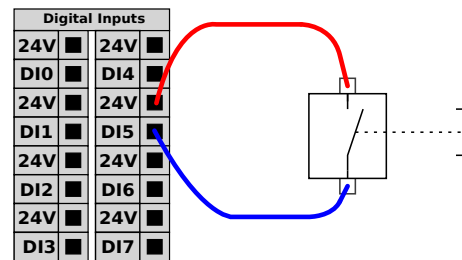
The general purpose I/O can be used to drive equipment like pneumatic relays directly or for communication with other PLC systems. All Digital Outputs can be disabled automatically when program execution is stopped.

In this mode, the output is always low when a program is not running. Examples are shown in the following subsections.

These examples use regular Digital Outputs but any configurable outputs could also have been used if they are not configured to perform a safety function.

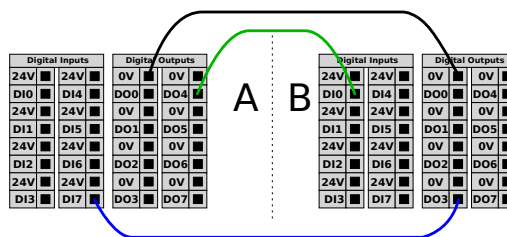


In this example a load is controlled from a Digital Outputs when connected.



In this example a simple button is connected to a Digital Input.

**Communication with other machines or PLCs** You can use the digital I/O to communicate with other equipment if a common GND (0V) is established and if the machine uses PNP technology, see below.





## 8.10.1. Digital Output

---

**Digital Output** The tool communication interface allows two digital outputs to be independently configured. In PolyScope, each pin has a drop-down menu that allows the output mode to be set. The following options are available:

- **Sinking:** This allows the pin to be configured in an NPN or Sinking configuration. When the output is off, the pin allows a current to flow to the ground. This can be used in conjunction with the PWR pin to create a full circuit.
- **Sourcing:** This allows the pin to be configured in a PNP or Sourcing configuration. When the output is on, the pin provides a positive voltage source (configurable in the IO Tab). This can be used in conjunction with the GND pin to create a full circuit.
- **Push / Pull:** This allows the pin to be configured in a Push / Pull configuration. When the output is on, the pin provides a positive voltage source (configurable in IO Tab). This can be used in conjunction with the GND pin to create a full circuit. When the output is off, the pin allows a current to flow to the ground.

After selecting a new output configuration, the changes take effect. The currently loaded installation is modified to reflect the new configuration. After verifying the tool outputs are working as intended, make sure to save the installation to prevent losing changes.

---

**Dual Pin Power** Dual Pin Power is used as a source of power for the tool. Enabling Dual Pin Power disables default tool digital outputs.

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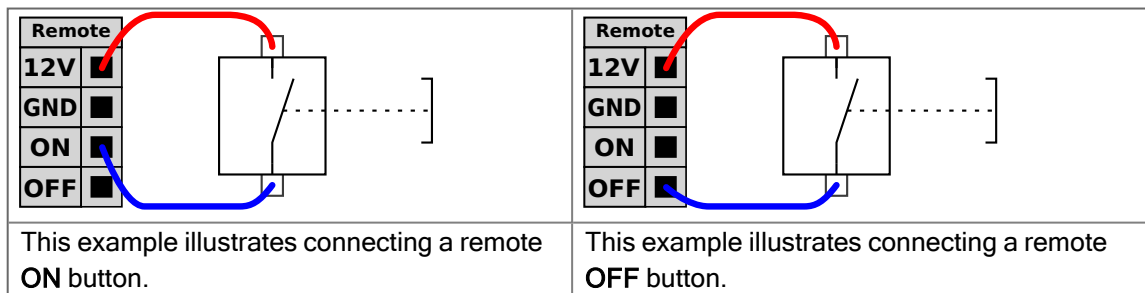
## 8.11. Remote ON/OFF control

**Description** Use remote **ON/OFF** control to turn the Control Box on and off without using the Teach Pendant. It is typically used:

- When the Teach Pendant is inaccessible.
- When a PLC system must have full control.
- When several robots must be turned on or off at the same time.

**Remote Control** The remote **ON/OFF** control provides a auxiliary 12V supply, kept active when the Control Box is turned off. The **ON** input is intended only for short time activation and works in the same way as the **POWER** button. The **OFF** input can be held down as desired. Use a software feature to load and start programs automatically. The electrical specifications are shown below.

Terminals	Parameter	Min	Typ	Max	Unit
[12V - GND]	Voltage	10	12	13	V
[12V - GND]	Current	-	-	100	mA
[ON / OFF]	Inactive voltage	0	-	0.5	V
[ON / OFF]	Active voltage	5	-	12	V
[ON / OFF]	Input current	-	1	-	mA
[ON]	Activation time	200	-	600	ms



### CAUTION

Maintaining a press and hold on the power button switches the Control Box OFF without saving.

- Do not press and hold the **ON** input or the **POWER** button without saving.
- Use the **OFF** input for remote off control to allow the Control Box to save open files and shut down correctly.



## 8.12. End Effector Integration

**Description** The end effector can also be referred to as the tool and the workpiece in this manual.



### NOTICE

UR provides documentation for the end effector to be integrated with the robot arm.

- Refer to the documentation specific to the end effector/tool/workpiece for mounting and connection.

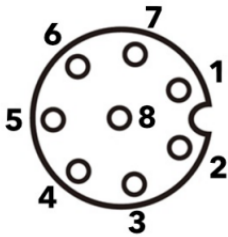


## 8.12.1. Tool I/O

### Tool Connector

The tool connector illustrated below provides power and control signals for the grippers and sensors used on a specific robot tool. The tool connector has eight holes and is located next to the tool flange on Wrist 3.

The eight wires inside the connector have different functions, as listed in the table:

	Pin #	Signal	Description
	1	AI3 / RS485-	Analog in 3 or RS485-
	2	AI2 / RS485+	Analog in 2 or RS485+
	3	TO0/PWR	Digital Outputs 0 or 0V/12V/24V
	4	TO1/GND	Digital Outputs 1 or Ground
	5	POWER	0V/12V/24V
	6	TI0	Digital Inputs 0
	7	TI1	Digital Inputs 1
	8	GND	Ground

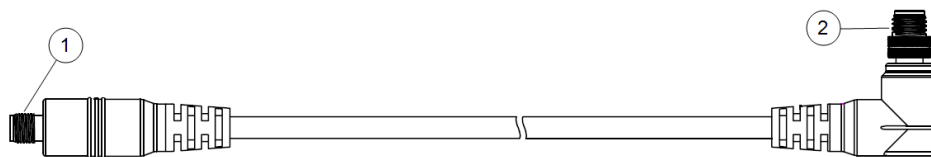


#### NOTICE

The Tool Connector must be manually tightened up to a maximum of 0.4 Nm.



**Tool Cable Adapter** The Tool Cable Adapter is the electronic accessory that allows compatibility between the tool I/O and e-Series tools.



- 1 Connects to the tool/end effector.
- 2 Connects to the robot.

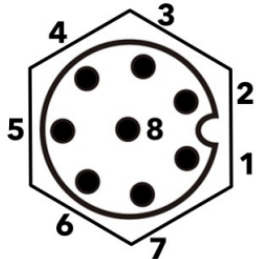


### WARNING

Connecting the Tool Cable Adapter to a robot that is powered on can lead to injury.

- Connect the adapter to the tool/end effector before connecting the adapter to the robot.
- Do not power on the robot if the Tool Cable Adapter is not connected to the tool/end effector.

The eight wires inside the Tool Cable Adapter have different functions, as listed in the table below:

	Pin #	Signal	Description
	1	AI2 / RS485+	Analog in 2 or RS485+
	2	AI3 / RS485-	Analog in 3 or RS485-
	3	TI1	Digital Inputs 1
	4	TI0	Digital Inputs 0
	5	POWER	0V/12V/24V
	6	TO1/GND	Digital Outputs 1 or Ground
	7	TO0/PWR	Digital Outputs 0 or 0V/12V/24V
	8	GND	Ground



### GROUND

The tool flange is connected to GND (Ground).



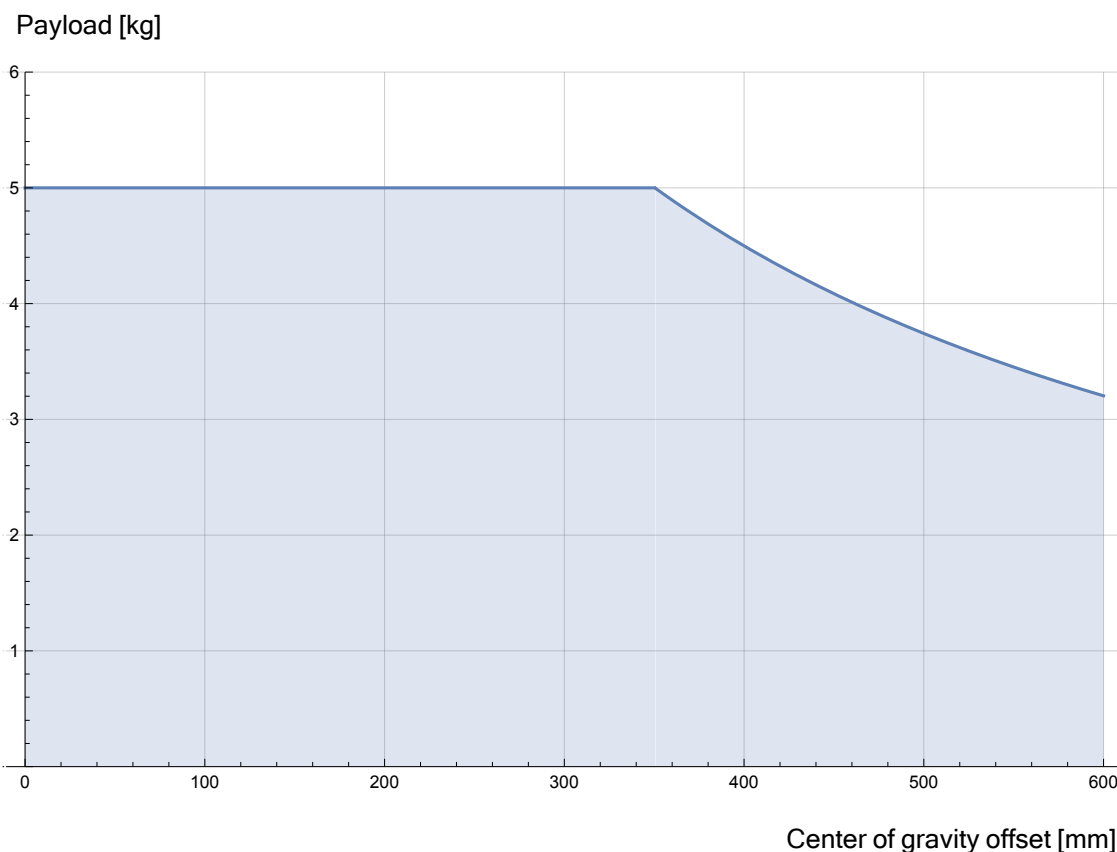
## 8.12.2. Maximum Payload

### Description

The rated robot arm payload depends on the center of gravity (CoG) offset of the payload, as shown below. The CoG offset is defined as the distance from the center of the tool flange to the center of gravity of the attached payload.

The robot arm can accommodate a long center of gravity offset, if the payload is placed below the tool flange. For example when computing the payload mass in a pick and place application, consider both the gripper and the workpiece.

The robot's capacity to accelerate can be reduced if the payload CoG exceeds the robot's reach and payload. You can verify the reach and payload of your robot in the Technical Specifications.



*The relationship between the rated payload and the center of gravity offset.*



**Payload  
inertia**

You can configure high inertia payloads, if the payload is set correctly.

The controller software automatically adjusts accelerations when the following parameters are correctly configured:

- Payload mass
- Center of gravity
- Inertia

You can use the URSim to evaluate the accelerations and cycle times of the robot motions with a specific payload.

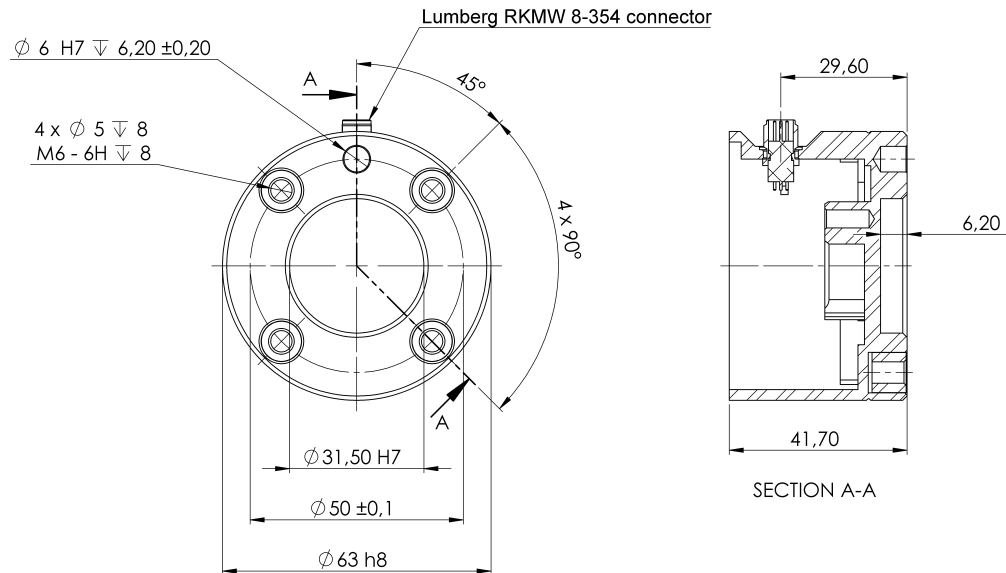
---



### 8.12.3. Securing Tool

#### Description

The tool or workpiece is mounted to the tool output flange (ISO) at the tip of the robot.



Dimensions and hole pattern of the tool flange. All measurements are in millimeters.

#### Tool flange

The tool output flange (ISO 9409-1) is where the tool is mounted at the tip of the robot. It is recommended to use a radially slotted hole for the positioning pin to avoid over-constraining, while keeping precise position.



#### CAUTION

Very long M6 bolts can press against the bottom of the tool flange and short circuit the robot.

- Do not use bolts that extend beyond 8 mm to mount the tool.



#### WARNING

Failure to tighten bolts properly cause injury due to loss of the adapter flange and/or end effector.

- Ensure the tool is properly and securely bolted in place.
- Ensure the tool is constructed such that it cannot create a hazardous situation by dropping a part unexpectedly.



## 8.12.4. Set Payload

### Safely Setting the Active Payload

---

#### Verify Installation

Before using PolyScope X, verify that the Robot Arm and Control Box are correctly installed.

1. On the Teach Pendant, press the emergency stop button.
  2. On the screen, tap **OK** when the Robot Emergency Stop box appears.
  3. On the Teach Pendant, press the power button and allow the system to start and load PolyScope X.
  4. Tap the on-screen **Power** button at the bottom left of the screen.
  5. Hold and twist the emergency stop button to unlock.
  6. On the screen, verify the **Robot State** is **Off**.
  7. Step outside the reach (workspace) of the robot arm.
  8. Tap the on-screen **Power** button
  9. In the Initialize popup, tap **Power On** and allow robot arm state change to **Locked**.
  10. In the Active Payload, verify the payload mass.  
You can also verify the mounting position is correct, in the 3D view.
  11. Tap **UNLOCK** for the robot arm to release its brake system.
-





## 8.12.5. Tool I/O Installation Specifications

### Description

The electrical specifications are shown below. Access Tool I/O in the Installation Tab to set the internal power supply to 0V, 12V or 24V.

Parameter	Min	Typ	Max	Unit
Supply voltage in 24V mode	23.5	24	24.8	V
Supply voltage in 12V mode	11.5	12	12.5	V
Supply current (single pin)*	-	1000	2000**	mA
Supply current (dual pin)*	-	1500	2000**	mA
Supply capacitive load	-	-	8000***	uF

\* It is highly recommended to use a protective diode for inductive loads.

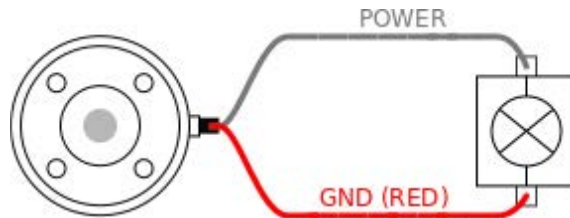
\*\* Peak for max 1 second, duty cycle max: 10%. Average current over 10 seconds must not exceed typical current.

\*\*\* When tool power is enabled, a 400 ms soft start time begins allowing a capacitive load of 8000 uF to be connected to the tool power supply at start-up. Hot-plugging the capacitive load is not allowed.



## 8.12.6. Tool Power Supply

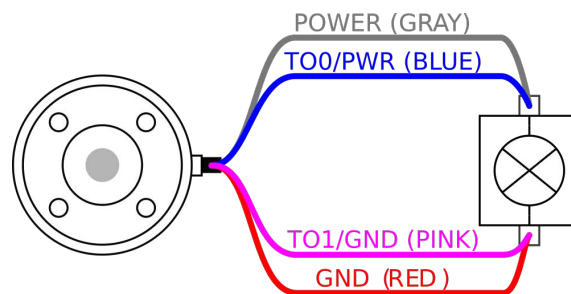
**Description** Access Tool I/O in the Installation Tab



### Dual Pin Power Supply

In Dual Pin Power mode, the output current can be increased as listed in Tool I/O.

1. In the Header, tap **Installation**.
2. In the list on the left, tap **General**.
3. Tap **Tool IO** and select **Dual Pin Power**.
4. Connect the wires Power (gray) to TO0 (blue) and Ground (red) to TO1 (pink).



#### NOTICE

Once the robot makes an Emergency Stop, the voltage is set to 0V for both Power Pins (power is off).



