PREFACE

Our modular solutions can be used in a huge variety of industrial fields due to their adaptability and flexibility. Such applications as welding, assembly, machine tending, materials handling, and many more are possible with appropriate tool/end-effector and proper selection of RobCo-Modules.

Modular robots enable you to tailor a robot system to your individual needs. The flexibility that results from modularity allows you to easily adapt your robot as your automation task changes. Furthermore, you can optimize the robot's kinematic structure for any application. Modular robots behave like ordinary lightweight industrial robots after assembly with the added benefit of flexibility and adaptability.

The modular robotic system at hand features a web-based graphical user interface for general operation and a UDP interface for advanced lower-level communication. This interface can be used to issue commands to the robot system and to retrieve information about its state. Please contact RobCo in case you need to work with the UDP interface.

The robotic arm can be programmed to move a tool, and communicate with other machines using electrical signals. Using our programming interface, it is easy to program the robot to move the tool along the desired trajectory.

What do the Boxes contain

The RobCo-Package contains:

- The robotic arm configuration with clamps, drive, and link modules (of different sizes)
- Base module
- End-effector flange with tool connection (optional)
- Control Unit with an attached handheld device
- Key for the operational mode key switch
- mains power, robot power cables
- One Robot communication cable
- Emergency disassemble key set

Important Safety Notice

The robotic arm is *partly completed machinery*, so it must be integrated into the safety concept of an overall system. The integration must be verified in accordance with the applicable regulations and guidelines.

How to Read this Manual

This manual contains instructions for installing and programming the robot. The manual is separated into two parts:

- PART I: Hardware Installation Manual

  The mechanical and electrical installation of the robot as well as safety notes.

- PART II: Software Manual

  Programming of the robot.

This manual is intended for the robot integrator who must have a basic level of mechanical and electrical training, as well as be familiar with elementary programming concepts. (see table of requirements)

More Information

More information on our modular systems can be found on RobCo Website

PART I: Hardware Installation Manual

Contents:

Technical Specifications

Robotic Arm Configurations

Degrees of Freedom	1 to 8
Payload	1 to 55 kg
Range	200 to 1900mm
Max. Velocity	up to 230°/s, cartesian velocity dependent on robot composition
Working Area	up to ± 270°
Base Area	191mm x 175mm
Power Consumption	ca. 250W nominally; depending on robot composition
Noise Level	comparatively silent (60 dB(A))
Material	Aluminium, Polypropylene
Ambient Temperature	0°C to 45°C at 50% rH
Storage and Transportation Temperature	-25° C to 55° C
Max. installation altitude	1000 m
Safety Functions	6 Safety Functions in compliance with EN ISO 10218-1 EN ISO 13849-1, PL d, Cat. 3; IP 54

Control Unit

Dimensions	L 400mm, W 200mm, H 300mm
Operating Voltage	220-240V AC / 50-60Hz
Protection Class	IP 54
Interfaces	2xEthernet, 8xDigital input, 8xDigital Output, 4xsafety digital input, 2x safety digital output, 1xexternal Emergency stop, 1x external RESET
Programming	Intuitive graphical user interface in a web browser or on 12″ control panel with a mounting device, MATLAB or RobCo-ROS

Drive Modules

Parameter	M (D86)	L (D116)	XL (D148)

Diameter	86 mm	116 mm	148 mm
Nominal Torque	29,7 Nm	55 Nm	120 Nm
Max. Torque	70 Nm	178 Nm	374 Nm
Nominal Power	131 W	141 W	165 W
Max. Velocity	230°/s	180°/s	180°/s
Protection Class	IP54		

Link Modules

Diameter	86mm	116mm	148mm
Minimum Length	100mm	100mm	100mm
Maximum Length	500mm	800mm	1000mm
Length Step Size	50mm	50mm	50mm
Available Shapes	Straight links(e.g. I86-300 for a straight link with 86mm diameter and 300mm length) and angled links (e.g. L148-900 for angled link with 148mm diameter and 900mm length)		
Protection Class	IP54		

Overall System Specification

The modular robot is a system consisting of two main parts: the robot (modules + end-effector/tool + base) and the Control Unit. The system works in the following way: the PC/Tablet sends data via Ethernet to the Control Unit, where the data is processed along with the signals sent by external (safety) devices (connected to one or several I/O blocks, see Electrical Parts and Installation) so that the robot is controlled. The drive modules execute the rotational movement, while the link modules are used to connect the parts of the robot to extend its workspace and reach the desired configuration. To build the robotic arm configuration, please refer to Mechanical Parts and Installation.
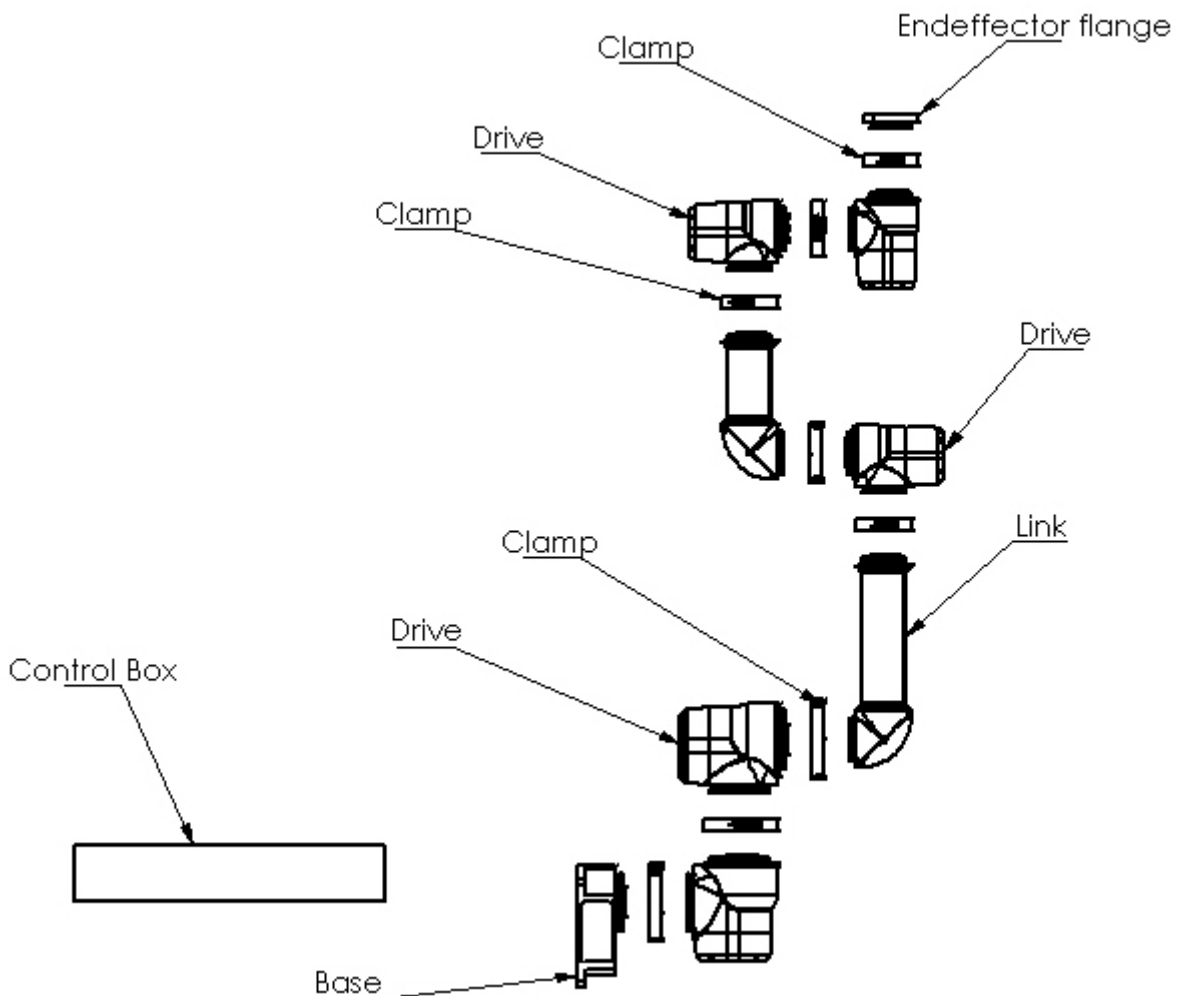
Possible robotic arm configuration(5 drive modules, 2 link modules, one base, and one end-effector flange)

Intended Use

RobCo industrial modular robotic applications incorporate a very broad field of industrial applications, including transportation of materials and parts, welding, assembling, machine tending, and many more. For the optimal usage of the robot, the following positions should be followed:

- The incomplete machine is only used to manipulate objects/components for industrial applications.
- The operating personnel are outside the work area of the robot during automatic operation. The incomplete machine may only be operated by one operator at the same time.
- The robotic arm should be assembled with two people carrying safety shoes!
- The incomplete machine may only be put into operation when it has been determined that the machine or system in which the incomplete machine was installed and integrated complies with the provisions of the Machinery Directive (2006/42 / EC).
- The incomplete machine may only be installed and operated in industrially or commercially used machines or systems.
- The machine must not be operated in areas with an explosive atmosphere.
- The prerequisite for the intended use is that the operators read, understand, and follow the assembly instructions.
- Intended use includes observing and adhering to all information in the assembly instructions.
- The incomplete machine must be checked and serviced regularly.

Any use beyond those positions is considered improper.

General Safety

Introduction

This chapter contains important safety information, which must be read and understood by the integrator or the user of the RobCo modular robot system before the robot is powered on for the first time. In this chapter, the first subsections are general. The later subsections contain specific engineering data relevant to enable setting up and programming the robot (see UDP Interface). Safety Functions describes and defines all safety-related functions. Please read through instructions and guidance provided in Safety Functions as well as in section Risk Assessment attentively. It is essential to observe and follow all assembly instructions and guidance provided in all chapters and parts of this manual. Special attention shall be paid to notices associated with warning symbols.

> ❶ Note
>
> RobCo disclaims any liability if the robot (Modules, Control Unit) is damaged, changed, or modified in any way. RobCo cannot be held responsible for any damages caused to the robot or any other equipment due to programming errors or malfunctioning of the robot. RobCo GmbH cannot be held responsible for any damage caused by the transportation, or the unintended use (see Intended Use) of the equipment.

Validity and Responsibility

The information in this manual does not cover designing, installing, and operating a complete robot application, nor does it cover all peripheral equipment that can influence the safety of the complete system. The complete system must be designed and installed following the safety requirements outlined in the standards and regulations of the country where the robot is installed. The integrators and users of RobCo robots are responsible for ensuring that the applicable safety laws and regulations in the country concerned are observed and that any significant hazards in the complete robot application are eliminated. This includes, but is not limited to:

- Performing a risk assessment for the complete robot system
- Interfacing other machines and additional safety devices if defined by the risk assessment
- Setting up the appropriate safety settings
- Ensuring that the user will not modify any safety measures
- Validating that the total robot system is designed and installed correctly
- Specifying instructions for use of the complete robot system

- Marking the robot installation with relevant signs and contact information of the integrator
- Collecting all documentation in a technical file; including the risk assessment and this manual

Limitation of Liability

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

Warning Categories in this Manual

Within this manual, three levels of danger are specified:

This indicates an imminently hazardous situation that, if not avoided, could result in death or serious injury.

This indicates a potentially hazardous situation that, if not avoided, could result in injury or major damage to the equipment.

This indicates a situation that, if not avoided, could result in damage to the equipment.

Warning Symbols in this Manual

The symbols below define the captions used throughout this manual:

	DANGER

This indicates an imminently hazardous electrical danger situation.

	DANGER

This indicates an imminently hazardous danger situation.

	WARNING

This indicates a potentially hazardous electrical situation.

	WARNING

This indicates a potentially hazardous situation.

	WARNING

This indicates a potentially hazardous hot surface that, if touched, could result in injury.

	CAUTION

This indicates a cautious situation.

General Specifications and Warnings

This section contains some general warnings and cautions that can be repeated or explained in different parts of this manual.

> **ⓘ Note**
>
> 1. If the integrators of the robot and robotic modules should take sound-insulating actions, the maximum sound level of the robot is 70 dB(A)!
> 2. The modules are built to carry them safely with two hands and safely hold them with one hand while assembling the robot arm.
> 3. The integrators, responsible for the assembly of the robot, should not lock in a person through building the robot. If a person gets locked, the integrators could safely disassemble several modules from each other.
> 4. The Control Unit must be placed outside of the reachable area of the robotic arm!
> 5. If energy shutdowns/fluctuations occur, they are being detected, the Control Unit goes into Error-Mode and all outputs go to Safe State. After the energy flow restores to normal the Control Unit must be restarted.

⚠️	DANGER

Make sure to install the robot and all electrical equipment according to the specifications and warnings found in Mechanical Parts and Installation and Electrical Parts and Installation. The Control Unit can only be supplied via 220-240V AC network! Do not touch any open electrical contacts while the cables are connected to the socket!

⚠️	WARNING

1. Make sure all modules are securely mounted in place according to Mechanical Parts and Installation.
2. Make sure the robotic arm has space to operate freely.
3. Make sure the Robot is operated in a closed (covered) space
4. Make sure nobody can enter the robot operation space while the robot is supplied with power and in automatic mode.
5. Make sure that safety measures and/or robot safety configuration parameters have been set up to protect both programmers, operators, and bystanders, as defined in the risk assessment.

6. Do not wear loose clothing or jewelry when working with the robot. Make sure long hair is tied back when working with the robot.
7. Two operators are required to assemble the robot. They are also required to wear safety shoes.
8. Never use the robot if it is damaged, for example, if one of the modules is loose, broken, or removed.
9. If the software prompts an error, immediately press emergency stop, write down the conditions that led to the error, find the corresponding error codes on the log screen, and contact your supplier.
10. Do not connect any safety equipment to the standard I/Os. Use safety-related I/Os only.
11. Make sure to use the correct installation settings (e.g. Robot mounting angle, mass in TCP, TCP offset, safety configuration).
12. Tool/end effectors and obstacles shall not have sharp edges or pinch points.
13. Make sure to warn people to keep their heads, arms, and feet outside the reach of the operating robot or robot about to start operating.
14. Be aware of robot movement when using the handheld device.
15. Combining different machines can increase hazards or create new hazards. Always make an overall risk assessment for the complete installation. Depending on the assessed risk, different levels of functional safety can apply; as such, when different safety and emergency stop performance levels are needed, always choose the highest performance level. Always read and understand the manuals for all equipment used in the installation.
16. Make sure the users of the robot are informed of the location of the emergency stop button(s) and are instructed to activate the emergency stop in case of emergency or abnormal situations.

WARNING

1. The robot and its control unit generate heat during operation. Do not handle or touch the robot while in operation or immediately after operation as prolonged contact can cause discomfort. You can cool down the robot by powering it off and waiting one hour.
2. Never stick fingers behind the internal cover of the control unit.

CAUTION

When the robot is combined or working, with machines capable of damaging the robot, it is highly recommended to test all functions and the robot program separately.

Foreseeable Misuse

Any use of the RobCo modular system or application deviating from intended use is deemed to be impermissible misuse. This includes, but is not limited to:

- Use in potentially explosive environments.
- Processing of material/workpieces, the specification of which does not correspond to the specifications for this machine.
- Use through unqualified/insuficciently qualified personnel
- Use in medical and life-critical applications.
- Use before performing a risk assessment.
- Use outside of stated specifications.
- Use as a climbing aid.
- Operation outside the permissible operating parameters.

Risk Assessment

One of the most important things that an integrator needs to do is to perform a risk assessment. In many countries, this is required by law. The RobCo modular robot system itself is a partly completed machinery, as the safety of the robot installation depends on how the robot is integrated (E.g. tool/end effector, obstacles and other machines, module composition).

It is recommended that the integrator uses the machinery directive, ISO 12100, and ISO 10218-2 to conduct the risk assessment. The risk assessment that the integrator conducts shall consider all work tasks throughout the lifetime of the robot application, including but not limited to:

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

A risk assessment must be conducted **before** the robot arm is powered on for the first time. A part of the risk assessment conducted by the integrator is to identify the proper safety configuration settings, as well as the need for additional emergency stop buttons and/or other protective measures required for the specific robot application.

