



MVK01 VACUUM AND I/O MODULE

USER MANUAL

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Original instructions

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CONTENTS




- 1. INTRODUCTION 1
 - 1.1. Inside the box 1
- 2. TECHNICAL SPECIFICATIONS 3
- 3. INSTALLING THE MVK01 KIT 5
- 4. CABLING THE INPUTS AND OUTPUTS 8
- 5. OPERATING THE MVK01 MODULE 10
 - 5.1. Adjusting the purging force 10
 - 5.2. Firmware update 10
 - 5.3. Integration into the MecaPortal 10
 - 5.4. Safety 10
 - 5.5. Resets of the state of the MVK01 11

ABOUT THIS MANUAL

This user manual describes how to install Mecademic's MVK01 vacuum and I/O module kit onto Mecademic's MCS500 (R1) SCARA industrial robot arm and how to use it. You must read this manual thoroughly before installing or operating the MVK01.

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 messages in this manual.

SYMBOL	DEFINITION
	NOTICE. Identifies information that requires special consideration.
	CAUTION. Provides indications that must be respected in order to avoid equipment or work (data) on the system being damaged or lost.
	WARNING. 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
A	March 4, 2024	This version.

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

1. INTRODUCTION

The MVK01 kit contains a vacuum and I/O module developed by Mecademic, specifically for the MCS500 (R1) SCARA robot arm. The module essentially consists of a configurable vacuum ejector with a pressure sensor and circuitry for 8 digital inputs and 8 digital outputs. The MVK01 kit also comes with several accessories: three suction cups, a mechanical adaptor, 4-mm (OD) tubing, and four cable connectors.



Familiarity with the MCS500 robot and its user manual is required prior to installing and using the MVK01 vacuum and I/O module.



This vacuum and I/O module could function only when properly installed underneath the base of the MCS500 robot. Improper installation could damage the robot and the module itself. This module should therefore be used only by technical personnel who are familiar with the MCS500.

1.1. Inside the box

The MVK01 kit is supplied separately from the MCS500 (R1), even when purchased together. The module, shown in [Figure 1](#), is delivered assembled with two metric push-in pneumatic fittings and a pneumatic muffler. In addition, the MVK01 kit comes with the following items in separate plastic bags:

- a sample of 3 suction cups ([Figure 2](#));
- 1 m of 4-mm (OD) tubing;
- a suction cup holder to be attached to the flange of the MCS500 ([Figure 3](#));
- an alternative connector for the IN port, for 1/4-in (OD) tubing;
- 4 push-in cable connectors for the 8 inputs and 8 outputs ([Figure 4](#));
- 4 socket head screws (black-oxide), M6×1, 45 mm long, partially threaded.



Figure 1: MVK01 vacuum and I/O module, as delivered



Figure 2: The three suction cups from Schmalz (from left to right): [SUF 15 NBR-55 M5-AG](#), [SUF 10 NBR-55 M5-AG](#), [SUF 5 NBR-55 M5-AG](#)



Figure 3: Suction cup holder to be attached to the flange of the MCS500, with M3 set screw, push-in pneumatic fitting for 4-mm (OD) tubing and an M5-threaded hole for installing a suction cup



Figure 4: Push-in cable connector for the digital I/Os (Phoenix Contact, [Product Number 1778861](#))

2. TECHNICAL SPECIFICATIONS

Table 1 lists the main technical specifications for the MVK01 vacuum and I/O module and Figure 5 shows the principal dimensions of the module.

Table 1: Technical specifications for the MVK01 vacuum and I/O module

TECHNICAL SPECIFICATIONS	
Characteristic	Value
Compressed air connector	port IN
Operating pressure	7 bar (102 psi)
Vacuum connector	port VAC
Maximum vacuum	-75 kPa
Pressure sensor accuracy	±1.5 kPa
Suction rate (max.)	37.5 l/min
Air consumption suction	23.5 l/min
Maximum for inputs	24 V (DC), 10 mA
Minimum for inputs	3.3 V (DC), 1.1 mA
Maximum for outputs	24 V (DC), 250 mA
Ports	Three M5 threaded orifices, of which port IN comes with preinstalled push-in pneumatic fitting for 6-mm OD tubes, port VAC comes with preinstalled push-in pneumatic fitting for 4-mm OD tubes, and port EXH comes with a preinstalled pneumatic muffler.
Mechanical adjustments	Screw for adjusting the force of the air purging (marked ADJ)
Housing	Black anodized aluminum alloy
Total weight	572 g
Operating temperature	5° to 45°C
Operating humidity	[10%, 80%] (non-condensing)



To prevent the module from malfunctioning, please ensure that compressed air is supplied within the specified limits, as detailed in Table 1.