## 8.12.7. Tool Digital Outputs

**Description** Digital Outputs support three different modes:

Mode	Active	Inactive
Sinking (NPN)	Low	Open
Sourcing (PNP)	High	Open
Push / Pull	High	Low

Access Tool I/O in the Installation Tab to configure the output mode of each pin. The electrical specifications are shown below:

Parameter	Min	Typ	Max	Unit
Voltage when open	-0.5	-	26	V
Voltage when sinking 1A	-	0.08	0.09	V
Current when sourcing/sinking	0	600	1000	mA
Current through GND	0	1000	3000*	mA



### NOTICE

Once the robot makes an Emergency Stop, the Digital Outputs (DO0 and DO1) are deactivated (High Z).

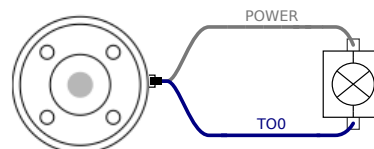


### CAUTION

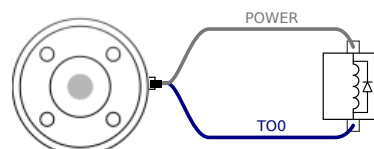
The Digital Outputs in the tool are not current-limited. Overriding the specified data can cause permanent damage.

### Using Tool Digital Outputs

This example illustrates turning on a load using the internal 12V or 24V power supply. The output voltage at the I/O tab must be define. There is voltage between the POWER connection and the shield/ground, even when the load is turned off.



It is recommended to use a protective diode for inductive loads, as shown below.





## 8.12.8. Tool Digital Inputs

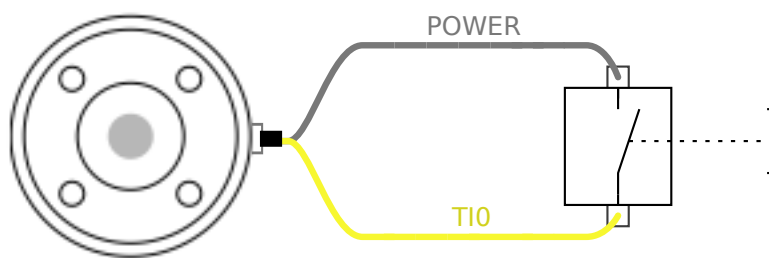
**Description** The Startup screen contains settings for automatically loading and starting a default program, and for auto-initializing the Robot arm during power up.

**Table** The Digital Inputs are implemented as PNP with weak pull-down resistors. This means that a floating input always reads as low. The electrical specifications are shown below.

Parameter	Min	Type	Max	Unit
Input voltage	-0.5	-	26	V
Logical low voltage	-	-	2.0	V
Logical high voltage	5.5	-	-	V
Input resistance	-	47k	-	$\Omega$

**Using the Tool Digital Inputs**

This example illustrates connecting a simple button.



## 8.12.9. Tool Analogue Inputs

**Description** Tool Analogue Input are non-differential and can be set to either voltage (0-10V) or current (4-20mA) on the I/O tab. The electrical specifications are shown below.

Parameter	Min	Type	Max	Unit
Input voltage in voltage mode	-0.5	-	26	V
Input resistance @ range 0V to 10V	-	10.7	-	k $\Omega$
Resolution	-	12	-	bit
Input voltage in current mode	-0.5	-	5.0	V
Input current in current mode	-2.5	-	25	mA
Input resistance @ range 4mA to 20mA	-	182	188	$\Omega$
Resolution	-	12	-	bit

Two examples of using Analog Input are shown in the following subsections.



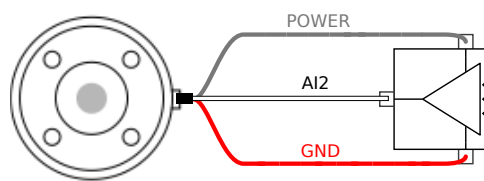
**Caution****CAUTION**

Analog Inputs are not protected against over voltage in current mode. Exceeding the limit in the electrical specification can cause permanent damage to the input.

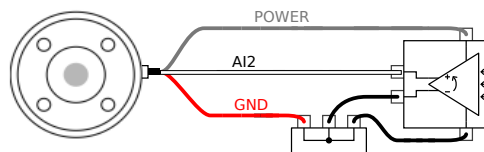
**Using Tool  
Analog Inputs,  
Non-  
differential**

This example shows an analog sensor connection with a non-differential output. The sensor output can be either current or voltage, as long as the input mode of that Analog Input is set to the same on the I/O tab.

Note: You can check that a sensor with voltage output can drive the internal resistance of the tool, or the measurement might be invalid.


**Using Tool  
Analog Inputs,  
differential**

This example shows an analog sensor connection with a differential output. Connecting the negative output part to GND (0V), works in the same way as a non-differential sensor.



## 8.12.10. Tool Communication I/O

**Description**

- **Signal requests** The RS485 signals use internal fail-safe biasing. If the attached device does not support this fail-safe, signal biasing must either be done in the attached tool, or added externally by adding pull-up resistors to RS485+ and pull-down to RS485-.
- **Latency** The latency of messages sent via the tool connector ranges from 2ms to 4ms, from the time the message is written on the PC to the start of the message on the RS485. A buffer stores data sent to the tool connector until the line goes idle. Once 1000 bytes of data have been received, the message is written on the device.

Baud Rates	9.6k, 19.2k, 38.4k, 57.6k, 115.2k, 1M, 2M, 5M
Stop Bits	1, 2
Parity	None, Odd, Even



## 9. First Time Use

---

<b>Description</b>	This section describes how you get started using the robot. Among other things, it covers easy start-up, an overview of the PolyScope user interface and how to set up your first program. Additionally, it covers freedrive mode and basic operation.
--------------------	--

---

### 9.1. Settings

---

<b>Description</b>	The settings in PolyScope X can be access via the hamburger menu in the top left corner. You can access the following sections:
--------------------	---

- General
- Password
- Connection
- Security

---

<b>General Settings</b>	In the general settings, you can change the preferred language, units of measurements, etc. You also update the software from the general settings.
-------------------------	---

<b>Password Settings</b>	In the password settings, you can find the default passwords, and how to change them to the preferred and secure passwords.
--------------------------	---

<b>Connection Settings</b>	In the connection settings, you can set network settings such as IP address, DNS server, etc. Settings related to UR Connect is also found here.
----------------------------	--

<b>Security Settings</b>	The security settings related to SSH, admin password permissions and enabling/disabling of various services in the software.
--------------------------	--

---

#### 9.1.1. Password

---

<b>Description</b>	In the password settings in PolyScope X, you can find three different types of password. <ul style="list-style-type: none"> <li>• Operational Mode</li> <li>• Safety</li> <li>• Admin</li> </ul>
--------------------	--

It is possible to set the same password in all three instances, but it is also possible to set three different password to separate access and options.

---



## Password - Admin

---

### Description

All options under Security are protected by an Admin password. The Admin password protected screens are locked by a transparent overlay rendering the settings unavailable. Accessing the Security allows you to configure the settings in the following:

- Secure Shell
- Permissions
- Services

The settings can only be modified by designated administrator/s.

Unlocking any one of the options under Security, also unlocks the other options until you exit the Settings menu.

---

### Default Password

The default password for the admin password is: easybot



#### NOTICE

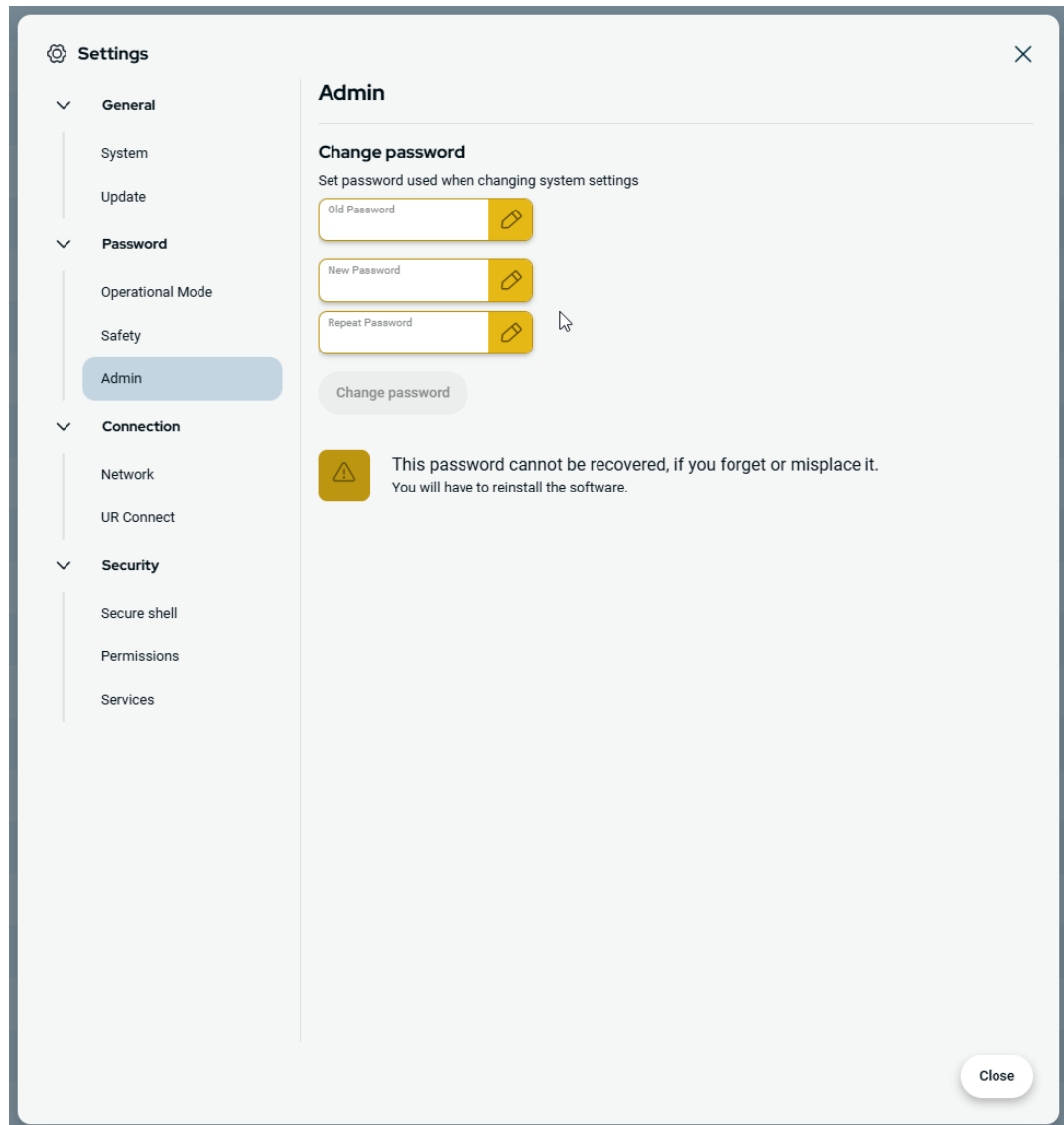
If you forget your admin password, it cannot be replaced or recovered. You will have to reinstall the software.



### To set the Admin password

Before you can use the Admin password to unlock protected screens, you have to change the default password.

1. Access the Hamburger menu and select **Settings**
2. Under Password, tap **Admin**.
3. Change the current Admin password to a new one.
  - If this is the first time, change the default Admin password from "easybot" to a new password. The new password must be at least 8 characters long.
4. Use the new password to unlock the Settings menu and access the options under Security.



### To exit the Settings menu

When one of the Security options is unlocked, the Close button in the bottom right of the Settings menu changes. The Close button is replaced by the Lock and Close button indicating security is unlocked.

1. On the Settings menu locate and tap the **Lock and Close** button.



## Password - Operational Mode

---

### Default Password

The default password for operational mode: operator



#### NOTICE

If you forget your password, it cannot be replaced or recovered.  
You will have to reinstall the software.

You must use the default password, when you change the password for the first time.

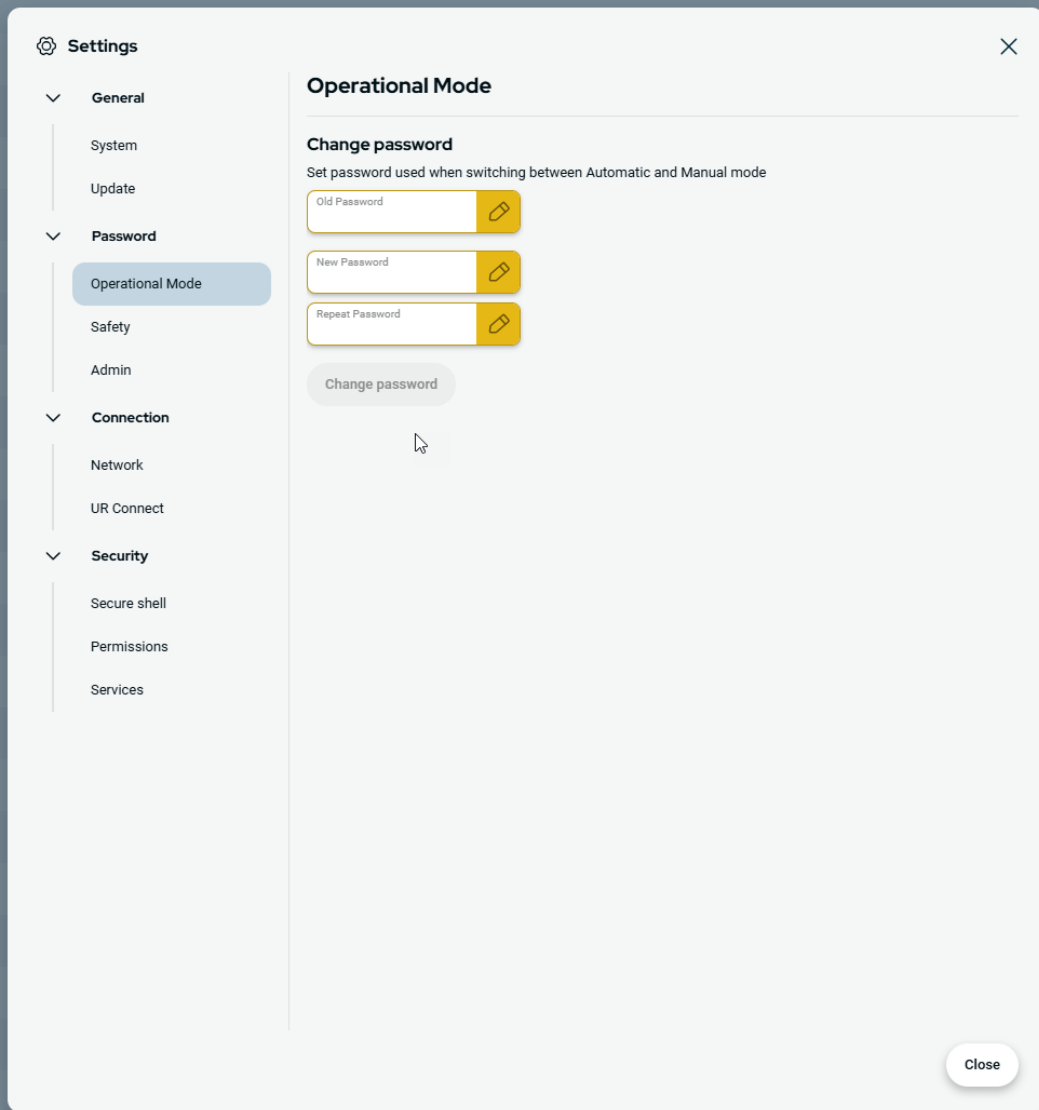
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## Change Operational Mode Password

This is how you change the password for operational mode in the PolyScope X settings.

1. Click the hamburger menu in the top left corner.
2. Click Settings.
3. Click Operational Mode in the Password section.
4. Add the default password, if it is the first time.
5. Add your preferred password, at least 8 characters.



The screenshot shows the 'Settings' window with a sidebar on the left and a main content area on the right. The sidebar has sections: 'General' (System, Update), 'Password' (Operational Mode, Safety, Admin), 'Connection' (Network, UR Connect), and 'Security' (Secure shell, Permissions, Services). The 'Operational Mode' option under 'Password' is selected. The main content area is titled 'Operational Mode' and contains a 'Change password' section. Below the title, it says 'Set password used when switching between Automatic and Manual mode'. There are three input fields: 'Old Password', 'New Password', and 'Repeat Password', each with a yellow password icon to its right. Below these fields is a 'Change password' button. A mouse cursor is pointing at the button. A 'Close' button is in the bottom right corner of the window.



## Password - Safety

---

### Default Password

The default password for safety: ursafe



#### NOTICE

If you forget your password, it cannot be replaced or recovered.  
You will have to reinstall the software.

You have to use the default password, when you change the password for the first time.

