

EPSON

Robot Controller RC-A101 Manual

Original Instructions

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Safety Manual

The following information is provided in the “AX6 / RC-A101 Safety Manual.”

- Manufacturer
- Importer
- Contact Information
- Disposal

For details, refer to the “AX6 / RC-A101 Safety Manual.”

Introduction

Thank you for purchasing this Epson robot system. This manual provides the information necessary for correctly using the controller box RC-A101.

The controller box of AX6 contains the main control electronics, the power supply and I/Os. The controller box is not a standalone device but, together with the AX6 manipulator, forms the robot system AX6.

After reading this manual, store it in an easily accessible location for future reference.

Epson conducts rigorous testing and inspection to ensure that the performance of their robot systems meets their standards. Please note that if the Epson robot system is used outside the operating conditions described in the manual, the product will not perform up to its basic performance.

This manual describes potential hazards and problems that are foreseen. To use the Epson robot system safely and correctly, be sure to follow the safety information contained in this manual.

1. Safety

1.1 Conventions

The table below explains the symbols used in this document and on the product itself.

 WARNING	This symbol indicates that a danger of possible serious injury or death exists if the associated instructions are not followed.
 WARNING	This symbol indicates that a danger of possible harm to people or death caused by electric shock exists if the associated instructions are not followed properly.
 CAUTION	This symbol indicates that a danger of possible harm to people or physical damage to equipment and facilities exists if the associated instructions are not followed properly.
	This symbol indicates that safety goggles must be worn.

1.2 Intended Use

Together with the AX6 manipulator, the Robot Controller RC-A101 builds an industrial robot system. Before AX6 is used for the first time, a risk assessment must be carried out for the final system into which AX6 is to be integrated. This risk assessment must conform to the country-specific safety standards and directives. In the case of collaborative applications, special attention must be paid for avoiding hazards to humans in the risk assessment. AX6 may be used across different industries for stationary or mobile applications. Its main purpose is handling or assembling parts, executing automated processes with end effectors, tools or fixtures and direct interaction with people when the safety functions for collaborative operation are enabled.

The Robot Controller RC-A101 is intended to be used exclusively with the AX series only. It shall not be modified or used with any 3rd party manipulator.

 WARNING	Any use that does not fall within the intended use is considered misuse and is not permitted. Some examples of misuse (the list is not exhaustive): • Any application that causes harm to humans or animals. • Any application that could endanger human or animal life or cause injury in the event of a malfunction. • Handling or use of hazardous objects or substances in collaborative applications. • Exceeding the specified operating limits or operating the robot not within the allowed environmental conditions. • Lifting any humans or animals. • Use in explosive environments. • Fully or partially disabling safety functions, especially in environments of collaborative operation. • Operating the robot with damaged cables or exposed internal components of the Robot Controller RC-A101. • Ignoring warning signals or error messages from the AX Portal, Robot Controller RC-A101 or the manipulator. • Attempting to repair or modify internal components of the Robot Controller RC-A101 or manipulator without proper authorization and training.
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1.3 Installation and Operation Safety

The design and installation of this robot system must be carried out by personnel who have been trained in robotic systems by Epson or their respective suppliers. Users must undergo system-specific training and be informed about all safety aspects.

 WARNING	Pay attention to the following safety instructions: • Please read this manual, the “Collaborative Robot: 6-Axis Robots AX6 Manual” and the “AX6 / RC-A101 Safety Manual” before using this robot system. Operating the robot system without understanding the safety precautions is extremely hazardous and may result in serious bodily injury and/or severe equipment damage to the robot system. • The robot system must be used in accordance with the environmental conditions described in the relevant manual. Using the product in an environment that exceeds these conditions can shorten its service life and cause serious safety problems.
 WARNING	Performing any work or opening the controller or the manipulator while the power on is extremely hazardous and may result in electric shock and/or malfunction of the robot system! Pay attention to the following safety instructions regarding electricity: • In order to turn ON the device, make sure to connect the AC power cable to an appropriate power receptacle or the DC input to a suitable power supply according to the technical specifications of the robotic system. Only then switch on the respective circuit breaker on the front panel of the controller • Before performing any replacement procedure, stop the application, turn the controller, manipulator and related equipment off, then disconnect the power plug from the power source.
 WARNING	Pay attention to the following safety instructions regarding emergencies: • Never operate the robot without an installed Emergency Stop button. Make sure that an Emergency Stop button is always accessible. Ignoring this may lead to dangerous situations. • In the event of an emergency, such as a malfunction or any other dangerous situation, press the Emergency Stop button immediately.

The following information is provided in the “AX6 / RC-A101 Safety Manual.”

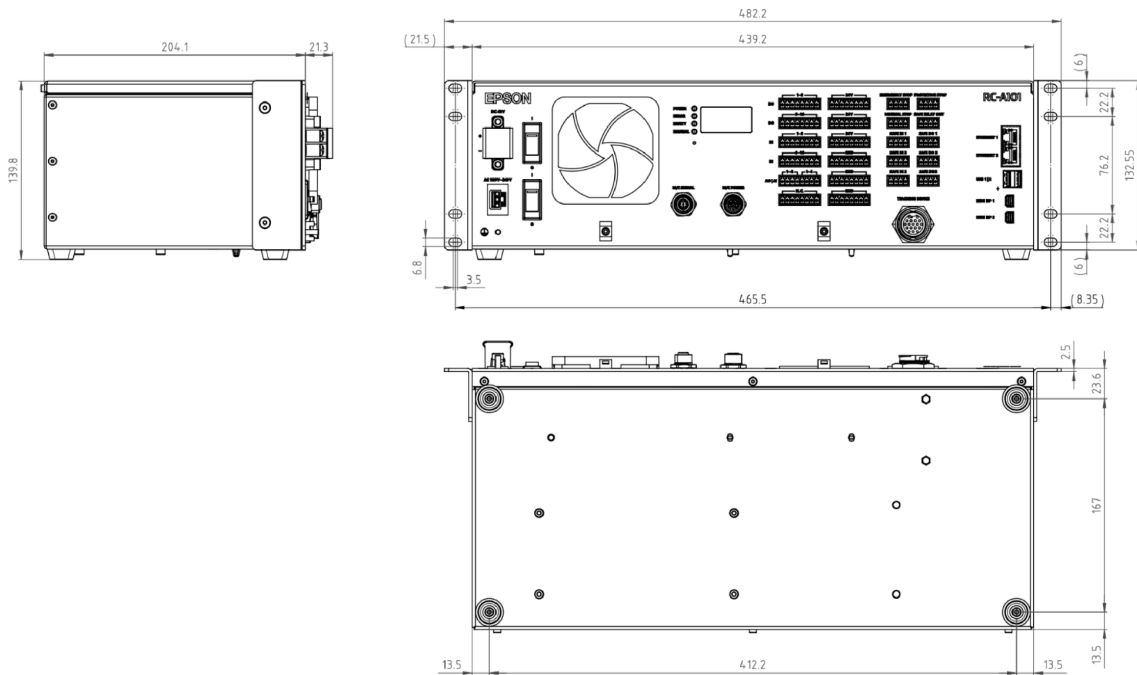
- Safety Compliance
- Role for Safety Managers
- Knowledge and Training Required to Work with Robot Systems

For details, refer to the “AX6 / RC-A101 Safety Manual.”

2. Specification

2.1 Dimensions

The dimensions of the RC-A101 are shown in the drawing below.



Dimensions of RC-A101.

2.2 Technical Data

The table below shows technical data of the controller box.

Model		RC-A101
Weight (without cables)		5.5 kg / 12.1 lbs
Ports	AC Input	100 to 240 VAC, 50 to 60 Hz
	DC Input	48 VDC $\pm$ 15 %
	Embedded PC ports	2x Ethernet 2x USB 2x Display Port
	Safe I/O	Emergency Stop Protective Stop Normal Stop 3x Safe Input 1x Safe Relay Out 3x Safe Output
	Teaching Device	Ethernet Power 24 V Emergency Stop Enabling Device
	Digital I/O	16x Digital Out 16x Digital In
	Analog I/O	4x Analog Out, 4x Analog In Current & Voltage Mode available
	24 V Out	3x 8 Pin 24 V + 3x 8 Pin GND
Power Consumption		200 W Average
Short-circuit Current Rating		1 kA
Leakage Current		Less than 2 mA / 240 VAC
Maximum Allowable Fault Loop Impedance	IEC 60204-1	TN System: 0.833 Ω TT System: 346.38 Ω
Insulation Resistance	IEC 60204-1	Primary–PE: 2.835 G Ω Primary–Secondary: 2.546 G Ω
Housing Material		Aluminium (painted)
Mounting Orientation		Flat mounting Rack-mounting Left-side up mounting

2.3 AC Input

The circuit breaker of the controller for the AC input is rated for a typical current of 10 A.

Parameter	Min	Typical	Max
Input AC Voltage	~100 V	–	~240 V
Input AC Frequency	50 Hz	–	60 Hz
Rated AC Current	–	–	10 A

2.4 DC Input

The controller can also be powered via a suitable DC power source. No additional adjustments are required to switch between AC and DC power supply. The DC power source can be connected directly to the DC input on the front of the controller before the relevant main switch is turned on.

In accordance with the specifications listed below, the DC power source must be capable of delivering a short-term peak power of at least 1 kW.

The control unit's main switch for the DC input is rated for a typical current of 20 A.

