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. 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. Configuring a set of configurable I/O for safety functions are done through the GUI, (see part Part II PolyScope Manual).

CAUTION

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

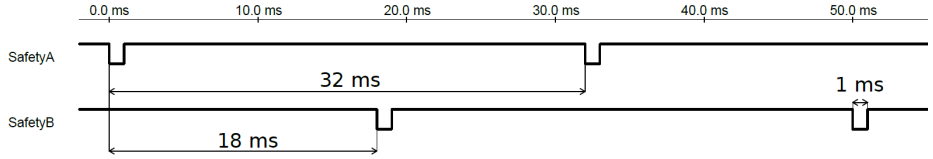
- Safety functions shall be verified before putting the robot into operation.
- Safety functions shall be tested regularly.

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)

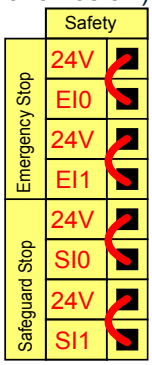


To enable OSSD for Safety Output

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.

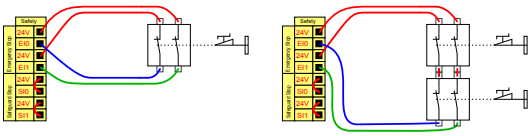
Default safety configuration

The robot is delivered with a default configuration, which enables operation without any additional safety equipment (see illustration below).



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.

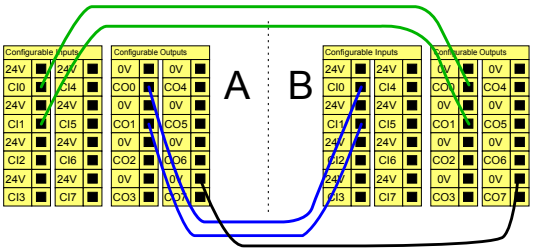


Sharing the Emergency Stop with other machines

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 emergency 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.

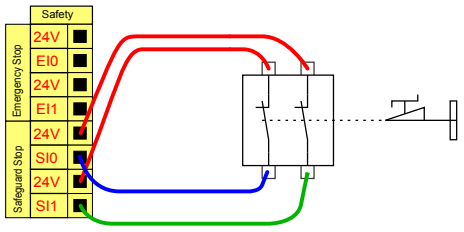


Safeguard stop with automatic resume

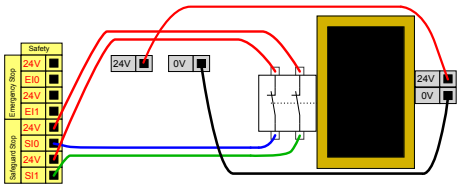
This configuration is only intended for applications where the operator cannot go through the door and close it behind him. The configurable I/O is used to setup a reset button outside the door to reactivate robot motion. The robot resumes movement automatically when the signal is re-established.

WARNING

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



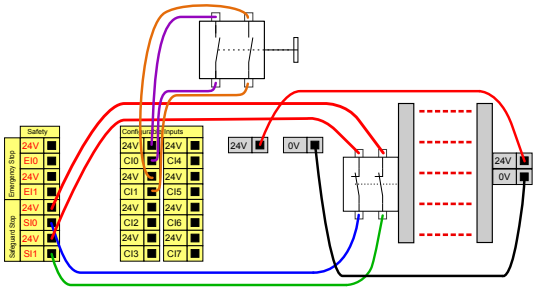
This example illustrates a door switch is a basic safeguard device where the robot is stopped when the door is opened.



This example illustrates 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

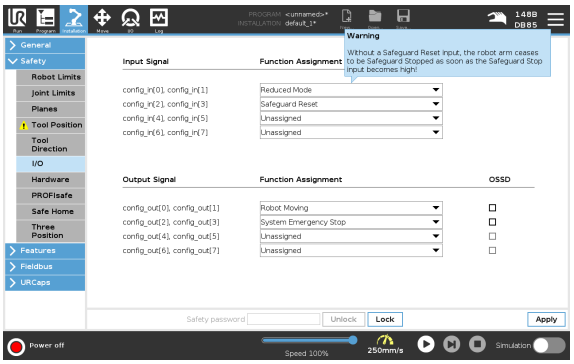
If the safeguard interface is used to interact with a light curtain, a reset outside the safety perimeter is required. The reset button must be a two channel type. In this example the I/O configured for reset is CI0-CI1 (see below).



8.2.1. 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 and PLd I/O.



Input Signals

The following Safety Functions can be used with the input signals:

System Emergency Stop	This is an emergency stop button alternative to the one on the Teach Pendant, providing the same functionality if the device complies with ISO 13850.
Reduced	All safety limits can be applied while the robot is using a **Normal** configuration, or a **Reduced** configuration (see Software Safety Modes). 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. 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.
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.
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.