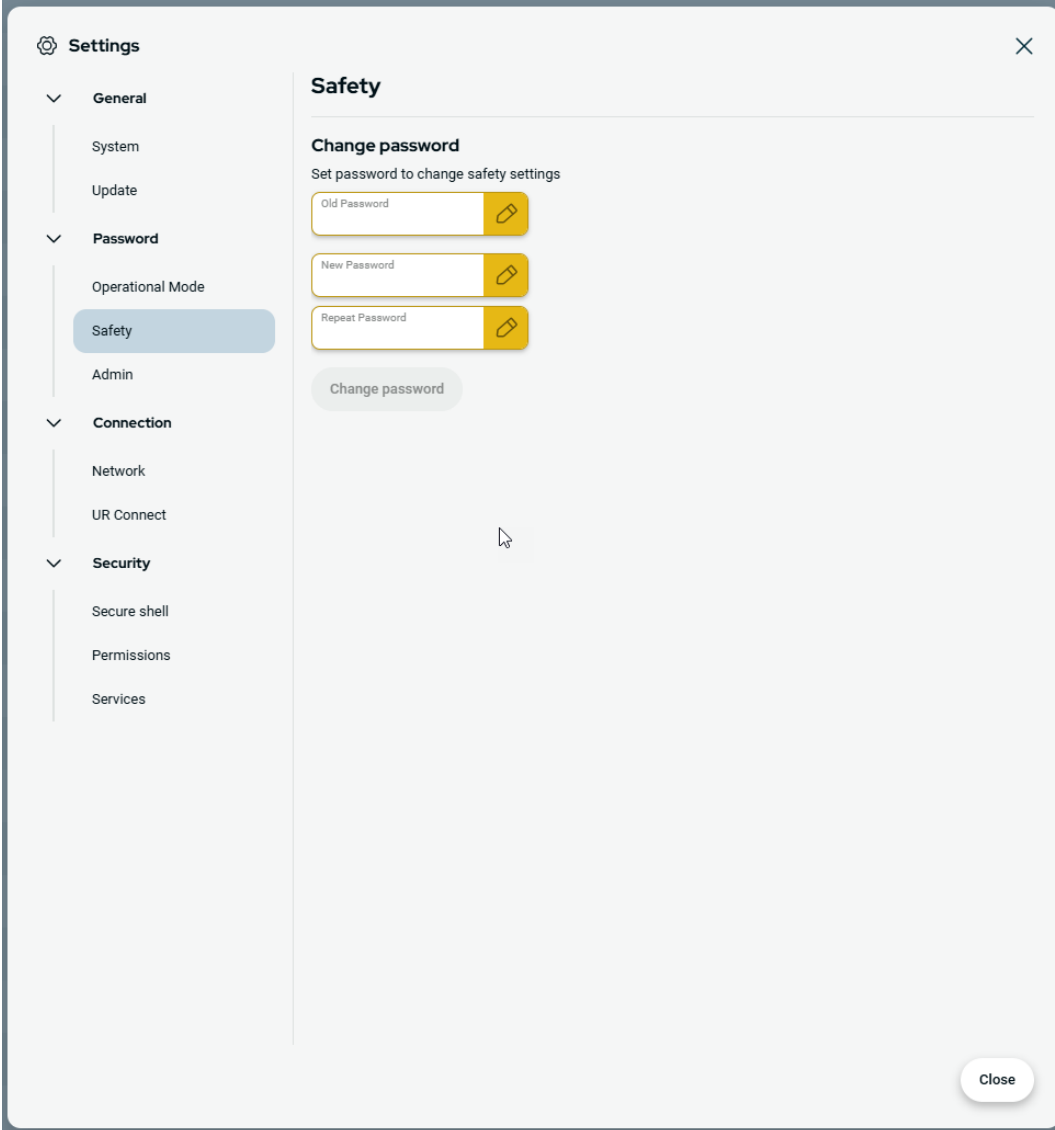
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## Change Safety Password

This is how you change the safety password in the PolyScope X settings.

1. Click the hamburger menu in the top left corner.
2. Click Settings.
3. Click Safety in the Password section.
4. Add the default password, if it is the first time.
5. Add your preferred password, at least 8 characters.



The screenshot shows the 'Settings' window with a sidebar on the left and a main content area on the right. The sidebar has a 'Settings' header with a gear icon and a close button (X) in the top right corner. The sidebar menu includes: General (System, Update), Password (Operational Mode, Safety, Admin), Connection (Network, UR Connect), and Security (Secure shell, Permissions, Services). The 'Safety' option under the 'Password' section is highlighted. The main content area is titled 'Safety' and contains a 'Change password' section. This section has the instruction 'Set password to change safety settings' and three password input fields: 'Old Password', 'New Password', and 'Repeat Password'. Each field has a yellow eye icon to toggle visibility. Below the fields is a 'Change password' button. A 'Close' button is located in the bottom right corner of the window.



## 9.1.2. Secure Shell (SSH) Access

<b>Description</b>	You can manage remote access to the robot using Secure shell (SSH). The Secure shell security settings screen allows administrators to enable or disable SSH access to the robot.
<b>To enable/disable SSH</b>	<ol style="list-style-type: none"> <li>1. Access the Hamburger menu and select <b>Settings</b>.</li> <li>2. Under Security, tap <b>Secure shell</b>.</li> <li>3. Slide the <b>Enable SSH Access</b> to the on position.</li> </ol> <p>To the far right of the Enable SSH Access toggle button, the screen shows the port used for SSH communication.</p>
<b>SSH Authentication</b>	<p>Authentication can occur with a password and/or with a pre-shared, authorized key. Security keys can be added by tapping the <b>Add Key</b> button and selecting a security key file. Available keys are listed together. Use the trash icon to remove a selected key from the list.</p>

## 9.1.3. Permissions

<b>Description</b>	Access to the Networking, URCap Management and Updating PolyScope X screens is restricted by default, to prevent unauthorized changes to the system. You can change the permission settings to allow access to these screens. An Admin password is required to access Permissions.
<b>To access Permissions</b>	<ol style="list-style-type: none"> <li>1. Access the Hamburger menu and select <b>Settings</b>.</li> <li>2. Navigate to Security and tap <b>Permissions</b>.</li> </ol>
<b>Additional system permissions</b>	<p>You can also lock a few important screens/functionalities with the Admin password. On the Permissions screen in Security section in the Settings menu, it is possible to specify which additional screens are to be protected by the Admin password and which screens are available to all users. The following screens/functionalities can optionally be locked:</p> <ul style="list-style-type: none"> <li>• Network settings</li> <li>• Update settings</li> <li>• URCaps section in the System Manager</li> </ul>



**To  
enable/disable  
system  
permissions**

1. Access Permission as previously described. The protected screens are listed under Permissions.
2. For the desired screen, slide the On/Off toggle switch to the On position to enable it.
3. To disable the desired screen, slide the On/Off toggle switch to the Off position.

The screen locks again once the toggle is in the Off position.

## 9.1.4. Services

**Description**

Services allow administrators to enable or disable remote access to the standard UR services running on the robot, such as Primary/Secondary Client interfaces, PROFINET, Ethernet/IP, ROS2, etc.

Use the Service screen to restrict remote access to the robot by only allowing external access to the services on the robot which the specific robot application is actually using. All services are disabled by default to provide maximum security. The communication ports for each service are to right of the On/Off toggle button in the list of services.

**Enabling  
ROS2**

When the ROS2 service is enabled on this screen, you can specify the ROS Domain ID (values 0-9). After changing the Domain ID, the system restarts to apply the change.

## 9.2. Safety Related Functions and Interfaces

Universal Robots robots are equipped with a range of built-in safety functions as well as safety I/O, digital and analog control signals to or from the electrical interface, to connect to other machines and additional protective devices. Each safety function and I/O is constructed according to EN ISO13849-1 with Performance Level d (PLd) using a category 3 architecture.


**WARNING**

The use of safety configuration parameters different from those determined as necessary for risk reduction, can result in hazards that are not reasonably eliminated, or risks that are not sufficiently reduced.

- Ensure tools and grippers are connected correctly to avoid hazards due to interruption of power.


**WARNING: ELECTRICITY**

Programmer and/or wiring errors can cause the voltage to change from 12V to 24V leading to fire damage to equipment.

- Verify the use of 12V and proceed with caution.



**NOTICE**

- The use and configuration of safety functions and interfaces must follow the risk assessment procedures for each robot application.
- The stopping time should be taken into account as part of the application risk assessment
- If the robot detects a fault or violation in the safety system (e.g. if one of the wires in the Emergency Stop circuit is cut or a safety limit is exceeded), then a Stop Category 0 is initiated.

**NOTICE**

The end effector is not protected by the UR safety system. The functioning of the end effector and/or connection cable is not monitored

### 9.2.1. Configurable Safety Functions

Universal Robots robot safety functions, as listed in the table below, are in the robot but are meant to control the robot system i.e. the robot with its attached tool/end effector. The robot safety functions are used to reduce robot system risks determined by the risk assessment. Positions and speeds are relative to the base of the robot.

Safety Function	Description
Joint Position Limit	Sets upper and lower limits for the allowed joint positions.
Joint Speed Limit	Sets an upper limit for joint speed.
Safety Planes	Defines planes, in space, that limit robot position. Safety planes limit either the tool/end effector alone or both the tool/end effector and the elbow.
Tool Orientation	Defines allowable orientation limits for the tool.
Speed Limit	Limits maximum robot speed. The speed is limited at the elbow, at the tool/end effector flange, and at the center of the user-defined tool/end effector positions.
Force Limit	Limits maximum force exerted by the robot tool/end effector and elbow in clamping situations. The force is limited at the tool/end effector, elbow flange and center of the user-defined tool/end effector positions.
Momentum Limit	Limits maximum momentum of the robot.
Power Limit	Limits mechanical work performed by the robot.
Stopping Time Limit	Limits maximum time the robot uses for stopping after a protective stop is initiated.
Stopping Distance Limit	Limits maximum distance travelled by the robot after a protective stop is initiated.



## 9.2.2. Safety Function

When performing the application risk assessment, it is necessary to take into account the motion of the robot after a stop has been initiated. In order to ease this process, the safety functions *Stopping Time Limit* and *Stopping Distance Limit* can be used.

These safety functions dynamically reduces the speed of the robot motion such that it can always be stopped within the limits. The joint position limits, the safety planes and the tool/end effector orientation limits take the expected stopping distance travel into account i.e. the robot motion will slow down before the limit is reached.

## 9.3. Safety Configuration



### NOTICE

Safety Settings are password protected.

1. In the PolyScope X left header, tap the Application icon.
2. On the Workcell screen tap the Safety icon.
3. Observe that the Robot Limits screen displays, but settings are inaccessible.
4. Enter the safety password and tap UNLOCK to make settings accessible. Note: Once Safety settings are unlocked, all settings are now active.
5. Tap LOCK or navigate away from the Safety menu to lock all Safety item settings again.

## 9.4. Setting a Safety Password

1. In your PolyScope X header left corner, tap the Hamburger menu and then tap Settings.
2. On the left of the screen, in the blue menu, tap Safety Password.
3. For Old Password, type the current Safety password.
4. For New Password, type a password.
5. For Repeat Password, type the same password and tap Change Password.
6. In the top right of the menu, press CLOSE to return to previous screen.

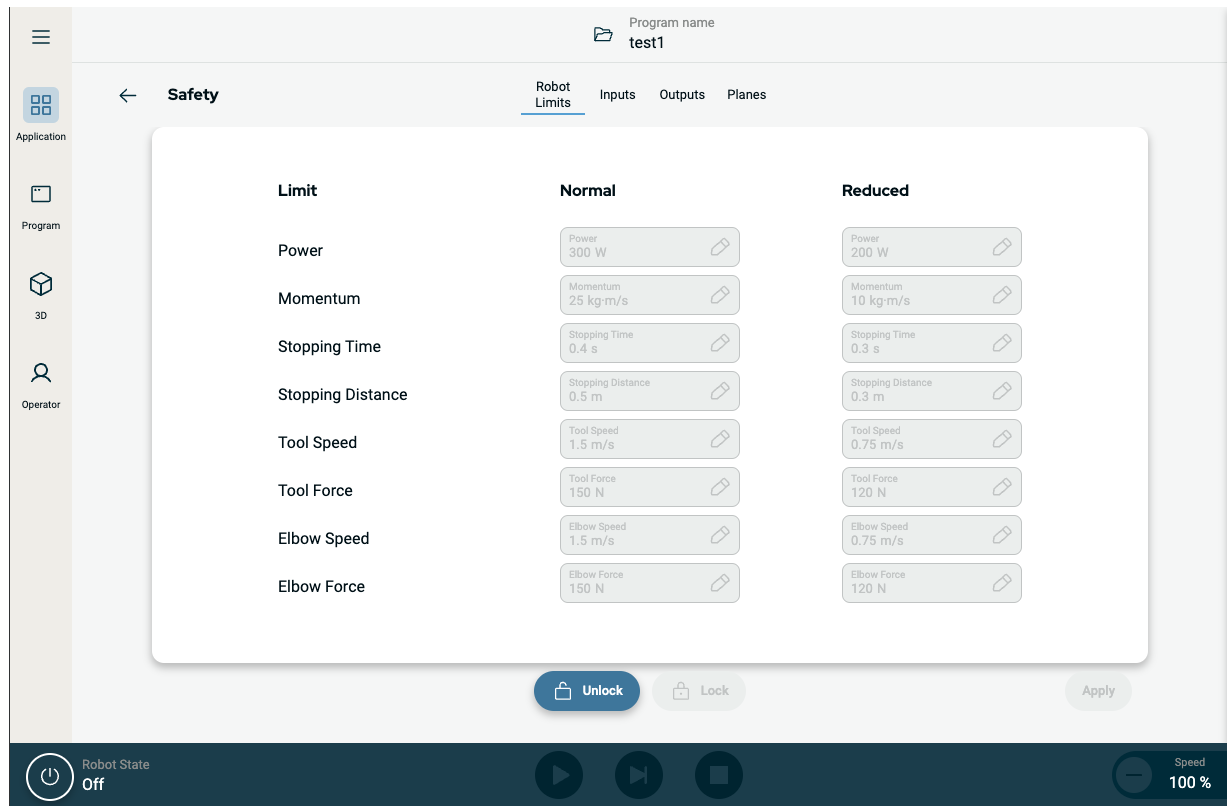
## 9.5. Software Safety Limits

The safety system limits are defined in the Safety Configuration. The safety system receives values from the input fields and detects any violation if any the values are exceeded. The robot controller prevents violations by making a robot stop or by reducing the speed.



## 9.5.1. Robot Limits

### Limits



Program name: test1

Limit	Normal	Reduced
Power	Power 300 W	Power 200 W
Momentum	Momentum 25 kg·m/s	Momentum 10 kg·m/s
Stopping Time	Stopping Time 0.4 s	Stopping Time 0.3 s
Stopping Distance	Stopping Distance 0.5 m	Stopping Distance 0.3 m
Tool Speed	Tool Speed 1.5 m/s	Tool Speed 0.75 m/s
Tool Force	Tool Force 150 N	Tool Force 120 N
Elbow Speed	Elbow Speed 1.5 m/s	Elbow Speed 0.75 m/s
Elbow Force	Elbow Force 150 N	Elbow Force 120 N

Robot State: Off

Speed: 100%

Limit	Description
Power	limits maximum mechanical work produced by the robot in the environment. This limit considers the payload a part of the robot and not of the environment.
Momentum	limits maximum robot momentum.
Stopping Time	limits maximum time it takes the robot to stop e.g. when an emergency stop is activated
Stopping Distance	limits maximum distance the robot tool or elbow can travel while stopping.
Tool Speed	limits maximum robot tool speed.
Tool Force	limits the maximum force exerted by the robot tool in clamping situations
Elbow Speed	limits maximum robot elbow speed
Elbow Force	limits maximum force that the elbow exerts on the environment



**Safety  
Mode****NOTICE**

Restricting stopping time and distance affect overall robot speed. For example, if stopping time is set to 300 ms, the maximum robot speed is limited allowing the robot to stop within 300 ms.

**NOTICE**

The tool speed and force are limited at the tool flange and the center of the two user-defined tool positions

Under normal conditions, i.e. when no Robot stop is in effect, the safety system operates in a Safety Mode associated with a set of safety limits <sup>1</sup>:

Safety mode	Effect
<b>Normal</b>	This configuration is active by default.
<b>Reduced</b>	This configuration activates when the Tool Center Point (TCP) is positioned beyond a Trigger Reduced mode plane, or when triggered using a configurable input.

<sup>1</sup>Robot stop was previously known as "Protective stop" for Universal Robots.



## 9.5.2. Safety Planes

### Description

Safety planes restrict robot workspace, the tool and the elbow.



#### WARNING

Defining safety planes only limits the defined Tool spheres and elbow, not the overall limit for the robot arm.  
Defining safety planes does not guarantee that other parts of the robot arm will obey this type of restriction.

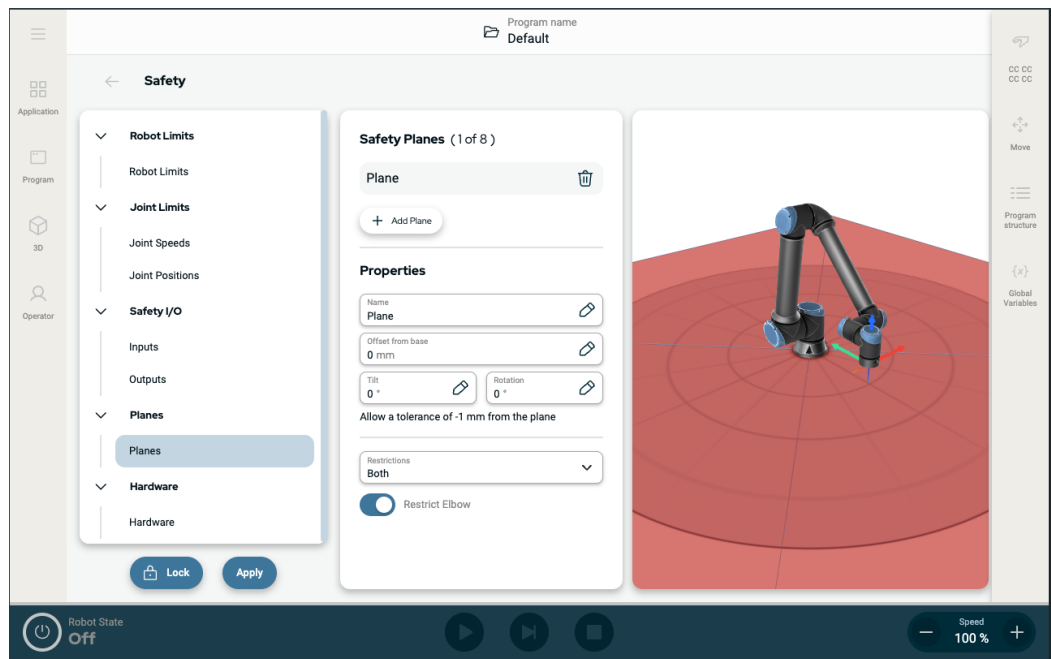


Figure 1.4: PolyScope X screen displaying safety planes.



### Configuring a Safety Plane

You can configure safety planes with the properties listed below:

- **Name** This is the name used to identify the safety plane.
- **Offset from base** This is the height of the plane from the base, measured in the -Y direction.
- **Tilt** This is the tilt of the plane, measured from the power cord.
- **Rotation** This is the rotation of the plane, measured clockwise.