Parameter	Min	Typical	Max
Input DC voltage	40.8 V	48 V	55.2 V
Rated DC Current	–	–	20 A

3. Installation

3.1 Environment

A suitable environment is necessary for the robot system to function properly and safely. Install the controller in a location that fulfils the following conditions:

- The controller is not designed for cleanroom specification. Install it in a proper enclosure with adequate ventilation and cooling when you use it in a cleanroom
- Install the controller unit in a location that allows easy connection and disconnection of the cables.
- Install the controller unit outside of the safety barrier.
- If there are conductive things such as fences or ladders within 2.5 m of the controller, ground the things.

Environment	Condition
IP classification	IP20 generally, IP40 top surface ¹
Ambient temperature	Transport/Storage: -20 to 60 °C Operation: 5 to 40 °C
Ambient relative humidity	Transport/Storage: 10 to 90 % (no condensation) Operation: 10 to 80 % (no condensation)
Fast transient burst noise	1 kV or less
Electrostatic discharge	4 kV or less
Overvoltage category	2
Pollution Degree	2
Base table	Use a base table that is at least 100 mm off the floor. Placing the controller directly on the floor could allow dust penetration leading to malfunction.
Altitude	Max. 2000 m

If the controller must be used in an environment that does not fulfill the conditions mentioned above, take adequate countermeasures. For example, the controller may be enclosed in a cabinet with adequate ventilation and cooling.

¹The IP protection rating of this product is based on a design evaluation conducted with reference to the relevant standards. This description does not guarantee the dustproof or water-resistant performance of the product at the time of shipment or under actual installation and operating conditions.

Please make sure:

- Install indoors, and place in a well-ventilated area.
- Keep away from direct sunlight.
- Keep away from radiation heat.
- Keep away from dust, oily smoke, oil, salinity, metal powder or other contaminants.
- Keep away from water.
- Keep away from shocks or vibrations.
- Keep away from sources of electronic noise.
- Keep away from strong electric or magnetic fields.

3.2 Installation

3.2.1 Mounting

You may install the controller as shown in the three pictures below:

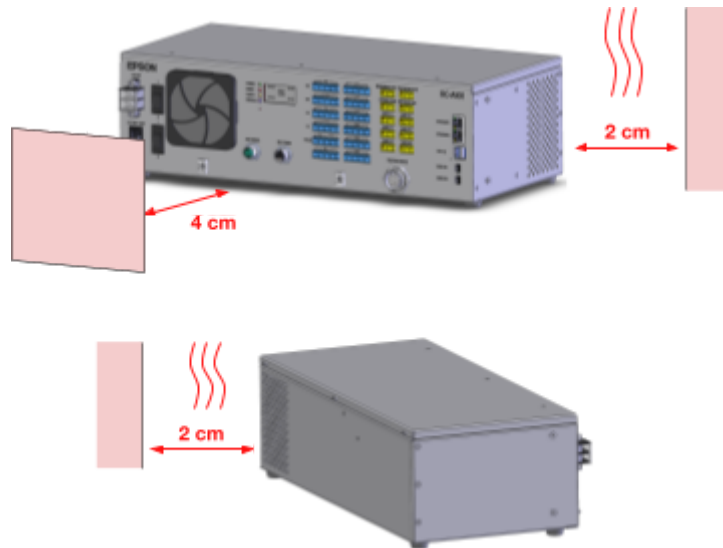
		
Flat mounting.	Left-side up mounting.	Rack mounting.

Note:

- For left-side up mounting, remove the feet and fix the controller with four M4 screws and a maximum torque of 1 Nm. Alternatively, the rack mounting brackets might be used as described below. The ventilation slots need to be on the bottom in order to retain IP40 on the top surface. Make sure the required distance for the ventilation slots below the controller is maintained as described see below.
- For rack mounting, it may be required to remove the feet. Install the rack mounting brackets with the supplied screws and a maximum of 1.2 Nm torque.
- In order to convert from rack mounting back to flat mounting, install the feet again using the supplied screws a torque of 0.8 Nm.

Ventilation Slots:

- In any orientation of the controller, there must be at least 4 cm of free space for the airflow in front of the front intake, at least 2 cm next to the ventilation slots at both exhausts on the right side as well as the back side. See image.
- Prevent liquids from splashing into the ventilation openings.



Distance to ventilation slots.

3.2.2 Electrical Installation

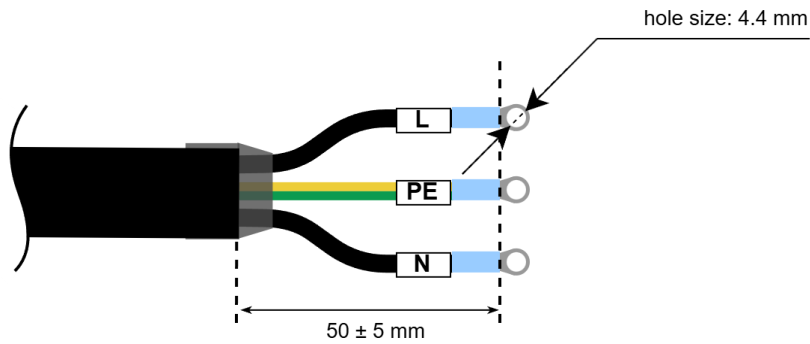
In the following section, details about connecting the controller to a power source are outlined. The controller can be powered by using either AC power or DC power. The controller is not intended to be powered with both AC and DC at the same time and such use cases should be avoided. There is a circuit breaker on the front panel for both AC and DC operation.

Before attempting to power on the device, carefully read the installation and operation safety instructions from the previous section and the “AX6 / RC-A101 Safety Manual” provided with this device.

 WARNING	Make sure the cables are always connected. Use a protective cover to protect the cables. Do not place any objects on the cables, do not kink them, and do not pull on them with force; also ensure that the cables do not become trapped. Damaged cables, broken wires or faulty connections are extremely dangerous and can lead to electric shock and/or malfunction of the robot system.
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3.2.2.1 AC Power

The 5 m long power cable supplied with the controller has a plug on the controller end and, on the mains end, three wires fitted with ring terminals. A detailed diagram is provided below. Connect the power cable to a suitable power source.

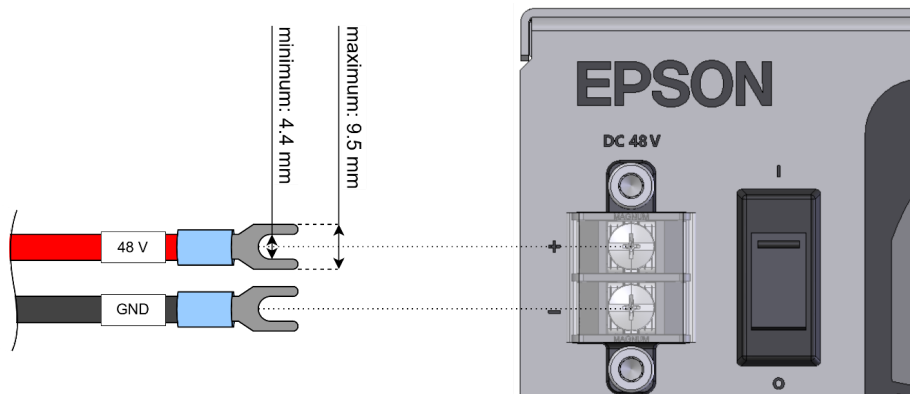


AC power cable.

To power the robot, first make sure that the circuit breakers on the front panel of the controller are switched off. Next, connect the AC power cable to the controller and then to the power source.

3.2.2.2 DC Power

No additional modifications need to be done in order to switch between AC and DC power input. The DC power source can be directly connected to the DC input on the front panel of the controller. A detailed drawing about the connector is shown below.



DC power cable.

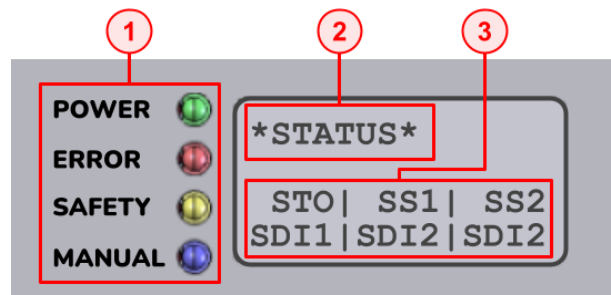
3.3 Connect to a Computer or Tablet

Accessing the AX Portal interface can be done in the following three ways:

1. By connecting a monitor, keyboard and mouse directly to the controller using its “Mini DP 2” port and the USB ports respectively. Please refer to section [Periphery Connectors](#).
2. By connecting a standalone computer and accessing the AX Portal interface using one of the RJ45 network ports of the controller. For more information please, refer to the separate “AX Portal User’s Guide”.
3. Accessing the AX Portal using a suitable tablet attached to the teach pendant holder. For more information on this, please refer to section [Teaching Devices](#).

3.4 Status Indicators

The controller features a display and LEDs that indicate the status of the robot system (see figure below).



Display and LEDs on Controller.
 1. LEDs: Power, Error, Safety, Manual
 2. Status Description, 3. Safety Status

3.4.1 Status LEDs

The colour of the LEDs on the controller front panel indicate the operation mode of AX Portal.

LED status	Motor Power	Description
Power	Any	Controller operational
Error	Off	Stop due to safety function or error (e.g. Emergency Stop)
Safety	On	Any safety feature active (e.g. SS2 Protective Stop, collision)
Manual	On	Manual mode active.
Light off	Off	Controller off.

3.4.2 Display

The display shows the current status of the robot system as well as which safety functions are active at a time. The table below describes all statuses.