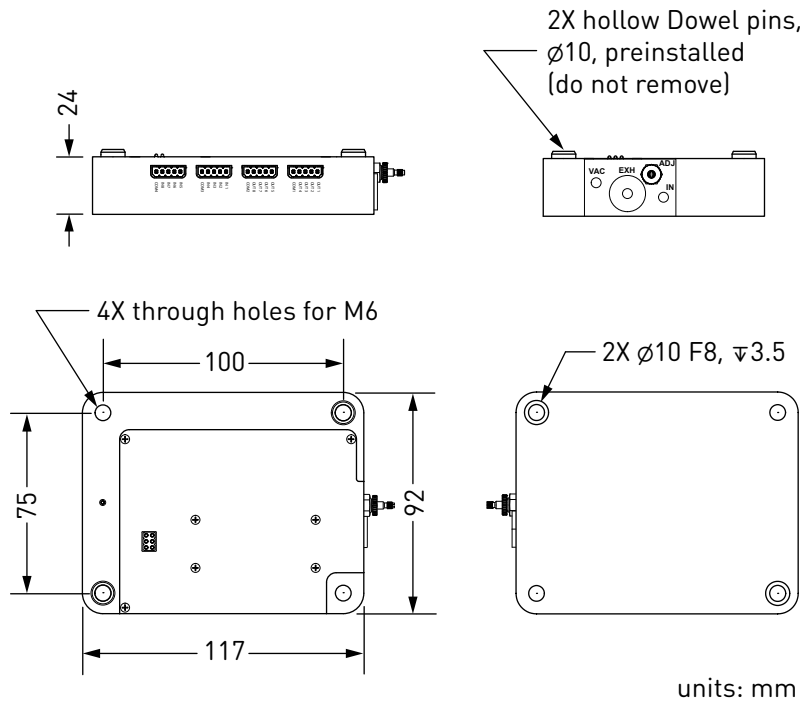


Figure 5: MVK01 module dimensions

3. INSTALLING THE MVK01 KIT

The MVK01 module is designed for only one type of installation, underneath the base of the MCS500 R1, as shown in [Figure 6](#).



Make sure the MCS500 robot is powered off and the connectors on top of the MVK01 and on the bottom of the robot's base are unobstructed, before installing the MVK01 module.



(a) MCS500 (R1) inserted onto the MVK01



(b) Assembly screwed in with four M6 screws

Figure 6: Installing the MVK01 module underneath the base of the MCS500 (R1)

The electric connection between the MCS500 robot and the MVK01 module is made through the seven spring-loaded connectors on top of the MVK01. Make sure there's nothing that obstructs that connection, before installing the MVK01 module. Then make sure the MCS500 robot is switched off and the arm fully folded and follow these steps:

1. Align the two diagonally opposed centering sleeves (hollow Dowel pins) with the corresponding locating holes at the bottom of the robot base, and then gently slide down the MCS500 until there is no gap between the top of the MVK01 module and the bottom of the robot's base ([Figure 6a](#)).
2. Carefully align the new assembly with the four M6 threaded holes for mounting the MCS500 and attach the assembly with four M6 screws of length 45 mm or more ([Figure 6b](#)). Tighten the screws with a torque of 8 Nm.

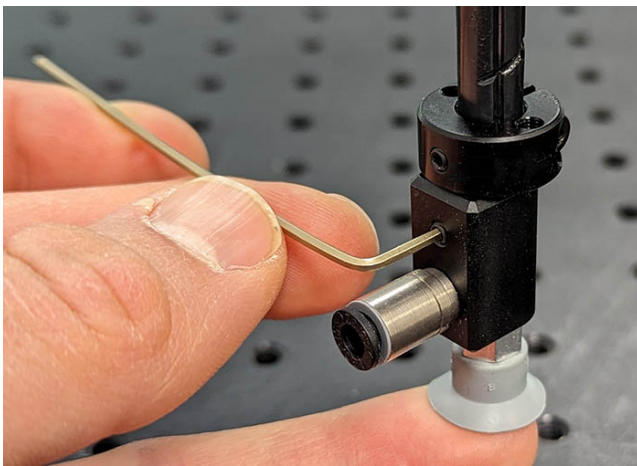


Until the base of the MCS500 is fixed with at least two M6 screws, keep the arm fully folded and always hold the robot with one hand to prevent the robot from tipping over.

Note that the MVK01 is precision machined and you can use locating pins to constrain the module, and therefore the complete robot-module assembly, in the same way as you would constrain the base of the MCS500. You can use 2+1 locating pins touching two adjacent sides of the module, as we do in our MUAP02 adaptor plate (which you can use for the module too).