The integrator must prevent unauthorized access to the safety configuration.

RobCo identifies the potential significant hazards listed below as hazards that must be considered by the integrator.

> ❶ Note
>
> Other significant hazards can be present in a specific robot installation.

1. Penetration of skin by sharp edges and sharp points on tool/end effector or tool/end effector connector.
2. Penetration of skin by sharp edges and sharp points on obstacles near the robot track.
3. Bruising due to contact with the robot.
4. Sprain or bone fracture due to strokes between a heavy payload and a hard surface.
5. Consequences due to loose bolts/clamps that hold the base/modules or tool/end effector.
6. Items falling out of tool/end effector, e.g. due to a poor grip or power interruption.
7. Mistakes due to different emergency stop buttons for different machines.
8. Mistakes due to unauthorized changes to the safety configuration parameters.

Pre-Use Assessment

The following tests must be conducted before using the robot for the first time or after any modifications are made. Verify that all safety input and output are appropriately and correctly connected (check SF5 in Safety Functions). Test that all connected safety input and output, including devices common to multiple machines or robots, are functioning. As such you must:

- Test that emergency stop buttons (hand-held device) and input stop the robot and engage brakes.
- Test that the safeguard input stops the robot motion. If safeguard reset is configured, check that it needs to be activated before motion can be resumed.
- Test that the 3-position enabling device must be held in the middle position to enable motion in manual mode and that the robot is under reduced speed control.
- Test that System Emergency Stop outputs are capable of bringing the whole system to a safe state.
- Test that the system connected to Robot Stop output can detect the output changes.
- Test that the key switch changes the operating mode and that an emergency stop occurs during the mode change.

Movement without Drive Power

The robotic arm cannot be moved without drive power. In the unlikely case, that movement of the robot in an emergency situation is necessary but robot power is not available or undesirable, the robot's modules can be disassembled.

> ❶ Note

If any person is locked by the robot, the robotic arm could be disassembled with help of provided allen keys! All modules, that could fall must be either hung or disassembled carefully. The provided allen keys must be placed according to the performed risk assessment at a place reachable in hazardous situations. For this, two mounting brackets are included: one for flat surfaces and one for curved surfaces like the robot's link modules.

The allen keys to open the clamps and disassemble the modular configuration

1. Do not use the emergency allen keys in any other case. Not placing them in their bracket can increase the likelihood of permanent injuries in emergencies.
2. When disassembling the robot in an emergency, parts of the robot can fall down and lead to injuries!

Safety Functions

This section provides an overview of the safety functions of the RobCo modular robot system.

The RobCo modular robot contains a series of build-in safety functions including safe inputs and outputs (*safe I/O*) for external electrical safety devices. Each safety function and *safe I/O* is observed according to EN ISO 13849-1:2015 (see Certifications) (certificate pending). The supervision is of performance level d (PLd) and Category 3-Architecture.

> ❶ Note
>
> 1. The use and configuration of safety functions and interfaces must follow the risk assessment procedures for each robot application (see General Safety section *Risk Assessment*).
> 2. If the robot discovers a fault or violation in the safety system (e.g. if one of the wires in the Emergency Stop circuit is cut) then the emergency stop is initiated.
> 3. The stopping time and distance should be considered as part of the application's risk assessment.

⚠️ | **DANGER**

1. Ensure tools and grippers are connected appropriately so if there is an interruption of power, no hazards occur.
2. The use of a safety configuration different from the one determined by the risk assessment can result in hazards that are not reasonably eliminated or risks that are not sufficiently reduced.
3. If using any external safety devices, they must comply with pl d cat. 3 according to EN ISO 13849-1!
4. The end effector is not protected by the RobCo safety system. If no tool/end effector is applied, please cover the last module's outlet with a safety cap!

Stop Categories

Depending on the safety function, the modular robot can perform two kinds of stop-categories (according to IEC 60204-1). They are described in the following table:

Stop Category	Description
0 (SS0)	immediately cutting the power connection to the servo motors and engaging safety brakes
1 (SS1)	robot is stopped in a controlled manner, after 500 ms the power connection to the servo motors is cut and the safety brakes are engaged.

Safety Functions

The robot safety functions are used to reduce robot system risks determined by the risk assessment. The maximum delay between triggering a safety function and the robot stopping time is 527 ms. The following safety functions are implemented:

- SF0: Emergency Stop
- SF1: Safeguard Stop
- SF2: Safeguard Stop with optional Automatic Reset
- SF3: Three Position Enabling Device
- SF4: Mode Selection
- SF5: Robot Stop Output

❶ Note

Testing of the safety functions is necessary after each reconfiguration of the robot system. Especially external safety devices need to be tested regularly in compliance with the conducted risk assessment/the required category and performance level

SF0: Emergency Stop

Description: Pressing the *emergency stop button* on the hand-held device or, if used, an external emergency stop results in a category 1 stop according to IEC 60204-1. After the release of the emergency stop, the *RESET* button must be pressed to re-enable the operation.

performance level and structure category: PL d, cat 3, ISO 13849-1:2015

SF1: Safeguard Stop

Description: Safeguard Stop 1 is one of the two safe inputs. The Safeguard Stop 1 results in a category 1 stop as SF0 but it is for connecting external safety devices like light curtains or door switches or connecting an external safety device. After the release of the Safeguard Stop 1, the *RESET* button must be pressed to re-enable the operation. This function is only active in automatic mode (see SF4). OSSD is not required but tolerated. In case no external

safety devices are connected, the safety function can be disabled by bridging it with two jumper wires (see Electrical Parts and Installation, chapter *Safety I/O*), which is done by default

performance level and structure category: PL d, cat 3, ISO 13849-1:2015

Mean Time to dangerous Failure (MTTF_d): 273 years

Diagnostic coverage (DC_avg): 99%

SF2: Safeguard Stop with Optional Automatic Reset

Description: Safeguard Stop 2 is the second of two safety inputs. It's got the same functionality as SF1 but with an optional automatic restart. By default, the optional automatic restart is disabled and Safeguard Stop 2 behaves analogously to Safeguard Stop 1. The optional automatic reset can be activated by inserting a bridge at the safety inputs/outputs panel (see :doc: *electrical*) After the release of the Safeguard Stop 2 with Automatic Reset, no external reset signal is needed, the robot resumes operability automatically. This function is only to be used with suitable safety devices like LIDAR scanners or an external safety device. This function is only active in automatic mode (see SF4). OSSD is not required but tolerated. In case no external safety devices are connected, the safety function can be disabled by bridging it with two jumper wires (see Electrical Parts and Installation, chapter *Safety I/O*), which is done by default.

performance level and structure category: PL d, cat 3, ISO 13849-1:2015

Mean Time to dangerous Failure (MTTF_d): 273 years

Diagnostic coverage (DC_avg): 99%

SF3: Three Position Enabling Device

Description: When the *three-position switch* is not held in its middle position, an emergency stop (SF0) is active. After pressing the three-position switch in the middle position, the *RESET* button must be pressed to reenable the operation. This Function is only active in Setup mode (see SF4).

performance level and structure category: PL d, cat 3, ISO 13849-1:2015

SF4: Mode Selection

Description: If the mode selection switch is set to the *Setup mode* the programming/teaching mode is selected (i.e. SF1 and SF2 are disabled, SF3 is enabled). If the mode switch is set to *automatic mode*, the operation mode is selected (i.e. SF1 and SF2 are enabled, SF3 is

disabled). When switching between modes, an emergency stop (SF0) is triggered. A key switch is used to only allow authorized persons to switch between modes. The switch can be locked in both positions.

performance level and structure category: PL d, cat 3, ISO 13849-1:2015

SF5: Robot Stop Output

Description: If there is an emergency stop (SF0) or Safeguard Stop (SF1 or SF2) condition, the dual outputs are Low. Otherwise, the redundant outputs are high. This function can be used for communication with an external safety controller.

performance level and structure category: PL d, cat 3, ISO 13849-1:2015

**Mean Time to dangerous Failure (MTTF_d):** 21 416 years

Diagnostic coverage (DC_avg): 99%

Reactions of the Safety System

The safety system is acting by observing its state and the state of its inputs, eg. whether a safety stop was triggered. The safety system reacts the following way:

Source	Reaction
triggering a safety function (SF0 to SF4)	stop category 1
error detection (e.g. power breakdown)	stop category 0

In order to reenable the robot after it has stopped, pressing the *RESET* button is necessary. A flashing *RESET* button indicates that all safety functions are satisfied, and the robot can be activated by pressing the *RESET* button. The *RESET* button then changes to steady light, indicating that the safety functions and the robot are set active. A non-lit *RESET* button indicates that the robot is not activated and in its safe state and can't be activated by pressing the *RESET* button.
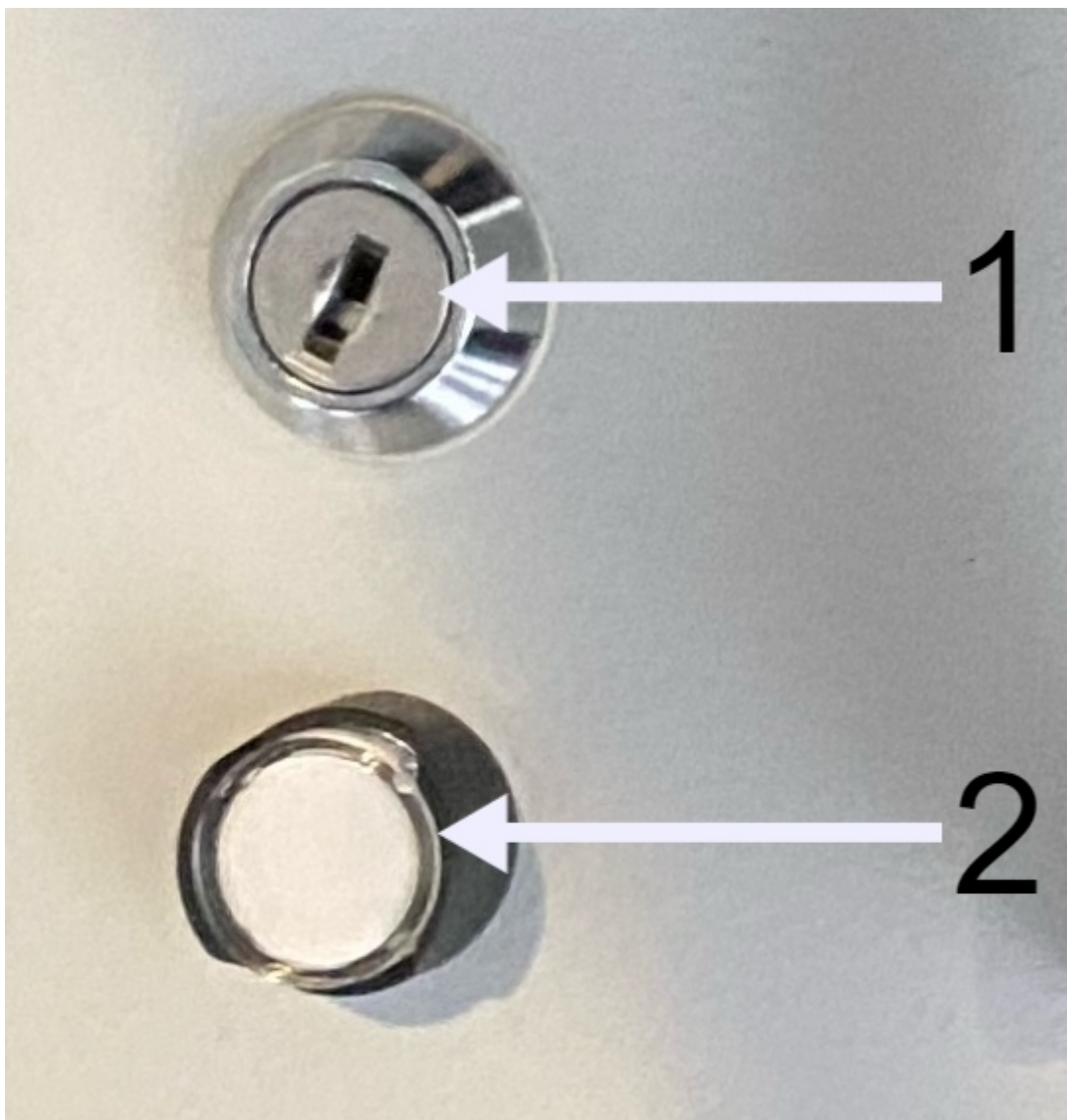
Key switch(1) and the RESET button(2) on the Control Unit

Modes of Operation

The robot's safety system knows two modes: *Setup mode* and *automatic mode*. The operator can switch between the modes with the *Key Switch*, shown in the above figure. In both modes, no communication loss is expected due to constant I/O exchange.

⚠️	WARNING

The Key for Key Switch should be kept away from any unauthorized usage!

Setup mode: *Setup mode* can be used for teaching a new robot task. In this mode, the external safety inputs (SF1 and SF2) are disabled, the *three-position enabling device* (SF3) is enabled. To teach a robot, hold the Three-Position-Switch in the middle position and move the robot on the correct trajectory via jogging (see UDP Interface for details). All movements of the robot are limited to 250 mm/s (no safety function).

DANGER

1. In this mode every operator must stay clear of the working area of the robot!
2. The *teaching operator* should see the whole working area of the robot!
3. The end-effector velocity is limited but not safely supervised in this mode.

Automatic mode: *Automatic mode* is selected for the automatic operation of the robot. The external safety inputs (SF1 and SF2) are enabled, the *three-position enabling device* (SF3) is disabled. Suitable safety sensors must be connected to the safety inputs to reduce risks according to the performed risk assessment.


DANGER

1. The function of all safety instances must be restored **before** the Automatic Mode is switched on!
2. In this mode the operator is required to stay clear of the robot's working area!
3. Suitable guards must be present in automatic mode.

Furthermore, within the automatic mode, the second external safety input can be set to automatic reset mode. This can be done by inserting a wire bridge at the safety inputs/outputs panel (see Electrical Parts and Installation, chapter *Safety I/O*).