Status	Motor Power	Description
DISCONNECTED	Off	Manipulator powered off
OPERATIONAL	On	Manipulator powered on
HGC	On	Hand Guided Control active
COLLISION	On	Collision detected
PROCEED	On	User confirmation required
PAUSED	On	Application paused
ERROR	Off	Stop due to an error
EMERGENCY_STOP	Off	Emergency stop active
PROTECTIVE_STOP	On	Protective stop active
NORMAL_STOP	Off	Normal Stop active
STO	Off	Safe torque off active
SS1	Off	Safe stop 1 active
SS2	On	Safe stop 2 active
SDI1	–	Safe digital input 1 active
SDI2	–	Safe digital input 2 active
SDI3	–	Safe digital input 3 active
Display off	Off	Powered off

3.5 Power-off

To shut off power to the robot system:

1. Stop the manipulator's movement:
 - Stop any movement of the robot in AX Portal, then power down the robot in the AX Portal or
 - press the Normal Stop button.
2. Switch off the circuit breakers on the front panel of the controller. Finally, disconnect the power plug from the power source.



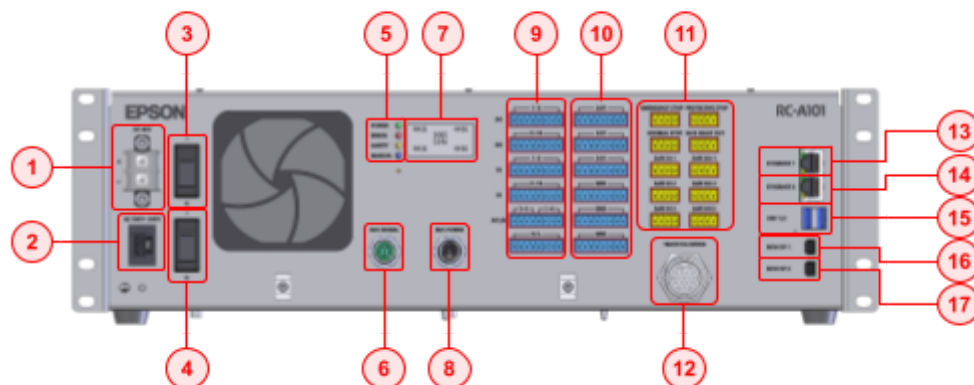
CAUTION

Never switch off the robot system using the circuit breaker while the manipulator is moving. Switching off the robot system while the manipulator is moving may damage the manipulator.

4. Electrical Interfaces

4.1 Connectors on the Controller Box

On the front of the controller, there is a panel with multiple connections as specified in this section.



Connectors on controller.

1. DC input, 2. AC input,
3. DC Circuit Breaker, 4. DC Circuit Breaker
5. Status LEDs, 6. M/C Signal,
7. Display, 8. M/C Power,
9. I/Os, 10. Supply,
11. Safe I/Os, 12. Teaching Device,
13. Ethernet 1, 14. Ethernet 2, 15. USB 1|2,
16. Mini DP 1 (not used), 17. Mini DP 2

4.1.1 Connector Types

For ordering additional connectors, please refer to the table below which shows the connector types.

Use	Name/Type
AC Input	Winsta Mini
DC Input	Screw Terminal (see DC Power)
M/C Signal	M12 male, 8 Pins
M/C Power	M12 male, 5 Pins
I/O	Terminal Block, 8 Pins, 3.81 mm
Safe I/O	Terminal Block, 4 Pins, 3.81 mm
Teaching Device	Maxi-Con-X, 18 Pins
Ethernet 1	RJ45
Ethernet 2	RJ45

Use	Name/Type
USB 1 and 2	USB type A
Mini DP 1 and 2	Mini Display Port

4.2 Digital and Analog Input and Output (Main I/O)

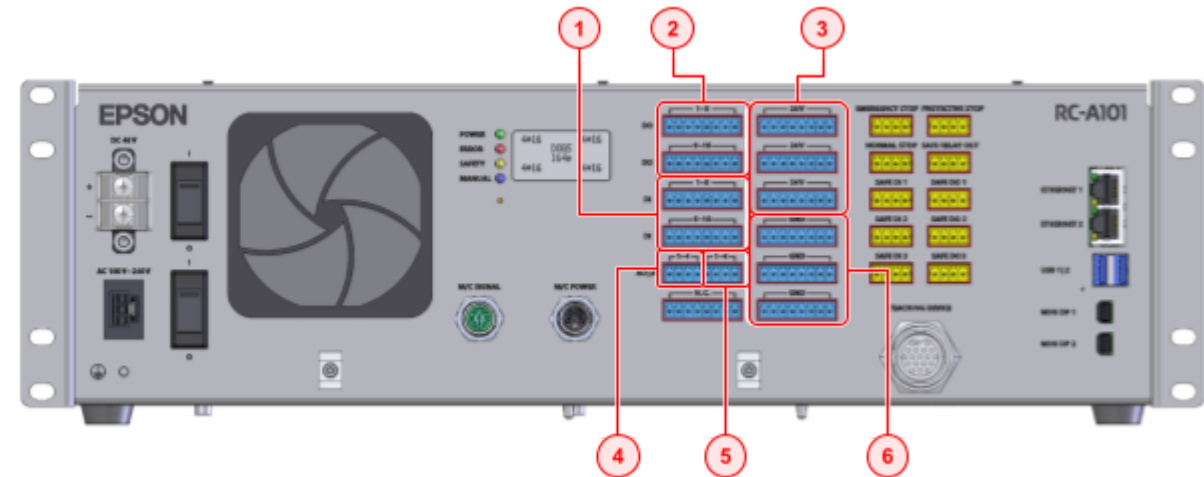
4.2.1 Introduction

The front panel features a series of general inputs, outputs, supply and ground connections, that can be used to interface and/or power external devices such as sensors, actuators, PLCs etc. The available connections are specified in this section.



WARNING

For safety related connections such as human presence sensors, light barriers, Emergency Stops etc. **do not** use these general I/Os but the dedicated safe I/Os instead.



Main I/O connectors on controller

- 1. Digital Input, 2. Digital Output, 3. 24V Supply
- 4. Analog Output, 5. Analog Input, 6. GND



CAUTION

Do not reverse the polarity of the digital I/Os or exceed any current or voltage limitations.

4.2.2 I/O Supply

The 24 V and the GND terminals are used to supply power to the circuits and devices connected to the digital and analogue inputs and outputs.

Output Voltage	24 V
Max. Current per Pin	1 A (1.1 A OCP)
Max. Total Current	5 A (sum of all pins incl. Digital Outputs)

4.2.3 I/O Configuration

In AX Portal, the analog and digital IOs can be configured via the “*I/Os Configuration*” panel before powering up the robot.

The digital inputs can be either configured as “*Input*” (default, pull-downs enabled) or “*Input (Pull-Up)*” which disables the switchable pull-down resistors.

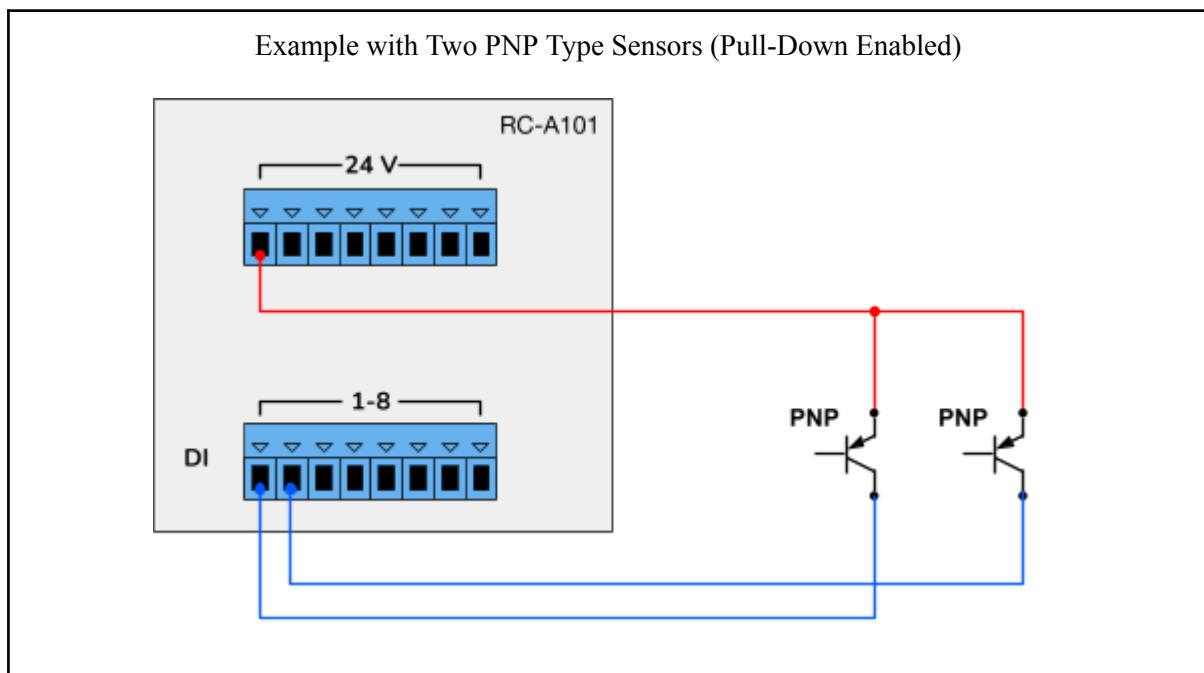
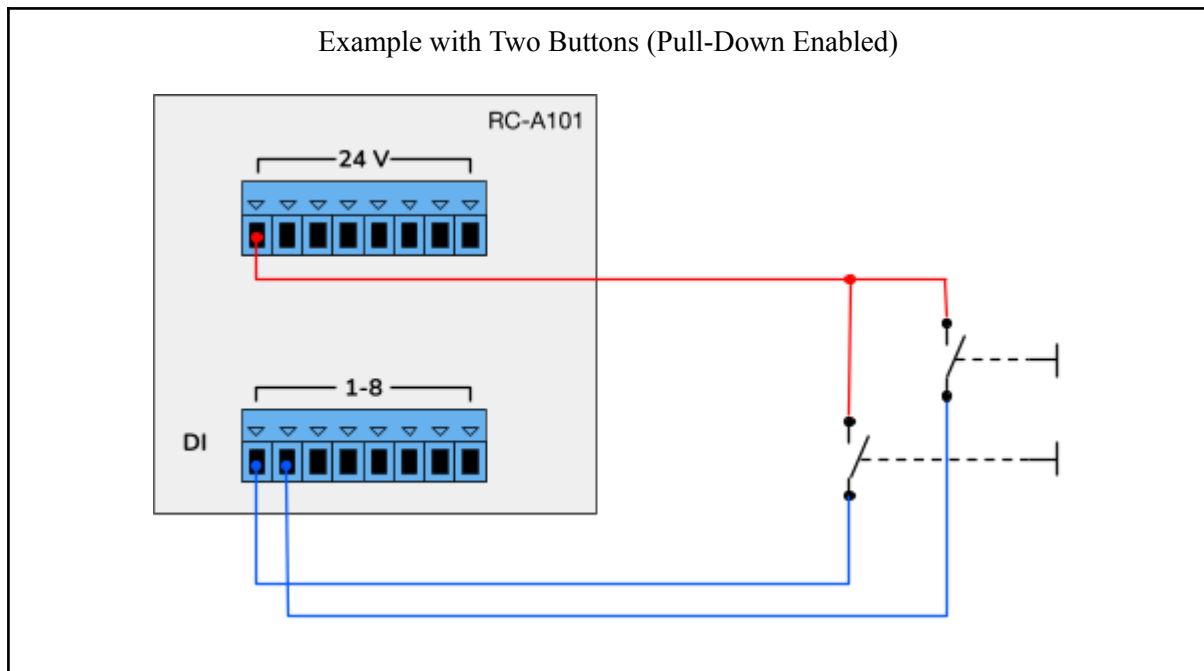
Each of the analog inputs and outputs are circuits that can be configured to operate in either voltage or current mode as described below.