Input Signals

Operational Mode	When defined, this input can be used to switch between **Automatic Mode** and **Manual Mode**.
Safeguard Reset	When a Safeguard Stop occurs, this output ensures that the Safeguard Stop state continues until a reset is triggered.
Automatic Mode Safeguard Stop	Once configured, an **Automatic Mode Safeguard Stop** performs a Safeguard Stop when the input pins are low and ONLY when the robot is in Automatic mode.

WARNING

- If you disable the default Safeguard Reset input, the Robot Arm is no longer Safeguard Stop stopped as soon as the input is high. A program paused only by the Safeguard stop resumes.
- Similar to the Safeguard Reset, if the default Automatic Mode Safeguard Reset is disabled, the Robot Arm is no longer Safeguard Stop stopped once the Automatic Mode Safeguard Stop input is high. A program paused only by the Automatic Mode Safeguard Stop resumes.

Output Signals

You can apply the following Safety functions for output signals. All signals return to low when the state which triggered the high signal has ended:

System Emergency Stop	Signal is *Low* when the safety system has been triggered into an Emergency Stopped state by the Robot Emergency Stop input or the Emergency Stop Button. To avoid deadlocks, if the Emergency Stopped state is triggered by the System Emergency Stop input, low signal will not be given.
Robot Moving	Signal is *Low* if the robot is moving, otherwise high.
Robot Not Stopping	Signal is *High* 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 *Low* when the robot arm uses reduced parameters 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.
Safe Home	Signal is *High* if the Robot Arm is stopped in the configured Safe Home Position. Otherwise, the signal is *Low*.

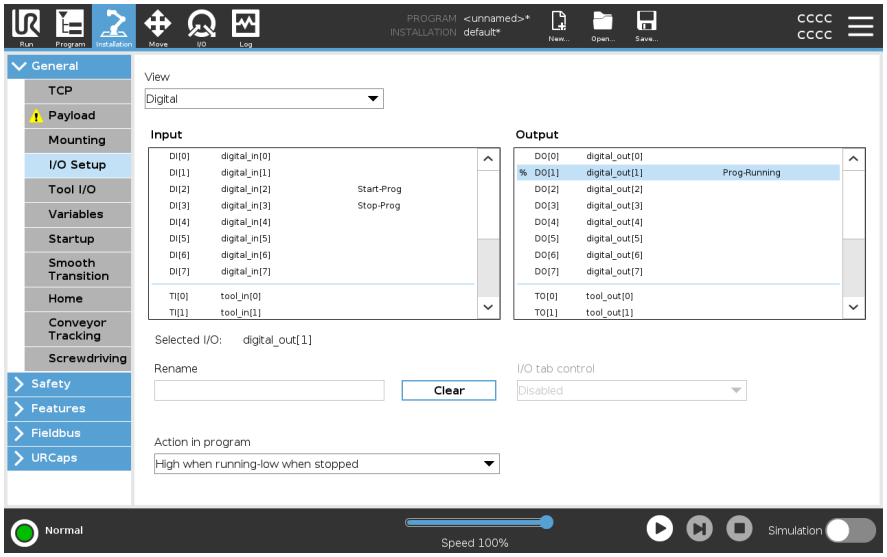
NOTICE

Any external machinery receiving its Emergency Stop state from the robot through the System Emergency 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 Emergency 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.

8.2.2. I/O Setup

Description

Use the I/O Setup screen to define I/O signals and configure actions with the I/O tab control. The types of I/O signals are listed under **Input** and **Output**.
You can use a fieldbus, for example, Profinet and EtherNet/IP, to access the general purpose registers.
If you enable the Tool Communication Interface (TCI), the tool analog input becomes unavailable.



NOTICE

When starting programs from an I/O or fieldbus input, the robot can begin movement from the position it has, there will not be any manual movement to the first waypoint via PolyScope required.

I/O Signal Type

To limit the number of signals listed under **Input** and **Output**, use the **View** drop-down menu to change the displayed content based on signal type.

Assigning User-defined Names

You can name the Input and Output signals to easily identify the ones being used.

1. Select the desired signal.
2. Tap the text field to type a name for the signal.
3. To reset the name to default, tap **Clear**.

You must provide a user-defined name for a general purpose register to make it available in the program (i.e., for a **Wait** command or the conditional expression of an **If** command). The **Wait** and **If** commands are described in (Wait) and (If), respectively. You can find named general purpose registers in the **Input** or **Output** selector on the **Expression Editor** screen.

I/O Actions and I/O Tab Control

You can use Physical and Fieldbus digital I/Os to trigger actions or react to the status of a program.