You can configure each plane with the restrictions listed below:

- **Normal** When the safety system is in Normal mode, a normal plane is active and it acts as a strict limit on the position.
- **Reduced** When the safety system is in Reduced mode, a reduced mode plane is active and it acts as a strict limit on the position.
- **Both** When the safety system is either in Normal or Reduced mode, a normal and reduced mode plane is active and acts as a strict limit on the position.
- **Trigger Reduced Mode** The safety plane causes the safety system to switch to Reduced mode if the robot Tool or Elbow is positioned beyond it.

---

### Elbow Joint Restriction

You can prevent the robot elbow joint from passing through any of your defined planes.

Disable Restrict Elbow for elbow to pass through planes.

---



# 10. Cybersecurity Threat Assessment

## Description

This section provides information to help you strengthen the robot against potential cybersecurity threats. It outlines requirements for addressing cybersecurity threats and provides security hardening guidelines.

## 10.1. General Cybersecurity

### Description

Connecting a Universal Robots robot to a network can introduce cybersecurity risks. These risks can be mitigated by using qualified personnel and implementing specific measures for protecting the robot's cybersecurity.

Implementing cybersecurity measures requires conducting a cybersecurity threat assessment.

The purpose is to:

- Identify threats
- Define trust zones and conduits
- Specify the requirements of each component in the application



#### WARNING

Failure to conduct a cybersecurity risk assessment can place the robot at risk.

- The integrator or competent, qualified personnel shall conduct a cybersecurity risk assessment.



#### NOTICE

Only competent, qualified personnel shall be responsible for determining the need for specific cybersecurity measures and for providing the required cybersecurity measures.

## 10.2. Cybersecurity Requirements

### Description

Configuring your network and securing your robot requires you to implement the threat measures for cybersecurity.

Follow all the requirements before you start configure your network, then verify the robot setup is secure.



**Cybersecurity**

- Operating personnel must have a thorough understanding of general cybersecurity principles and advanced technologies as used in the UR robot.
- Physical security measures must be implemented to allow only authorized personnel physical access to the robot.
- There must be adequate control of all access points. For example: locks on doors, badge systems, physical access control in general.

**WARNING**

Connecting the robot to a network that is not properly secured, can introduce security and safety risks.

- Only connect your robot to a trusted and properly secured network.

**Network  
configuration  
requirements**

- Only trusted devices are to be connected to the local network.
- There must be no inbound connections from adjacent networks to the robot.
- Outgoing connections from the robot are to be restricted to allow the smallest relevant set of specific ports, protocols and addresses.
- Only URCaps and magic scripts from trusted partners can be used, and only after verifying their authenticity and integrity

**Robot setup  
security  
requirements**

- Change the default password to a new, strong password.
- Disable the "Magic Files" when not actively used (PolyScope 5).
- Disable SSH access when not needed. Prefer key-based authentication over password-based authentication
- Set the robot firewall to the most restrictive usable settings and disable all unused interfaces and services, close ports and restrict IP addresses
-



## 10.3. Cybersecurity Hardening Guidelines

### Description

Although PolyScope includes many features for keeping the network connection secure, you can harden security by observing the following guidelines:

- Before connecting your robot to any network, always change the default password to a strong password.



#### NOTICE

You cannot retrieve or reset a forgotten or lost password.

- Store all passwords securely.

- Use the built-in settings to restrict the network access to the robot as much as possible.
- Some communication interfaces have no method of authenticating and encrypting communication. This is a security risk. Consider appropriate mitigating measures, based on your cybersecurity threat assessment.
- SSH tunneling (Local port forwarding) must be used to access robot interfaces from other devices if the connection crosses the trust zone boundary.
- Remove sensitive data from the robot before it is decommissioned. Pay particular attention to the URCaps and data in the program folder.
  - To ensure secure removal of highly sensitive data, securely wipe or destroy the SD card.



# 11. Communication Networks

---

## Fieldbus

You can use the Fieldbus options to define and configure the family of industrial computer network protocols used for real-time distributed control accepted by PolyScope:

- Ethernet/IP
  - PROFINET
-



## 11.1. Ethernet/IP

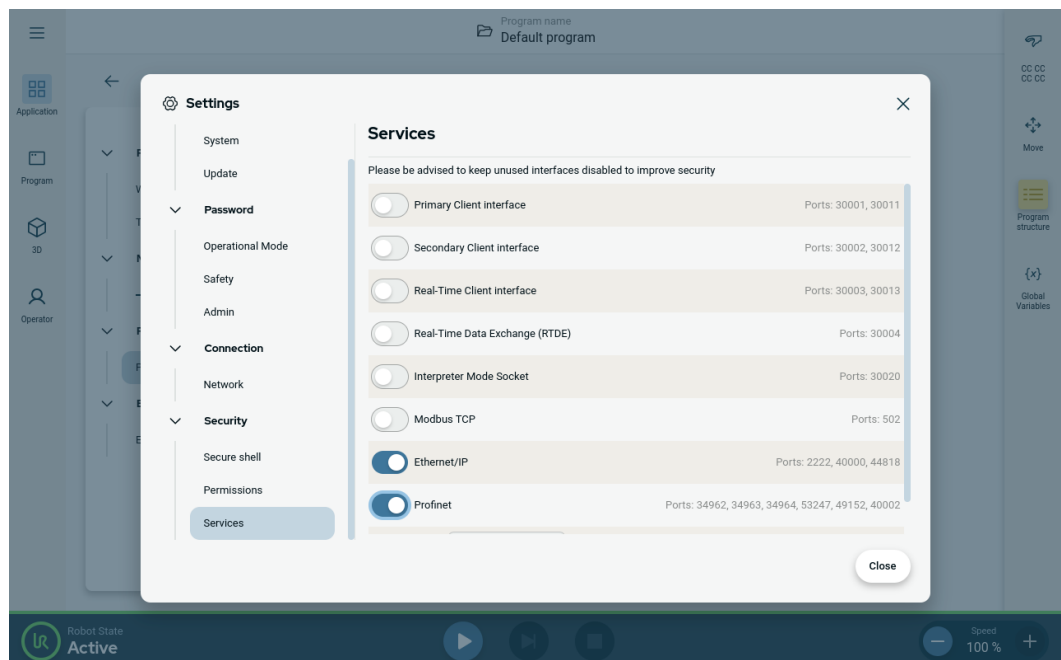
### Description

EtherNet/IP is a network protocol that enables the connection of the robot to an industrial EtherNet/IP scanner device. If the connection is enabled, you can select the action that occurs when a program loses EtherNet/IP scanner device connection.

### Enable Ethernet/IP

This is how you enable to Ethernet/IP function in PolyScope X.

1. In the top right of the screen, tap the Hamburger menu and then tap Settings.
2. In the menu on the left, under Security, tap Services.
3. Tap the Profinet button to switch Profinet on.





### Using Ethernet/IP

Find the Ethernet/IP functions in PolyScope X:

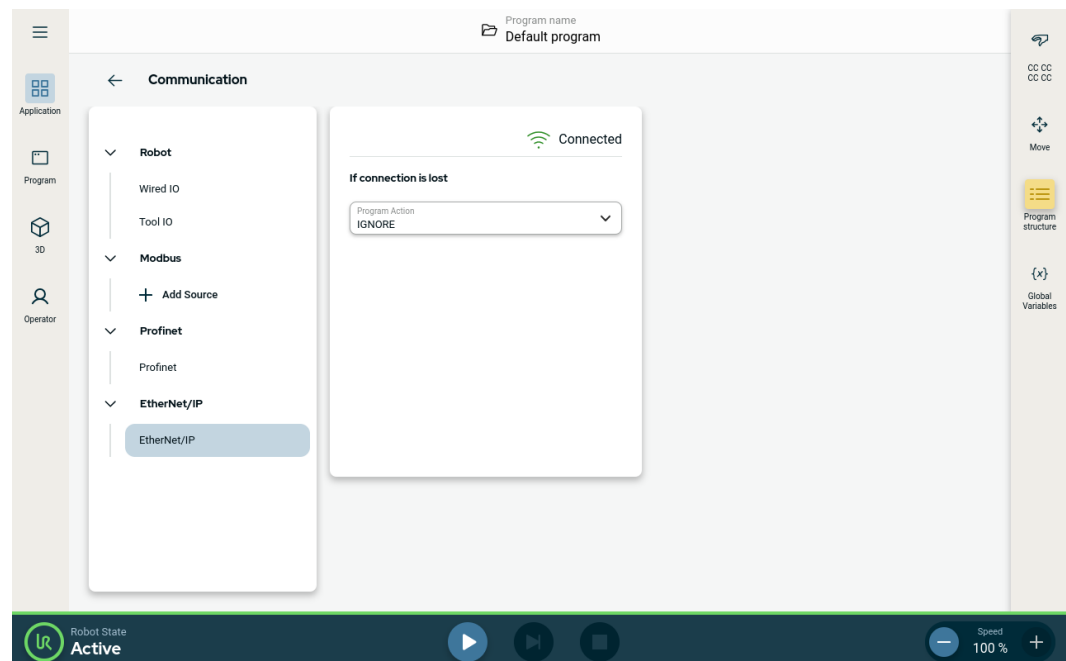
In the PolyScope X left header.

1. Tap the Application icon.
2. Select the relevant action from the list.

**Ignore** PolyScope X ignores the loss of EtherNet/IP connection, and the program continues to run.

**Pause** PolyScope X pauses the current program. The program resumes from where it stopped.

**Stop** PolyScope X stops the current program.



In the upper right corner of this screen, you can see the Ethernet/IP status.

**Connected** The robot is connected to the Ethernet/IP Scanner Device.

**No Scanner** Ethernet/IP is running, but no device is connected to the robot via Ethernet/IP.

**Disabled** Ethernet/IP is not enabled.

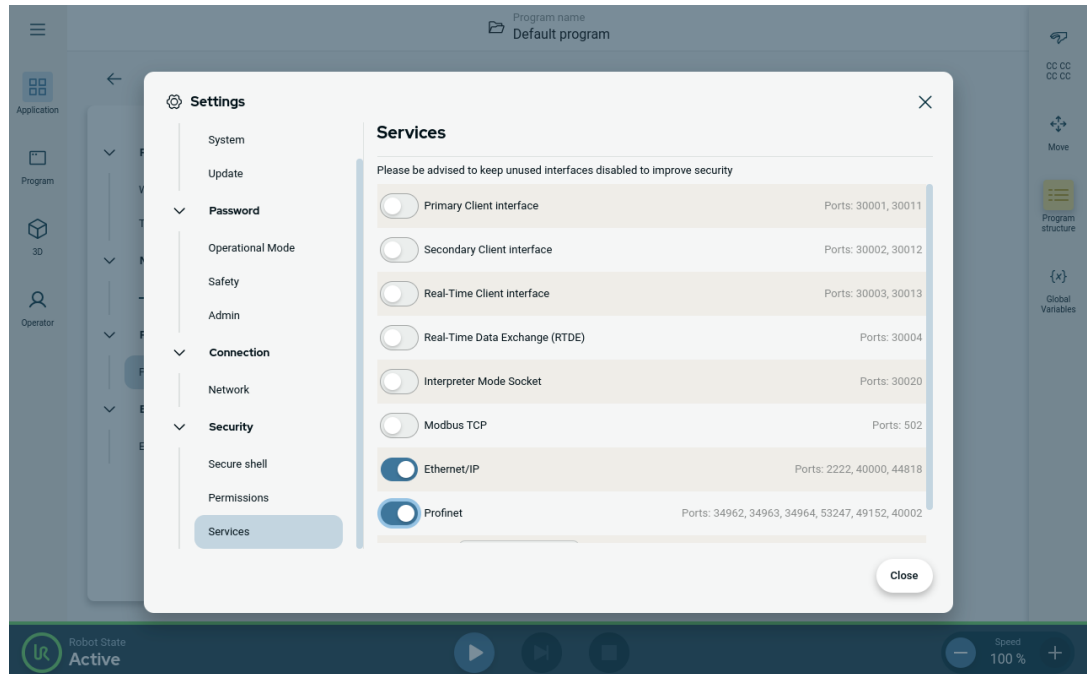
## 11.2. Profinet

### Description

The PROFINET network protocol enables or disables the connection of the robot to an industrial PROFINET IO-Controller. If the connection is enabled, you can select the action that occurs when a program loses PROFINET IO-Controller connection.



1. In the top right of the screen, tap the Hamburger menu and then tap Settings.
2. In the menu on the left, under Security, tap Services.
3. Tap the Profinet button to switch Profinet on.





## Using Profinet

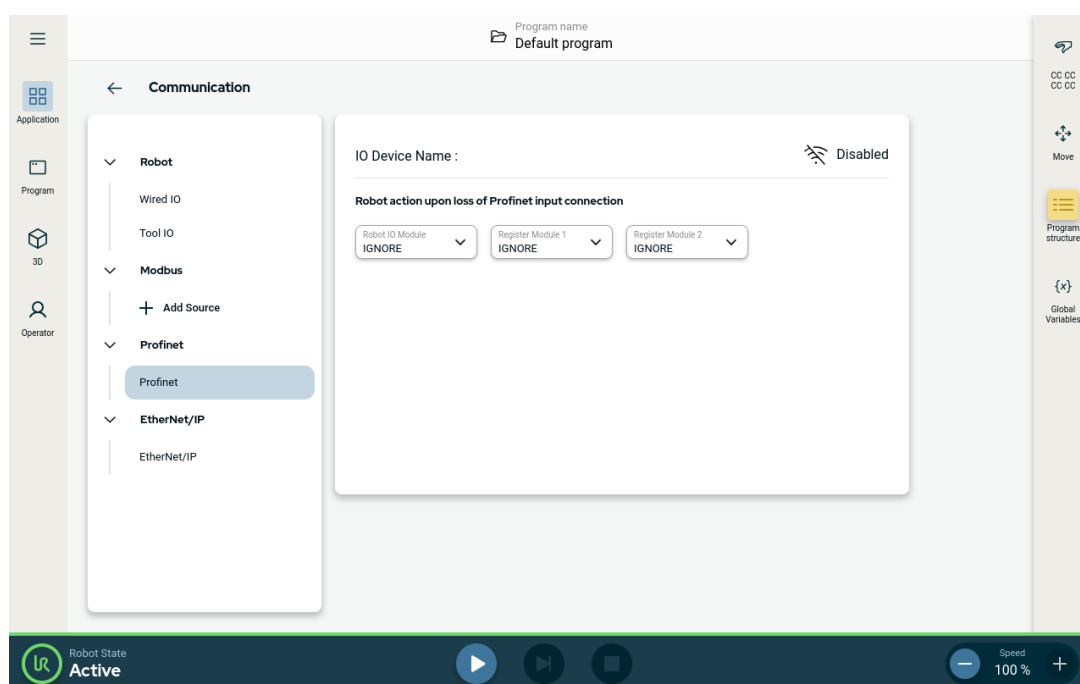
Find the profinet functions in PolyScope X:

In the PolyScope X left header.

1. Tap the Application icon.
2. Select Profinet from the left menu.

Select the relevant action from the list:

Ignore	PolyScope X ignores the loss of Profinet connection, and the program continues to run.
Pause	PolyScope X pauses the current program. The program resumes from where it stopped.
Stop	PolyScope X stops the current program.



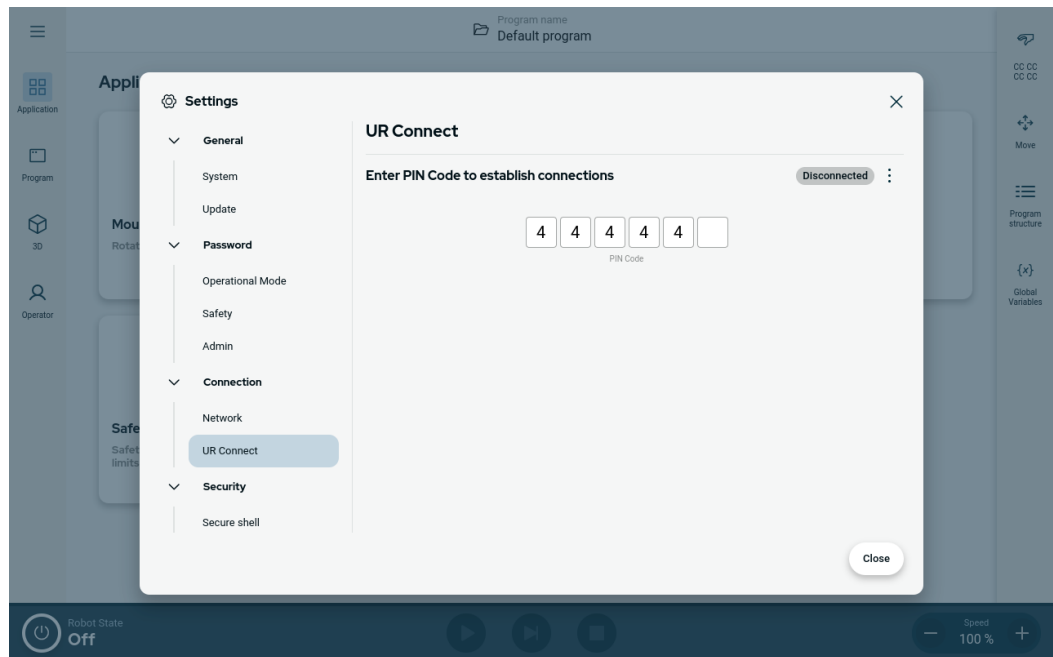


## 11.3. UR Connect

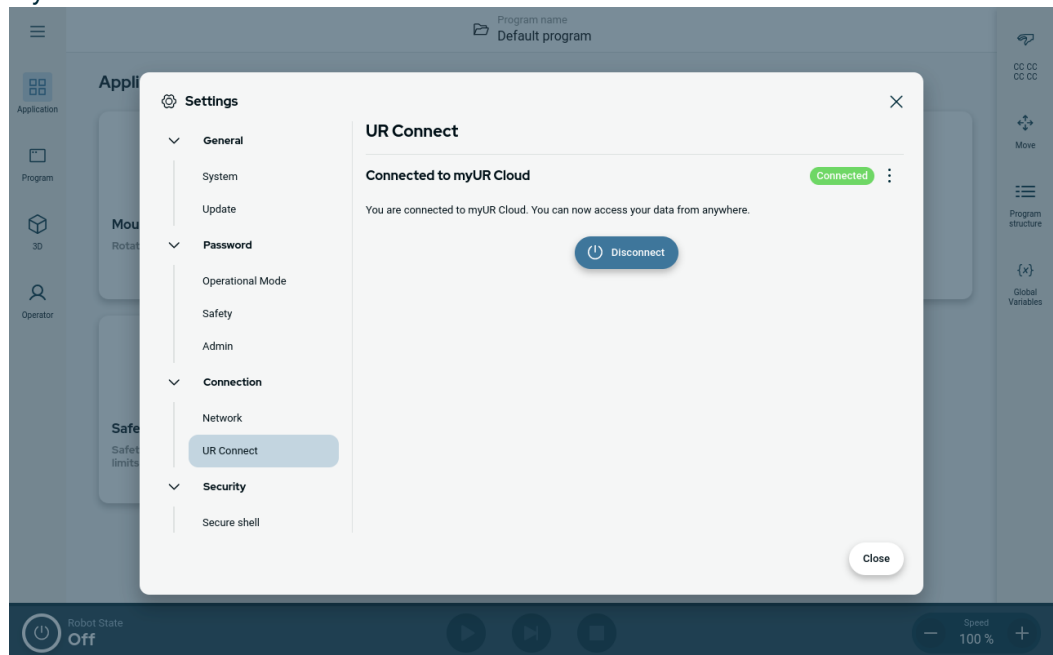
### Connect PolyScope X to myUR Cloud

You have to connect your PolyScope X software to the myUR Cloud service. You need to find you PIN code in your myUR account.