4.2.4 Digital Inputs (Main I/O)

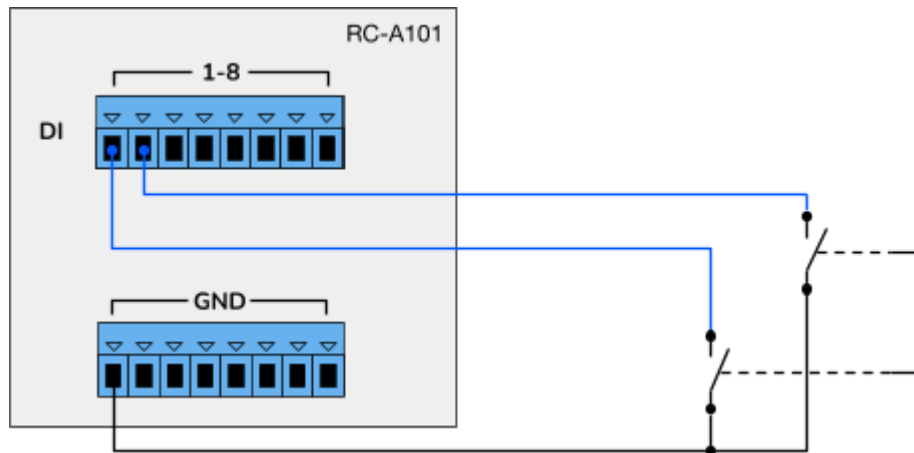
Each of 16 available digital inputs is a high impedance circuit with a fixed pull-up and switchable pull-down resistor configurations (default is pull-down enabled). The inputs allow for both PNP and NPN type sensors to be used. Example connection diagrams for each of the above configurations are shown below. Note that each of the inputs can be used differently (e.g. Digital In 1 as pull-down enabled and Digital In 2 as pull-down disabled).

Max Input Voltage	24 V
ON Voltage	≥ 3 V
OFF Voltage	< 1 V
Input Resistance	14.7 k Ω (pull-down enabled) 334 k Ω (pull-down disabled)
Input Current	2.17 mA at 24 V (pull-down enabled) 1.23 mA at 24 V (pull-down disabled)

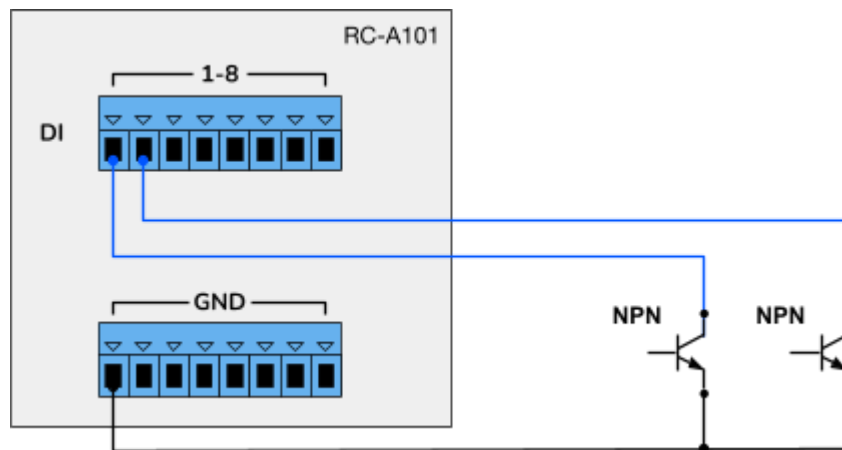
Note: The following examples use connector “DI 1–8” but connector “DI 9–16” has the exact same functionality:



Example with Two Buttons (Pull-Down Disabled)



Example with Two NPN Type Sensors (Pull-Down Disabled)



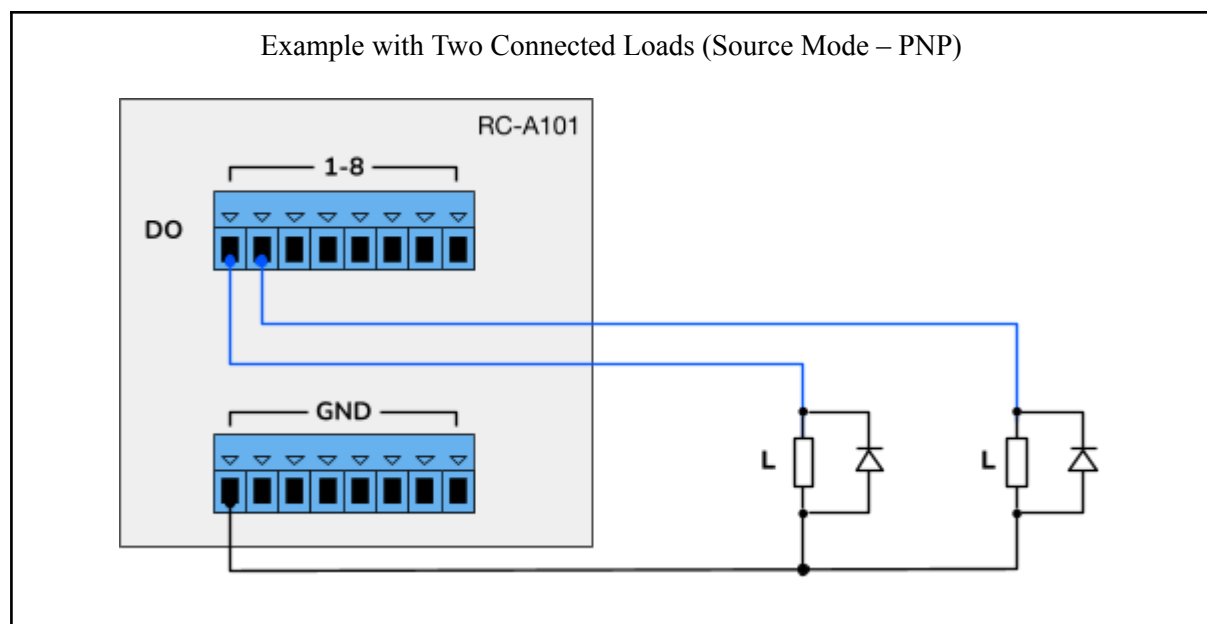
4.2.5 Digital Outputs (Main I/O)

Output driver	Half-bridge power driver
Output Voltage	24 V
Maximum Output Current (Sourcing or Sinking)	1 A (1.1 A OCP) ²

Each of the digital outputs is a current limited, push-pull, half-bridge power driver. The driver allows operation in source mode (PNP type), sink mode (NPN type) and a full-bridge type configuration using two outputs. Example connection diagrams for each of the above configurations are shown below. The default state of the digital outputs is LOW. For the configuration, see “AX Portal User’s Guide”.