I/O Tab Control

Use I/O Tab Control to specify whether an output is controlled on the I/O tab (by either programmers, or both operators and programmers), or if it is controlled by the robot programs.

Available Input Actions

Command	Action
Start	Starts or resumes the current program on a rising edge (only enabled in Remote Control, see Settings)
Stop	Stops the current program on a rising edge
Pause	Pauses the current program on a rising edge
Freedrive	When the input is high, the robot goes into freedrive (similar to the freedrive button). The input is ignored if other conditions disallow freedrive.

WARNING

If the robot is stopped while using the Start input action, the robot slowly moves to the first waypoint of the program before executing that program. If the robot is paused while using the Start input action, the robot slowly moves to the position from where it was paused before resuming that program.

Available Output Actions

Action	Output state	Program state
Low when not running	Low	Stopped or paused
High when not running	High	Stopped or paused
High when running, low when stopped	Low High	Running, Stopped or paused
Low on unscheduled stop	Low	Program terminated unscheduled
Low on unscheduled stop, otherwise High	Low High	Program terminated unscheduled Running, stopped or paused
Continuous Pulse	Alternates between high and low	Running (pause or stop the program to maintain the pulse state)

Program Termination Cause

An unscheduled program termination can occur for any of the reasons listed below:

- Robot stop
- Fault
- Violation
- Runtime exception

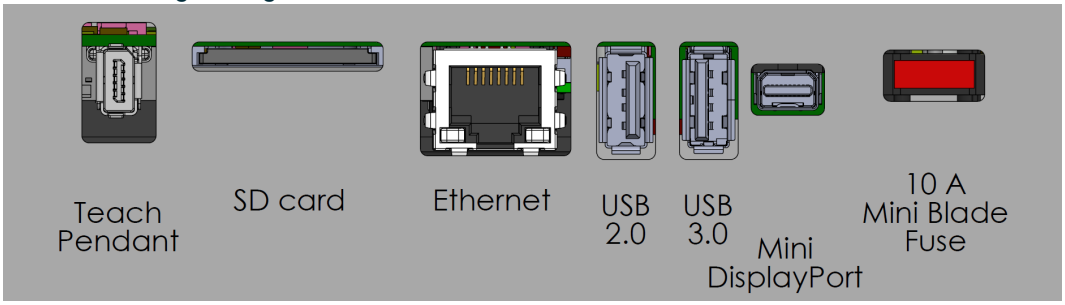
8.3. Control Box Connection Ports

Description

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

External connection ports

The Mini Displayport supports monitors using Displayport. This requires an active Mini Display to DVI or HDMI converter. Passive converters do not work with DVI/HDMI ports. The Fuse must be a UL marked, Mini Blade type with maximum current rating: 10A and minimum voltage rating: 32V



NOTICE

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

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

Do not connect or disconnect the Teach Pendant while Control Box is powered on. This can cause damage to Control Box.

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.

8.3.1. 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.

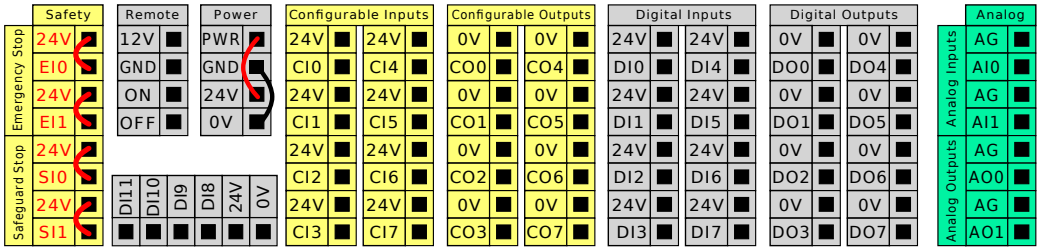
The electrical specifications are shown in the table below.

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

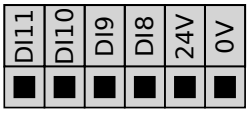
8.4. Controller I/O

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.

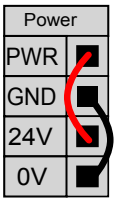
- Safety I/O.
- Configurable I/O.
- General purpose I/O.

> **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.

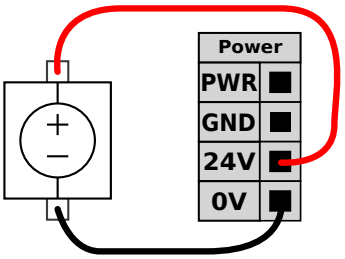
Install the robot according to the electrical specifications which are the same for all three inputs.
It is possible to power the digital I/O from an internal 24V power supply or from an external power source by configuring the terminal block called **Power**. This block consists of four terminals. The 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 (see below).

Power supply

If more current is needed, connect an external power supply as shown below.



