6. Assembly

Description Install and power on the robot arm and Control Box to start using PolyScope.

Assemble the robot 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

6.1. 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.

- Consider the information below when choosing the operating space for the robot.

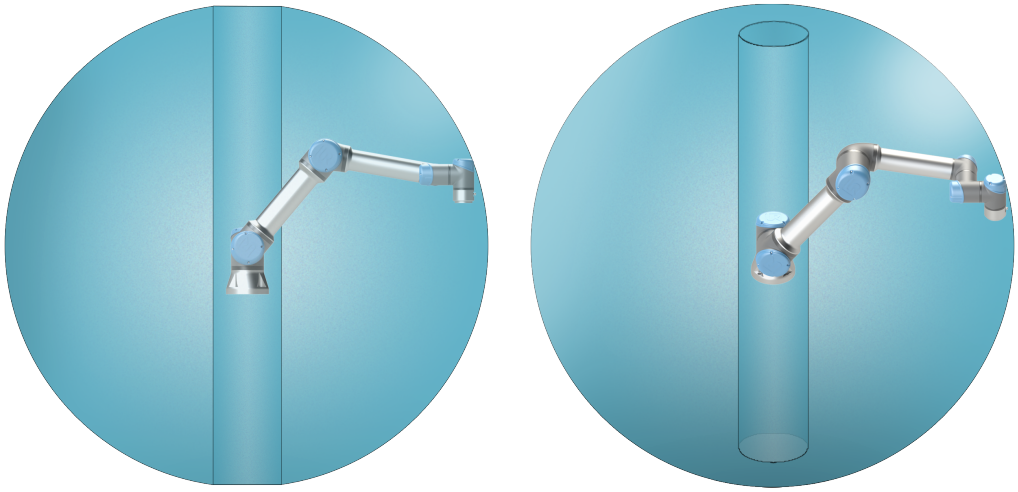
NOTICE

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

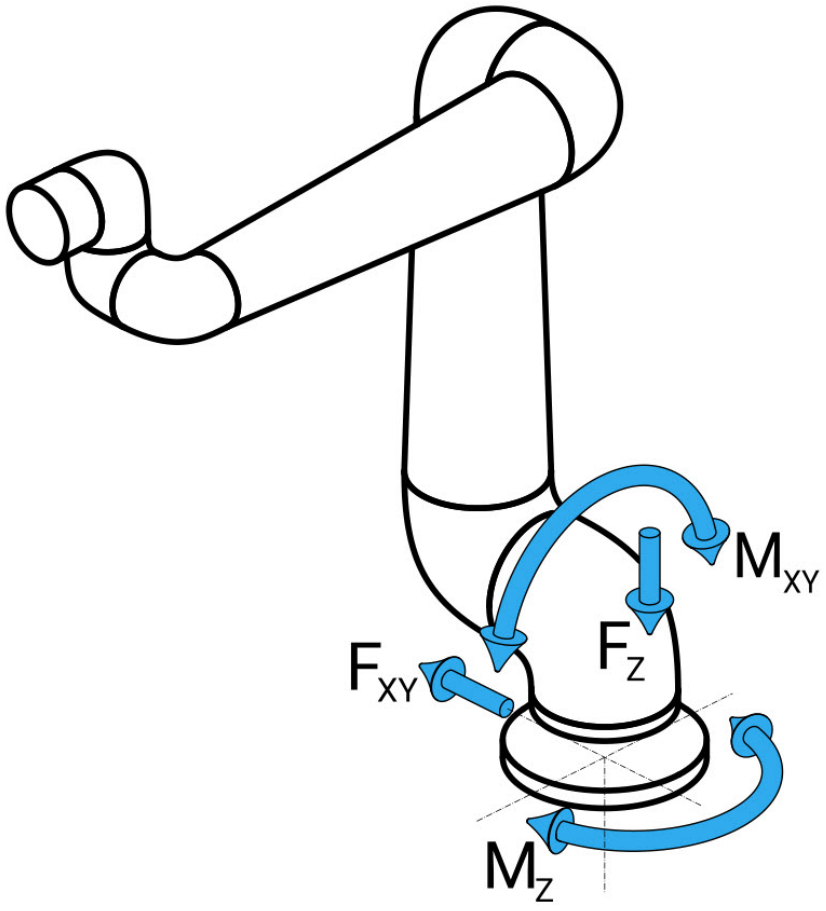
6.2. Dimensioning the Stand

Dimensioning the Stand

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:

- Mz: Torque around the base z axis.
- Fz: Forces along base z axis.
- Mxy: Tilting torque in any direction of the base xy plane.
- Fxy: Force in any direction in the base xy plane.



Definition of force and moment at the base flange.

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]	M_{xy}[Nm]	F_{xy} [N]
UR5e	450	1090	750	910

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

Robot Model	Mz [Nm]	Fz[N]	M_{xy}[Nm]	F_{xy} [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.

Dimensioning the Stand

Users have the option to 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 eigenfrequency 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.

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 the script command set_base_acceleration()
- High accelerations might cause the robot to make safety stops.

WARNING

- Potential for tip-over Hazards.
- The robot arm's operational loads may 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.

6.3. Mounting Description

Description

Robot arm (Base)	Mounted with four 8.8 strength, 8.5 mm bolts and four M8 mounting holes at the base.
Tool (Tool Flange)	Uses four M6 thread holes for attaching a tool to the robot. The M6 bolts shall be tightened with 8 Nm, strength class 8.8. 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: IP rating

CAUTION

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: Mounting

WARNING

Unstable mounting can lead to accidents.