Handheld Device

The Handheld device has a Three-position switch (must be held in the middle position in teaching mode) and an *Emergency Stop button* as well as redundant buttons. It is delivered already connected to the Control Unit. Activation of the *emergency stop button* results in an SF0-stop in any mode.
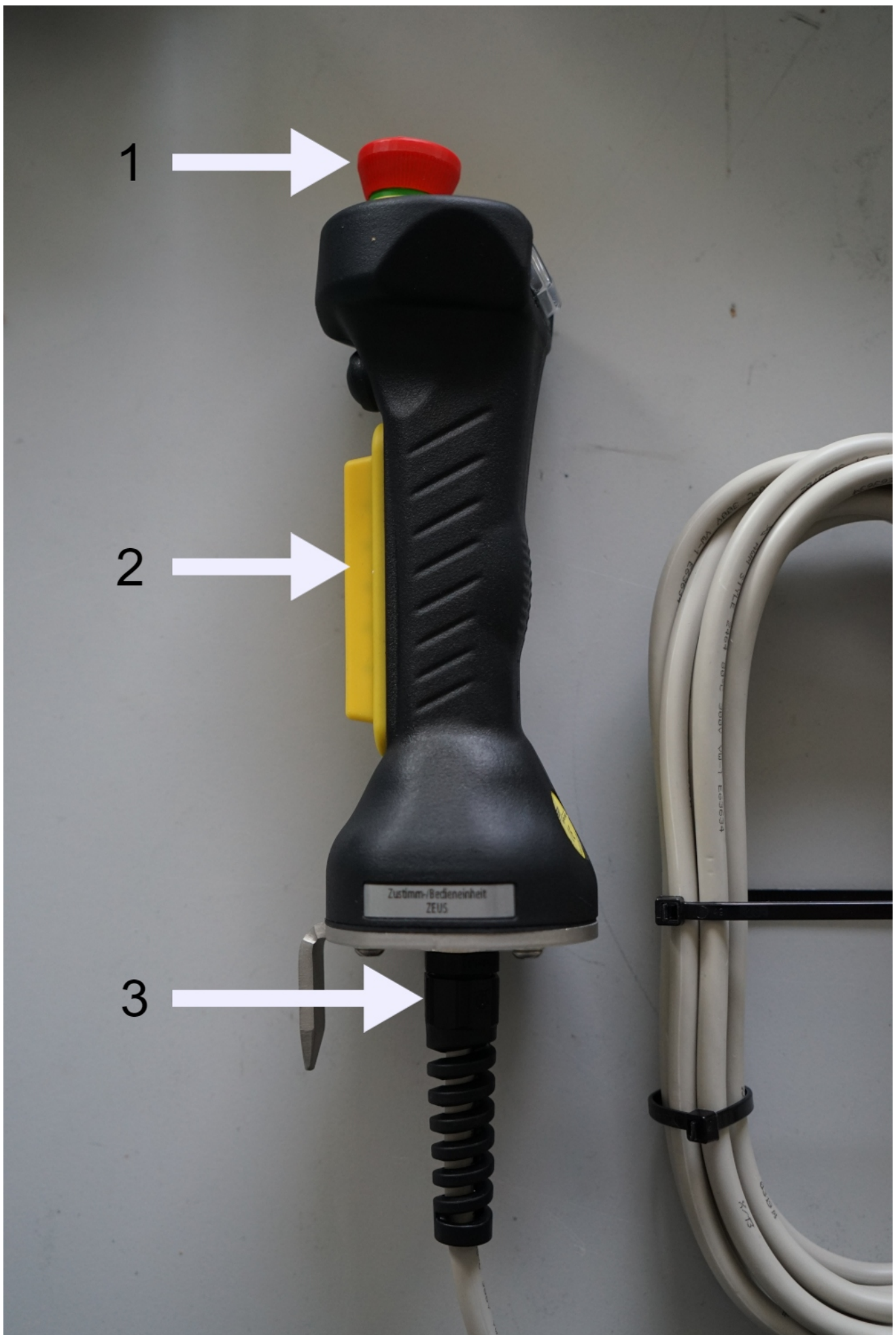
Handheld device. 1-Emergency stop button, 2-Three-position switch, 3-Connection to control unit

Mechanical Stops

If required according to the conducted risk assessment mechanical stops can be fitted to the drive modules of sizes D116 and D148. These restrict the working angle of these modules to +-172.5° and +-174° respectively. For mounting the mechanical stops, the Module has to be separated. The stop cover must be removed and replaced by the stop pin. Fasten the two screws properly.
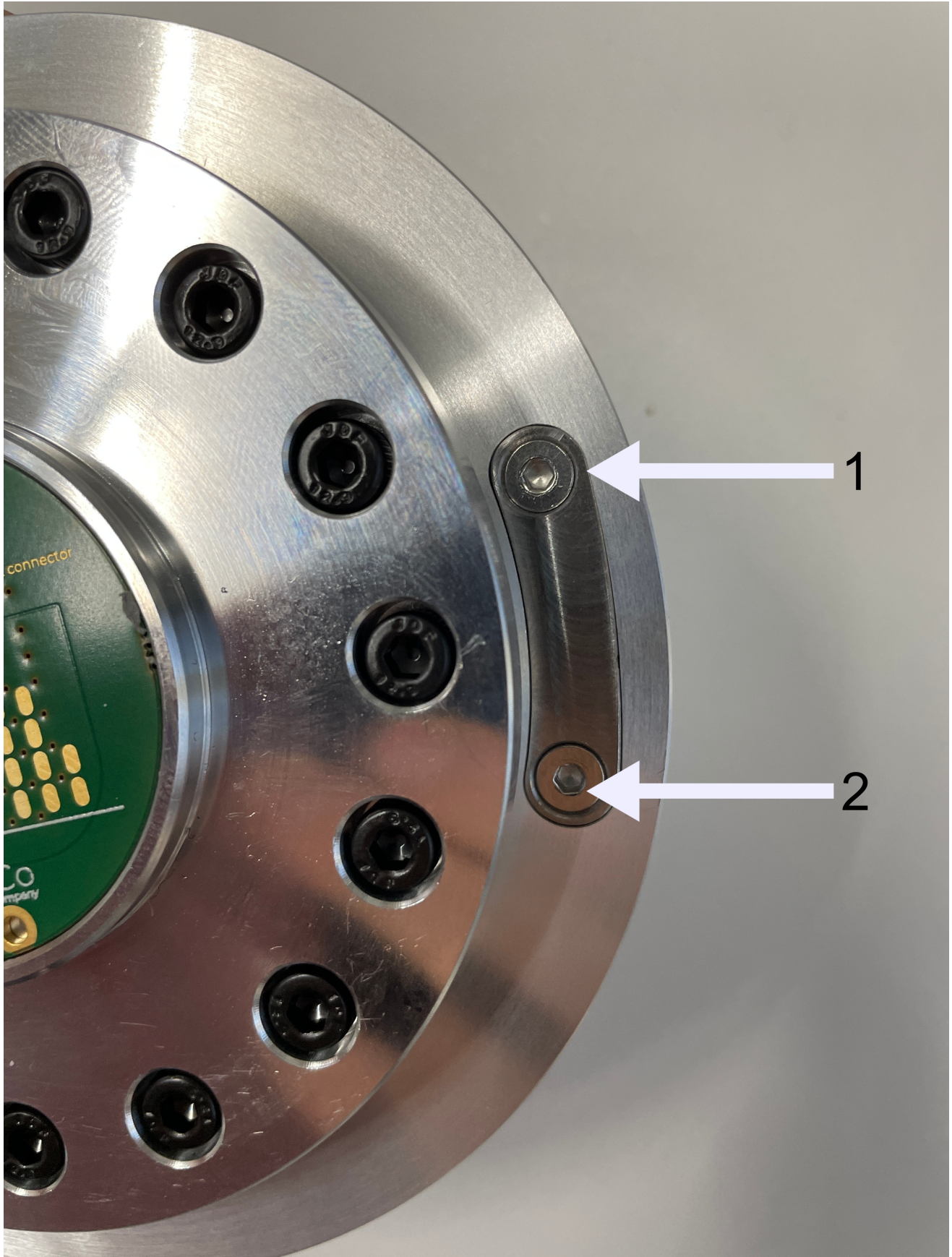
The two screws (1) & (2)

Transportation and Storage

Only transport and store the modules in original packaging. Save the packaging material in a dry place if you want to move the modules later.

When moving the modules from their packaging to the installation space, hold them with both hands at the same time. Make sure to mount the base and apply the clamps on the modules properly. Also, make sure the bolt-hole interface between the modules fits. When storing the modules store them in a dry place. Prevent direct sunlight.

Lift single modules only. If lifting of a robot assembly is necessary, move the robot into a suitable position and attach lifting straps to link modules. Contact RobCo for the suitable lifting position and positioning of lifting straps for your robot composition.

⚠️	WARNING

1. Make sure not to overload your back or other body parts when lifting the robot modules. Use proper lifting equipment. All regional and national lifting guidelines shall be followed.
2. Make sure to mount the robot according to the instructions in Mechanical Parts and Installation.
3. Lifting the robot as a whole assembly in an unsuitable position can lead to the robot falling down.

⚠️	WARNING

Beware of electrostatic discharge during transportation of the modules!

Mechanical Parts and Installation

This chapter describes the basics of mounting the parts of the RobCo system. Electrical installation instructions in Electrical Parts and Installation must be observed.

Workspace of the Robot

Since lots of configurations are available, the robotic arm could extend from 200mm up to more than 1900mm from the base joint. It is also important to consider the robot's reachable length to estimate the maximum reachable height to mount the Base in a proper place. The respected workspace should be estimated for each configuration separately.

> ❶ Note
>
> The length and workspace of the robotic arm depend on the configuration!
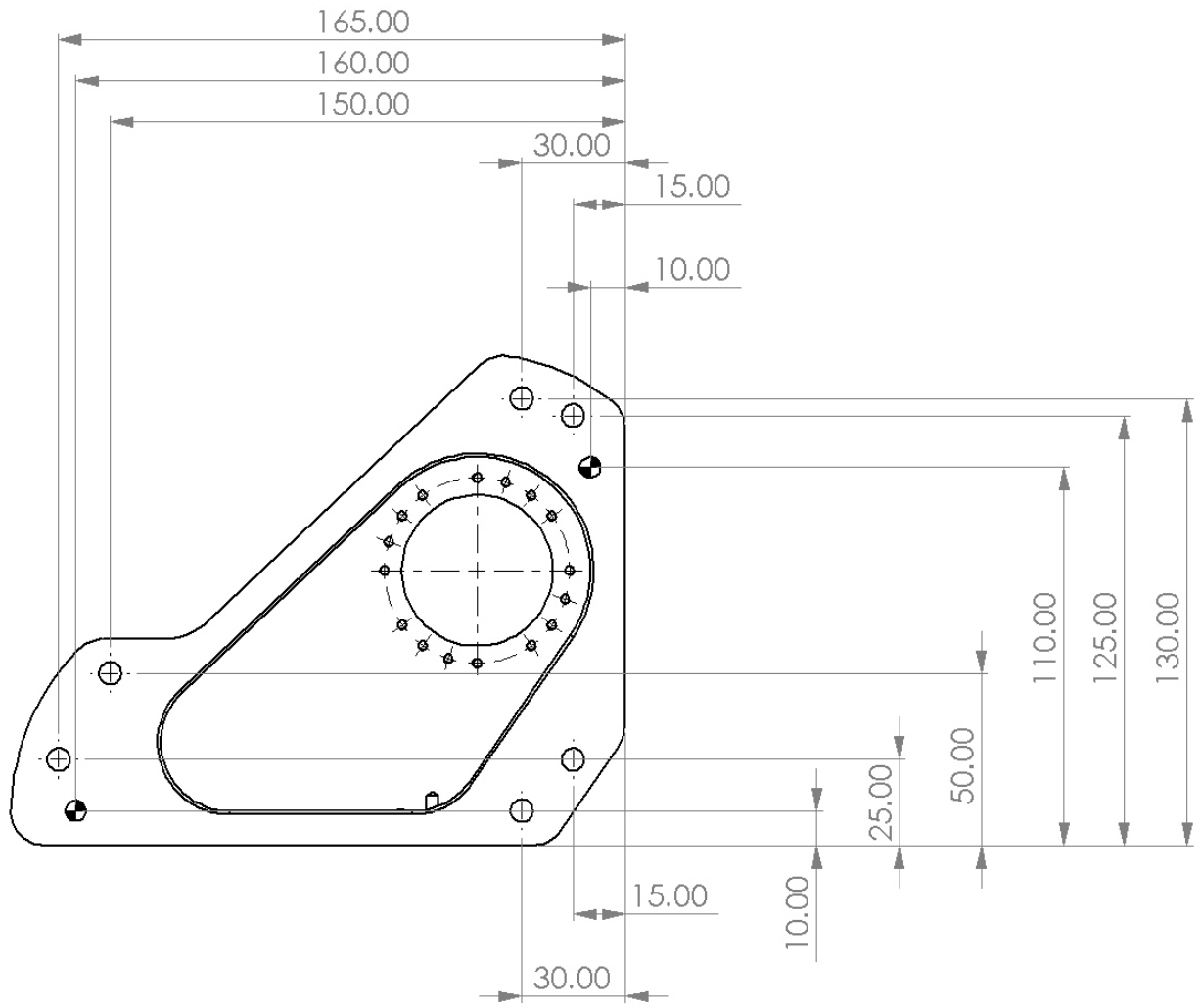
Mounting

Base

> ❶ Note
>
> The Base Module must be mounted on a rigid and planar surface. It must be suitable for carrying the dynamic loads of the robot and its payload in emergencies as well.

There are two types of bases available depending on the field of application:

The plane Base:

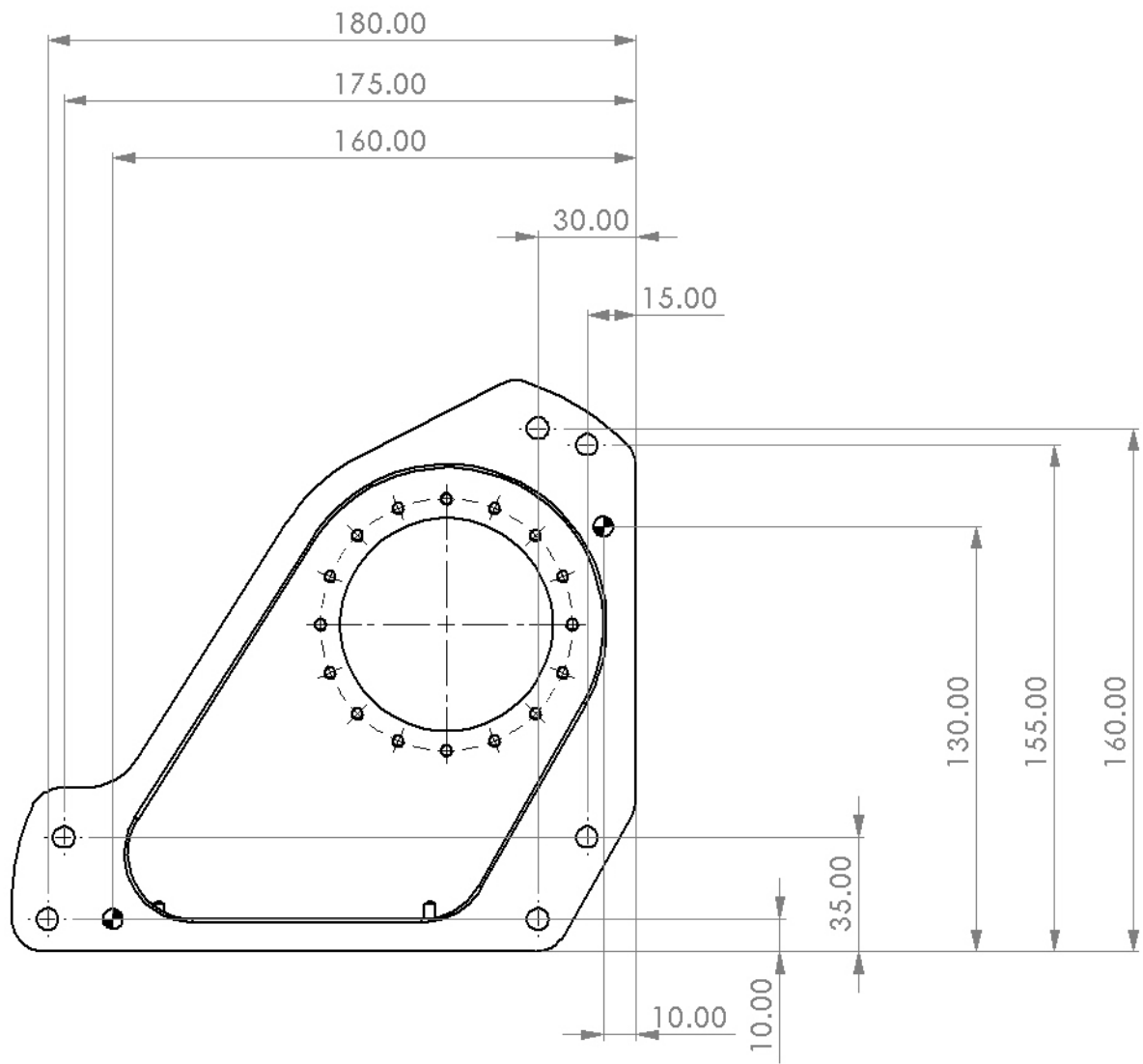The base module is fixed with six M6 bolts and two 6.0 mm dowel pins in the appropriate holes. Please apply a thread locker before screwing the bolts. Since the base module is available in three sizes, the hole positions differ. The following drawings show the exact position of the mounting holes (all data is in mm). The base module is shown from below:

1. Plane base B86:

2. Plane base B116:

3. Plane base B148:

DANGER

The horizontal base's bolts should be mounted with 10 Nm torque (minimum hardness 8.8 for bases' bolts)!