This example illustrates the default configuration using the internal power supply



This example illustrates the default configuration with an external power supply for more current.

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

Terminals	Parameter	Min	Typ	Max	Unit
Internal 24V power supply					
[PWR - GND]	Voltage	23	24	25	V
[PWR - GND]	Current	0	-	2*	A
External 24V input requirements					
[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
Digital Outputs					
[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
Digital Inputs					
[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. Teach Pendant with 3-Position Enabling Device

Description

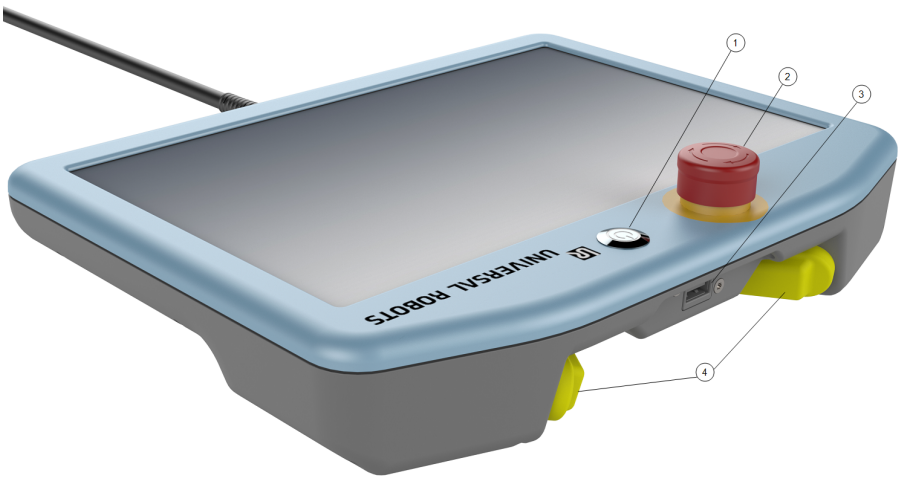
Depending on the robot generation, your Teach Pendant can be with or without a 3-Position Enabling device (3PE).
UR20 and UR30 robots have the built-in 3PE called a 3-Position Enabling Teach Pendant (3PE TP). The Teach Pendant without the 3PE will not work with the UR20 and UR30.
The enabling buttons are 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, an external 3PE device must be connected and configured. The 3PE TP functionality extends to the PolyScope interface, where there are additional functions in the Header.

NOTICE

The 3PE Teach Pendant is not included with the purchase of the OEM Control Box, so enabling device functionality is not provided. Using a UR20, or a UR30, 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.

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.

8.5.1. 3PE Teach Pendant Installation

Hardware Installation

To remove a Teach Pendant

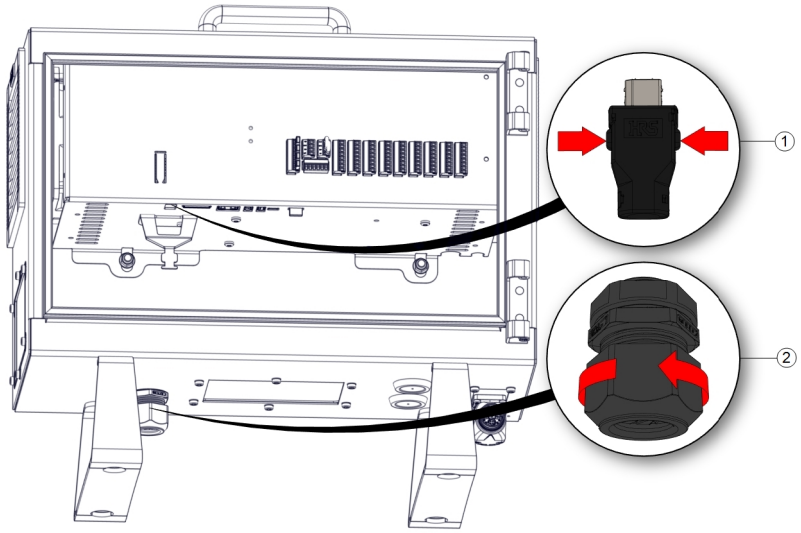
NOTICE

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

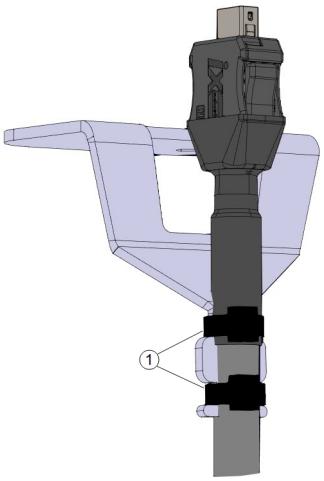
- Always select the correct configuration for the type of Teach Pendant.