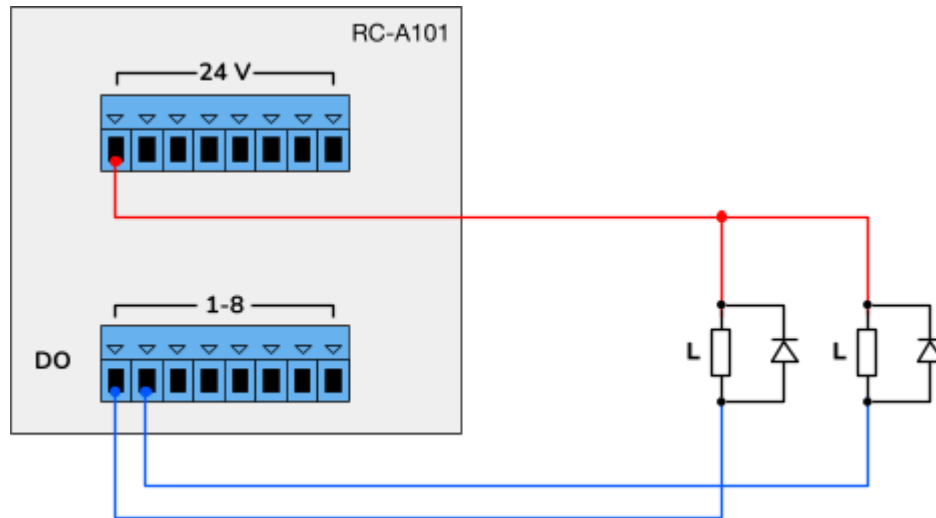
 CAUTION	The 24 V and GND connections of the indicated external device should be sourced from the corresponding pins provided from the respective controller connector used. Also note the current limitation.
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Examples:

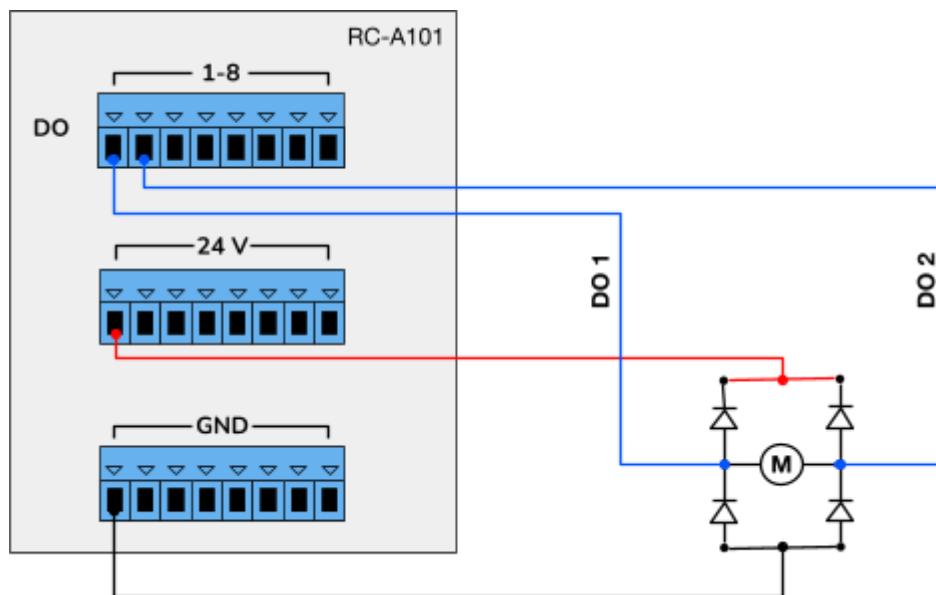


² Please note that the sum of all output currents (digital outputs and 24 V supply) must not exceed 5 A.

Example with Two Connected Loads (Sink Mode – NPN)



Example with a Connected Motor (Full Bridge Mode)



CAUTION

Warning about DC Motor Usage

For the specific usage of inductive loads such as e.g. brushed DC motors, relays or solenoids, external flyback diodes should be added to contain the back-EMF and re-circulate any excess inertial energy when the motor is switched off.

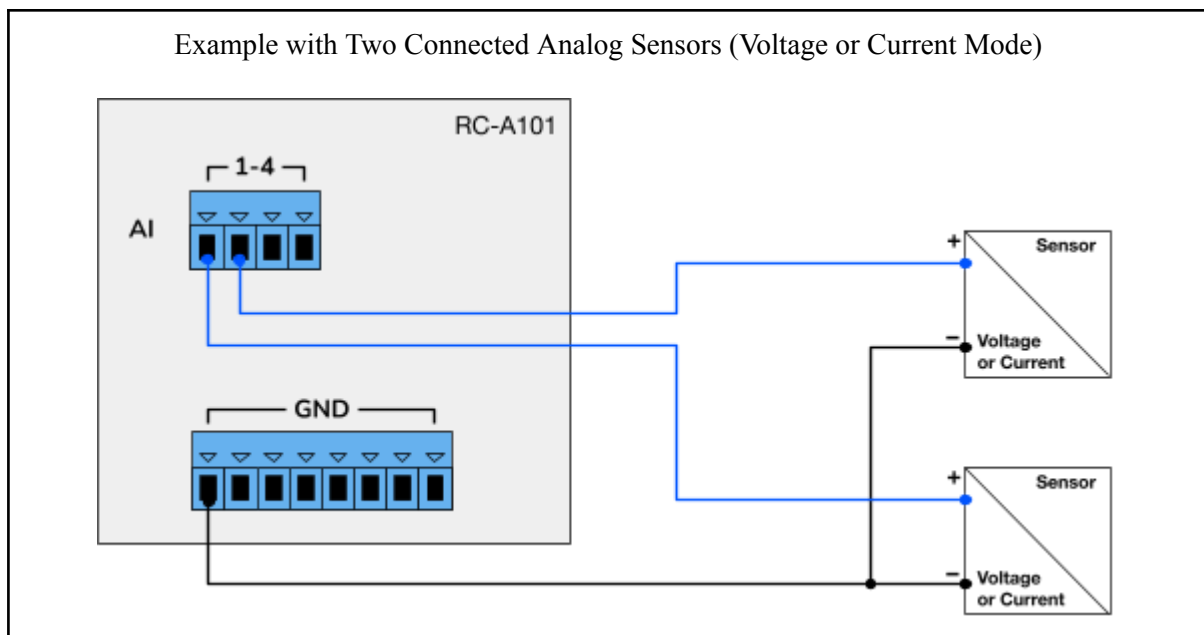
4.2.6 Analog Inputs (Main I/O)

The Main I/O analog inputs can be configured as voltage or current mode. In voltage mode, analog readings in the range of 0–10 V are possible. In current mode, a sense resistor in the circuit is activated which allows current readings in the range of 4–20 mA. An example connection diagram is shown below, which is valid both for current and voltage mode.

Analog Input Configuration

General Specifications	Maximum sampling frequency	20 Hz
	Maximum input voltage	10 V
	Sampling resolution	12 bit
Voltage Mode	Input voltage range	0–10 V
	Input current consumption	< 1 mA
	Minimum local impedance	$\geq 100 \text{ k}\Omega$
Current Mode	Input current range	4–20 mA ³
	Sense resistance	135 Ω

Examples:



³ Operation within the 0–20 mA range is permitted, but fault detection is not available.

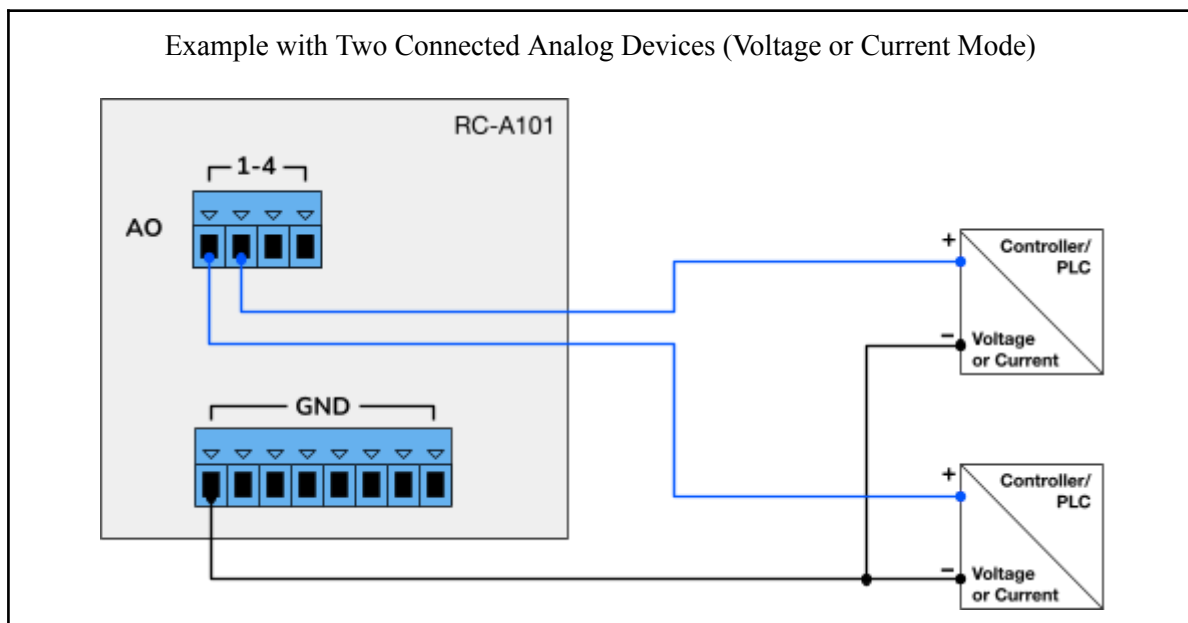
4.2.7 Analog Output (Main I/O)

The Main I/O analog outputs can be configured as voltage or current mode. In voltage mode, analog outputs in the range of 0–10 V are possible. In current mode, an output in the range of 0–20 mA can be generated. An example connection diagram is shown below, which is valid both for current and voltage mode.

