MC-UM-MECA500

Revision number: 11.1.43

Mecademic Robotics

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Contents

User Manual for the Meca500 Industrial Robot (R3&R4)

For firmware version: 11.1

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Original instructions

About this manual

This user manual describes how to use Meca500 industrial robot system (revision R3 or R4). It will guide you through the steps required for setting up your Meca500 and for using it in a safe manner. You must read this user manual thoroughly during the unpacking and first use of your Meca500.

Symbol definitions

The following table lists the symbols that may be used in Mecademic documents to denote certain conditions. Particular attention must be paid to the warning and danger messages in this manual.

Note

Identifies information that requires special consideration.

Warning

Provides indications that must be respected in order to avoid equipment or work (data) on the system being damaged or lost.

Danger

Provides indications that must be respected in order to avoid a potentially hazardous situation, which could result in injury.

Revision history

The firmware that is installed on Mecademic products has the following numbering convention:

{major}.{minor}.{patch}.{build}

Each Mecademic manual is written for a specific {major}.{minor}.{*}.{*} firmware version. On a regular basis, we revise each manual, adding further information and improving certain explanations. We only provide the latest revision for each {major}.{minor}.{*}.{*} firmware version. Below is a summary of the changes made in each revision.

Revision	Date	Comments
B	July 14, 2025	Reflected the change in the color of the Power LED on the robot base of new robots. Revised Sections 2 and 5. Replaced references to “power supply” with “PS200 module”.
A	March 17, 2025	Original version

The document ID for each Mecademic manual in a particular language is the same, regardless of the firmware version and the revision number.

Introduction

The Meca500 is a six-axis industrial robot arm designed for moving tools and workpieces within factory or laboratory environments with high precision and six degrees of freedom. The Meca500 is easy to use, robust and lightweight. However, the robot is a precision device with rapidly moving parts and should therefore be used only by *trained technical personnel* who have read and understood this user manual.

Following the guidelines in this manual is essential to avoid damage to the robot, its end-effector, any workpiece and adjacent equipment, and most importantly, to prevent injuries to personnel. This manual will guide you through proper setup, operation, and maintenance procedures to ensure safe and effective use of your Meca500 robot.

Inside the box

Table 1 shows the items that come with a standard shipment of a Meca500 robot system. Your box may also contain the MEGP 25E or MEGP 25LS electric gripper, the MPM500 pneumatic module, or other small accessories. Do not open these additional packages immediately. You must read the grippers (MC-UM-MEGP25) or pneumatic module (MC-UM-MPM500) user manuals prior to installing the end-of-arm-tooling (EOAT) on the robot.

Warning

DO NOT remove the contents of the box until you read Section 4.

Table 1: Standard parts lists

Qty	SKU	Description	Photo
1	9100-001 OR 9100-002 OR 9100-003	Meca500-R3 robot arm OR Meca500-R4 robot arm OR Meca500-R4-OB robot arm with optical black surface treatment	
1	9200-001 OR 9200-003 OR 9200-004	PS200-R3 module OR PS200-R4 module OR PS200NB-R4 module without physical E-Stop and Reset buttons	
1	9403-001	D-Sub DB15 dongle (comes only with PS200-R3 and PS200-R4)	
1	2003-005	2-meter, M12 D-Code to RJ45, Ethernet cable	
1	2003-006	2-meter, M12 circular male to M12 circular female, communications and DC power cable for Meca500 (R3 and R4)	

Note

You are responsible for supplying the following components:

- An AC power cord with a three-prong IEC C13 connector on one end and a country-specific power plug on the other, along with a surge protector.
- M6 screws of appropriate length for securing the robot's base and PS200 module.
- One cable with DB15 connector.
- Properly wired safety I/O connections.

Note

Remember to not discard your shipping box and packing foam.

Overall description

Figure 1 shows a schematics of the complete Meca500 robot system in a typical installation. The D-Sub 15-pin dongle provided is not shown as it must be used only during setup and testing. The Meca500 robot arm consists of seven bodies connected in series through six motorized revolute joints. The first body is the robot base and the seventh body is the flange (mechanical interface). The joints are numbered from 1 to 6 , starting from the joint connected to the base, and are labeled on the robot as A1, A2, ..., A6. Joints 1, 2, and 3 are equipped with emergency brakes, which are automatically applied when power is removed from the motors. Joints 4, 5, and 6 have no brakes.

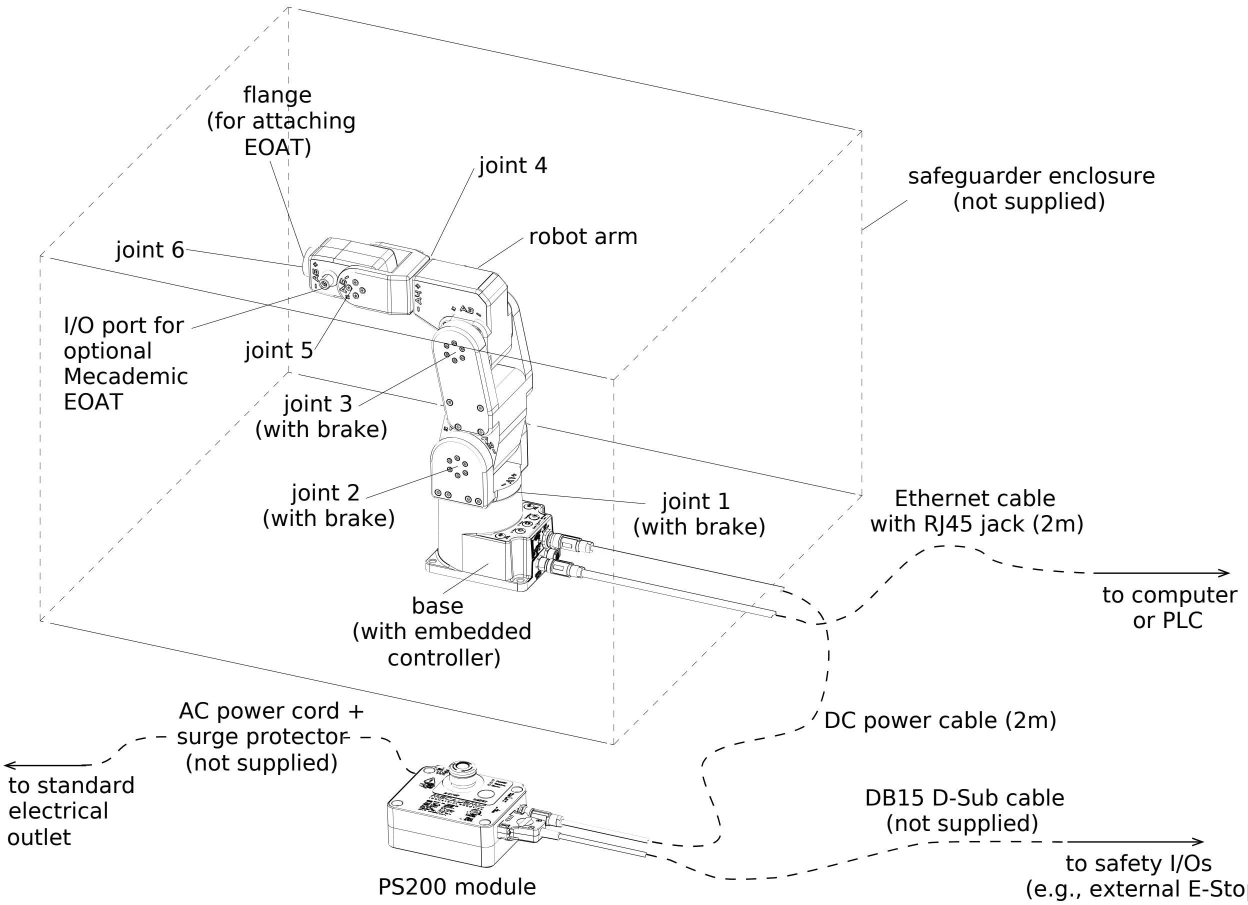


Figure 1: Schematic of the Meca500 robot system installed

Description of the PS200 module

The PS200 module, which includes the AC-DC power adapter, must be connected to an AC source supplying 90–250 V at 50–60 Hz, via a surge protector. *Applying AC voltage outside this range may damage the PS200 module*.

While the PS200 module includes the main power supply (AC to 24 V DC conversion), it also integrates safety I/O, an E-Stop and a Reset button, indicator LEDs, and internal logic. Use only the PS200 module provided by us to power your Meca500 robot arm. *The Meca500 will not function with the PS200 module of another revision or with a third-party 24 V DC power supply*.

> **Warning**
>
> The latest, R4, revision of the Meca500 incorporates one major change compared to version R3: the E-Stop function no longer cuts power to the complete robot, but only to the motor drives. Do not use the PS200 module of an R3 version with a Meca500 R4, and vice versa. The R4 robot arms and PS200 modules are clearly indicated as being R4.

Figure 2 shows the standard PS200 module. Its main features are:

- A: Emergency stop button (Stop Category 1), designed to achieve PL=d.
- B: Power, Status and Error LEDs.
- C: Reset button.
- D: communications and DC power cable port (for connecting to robot);
- E: D-Sub 15-position interface for connecting safety I/O.

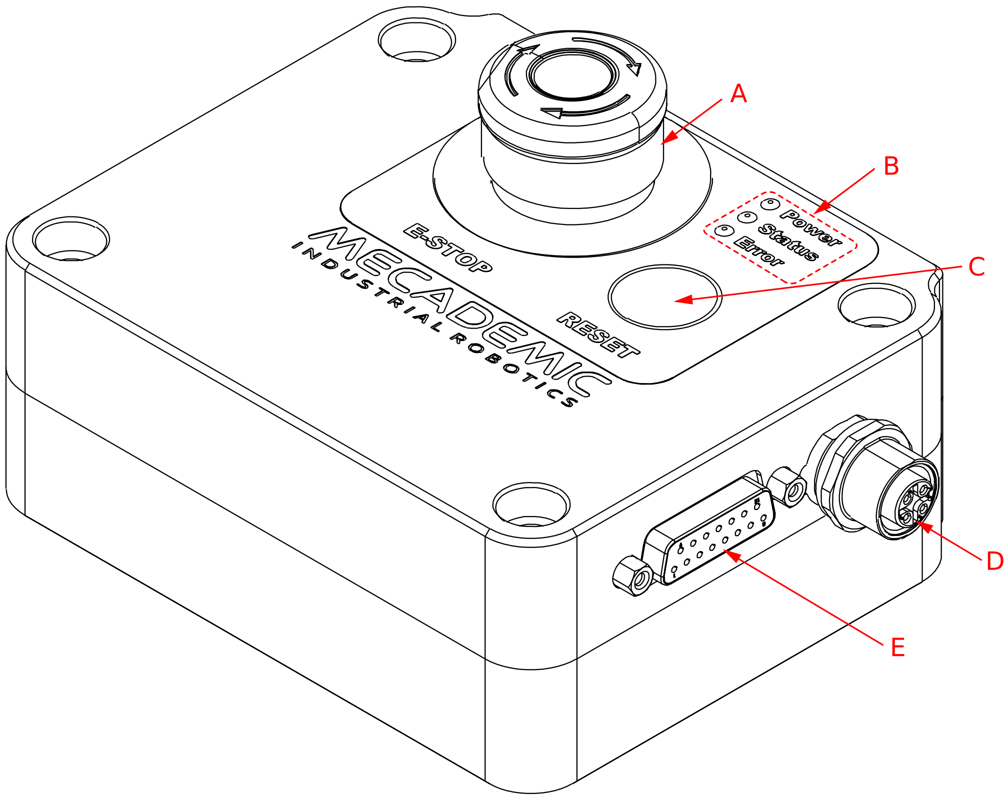


Figure 2: Standard PS200 module

> **Note**
>
> The optional PS200NB-R4 module is identical to the PS200-R4, except that it has no physical E-Stop and Reset buttons.

Figure 3 shows the AC power connector, of type IEC C14, and indicates the Neutral (N), Protective Earth (PE) and Live (L) pins. It also illustrates the main switch ("I" stands for ON, "O" stands for OFF).

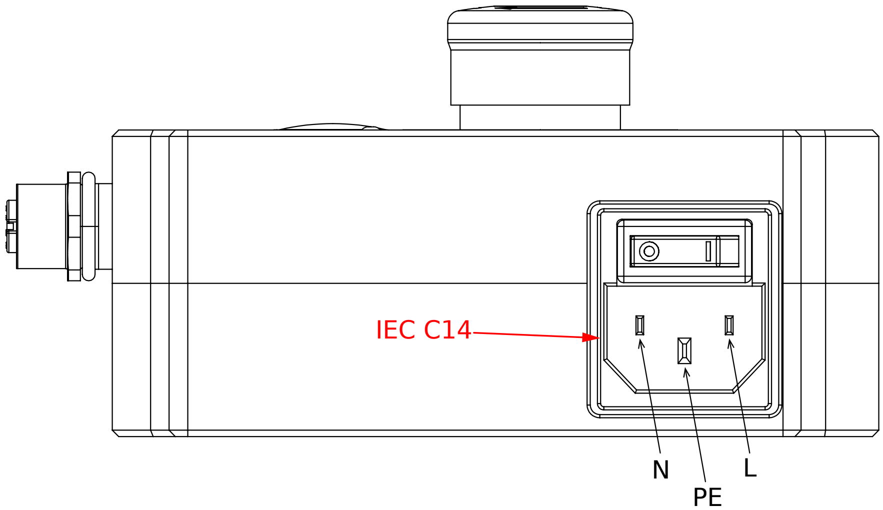


Figure 3: IEC C14 power entry receptacle and main switch

Use only the supplied DC power cable to connect the robot to the PS200 module and never modify this cable. Once the robot is connected to the PS200 module and the module is plugged into a suitable AC source, you may switch on the PS200 module.

When disconnecting the AC power, either by using the on/off switch on the PS200 module or by unplugging the AC cord, the brakes on the first three joints will engage immediately. Therefore, to avoid premature wear of the brakes, *NEVER disconnect the AC power when the robot is moving*.

When disconnecting the AC power, activating the E-Stop function or activating the protective stop 1, joints 3, 4 and 5 of the robot become free. This minimizes the risks of pinning and pinching from the robot.

The PS200 module is equipped with

- one E-Stop button (Stop Category 1), designed to achieve PL=d,
- one Reset button,
- one input connection for an external Reset,
- one external software stop that will be referred to as SWStop (not safety rated),

safety (redundant) input connections for

- one E-Stop function (Stop Category 1),
- one external protective stop (Stop Category 1) that will be referred to as P-Stop 1,

and output connection for

- one Power Status signal.

Applied standards

The Meca500 R4 and its power supply comply with the following European directives and harmonized standards:

- Machinery directive 2006/42/EC
- EN EIC 61326-1:2021 (Electrical equipment for measurement, control and laboratory use – EMC requirements – Part 1: General requirements)
- EMC directive 2014/30/EU
- Low voltage directive 2014/35/EU
- RoHS Directive (EU) 2015/863
- Harmonic Current Emission Limits EN IEC 61000-3-2 (2019) A1 (2021)
- Voltage Fluctuations and Flicker Limitations EN 61000-3-3 (2013) A1 (2019) A2 (2021)
- Electrostatic Discharge Immunity IEC 61000-4-2 (2008)
- Radiated Electromagnetic Field Immunity IEC 61000-4-3 (2020)
- Electrical Fast Transient Immunity IEC 61000-4-4 (2012)
- Surge Immunity IEC 61000-4-5 (2014) A1 (2017)
- Immunity to Conducted Disturbances, Induced by Radio-Frequency Fields IEC 61000-4-6 (2013)
- Power Frequency Magnetic Field Immunity IEC 61000-4-8 (2009)

Further details related to EMC are given in *Appendix 1* (page 77) and *Appendix 2* (page 80)

In addition, the design of the Meca500 R4 robot arm and its power supply was guided by the following harmonized standards, incorporating a tailored approach to meet our unique objectives:

- ISO 10218-1:2011 (Robots and robotic devices – Safety requirements for industrial robots. Part 1: Robots)
- IEC 60204-1:2016 (Safety of machinery – Electrical equipment of machines. Part 1: General requirements)
- ISO 13849-1:2015 and ISO 13849-2:2012 (Safety of machinery – Safety-related parts of control systems)
- ISO 13850:2015 (Safety of machinery – Emergency stop – Principles for design)

The following two EU declarations (certificates) are available separately, as PDF files:

EU Declaration of Incorporation for Meca500 R4 (DOI Certificate), for robots manufactured after October 2024

EU Declaration of Conformity for Meca500 R4 (CE Certificate), for robots manufactured before October 2024

EU Declaration of Incorporation for Meca500 R3 (DOI Certificate)

Safety

The Meca500 weighs less than 5 kg, however, it can move fast and cause injuries, especially when certain end-effectors are attached to its flange (e.g., a sharp tool or a laser).