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	Clips	2	Plastic grommet



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.

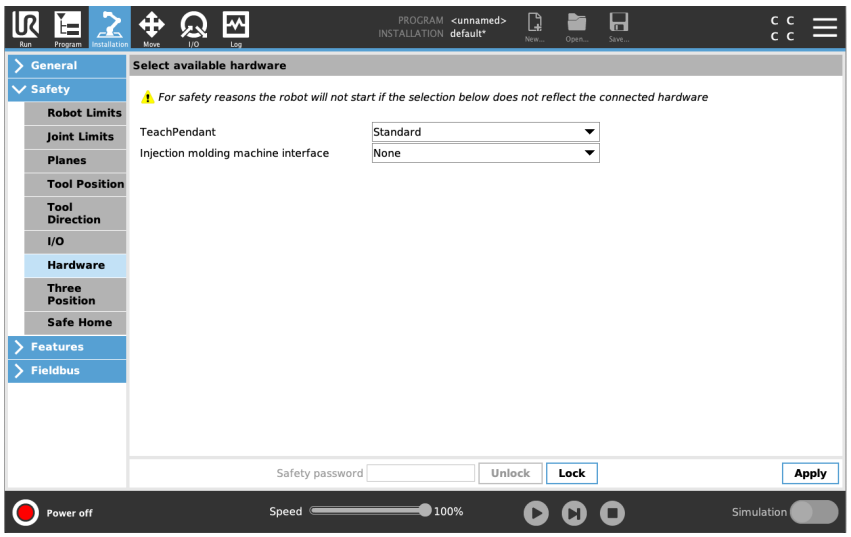
There is always a length of cable with the Teach Pendant that can present a tripping hazard if it is not stored properly.

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

New Software Installation

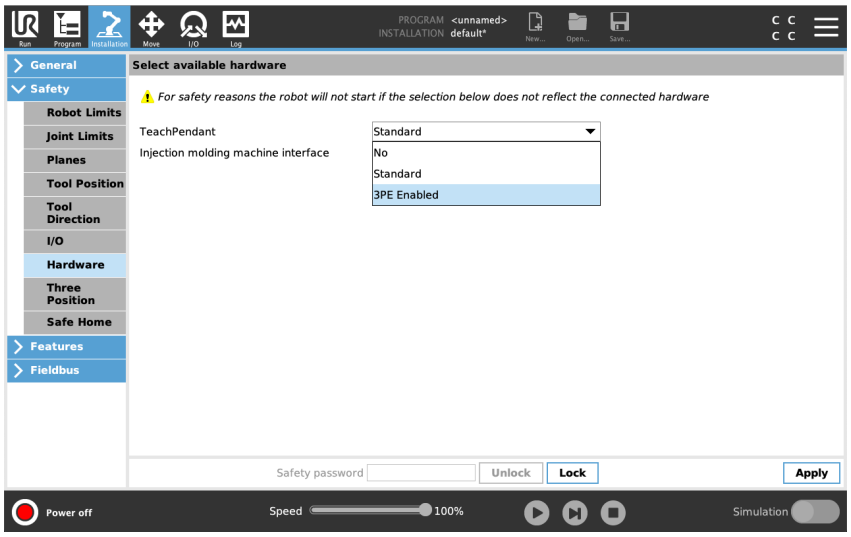
To configure the 3PE TP software

1. On PolyScope, in the Header, tap Installation and select **Safety**.



2. Tap Hardware and unlock the options on the **Select available hardware** screen.

   A password is required to unlock this screen.



3. In the **Teach Pendant** drop-down list, select **3PE Enabled**.
4. Tap **Apply** to restart the system. PolyScope continues to run.
5. Tap **Confirm Safety Configuration** to complete the 3PE Teach Pendant software installation.
6. As the robot restarts and initializes, light-press the 3PE button and tap **Start** on PolyScope.

8.5.2. 3PE Teach Pendant Button Functions

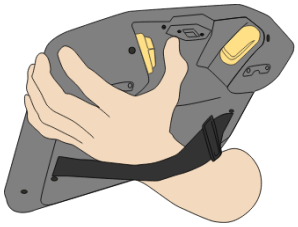
Description

NOTICE

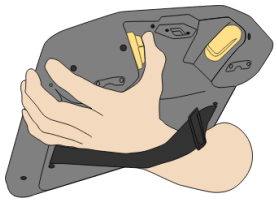
The 3PE buttons are only active in Manual mode. In Automatic mode, robot movement does not require 3PE button action.

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.



1 Button release



2 Button press

8.5.3. Using the 3PE Buttons

Using the 3PE

To play a program

1. On PolyScope, ensure the robot is set to **Manual mode**, or switch to **Manual mode**.
2. Maintain a light-press on the 3PE button.
3. On PolyScope, tap **Play** to run the program.