Analog Output Configuration

General Specifications	Maximum output frequency	20 Hz
	Output resolution	12 bit
Voltage Mode	Output voltage range	0–10 V
	Maximum output current	1 mA
	Minimum remote impedance	$\geq 50 \text{ k}\Omega$ $\geq 100 \text{ k}\Omega$ recommended
Current Mode	Maximum output voltage	10 V
	Output current range	0–20 mA
	Output load resistance	$< 300 \text{ }\Omega$

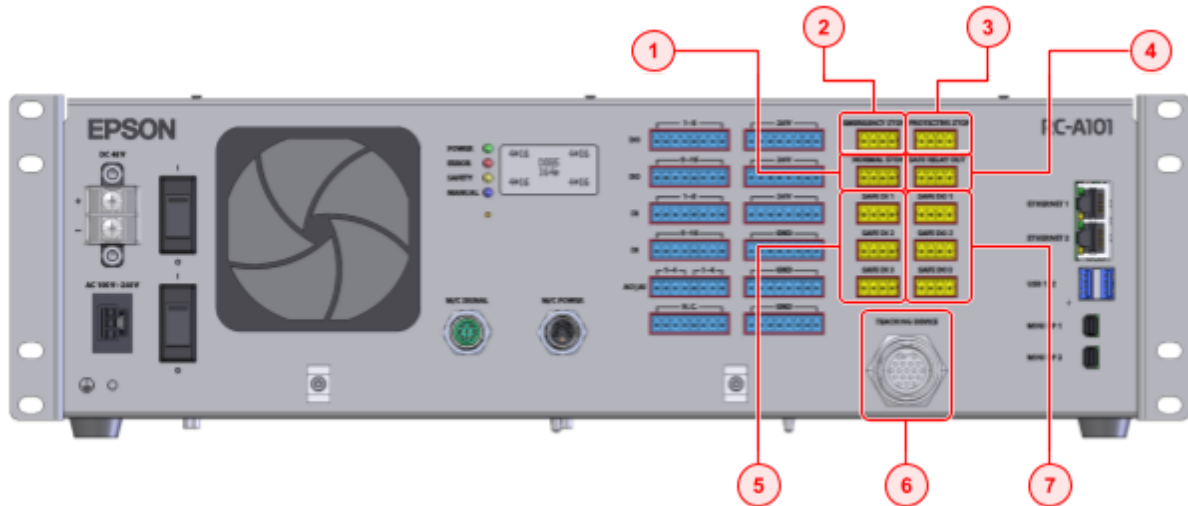
Example with Two Connected Analog Devices (Voltage or Current Mode)



4.3 Safe Input and Output

4.3.1 Introduction

The controller features a series of safe digital inputs and outputs (yellow connectors). Safe I/Os have full redundancy and connect directly to the Safety PLC inside the controller. The following chapter will further discuss the available connections.



Connectors for safety devices on the controller.

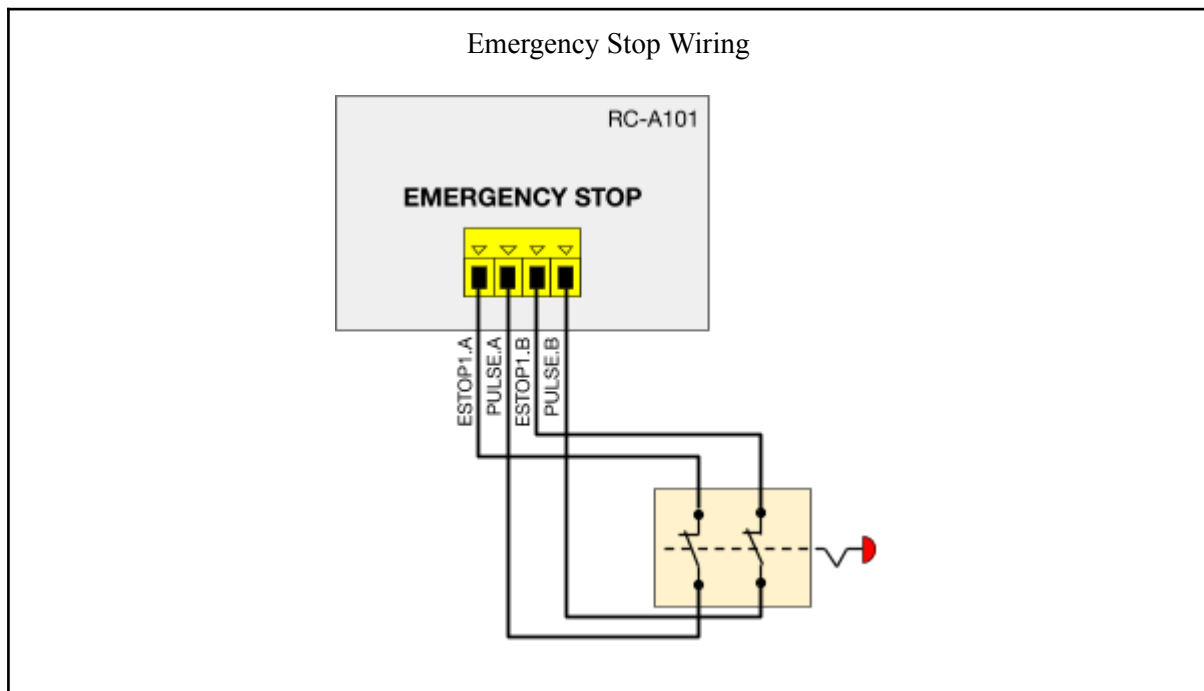
1. Normal Stop, 2. Emergency Stop, 3. Protective Stop, 4. Safe Relay Out,
5. Safe Digital Input 1–3, 6. Teaching Device, 7. Safe Digital Output 1–3

4.3.2 Pulsed Signals and OSSDs

All safe digital inputs and outputs use/expect pulsed signals for short-to-high, cross-channel and stuck-on-high detection. These test pulses have a length of 250 μ s and are sent in 500 ms intervals. All safe digital inputs can accept signals from output signal switching devices (OSSD) such as other safety devices. All safe digital inputs and outputs are dual channel except the Normal Stop which is a single channel safe digital input.

4.3.3 Emergency Stop

Pressing the Emergency Stop causes the manipulator to stop with maximum deceleration and then cut the motor power and immediately apply the brakes (Stop Category 1 according to EN 60204). This can result in small deviations from the path, as the pin brakes of the manipulator allow for some play. The Emergency Stop is designed according to ISO EN ISO13849-1:2008 with Performance Level d, Category 3.



4.3.4 Protective Stop

The Protective Stop has the same behaviour as the Emergency Stop, but the robot movement can start automatically (if configured this way) when the Protective Stop is released. The Protective Stop is designed according to ISO EN ISO13849-1:2008 with Performance Level d, Category 3. If the Protective Stop is configured as an SS1, the same points regarding path deviations as for the Emergency Stop apply. With SS2, there is no deviation from the path.

 WARNING	Never use the Protective Stop as an Emergency Stop. An unintended automatic start is extremely hazardous and may result in serious body injury and/or severe equipment damage to the robot system.
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4.3.5 Normal Stop

Pressing the Normal Stop will bring the manipulator to a stop without causing unnecessary wear. It is a Category 1 controlled stop where the power is maintained until the stop is achieved, then the brakes are engaged. As mentioned before, the Normal Stop is only a single channel safe digital input. It is designed according to ISO EN ISO13849-1:2008 with Performance Level b, Category 1.

4.3.6 Safe Digital Inputs

The Safe Digital Inputs (SDI 1–3) can be used to activate predefined safety settings for up to three different Safe Cases. Such a case can for example limit the maximum speed or restrict the joint angles or workspace of the manipulator. Each of the three available cases can be set individually by an authorized safety officer using the AX Portal software.

Max Input Voltage	24 V
Input Current	20 mA at 24 V
Properties	Pulsed, OSSD style, Type 2 acc. to IEC 61131-2

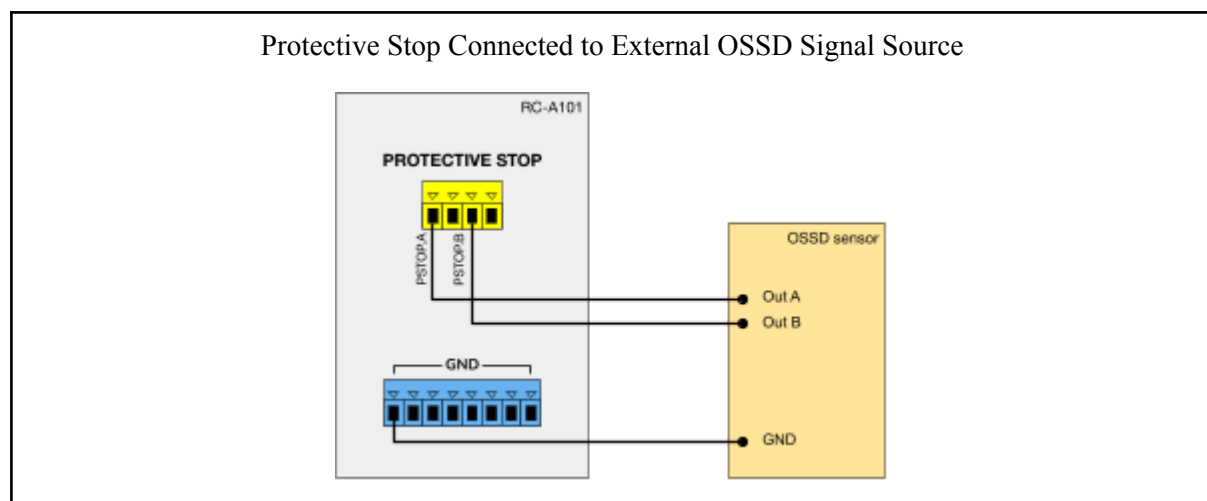
For more information, setup and use with AX Portal, please refer to the separate “AX Portal User’s Guide”.