Fundamental safety information

Safety symbols and signal words

The following are the three types of safety indicators used in this manual. Each is visually distinguished by a specific color, an icon, and a signal word to convey certain information.

Note

Identifies information that requires special consideration.

Warning

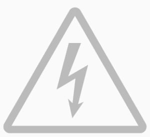
Provides indications that must be respected in order to avoid equipment or work (data) on the system being damaged or lost.

Danger

Provides indications that must be respected in order to avoid a potentially hazardous situation, which could result in injury.

The following table lists the safety labels and engravings on the robot arm and the PS200 module, respectively.

Table 2: Safety labels and engravings

Symbol	Description
	Read the user manual carefully before operating the robot system.
	Pinch point hazard — Keep hands and fingers away.
	Crush hazard — Stay clear of reciprocating spline shaft and robot’s distal link.
	Electric shock hazard — Do not disassemble.
	Hot surface — Do not touch for extended periods.

Required personnel qualifications

Only trained and qualified personnel who have read and understood this manual are permitted to install, operate, maintain, or decommission the Meca500 robot system. Personnel must be familiar with applicable safety standards and should have received appropriate training in industrial robot safety procedures.

Intended use

Use the Meca500 robot system only in industrial settings for handling an end-effector. For the required operating conditions, see the remainder of this user manual.

Risk assessment

Conduct a risk assessment to satisfy legal obligations. Because the Meca500 is partly completed machinery, its safe operation depends on how it is integrated into the overall system. A qualified third-party integrator or the user acting as integrator must evaluate the hazards of the entire robot cell, including the Meca500, its end effector, and all adjacent equipment. We recommend following the guidelines of ISO 12100:2010 and ISO 10218-2:2025 when conducting and documenting this assessment.

Limitation of liability

Mecademic assumes no responsibility for injuries or damages resulting from improper installation, operation, maintenance, or unauthorized modification of the Meca500 robot system.

This manual provides comprehensive safety guidelines specific to the Meca500, but does not cover the design, installation, or operation of the complete robot application or peripheral equipment that may affect system safety. System integrators are responsible for ensuring that the complete robot application complies with all applicable laws, standards, and regulations in the relevant jurisdiction and for identifying and mitigating any significant hazards.

Even when all instructions in this manual are followed, residual risks may remain. Mecademic cannot be held liable for any resulting harm or property damage.

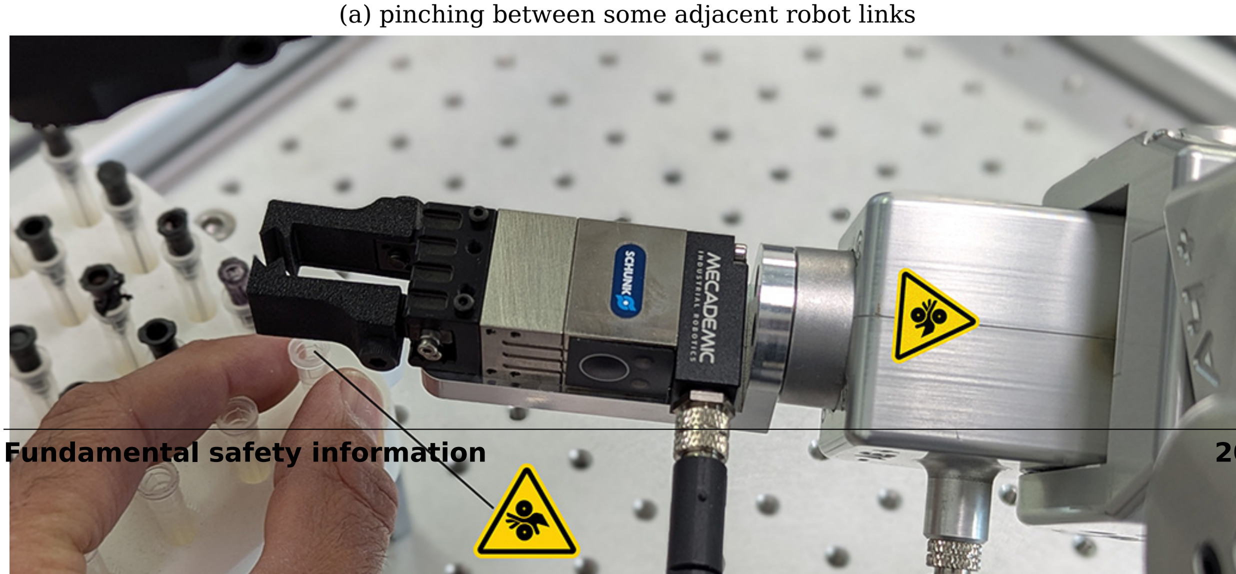
Residual risks

Despite full compliance with installation guidelines and protective measures, certain residual hazards remain — especially during manual interventions or whenever a safety system is overridden:

- *pinching* of fingers or hands (Figure 4a);
- *crushing* or *pinning* of fingers or hands (e.g., Figure 4b);
- *entanglement* of loose clothing or long hair in moving parts (e.g., an end-effector);
- *puncture*, *burn*, or similar injuries from hazardous tools (e.g., syringe needle, soldering iron) if joints 4–6, which lack holding brakes, slowly back-drive under gravity and bring the tool into contact with the operator.

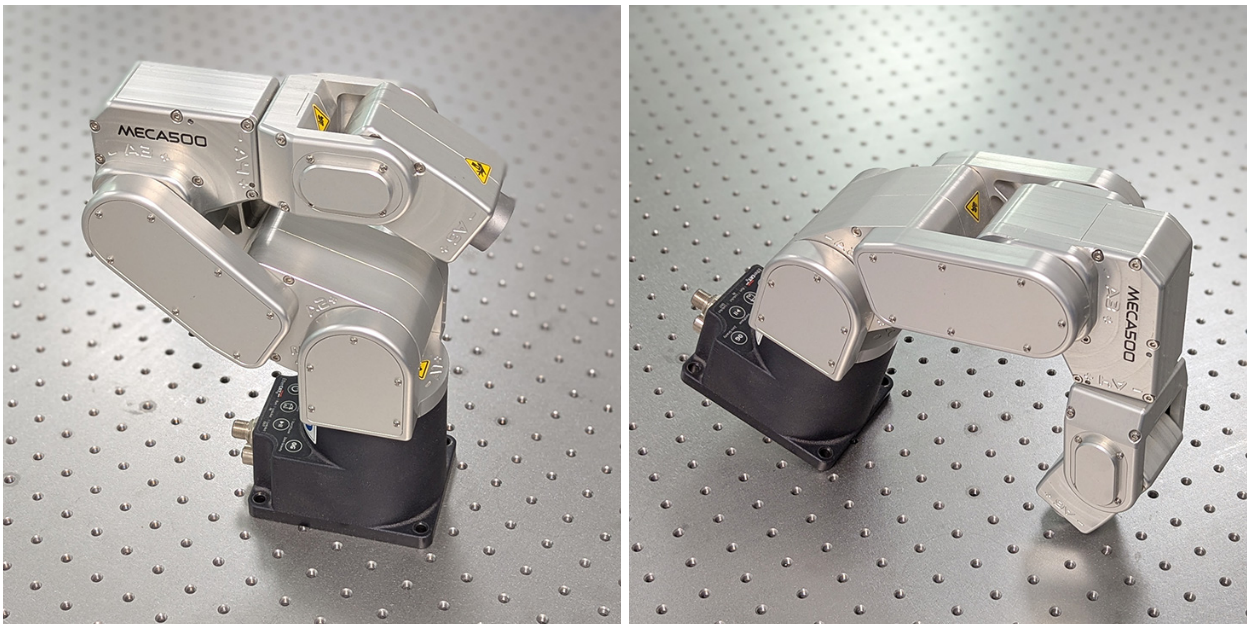
The risk of sustained pinning or pinching is low because the robot joints are easily back-driven (overpowered), allowing an operator to push the arm away.

(a) pinching between some adjacent robot links



General safety guidelines

> **Danger**
>
> In the shipping position, the robot can be temporarily deposited on its base (Figure 5a). In other robot positions (e.g., Figure 5b), the robot may tip and should not be placed on its base without fixing it. If the robot tips and falls from a height, it may cause an injury, and certainly get damaged.



(a) correct

(b) NOT correct

Figure 5: You may temporarily place the Meca500 on its base, but only if the robot arm is in its shipping position.

> **Danger**
>
> - Ensure the robot arm and end of arm tooling are securely fastened.
> - Do not modify or disassemble the robot arm or the PS200 module.
> - Do not touch the PS200 module for extended periods, while in operation.
> - Keep your head and hands away from the robot arm.
> - Ensure all clothing fits closely and remove jewelry before operating the robot. Secure long hair away from any moving parts.
> - Wear protective gloves and/or safety glasses when required for specific end-of-arm tooling and manipulated objects.

Warning

- Handle the robot with care.
- The Meca500 is equipped with brakes on its first three joints (the ones close to the base). When the robot is not activated, these brakes are automatically applied.
- *Do not overpower the robot brakes*, unless there is an emergency!
- Inspect the robot and PS200 module for damages. If either appears damaged, do not use them and contact us immediately.
- *Do not modify or disassemble the robot or the PS200 module*. This will void your warranty.
- Do not apply pressure to the cover plate on the bottom of the robot's base.
- Do not use or store the Meca500 in a humid environment or outdoors.
- Do not operate the Meca500 at temperatures below 5°C or above 35°C.
- Use only the PS200 module provided with your system.
- Use only the Ethernet and DC-power cables provided. Contact us if you need longer cables.

Safety-related functions and operating modes

The PS200 module features built-in safety functions and provides safety I/O digital control signals via one ports on the PS200 module for connection to PLCs and protective devices. All safety functions and I/O channels are designed in accordance with EN ISO 13849-1, using a Category 3 architecture to achieve Performance Level d (PL d).

The R4 version of the PS200 is shown in Figure 6. The R3 version is visually identical to the R4 version, except for the engravings. However, there are some hardware differences. *Therefore, never use a PS200-R3 with a Meca500 R4 or PS200-R3 a Meca500 R3.* The D-Sub D15 dongle is, however, identical in both versions.

Figure 6: The PS200-R4 module

The optional PS200NB-R4 module is identical to the PS200-R4, expect that is has no physical E-STOP and RESET buttons. Because of the lack of a physical Reset button, the PS200NB-R4 does not function with a safety bypass D-Sub D15 dongle.

Stop categories

The robot can initiate only one stop categories—as defined in IEC 60204-1—depending on the circumstances, as shown in Table 3.

Table 3: Stop categories

Stop Category	Description
1	When initiated, the robot decelerates in a controlled manner to a full stop within 150 ms. Power is removed from the motors after 380 ms regardless of system state. During deceleration, the robot may deviate from its initial path.

Safety functions

The Meca500's safety functions are listed in Table 4. For each function, the table indicates the robot operating mode in which it is active and the resulting stop category.

Table 4: Safety functions

Trigger	Description	Reaction
E-Stop	Emergency Stop	Stop Category 1
P-Stop 1	Protective Stop 1	Stop Category 1

The E-Stop function of the Meca500 meets the performance level required by ISO 10218-1:2025 (5.4.2) which is PL=d with a circuit structure of Category 3 based on ISO 13849-1:2023. As per ISO 10218-1:2025 (5.4.2), a Category 3 structure means that:

- A single fault in any subcomponent does not lead to the loss of the safety functions.
- The single fault shall be detected at or before the next demand upon the safety function.
- When the single fault occurs, the safety function is always performed and a safe state shall be maintained until the detected fault is corrected.

Safety equipment connected to the Protective Stop 1 function must meet the same requirements (PL=d and Category 3).

The E-Stop and P-Stop 1 functions on the Meca500 are Stop Category 1, as per ISO 13850:2008 (4.1.4). Once the stop is initiated, the robot arm will stop any motion in a controlled manner in less than 150 ms. The power is removed from the robot (R3) or from the robot's motors (R4) after 500 ms regardless of the state of the system.

The E-Stop and Protective Stop 1 inputs are redundant with two separate channels and monitoring circuitry is used to ensure that no tampering is possible. This means the inputs must switch states in tandem within 50 ms otherwise a Stop Category 0 will occur (power is removed from the motors).

Robot operating modes

Because of the robot's small size, it is not equipped with an operating mode switch and *can operate only in automatic mode*. Therefore, the robot does not require a three-position enabling device, but must be operated inside a safety enclosure (Figure 7). The PS200 module must be outside the safety enclosure.

> **Danger**
>
> The Meca500 is not designed for collaborative robot applications. Furthermore, it can operate only in automatic mode. Therefore, it must be operated inside a safety enclosure. Human operators must not enter the safeguarded zone while the robot motors are powered.

Figure 7: The Meca500 must be operated inside a safety enclosure (photo courtesy of Mati Therapeutics)

Safety I/O connections

After performing a risk assessment for your installation, you must design and connect the appropriate safety circuit to the D-Sub DB15 connector. Figure 8 shows the pinout of that connector. The following explains the different connections:

- E-Stop function, four pins (E-Stop – A1, E-Stop – B1, E-Stop – A2, E-Stop – B2). This is the input that provides the E-Stop functionality to the robot.
- P-Stop 1, four pins (P-Stop 1 – A1, P-Stop 1 – K1, P-Stop 1 – A2, P-Stop 1 – K2). This (redundant) safety input is intended for connecting optical curtains, or other presence-sensing safety devices.
- Software stop, two pins (SWStop – A, SWStop – B).
- Reset, two pins (Reset – A, Reset – K). This input is for wiring an external reset button that will have the same functionality as the one on the PS200 module.
- Power status, two pins (Power Status – A, Power Status – B). This output indicates whether the robot motors are powered.

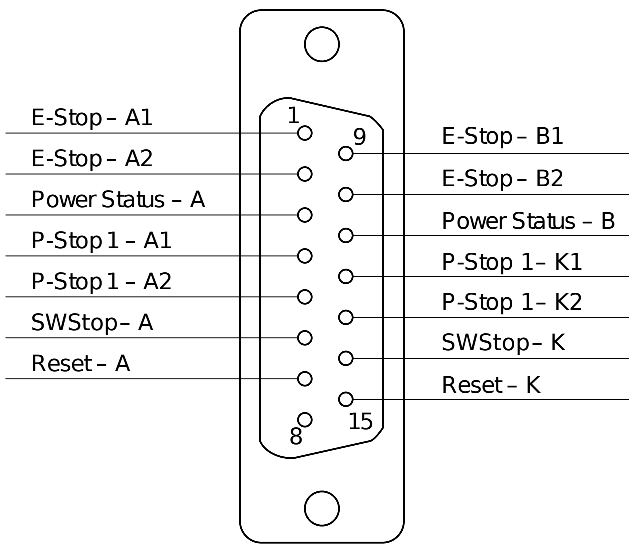


Figure 8: Pinout of the D-Sub DB15 connector on the PS200 module

Warning

Electromechanical relays are not recommended for triggering P-Stop 1, SWStop, and Reset functions due to the contact bounce during transitions. For the P-Stop 1 function, the use of such relays can cause a channel mismatch, leading to the PS200 module to detect a hardware fault. Solid-state relays, however, are suitable for these functions as they do not experience contact bounce.