   The program runs if the robot arm is in the first position of the program.
   If the robot is not in the first position of the program, the **Move Robot into Position screen** appears.

To stop a program

1. Release the 3PE button or, on PolyScope, tap **Stop**.

To pause a program

1. Release the 3PE button, or, in PolyScope, tap **Pause**.

   To continue the program execution, keep the 3PE button light pressed and tap **Resume** in PolyScope.

Freedrive with 3PE Buttons

Description

Freedrive allows the robot arm to be manually pulled into desired positions and/or poses.

To use the 3PE button to freedrive the robot arm

1. Rapidly light-press, release, light-press again and keep holding the 3PE button in this position.

   Now you can pull the robot arm into a desired position, while the light-press is maintained.

Using Move Robot into Position

Description

Move Robot into Position allows the robot arm to move to that start position, after you complete a program. The robot arm must be in the start position before you can run the program.

Move into position

To use the 3PE button to move the robot arm into position:

1. When your program is complete, press **Play**.
2. Select **Play from beginning**.

   On PolyScope, the **Move Robot into Position** screen appears displaying robot arm movement.
3. Light-press and hold the 3PE button.
4. Now, on PolyScope, press and hold **Automove** for the robot arm to move to the start position.

   The Play Program screen appears.
5. Maintain a light-press on the 3PE button to run your program.

   Release the 3PE button to stop your program.

8.5.4. 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.

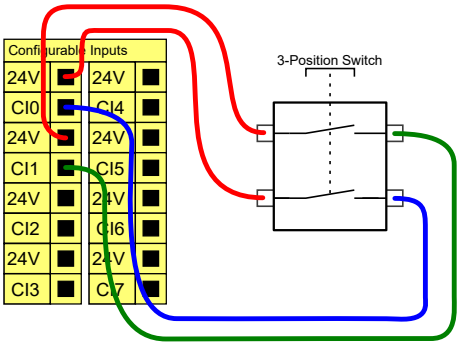
8.6. Three Position Enabling Device

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.

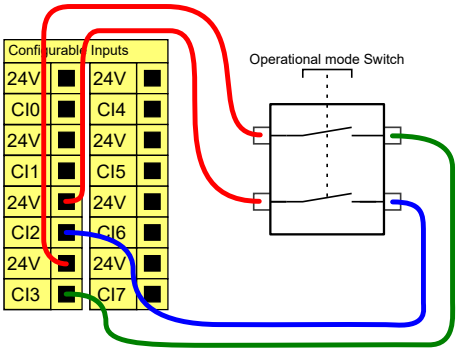
NOTICE

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.



8.7. End Effector Integration

Description

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

NOTICE

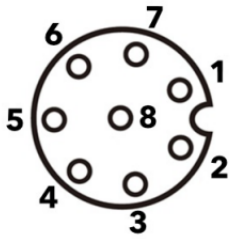
UR provides documentation for the end effector to be integrated with the robot arm.

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

8.7.1. 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

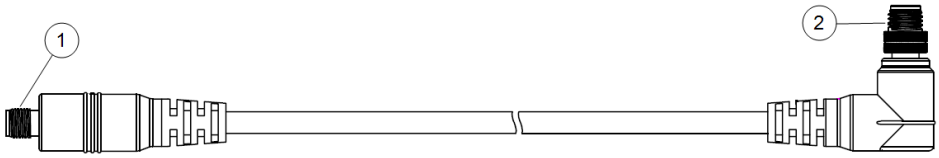
The Tool Connector must be manually tightened up to a maximum of 0.4 Nm.

Tool I/O Accessories

The UR20 tool I/O can require an accessory element to facilitate connection with tools. Depending on the tool, you can use the following tool I/O accessories: Tool Flange Adapter (see Tool Flange Accessories) and/or Tool Cable Adapter.

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.

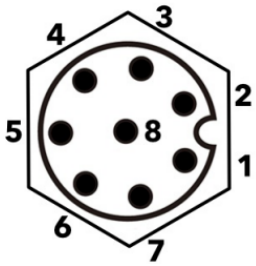
2 Connects to the robot.

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).

8.7.2. 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.

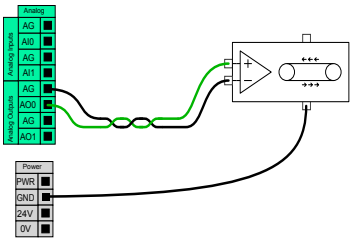
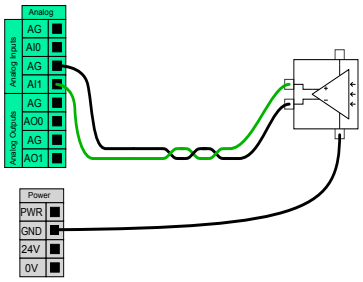
- Use the AG terminal closest to the I/O. The pair share a common mode filter.
- Use the same GND (0V) for equipment and Control Box. The analog I/O is not galvanically isolated from the Control Box.
- Use a shielded cable or twisted pairs. Connect the shield to the GND terminal at the terminal called **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 (see part Part II PolyScope Manual). The electrical specifications are shown below.