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

6.3.1. Singularity Prevention

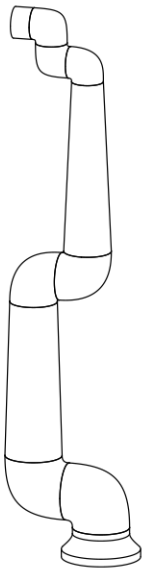
Description

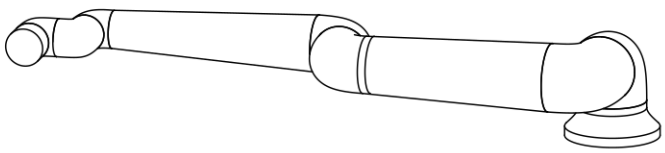
A singularity is a pose that restricts the motion and the ability to position the robot. The robot arm can stop moving or have very sudden and fast movements if it approaches a singularity. As the robot arm approaches a singularity position, resistance increases making it feel heavy to position.

WARNING

Singularity can cause injury to a person within reach of motion of the robot arm, end effector and workpiece.

- Avoid programming motions that result in any poses that can cause a singularity.



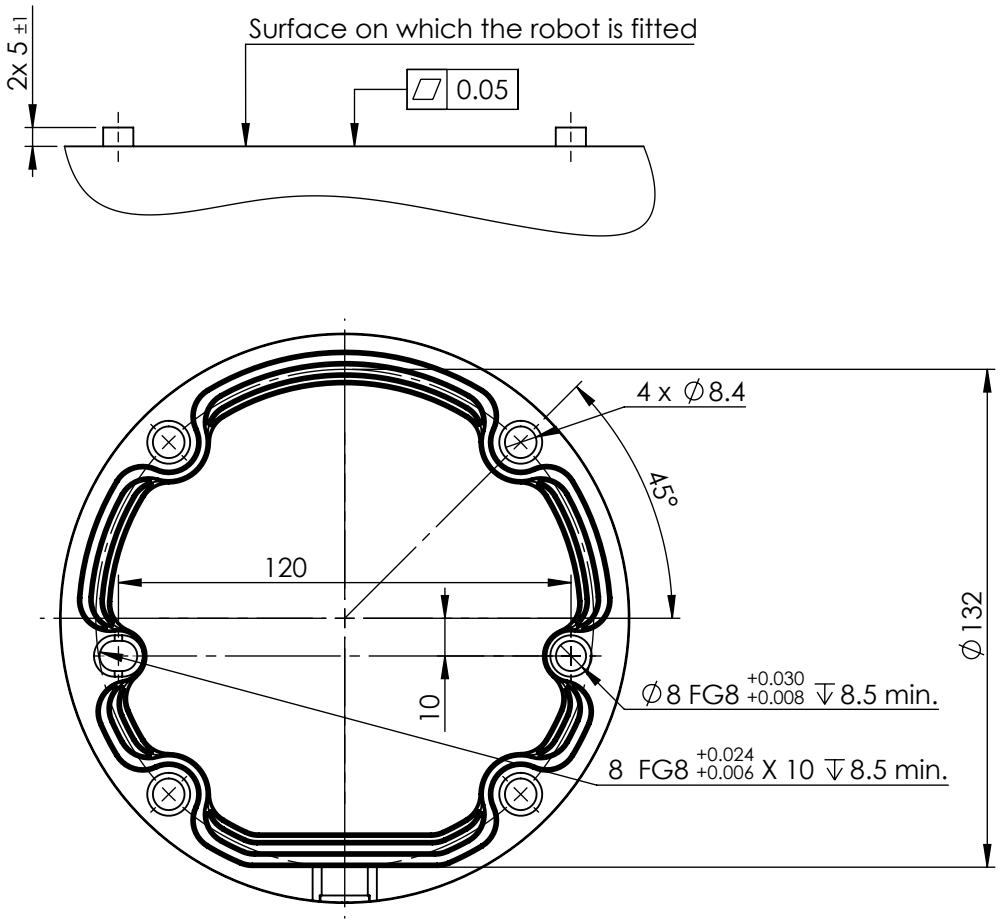


6.3.2. Fixed and Movable Installation

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.

6.4. 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. Press the power button on the Teach Pendant to turn off the robot.
2. Unplug the mains cable / power cord from the wall socket.
3. Allow 30 seconds for the robot to discharge any stored energy.

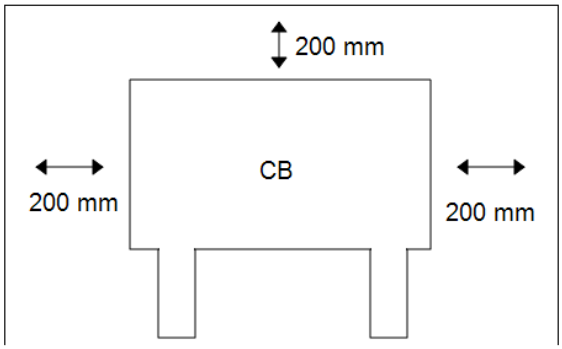
To secure the robot arm

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.

6.5. Control Box Clearance

Description

The flow of hot air in the Control Box can result in equipment malfunction.
The Control Box requires a minimum clearance of 50 mm on each side for sufficient cool airflow. The recommended Control Box clearance is 200 mm.



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.

6.6. 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 connector establishes the robot connection by connecting 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

The maximum robot connection from the robot arm to the Control Box is 6 m. Improper robot connection can result in loss of power to the robot arm.

- Do not extend a 6 m 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.

6.7. Robot Connections: Robot Cable

Description

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

Connect arm and Control box

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 (see illustration below). Twist the connector twice to ensure it is properly locked before turning on the robot arm.
You can turn the connector to the right to make it easier to lock after the cable is plugged in.

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.

6.8. 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 connecter on the power cord connects to the IEC C14 appliance inlet at the bottom of the Control Box.

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.