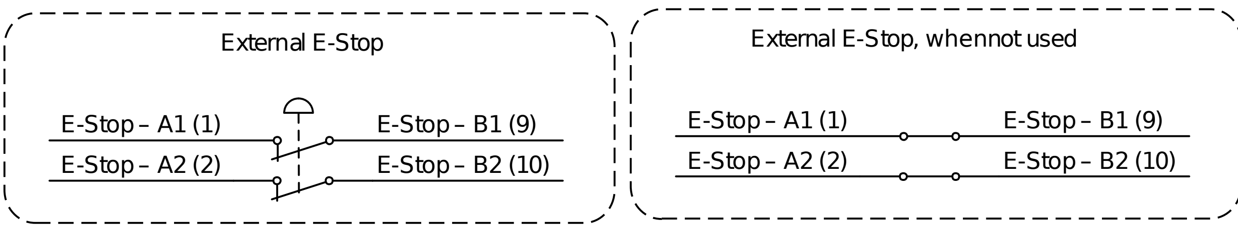
Warning

Output signal switching device (OSSD) signals are not supported.

The following subsections provide examples and further important details regarding the connections of the Safety I/O port.

E-Stop function

The external E-Stop performs the same function as the E-Stop on the PS200 module. The terminals of the external E-Stop are connected in series with the E-Stop on the PS200 module. Figure 9 shows two examples for the wiring of the four external E-Stop terminals. You may also, for example, connect several E-Stops in series or use a safety PLC. If you choose not to use any external E-Stop, remember to wire the pins as in Figure 9b.



(a) Wiring when an external E-Stop is used

(b) Wiring when no External E-Stop is used

Figure 9: Examples of wiring of the external E-Stop connections

Note

The E-Stop function is considered *active* whenever the external E-Stop circuit is open or the PS200 module's E-Stop button is engaged.

Danger

- Robot motor power is disabled when the E-Stop function is active.
- This is a redundant safety signal. It must be connected using two independent signals.
- All faults (differences) between signals will generate a non-resettable error.

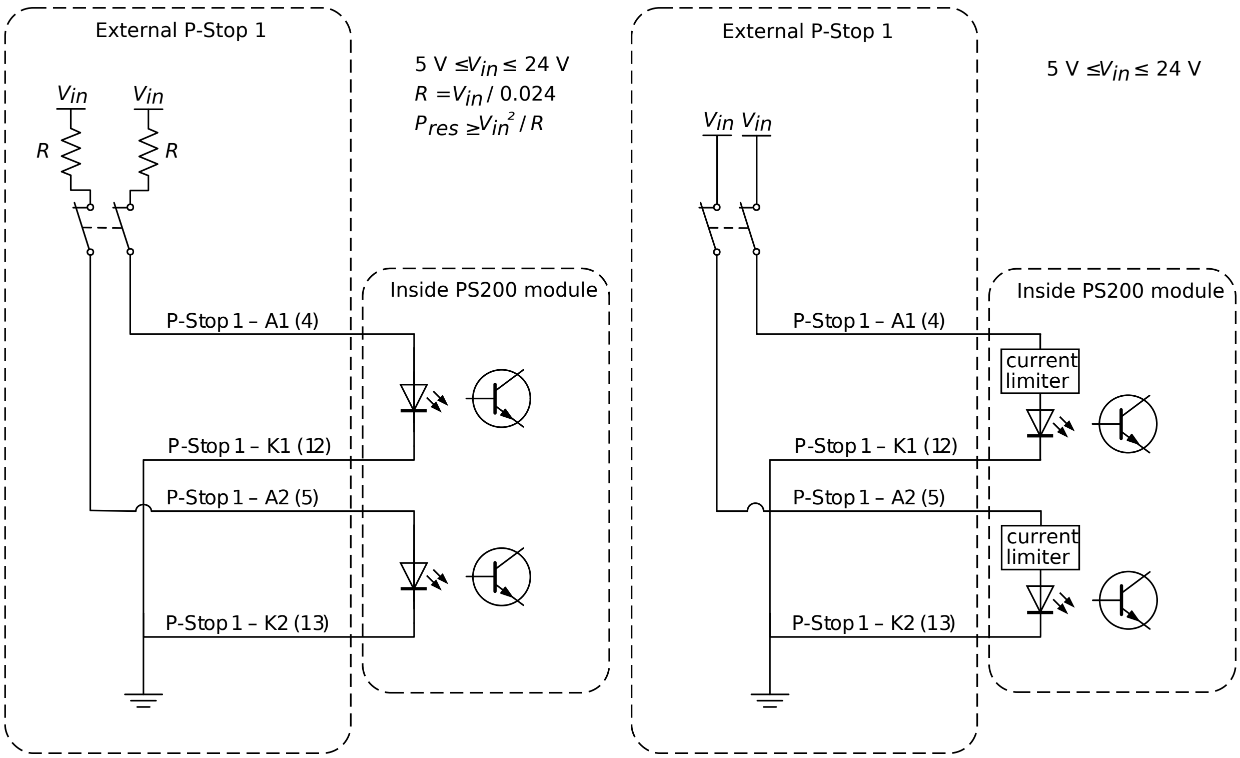
P-Stop 1 function

The E-Stop safety function and the P-Stop 1 are inter-related in an OR logic. In other words, activating the E-Stop safety function or removing power to the P-Stop 1 has the same effect: removing power from the motors of the robot, from the brakes disengaging mechanisms, and from the robot's EOAT (if R4) or in the complete robot (if R3).

Figure 10 shows the wiring diagram for the P-Stop 1 terminals in the case of the R3 and R4 versions of the Meca500. The P-Stop 1 signal would generally come from a safety PLC, which will be connected to a safety switch such as a safety light curtain or an interlock door switch.

Note, however, that in the R3 version, the current that reaches the PS200 module at the P-Stop 1 terminals must be a 24 mA continuous forward current. This is why the use of proper resistances is compulsory in the R3 (see Figure 10a), or else you will damage the PS200 module.

In the case of the Meca500 R4, a current limiting circuitry has been implemented, and the use of a resistance is not necessary.



(a) Wiring the P-Stop 1 in the Meca500 R3

(b) Wiring the P-Stop 1 in the Meca500 R4

Figure 10: Examples of wiring the P-Stop 1 in the Meca500 R3 and R4

Warning

In the Meca500 R3, you MUST USE RESISTANCES to limit the current applied to the P-Stop 1 terminals to 24 mA, or else you will damage the PS200 module.

Danger

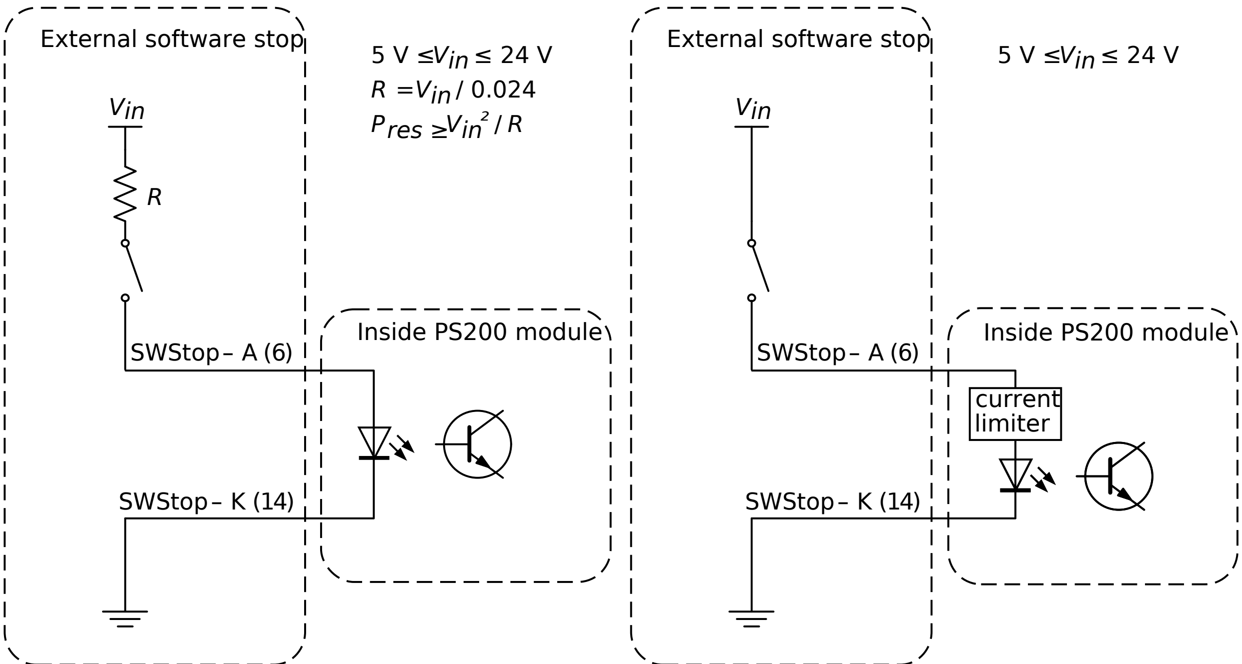
- Robot motor power is disabled when P-Stop 1 signal is logical *low*, at which point the

P-Stop 1 function is considered *active*.

- The P-Stop 1 is a redundant safety function that must be wired through two independent signals.
- All faults (differences) between signals will generate a non-resettable error.

Software Stop (SWStop) function

The software stop is equivalent to sending the command PauseMotion or ClearMotion, and is configurable with the command SetPStop2Cfg. The SWStop signal would normally come from a safety PLC. Simple examples for the wiring diagrams in the case of the R3 and R4 versions of the Meca500 are shown in Figure 11. The same specifications for the input voltage and current apply, as in the case of the P-Stop 1, as shown in Figure 11.



(a) Wiring the SWStop in the Meca500 R3 (b) Wiring the SWStop in the Meca500 R4

Figure 11: Examples of wiring the SWStop in the Meca500 R3 and R4

Warning

In the Meca500 R3, you MUST USE RESISTANCES to limit to current applied to the SWStop terminals to 24 mA, or else you will damage the PS200 module.

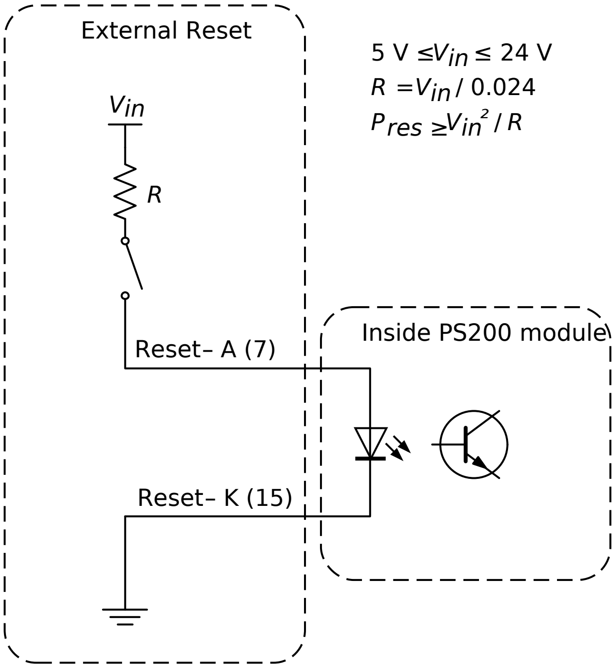
Danger

- In contrast to P-Stop 1, the SWStop function is considered *active* when the SWStop signal is logical *high*, a state that prevents robot movement while motor power remains applied.
- The SWStop function is not safety-rated and must not be treated as a protective stop.

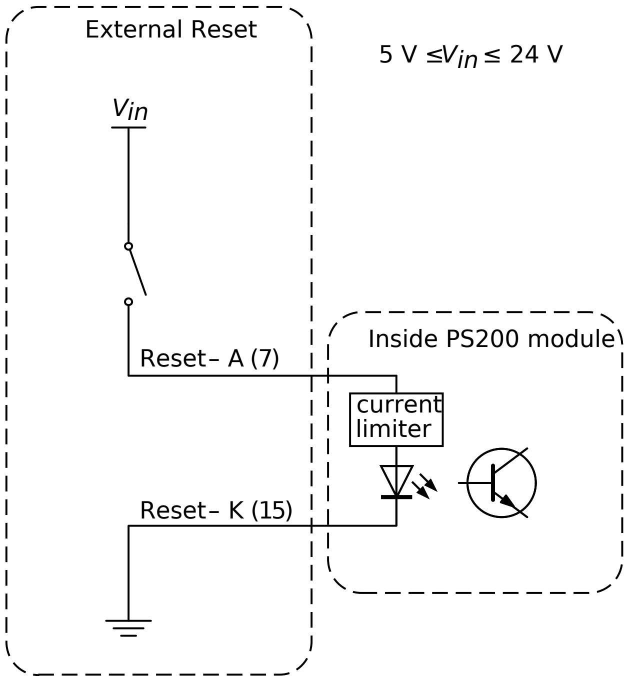
Reset function

The external reset connection performs the same function as the Reset button on the PS200 module. Activating either of these yields the same action, as long as the other is deactivated. The terminals of the external reset are connected in parallel with the Reset on the PS200 module.

The external reset signal would normally come from a safety PLC. Simple examples for wiring diagrams in the case of the R3 and R4 versions of the Meca500 are shown in Figure 12. The same specifications for the input voltage and current apply, as in the case of the SWStop, as shown in Figure 12.



(a) Wiring the external reset in the Meca500 R3



(b) Wiring the external reset in the Meca500 R4

Figure 12: Examples of wiring the external reset in the Meca500 R3 and R4

Warning

In the Meca500 R3, you MUST USE RESISTANCES to limit to current applied to the reset terminals to 24 mA, or else you will damage the PS200 module.

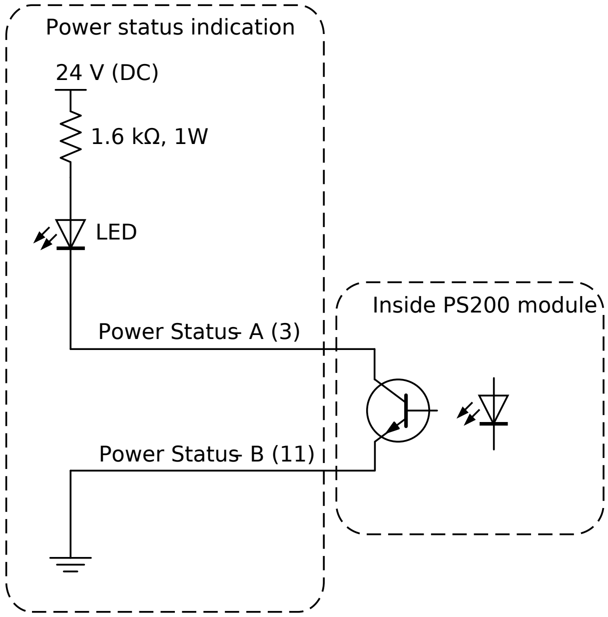
Note

- The E-Stop, P-Stop 1 and SWStop functions must be deactivated when sending the Reset signal.
- Pulse logical *high* for at least 15 ms but less than 1 s to reset robot. Recommended pulse duration is between 50 ms and 500 ms.

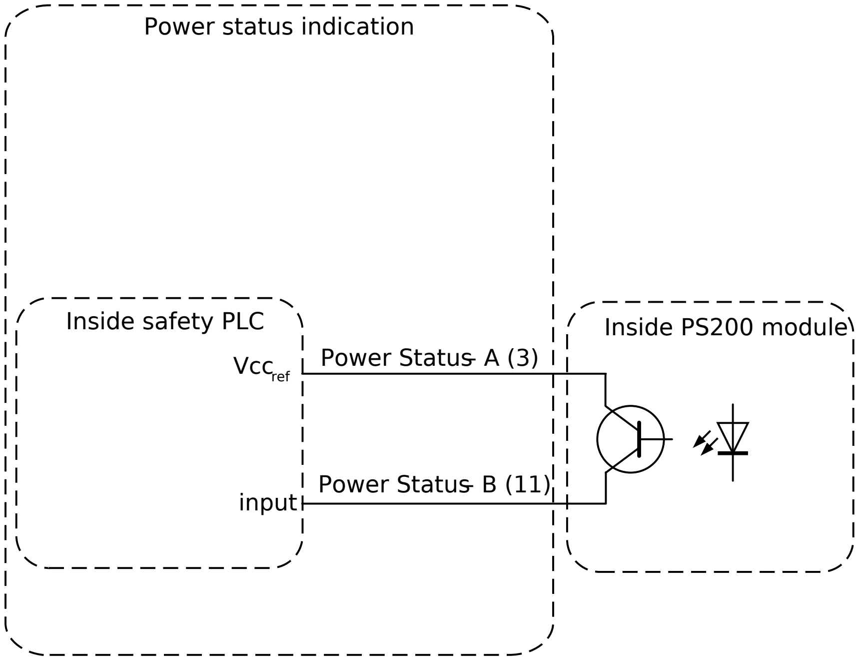
Power status

The power status terminals provide an output signal that corresponds to the power state of the robot (in the case of R3) or of the robot motors (in the case of R4). The current on these terminals is limited to 60 mA, and the voltage to 24 V (DC). There is no difference between the R3 and R4 with regards to the power status connection.