Next, if you choose to use the suction cup holder supplied in this kit (Figure 3), install it on the bottom extremity of the robot's spline shaft or on the top extremity, depending on your application, by following these steps:

1. Unscrew (if necessary) the set screw in the adaptor with a 1.5-mm Allen key so that the screw is not protruding into the 8-mm hole.
2. Slide the suction cup holder's 8-mm hole onto the extremity of the robot's spline shaft until it makes contact with the black retaining ring on the spline shaft.
3. Reorient the adaptor while pushing it against the retaining ring, until the set screw on top of the push-in connector aligns with the set screw of the retaining ring. It is extremely important to make sure that the set screw on the suction cup holder is perpendicular to the Weldon flat surface, or else you will damage the spline shaft of the robot in step 4.
4. Screw in the set screw of the suction cup holder and tightened it using a torque of 1.5 Nm (Figure 7a).
5. Screw the desired suction cup into the M5 threaded hole of the suction cup holder (this step can be done in advance, Figure 7b).



(a) Installing the suction cup adaptor



(b) Suction cup fully installed

Figure 7: Installing the suction cup holder



Do not remove the retaining rings from the spline shaft, as doing so will cause irreversible damage to the ball-screw spline assembly.

Figure 8 shows the main dimensions of the suction cup holder.

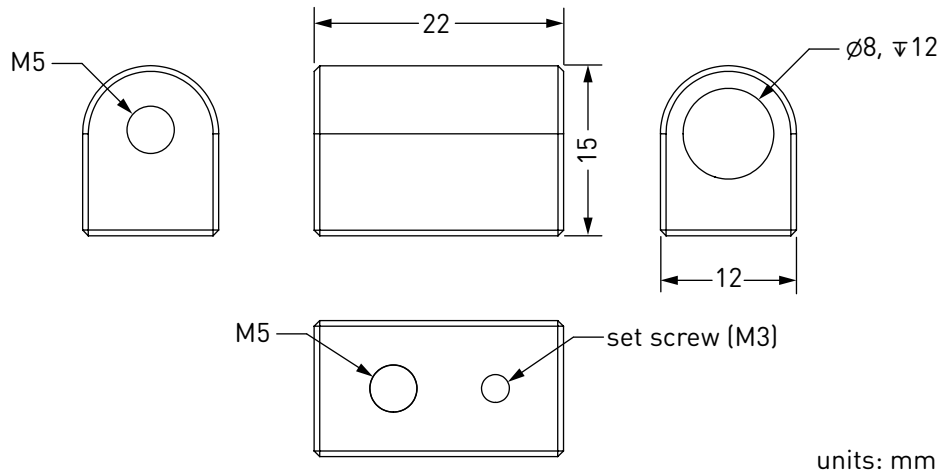


Figure 8: Main dimensions of the suction cup holder

Finally, insert the 6-mm (OD) pneumatic tubing providing the compressed air (7 bar) into the push-in connector of the IN port on the MVK01 module. Then, cut the proper length of pneumatic tubing with 4-mm outer diameter and connect one end to the VAC port on the MVK01 module and the other to the push-in connector of the suction cup holder. Attach the tubing with a tie wrap to the rigid cable conduit of the SCARA robot as shown in Figure 9. Make sure the tubing is sufficiently long for the active joint ranges of the robot, specified by the command SetJointLimits.