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

8.7.3. General Purpose Digital I/O

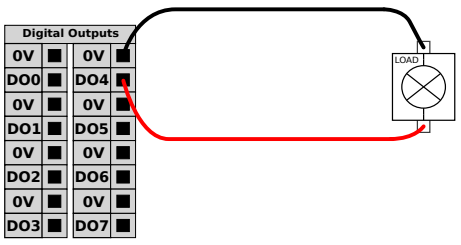
Description

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

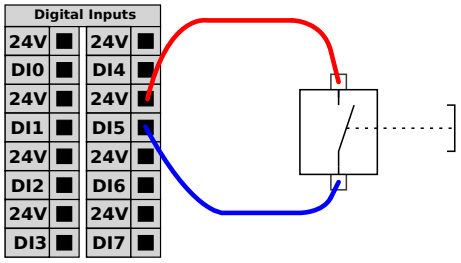
General purpose digital I/O

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 common specifications in section 8.7.3 General Purpose Digital I/O above must be observed.

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, see part Part II PolyScope Manual.
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 be used if they are not configured to perform a safety function.



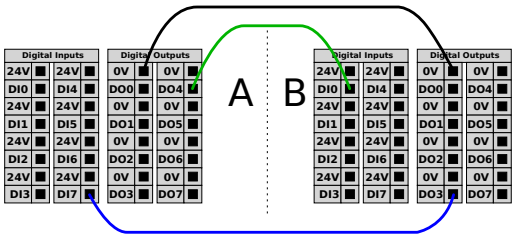
This example shows how a load is controlled from a Digital Outputs when connected.



This example shows how 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.



8.7.4. Remote ON/OFF control

Description

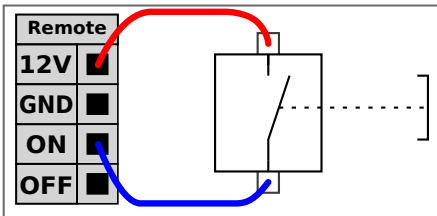
Use remote **ON/OFF** control to turn the Control Box on and off without using the Teach Pendant. It is typically used:

- 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.

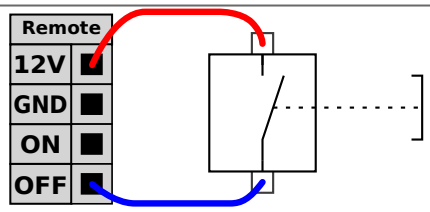
Remote Control

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 (see part Part II PolyScope Manual).
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



This example illustrates connecting a remote **ON** button.



This example illustrates connecting a remote **OFF** button.

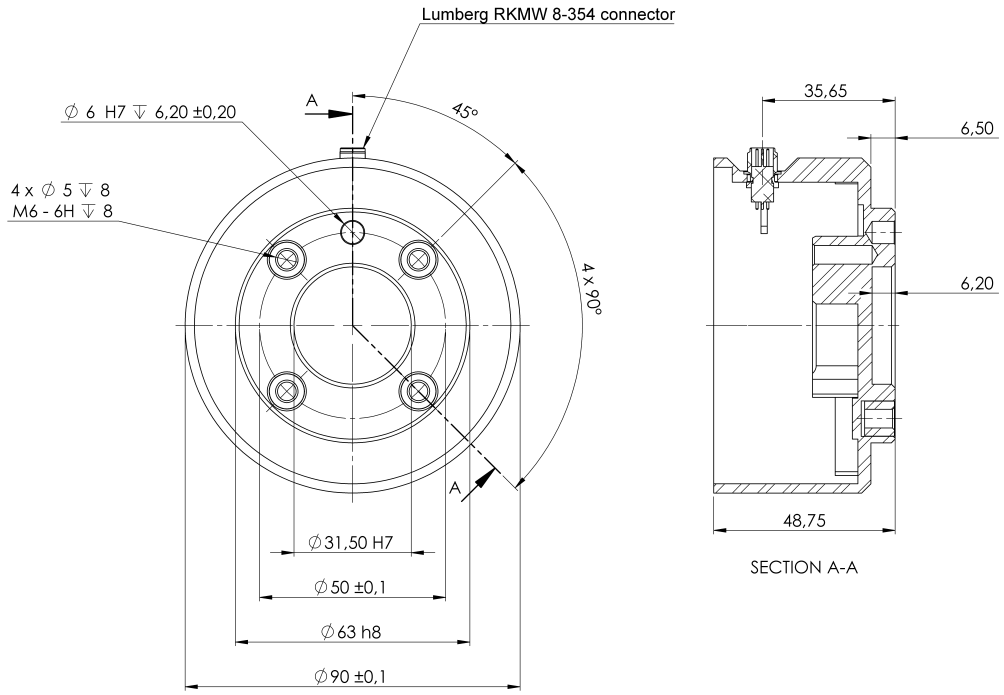
CAUTION

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.