Two examples of wiring the power status terminals are given in Figure 13.



(a) Wiring the power status signal to a LED



(b) Wiring the power status to a safety PLC

Figure 13: Examples of wiring the power status in the Meca500 R3 and R4

> **Warning**
>
> In both the R3 and R4 versions of the Meca500, the maximum voltage applied at the power status terminals must be 24 V (DC), and the maximum current must be limited to 60 mA.

Danger

- The Power status signal is logical *high* when robot motor power is enabled.
- The Power status signal is not safety-rated.

D-Sub DB15 dongle (first time use and maintenance only)

The provided D-Sub DB15 dongle can be used to temporary bypass safety connections as during first time use or during maintenance. Connect the dongle to the D-Sub interface of the PS200 module (Figure 14). This would deactivate the external P-Stop 1 and E-Stop connections.

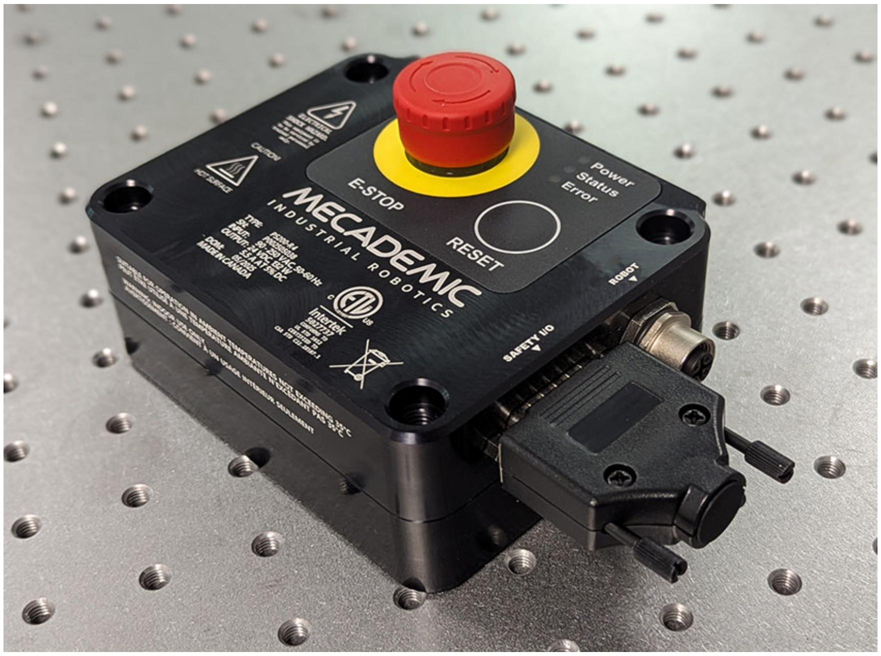


Figure 14: D-Sub DB15 safety dongle installed

Warning

Connect the D-Sub dongle to the power supply interface, while the PS200 module is still switched off. NEVER CONNECT OR UNPLUG THE DONGLE WHILE THE MODULE IS ON.

Warning

The D-Sub dongle cannot be used with the PS200NB-R4, which has no physical E-Stop and Reset buttons.

Danger

The D-Sub dongle is a bypass device, to be used during setup and maintenance only. You must wire the appropriate safety I/O connections when using the robot in production mode (see Section 4).

Danger

Stand away from the robot when it is activated, wear safety goggles and close-fitting clothing, keep long hair securely tied back and be attentive and alert. In case of an emergency, press the E-Stop button (on the PS200 module) immediately.

Further safety information

Figure 15 shows a description of the main components of the Meca500 robot arm.

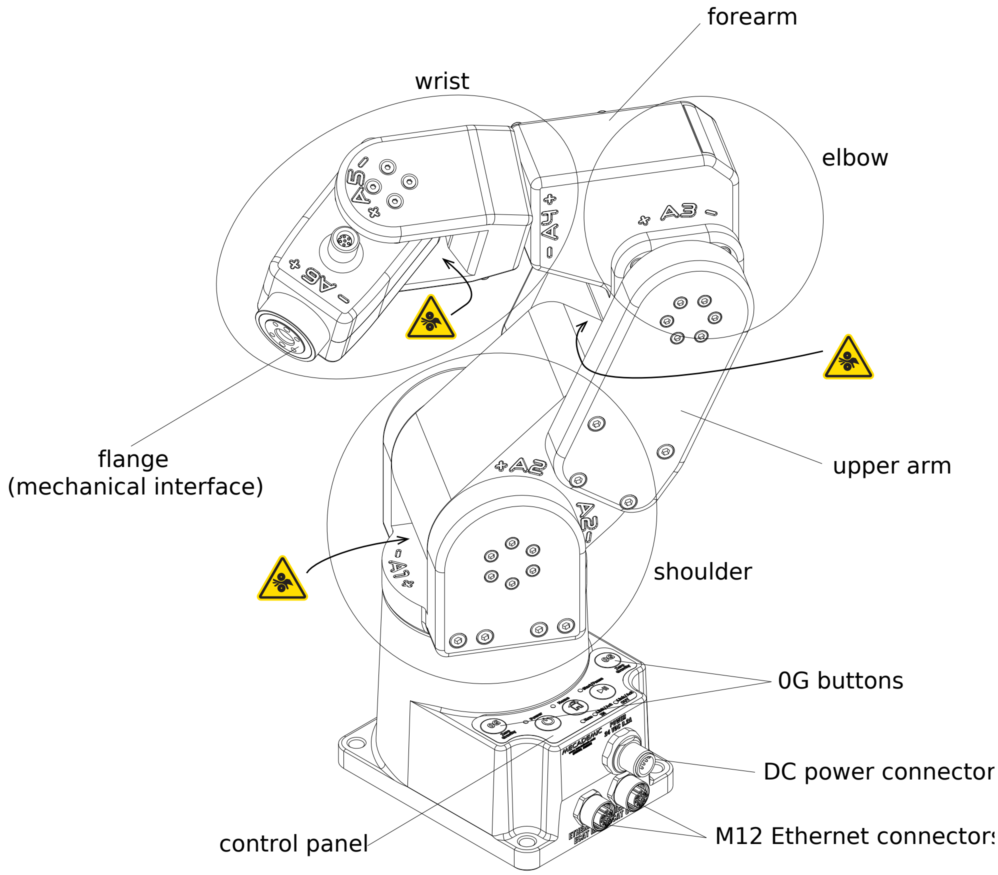


Figure 15: Meca500 robot arm

Brakes and limitations

As already mentioned, the Meca500 has brakes on joints 1, 2 and 3 only. Therefore, when the robot is deactivated, powered off, or put in safety stop (E-Stop or Protective Stop 1), the brakes on these joints be immediately applied and the joints will be immobilized instantly. Simultaneously, joints 4, 5, and 6 will become free. This minimizes the risks of pinning and pinching from the wrist and the end-effector. However, beware that the end-effector might slowly move downwards under the effects of gravity, as shown in Figure 16. Depending on the type of end-effector used, this residual motion might lead to an injury.

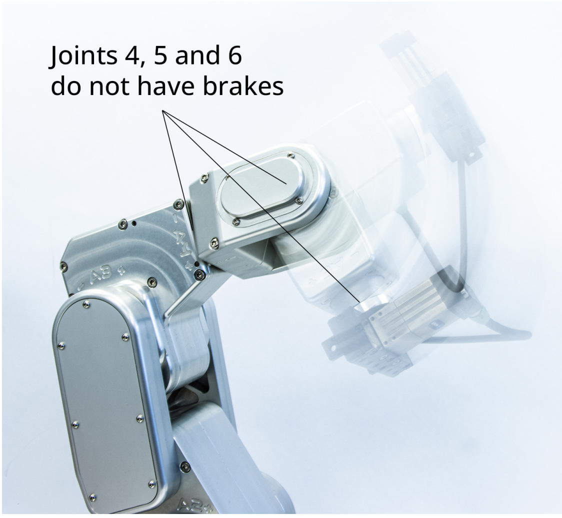


Figure 16: When the robot is deactivated, the end-effector will slowly move downwards under the effects of gravity

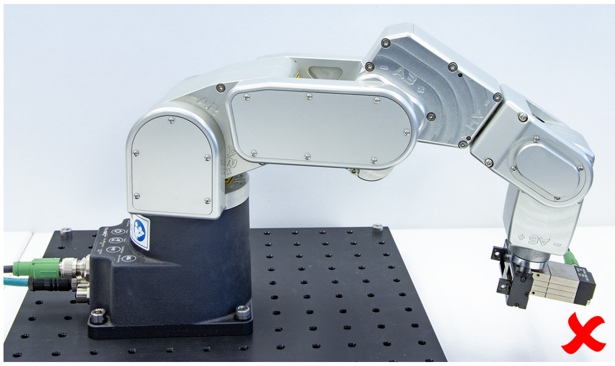
Danger

Beware that the end-effector might slowly move downwards under the effects of gravity or inertia when you deactivate the robot (e.g., by pressing the E-Stop button).

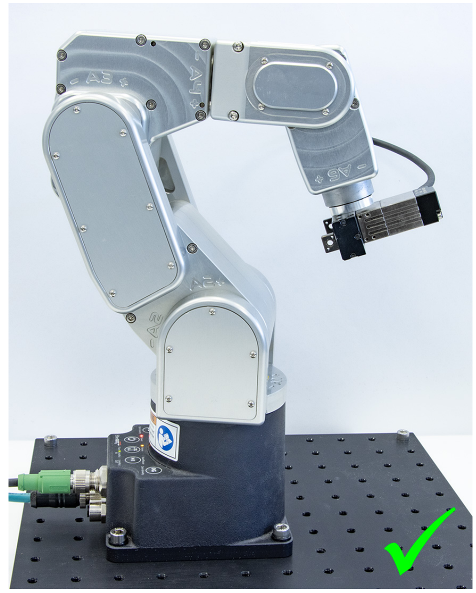
In addition, remember that the *brakes used on joints 1, 2 and 3 are emergency brakes, not locking brakes*. Therefore, if you leave the robot in a configuration where the robot's upper arm and forearm are nearly horizontal, the robot will slowly fall down under the effects of gravity, especially if you have the maximum payload. For example, if you deactivate the robot in the configuration shown in Figure 17(a), the robot's gripper might eventually collide with the table.

Warning

Before leaving the robot deactivated or powered off for an extended period of time, bring it to a position that minimizes the static torques on joints 1, 2 and 3.



(a) DO NOT leave the robot deactivated like this



(b) DO leave it like this

Figure 17: Before leaving the robot for a long period of time, move it to a position that minimizes the joint torques

Releasing the brakes

You can disable the brakes of joints 1, 2 and 3, ONLY if the robot motors are powered AND the robot is deactivated. (There are no purely mechanical means for doing so.) This means that the E-Stop or protective stop should not be activated, which does not meet the requirements of ISO 10218-1:2025.

The only situation where you might need to disable the robot brakes and move the robot by hand, is if you are about to power up the robot, but some of its links are leaning against an obstacle, thus preventing a joint to rotate in both directions. This slight rotation is part of the homing procedure, which is necessary only during the first activation of the robot (after a power-up). That said, in such a scenario, always try to use the recovery mode first, which does not require homing. This would avoid having to disable the brakes.

If you do need to disable the brakes, with a safety feature like a light curtain installed to prevent entry into the robot's safety zone without triggering the P-Stop 1 (as in Figure 7), disengaging the robot's brakes while manually holding the robot becomes impossible. To proceed, in the case of PS200-R3 and PS200-R4, you would need to temporarily swap your current D-Sub connection with our D-Sub dongle.

Danger

If your hands are penetrating the working zone of the Meca500, keep your fingers away from the pinch points of the robot. The procedure for disengaging the brakes of the robot while holding the robot does not meet the requirements of ISO 10218-1:2025.

Once you can approach the robot without triggering a P-Stop 1 event, turn on the power and ensure that the E-Stop on the PS200 module is not pressed. Next, to minimize the risks that a remote commands activates the robot, unplug the Ethernet cable controlling the robot. Then, while the robot is still deactivated, press one of the two 0G buttons on the base of the robot continuously while holding the robot with your other hand. After 3 seconds, you will hear the deactivation of the brakes. Continue holding the 0G button pressed and move the robot links away from obstacles. Finally, release the 0G button, and move away from the robot.

Note

Note that in the case of a collision, the robot is not deactivated and you can easily reset the motion error and jog the robot away, without entering the safety enclosure of the robot. If you are worried about damaging your equipment, it is advisable to first enter recovery mode (as described in the Programming Manual).

Stopping times and distances

As already mentioned, in the Meca500, when an E-Stop is applied, the PS200 module sends a signal to the robot to decelerate to a complete stop and after 450 ms removes power from the robot (R3) or from the motors (R4). Once power is removed from the motors, the brakes are automatically applied.

Table 5 shows values for the worst possible scenario, where the stop signal from the PS200 module is not detected by the robot. These are only theoretical values, because applying the brakes without decelerating the robot will permanently damage the robot. The actual values will be slightly larger due to the slip of the brake pads.

Danger

Note that only the E-Stop function is designed to achieve PL=d. Therefore, we cannot guarantee that the robot will immediately detect the signal from the power supply.

Table 5: Stopping distances and times at 100% speed for worst case scenario (the robot will be damaged)

Joint	Stopping distance	Stop time
1	67°	0.450 s
2	67°	0.450 s
3	81°	0.450 s

In normal, fault-free operation, the stopping times and distances for an E-Stop (category 1) at 100% speed and payload are presented in Table 6. All test results are for a single joint moving at a time, while the other joints are positioned in a way that the arm is fully stretched (i.e. worst condition). The results are valid only for an installation where the axis of joint 1 is parallel to the direction of gravity.

Table 6: Stopping distances and times for fault-free operation

Joint	Stopping distance	Stop time
1	6.2°	0.104 s
2	6.2°	0.125 s
3	8.1°	0.129 s

Joint limits

Because of the robot's compact dimensions, mechanical means to limit joint range have not been incorporated. It is possible to design a fixture that can be attached to the robot's base and that limits mechanically the range of joint 1. However, remember to not modify the robot itself (e.g., by removing screws from the robot).

The robot's joint limits can be reduced by software means using the MecaPortal or the command SetJointLimits. The new software limits remain active even after power shutdown. These software limits are not safety rated.

Danger

Due to the extremely compact size of the robot, there are no provisions for adjustable hardware joint limits.

Joint torque limits

Once a robot is activated and homed, you can also reduce the joint torque limits using the command SetTorqueLimits. However, the joint torque limits are reset to 100% every time, the robot is reactivated. Furthermore, these joint torque limits are not safety rated.

Local control

The Meca500 provides no built-in means of local control. It is therefore the responsibility of the robot integrator to equip the control station with a suitable local interface, such as keyed switch or safety-gate interlock, that lets an operator enable or disable the remote connection whenever local intervention is required. The control station must be designed and installed in full compliance with all applicable local laws, regulations, and safety standards.

Loss of Ethernet connection

When using the MecaPortal web interface or any other TCP/IP client, as soon as the robot detects a loss in the connection while moving, it will stop within 0.1 s. To prevent delays due to the use of Ethernet switches, at all times (not only while the robot is moving), use the ConnectionWatchdog command (available since firmware 10.1).

Locking up the robot system

To prevent unauthorized or accidental powering of the robot, we suggest unplugging the AC cord and using a detachable IEC Plug Lockout device such as the one from Brady.

Technical specifications

The following table lists the main technical specifications of the Meca500 robot arm.