1. Go to Settings.
2. Go to UR Connect.
3. Hit the "Connect" button on the main UR Connect page.
4. Add you pin code from myUR.



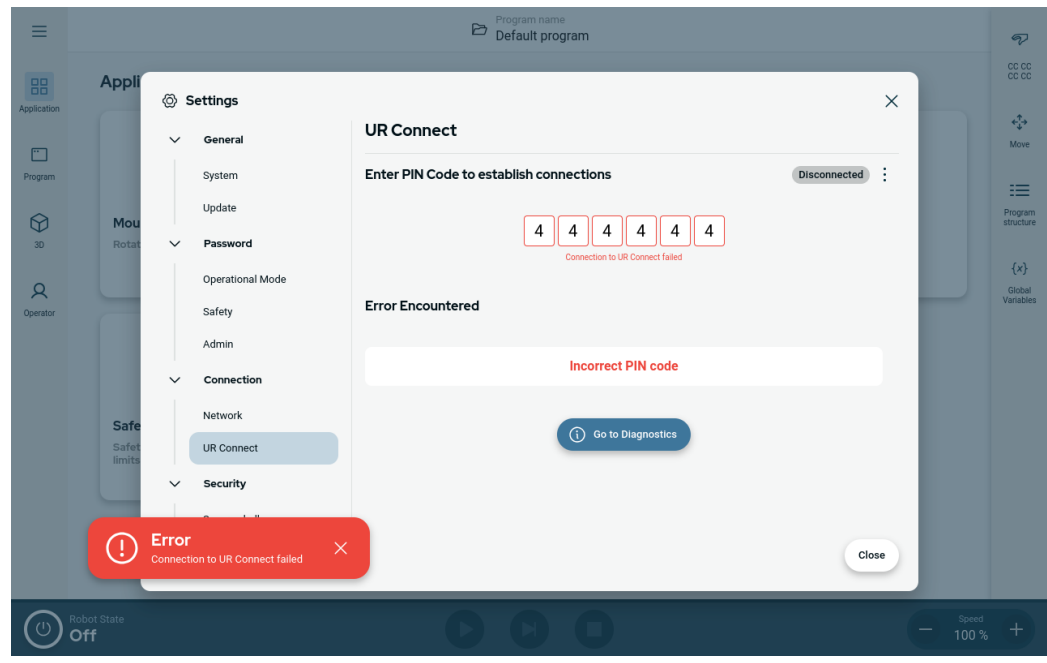
When you see the green icon in the right corner of the window, you are connected to the myUR Cloud.





**Unsuccessful  
connect**

If you see the "Incorrect PIN code", please review your PIN code from myUR.

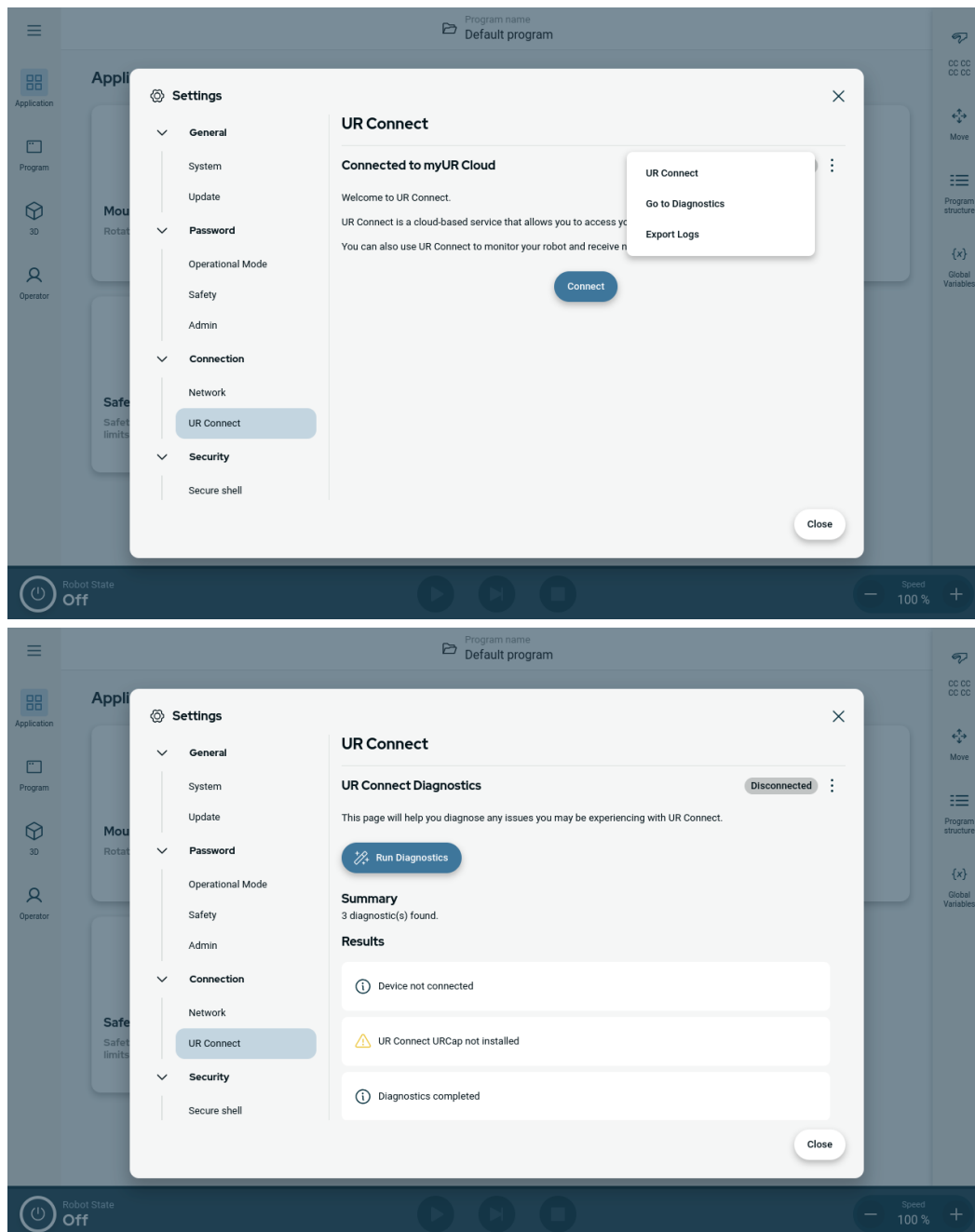




## Diagnostics

If you experience any unexpected when the UR Connect is active, you can go to the Diagnostics.

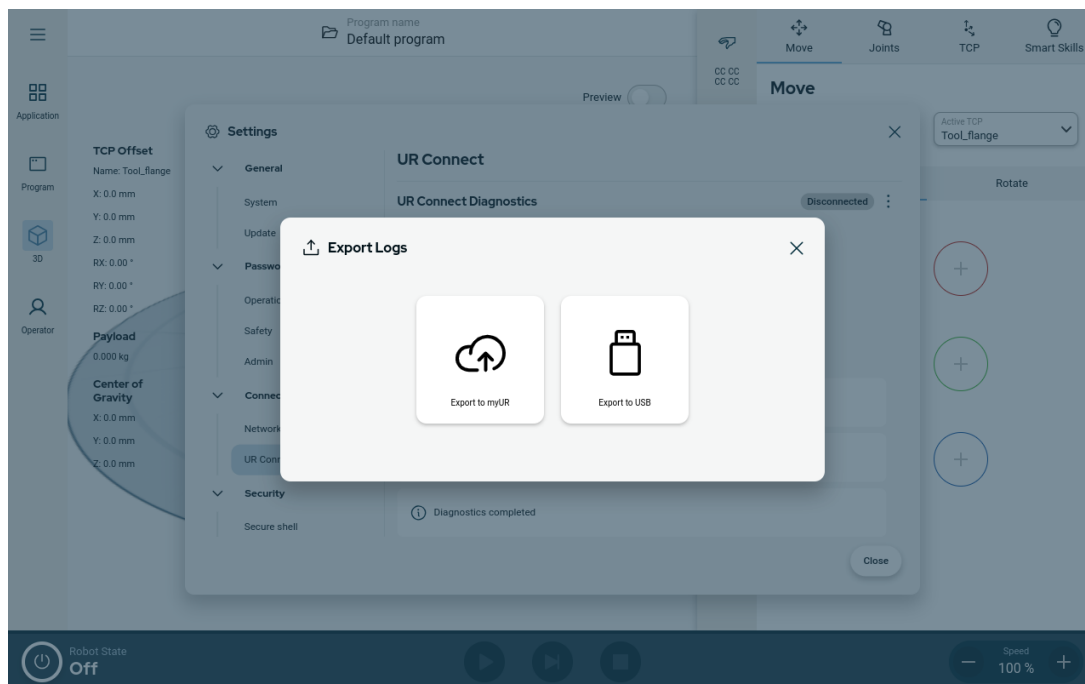
1. Go to Settings.
2. Go to UR Connect.
3. Hit the kebab menu in the top right corner.
4. Select the "Diagnostics".





**Export logs** It is possible to export the UR Connect logs from your PolyScope X software.

1. Go to Settings.
2. Go to UR Connect.
3. Hit the kebab menu in the top right corner.
4. Select the "Export Logs"
5. Select "Export to myUR" or "Export to USB".





# 12. Emergency Events

<b>Description</b>	Follow the instructions here to handle emergency situations, such as activating the emergency stop using the red push-button. This section also describes how to manually move the system without power.
--------------------	--

## 12.1. Emergency Stop

<b>Description</b>	<p>The Emergency Stop or E-stop is the red push-button located on the Teach Pendant. Press the emergency stop push-button to stop all robot motion. Activating the emergency stop push-button causes a stop category one (IEC 60204-1). Emergency stops are not safeguards (ISO 12100).</p>
--------------------	---

Emergency stops are complementary protective measures that do not prevent injury. The risk assessment of the robot application determines if additional emergency stop push-buttons are required. The emergency stop function and the actuating device must comply with ISO 13850.

After an emergency stop is actuated, the push-button latches in that setting. As such, each time an emergency stop is activated, it must be manually reset at the push-button that initiated the stop.

Before resetting the emergency stop push-button, you must visually identify and assess the reason the E-stop was first activated. Visual assessment of all the equipment in the application is required. Once the problem is solved, reset the emergency stop push-button.

### To reset the emergency stop push-button

1. Hold the push-button and twist clockwise until the latching disengages.  
You should feel when the latching is disengaged, indicating the push-button is reset.
2. Verify the situation and whether to reset the emergency stop.
3. After resetting the emergency stop, restore power to the robot and resume operation.



## 12.2. Movement Without Drive Power

### Description

In the event of an emergency, when powering the robot is either impossible or unwanted, you can use forced back-driving to move the robot arm.

Forced back-driving requires you to push, or pull, the robot arm hard to move the joint. Bigger robot arms can involve more than one person to move the joint.

Each joint brake has a friction clutch that enables movement during high forced torque. Forced back-driving requires high force and one or more people may be required to move the robot.

In clamping situations, two or more people are required to do the forced back-driving. In some situations, two or more people are required to disassemble the robot arm.

Personnel using the UR robot are to be trained to respond to emergency events. Supplemental information shall be provided, on integration.



#### WARNING

Risks due to an unsupported robot arm breaking or falling can cause injury or death.

- Do not disassemble the robot during an emergency event.
- Support the robot arm before removing power.



#### NOTICE

Moving the robot arm manually is intended for emergency and service purposes only. Unnecessary moving of the robot arm can lead to property damage.

- Do not move the joint more than 160 degrees, to ensure the robot can find its original physical position.
- Do not move any joint more than necessary.



## 12.3. Operational Mode

### Description

You access and activate different modes using Teach Pendant or the Dashboard Server. If an external mode selector is integrated, it control the modes - not PolyScope or the Dashboard Server.

**Automatic Mode** When this mode is activated the robot can only execute a program of pre-defined tasks. You cannot modify or save programs and installations.

**Manual Mode** When this mode is activated you can program the robot. You can modify and save programs and installations. The speeds used in Manual Mode must be limited to prevent injury. When the robot is operating in Manual Mode, a person could be positioned within reach of the robot. The speed must be limited to the value that is appropriate for the application risk assessment.



#### WARNING

Injury can occur if the speed used, while the robot is operating in Manual Mode, is too high.

**Recovery Mode** This mode activates when a safety limit from the active limit set is violated, the robot arm performs a Stop Category 0. If an active safety limit, such as a joint position limit or a safety boundary, is violated already when the robot arm is powered on, it starts up in Recovery mode. This makes it possible to move the robot arm back within the safety limits. In Recovery mode, the movement of the robot arm is restricted by a fixed limit that you cannot customize.

The robot performs a Safeguard Stop in Manual mode, if a Three-Position Enabling Device is configured, and either released (not pressed) or it is fully compressed.

Switching between Automatic mode to Manual mode requires the Three-Position Enabling Device to be fully released and pressed again to allow the robot to move.

### Mode switching

Operational Mode	Manual	Automatic
Speed Slider	x	x
Move robot with +/- on Move Tab	x	
Freedrive	x	
Execute Programs	Reduced speed***	x
Edit & save program	x	

\*\*\* When tool power is enabled, a 400 ms soft start time begins allowing a capacitive load of 8000 uF to be connected to the tool power supply at start-up. Hot-plugging the capacitive load is not allowed.



**WARNING**

- Any suspended safeguards must be returned to full functionality before selecting Automatic Mode.
- Wherever possible, Manual Mode shall only be used with all persons located outside the safeguarded space.
- If an external mode selector is used, it must be placed outside the safeguarded space.
- No-one is to enter, or be within, the safeguarded space in Automatic Mode, unless safeguarding is used or the collaborative application is validated for power and force limiting (PFL).

**Three-Position Enabling Device**

When a Three-Position Enabling Device is used and the robot is in Manual Mode, movement requires pressing the Three-Position Enabling Device to the center-on position. The Three-Position Enabling Device has no effect in Automatic Mode.

**NOTICE**

- Some UR robot sizes might not be equipped with a Three-Position Enabling Device. If the risk assessment requires the enabling device, a 3PE Teach Pendant must be used.

A 3PE Teach Pendant (3PE TP) is recommended for programming. If another person can be within the safeguarded space when in Manual Mode, an additional device can be integrated and configured for the additional person's use.

**Switching Modes**

To switch between modes, in the Right Header, select the profile icon to display the Mode Section.

- Automatic indicates the operational mode of the robot is set to Automatic.
- Manual indicates the operational mode of the robot is set to Manual.

PolyScope X is automatically in Manual Mode when the Safety I/O configuration with Three-Position Enabling Device is enabled.



# 13. Transportation

**Description** Only transport the robot in its original packaging. Save the packaging material in a dry place if you want to move the robot later.  
When moving the robot from its packaging to the installation space, hold both tubes of the robot arm at the same time. Hold the robot in place until all mounting bolts are securely tightened at the base of the robot.  
Lift the Control Box by its handle.



## WARNING

Incorrect lifting techniques, or using improper lifting equipment, can lead to injury.

- Avoid overloading your back or other body parts when lifting the equipment.
- Use proper lifting equipment.
- All regional and national lifting guidelines shall be followed.
- Make sure to mount the robot according to the instructions in Mechanical Interface.



## NOTICE

If the robot is transported as an assembled application with any external equipment, the following applies:

- Transporting the robot without its original packaging will void all warranties from Universal Robots A/S.
- If the robot is transported attached to a 3rd-party application / installation, follow the recommendations for transporting the robot without the original transport packaging.

**Disclaimer** Universal Robots cannot be held responsible for any damage caused by transportation of the equipment.  
See the recommendations for transportation without packaging at: [universal-robots.com/manuals](https://universal-robots.com/manuals)



**Description**

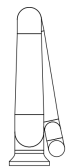
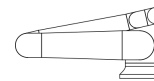
Universal Robots always recommends transporting the robot in its original packaging. These recommendations are written to reduce unwanted vibrations in joints and brake systems and reduce joint rotation.

If the robot is transported without its original packaging, then please refer to the following guidelines:

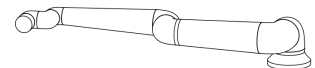
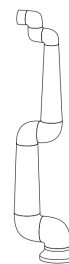
- Fold the robot as much as possible - do not transport the robot in the singularity position.
- Move the center of gravity in the robot as close to the base as possible.
- Secure each tube to a solid surface on two different points on the tube.
- Secure any attached end effector rigidly in 3 axes.