The 90° base:

The 90° base allows mounting the robot 90° to the surface. This base is fixed with four M8 bolts into four holes. Please apply a thread locker before screwing the bolts. The 90° base module is also available in three sizes. They share a common mounting hole scheme, the
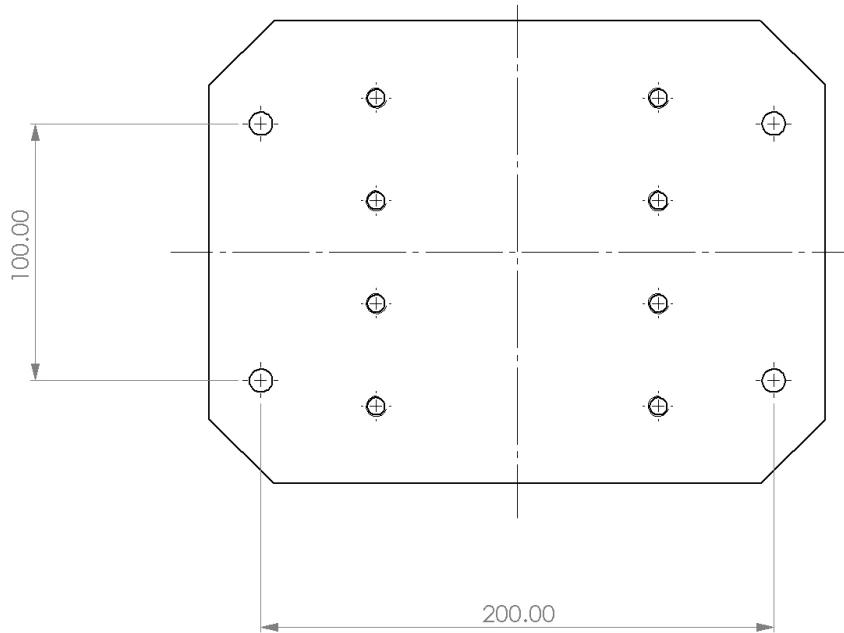
positions of the holes are displayed below:

DANGER

1. The 90° corner base's bolts with 20 Nm torque (minimum hardness 8.8 for bases' bolts)!
2. Check the torques, the base is the most important element for the robot's mechanical stability!
3. Mount the base on a steady, plane surface!
4. The mounting surface for the base modules must be horizontal. Contact RobCo in case you want to mount the base vertically, or from the ceiling, or in any other way.

Module Assembly

This section provides information on how to assemble a robot from individual modules starting from base up to the end-effector.


DANGER

1. Please beware of all the warnings on the base!
2. For assembling the Robot two persons equipped with safety shoes and gloves are required!

3. The Control Unit must be placed away from Robot's reachable area!
4. Mount the robot in an environment suited for its IP rating (see technical specification). The robot must not be operated in environments that exceed those corresponding to the IP ratings of the robot!

⚠️ **DANGER**

Before (dis-)/assembling the robot the control unit must be switched off and all energy sources must be disconnected from the base module!
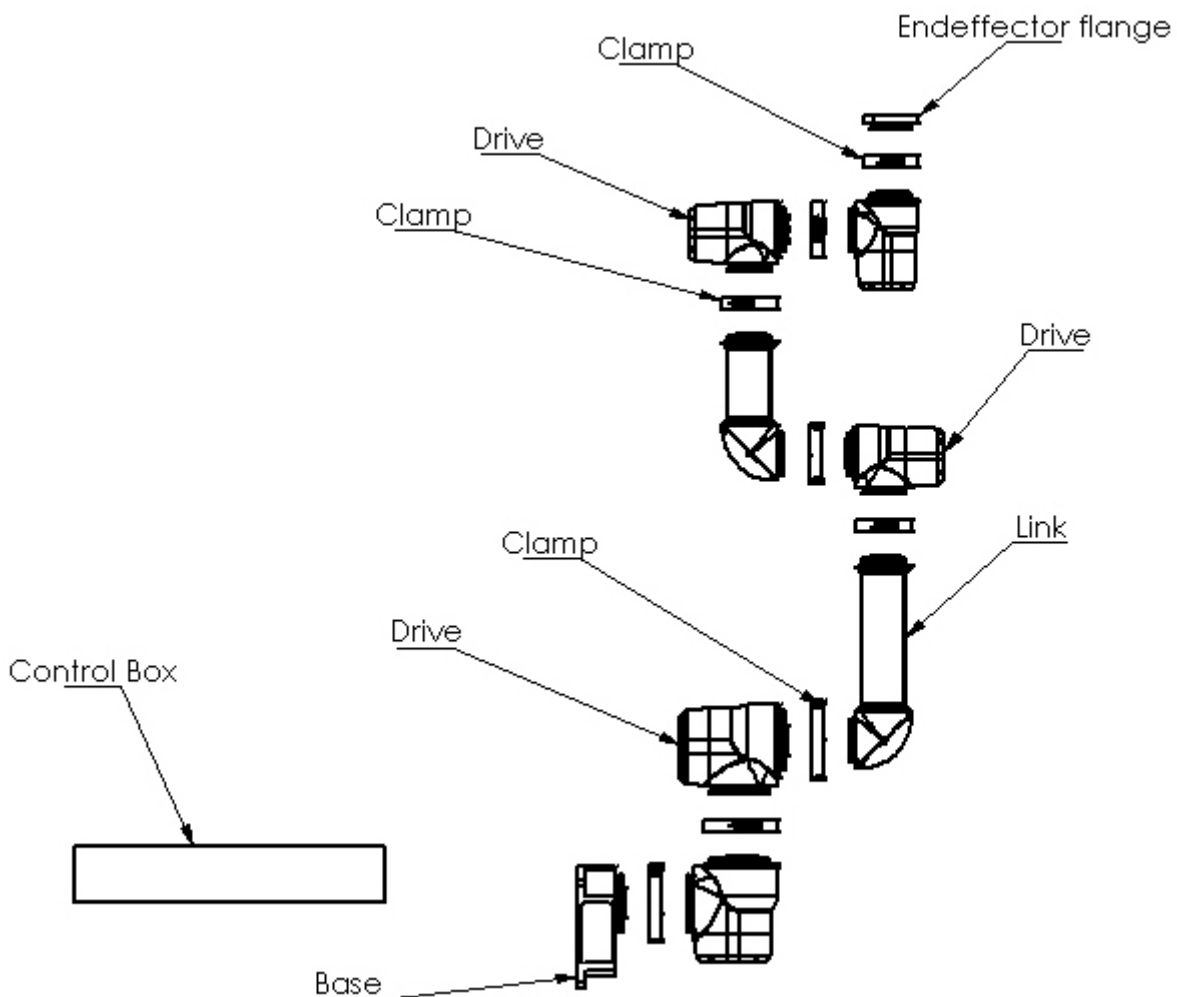
Possible robot assembly(5 drives, 2 links, base, and end-effector)

❶ Note

The modules are designed in such a way, that it is easily possible to hold each with two hands and also hold each with one hand while assembling the robotic arm configuration. Each module has a label including the following information on:

1. Name, Serial Number, **Torque**, Type, and Mass for **Drive** Modules
2. Name, Serial Number, **Length**, Type, and Mass for **Link** Modules
3. Name, Serial Number, Type, and Mass for all other modules
4. Name, Serial Number, and Power for Control Units

What is needed for module connection:

1. Two modules (drive-link, drive-drive or link-link)
2. Two half-clamps of the appropriate size.
3. Two M4x16-12.9, M5x16-12.9, or M6x25-12.9 bolts for different sizes of clamps. The hardness of the bolts is 12.9 and the respectful torques for their proper installation are 4.5, 9, 15 Nm for the three different sizes.

The modules are being connected in the following way:

1. Connect the modules face to face, such that the dowel pin and hole fit together. The pin will create a distance between the modules, resulting in a visible attribute of a false connection, if the pin-hole connection is wrong!
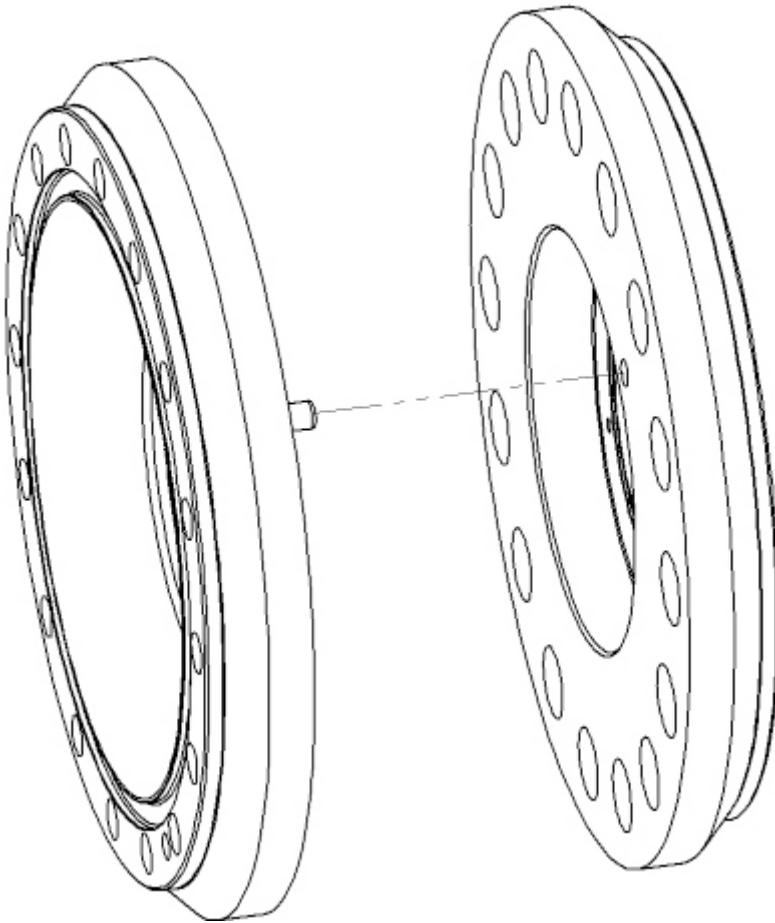
BH connection

2. Apply the clamp on the interface for a stable connection. For this, you need two half-clamps and two bolts of the respectful size. Turn one of the halves, so that the bigger hole of one is near the smaller of the other, bolt the clamp together as shown below. Make

sure both clamps have an equal distance to each other on both sides/screw connections. A skew connection may result in inaccuracies. Re-tighten both sides twice.
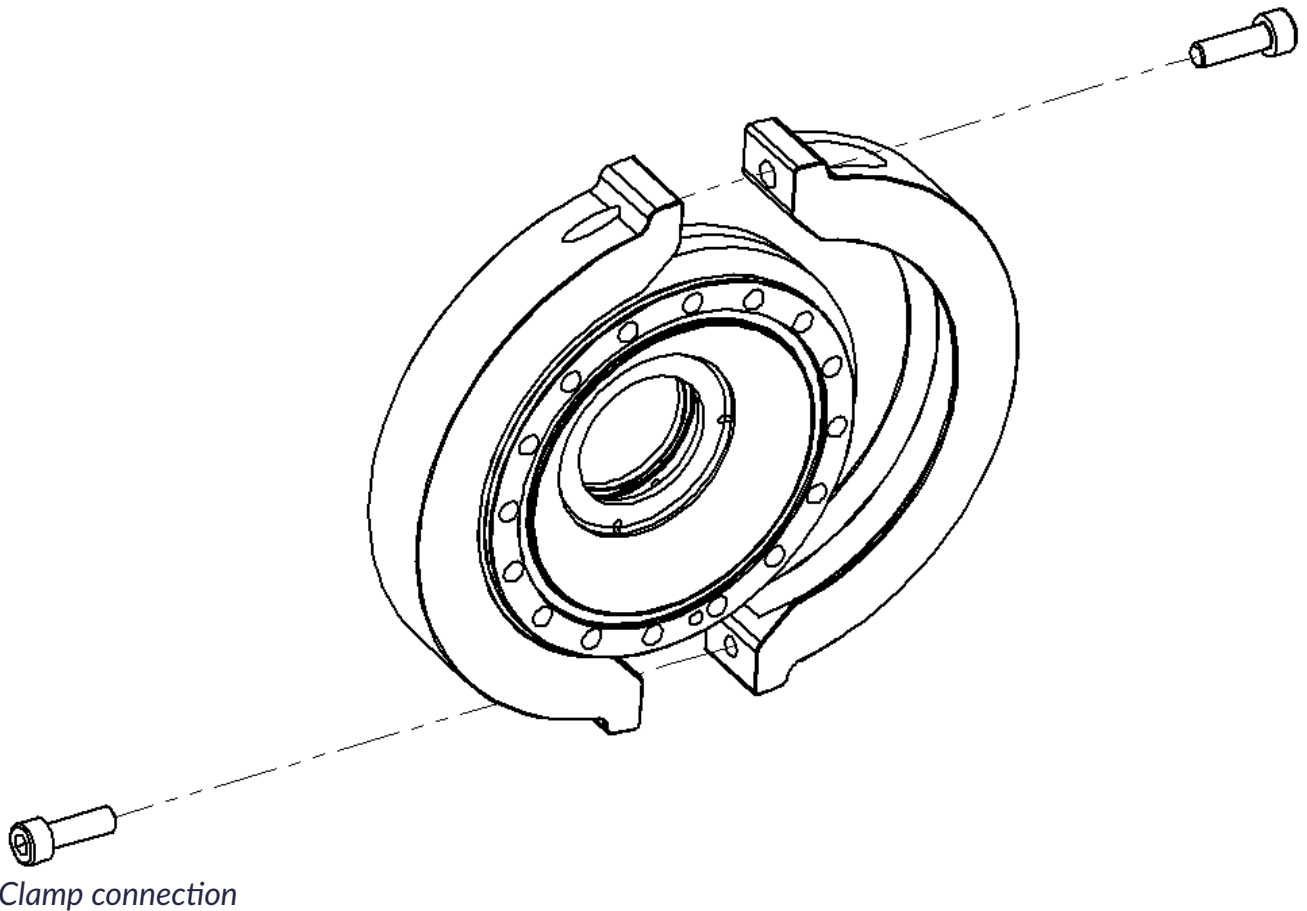
Clamp connection

DANGER

1. Apply thread locker and spring washers on the bolts for a more stable connection!
2. Check the torques while applying the clamp!
3. Unproper fix of modules (pin-hole, or clamp connection, or skew fixation) may result in sudden fall of the module(s) and injuries, at least in the inaccuracy of the robot!
4. Once a module is loose or falls due to insufficient clamp connection, the system initiates a stop.
5. Do not touch the open module contacts (out- or input) while the robot is connected to the power source!

3. Build the respectful Robot configuration with the two steps above. Apply the end effector/tool/safety cap on the last module.

Final Inspection

1. If no end effector/tool is available, apply a safety cap on the end module!
2. Make sure no cables (Control Unit, Handheld Device, or Robot connection) can come in contact with liquids. A wet Control Unit could result in a lethal outcome!

1. Ensure the tool is properly and securely bolted in place.
2. Ensure the tool is such that it cannot create a hazardous situation by dropping a part unexpectedly during the operation of the Robot/Tool.

Also, make sure to:

1. Check the correct torques on the clamp bolts
2. Check that all the parts are fixed properly and nothing falls off
3. Check that the base is securely mounted on a stable, solid ground
4. Check that no electrical open inputs/outputs are present
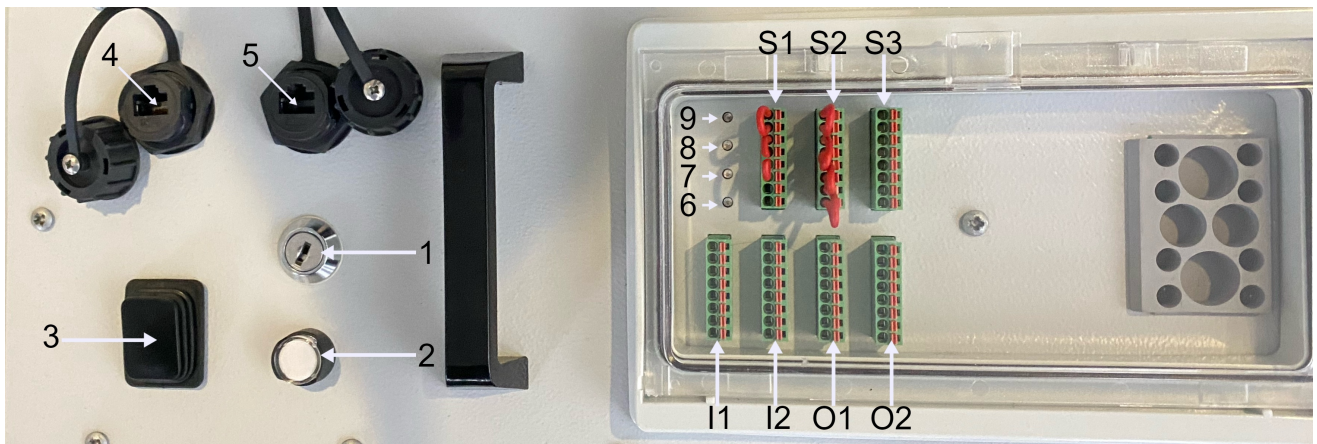5. Check that the tool is fixed properly

Maximum Load

The maximum carriable load depends on the configuration, the loads are specified in technical data.