Table 7: Technical specifications for the Meca500 robot arm (R3 and R4)

Characteristics	Value
Position repeatability	0.005 mm
Rated payload	0.5 kg
Weight (without the cables)	4.6 kg
Maximum reach at flange	330 mm
Mounting orientations	any angle
Range for joint 1	[−175°, 175°]
Range for joint 2	[−70°, 90°]
Range for joint 3	[−135°, 70°]
Range for joint 4	[−170°, 170°]
Range for joint 5	[−115°, 115°]
Range for joint 6	[−36,000°, 36,000°]
Maximum speed for joints 1 & 2 (R3|R4)	150°/s | 225°/s
Maximum speed for joint 3 (R3|R4)	180°/s | 225°/s
Maximum speed for joints 4 & 5 (R3|R4)	300°/s | 350°/s
Maximum speed for joint 6 (R3|R4)	500°/s | 500°/s
Maximum acceleration torque for joints 1, 2, 3 (R3|R4)	16.6 Nm | 16.6 Nm
Maximum acceleration torque for joints 4 & 5 (R3|R4)	2.5 Nm | 2.5 Nm
Maximum acceleration torque for joint 6 (R3|R4)	1.5 Nm | 1.5 Nm
Maximum continuous torque for each joint	50% of the acceleration torque value
Input voltage	24 V (DC)
Maximum input current	5.5 A
Operating ambient temperature range	[5°C, 35°C]
Operating ambient relative humidity range	[10%, 80%] (non-condensing)
Airborne noise level	50dB (only when the robot is moving fast; when it is immobile, the noise is barely perceptible)
Maximum operating altitude	2000 m
Cleanroom classification	ISO Class 6

Figure 18 shows all the link lengths and offsets of the Meca500, necessary for obtaining the so-called Denavit-Hartenberg parameters. Note that all joints are at zero degrees in the configuration drawn in black line. Also note that the gray zone is the area attainable by the center of the robot's wrist (the intersection point of the last three axes), for a fixed angle of joint 1. This area, or even the volume obtained by sweeping this area about the axis of joint 1 is NOT the workspace of the robot. The workspace of the robot is a six-dimensional entity depending on the definition of the tool reference frame. The workspace is the set of all attainable poses (positions and orientations) of the tool reference frame with respect to the robot's base. Even for a specific choice of a tool reference frame, it is impossible to represent this six-dimensional workspace (read this tutorial of ours).

Similarly, while the maximum tool-center point (TCP) speed is software limited to 5,000 mm/s when the robot executes Cartesian-space motion commands, it makes little sense to specify here the actual maximum attainable TCP speed. Indeed, the actual maximum TCP speed is highly dependent on the robot joint position and, of course, on the TCP definition. For example, for a TCP that is located some 50 mm away from the robot's flange, along the axis of joint 6, the maximum attainable TCP speed is approximately 3,500 mm/s for the Meca500 R4, when the robot is fully stretched and all joints rotate at full speed. However, in most situations, the maximum TCP speed will be much lower.

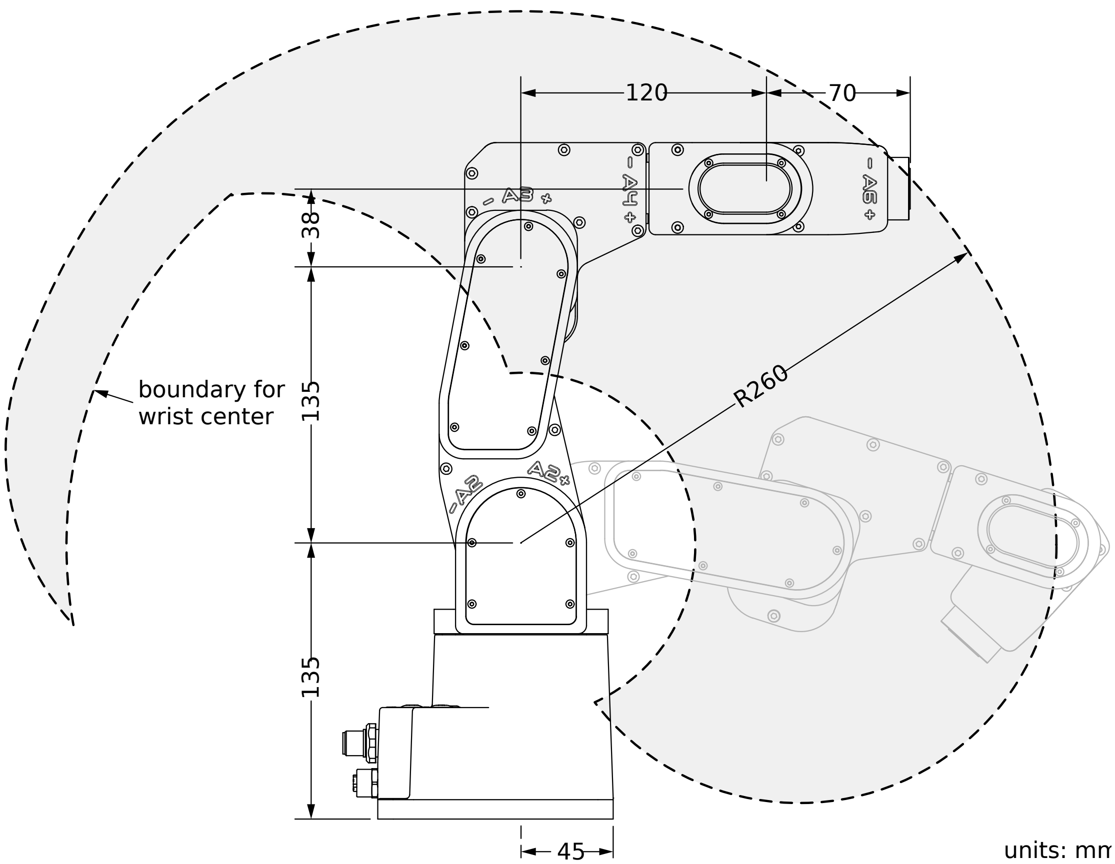


Figure 18: The dimensions of the Meca500 (R3 and R4)

Table 8 lists the technical specifications for the PS200 module for both R3 and R4 revisions of the Meca500. As already mentioned, the PS200 provided has an IEC C14 connector that accepts an AC power cord with three-prong IEC C13 connector on one end, and your own country's power plug on the other. You can connect this power cord to any AC source that supplies voltage between 90 V and 250 V at frequency between 50 Hz to 60 Hz. We also recommend that you use a surge protector.

> **Warning**
>
> We recommend that you use a surge protector when connecting the PS200 module to an AC power source.

Table 8: Technical specifications for the PS200 module (all three versions)

Characteristics	Value
Weight	0.7 kg
Mounting orientations	any angle
Input voltage range	[90 V, 250 V], AC, single phase
Input frequency range	[50 Hz, 60 Hz]
Maximum input current	4 A
Input power connector	IEC C14
Power factor	0.95
Maximum power output	132 W at 5% duty cycle
Maximum measured leakage current	0.047 mA
System grounding type	TN
Operating ambient temperature range	[5°C, 35°C]
Operating ambient relative humidity range	[10%, 80%] (non-condensing)
Maximum operating altitude	2000 m
Robot body material	Anodized aluminum alloy
IP rating	IP40

Table 9 and Table 10 list the requirements for the I/O connections on the PS200 module in the case of the Meca500 R3 and R4, respectively. Further details will be provided in Section 4.

Table 9: Technical specifications for the safety I/O interface on PS200-R3

Parameter	Min.	Typical	Max.	Unit
Safety input voltage	5	–	24	V
Safety input current	–	24	24	mA
Power status output voltage	0	–	24	V
Power status output current	0	–	60	mA

Table 10: Technical specifications for the safety I/O interface on PS200-R4 and PS200NB-R4

Parameter	Min.	Typical	Max.	Unit
Safety input voltage	5	–	24	V
Safety input current	–	–	10[1]	mA
Power status output voltage	0	–	24	V
Power status output current	0	–	60	mA

Finally, the CAD files of the Meca500 robot arm and of its PS200 module (in STEP format) can be downloaded from here. You can also use one of several robot simulation and offline programming software packages that include a model of our Meca500, including Visual Components and RoboDK. Note that we also offer a Mecademic-only version of RoboDK, for exclusive use with our robots.

[1] The maximum current output is 60 mA under standard conditions.

Installing the robot system

Before operating your Meca500, you must fix solidly its base with four M6 screws, at 3 Nm, with at least 6 mm of thread engagement. We typically use metric breadboards such as those from Thorlabs, but you can also use our adapter plate (MUAP01.zip) or build your entire robot cell at Vention. We recommend that you use three kinematic positioners to constrain your base, so that you can always remove and then install it in the exact same location. Our adaptor plate, for example, incorporates three locating pins.

The dimensions of the robot base are shown in Figure 19 and an example of installation is shown in Figure 20. Note that you can install the robot base in any orientation. The robot will automatically detect the angle between the axis of joint 1 and the gravity vector (no need to manually specify this angle). Also, note that you can mount the robot's base on a mobile body (e.g., on the carriage of a linear guide), but only if you do not intend to move the robot's joints, while the robot's base is accelerating with respect to the ground.

Warning

Ensure that the mounting surface is perfectly flat and that nothing exerts pressure on the cover at the bottom of the robot's base.

Danger

Secure the robot base firmly using four M6 screws tightened to a torque of 3 Nm. Periodically inspect the screws to ensure they remain properly tightened.

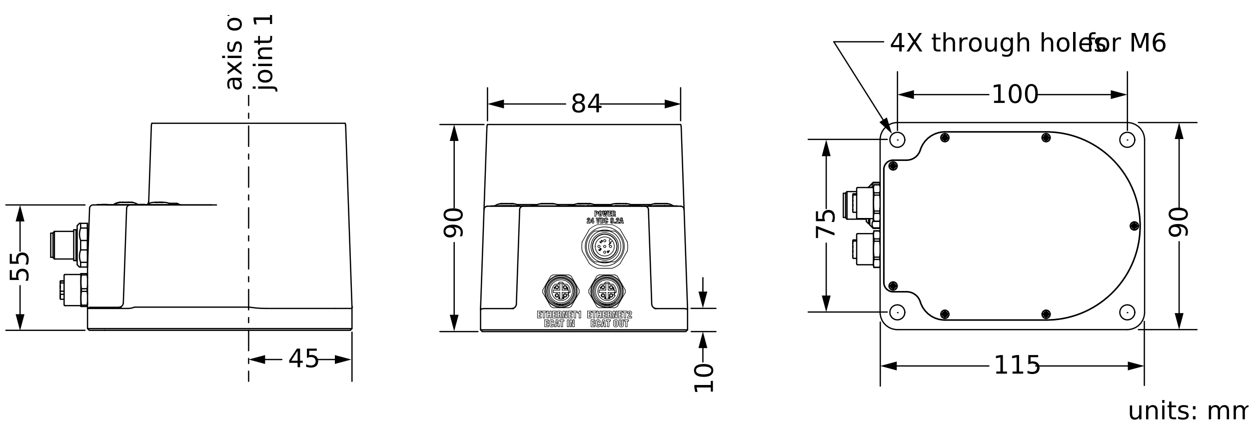


Figure 19: Dimensions of the robot base

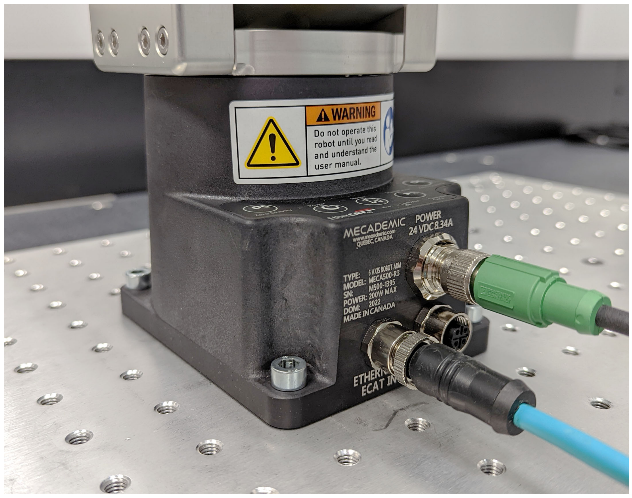


Figure 20: The robot base installed, with the connectors attached

Do not install any end-effector yet. We will cover this topic in Section 8.

Next, *securely mount the PS200 module* using four M6 screws (Figure 21) at a location sufficiently close to the robot's base to allow connection with the 2-meter DC cable provided, but outside the robot's safety enclosure. Unless you are using an external emergency stop wired via the D-Sub connector, you must fix the PS200 at a location that makes the integrated E-Stop button readily accessible by an operator.

> ⚠ **Warning**
>
> To improve heat dissipation, mount the PS200 module onto a solid metal plate.

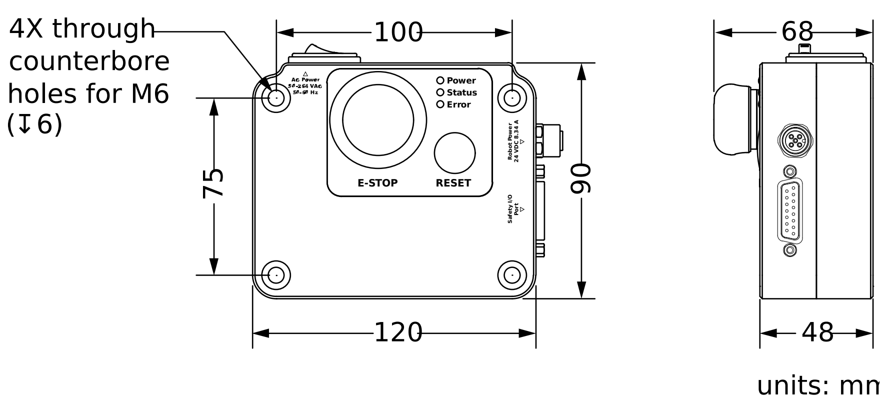


Figure 21: Dimensions of the PS200 module

Next, attach the circular connector of the Ethernet cable to the ETHERNET1 port on the robot's base and connect the RJ-45 jack to your computer or router (Figure 20). The two Ethernet ports on the robot base act as a bridge, so you can daisy-chain several Meca500 robots, or connect an Ethernet I/O module on the ETHERNET2 port.

Finally, use the DC power cable provided to connect the *unpowered* PS200 module to the robot's DC power connector (Figure 20). Make sure the connectors are completely screwed, or else you may damage the robot. Then, connect the PS200 module to your country-specific AC power cord (not provided).

Warning

Always connect the DC power cable before connecting the PS200 module to an AC outlet. Always disconnect the PS200 module from the AC outlet before disconnecting the DC power cable.

Operating the robot system

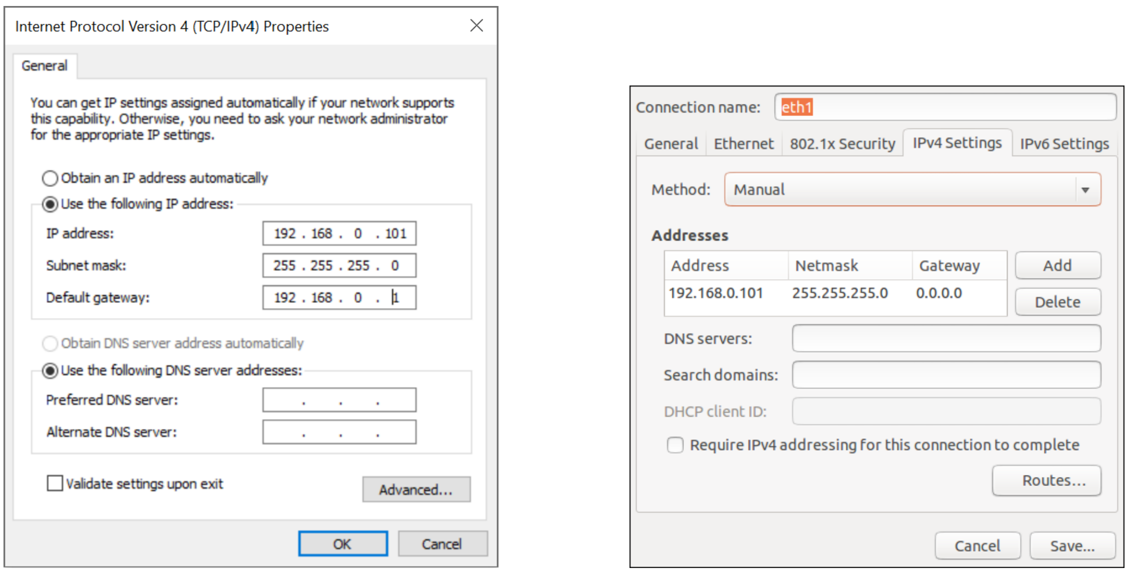
This section presents the basic procedures for setting up and operating the Meca500 robot system. For further details, refer to the MecaPortal Operating Manual (MC-OM-MECA500), which describes the web interface of the robot, and to the Programming Manual (MC-PM-MECA500).