Safe inputs and outputs both use and expect an OSSD signal respectively. External OSSDs such as compatible light barriers, light curtains, door sensors or other safety conform devices can be connected to the Protective Stop, the Normal Stop and/or the three safe digital inputs.

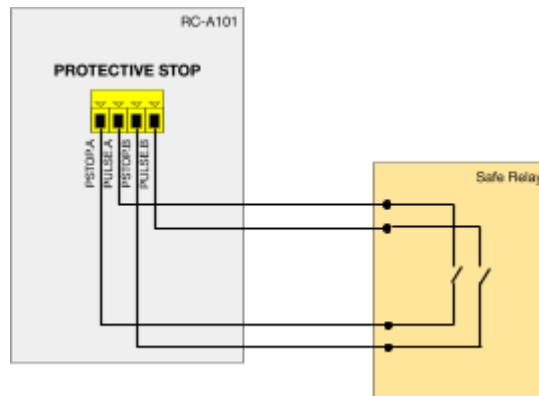
Please note that for external devices, the proper functionality must be guaranteed by the system integrator.

 WARNING	If any safe digital input is controlled by an external non-safe (dual channel) relay, the short-to-high, cross-channel and stuck-on-high detection provided by the OSSD architecture is essentially bypassed. Except for the Normal Stop, this lowers the operation to Performance Level c, Category 2, is potentially hazardous and may result in serious body injury and/or severe equipment damage to the robot system.
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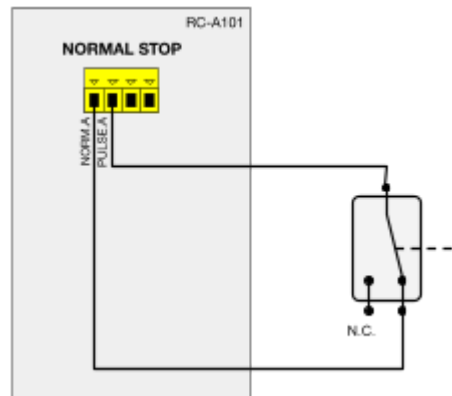
In the following, a few examples are given on how to connect the Protective Stop, Normal Stop and other Safe Digital Inputs.



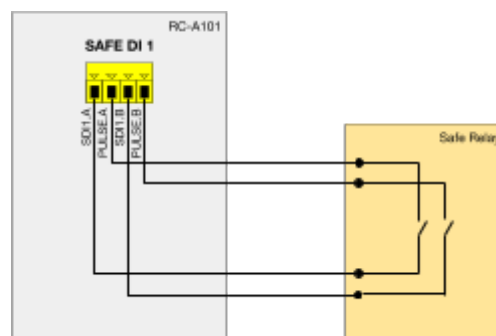
Protective Stop Connected to External Safety Relay



Normal Stop Connected to a Switch (Normally Closed)



Safe Digital Input 1 Connected to External Safety Relay

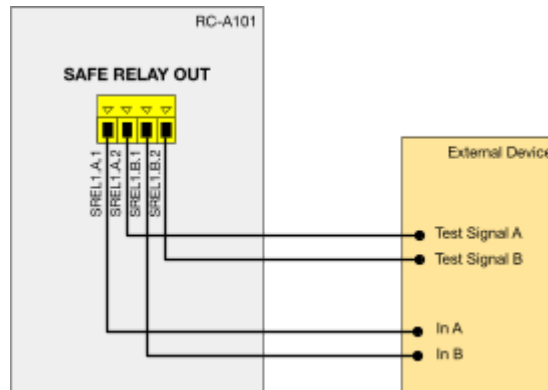


The same applies for the safe digital inputs 2 and 3.

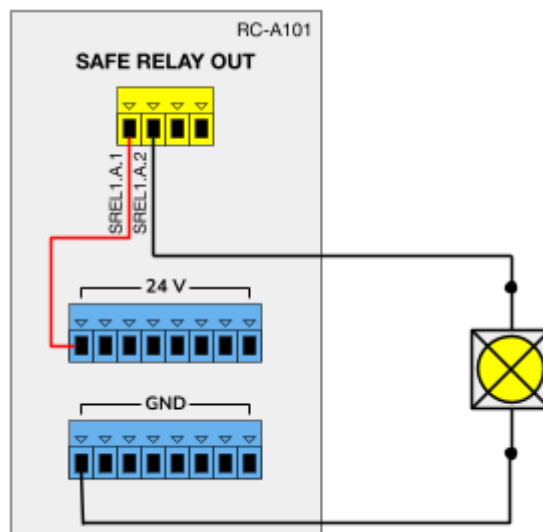
4.3.7 Safe Relay Output

There is an internally protected two channel safe relay available that can be used to switch up to 2 A at a maximum voltage of 24 V. It can e.g. be used to safely switch external devices that may use test pulses (OSSD) or constant signals.

Safe Relay Output Connected to Control External Device



Safe Relay Connected to a 24 V Source and Consumer



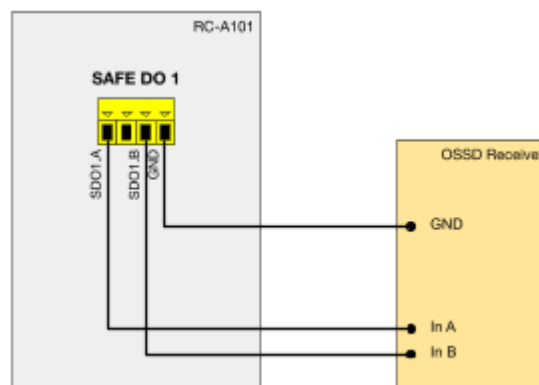
4.3.8 Safe Digital Outputs

The safe digital outputs each provide a set of 24 V, OSSD style pulsed signals and ground connections. They can be used to connect to an external receiving safety device. Alternatively, they can also be used to power electronics directly with current consumption up to 500 mA.

Max Output Voltage	24 V
Output Current	500 mA at 24 V
Properties	Pulsed, OSSD style

Please note that due to the signal's pulsed nature, these outputs may not be suitable for all types of electronics or may cause unwanted behaviour such as e.g. flickering of LEDs.

Safe Digital Output 1 Connected to External OSSD



The same applies for the safe digital outputs 2 and 3.

4.3.9 Safe Outputs Status Overview

The electrical status of each safe output is related to predefined functions and described in the following table:

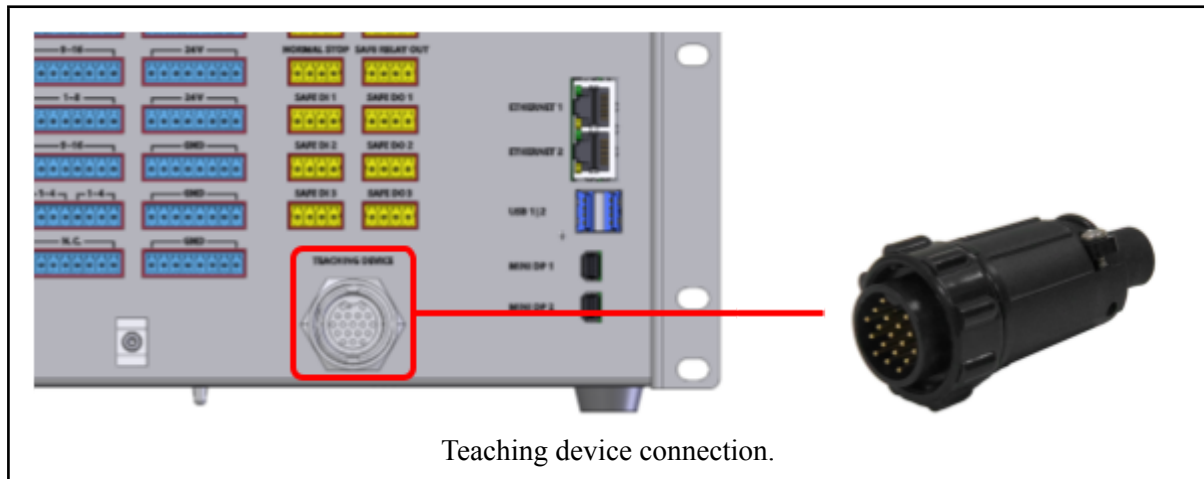
Type (Name on Controller Front panel)	Function
Relay Output (SREL1_a.1) Relay Output (SREL1_a.2)	STO state: Contact between _a.1 & _a.2 <u>closed</u> when STO is <u>not</u> active <i>Note: When FSoE is not running (fail state) or STO state active, this contact is <u>open</u>.</i>
Relay Output (SREL1_b.1) Relay Output (SREL1_b.2)	STO state: Contact between _b.1 & _b.2 <u>closed</u> when STO is <u>not</u> active <i>Note: When FSoE is not running (fail state) or STO state active, this contact is <u>open</u>.</i>
Digital 24 V (SDO1_a) Digital 24 V (SDO1_b)	Teaching device 3-Pos. Enable switch status: Switch in middle position (high 24 V) Not pressed or fully pressed (low 0 V) <i>Note: When FSoE is not running (fail state) or STO state active, this output is always low (0 V).</i>
Digital 24 V (SDO2_a) Digital 24 V (SDO2_b)	Operation mode (Auto/Manual): Auto Mode (high 24 V) Manual Mode (low 0 V) <i>Note: When FSoE is not running (fail state), this output is always low (0 V), also when auto mode is selected in the AX portal.</i>
Digital 24 V (SDO3_a) Digital 24 V (SDO3_b)	SOS State: SOS activated (high 24 V) Not activated (low 0 V) <i>Note: When FSoE is not running (fail state) or STO state active, this output is always low (0 V).</i>

4.3.10 Teaching Device

Multiple options of teaching devices are available as an option part to the robot system. These come with an additional emergency button as well as an enable button. For more information about available devices, please refer to section [Option Parts](#).