**Transport**

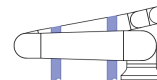
Fold the robot as much as possible.



Do not transport extended.  
(singularity position)



Secure the tubes to a solid surface.  
Secure attached end effector in 3 axes.



## 13.1. Teach Pendant Storage

**Description**

The operator needs to have a clear understanding about what the e-Stop on the Teach Pendant affects when pressed. For example there can be confusion with a multi-robot installation. It should be made clear if the e-Stop on the Teach Pendant stops the whole installation or only its connected robot.

If there could be confusion, store the Teach Pendant such that the e-Stop button is not visible or usable.



# 14. Maintenance and Repair

**Description**

Any maintenance work, inspection and calibration shall be conducted in compliance with all safety instructions in this manual, the UR Service Manual, and according to local requirements.

Repair work shall be done by Universal Robots. Client designated, trained individuals can do repair work, provided they follow the Service Manual.

**Safety for Maintenance**

The purpose of maintenance and repair is to ensure the system is kept functioning as expected.

When working on the robot arm or control box, you must observe the procedures and warnings below.



## WARNING

Failure to adhere to any of the safety practices, listed below, can result in injury.

- Unplug the main power cable from the bottom of the Control Box to ensure that it is completely unpowered. Power off any other source of energy connected to the robot arm or Control Box. Take necessary precautions to prevent other persons from powering on the system during the repair period.
- Check the earth connection before re-powering the system.
- Observe ESD regulations when parts of the robot arm or Control Box are disassembled.
- Prevent water and dust from entering the robot arm or Control Box.



**Safety for Maintenance****WARNING**

Failure to leave space to accommodate the Control Box with the door fully open can lead to injury.

- Provide at least 915 mm of space to enable the Control Box door to open fully, providing access for servicing.

**WARNING: ELECTRICITY**

Disassembling the Control Box power supply too quickly after switching off, can result in injury due to electrical hazards.

- Avoid disassembling the power supply inside the Control Box, as high voltages (up to 600 V) can be present inside these power supplies for several hours after the Control Box has been switched off.

After troubleshooting, maintenance, and repair work, ensure that safety requirements are fulfilled. Adhere to national or regional work safety regulations. The correct functioning of all safety function settings shall also be tested and validated.

## 14.1. Testing Stopping Performance

**Description**

Test periodically to determine if stopping performance is degraded. Increased stopping times can require safeguarding to be modified, possibly with changes to the installation. If stop time and/or stop distance safety functions are used and are the basis of the risk reduction strategy, no monitoring or testing of stopping performance is required. The robot does continuous monitoring.

## 14.2. Robot Arm Cleaning and Inspection

**Description**

As part of regular maintenance the robot arm can be cleaned, in accordance with the recommendations in this manual and local requirements.



**Cleaning Methods**

To address the dust, dirt, or oil on the robot arm and/or Teach Pendant, simply use a cloth alongside one of the cleaning agents provided below.

**Surface Preparation:** Before applying the below solutions, surfaces may need to be prepared by removing any loose dirt or debris.

**Cleaning agents:**

- Water
- 70% Isopropyl alcohol
- 10% Ethanol alcohol
- 10% Naphtha (Use to remove grease.)

**Application:** The solution is typically applied to the surface that needs cleaning using a spray bottle, brush, sponge, or cloth. It can be applied directly or diluted further depending on the level of contamination and the type of surface being cleaned.

**Agitation:** For stubborn stains or heavily soiled areas, the solution may be agitated using a brush, scrubber, or other mechanical means to help loosen the contaminants.

**Dwell Time:** If necessary, the solution is allowed to dwell on the surface for a up to 5 minutes to penetrate and dissolve the contaminants effectively.

**Rinsing:** After the dwell time, the surface is typically rinsed thoroughly with water to remove the dissolved contaminants and any remaining cleaning agent residue. It's essential to ensure thorough rinsing to prevent any residue from causing damage or posing a safety hazard.

**Drying:** Finally, the cleaned surface may be left to air dry or dried using towels.

**WARNING**

DO NOT USE BLEACH in any diluted cleaning solution.



**WARNING**

Grease is an irritant and can cause an allergic reaction. Contact, inhalation or ingestion can cause illness or injury. To prevent illness or injury, adhere to the following:

- **PREPARATION:**
  - Ensure that the area is well ventilated.
  - Have no food or beverages around the robot and cleaning agents.
  - Ensure that an eye wash station is nearby.
  - Gather the required PPE (gloves, eye protection)
- **WEAR :**
  - Protective gloves: Oil resistant gloves (Nitrile) impermeable and resistant to product.
  - Eye protection is recommended to prevent accidental contact of grease with eyes.
- **DO NOT INGEST.**
- **In the event of**
  - contact with skin, wash with water and a mild cleaning agent
  - a skin reaction, get medical attention
  - contact with the eyes, use an eyewash station, get medical attention.
  - inhalation of vapors or ingestion of grease, get medical attention
- **After grease work**
  - clean contaminated work surfaces.
  - dispose responsibly of any used rags or paper used for cleaning.
- **Contact with children and animals is prohibited.**



**Robot Arm  
Inspection  
Plan**

The table below is a checklist of the type of inspections recommended by Universal Robots. Perform inspections regularly as advised in the table. Any referenced parts found to be in an unacceptable state must be rectified or replaced.

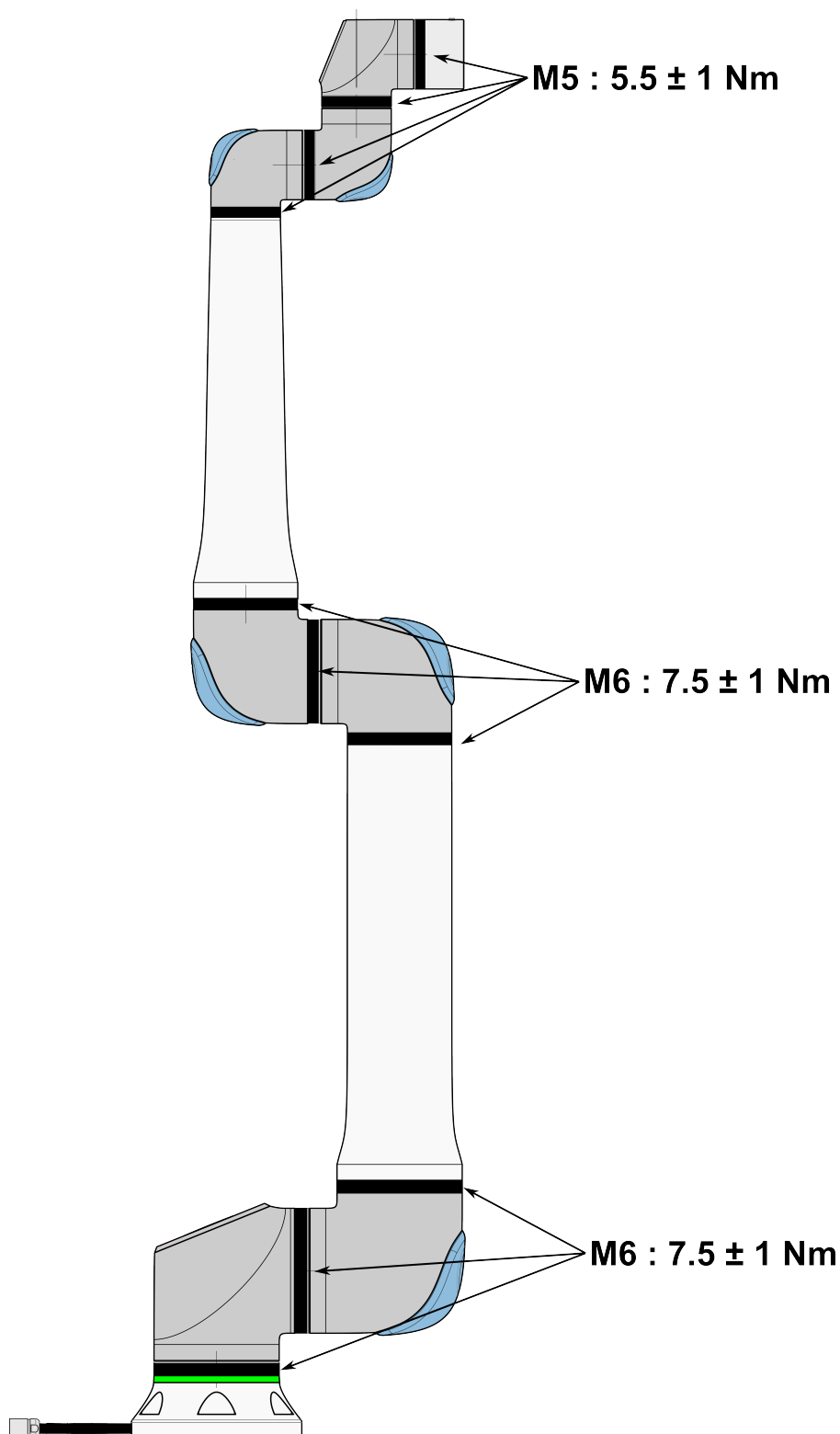
Inspection action type			Timeframe		
			Monthly	Biannually	Annually
1	Check flat rings	V		X	
2	Check robot cable	V		X	
3	Check robot cable connection	V		X	
4	Check Robot Arm mounting bolts *	F	X		
5	Check Tool mounting bolts *	F	X		
6	Round Sling	F			X



**Robot Arm  
Inspection  
Plan****NOTICE**

Using compressed air to clean the robot arm can damage the robot arm components.

- Never use compressed air to clean the robot arm.





### Robot Arm Inspection Plan

1. Move the Robot Arm to ZERO position, if possible.
2. Turn off and disconnect the power cable from Control Box.
3. Inspect the cable between Control Box and Robot Arm for any damage.
4. Check the base mounting bolts are properly tightened.
5. Check the tool flange bolts are properly tightened.
6. Inspect the flat rings for wear and damage.
  - Replace the flat rings if they are worn out or damaged.

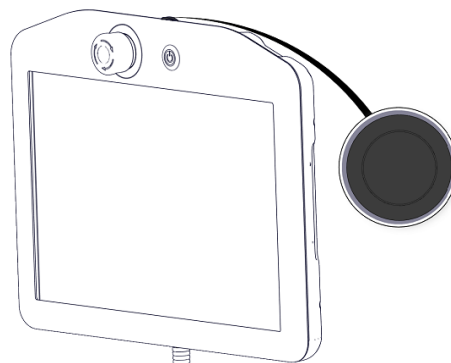


#### NOTICE

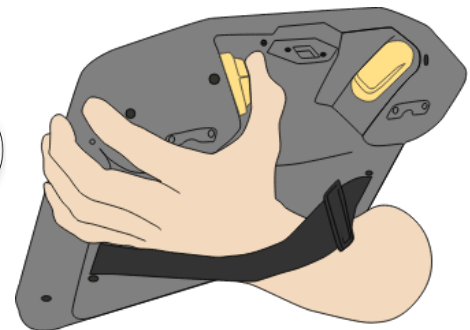
If any damage is observed on a robot within the warranty period, contact the distributor where the robot was purchased.

### Inspection

1. Unmount any tool/s or attachment/s or set the TCP/Payload/CoG according to tool specifications.
2. To move the robot arm in Freedrive:
  - On a 3PE Teach Pendant, rapidly light-press, release, light-press again and keep holding the 3PE button in this position.

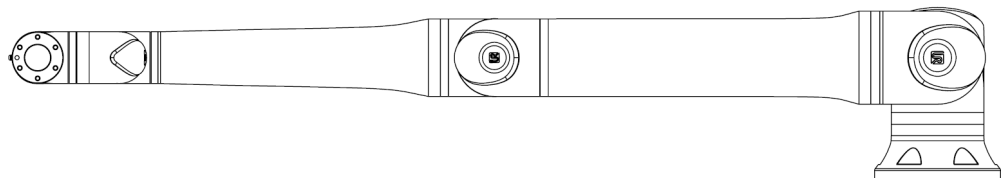


Power button



3PE button

3. Pull/Push the robot to a horizontally elongated position and release.



4. Verify the robot arm can maintain the position without support and without activating Freedrive.



## 15. Disposal and Environment

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**Description** Universal Robots robots must be disposed of in accordance with the applicable national laws, regulations and standards. this responsibility rests with the owner of the robot.

UR robots are produced in compliance with restricted use of hazardous substances to protect the environment; as defined by the European RoHS directive 2011/65/EU. If robots (robot arm, Control Box, Teach Pendant) are returned to Universal Robots Denmark, then the disposal is arranged by Universal Robots A/S.

The disposal fee for UR robots sold on the Danish market is prepaid to DPA-system by Universal Robots A/S. Importers in countries covered by the European WEEE Directive 2012/19/EU must make their own registration to the national WEEE register of their country. The fee is typically less than 1€/robot.

You can find a list of national registers here: <https://www.ewrn.org/national-registers>.  
Search for Global Compliance here: <https://www.universal-robots.com/download>.



**Substances in the UR robot****Robot arm**

- Tubes, Base Flange, Tool mounting bracket: Anodized aluminum
- Joint housings: Powder coated aluminum
- Black band sealing rings: AEM rubber
  - additional slip ring under black band: moulded black plastic
- Endcaps/ lids: PC/ASA Plastic
- Minor mechanical components e.g. screws, nuts, spacers (steel, brass, and plastic)
- Wire bundles with copper wires and minor mechanical components e.g. screws, nuts, spacers (steel, brass, and plastic)

**Robot arm joints (internal)**

- Gears: Steel and grease (detailed in the Service Manual)
- Motors: Iron core with copper wires
- Wire bundles with copper wires, PCB's, various electronic components and minor mechanical components
- Joint seals and O-rings contain a small amount of PFAS which is a compound within PTFE (commonly known as Teflon™).
- Grease: synthetic + mineral oil with a thickener of either lithium complex soap or Urea. Contains molybdenum.
  - Depending on model and date of production, the color of the grease could be yellow, magenta, dark pink, red, green.
  - The Service Manual details the handling precautions and Grease Safety Data Sheets

**Control box**

- Cabinet (enclosure): Powder coated steel
  - Standard Control Box
- Aluminum sheet metal housing (internal to the cabinet). This is also the housing of the OEM controller.
  - Standard Control Box and OEM controller.
- Wire bundles with copper wires, PCB's, various electronic components, plastic connectors, and minor mechanical components e.g. screws, nuts, spacers (steel, brass, and plastic)
- A lithium battery is mounted to a PCB. See the Service Manual for how to remove.



# 16. Risk Assessment

---

## Description

The risk assessment is a requirement that shall be performed for the application. The application risk assessment is the responsibility of the integrator. The user can also be the integrator.

The robot is partly completed machinery, as such the safety of the robot application depends on the tool/end effector, obstacles and other machines. The party performing the integration must use ISO 12100 and ISO 10218-2 to conduct the risk assessment. Technical Specification ISO/TS 15066 can provide additional guidance for collaborative applications. The risk assessment shall consider all tasks throughout the lifetime of the robot application, including but not limited to:

- Teaching the robot during set-up and development of the robot application
- Troubleshooting and maintenance
- Normal operation of the robot application

A risk assessment must be conducted **before** the robot application is powered on for the first time. The risk assessment is an iterative process. After physically installing the robot, verify the connections, then complete the integration. A part of the risk assessment is to determine the safety configuration settings, as well as the need for additional emergency stops and/or other protective measures required for the specific robot application.

---



### Safety configuration settings

Identifying the correct safety configuration settings is a particularly important part of developing robot applications. Unauthorized access to the safety configuration must be prevented by enabling and setting password protection.



#### WARNING

Failure to set password protection can result in injury or death due to purposeful or inadvertent changes to configuration settings.

- Always set password protection.
- Set up a program for managing passwords, so that access is only by persons who understand the effect of changes.

Some safety functions are purposely designed for collaborative robot applications. These are configurable through the safety configuration settings. They are used to address risks identified in the application risk assessment.

The following limit the robot and as such can affect the energy transfer to a person by the robot arm, end effector and workpiece.

- **Force and power limiting:** Used to reduce clamping forces and pressures exerted by the robot in the direction of movement in case of collisions between the robot and the operator.
- **Momentum limiting:** Used to reduce high transient energy and impact forces in case of collisions between robot and operator by reducing the speed of the robot.
- **Speed limitation:** Used to ensure the speed is less than the configured limit.

The following orientation settings are used to avoid movements and reduce exposure of sharp edges and protrusions to a person.

- **Joint, elbow and tool/end effector position limiting:** Used to reduce risks associated with certain body parts: Avoid movement towards head and neck.
- **Tool/end effector orientation limiting:** Used to reduce risks associated with certain areas and features of the tool/end effector and work-piece: Avoid sharp edges being pointed towards the operator, by turning the sharp edges inward towards the robot.

### Stopping performance risks

Some safety functions are purposely designed for any robot application. These features are configurable through the safety configuration settings. They are used to address risks associated with the stopping performance of the robot application.

The following limit the robot stopping time and stopping distance to ensure stopping will occur before reaching the configured limits. Both settings automatically affect the speed of the robot to ensure the limit is not exceeded.

- **Stopping Time Limit:** Used to limit the stopping time of the robot.
- **Stopping Distance Limit:** Used to limit the stopping distance of the robot.

If either of the above is used, there is no need for manually performed periodic stopping performance testing. The robot safety control does continuous monitoring.



If the robot is installed in a robot application where hazards cannot be reasonably eliminated or risks cannot be sufficiently reduced by use of the built-in safety-related functions (e.g. when using a hazardous tool/end effector, or hazardous process), then safeguarding is required.



### WARNING

Failure to conduct an application risk assessment can increase risks.

- Always conduct an application risk assessment for foreseeable risks and reasonably foreseeable misuse.

For collaborative applications, the risk assessment includes the foreseeable risks due to collisions and to reasonably foreseeable misuse.

The risk assessment shall address:

- Severity of harm
- Likelihood of occurrence
- Possibility to avoid the hazardous situation

### Potential hazards

Universal Robots identifies the potential significant hazards listed below for consideration by the integrator. Other significant hazards can be associated with a specific robot application.