First-time use

> **Danger**
>
> For prototyping purposes, the Meca500 comes with a safety bypass DB15 dongle (recall Section 4). To start using the MCS500, plug the D-Sub dongle, while the PS200 module is unpowered. Once you have become acquainted with the Meca500 and performed your risk assessment, remove the dongle and wire your safety I/O connections (see Section 4).

Configuring your Ethernet connection (first time use)

Configure your computer Ethernet connection with a static IP address, on the same subnet as the robot's default IP address, i.e., *192.168.0.100*. The way to do this differs from one operating system to another. Figure 22 shows how to do this in Windows and in Linux.



(a) Windows (b) Linux

Figure 22: Two examples of how to configure the IP address of your computer

Power-up procedure

Powering the robot

1. Turn on the PS200 module. The green LED on the PS200 module (next to “Power”) will be illuminated.
2. Make sure the E-STOP button is disengaged by twisting it counter-clockwise.
3. In the case of Meca500 R3, activate the Reset function (e.g., press the RESET button) to provide power to the robot.
4. You will hear a clicking sound coming from the PS200 module, and the robot’s LEDs will start flashing for a few seconds while the robot’s controller is booting. Once the controller ready, the Power LED on the robot’s base will start flashing intermittently.
5. Depending on which of the two Ethernet ports was used in step 1, the Link/Act IN (for ETHERNET1) or Link/Act OUT (for ETHERNET2) green LED will stop flashing and remain illuminated, but only once the robot has finished booting.
6. In the case of the Meca500 R4, activate the Reset function (e.g., press the RESET button) to provide power to the robot’s motors.

Connecting to the robot

1. Open (preferably) the latest version of Google Chrome and type Meca500’s default IP address *192.168.0.100* in the address bar.
2. Meca500’s web interface, called MecaPortal, should load instantaneously (Figure 23). The MecaPortal will be described in detail in a separate manual (MC-OM-MECA500).

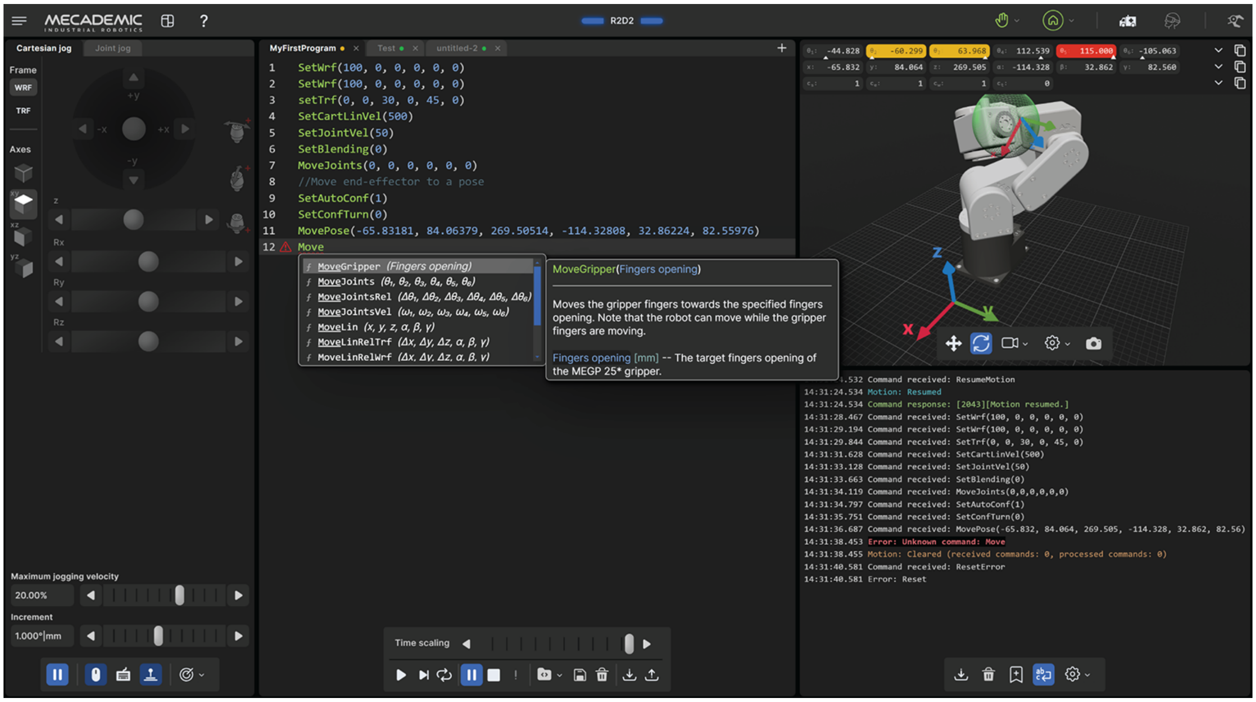


Figure 23: Overview of the MecaPortal

Changing the robot's network configuration (optional)

1. Click on the connection state button on the top right of the MecaPortal and select ✋ "Control" (see Figure 24).
2. Click on the configuration menu button, ☰, in the top left corner of the MecaPortal and select "Network configuration".
3. Depending on your configuration, activate the toggle DHCP to automatically receive an address from your router or leave untoggled to force a specific IP. You don't need to reboot the robot; the new configuration will be applied as soon as you click on the Apply button (Figure 25).

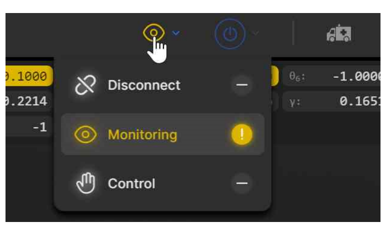


Figure 24: Connection state button

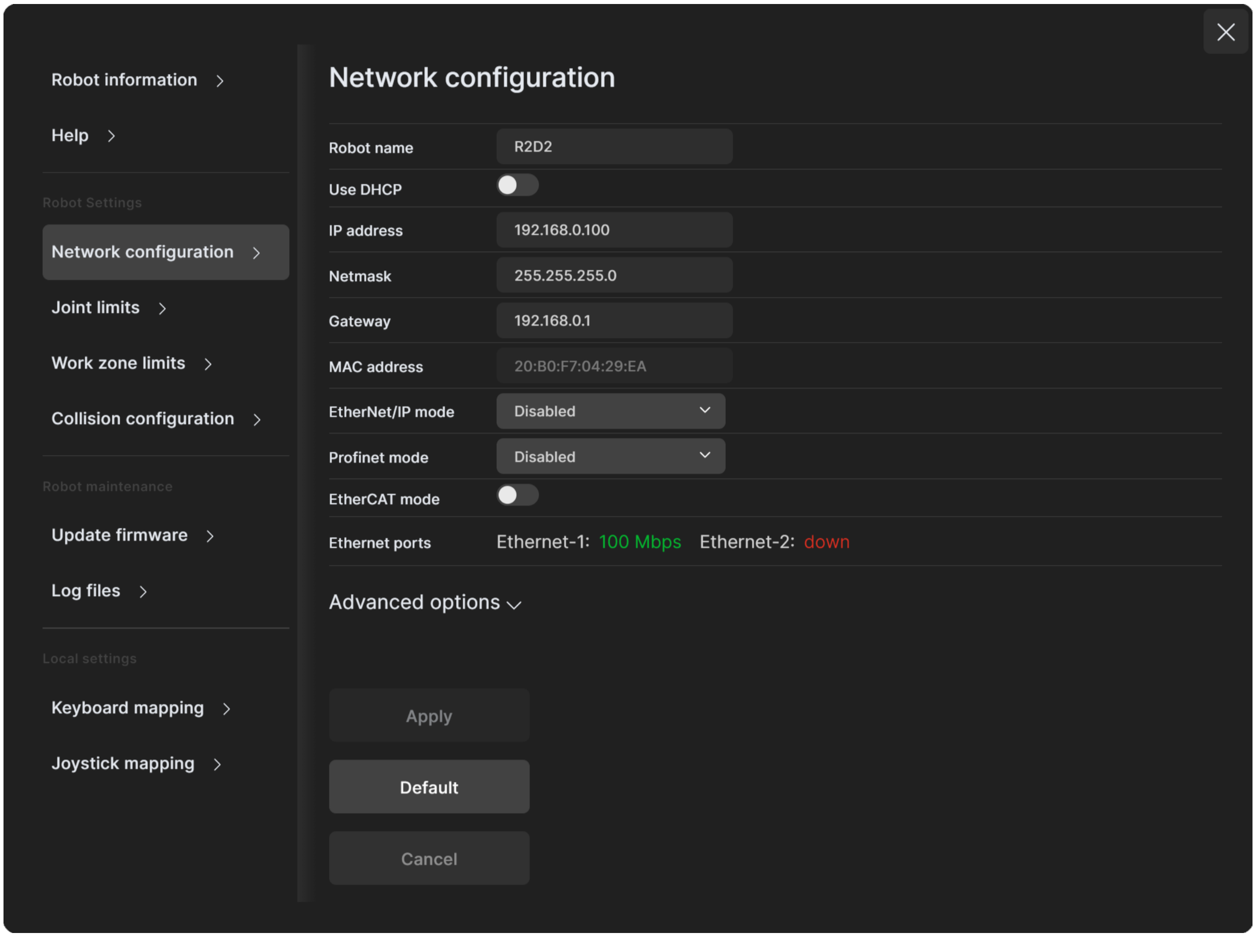


Figure 25: Changing the robot's network configuration

Activating and homing the robot

Click the button in the menu bar and select "Activate then Home".

Warning

The robot will move slightly during homing. Before homing it, make sure that there is no risk for mechanical interference.

Testing joint 6

After homing, type "0" in the text field next to θ_6 (joint 6) in the Jog joint tab and press Enter. The flange of the robot must be exactly as in Figure 26. Later, when you connect tooling to the flange of the robot, you must remember the correct orientation of the tooling when joint 6 is at zero degrees, and continue to perform this test every time you start your robot.

If the flange is rotated ±120° with respect to the orientation shown in Figure 26, perform the procedure given below, before continuing to use the robot.

> **Note**
>
> The range of the absolute encoder of joint 6 is only ±420°. *Therefore, you must always rotate joint 6 within that range before switching the robot off.* Failure to do so may lead to an offset of ±120° in joint 6. If this happens, unpower the robot and disconnect your tooling. Then, power up and activate the robot, perform its homing, and zero joint 6. If the screw on the robot's flange is not as in Figure 26, then rotate joint 6 to +720°, and deactivate the robot. Next, reactivate it with the command ActivateRobot(1), which reinitializes the drives, then home the robot, and zero joint 6 again. Repeat one more time if the problem is not solved.

Figure 26: Joint 6 at zero degrees

Moving the robot

A six-axis robot arm is a complex mechanism and no matter how intuitive its programming interface is, the robot will still have limits. These limitations are not always obvious. For example, in any six-axis robot arm, there are often paths that the robot cannot follow, even though they seem to be inside the robot's workspace. The workspace of a typical six-axis robot is a very intricate six-dimensional entity.

> **Note**
>
> If you know nothing about orientation representations and robot singularities, we strongly advise you to read some introductory notes on robotics and our tutorials on Euler angles and on robot singularities.

After homing, click the button in the jogging panel and select "Zero all joints". The robot will move all of its joints to their 0° positions. In this robot joint set (shown in Figure 18), the robot is in a so-called wrist singularity. Most industrial robots cannot move in Cartesian mode from such a singularity. In order to simplify the use of the Meca500, as of firmware 9, we have implemented an algorithm that allows the robot to move through such a singularity.

> **Note**
>
> The Cartesian coordinates displayed above the robot in the web interface are those of the Tool Reference Frame (*TRF* (page 85)) with respect to the World Reference Frame (*WRF* (page 85)). Both frames are displayed in the web interface. By default, the TRF is located at the flange of the robot and the WRF at the bottom of the robot's base (as in Figure 27). The origin of the TRF is called the *TCP* (page 85) (Tool Center Point).

> **Note**
>
> We use Euler angles (α, β, γ) to define the orientation of a second reference frame with respect to a first one. More specifically, if we consider both frames initially coincident, we rotate the second frame about its x axis at α degrees, then about its y axis at β degrees, and finally about its z axis at γ degrees. This Euler-angle convention is sometimes referred to as XY'Z'', or as XYZ intrinsic (body-fixed) rotations.

Thus, for example, you can simply go to the Cartesian tab of the jogging menu, and with the TRF option selected, press the right arrow button of the x jogging bar. Alternatively, you can perform the same kind of linear motion by following any of these steps:

- Clear the programming text field, type MoveLin(250,0,150,0,90,0), and press ▶.

OR

- Clear the programming text field, type MoveLinRelTRF(58,0,0,0,0,0), and press ▶.

Figure 27 shows the resulting robot position.

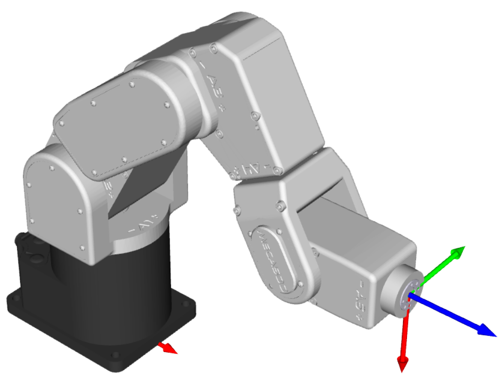


Figure 27: Robot position when the TRF is at x = 250 mm, y = 0 mm, z = 150 mm, α = 0°, β = 90°, γ = 0° with respect to the WRF

Testing the E-Stop function and the brakes (first time use)

Execute a movement command and, while the robot is still moving, activate the E-Stop function (e.g., by pressing the E-STOP button on the PS200 module). The PS200 module completely cuts power to the robot, in the case of R3 version, or only to the robot motors and Mecademic's EOAT, in the case of R4 version. In both cases, the robot brakes will be automatically applied to joints 1, 2 and 3. If joints 1, 2 or 3 continue to move, or if you notice that even after powering off the robot, one or more of these joints can be as easily rotated by hand as joints 4, 5, and 6, cease using the robot immediately and contact us immediately.

To use the robot again, you must power on the robot, deactivate the E-Stop function, activate the Reset function, then activate and home the robot.

Power-off procedure

Zeroing the robot joints

It might be a good idea to always bring the robot joints to their zero positions before turning the robot off. This can be done in two ways:

- send a MoveJoints command with all arguments equal to 0

OR

- click the button in the jogging panel and select "Zero all joints".

If you cannot zero all joints, you must at least bring joint 6 inside the range ±420° before switching the robot off (recall Section 7).

Deactivating the robot

To deactivate the robot

- clear the button and then select "Deactivate"

OR

- send the DeactivateRobot command via the programming editor.

> **Warning**
>
> Recall that there are no brakes on joints 4, 5, and 6. As soon as you deactivate the robot, the end-effector will slowly tilt down under the effects of gravity.

> **Note**
>
> If you accidentally close your web interface before deactivating the robot, the robot will stop (in case it was moving) but will remain activated.

Disconnecting the robot

To disconnect the web interface from the robot, select the option from the connection state group.

> **Danger**
>
> If you disconnect the web interface from the robot before deactivating the robot, the robot will stop moving.

Removing power

Finally, unplug the PS200 module from the AC outlet or switch the PS200 module off.

Warning

Never detach the DC power connector from the robot's base, before unplugging the PS200 module's AC power cord from the AC outlet or switching the PS200 module off.

Robot control panel

The set of buttons and LEDs on the robot's base is called the robot's control panel (Figure 28). The meanings of the LEDs and the functionalities of the buttons will be summarized in what follows.

Note that *these buttons and LEDs are intended mainly for development and demonstration purposes*, as they will not be physically accessible and possibly not visible during a normal operation of the robot, where the robot is fenced. The information conveyed from these LEDs and the actions controlled by these buttons are all available in the MecaPortal. The only exceptions are the Link/Act LEDs and the Run LED. The information conveyed by the Run LED, used only when the robot is controlled via EtherCAT, is accessible by the EtherCAT master.