Electrical Parts and Installation

This chapter describes electrical interface groups for the robotic arm and peripheral devices on the Control Unit.

Overview of Control Unit Connections

The front panel of the Control Unit. 1-Key mode switch, 2-RESET button, 3-Robot on/off, 4-PC/tablet main connection, 5- Ethernet for peripherals; 6,7,8,9 - LEDs; S1,2,3 - safety I/O; I1,2 - general digital input; O1,2 - general digital output

On the front panel of the RobCo modular robot's control unit, you will find two RJ45 connectors for Ethernet communication (see Ethernet, as well as a block of I/O ports including three slots to connect external safety devices/configure the safety functions. The Ethernet port labelled "PC" (4) is used to connect a control PC/Tablet, the other port (5) is used for peripheral device connection (see Ethernet for Peripherals).

1   2
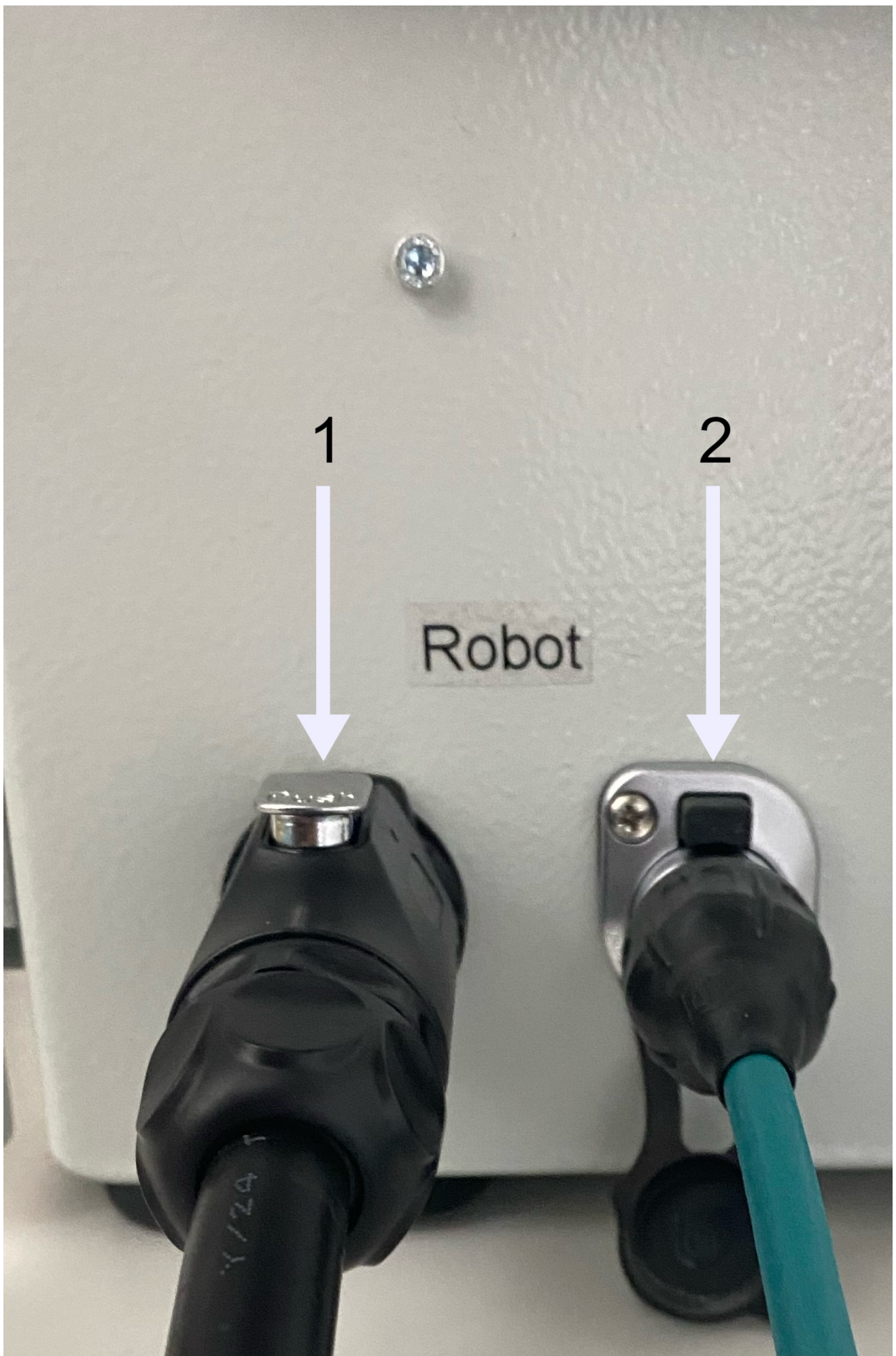
Robot

The front side of the Control Unit

On the front side of the Control Unit, you can find two connections: robot power(1) and robot communication(2).

The back side of the Control Unit

On the backside of the Control Unit, the mains power connector and M6 earthing connector are available.

Ethernet

The Ethernet can be used for:

- MODBUS, UDP and TCP
- Teaching device connection
- Peripheral device connection

It can be used to connect a PC or tablet device for programming and one or more peripheral devices if required. The PC connection is required in order to control the robot and bring it to operation.

Connect the Ethernet by opening the RJ 45 socket on the top of the Control Unit and then connect the matching end of the Ethernet cable to the Control Unit, and the other end to the respected device.

The specifications for Ethernet connections are:

Parameter	Min	Max
Communication speed		
(Peripheral)	10 Mb/s	1000 Mb/s
Communication speed (PC)	10 Mb/s	100 Mb/s

WARNING

Only use dedicated Ethernet cables with the corresponding plug to ensure IP protection class (IP67). In case an RJ45 socket is not used, it needs to be closed to ensure IP protection class.

Overview of Control Unit Buttons and LEDs
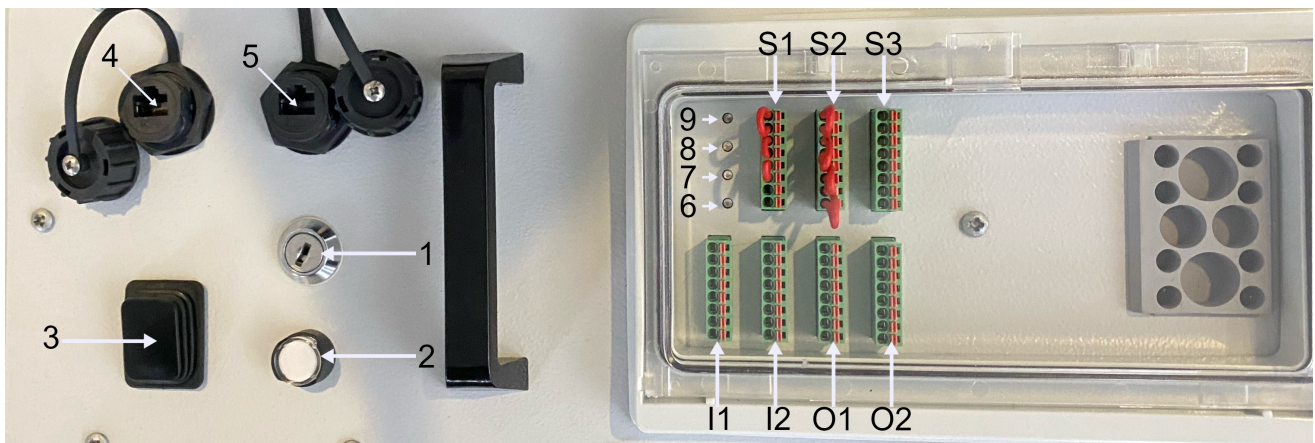
The two switches on top of the Control Unit

There are **two** switches on the control unit: A **power switch** (3) and a momentary **reset switch** (2). The power switch is used to switch power to the robot arm and the logic control on and off. Before you switch on the whole system, the mains power indicator, shown in the figure below, shines to show that the system is supplied with energy. After operating the switch, the indicators for 24V and 48V ((7) and (8) in the figure below) should light up.

The **RESET button** starts to blink after the start of the system ensuring the correct initialization of safety functions. It must be pressed in order to start the operation. It also can be pressed after E-stop, SF1-Stop, or any emergency (power shutdown, fluctuations etc.) to reenable the robot's operation.

The Control Unit LED's functions are shown in the image below:
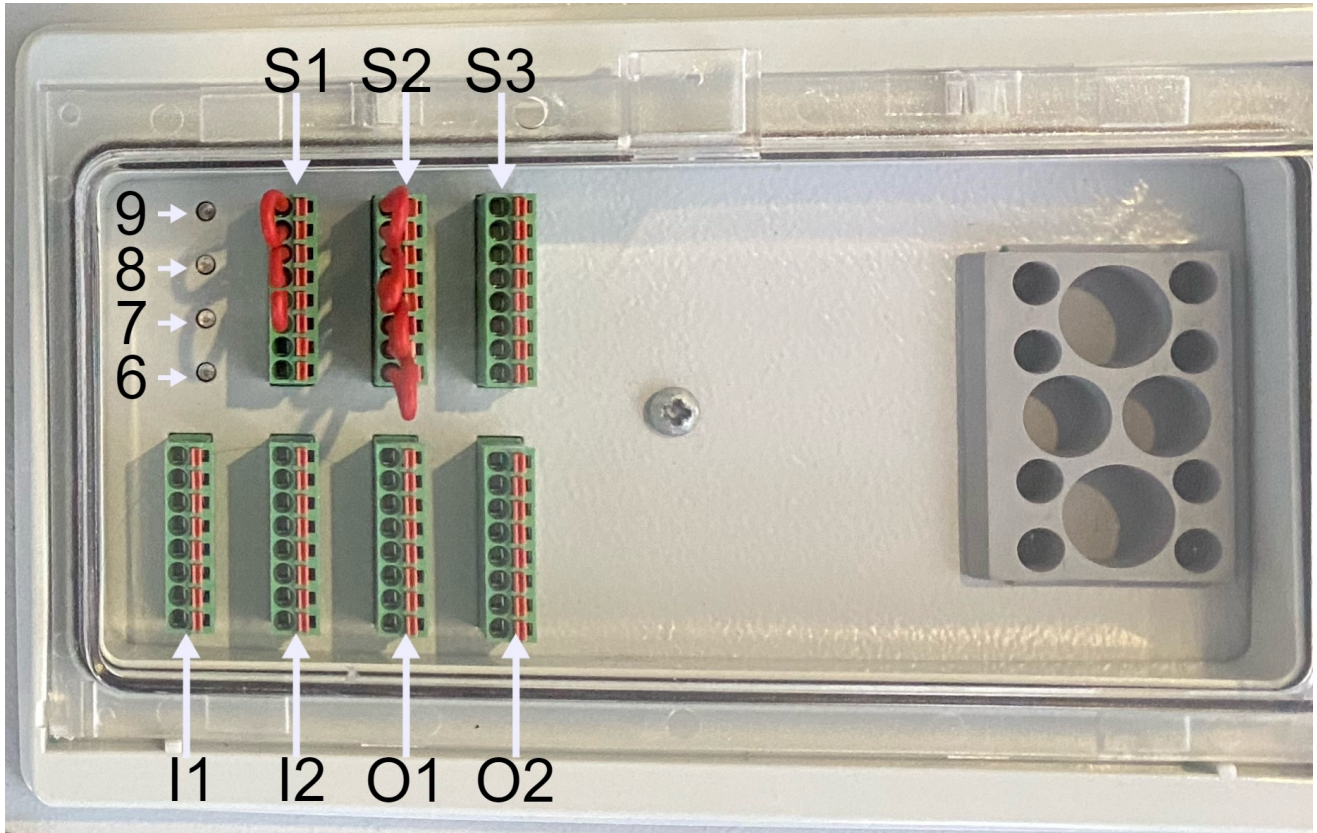
Overview of the Control Unit I/Os and LEDs. LEDs function: 6-mains OK, 7-48V OK, 8- 24V OK, 9- Safety error

Electrical Warnings and Cautions

Observe the following warnings for all the aforementioned interfaces (connections and buttons), when the robot application is designed and installed.

⚠	DANGER

1. Never connect safety signals to a PLC which is not a safety PLC with the correct safety level. Failure to follow this warning could result in serious injury or death as the safety functions could be overridden. All external safety devices must comply with cat. 3, PL d as of EN ISO 13849-1!
2. All safety-related signals are constructed redundantly (two independent channels). Keep the two channels separate so that a single fault cannot lead to loss of the safety function.

⚡	DANGER

1. Make sure all equipment not rated for water exposure remains dry.
2. Use only the original cables supplied with the robot! Do not use the robot for applications where the cables are subject to bending/flexing.
3. All cables connecting the Robot to the Control Unit must not be longer than 3 m!
4. The cables must not leave the room/closed space.

⚠️ **CAUTION**

1. The robot has been tested according to international IEC standards for *Electro Magnetic Compatibility* (EMC). Disturbing signals with levels higher than those defined in the specific IEC standards can cause unexpected behaviours from the robot. 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. RobCo cannot be held responsible for any damages caused by EMC problems.
2. Cables and wires going from the Control Unit to other machinery and factory equipment may not be longer than 30m unless additional tests are performed.

Earthing

For the modular robot system to be safe, function correctly and comply with the EMC standards, proper earthing must be provided. For this, the robot and the control unit must be attached to a suitable earthing. The robot must be mounted on a surface connected to earth, the control unit must be connected to this surface using the marked M6 earthing connection. Both connections must be sized according to the maximum system current, but not smaller than 6 mm².

M6 earthing connector

⚠	DANGER

All marked ground connections (GND) are only designed for functional use. Use the marked M6 Connection as protective earth connection (PE) at the control unit. Size the wiring according to the system's maximum current.

Connection of a Teach Device

The PC/Tablet represents the teaching and control device for the robot. In PART II: Software Manual it is explained, how to control and operate the robotic arm. After the device is connected to the Control Unit via Ethernet, the operator should visit http://app.robco.de in a browser to start using the system.

⚠	WARNING

Connect only **ONE** Tablet/PC directly to the teaching device Ethernet port. Do not apply chain connections (for example Control Unit->Router->PC) on the device or connect multiple devices to control the robot.

Ethernet for Peripherals

Peripheral devices extending the functionality of the robot system can be connected via the peripheral ethernet port. The respectful IP-Address of the peripheral device should be changed to differ from the one of the Control Unit (see UDP Interface).

Mains Connection

The control unit has a standardized power inlet. Connect an appropriate power cable with a compatible socket and a country-specific mains plug. Make sure to only use cables suitable for the input current of the robot system.

Only use the supplied mains cable to connect the robot system to mains power.

In order to energize the whole system, the Control Unit must be connected to the mains cable via powerCON TRUE1 TOP inlet. To connect the cable plug it in the power inlet with the button slightly turned to the left and rotate clockwise, until the button clicks. To disconnect from the powerCON TRUE1 TOP outlet pull the button, turn anti-clockwise and take the cable out.