- Penetration of skin by sharp edges and sharp points on tool/end effector or tool/end effector connector.
- Penetration of skin by sharp edges and sharp points on nearby obstacles.
- Bruising due to contact.
- Sprain or bone fracture due to impact.
- Consequences due to loose bolts that hold the robot arm or tool/end effector.
- Items falling out of, or flying from the tool/end effector, e.g. due to a poor grip or power interruption.
- Mistaken understanding of what is controlled by multiple emergency stop buttons.
- Incorrect setting of the safety configuration parameters.
- Incorrect settings due to unauthorized changes to the safety configuration parameters.



## 16.1. Pinch Hazard

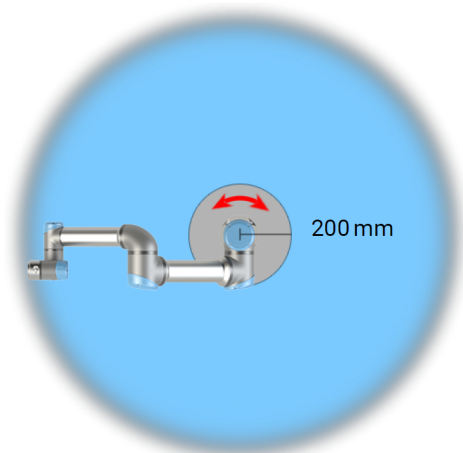
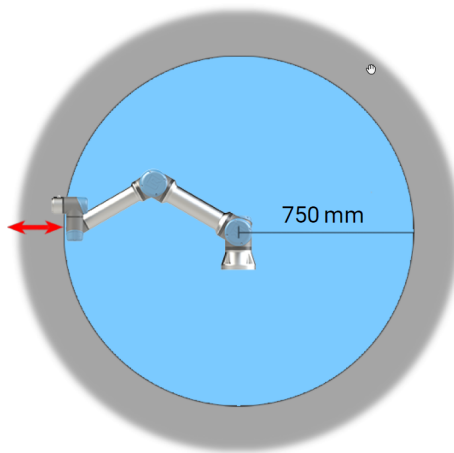
### Description

You can avoid pinching hazards by removing obstacles in these areas, by placing the robot differently, or by using a combination of safety planes and joint limits to eliminate the hazards by preventing the robot moving into this area of its workspace.



#### CAUTION

Placing the robot in certain areas can create pinching hazards that can lead to injury.



*Due to the physical properties of the robot arm, certain workspace areas require attention regarding pinching hazards. One area (left) is defined for radial motions when the wrist 1 joint is at least 750 mm from the base of the robot. The other area (right) is within 200 mm of the base of the robot, when moving tangentially.*



## 16.2. Stopping Time and Stopping Distance

### Description



#### NOTICE

You can set user-defined safety rated maximum stopping time and distance.

If user-defined settings are used, the program speed is dynamically adjusted to always comply with the selected limits.

The graphical data provided for **Joint 0 (base)**, **Joint 1 (shoulder)** and **Joint 2 (elbow)** is valid for stopping distance and stopping time:

- Category 0
- Category 1
- Category 2

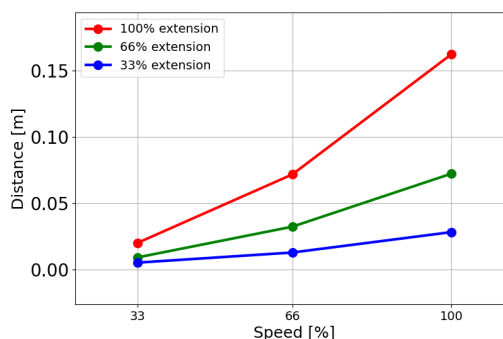
The **Joint 0** test was carried out using a horizontal movement, where the rotational axis was perpendicular to the ground. For the **Joint 1** and **Joint 2** tests, the robot followed a vertical trajectory, where the rotational axes were parallel to the ground, and the stop was done while the robot was moving downward.

The Y-axis is the distance from where the stop is initiated to the final position.

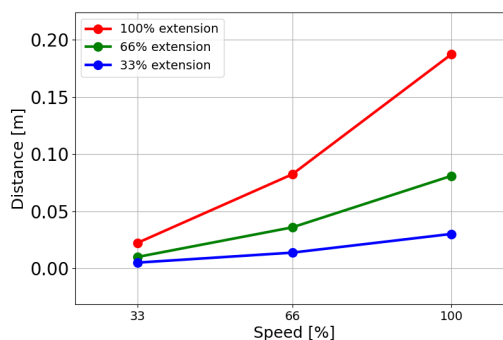
The payload CoG is at the tool flange.

### Joint 0 (BASE)

Stopping distance in meters for 33% of 5kg

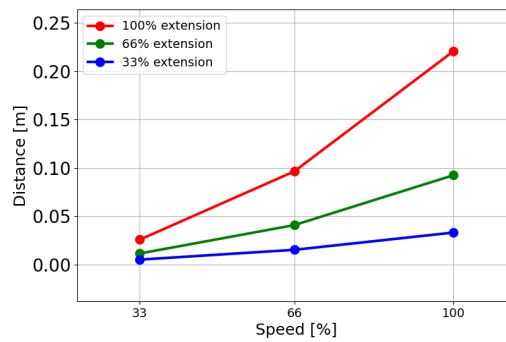


Stopping distance in meters for 66% of 5kg



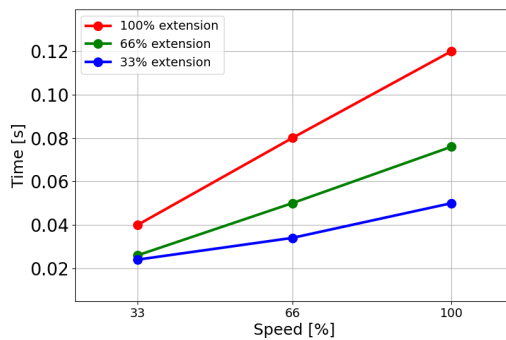


Stopping  
distance in  
meters for  
maximum  
payload of 5kg

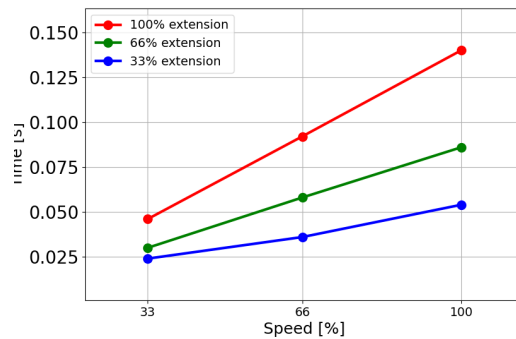


### Joint 0 (BASE)

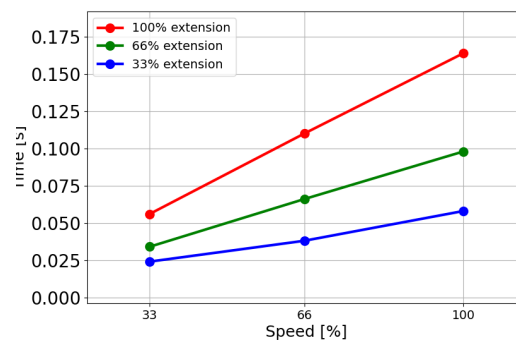
Stopping time  
in seconds for  
33% of 5kg



Stopping time  
in seconds for  
66% of 5kg



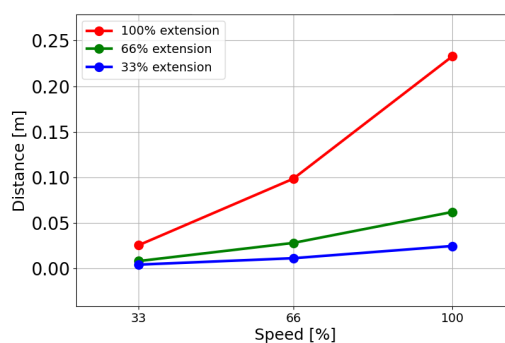
Stopping time  
in seconds for  
maximum  
payload of 5kg



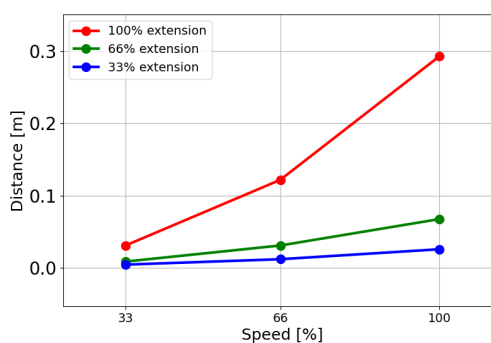


### Joint 1 (SHOULDER)

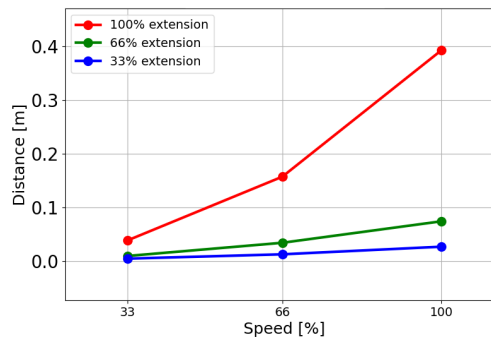
Stopping  
distance in  
meters for 33%  
of 5kg



Stopping  
distance in  
meters for  
66% of 5kg

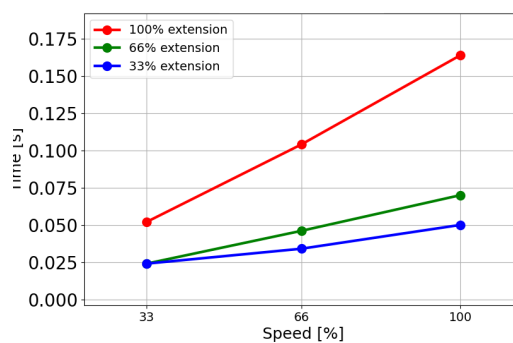


Stopping  
distance in  
meters for  
maximum  
payload of 5kg



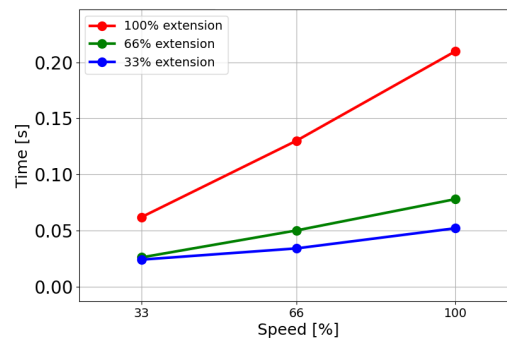
### Joint 1 (SHOULDER)

Stopping time in  
seconds for 33%  
of 5kg

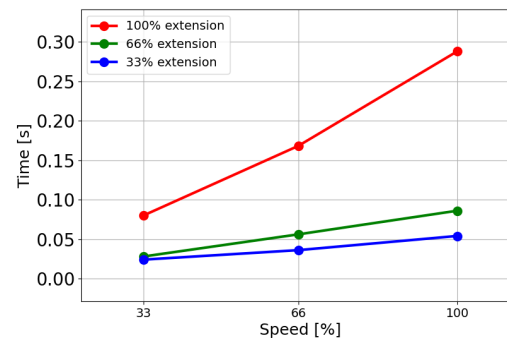




Stopping time  
in seconds for  
66% of 5kg

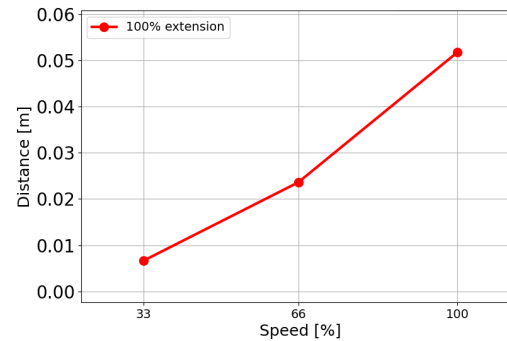


Stopping time  
in seconds for  
maximum  
payload of 5kg

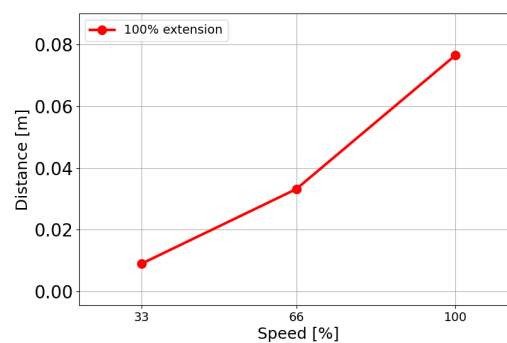


## Joint 2 (ELBOW)

Stopping  
distance in  
meters for  
33% of 5kg

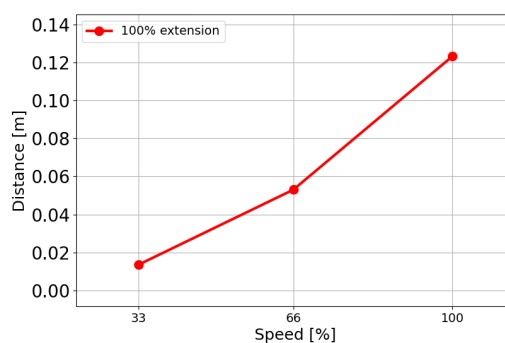


Stopping  
distance in  
meters for  
66% of 5kg



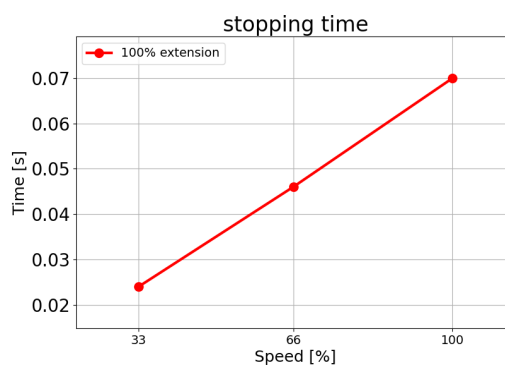


Stopping  
distance in  
meters  
maximum  
payload of 5kg

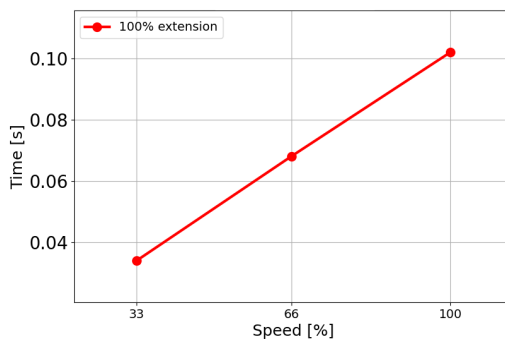


## Joint 2 (ELBOW)

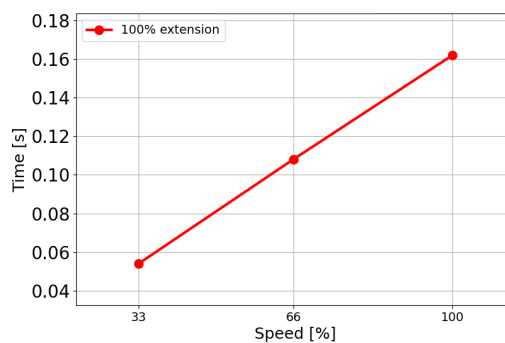
Stopping time  
in seconds for  
33% of 5kg



Stopping time  
in seconds for  
66% of 5kg



Stopping time  
in seconds for  
maximum  
payload of 5kg







## 17. Declaration of Incorporation (original)



**EU Declaration of Incorporation (DOI)** (in accordance with 2006/42/EC Annex II B)

<b>Manufacturer:</b>	<b>Person in the Community Authorized to Compile the Technical File:</b>	
Universal Robots A/S Energivej 51 DK-5260 Odense S Denmark	David Brandt Technology Officer, R&D Universal Robots A/S, Energivej 51, DK-5260 Odense S	
<b>Description and Identification of the Partly-Completed Machine(s):</b>		
<b>Product and Function:</b>	Industrial robot multi-purpose multi-axis manipulator with control box & with or without teach pendant Function is determined by the completed machine (robot application or cell with end-effector, intended use and application program).	
<b>Model:</b>	<b>UR3e, UR5e, UR7e, UR10e, UR12e UR16e</b> (e-Series): Below certifications & declaration include: Effective October 2020: Teach Pendants with 3-Position Enabling (3PE TP) & standard Teach Pendants (TP). Effective May 2021: UR10e specification improvement to 12.5kg maximum payload. <b>NOTE:</b> <i>This DOI is NOT applicable when the OEM Controller is used. See control box markings.</i>	
<b>Serial Number:</b>	Starting <b>2020 5 0 00000</b> and higher <div style="display: flex; align-items: center;"> <div style="text-align: center; margin-right: 10px;">             year <u>  </u>              e-Series           </div> <div style="text-align: center;">             Sequential numbering, restarting at 0 each year              3 = UR3e, 5 = UR5e, 7 = UR7e, 0 = UR10e (10kg payload), 1 = UR12e, 2 = UR10e (12.5kg), 6 = UR16e           </div> </div>	
<b>Incorporation:</b>	Universal Robots e-Series (UR3e, UR5e, UR7e, UR10e, UR12e and UR16e) shall only be put into service upon being integrated into a final complete machine (robot application or cell), which conforms with the provisions of the Machinery Directive and other applicable Directives.	
<b>It is declared that the above products fulfil, for what is supplied, the following directives as detailed below:</b> When this partly completed machine is integrated and becomes a complete machine, the integrator is responsible for the completed machine fulfilling all applicable Directives, applying the CE mark and providing the Declaration of Conformity (DOC).		
<b>I. Machinery Directive 2006/42/EC</b>	<b>The following essential requirements have been fulfilled:</b> 1.1.2, 1.1.3, 1.1.5, 1.2.1, 1.2.4.3, 1.2.5, 1.2.6, 1.3.2, 1.3.4, 1.3.8.1, 1.3.9, 1.4.1 with 3PE TP, 1.5.1, 1.5.2, 1.5.5, 1.5.6, 1.5.10, 1.6.3, 1.7.2, 1.7.4, 2.2.1.1, 4.1.2.1, 4.1.2.3, 4.1.3, 4.3.3, Annex VI. It is declared that the relevant technical documentation has been compiled in accordance with Part B of Annex VII of the Machinery Directive.	
<b>II. Low-voltage Directive 2014/35/EU</b>	Reference the LVD and the harmonized standards used below.	
<b>III. EMC Directive 2014/30/EU</b>	Reference the EMC Directive and the harmonized standards used below.	
<b>Reference to the harmonized standards used, as referred to in Article 7(2) of the MD &amp; LV Directives and Article 6 of the EMC Directive:</b>		
(I) EN ISO 10218-1:2011 <i>Certification by TÜV Rheinland</i> (I) EN ISO 13732-1:2008 as applicable (I) EN ISO 13849-1:2015 <i>Certification by TÜV Rheinland to 2015; 2023 edition has no relevant changes</i> (I) EN ISO 13849-2:2012 (I) EN ISO 13850:2015	(I) (II) EN 60204-1:2018 as applicable (II) EN 60529:1991+A1:2000+A2:2013 (I) EN 60947-5-5:1997+A1:2005 +A11:2013+A2:2017 (I) EN 60947-5-8:2020 (III) EN 61000-3-2:2019	(II) EN 60664-1:2007 (III) EN 61000-3-3: 2013 (III) EN 61000-6-1:2019 UR3e & UR5e ONLY (III) EN 61000-6-2:2019 (III) EN 61000-6-3:2007+A1: 2011 UR3e & UR5e ONLY (III) EN 61000-6-4:2019
<b>Reference to other technical standards and technical specifications used:</b>		
(I) ISO 9409-1:2004 [Type 50-4-M6] (I) ISO/TS 15066:2016 as applicable (III) EN 60068-2-1: 2007 (III) EN 60068-2-2:2007	(II) EN 60320-1:2021 (III) EN 60068-2-27:2008 (III) EN 60068-2-64:2008+A1:2019	(II) EN 61784-3:2010 [SIL2] (III) EN 61326-3-1: 2017 [Industrial locations SIL 2]
The manufacturer, or his authorised representative, shall transmit relevant information about the partly completed machinery in response to a reasoned request by the national authorities.		
Approval of full quality assurance system by the notified body Bureau Veritas: ISO 9001 certificate #DK015892 and ISO 45001 certificate #DK015891.		