Figure 28: Robot control panel

Buttons

When the robot is powered and deactivated, the 0G button is active but the other buttons are active only when no user is connected to the robot. In what follows, you must refer to the detailed descriptions of the commands associated with each button.

> **Danger**
>
> When pressing the buttons on the robot's base, keep your fingers away from the pinch points of the robot, and move away from the robot as soon as a button is released. These buttons are for development purposes only. They do not meet the requirements of ISO 10218-1.

Power button

The Power button acts as the ActivateRobot and DeactivateRobot commands:

- when the robot is deactivated, pressing Power will send the ActivateRobot command.
- when the robot is activated, pressing Power will send the DeactivateRobot command.
- when the robot is in error mode, pressing and holding Power for five seconds will send the DeactivateRobot command.

Pressing and holding Power during power-up will reset the robot network configuration.

Home button

The Home button acts as the Home and ResetError commands:

- when the robot is deactivated, pressing Home has no effect.
- when the robot is activated, pressing Home sends the Home command.
- when the robot is homed, pressing Home has no effect.
- when the robot is in error mode, pressing and holding Home for five seconds will send the ResetError command.

Start/Pause button

The Start/Pause button on the robot control panel acts as the StartProgram, PauseMotion, ResumeMotion, and ClearMotion commands:

- when the robot is activated, homed and not executing a program, briefly pressing Start/Pause will send the StartProgram(1) command three seconds after being pressed.
- when the robot is activated and homed, pressing Start/Pause for 3 seconds will send the ClearMotion command, whether the robot is moving or not.
- when the robot is activated, homed and moving, pressing Start/Pause will send the PauseMotion command.
- when the robot is activated, homed and stopped (by the PauseMotion command), pressing Start/Pause will send the ResumeMotion command.

0G button

Pressing and holding any of the two 0G buttons for three seconds, but only if the robot is deactivated, will release the brakes. While keeping 0G pressed with one hand, you can manually move the robot with your other hand. The brakes will re-engage as soon as the 0G button is released.

Danger

Once the robot is deactivated, hold the robot with one hand, before pressing the 0G button. Otherwise, the robot may fall down under the effect of gravity.

LEDs

After a power up, the Power, Home and Start/Pause LEDs will flash fast simultaneously during a couple of seconds. After that, the LEDs will be lit as described below.

Power LED

The Power LED is green and indicates the activation state of the robot:

- The LED will flash slowly when the robot is deactivated.
- The LED will flash fast when the robot is being activated.
- The LED will be lit continuously when the robot is activated.

Note

For robots manufactured before May 2025, the Power LED was red, which did not comply with the requirements of IEC 60204-1.

Home LED

The Home LED is yellow and indicates the homing state of the robot:

- The LED will be off when the robot is not homed.
- The LED will flash slowly when the robot is being homed.
- The LED will be lit continuously when the robot is homed.

Start/Pause LED

The Start/Pause LED is yellow and indicates the motion state of the robot:

- The LED will flash fast when the Start/Pause button was pressed and the program saved in the robot is about to start.
- The LED will be off when the robot is not moving.
- The LED will be lit continuously when the robot is moving.

Link/Act IN and Link/Act Out LEDs

Both LEDs are green and flash when there is network activity in the corresponding Ethernet port. The LEDs function in the same manner as on a normal Ethernet RJ-45 port.

Run LED

Used only when the robot is controlled via EtherCAT (see the Programming Manual).

Finally, when the robot is in error mode, the Power, Home and Start/Pause LEDs flash fast simultaneously. Also, if you keep the Power button pressed continuously during power-up, which provokes a network reset of the robot, the Power, Home and Play LEDs, will first flash simultaneously eleven times, and then blink several times sequentially.

Offline mode (for demonstrations only)

You can store a program in the robot and execute it without an external computer. This program is kept, even after power off, until replaced by another one. You can save up to 500 programs, but only the first one can be executed from the robot control panel.

Saving the program via the MecaPortal

You can use the MecaPortal to write programs to the robot, as described in *the-mecaportal-code-editor* of the MecaPortal operating manual. To write a program that can be executed by pressing the Start/Pause button on the robot's base, follow the steps below:

- Open the web portal and write the program in the code editor panel.
- To run the program on infinite loop, insert the command SetOfflineProgramLoop(1). (The checkbox has no effect on the execution of the program.)
- Click on the button and change the name of the program to "1".

Running a program

To execute the program 1, make sure there is no user connected to the robot and press the Start/Pause button on the robot base. The Start/Pause LED will flash rapidly for three seconds, after which the robot will start executing the program.

Danger

Immediately after pressing the Start/Pause button on the robot's base, move away your hand and stay outside the robot's reach.

It is highly recommended to run programs using any of the communication protocols, rather than by using the button on the robot control panel, which not only presents certain safety risks but can only execute program 1.

Operating the PS200 module

Emergency, protective and software stops

Once you power up the robot, you must make sure the E-Stop function is deactivated. Then, activating the Reset function sends power to the robot motors and to the EOAT (if R4) or to the complete robot (if R3).

Once the robot is activated and homed, activating the E-Stop function at any time instantly sends a signal to the robot to rapidly decelerate and come to a complete stop. The PS200 module then waits for a signal from the robot indicating that the robot is completely stopped, and as soon as that signal is received, but no later than in 500 ms, the PS200 module completely cuts power to the robot, in the case of R3 version, or only to the robot motors and Mecademic's EOAT, in the case of R4 version. In both cases, the robot brakes are then automatically applied to joints 1, 2, and 3. To use the robot again, you must deactivate the E-Stop function, and activate the Reset function, then activate and home the robot.

Of course, you will also need to manage the stream of commands being sent to the robot. For example, if a PLC sends commands to the robot, while the robot is powered off, the program that runs on your PLC will need to be able to detect and manage this situation. To do so, you can get a signal from the PS200 module that an E-Stop has been engaged by connecting your PLC to the D-Sub connected, as will be explained in the following pages. In the case of the R4 version, the event is also reported by the robot controller.

LEDs on the PS200 module

The PS200 module is equipped with three LEDs. As long as the PS200 module is switched on (using its on/off button) and connected to an AC source supplying 90–250 V at 50–60 Hz, the green LED next to "Power" stays illuminated. *Applying AC voltage outside this range may damage the PS200 module*.

Once the PS200 module is switched on, the yellow Status LED indicates the status of the PS200 module. If the yellow LED is off, you need to activate the Reset function, which sends power to the robot. If the proper Meca500 is correctly connected to the power supply, the yellow LED will turn on and stay lit.

If, in any situation, the yellow LED blinks regularly, it indicates that an emergency stop or the external SWStop is activated. You need to deactivate the E-Stop function or remove the cause for the SWStop and then activate the Reset function.

If the yellow LED flashes in sets of two, it indicates that the Reset function has been activated for too long. To resolve this, ensure the Reset function is deactivated, then activate it again briefly.

Finally, the red Error LED indicates if there is a problem with the PS200 module or with some of the connections to the D-Sub interface. If the red LED flashes (0.1 s on, 0.9 s off), either there is no robot connected to the PS200 module or the robot connected is an old version that is not supported by this PS200 module. If the red LED illuminates in sets of two quick flashes, the robot has detected a problem and sent a request to the PS200 module to be shut down. If this happens, contact us. If the red LED blinks in regular intervals (0.5 s on, 0.5 s off), this means that there is either a problem in your external emergency stop or Stop Category 1 connections or in our PS200 module. If you don't see any problem in your connections, contact us. Finally, if the red LED is constantly lit, there is a problem with the PS200 module. Switch off the PS200 module and contact us.

Table 11 summarizes the different states of the three LEDs as well as their meanings.

Table 11: The various states of the LEDs on the PS200 module

LED	Name	LED state	Explanation
Green	Power	Off	The PS200 module is turned off
		On	The PS200 module is turned on
Yellow	Status	Off	Robot is not powered. Activate the Reset function
		Blinking	Robot is not powered and a Stop Category 1 stop is pressed or the dongle is not plugged in. Remedy the situation and activate the Reset function
		Two flashes	Robot is not powered because the Reset function has been activated for too long. To resolve this, ensure the Reset function is deactivated, then activate it again briefly.
		On	Robot is powered.
Red	Error	Off	There is no error.
		Flashes	No proper robot connected.
		Two flashes	Robot has detected a problem and requested that power be shut down. Contact our support team.
		Blinking	Problem with Stop Category 1 stops detected. Check external stop connections and contact our support team if no solution found.
		On	Voltage error encountered. Power is cut and locks in power down state

Installing an end-effector

The Meca500 comes with a proprietary tool I/O (input/output) port located at the robot extremity (Figure 29). However, this tool I/O port is reserved uniquely for our end-of-arm-tooling (EOAT), i.e., our electric grippers MEGP 25E and MEGP 25LS, and our pneumatic module MPM500. We do not share the pinout of this port or its custom-made communication protocol. To install our grippers or pneumatic module, refer to their user manuals (MC-UM-MEGP25 and MC-UM-MPM500).

If you want to use any other end-effector with the Meca500, you will need to control it independently from the Meca500. You can attach the cabling of your end-effector along the robot arm using adhesive-backed tie mounts. Finally, you must fix the end-effector to the robot's flange (Figure 30) using four M3 screws tightened at 1.5 Nm, and, optionally, one Ø3 locating pin, all of properly selected length.

Danger

- Keep the robot unpowered while installing/removing a tool to its flange.
- Do not exceed the robot payload (0.5 kg).
- Do not exceed 3.4 Nm for the moment load on the robot flange.
- Securely fasten the tool to the robot flange.

Note that since joint 6 is multi-turn, there is no way of knowing the angle of joint 6 (even approximately), unless the robot is activated and homed. Therefore, prior to mounting an end-effector, it is important that you activate and home your robot, rotate joint 6 to its zero position, and finally unpower the robot. However, if the screw on the flange of the robot is not as in Figure 29 when $\theta_6 = 0°$, then you need to follow the procedure described in *homing* of the Programming Manual.

Figure 29: Closeup of the mechanical interface (flange).

Note

The flange is the Ø20 disk, inside the black isolation ring, and is the only one to rotate when joint 6 rotates.

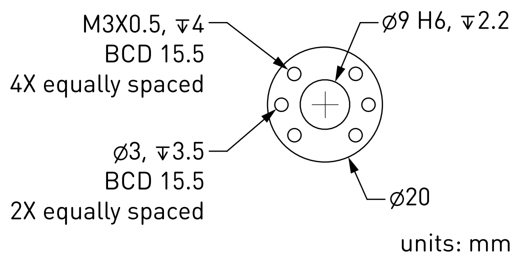


Figure 30: Dimensions of the mechanical interface (flange)

Warning

- Make sure that joint 6 is approximately at 0° before attaching an end-effector.
- Tighten the M3 screws with a torque of 1.5 Nm and a thread penetration of 4 mm. Do not thread more than 4 mm into the flange or else you may damage the gearbox of joint 6.
- Attach the tool cabling in such a manner that it obstructs as little as possible the motions of the robot.
- Unless you plug the connector of one of our own EOAT, keep the screw cap (not shown in Figure 29) of the tool I/O port in place at all times.

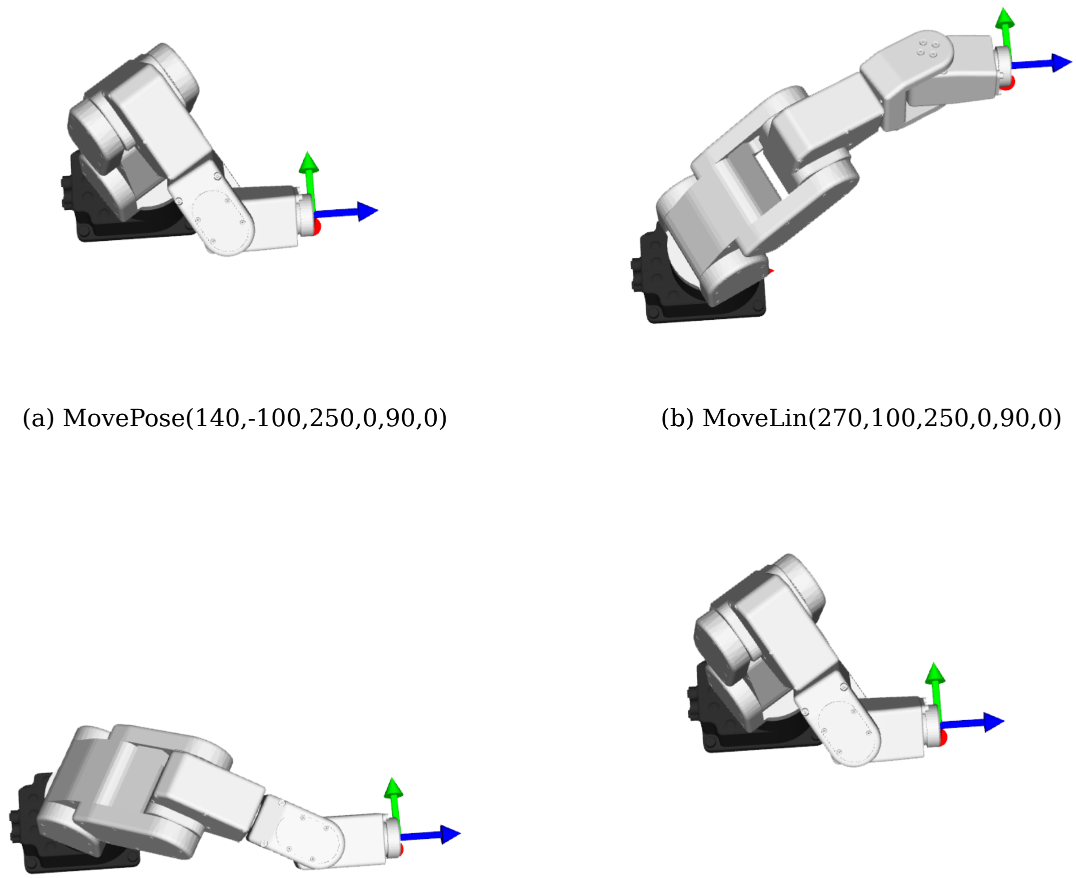
Finally, note that it is better that you specify the mass and the center of mass of your payload using the SetPayload command.

Examples

Here is an example of a very simple program that makes the robot’s TCP follow a square path, using the MoveLin command:

```
ActivateRobot
Home
MoveJoints(0,0,0,0,0,0)
MovePose(140,-100,250,0,90,0)
MoveLin(140,100,250,0,90,0)
MoveLin(270,100,250,0,90,0)
MoveLin(270,-100,250,0,90,0)
MoveLin(140,-100,250,0,90,0)
MoveJoints(0,0,0,0,0,0)
```

Figure 31 shows the result of four of the motion commands.



(a) MovePose(140,-100,250,0,90,0)

(b) MoveLin(270,100,250,0,90,0)

(c) MoveLin(270,-100,250,0,90,0)

(d) MoveLin(140,-100,250,0,90,0)

Figure 31: The four separate robot positions that define the motion sequence

Inspection and maintenance

Depending on the usage of your Meca500, the robot may require some minimum maintenance. However, it does never require disassembly. There is no battery to replace and joints 1 and 2 do not require greasing.

Locking up the robot

Follow the procedure described in Section 4.

Cleaning

Turn off the PS200 module and wipe away any dust or dirt observed on the robot arm using a soft, lint-free cloth and Isopropyl alcohol. *Never use compressed air to clean the robot arm.*

Visual and functional inspection

1. Turn the power on, activate and home the robot, and then move all joints to their zero position. The robot must look like in `fig:Meca500-Joint-Numbering` of the Programming Manual. If only joint 6 is offset, follow the procedure given in the section Homing of the Programming Guide.
2. Turn the power off and disconnect the power cable from both the robot and the power supply unit (PSU). Inspect the cable and the two connectors for any damage.
3. Verify that the four M6 screws on the base of the robot are sufficiently tightened. They must be tightened with torque of 3 Nm.
4. Verify that the four M3 screws attaching your tool to the flange of the robot are sufficiently tightened. They must be tightened with a torque of 1.5 Nm.
5. If you have an MEGP 25E* gripper or an MPM500 pneumatic module disconnect the tooling cable and inspect the tool I/O port and cable for any damage. Then, screw in the cable and validate that the cable is not loose.