The mains supply is equipped with the following:

- Connection to ground
- Main fuse
- Residual current device

The electrical specifications are shown in the table below. The mains supply connected to the robot must fulfil these requirements:

Parameter	Min	Typ	Max
Input Voltage	207 VAC	230 VAC	253 VAC
External mains fuse (@0, 230V)	14 A		16 A
Input frequency	47 Hz		63 Hz
Stand-by Power			2 W
Nominal Power			1200 W

1. Lockout-Tagout all power for the complete robot installation during service. Other equipment shall not supply voltage to the robot I/O when the system is locked out.
2. Ensure all cables are connected correctly before the whole system is powered on. Always use the original power cord.
3. Make sure the robot is correctly earthed. Use the unused screws that belong to the earthing symbols on the Control Unit to make a shared earthing for all devices in the system. The actual current in this system must not lie below the maximum allowed current of the system.
4. Ensure that the input power is protected with an earth leakage circuit breaker and a proper fuse

Make sure that *Power Switch* is in the *Off* position before connecting or disconnecting the mains power connection!

Robot Connection

To connect the robot to energy simply plug the robot power cable in the Control Unit and robots base until the button clicks, to unplug the cable press the button and remove it. Also, plug in the robot communication cable to the robot and Control Unit respectively.

1. Disconnect neither robot communication nor robot power cable, when the robotic arm is turned on.
2. Do not extend or modify original cables.
3. Make sure that *Power Switch* is in the *Off* position before connecting or disconnecting the robot power cable

Controller I/O

You can use the I/O on the top of the Control Unit for a wide range of equipment including pneumatic relays, PLCs, emergency stop buttons, light curtains, etc.

The illustration below shows the layout of electrical interface groups on the Control Unit:
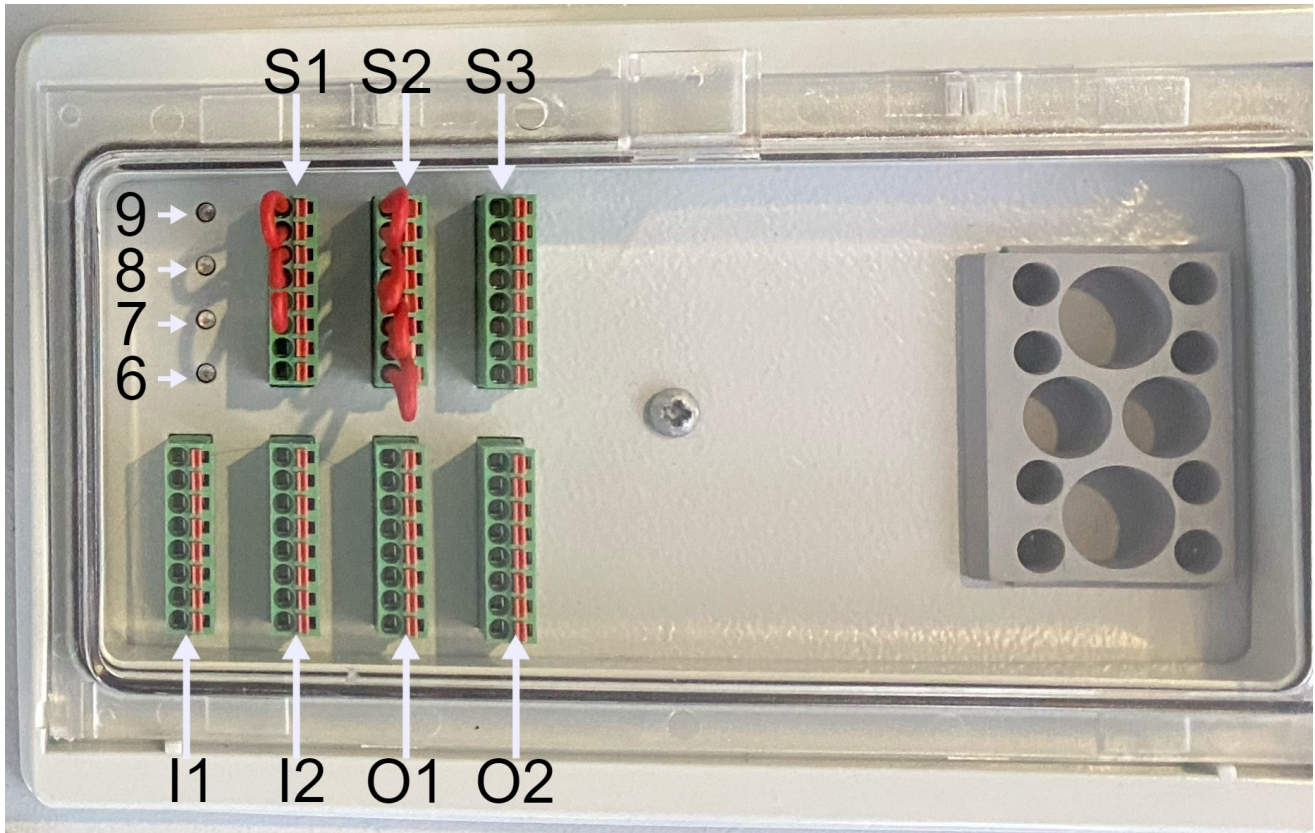
Overview of Control Unit digital I/Os

The connectors I1, I2, O1, and O2 are used for general purposes (connection to other devices/machines/PLCs etc.), the connectors S1, S2, and S3 connectors are reserved for safety functions.

Common specifications for all digital I/O

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

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

Install the robot according to the electrical specifications which are different for inputs/outputs. Some of the output ports of the I/O blocks are connected to an internal 24V power supply, some of the input ports to the GND.

S1

Pin	Signal
8	Automatic Reset SF2 in
7	24V
6	Ext. Reset in
5	24V
4	E-Stop 2 in
3	E-Stop 2 out
2	E-Stop 1 in
1	E-Stop 1 out

S2

Pin	Signal
8	SF2 input 2
7	24V
6	SF2 input 1
5	24V
4	SF1 input 2
3	24V
2	SF1 input 1
1	24V

S3

Pin	Signal
8	
7	
6	
5	
4	SF5 output 2
3	GND
2	SF5 output 1
1	GND

I1

Pin	Signal
8	I4
7	24 V
6	I3
5	24 V
4	I2
3	24 V
2	I1
1	24 V

I2

Pin	Signal
8	I8
7	24 V
6	I7
5	24 V
4	I6
3	24 V
2	I5
1	24 V

O1

Pin	Signal
8	O4
7	GND
6	O3
5	GND
4	O2
3	GND
2	O1
1	GND

O2

Pin	Signal
8	O8
7	GND
6	O7
5	GND
4	O6
3	GND
2	O5
1	GND

Mapping of the CU I/Os. The safety block is highlighted in yellow

The digital I/Os are constructed in compliance with IEC 61131-2. The electrical specifications for the whole I/O block are shown below:

Parameters	Min	Typ	Max
General I/Os: *Outputs*			
Current			0,5A
Output Voltage	20,4V	24VDC	28,8V
Inputs			
Current		3mA	
OFF Region	-3V		5V
ON Region	11V		30V
Safety I/Os: *Outputs*			
Current			2A
Output Voltage	20,4V	24VDC	28,8V
Inputs			
Current	0mA		3mA

OFF Region	0V		5V
ON Region	11V		30V

Safety I/O

In this subchapter, the safety connectors are described, and their proper wiring is shown. Follow the common specifications for all digital I/O in Common specifications for all digital I/O. Safety devices and equipment must be installed according to the safety instructions and the risk assessment as described in General Safety. There are two permanent safety input types:

- **Robot Emergency Stop** for emergency stop equipment only.
- **Safeguard Stop** for other safety-related protective equipment.

The functional difference is shown below:

System	Emergency Stop	Safeguard Stop
Robot stops moving	Yes	Yes
Program execution	Pauses	Pauses
Drive power	Off	Off
Reset	Manual	Automatic or manual
Frequency of use	Infrequent	Every cycle to infrequent
Requires re-initialization	After every use	After every use
Stop Category(IEC 60204-1)	1	1
Performance level	PLd	PLd

Use the available safety I/O to set up additional safety I/O functionality, e.g. Emergency Stop Output.


DANGER

1. Never connect safety signals to a PLC that is not a safety PLC with the correct safety level. Failure to follow this warning could result in serious injury or death. It is important to keep safety interface signals separated from the normal I/O interface signals.
2. Safety functions must be verified before putting the robot into operation. Safety functions must be tested regularly.
3. The robot installation shall conform to these specifications. Failure to do so could result in serious injury or death.

OSSD signal filtering

All 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.

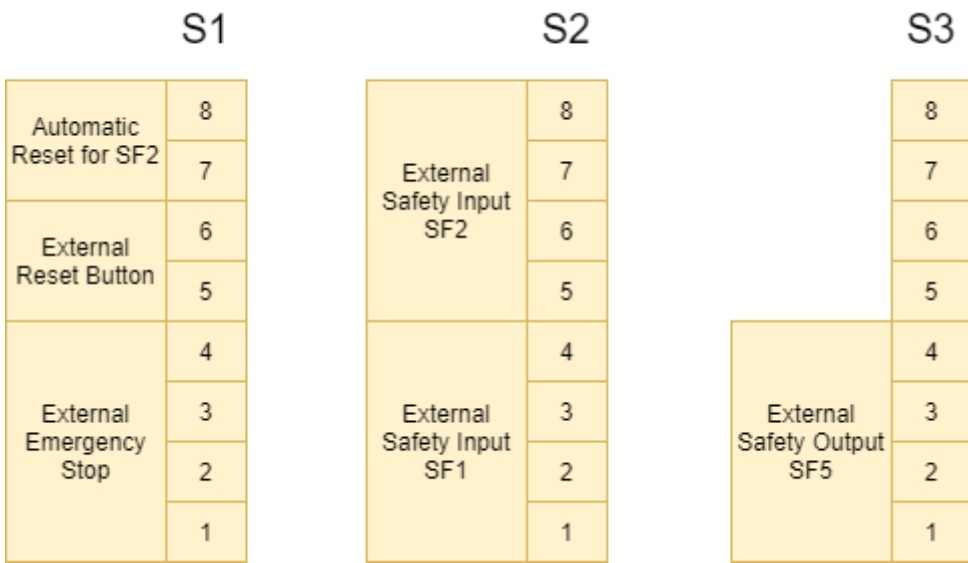## Default safety configuration

The robot is delivered with a default configuration, which enables operation without any additional safety equipment (see illustration below). In this configuration, all connectors used to configure/extend SF0, SF1, and SF2(except for Auto-reset) are wired.
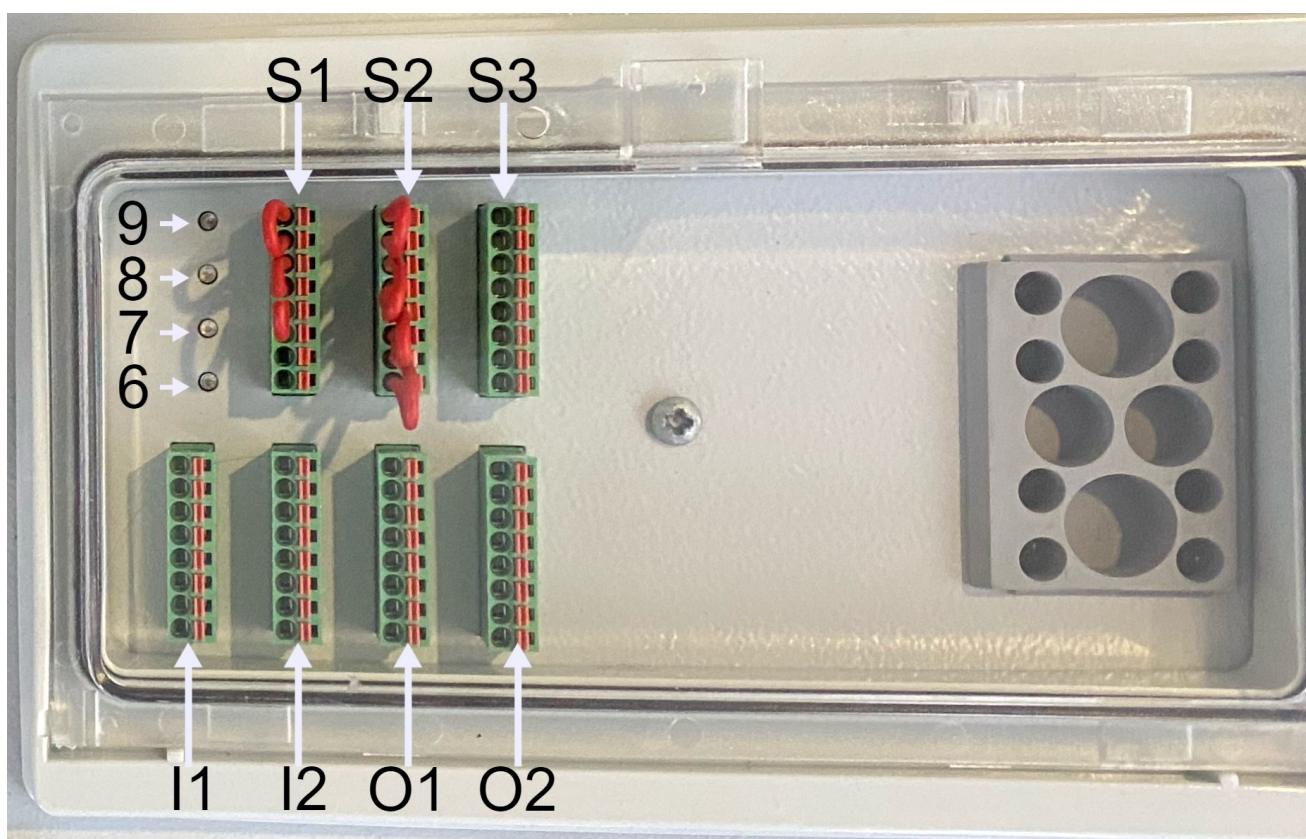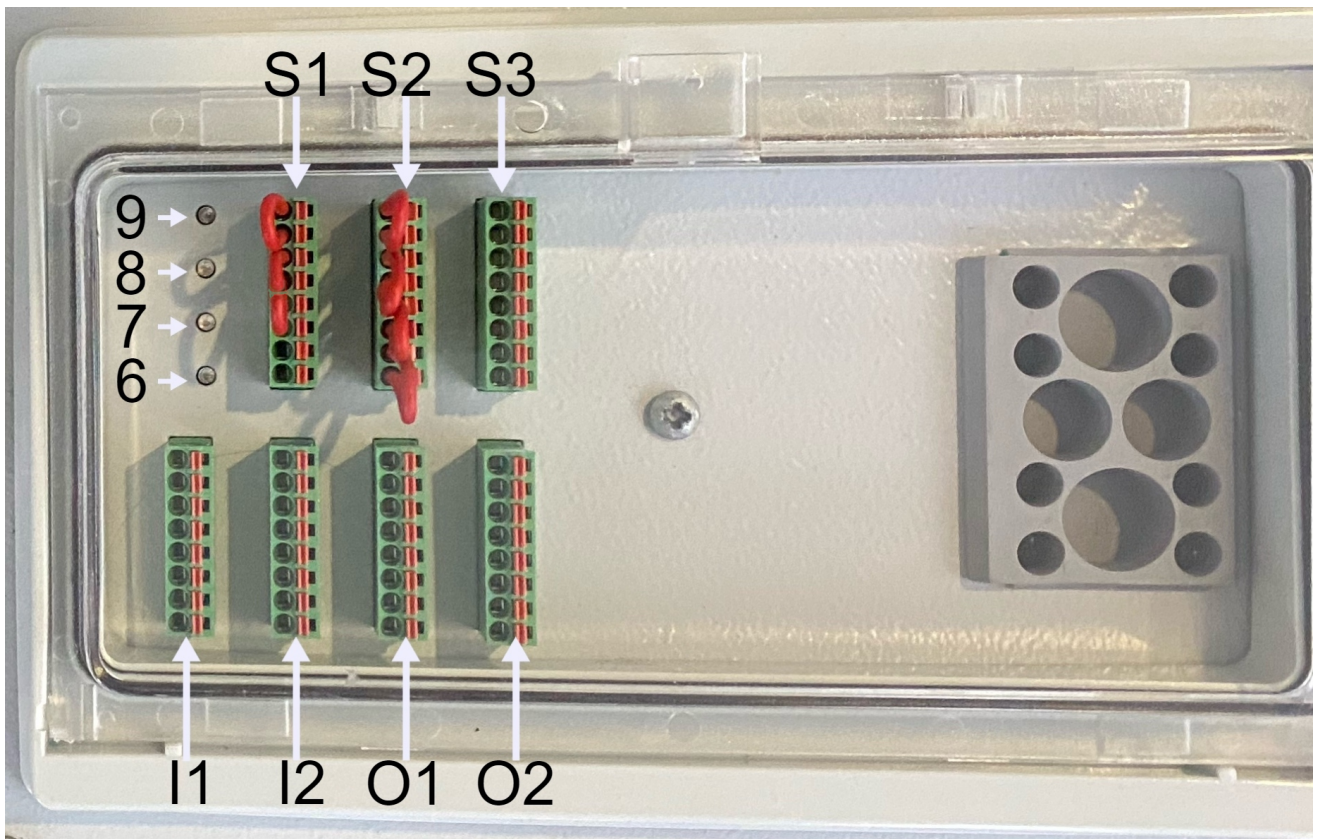

Default wired safety connectors (red cables)

Safety Connectors

The safety connectors *S1*, *S2*, and *S3* are placed on the upper side of the control unit under the protective cover.