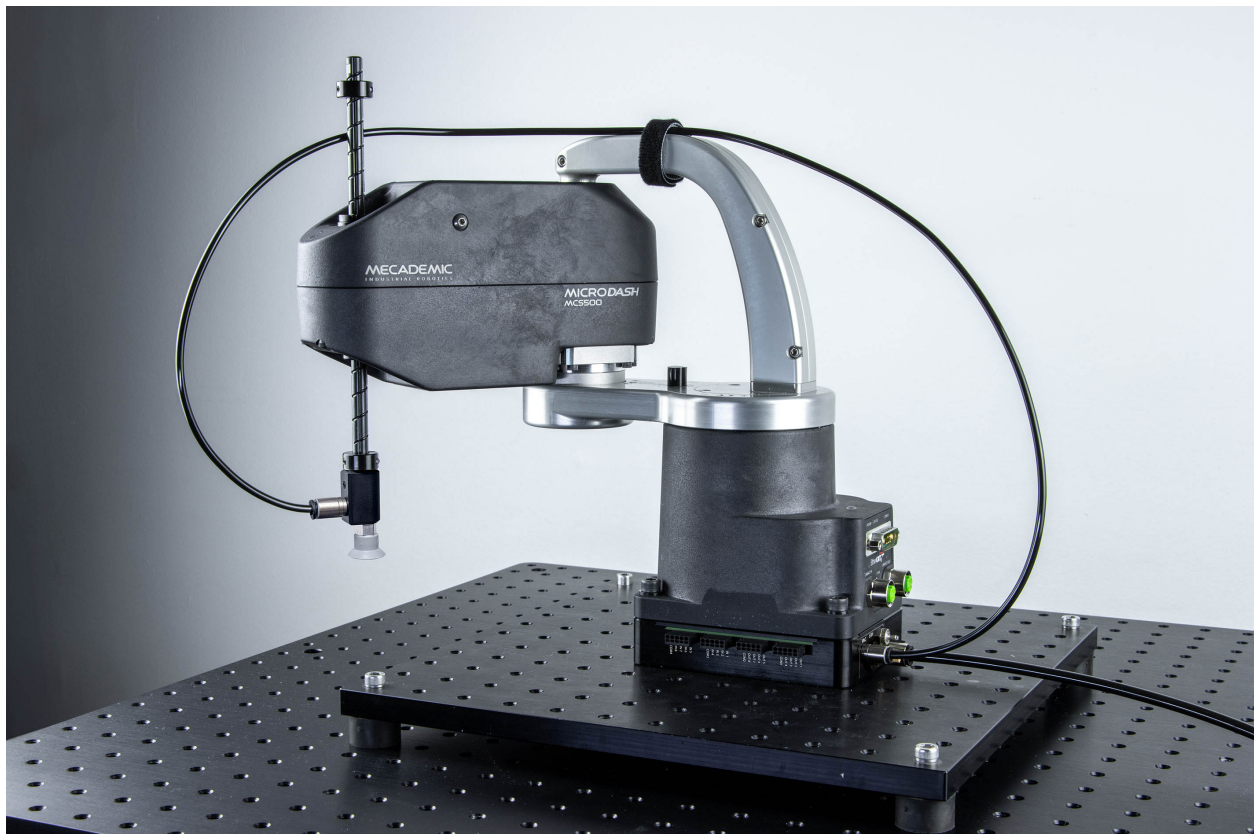


Figure 9: Complete installation of the MVK01 kit

4. CABLING THE INPUTS AND OUTPUTS

As already specified, the MVK01 provides 8 digital inputs and 8 digital outputs. Each group is divided into two sets, with its independent common terminal (Figure 10). By default, all inputs and outputs are normally open. Also, each group of four inputs or four outputs has its own common (i.e., OUT 1–4 share COM1, OUT 5–8 share COM2, IN 1–4 share COM3, and IN 5–8 share COM4).

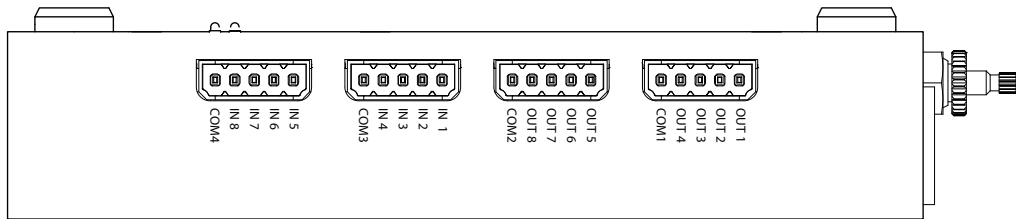


Figure 10: The four connectors on the MVK01 for connecting the 8 digital inputs and 8 digital outputs



Each group of four inputs or outputs has its own independent common terminal.

You must use the four push-in cable connectors provided (Figure 4) to wire your inputs and outputs. Refer to the specifications of these connectors for details: Phoenix Contact, [Product Number 1778861](#).

Figure 11 and Figure 12 show the electric diagrams that you must follow to connect devices to the inputs and outputs of the MVK01.