Safety inspection

1. Turn the power on, activate and home the robot, and then execute a large motion at high velocity. Quickly, while the robot is still moving, press the E-STOP button and verify whether the robot stops immediately.
2. If you have an R3 version, turn the power on, activate and home the robot. Bring your robot to a fully-stretched horizontal position by executing the command MoveJoints(0,90,-90,0,0,0), or to the most stretched position that is free of mechanical interferences. Then turn the power off and verify whether the brakes of joints 1, 2, and 3 are stiff enough.

Troubleshooting

No LEDs are on upon power up

- Make sure all connectors are properly attached.
- Make sure the AC outlet works (the green LED on the PS200 module should be on).

No connection to the robot's web interface

- Make sure EtherCAT mode has not been enabled. To switch the robot back to Ethernet TCP/IP mode, the simplest way is to do a network configuration reset (see below).
- Make sure the router/switch works by checking the LEDs of the connection socket.
- Make sure you are connected to the same network as the robot.
- If you are using static IP addresses, make sure that the robot's IP default address (192.168.0.100) does not conflict with any other device on the network. For example:

  Robot: IP = 192.168.0.100, netmask = 255.255.255.0, gateway = 192.168.0.1
  Computer: IP = 192.168.0.101, netmask = 255.255.255.0, gateway = 192.168.0.1

- If you are using DHCP, make sure to verify the robot's IP address via your router's web interface.
- Make sure you do not have a firewall preventing traffic on TCP ports 80, 10000, 10001, 10010, 10011, 10020, 10021. These ports are used by the MecaPortal for communicating with the robot.
- Make sure the Ethernet cable is properly connected. The green Ethernet LED should pulse like on an RJ-45 connector when there is communication between the robot and the computer. If the green LED is not illuminated, detach and reconnect the Ethernet cable.

Robot fails to boot

- Disconnect the PS200 module from the AC outlet and wait for the green LED of the module to turn off. Then reconnect the module and boot the robot.

Robot's IP address forgotten

- You can reset the robot's Ethernet configuration (i.e., set the robot's IP address to 192.168.0.100 and the communications mode to TCP/IP) by performing a network configuration reset.

Network configuration reset

- Power off the robot;
- *On the Meca500 R4, activate the E-Stop function for safety reasons.*
- Press the Power button on the robot base while powering on the robot and keep button pressed for about 40 seconds until the red and yellow LEDs on the robot base start to blink sequentially.

Factory reset

- On the Meca500, it is not possible to perform a factory reset, initializing all persistent configuration data and erasing all user programs.

Storing the robot in its shipping box

- To put the Meca500 back into the foam insert of its original shipping box, send the command MoveJoints(0,-60,60,0,0,0). Recall that you must not force the brakes on joints 1, 2, and 3.

Warning

Never disassemble the robot. The robot requires no maintenance, and if you think it is damaged, stop using it immediately and contact us.

Note

If you are unable to solve your technical problem, do not hesitate to contact our technical support team by creating a ticket at support.mecademic.com.

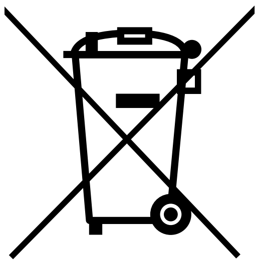
Decommissioning

Even when the Meca500 reaches the end of its product's life cycle or is deemed to be damaged beyond repair, we encourage you to contact us to verify if complete disposal can be avoided.

If you do decide to dispose of the Meca500 system (robot arm, PS200 module and cables), you must do so in accordance with the applicable national laws, regulations and standards.

The Meca500 system is produced with restricted use of hazardous substances to protect the environment; as defined by the European RoHS directive 2011/65/EU. These substances include mercury, cadmium, lead, chromium VI, polybrominated biphenyls and polybrominated diphenyl ethers. Specialized organisms can dismantle the unit and sort out these materials. They can also remove and recycle the aluminum parts of the robot.

If the robot is not contaminated, you can also ship it back to us.



Appendix 1. Meca500 R4 EMC test results

Table 12 lists all the tests passed by the Meca500 R4, called by the harmonized standards related to electromagnetic compatibility.

Table 12: Summary of EMC test results for the Meca500 R4

Test Name / Standards	Test specifications	MPCR[Page]	Result
Conducted Emissions FCC part 15 (2021) subpart B	Class A 150kHz–30MHz	n/a	Pass
Radiated Emissions FCC part 15 (2021) subpart B	Class A 30MHz–6GHz	n/a	Pass
Conducted Emissions ICES-001 Issue 5 (2020)	Group 1 - class A 150kHz–30MHz	n/a	Pass
Conducted Emissions ICES-001 Issue 5 (2020)	Group 1 - class A 150kHz–30MHz	n/a	Pass
Radiated Emissions ICES-001 Issue 5 (2020)	Group 1 - class A 30MHz–1GHz	n/a	Pass
Conducted Emissions CISPR 11 (2015) A1 (2016) A2 (2019)	Class A 150kHz–30MHz	n/a	Pass

continues on next page

Table 12 – continued from previous page

Test Name / Standards	Test specifications	MPCR[1]	Result
Radiated Emissions CISPR 11 (2015) A1 (2016) A2 (2019)	Class A 30MHz–5GHz	n/a	Pass
Electrostatic Discharge Immunity IEC61000-4-2 (2008)	Contact: ±4kV Air: ±2kV, ±4kV, ±8kV	B	Pass
Radiated Electromagnetic Field Immunity IEC 61000-4-3 (2020)	80MHz–1000MHz: 10V/m 1.4GHz–6GHz: 3V/m	A	Pass
Electrical Fast Transient Immunity IEC61000-4-4 (2012)	Power: ±2kV / 5kHz I/O Ports: ±1kV / 5kHz Communication Ports: ±1kV / 5kHz	B	Pass
Surge Immunity IEC 61000-4-5 (2014) A1 (2017)	Power: ±2kV L-PE / ±1kV L-L I/O Ports: N/A Communication Ports: N/A	B	Pass
Immunity to Conducted Disturbances, Induced by Radio-Frequency Fields IEC61000-4-6 (2013)	Power: 3V I/O Ports: 3V Communication Ports: 3V	A	Pass
Power Frequency Magnetic Field Immunity IEC61000-4-8 (2009)	Continuous Field: 30A/m / 50Hz & 60Hz	A	Pass

continues on next page

Table 12 – continued from previous page

Test Name / Standards	Test specifications	MPCR[1]	Result
			Pass
Voltage Dips, Short Interruptions and Voltage Variation Immunity on AC Input IEC 61000-4-11 (2020)	Voltage dips: 0% Un during 1 cycle 40% Un during 10 cycles (at 50Hz) 40% Un during 12 cycles (at 60Hz) 70% Un during 25 cycles (at 50Hz) 70% Un during 30 cycles (at 60Hz) Short interruptions: 0% Un during 250 cycles(at 50Hz) 0% Un during 300 cycles (at 60Hz)	B C C C C C C	

[1] Minimum performance criterion required

Appendix 2. Meca500 R3 EMC test results

Table 13 lists all the tests passed by the Meca500 R4, called by the harmonized standards related to electromagnetic compatibility.

Table 13: Summary of EMC test results for the Meca500 R4

Test Name / Standards	Test specifications	MPCR[Page]	Result
Conducted Emissions FCC part 15 (2018) subpart B	Class A 150kHz–30MHz	n/a	Pass
Radiated Emissions FCC part 15 (2018) subpart B	Class A 30MHz–5GHz	n/a	Pass
Conducted Emissions CISPR11 (2015) A1 (2016)	Group 1 - class A 150kHz–30MHz	n/a	Pass
Radiated Emissions CISPR11 (2015) A1 (2016)	Group 1 - class A 30MHz–1GHz	n/a	Pass
Conducted Emissions ICES-003 (2016)	Class A 150kHz–30MHz	n/a	Pass
Radiated Emissions ICES-003 (2016)	Class A 30MHz–5GHz	n/a	Pass

continues on next page

Table 13 – continued from previous page

Test Name / Standards	Test specifications	MPCR[1]	Result
Electrostatic Discharge Immunity IEC61000-4-2 (2008)	Contact: ±4kV Air: ±8kV	B	Pass
Radiated Electromagnetic Field Immunity IEC61000-4-3 (2006) A1 (2007) A2 (2010)	80MHz–1000MHz: 10V/m 1.4GHz–6GHz: 3V/m 2GHz–2.7GHz: 1V/m	A	Pass
Electrical Fast Transient Immunity IEC61000-4-4 (2012)	Power: ±2kV / 5kHz I/O Ports: ±1kV / 5kHz Communication Ports: ±1kV / 5kHz	B	Pass
Surge Immunity IEC61000-4-5 (2014)	Power: ±2kV L-PE / ±1kV L-L I/O Ports: N/A Communication Ports: N/A	B	Pass
Immunity to Conducted Disturbances, Induced by Radio-Frequency Fields IEC61000-4-6 (2013)	Power: 3V I/O Ports: 3V Communication Ports: 3V	A	Pass
Power Frequency Magnetic Field Immunity IEC61000-4-8 (2009)	Continuous Field: 30A/m / 50Hz & 60Hz	A	Pass

continues on next page

Table 13 – continued from previous page

Test Name / Standards	Test specifications	MPCR[1]	Result
			Pass
Voltage Dips, Short Interruptions and Voltage Variation Immunity on AC Input IEC61000-4-11 (2004)	Voltage dips: 0% Un during 1 cycle 40% Un during 10 cycles (at 50Hz) 40% Un during 12 cycles (at 60Hz) 70% Un during 25 cycles (at 50Hz) 70% Un during 30 cycles (at 60Hz) Short interruptions: 0% Un during 250 cycles (at 50Hz) 0% Un during 300 cycles (at 60Hz)	B C C C C C C	

[1] Minimum performance criterion required

Terminology

Below is the list of terms used by us in our technical documentation.

active line: The line in the MecaPortal where the cursor is currently positioned.

BRF: Base Reference Frame.

Cartesian space: The six-dimensional space defined by the position (x, y, z) and orientation (α, β, γ) of the TRF with respect to the WRF.

control port: The TCP port 10000, over which commands to the robot and messages from the robot are sent.

data request commands: Commands used to request some data regarding the robot (e.g., GetTrf, GetBlending, GetJointVel). These commands are executed immediately and generally return values for parameters that have already been configured (sent and executed) with a Set* command (or the default values).

default value: There are different settings in the robot controller that can be configured using Set* commands (e.g., SetCartAcc). Many of these settings have default values. Every time the robot is powered up, these settings are initialized to their default values. In the case of motion commands settings, their values are also initialized to their default values every time the robot is deactivated. In contrast, some settings are persistent and their values are stored on an SD drive.

detailed event log: This file mirrors the content of the event log panel in the MecaPortal when in detailed mode. It can be downloaded from the MecaPortal (see `troubleshoot-prog` of the Programming Manual).

EOAT: End-of-arm tooling.

EOB: End-of-block message, [3012][], sent by default every time the robot has stopped moving AND its motion queue is empty. You can disable this message with the command SetEob.

EOM: End-of-motion message, [3004][], sent by the robot whenever it has stopped moving for at least 1 ms, if this option is activated with SetEom.

error mode: The robot goes into error mode when it encounters an error while executing a command or a hardware problem (see `tab:error-messages`).

Euler angles: A set of three angles, {α, β, γ}, used the define an orientation in space. We use the mobile (intrinsic) XYZ convention. See `Euler-angles` of the Programming manual for more details.

FCP: Flange Center Point. The origin of the FRF.

FRF: Flange Reference Frame.

instantaneous commands: These are commands that are executed immediately, as soon as received by the robot. All data request commands (Get*), all robot control commands, all work zone supervision and collision prevention commands and some optional accessories commands (*_Immediate) are instantaneous.

inverse kinematics: The problem of obtaining the robot joint sets that correspond to a desired end-effector pose. See *inverse-kinematics* of the Programming manual for more details.

joint position: The joint angle associated with a specific joint.

joint set: The set of all joint positions.

joint space: The six-dimensional space defined by the positions of the robot joints.

monitoring port: The TCP port 10001, over which data is sent periodically from the robot.

motion commands: Commands used to construct the robot trajectory (e.g., Delay, MoveJoints, SetTRF, SetBlending). When a Mecademic robot receives a motion command, it places it in a motion queue. The command will be run once all preceding motion commands have been executed.

motion queue: The buffer where motion commands that were sent to the robot are stored and executed on a FIFO basis by the robot.

offline program: A sequence of commands saved in the internal memory of the robot. The term *offline* is often omitted and will eventually be removed altogether.

online mode programming: Programming the robot in online mode involves moving it directly to each desired robot position, typically using jogging controls.

PDO (**Process Data Object**): In EtherCAT, a Process Data Object (PDO) is a data structure used for exchanging real-time cyclic data between an EtherCAT master and its slave devices. PDOs can contain individual bits, bytes, or words.

persistent settings: Some settings in the robot controller have default values (e.g., the robot name set by the command SetRobotName), but when changed, their new values are written on an SD drive and persist even if the robot is powered off.

pose: The position and orientation of one reference frame with respect to another.

position mode: One of the two control modes, in which the robot's motion is generated by requesting a target end-effector pose or joint set (see *pos-vel-modes* of the Programming Manual).

robot posture configuration: The set of two-value (−1 or 1) parameters c_s, c_e, and c_w that normally defines each of the eight possible robot postures for a given pose of the robot's end-effector.

queued commands: Commands that are placed in the motion queue, rather than executed immediately. All motion commands are queued commands, as well as some external-tool commands.

reach: The maximum distance between the axis of joint 1 and the center of the robot's wrist.

real-time data request commands: Commands used to request some real-time data regarding the current status of robot (e.g., GetRtTrf, GetRtCartPos, GetStatusRobot).

robot control commands: Commands used to immediately control the robot, (e.g., ActivateRobot, PauseMotion, SetNetworkOptions). These commands are executed immediately, i.e., are instantaneous.

robot is ready for motion: The robot is considered *ready* to receive motion commands, i.e. when it is activated and homed, or alternatively when recovery-mode is enabled while the robot is activated but not homed.

Note that if the robot is in error or if a safety stop condition is present, it will refuse motion commands, but it will still be considered *ready* since its motion queue remains initialized and retains the latest received settings (e.q., velocity, acceleration, blending, WRF, TRF, etc.).

robot log: This file is a more detailed version of the user log, intended primarily for our support team. It can be downloaded from the MecaPortal (see *troubleshoot-prog* of the Programming Manual).

robot position: A robot position is equivalent to either a joint set or the pose of the TRF relative to the WRF, along with the definitions of both reference frames, and the robot posture and last joint turn configuration parameters.

robot posture: The arrangement of the robot links. Equivalent to a joint set in which all joint angles are normalized, i.e. have been converted to the range (−180°, 180°].

SDO (**Service Data Object**): In EtherCAT, a Service Data Object (SDO) is a data structure used for non-real-time communication between an EtherCAT master and its slave devices. SDOs are typically used to configure device parameters and access diagnostic information through the object dictionary. Unlike PDOs, SDOs exchange structured data rather than individual bits or bytes.

singularities: A robot posture where the robot's end-effector is blocked in some directions even if no joint is at a limit (see *singularities* of the Programming Manual).

TCP: Tool Center Point. The origin of the TRF. Not to be confused with Transmission Control Protocol.

TRF: Tool reference frame.

turn configuration parameter: Since the last joint of the robot can rotate multiple revolutions, the turn configuration parameter defines the revolution number.

user log: This file is a simplified log containing user-friendly traces of major events (e.g., robot activation, movement, E-Stop activation). It can be downloaded from the MecaPortal (see *troubleshoot-prog* of the Programming Manual).

velocity mode: One of the two control modes, in which the robot's motion is generated by requesting a target joint velocity vector or end-effector Cartesian velocity vector (see *pos-vel-modes* of the Programming Manual).

workspace: The Cartesian workspace of a robot is the set of all feasible poses of its TRF with respect to its WRF. Note that many of these poses can be attained with more than one set of configuration parameters.

WRF: World reference frame.

wrist center: the point where the axes of joints 4, 5, and 6 intersect.