S1		
	8	
Automatic Reset for SF2	7	
	6	
External Reset Button	5	
	4	
	3	
External Emergency Stop	2	
	1	

S2		
	8	
External Safety Input SF2	7	
	6	
	5	
	4	
External Safety Input SF1	3	
	2	
	1	

S3		
	8	
	7	
	6	
	5	
	4	
External Safety Output SF5	3	
	2	
	1	

Overview of I/O safety function blocks

Overwiev of safety I/O and LEDs on CU

S1			S2			S3	
Automatic Reset SF2 in	8		SF2 input 2	8			8
24V	7		24V	7			7
Ext. Reset in	6		SF2 input 1	6			6
24V	5		24V	5			5
E-Stop 2 in	4		SF1 input 2	4		SF5 output 2	4
E-Stop 2 out	3		24V	3		GND	3
E-Stop 1 in	2		SF1 input 1	2		SF5 output 1	2
E-Stop 1 out	1		24V	1		GND	1

Overwiev of safety connectors

Wiring the External Emergency Stop Switch (SF0)

The following figures show the correct wiring of the safety connectors:

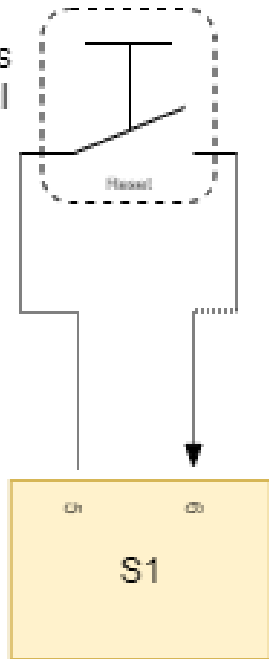### Connecting an external emergency stop
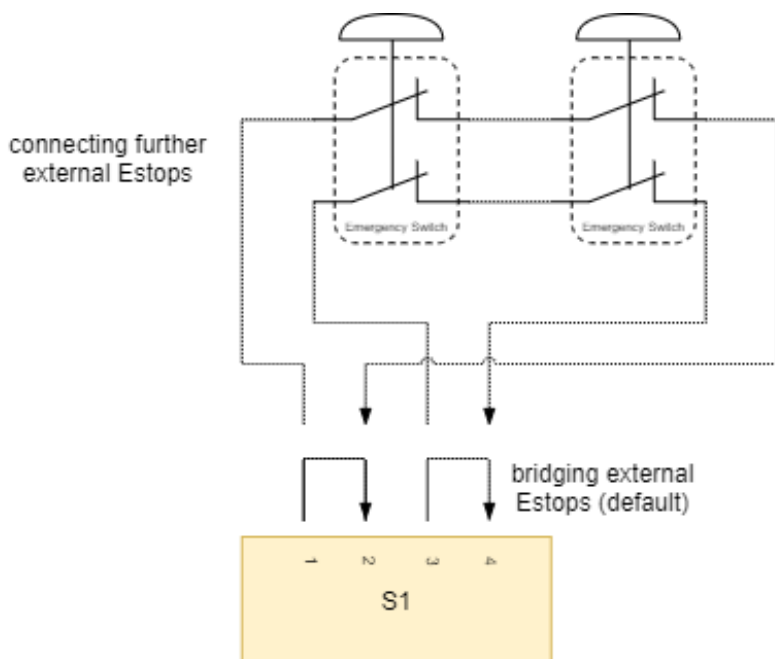
🛈 **Note**

The External E-Stop is bridged by two jumper wires (S1.1-S1.2 and S1.3-S1.4) by default and must stay so unless an external E-Stop is connected!
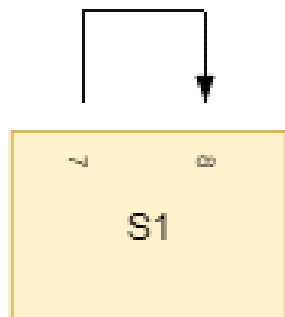
Connecting an external reset button

connecting further
external reset buttons
or outputs of external
devices

Reset

Ch	Cb

S1

Enabling the automatic reset mode of the second external safety input (SF2)

switching the second
external safety input
to automatic reset
mode

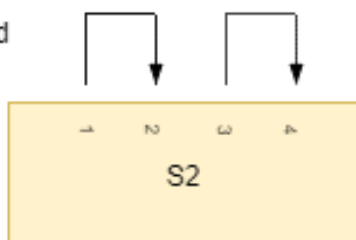| 7	8

S1

Connecting an external safety device/sensor (SF1)

connecting external
device

bridging Safeguard
Stop to disable it

1	2	3	4

S2

The External Safety Input 1 is bridged by two jumper wires (S2.1-S2.2 and S2.3-S2.4) by default and must stay so unless an external safety device is connected to this inlet!

Connecting another external safety device/sensor (SF2)
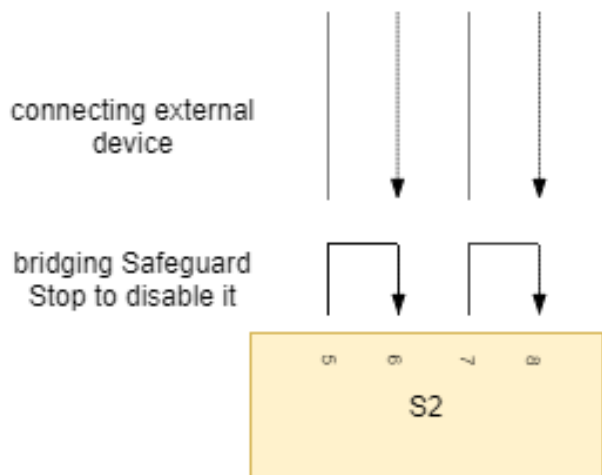
The External Safety Input 2 is bridged by two jumper wires (S2.5-S2.6 and S2.7-S2.8) by default and must stay so unless an external safety device is connected to this inlet!
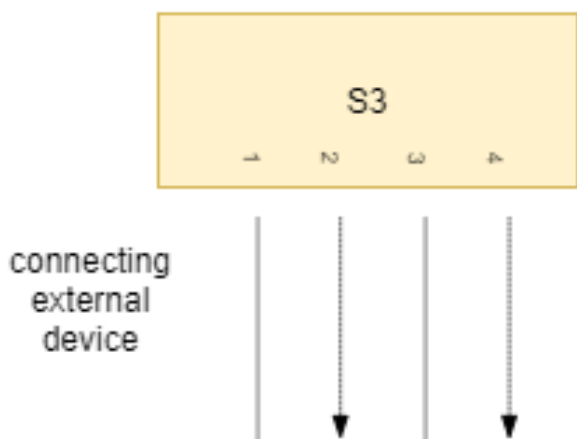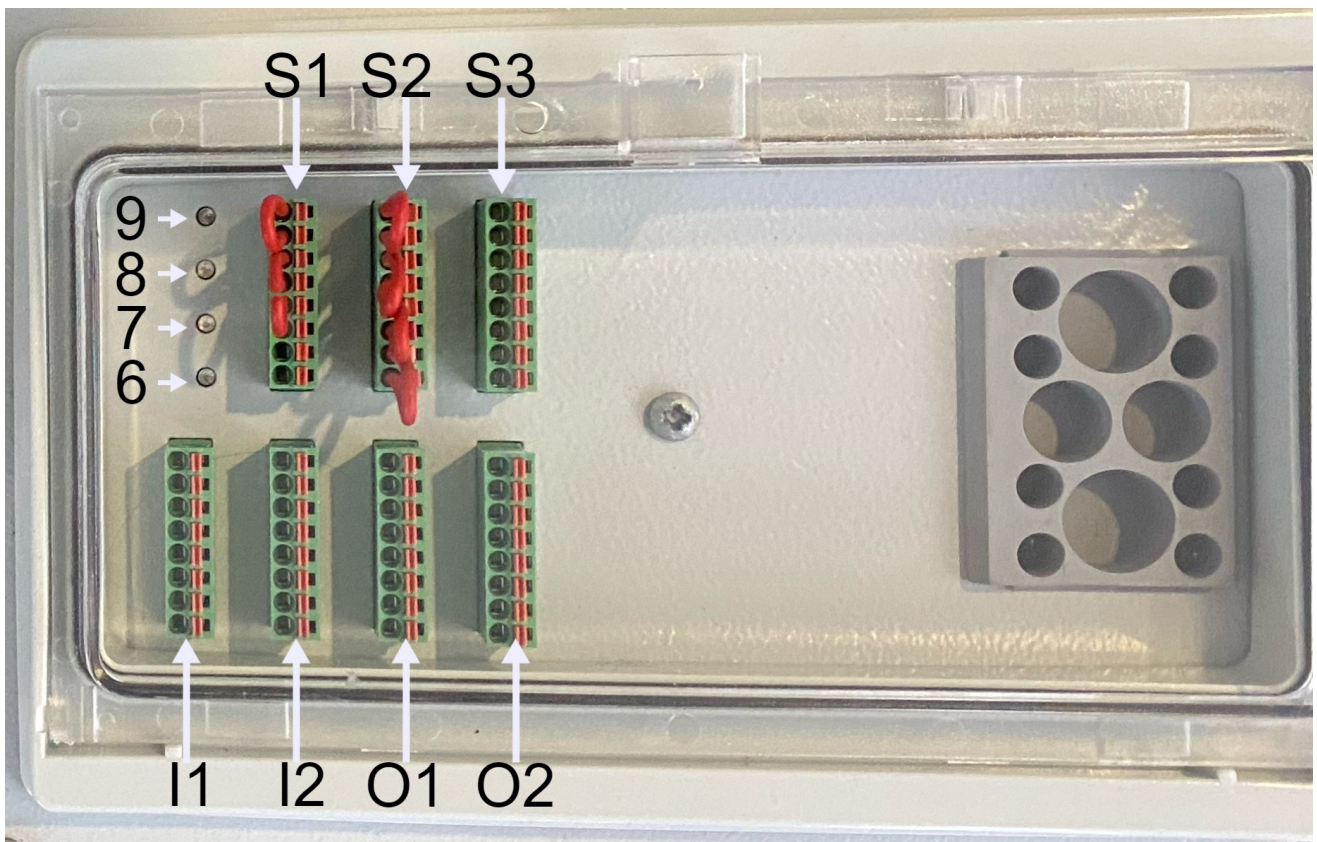
Connecting an external safety device to the robot stop output (SF5)

General Purpose Digital I/Os

The rest of the I/O connections on the Control Unit is reserved for the general digital I/Os.

Control Unit I/Os and LEDs. I1, I2, O1, O2 represent a general-purpose I/Os

In the following figure an overview of the exact connections for general I/Os is given:

I1			I2			O1			O2	
I4	8		I8	8		O4	8		O8	8
24 V	7		24 V	7		GND	7		GND	7
I3	6		I7	6		O3	6		O7	6
24 V	5		24 V	5		GND	5		GND	5
I2	4		I6	4		O2	4		O6	4
24 V	3		24 V	3		GND	3		GND	3
I1	2		I5	2		O1	2		O5	2
24 V	1		24 V	1		GND	1		GND	1

The exact positions of the connections are also the same (bottom->top: 1->8). This section describes the general-purpose 24V I/O. The common specifications in Common specifications for all digital I/O must be observed!

The general purpose I/O can be used to drive equipment like pneumatic relays, etc. directly. It can also be used to connect end-effectors (grippers, welding devices, etc.) and synchronize their usage with the robotic arm digitally only using the Control Unit. All Digital Outputs keep their last value, unless changed, may change staus when an emergency stop is active. Below an example for connecting a button to Input I1 is shown:
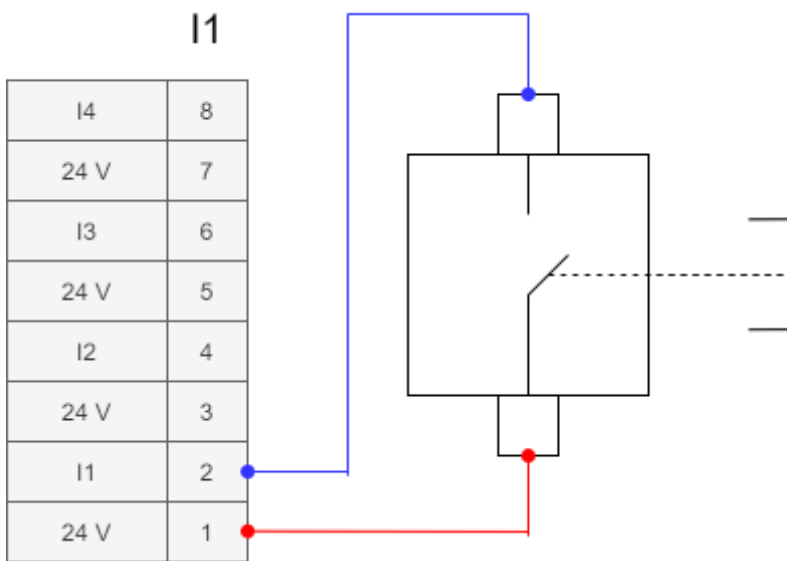
A simple button connection (one could use any pair of input and 24V connection from one of the two Input blocks)

Communication with machines/PLCs

The Control Unit can be connected to other devices via general-purpose I/O blocks (see General Purpose Digital I/Os and figure below) or via the peripheral Ethernet. To connect the machine/PLC to the I/O blocks wire it with a free input and/or output, as well as with 24v and GND connectors.