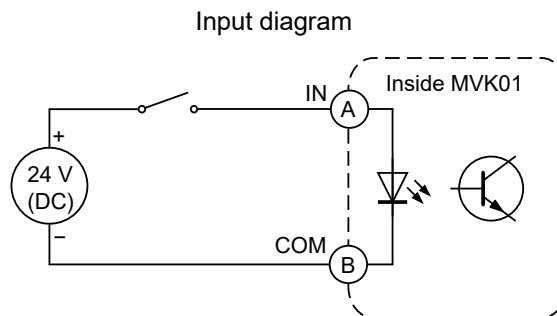


Figure 11: Electric diagrams to follow for connecting devices at the inputs

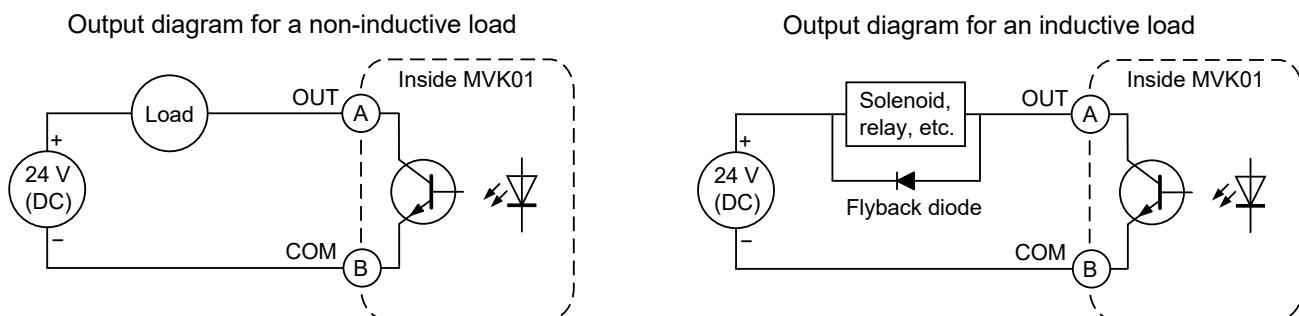


Figure 12: Electric diagrams to follow for connecting non-inductive and inductive loads at the outputs



Inductive loads such as relays and solenoids must include a flyback (freewheel) diode in the circuit as depicted in [Figure 12](#) (right). Otherwise, the MVK01 will be damaged permanently by the high voltage spike at the release of the inductive load.

5. OPERATING THE MVK01 MODULE

The MVK01 vacuum and I/O module is controlled in the same way as the MCS500. For example, you can control the vacuum using the commands `VacuumGrip/VacuumRelease` and configure it using the commands `SetVacuumThreshold`, `SetVacuumPurgeDuration`. You can also set the outputs using the command `SetOutputState` and read the inputs using the command `GetRtIoState`. For a complete description of these and other commands, refer to the Mecademic robot's programming manual.

5.1. Adjusting the purging force

The MVK01 is equipped with a purging function for quickly ejecting a part. During purging, the negative pressure at the suction cup is essentially quickly transformed into positive pressure. The duration of the air purge is set with the command `SetVacuumPurgeDuration`. You can also control the force of the purging (i.e., the purge air flow) using the rotating knob marked ADJ, next to the three ports on the MVK01 module. When the knob is completely screwed in, the force of purging is smallest. The more you unscrew the knob, the larger the purging force. You will need a flat 0.4 mm screwdriver for this operation.

5.2. Firmware update

The MVK01 module will be automatically updated to the same version as the MCS500 robot, either during the update of the robot (if the module is present) or during the first boot of the robot with the MVK01 installed.

5.3. Integration into the MecaPortal

The MecaPortal web interface automatically recognizes the MVK01 module and displays a CAD model of it underneath the MCS500, as well as a widget specific to the module (Figure 13). In the widget, you can control the eight digital outputs, see the status of the eight digital inputs, control the suction action, and see the pressure in the vacuum chamber.

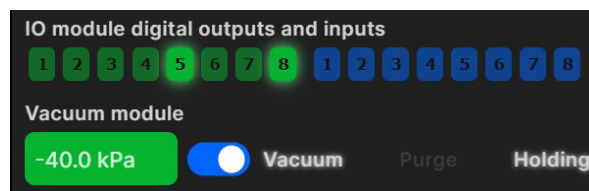


Figure 13: Widget that appears in the MecaPortal jogging panel when the MVK01 is detected

5.4. Safety

The MVK01 vacuum and I/O module is designed with safety in mind. However, additional tools connected to the VAC port may lead to risks of injuries. Make sure that all connections are properly made and that you respect the technical specifications of the MVK01 module.

Regularly make sure that the suction cup holder is solidly attached to the spline shaft.

5.5. Resets of the state of the MVK01

If an activated robot with an MVK01 module becomes deactivated, the MVK01 retains its state (i.e., if it was generating vacuum, it will continue to do so, and all outputs will remain the same).

However, if an E-Stop or a P-Stop 1 is activated or in the case of various other events that cut power to the robot motors (e.g., changing the operating mode), the vacuum generation is ceased but the state of all eight outputs remains unchanged. You can also continue to read the inputs.



When power to the robot motors is removed (e.g., during an E-Stop), the vacuum generation is ceased. Therefore, if the robot's suction cup is holding a part, the part will fall.

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