Odense Denmark, 20 December 2024

  
 Roberta Nelson Shea, Global Technical Compliance Officer

 Universal Robots A/S, Energivej 51, DK-5260 Odense S, Denmark  
 CVR-nr. 29 13 80 60

 Phone +45 8993 8989  
 Fax +45 3879 8989

 info@universal-robots.com  
 www.universal-robots.com



# 18. Declarations and Certificates

EU Declaration of Incorporation (DOI) (in accordance with 2006/42/EC Annex II B)	
Manufacturer	Universal Robots A/S Energivej 51, DK-5260 Odense S Denmark
Person in the Community Authorized to Compile the Technical File	David Brandt Technology Officer, R&D Universal Robots A/S, Energivej 51, DK-5260 Odense S
Description and Identification of the Partially-Completed Machine(s)	
Product and Function:	Industrial robot multi-purpose multi-axis manipulator with control box & with or without teach pendant Function is determined by the completed machine (robot application or cell with end-effector, intended use and application program).
Model :	UR3e, UR5e, UR10e, UR16e (e-Series): Below cited certifications and this declaration include: <ul style="list-style-type: none"> <li>Effective October 2020: Teach Pendants with 3-Position Enabling (3PE TP) &amp; standard Teach Pendants (TP).</li> <li>Effective May 2021: UR10e specification improvement to 12.5kg maximum payload.</li> </ul>
	Note: This Declaration of Incorporation is NOT applicable when the UR OEM Controller is used.
Serial Number:	Starting 20235000000 and higher year e-Series 3=UR3e, 5=UR5e, 7=UR7e, 0=UR10e (10kg payload), 1=UR12e, 2=UR10e (12.5kg), 6=UR16e sequential numbering, restarting at 0 each year
Incorporation:	Universal Robots e-Series (UR3e, UR5e, UR7e, UR10e, UR12e and UR16e) shall only be put into service upon being integrated into a final complete machine (robot application or cell), which conforms with the provisions of the Machinery Directive and other applicable Directives.
It is declared that the above products fulfil, for what is supplied, the following directives as detailed below: When this incomplete machine is integrated and becomes a complete machine, the integrator is responsible for determining that completed machine fulfils all applicable Directives and providing the Declaration of Conformity.	
I. Machinery Directive 2006/42/EC	The following essential requirements have been fulfilled: 1.1.2, 1.1.3, 1.1.5, 1.2.1, 1.2.4.3, 1.2.5, 1.2.6, 1.3.2, 1.3.4, 1.3.8.1, 1.3.9, 1.4.1 with 3PE TP, 1.5.1, 1.5.2, 1.5.5, 1.5.6, 1.5.10, 1.6.3, 1.7.2, 1.7.4, 2.2.1.1, 4.1.2.1, 4.1.2.3, 4.1.3, 4.3.3, Annex VI. It is declared that the relevant technical documentation has been compiled in accordance with Part B of Annex VII of the Machinery Directive.
II. Low-voltage Directive 2014/35/EU III. EMC Directive 2014/30/EU	Reference the LVD and the harmonized standards used below. Reference the EMC Directive and the harmonized standards used below.









Reference to the harmonized standards used, as referred to in Article 7(2) of the MD & LV Directives and Article 6 of the EMC Directive:		
(I) EN ISO 10218-1:2011 Certification by TÜV Rheinland (I) EN ISO 13732-1:2008 as applicable (I) EN ISO 13849-1:2015 Certification by TÜV Rheinland to 2015; 2023 edition has no relevant changes	(I) EN ISO 13849-2:2012 (I) EN ISO 13850:2015 (I) (II) EN 60204-1:2018 as applicable (II) EN 60529:1991+A1:2000+A2:2013 (I) EN 60947-5-5:1997+A1:2005 +A11:2013+A2:2017 (I) EN 60947-5-8:2020 (III) EN 61000-3-2:2019	(II) EN 60664-1:2007 (III) EN 61000-3-3:2013 (III) EN 61000-6-1:2019 UR3e & UR5e ONLY (III) EN 61000-6-2:2019 (III) EN 61000-6-3:2007+A1:2011 UR3e & UR5e ONLY (III) EN 61000-6-4:2019
Reference to other technical standards and technical specifications used:		
(I) ISO 9409-1:2004 [Type 50-4-M6] (I) ISO/TS 15066:2016 as applicable (III) EN 60068-2-1:2007	(III) EN 60068-2-2:2007 (II) EN 60320-1:2021 (III) EN 60068-2-27:2008	(III) EN 60068-2-64:2008+A1:2019 (II) EN 61784-3:2010 [SIL2] (III) EN 61326-3-1:2017 [Industrial locations SIL 2]
The manufacturer, or his authorised representative, shall transmit relevant information about the partly completed machinery in response to a reasoned request by the national authorities. Approval of full quality assurance system by the notified body Bureau Veritas: ISO 9001 certificate #DK015892 and ISO 45001 certificate #DK015891.		




# 19. Certifications UR5e

**Description** Third party certification is voluntary. However, to provide the best service to robot integrators, Universal Robots chooses to certify its robots at the recognized test institutes listed below.  
You can find copies of all certificates in the chapter: Certificates.

## Certification


	TÜV Rheinland	Certificates by TÜV Rheinland to EN ISO 10218-1 and EN ISO 13849-1. TÜV Rheinland stands for safety and quality in virtually all areas of business and life. Founded 150 years ago, the company is one of the world's leading testing service providers.
 TÜVRheinland®	TÜV Rheinland of North America	In Canada, the Canadian Electrical Code, CSA 22.1, Article 2-024 requires equipment to be certified by a testing organization approved by the Standards Council of Canada.
	CHINA RoHS	Universal Robots e-Series robots conform to CHINA RoHS management methods for controlling pollution by electronic information products.
	KCC Safety	Universal Robots e-Series robots have been assessed and conform to KCC mark safety standards.
	KC Registration	The Universal Robots e-Series robots have been evaluated for conformity assessment for use in a work environment. Therefore, there is a risk of radio interference when used in a domestic environment.
	Delta	Universal Robots e-Series robots are performance tested by DELTA.

## Supplier Third Party Certification

	Environment	As provided by our suppliers, Universal Robots e-Series robots shipping pallets comply with the ISMPM-15 Danish requirements for producing wood packaging material and are marked in accordance with this scheme.
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**Manufacturer  
Test  
Certification**

	Universal Robots	Universal Robots e-Series robots undergo continuous internal testing and end of line test procedures. UR testing processes undergo continuous review and improvement.
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**Declarations  
according to  
EU directives**

Although EU directives are relevant for Europe, some countries outside Europe recognize and/or require EU declarations. European directives are available on the official homepage: <http://eur-lex.europa.eu>.

According to the Machinery Directive, Universal Robots' robots are partly completed machines, as such a CE mark is not to be affixed.

You can find the Declaration of Incorporation (DOI) according to the Machinery Directive in the chapter: Declarations and Certificates.



# 20. Certificates UR5e

TÜV Rheinland

Page 1

## Certificate

<b>Certificate no.</b>	<b>T 72408049 0001</b>
------------------------	------------------------

<b>License Holder:</b> Universal Robots A/S Energivej 25 5260 Odense S Denmark	<b>Manufacturing Plant:</b> Universal Robots A/S Energivej 25 5260 Odense S Denmark
<b>Report Number:</b> 31875333 013	<b>Client Reference:</b> Roberta Nelson Shea
<b>Certification acc. to:</b> EN ISO 10218-1:2011 EN ISO 13849-1:2015	

**Product Information**

<b>Certified Product:</b>	Industrial Robot
<b>Model Designation:</b>	UR3, UR5, UR10, UR20, UR30, UR3e, UR5e, UR7e, UR10e, UR12e, UR16e
<b>Technical Data:</b>	Rated Voltage: AC 100-200V, 50/60Hz or AC 200-240V, 50/60Hz Rated Current: 15A or 8A Protection Class: I

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TÜV Rheinland of North America, Inc.  
 400 Beaver Brook Rd, Boxborough, MA 01719  
 Tel +1 (978) 266 9500, Fax +1 (978) 266-9992

www.tuv.com





TÜV Rheinland  
North America

Page 1

# Certificate

Certificate no. CA 72405127 0001

<b>License Holder:</b> Universal Robots A/S Energivej 25 5260 Odense S Denmark	<b>Manufacturing Plant:</b> Universal Robots A/S Energivej 25 5260 Odense S Denmark
<b>Report Number:</b> 31875333 006	<b>Client Reference:</b> Roberta Nelson Shea
<b>Certification acc. to:</b> CAN/CSA-Z434-14 + GI1 (R2019)	

**Product Information**

**Certified Product:** Industrial Robot  
**Model Designation:** UR3e, UR5e, UR10e, UR16e, UR20, UR30

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TÜV Rheinland of North America, Inc.  
400 Beaver Brook Rd, Boxborough, MA 01719  
Tel +1 (978) 266 9500, Fax +1 (978) 266-9992

www.tuv.com





China  
RoHS

**Management Methods for Controlling Pollution  
by Electronic Information Products  
Product Declaration Table For Toxic or Hazardous Substances**

**表1 有毒有害物质或元素名称及含量标识格式**



Product/Part Name 产品/部件名称	Toxic and Hazardous Substances and Elements 有毒有害物质或元素					
	铅 Lead (Pb)	汞 Mercury (Hg)	镉 Cadmium (Cd)	六价 Hexavalent Chromium (Cr+6)	多溴联苯 Polybrominated biphenyls (PBB)	多溴二苯醚 Polybrominated diphenyl ethers (PBDE)
UR Robots 机器人：基本系统 UR3 / UR5 / UR10 / UR3e / UR5e / UR7e UR10e / UR12e / UR16e / UR15e / UR20 / UR30	X	O	X	O	X	X

O: Indicates that this toxic or hazardous substance contained in all of the homogeneous materials for this part is below the limit requirement in SJ/T11363-2006.

O: 表示该有毒有害物质在该部件所有均质材料中的含量均在SJ/T 11363-2006规定的限量要求以下。

X: Indicates that this toxic or hazardous substance contained in at least one of the homogeneous materials used for this part is above the limit requirement in SJ/T11363-2006.

X: 表示该有毒有害物质至少在该部件的某一均质材料中的含量超出SJ/T 11363-2006规定的限量要求。  
(企业可在此处·根据实际情况对上表中打“X”的技术原因进行进一步说明。)

Items below are wear-out items and therefore can have useful lives less than environmental use period:

下列项目是损耗品,因而它们的有用环境寿命可能短于基本系统和可选项目的使用时间:

Drives, Gaskets, Probes, Filters, Pins, Cables, Stiffener, Interfaces

电子驱动器, 垫圈, 探针, 过滤器, 别针, 缆绳, 加强筋, 接口

Refer to product manual for detailed conditions of use.

详细使用情况请阅读产品手册。

Universal Robots encourages that all Electronic Information Products be recycled but does not assume responsibility or liability.

Universal Robots 鼓励回收再利用所有的电子信息产品, 但 Universal Robots 不负任何责任或义务

To the maximum extent permitted by law, Customer shall be solely responsible for complying with, and shall otherwise assume all liabilities that may be imposed in connection with, any legal requirements adopted by any governmental authority related to the Management Methods for Controlling Pollution by Electronic Information Products (Ministry of Information Industry Order #39) of the Peoples Republic of China otherwise encouraging the recycle and use of electronic information products. Customer shall defend, indemnify and hold Universal Robots harmless from any damage, claim or liability relating thereto. At the time Customer desires to dispose of the Products, Customer shall refer to and comply with the specific waste management instructions and options set forth at [www.universal-robots.com/about-universal-robots/social-responsibility](http://www.universal-robots.com/about-universal-robots/social-responsibility) and [www.teradyne.com/company/corporate-social-responsibility](http://www.teradyne.com/company/corporate-social-responsibility), as the same may be amended by Teradyne or Universal Robots.



## KC Safety



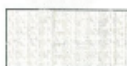
## 자율안전확인 신고증명서

신청인	사업장명	Universal Robots A/S	사업장관리번호	2016E110079
	사업자등록번호	016E110079	대표자 성명	Klaus Vestergaard
	소재지	Energivej 25, 5260 Odense S, Denmark		
자율안전인증대상 기계·기구명				
			산업용로봇	
형식(규격)	UR5e		용량(등급)	6 axis
자율안전확인번호	18-AB2EQ-01603			
제조사	Universal Robots A/S			
소재지	Energivej 25, 5260 Odense S, Denmark			

「산업안전보건법」 제35조제1항 및 같은 법 시행규칙 제61조제3항에 따라  
자율안전확인 신고증명서를 발급합니다.

2018년 11월 06일

한국산업안전보건공단 서울지역본부장








## KC Registration

6C8D-81FA-93C2-784A


<b>방송통신기자재등의 적합등록 필증</b> <i>Registration of Broadcasting and Communication Equipments</i>	
상호 또는 성명 <i>Trade Name or Registrant</i>	Universal Robots A/S
기자재명칭(제품명칭) <i>Equipment Name</i>	UR e-Series robot
기본모델명 <i>Basic Model Number</i>	UR5e
파생모델명 <i>Series Model Number</i>	
등록번호 <i>Registration No.</i>	R-R-URK-UR5e
제조사/제조(조립)국가 <i>Manufacturer/Country of Origin</i>	Universal Robots A/S / 덴마크
등록연월일 <i>Date of Registration</i>	2018-10-23
기타 <i>Others</i>	
<p>위 기자재는 「전파법」 제58조의2 제3항에 따라 등록되었음을 증명합니다.  It is verified that foregoing equipment has been registered under the Clause 3, Article 58-2 of Radio Waves Act.</p> <p style="text-align: right;">2018년(Year) 10월(Month) 23일(Day)</p> <p style="text-align: center;">국립전파연구원장    <i>Director General of National Radio Research Agency</i></p> <p style="text-align: center; color: red;">※ 적합등록 방송통신기자재는 반드시 "적합성평가표시" 를 부착하여 유통하여야 합니다.  위반시 과태료 처분 및 등록이 취소될 수 있습니다.</p>	



## Environment

### Climatic and mechanical assessment



<b>Client</b> Universal Robots A/S Energivej 25 5260 Odense S Denmark	<b>Force Technology project no.</b> 117-32120
<b>Product identification</b> UR 3 robot arms UR 3 control boxes with attached Teach Pendants. UR 5 robot arms UR5 control boxes with attached Teach Pendants. UR10 robot arms: UR10 control boxes with attached Teach Pendants. See reports for details.	
<b>Force Technology report(s)</b> DELTA project no. 117-28266, DANAK-19/18069 DELTA project no. 117-28086, DANAK-19/17068	
<b>Other document(s)</b>	
<b>Conclusion</b> The three robot arms UR3, UR5 and UR10 including their control boxes and Teach Pendants have been tested according to the below listed standards. The test results are given in the Force Technology reports listed above. The tests were carried out as specified and the test criteria for environmental tests were fulfilled in general terms with only a few minor issues (see test reports for details).  IEC 60068-2-1, Test Ae; -5 °C, 16 h IEC 60068-2-2, Test Be; +35°C, 16h IEC 60068-2-2, Test Be; +50°C, 16 h IEC 60068-2-64, Test Fh; 5 – 10 Hz: +12 dB/octave, 10-50 Hz 0.00042 g <sup>2</sup> /Hz, 50 – 100 Hz: -12 dB/octave, 1,66 grms, 3 x 1½ h IEC 60068-2-27, Test Ea, Shock; 11 g, 11 ms, 3 x 18 shocks	
<b>Date</b>  Hørsholm, 25 August 2017	<b>Assessor</b>  Andreas Wendelboe Højsgaard M.Sc.Eng.

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