8.7.5. 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 M8 bolts can press against the bottom of the tool flange and short circuit the robot.

- Do not use bolts that extend beyond 10 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.

8.7.6. Tool I/O Installation Specifications

Description

The electrical specifications are shown below. Access Tool I/O in the Installation Tab (see part Part II PolyScope Manual) 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)*	-	600	2000**	mA
Supply current (dual pin)*	-	600	2000**	mA
Supply capacitive load	-	-	8000***	uF

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

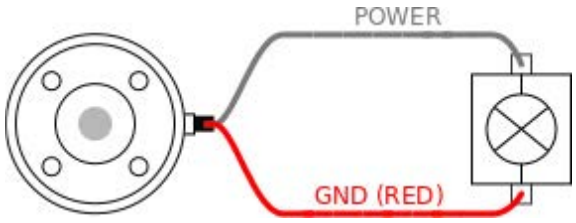
** Peak for max 1 second, duty cycle max: 10%. Average current over 10 seconds must not exceed typical current.

*** 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.

8.7.7. Tool Power Supply

Description

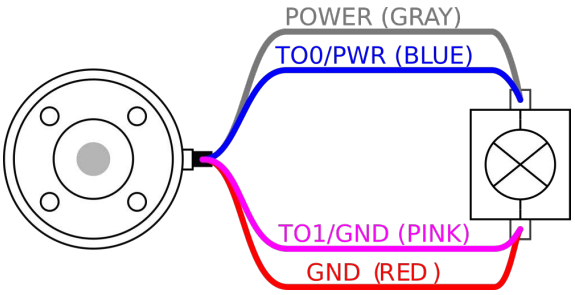
Access Tool I/O in the Installation Tab to set the internal power supply to 0V, 12V or 24V.



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).

8.7.8. 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

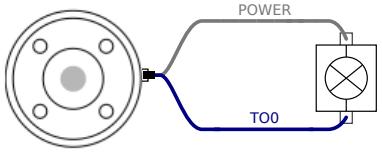
Once the robot makes an Emergency Stop, the Digital Outputs (DO0 and DO1) are deactivated (High Z).

CAUTION

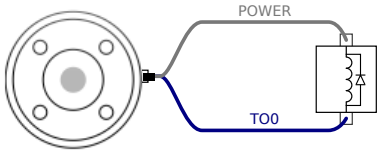
The Digital Outputs in the tool are not current-limited. Overriding the specified data can cause permanent damage.

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.



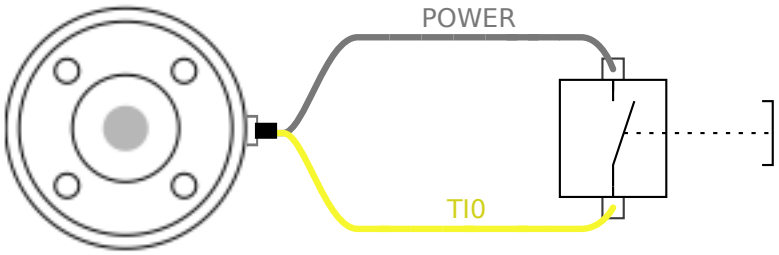
8.7.9. Tool Digital Inputs

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	-	Ω

Using the Tool Digital Inputs This example illustrates connecting a simple button.



8.7.10. 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	-	kΩ
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	Ω
Resolution	-	12	-	bit

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

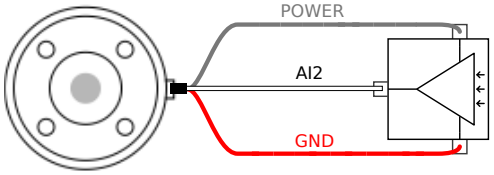
Caution

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.

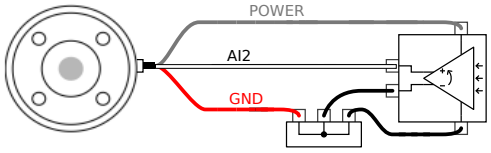
Using Tool Analog Inputs, Non-differential

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.



8.7.11. 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