No additional wiring is required, but in case no teaching device is used, the corresponding teaching device connector jumper must be connected for the system to function.

Please note that a teaching device is necessary to operate the robot in manual mode for testing new applications or for recovering the robot in case of position limit violations.



4.4 Periphery Connectors

The controller comes with a variety of connectors for connecting periphery devices:



1. Ethernet 1, 2. Ethernet 2, 3. USB 1|2, 4. Mini DP 1 (not used), 5. Mini DP 2

4.4.1 Ethernet

The two Ethernet ports can both be used to access the AX Portal web interface. But they differ significantly in their respective network setup.

Ethernet 1 is used to connect the controller to existing networks and can be configured in AX Portal to obtain an IP address automatically via DHCP or to use a static IP address defined by the user.

Ethernet 2 serves as a service port and will automatically assign IP addresses to any connected device using DHCP. AX Portal can then be accessed using common browsers using the IP address 10.0.0.203.

4.4.2 USB

There are 2x USB 3.0 Type A ports available for periphery such as keyboard, mouse and USB mass storage devices. A USB hub can be used to expand the number of available ports if more devices need to be connected simultaneously.

4.4.3 Mini Display Port

A monitor can be connected to the Mini DP 2 port. It is advised to connect the monitor first and then power on the controller box. The Mini DP 1 port is non-functional.

4.5 USB Mass Storage Device

4.5.1 Update

For the software update, please refer to the “AX Portal User’s Guide”.

4.5.2 Export of the Database

The database which contains user data like poses and scripts can be exported using the AX portal web interface. For more information, please refer to the “AX Portal User’s Guide”.

5. Maintenance

5.1 Clean or Exchange Fan Filter

The housing fan of the controller is protected against excessive dust by a clip-on filter. Depending on use and environmental dust, it is recommended to clean the dust filter every month. In rare cases of excessive dust collection beyond normal cleaning, the dust filter should be exchanged.

To remove the filter the plastic clips on all four sides need to be lifted carefully until the filter front can be removed from the fan.



5.2 Inspection Items and Their Inspection Frequency

Be sure to perform the maintenance inspection in accordance with the schedules:

Inspection Item	Frequency	Inspection Method	Check Method
Controller	yearly	Power down and restart	Starts up without errors
Safety functions	yearly	Trigger all safety functions such as Emergency Stop, Protective Stop, Normal Stop, SDI1-3	The safety functions work as expected without indication of errors
Fan filter	monthly	Perform a visual check and clean	No dirt accumulation
Fan (front)	monthly	Check for operating noise	No unusual noise
Enable switch (Option)	yearly	Use the Enable Switch in manual mode	The Enable Switch works as expected without indication of errors

5.3 Check for Damage

Any cable and/or connector that is plugged and unplugged often and/or is subjected to frequent vibrations and/or bending should be checked for damage regularly. Damaged parts should be replaced immediately, according to the separate⁴ “AX6 Manual – Controller Service”.

⁴Available for customers with service training only.

5.4 Cleaning the control unit

Clean the control unit housing if it is dirty: Switch off the control unit and disconnect it from the mains. Wipe away any dirt from the control unit using a soft microfibre cloth. If the unit is very dirty, or if you wish to disinfect it, you can dampen the cloth with 70% isopropyl alcohol. Take care not to scratch the paintwork on the control unit.

 WARNING	Please note the following: • Never clean the control unit whilst it is switched on. Cleaning a control unit that is switched on is extremely dangerous and may result in electric shock. • Disconnect the power supply before cleaning. Cleaning a control unit that is connected to the mains is extremely dangerous and may result in electric shock. • Never spray liquids, including cleaning agents, onto the control unit. If liquid is sprayed onto the control unit, this may result in electric shock.
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6. EMC Considerations

Our robot controller and manipulator are products designed to be incorporated into mechanical equipment. The EMC compatibility of the overall mechanical equipment incorporating our products varies depending on the equipment configuration, wiring, and installation conditions in the customer's operating environment. Therefore, evaluation of EMC compatibility as a final product must be performed by the customer.

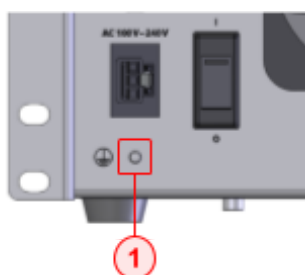
The following describes precautions to minimize susceptibility to noise and to prevent the generation of noise as much as possible.

Note that this information does not guarantee the EMC compatibility of the overall mechanical equipment incorporating our products.

6.1. Grounding in DC Power Supply Environments

In environments where a DC power supply is used, the controller enclosure and the functional ground (FG) may not be properly grounded.

Connect the ground point located at the lower left of the front panel of the controller to the GND terminal of the DC power supply.



Recommendation for ground connection (1. Ground Point):

Wire Size	AWG 14
Cable Length	3 m or less
Controller-side terminal	Ring terminal with 4 mm inner diameter

6.2. Adding Ferrite Cores to Safety Input/Output Cables

Cables connected to safety input/output signals other than those for the teaching device may be susceptible to noise interference. Insert an EMC suppression ferrite core as close to the controller as possible.

Recommendation for ferrite cores:

Ferrite Core Model	RFC-20
Ferrite Core Manufacturer	Kitagawa Industries Co., Ltd.
Number of Turns	2 turns
Distance from the Controller	15 cm or less

7. Option Parts

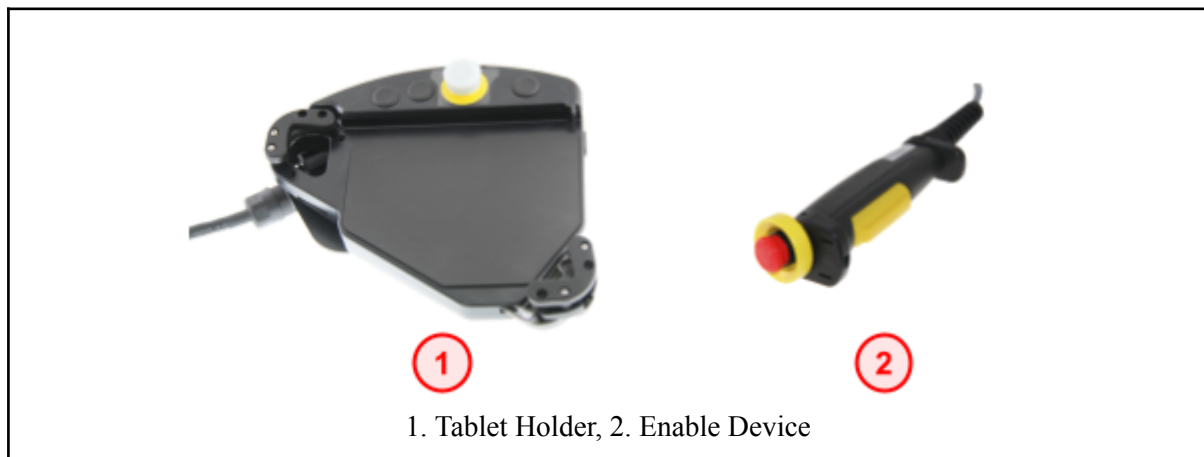
7.1 Option Parts

This chapter describes the option parts available for the AX6 robot system.

7.2 Teaching Devices

7.2.1 Overview

The teaching device allows for additional control of the robot. It features a 3-position enabling switch to allow robot movement in manual mode as well as an additional Emergency Stop button. There exist two versions depicted below. Supported teaching devices are:



Note: If no supported teaching device is used, the teaching device connector jumper must be connected instead, otherwise the robot cannot be operated. A teaching device is necessary to use the robot in manual mode.

Option Part	Code
Tablet Holder	R12NZ901WB
Enable Device	R12NZ901WC

7.2.2 Tablet Holder

The tablet holder is designed to securely hold a tablet device. An USB connection provides power for charging up to 30 W according to the Power Delivery standard. A wired network connection with up to 480 Mbit/s through USB allows for the AX Portal web interface to be accessed for programming and control of the robot on the tablet without the need of an external network environment.

Since modern tablets come with a USB-C connector, a corresponding USB-C cable with suitable length and network capabilities has to be sourced by the user.



Once the network connection to the tablet is established, the controller will automatically assign an IP address to the tablet. AX Portal should now be accessible using the supported browser using the IP address 10.0.2.203. For more information, please refer to the separate “AX Portal User’s Guide”.

The Tablet Holder can accept tablets of common brands between 10 and 13 inches that support Ethernet and charging through USB-C.

7.3 Manipulator/Controller Cables

The power and signal cable connecting the controller box and the manipulator are also available in different lengths.

Option Part	Code
M/C Power Cable 0.5 m	R12NZ901W3
M/C Power Cable 1.5 m	R12NZ901W4
M/C Power Cable 3.0 m	R12NZ901W5
M/C Power Cable 5.0 m	R12NZ901W6
M/C Signal Cable 0.5 m	R12NZ901VY
M/C Signal Cable 1.5 m	R12NZ901VZ
M/C Signal Cable 3.0 m	R12NZ901W1
M/C Signal Cable 5.0 m	R12NZ901W2

7.4 Ethernet Cables

M12 to RJ45 Ethernet cables can be connected to the base and the tool head of the manipulator to make use of its internal Ethernet connection. These cables are available in different lengths.

Option Part	Code
Ethernet Cable 0.5 m	R12NZ901W7
Ethernet Cable 1.5 m	R12NZ901W8
Ethernet Cable 3 m	R12NZ901W9
Ethernet Cable 5 m	R12NZ901WA