DANGER

Always connect Ground. Not doing so may violate the electrical safety of the whole building!
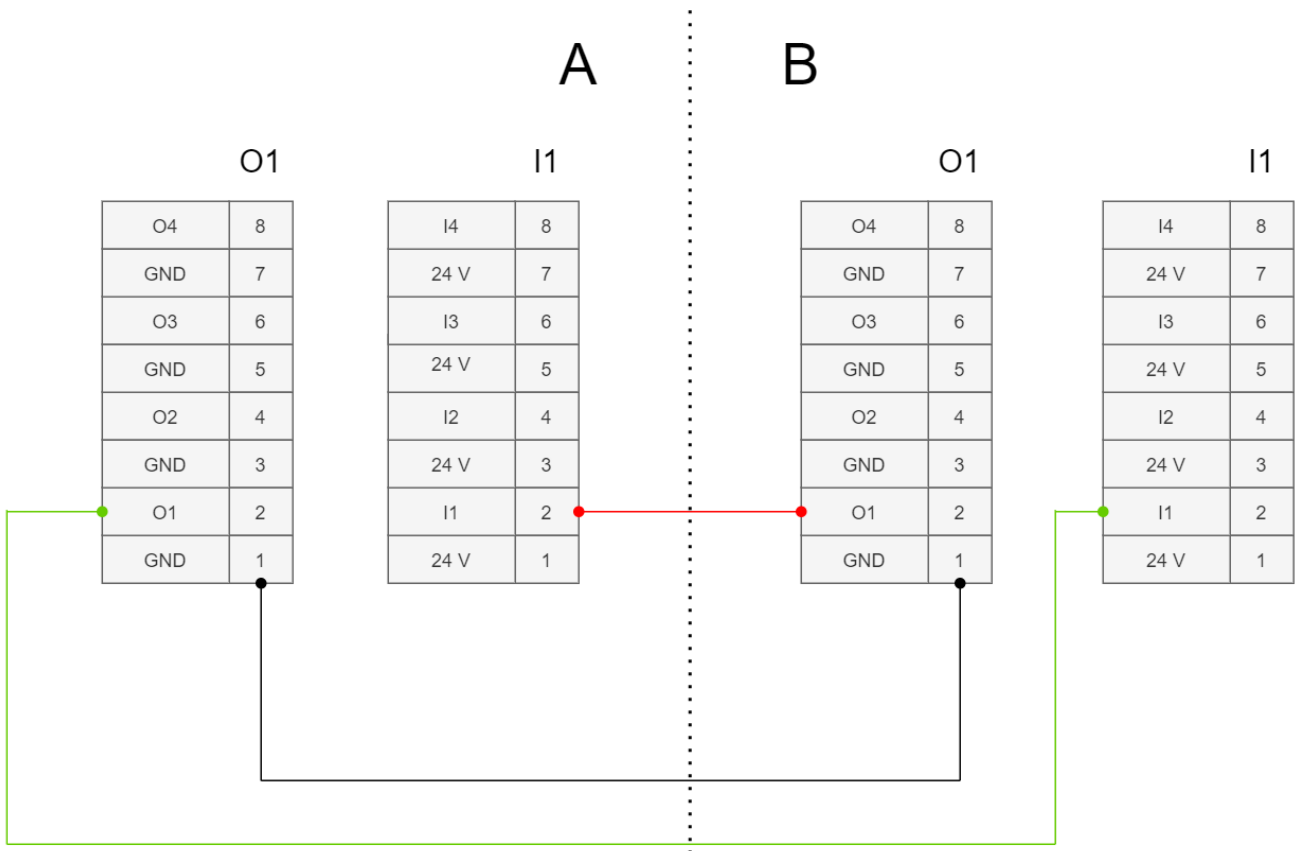
Example of an intermachine connection with same GND. A and B represent different machine's I/O blocks

Tool I/O

(not available yet)

Maintenance and Repair

You must perform maintenance and repair work in compliance with all safety instructions in this manual. You must perform maintenance, calibration, and repair work according to the latest versions of User Manuals on the support website. Only authorized system integrators, or RobCo, shall perform repairs and maintenance.

Safety Actions

After maintenance and repair work, checks must be done to ensure the required safety level. Checks must adhere to valid national or regional work safety regulations. The correct functioning of all safety functions shall also be tested.

The purpose of maintenance and repair work is to ensure that the system is kept operational or, in the event of a fault, that the system returns to an operational state. Repair work includes troubleshooting in addition to the actual repair itself. When working on the robot arm or control box, you must observe the procedures and warnings below:

<table>
<tr><td>⚠️</td><td>DANGER</td></tr>
</table>

1. Replace faulty components using new components with the same article numbers or equivalent components approved by RobCo for this purpose.
2. Reactivate any deactivated safety measures immediately after the work is completed.
3. Document all repairs and save this documentation in the technical file associated with the complete robot system.

<table>
<tr><td>⚡</td><td>DANGER</td></tr>
</table>

1. Before maintaining or repairing the robot or its modules, it should be separated from all energy supplies!
2. Prevent water and dust from entering the robot arm or control unit.
3. Observe ESD regulations when parts of the robot arm or control unit are disassembled.

4. Avoid opening the Control Unit and moving/cutting any cables there, since high voltages could be present.

| ⚠ | **WARNING** |

Make sure to give the Robot a cooldown after the operation.

Disposal and Environment

RobCo modular robots and modules must be disposed of in accordance with the applicable national laws, regulations, and standards.

They follow the restrictions on dangerous substances according to RoHS-Directive 2011/65/EU.

The following symbols are affixed on the robot to indicate conformity with the above legislation:

Certifications

Certifications through Third Party

RobCo has certified its modular robot system through the following, accredited institutes:

TÜV Nord: The RobCo Modular Robot System has been certified through TÜV NORD, a designated body according to the Machinery Directive 2006/42/EG. A copy of the certificate can be found in the appendix.

TQ Systems: The RobCo Modular Robot System has been checked by TQ Systems for electromagnetic compatibility (EMC) and environmental circumstances (temperature, vibration and shock). A copy of the transcript can be found in the appendix.

Declaration in accordance with EU-directives

The Robco modular robot system is certified in accordance to the following listed directives.

2006/42/EG - Machinery Directive: As defined in Machinery Directive 2006/42/EG the RobCo Modular Robotic System is an incomplete machine. As such, no CE-Marking is attached to it.

2006/95/EC - low voltage directive

2004/108/EC - Electromagnetic Compatibility Directive (EMC)

2011/65/EU - Restriction of Hazardous Substances Directive (RoHS)

2012/19/EU - Waste Electrical and Electronic Equipment Directive (WEEE)

CE/EU Declaration of incorporation

CE/EU Declaration of Incorporation (original)

Manufacturer:

RobCo GmbH, Marcel-Breuer-Str. 15, 80807 München, Germany

Partly completed Machinery:

Industrial Robot: RobCo Modular Robotic System

According to European Directive 2006/42/EC annex II 1.B. the manufacturer RobCo GmbH hereby declares that the machine may not be taken into operation before the complete machine it is part of has been declared to conform to the provisions of Directive 2006/42/EC and with the regulations transposing it into national law.

All technical documentation was generated according to Directive 2006/42/EC annex VII part B and available to national authorities upon legitimate request. The signer is based at the company address and authorized to compile the documentation.

Additional conformance:

2014/35/EU - Low Voltage Directive (LVD)
2014/30/EU - Electromagnetic Compatibility Directive (EMC)
2011/65/EU - Restriction of the use of certain hazardous substances (RoHS)

A list of the applied harmonized standards is provided as part of the product manual.

Munich, 24th February 2022

Paul Maroldt

Head Mechatronics and Safety

Safety Certificate

ZERTIFIKAT
CERTIFICATE

Hiermit wird bescheinigt, dass das unten beschriebene Produkt der Firma
This certifies that the product mentioned below from company

RobCo GmbH
Marcel-Breuer-Straße 15
80807 München
Deutschland

die Anforderungen der folgenden Prüfunterlage(n) erfüllt.
fulfills the requirements of the following test regulations.

Geprüft nach: **EN ISO 13849-1:2015**
Tested in accordance with: **EN ISO 10218-1:2011**

Beschreibung des Produktes: **Modularer Industrieroboter**
(Details s. Anlage 1)   *Modular industrial robot*
Description of product:
(Details see Annex 1)

Typenbezeichnung: **Modularer Industrieroboter**
Type designation: *Modular industrial robot*

Bemerkungen: **Keine**
Remarks:

Dieses Zertifikat bescheinigt das Ergebnis der Prüfung an dem vorgestellten Prüfgegenstand. Eine allgemein gültige Aussage über die Qualität der Produkte aus der laufenden Fertigung kann hieraus nicht abgeleitet werden.
This certifies the result of the examination of the product sample submitted by the manufacturer. A general statement concerning the quality of the products from the series manufacture cannot be derived there from.

Registrier-Nr. / *Registered No.* 44 799 21125601   Gültigkeit / *Validity*
Prüfbericht Nr. / *Test Report No.* 3529 8694   von / *from* 2022-02-01
Aktenzeichen / *File reference* 8003033748   bis / *until* 2027-01-31

Zertifizierungsstelle der   Essen, 2022-02-01
TÜV NORD CERT GmbH

TÜV NORD CERT GmbH   Am TÜV 1   45307 Essen   www.tuev-nord-cert.de   technology@tuev-nord.de

Bitte beachten Sie auch die umseitigen Hinweise
Please also pay attention to the information stated overleaf

Environmental Test Certificates

Product Compliance Center

EMC Test Results – Overview

Product Name:	modular robot system
Product Type:	industrial lightweight robot
Model Name:	n/a
Manufacturer:	RobCo GmbH
Applicant:	RobCo GmbH
	Mr. Paul Maroldt
	Marcel-Breuer-Str. 15
	80807 Munich
	Germany
Based on test report	
Document name:	EMC Compliance Report CE+modular robot system
Document number:	3TQ-21006-PR01-E01-01

The modular robot system has been tested according to the below listed standards and references.

Applicable Standards in December, 2021	EN IEC 61000-6-2 :2019
	EN IEC 61000-6-4 :2019
	EN 55011 :2016 + A1:2017
	EN IEC 61000-3-2 :2019
	EN 61000-3-3 :2013
	EN 61326-3-1 :2017
References	IEC 61000-4-4 :2012
	IEC 61000-4-2 :2008
	IEC 61000-4-8 :2009
	IEC 61000-4-6 :2013
	IEC 61000-4-5 :2014 +A1:2017
	IEC 61000-4-11 :2004 + AMD1:2017
	IEC 61000-4-3 :2020-09
	CISPR 11 :2015 +A1:2016
	IEC 61000-3-2 :2018
	IEC 61000-3-3 :2013
	IEC 61000-4-16 :2015

Date:	January, 2022

Oliver Ganser

Product Compliance Center

Environmental Test Results – Overview

Product Name:	Modular Robot	Control Unit
Model Name	Worst-case robot composition	CU1200
Manufacturer:	RobCo GmbH	RobCo GmbH
Applicant:	RobCo GmbH Mr. Paul Maroldt Marcel-Breuer-Str. 15 80807 München Germany	
based on test report:	MEC+3TQ-21006-PR01-M01 CLI+3TQ-21006-PR01-K01	

The modular robot and the control unit have been tested according to the below listed standards.

| Applicable Standards in December, 2021 | **Standards:** **DIN EN 60068-2-64:2020** 10 Hz: 0,022 $(m/s^2)^2$/Hz 30 - 200 Hz: 0,2 $(m/s^2)^2$/Hz 500 Hz: 0,0052 $(m/s^2)^2$/Hz Effective value aeff: 0,71 g Duration per axis: 30 minutes **DIN EN 60068-2-27:2010** Pulse shape: half sine Acceleration: 11 g Duration: 11 ms Number: 9 impacts per direction Totally number: 54 impacts | ☒ Original report MEC+3TQ-21006-PR01-M01 |
| | **Standards:** **DIN EN 60068-2-1:2008** Cold operation 0°C, 2h Low temperature switch on (0°C) **DIN EN 60068-2-2:2008** Dry heat operation +50°C, 2h | ☒ Original report CLI+3TQ-21006-PR01-K01 |

Date:	December, 2021

Alexander Gerum

Applied standards

The following standards were used for the development of the RobCo Modular Robot System:

DIN EN ISO 13849-1:2016-06 [PLd]

DIN EN ISO 13849-2:2013-02

Safety of machinery - Safety-related parts of control systems

Part 1: General principles for design

Part 2: Validation

The safety control is designed according to these standards, reaching performance level d.

DIN EN ISO 12100:2011-03

Safety of machinery - General principles for design - Risk assessment and risk reduction

The RobCo modular robot system is assessed according to the principles of this standard.

DIN EN ISO 10218-1:2012-01

Robots and robotic devices - Safety requirements for industrial robots Part 1: Robots

The robot manipulator is designed based on this standard. Part 2 is relevant for the installation of the robot within an application.

DIN EN 61000-4-2:2009-12

DIN EN IEC 61000-4-3:2021-11

DIN EN 61000-4-4:2013-04

DIN EN 61000-4-5:2019-03

DIN EN 61000-4-6:2014-08

DIN EN 61000-4-8:2010-11

DIN EN 61000-4-11:2019-06

DIN EN 61000-4-16:2016-10

DIN EN IEC 61000-6-2:2019-11

DIN EN IEC 61000-6-4:2020-09

Electromagnetic compatibility (EMC):

Part 4-2: Testing and measurement techniques - Electrostatic discharge immunity test

Part 4-3: Testing and measurement techniques - Radiated, radio-frequency, electromagnetic field immunity test

Part 4-4:Testing and measurement techniques - Electrical fast transient/burst immunity test

Part 4-5: Testing and measurement techniques - Surge immunity test

Part 4-6: Testing and measurement techniques - Immunity to conducted disturbances, induced by radio-frequency fields

Part 4-8: Testing and measurement techniques - Power frequency magnetic field immunity test

Part 4-11: Testing and measurement techniques - Voltage dips, short interruptions and voltage variations immunity tests

Part 4-16: Testing and measurement techniques - Test for immunity to conducted, common mode disturbances in the frequency range 0 Hz to 150 kHz

Part 6-2: Generic standards - Immunity standard for industrial environments

Part 6-4: Generic standards - Emission standard for industrial environments

These standards define the testing procedures and requirements for electric and electromagnetic compatibility.

DIN EN 61326-3-1:2018-04

Electrical equipment for measurement, control and laboratory use - EMC requirements

Part 3-1: Immunity requirements for safety-related systems and for equipment intended to perform safety-related functions

This standard defines advanced requirements for electromagnetic interference immunity regarding safety related equipment and functions.

EN 60947-5-5/A1:2005

EN 60947-5-1:2004

EN ISO 13850:2008

Low-voltage switchgear and controlgear - Part 5-5: Control circuit devices and switching elements - Electrical emergency stop device with mechanical latching function

Low-voltage switchgear and controlgear - Part 5-1: Control circuit devices and switching elements - Electromechanical control circuit devices

Safety of machinery - Emergency stop - Principles for design

The emergency stop button of the handheld device is designed according to these standards.

IEC60947-5-1

IEC60947-5-8

ISO12100-1

IEC60204-1

Low-voltage switchgear and controlgear - Part 5-1: Control circuit devices and switching elements - Electromechanical control circuit devices

Low-voltage switchgear and controlgear - Part 5-8: Control circuit devices and switching elements - Three-position enabling switches

Safety of machinery - General principles for design - Risk assessment and risk reduction

Safety of machinery - Electrical equipment of machines - Part 1: General requirements

The three-position enabling device of the handheld device fulfils these standards.

DIN EN 60529:2014-09

Degrees of protection provided by enclosures (IP Code)

The RobCo modular robotic system is designed according to this standard and its requirements regarding water and dust proofness.

DIN EN 60320-1:2016-04

Appliance couplers for household and similar general purposes

Part 1: General requirements

The mains wire meets this standard.

DIN EN ISO 9409-1:2004-09 [Typ 50-4-M6]

Manipulating industrial robots - Mechanical interfaces

Part 1: Plates

The general end-effector flange is designed according to this standard to enable the largest possible compatibility with available end-effectors.

DIN EN 60068-1:2015-09

DIN EN 60068-2-1:2008-01

DIN EN 600068-2-2:2008-05

DIN EN 60068-2-27

DIN EN 60068-2-64

Temperature testing

Part 1: general and guidance

Part 2-1: test section a, cold

Part 2-2: test section b, dry heat

Part 2-27: Tests - Test Ea and guidance: Shock

Part 2-64: Tests - Test Fh: Vibration, broadband random and guidance

The RobCo modular robotic system is tested according to these standards.

DIN EN 60204-1:2019-06

Safety of machinery - Electrical equipment of machines

Part 1: General requirements

The general requirements of this standard are followed and the RobCo modular robot system has been tested accordingly.

Disclaimer

⚠	CAUTION

It is generally advised to avoid the use of accelerations higher than needed for a given application. High accelerations, especially in combination with high loads, can lead to a reduced lifetime of the Robotic Arm. For applications with short cycle times and high requirements for speed, it is generally advised to use blends as much as possible to ensure smooth trajectories without the need for high accelerations.

Disclaimer

RobCo GmbH shall not be liable for any indirect, incidental, special, or consequential damages, including but not limited to lost profits, loss of use, loss of production, or damage to other production equipment.

In case of a device exhibiting defects, RobCo GmbH shall not cover any consequential damage or loss, such as loss of production or damage to other production equipment.

RobCo GmbH continues to improve the reliability and performance of its products and therefore reserves the right to upgrade the product without prior warning. RobCo GmbH takes every care that the contents of this manual are precise and correct but takes no responsibility for any errors or missing information.