



User Manual



VG10 Vacuum Gripper

Collaborative dual-channel electrical vacuum gripper

Original Instructions (en)

Version 1.1.1

The information contained herein is property of OnRobot A/S and shall not be reproduced in whole or in part without prior written approval of OnRobot A/S. The information herein is subject to change without notice and should not be construed as a commitment by OnRobot A/S. This manual is periodically reviewed and revised.

OnRobot A/S assumes no responsibility for any errors or omissions in this document.

Copyright © 2015–2019 by OnRobot A/S.

The OnRobot A/S logo is trademark of OnRobot A/S.

Technical sheet

Features

- Easy installation, programming and risk assessment
- Optimized for collaborative applications
- Dual grip with two independent gripping zones
- No need for external air or cables down the robot
- 10 kg lifting power on airtight and slightly porous surfaces
- Plug'n'Produce in 30 minutes (installation + robot programming)

| | <i>Minimum</i> | <i>Typical</i> | <i>Maximum</i> | <i>Unit</i> |
|----------------------------|----------------|----------------|----------------|-------------|
| Vacuum | 5 % | - | 80 % | Vacuum |
| | -0.05 | - | -0.810 | Bar |
| | 1.5 | - | 24 | inHg |
| Air flow | 0 | - | 12 | Nl/min |
| Arms adjustment | 0 | - | 270 | ° |
| Arm holding torque | - | 6 | - | Nm |
| Payload | 0 | - | 10 | kg |
| | 0 | - | 22 | lb |
| Recommended workpiece size | 10x10 | - | 500x500 | mm |
| | 0.5x0.5 | - | 20x20 | in |
| Vacuum cups | 1 | - | 16 | pcs. |
| Gripping time | - | 0.35 | - | s |
| Releasing time | - | 0.20 | - | s |
| Foot-inch-foot | - | 1.40 | - | s |

| | <i>Feature</i> |
|-----------------------|--|
| Vacuum pump | Integrated, electric BLDC |
| Arms | 4, adjustable by hand |
| Tool changer | Integrated, click-on |
| Mechanical interface | ISO 9409-1, type 50-4-M6 |
| Pneumatic interface | 16x G1/8 internal threads |
| Electrical interface | 8-pole M8 |
| Digital interfaces | URCap (PolyScope ≥ 3.3) UR scripts (PolyScope < 3.3) MODBUS RTU 24V I/O |
| Dust filters | Integrated 50µm, field replaceable |
| IP Classification | IP54 |
| Dimensions (folded) | 146 x 146 x 102 mm 5.75 x 5.75 x 4.00 inch |
| Dimensions (unfolded) | 390 x 390 x 102 mm 15.35 x 15.35 x 4.0 inch |
| Weight | 1.70 kg 3.75 lb |

Typical applications

- Pick and place
- Palletizing
- Machine tending
- Material handling

Operating conditions

| | <i>Minimum</i> | <i>Typical</i> | <i>Maximum</i> | <i>Unit</i> |
|------------------------------------|----------------|----------------|----------------|-------------|
| Power supply | 20.4 | 24 | 28.8 | Volts |
| Current consumption | 50 | 600 | 1500 | mA |
| Operating temperature | 0 | - | 50 | °C |
| | 32 | - | 122 | °F |
| Relative humidity (non-condensing) | 0 | - | 95 | % |
| Calculated MTBF (operating life) | 30000 | - | - | hours |

What's in the box?

Everything you need to get started with the VG10 is included:

- 1 x VG10 Industrial Robot Vacuum Gripper
- 1 x Easy Tool Changer
- 1 x 200 mm M8 tool cable
- 16 x Fittings for vacuum cups (pre-mounted)
- 16 x 30 mm vacuum cups (pre-mounted)
- 4 x 40 mm vacuum cups
- 4 x 15 mm vacuum cups
- 16 x Blind screws
- 4 x Torx T30 M6 bolts
- 1 x pin (rotation lock)
- Torx 30 key
- 3 mm Allen hex key
- User manual
- USB stick
 - URCaps (PolyScope >= 3.3 support)
 - User manual




Table of contents

| | |
|---|----|
| Technical sheet | 4 |
| Features | 4 |
| Typical applications | 5 |
| Operating conditions | 5 |
| What's in the box? | 5 |
| 1 Quick guides | 8 |
| Installation | 8 |
| Troubleshooting | 9 |
| Updating software | 9 |
| Uninstalling | 10 |
| 2 Software specification | 10 |
| URCap | 10 |
| The Installation Screen | 11 |
| Structures | 12 |
| VG10 Grip | 12 |
| VG10 Release | 14 |
| Script commands | 15 |
| VG10_grip (channel, vacuum, timeout, alert) | 15 |
| VG10_release(channel, timeout, autoidle) | 15 |
| VG10_get_vacuum(channel) | 16 |
| VG10_calibrate_ain() | 16 |
| VG10_idle(channel) | 16 |
| MODBUS RTU | 17 |
| Settings | 17 |
| Function codes | 17 |
| Registers | 18 |
| Manual control | 20 |
| 3 Hardware specification | 21 |
| Vacuum cups and fittings | 22 |

| | |
|--|-----------|
| Payload, vacuum and air flow | 23 |
| Suction area | 23 |
| Vacuum | 24 |
| Air flow | 24 |
| Maintenance and repair | 26 |
| Filters | 26 |
| Mechanical dimensions | 27 |
| Electrical characteristics | 28 |
| 4 Safety | 29 |
| Intended use..... | 29 |
| Risk assessment..... | 29 |
| Environmental safety..... | 31 |
| General safety instructions..... | 32 |
| 5 Warranties | 33 |
| Patents..... | 33 |
| Product warranty..... | 33 |
| Disclaimer | 33 |
| 6 Certifications | 34 |
| Applied standards..... | 34 |
| CE/EU Declaration of incorporation (Original)..... | 37 |

1 Quick guides



DANGER
 You must read, understand and follow all safety information in this manual, and the robot manual and all associated equipment before initiating robot motion. Failure to comply with safety information could result in death or serious injury.

Installation



- Unpack the box (See *What's in the Box Section* and the Unboxing video: <https://www.youtube.com/watch?v=SqK-ATtP0E>)
- Mount the tool changer on the robot:
 - Orient the robot tool flange for easy access
 - Unclick the robot half of the tool changer from the top of the VG10
 - Screw it onto the robot using the four Torx T30 bolts, Torque = 6Nm (See Figure 1.1 below)
 - Click on VG10 (See Figure 1.2 and 1.3 below)
- Mount the tool cable
 - The cable fits smoothly 270° around the VG10 and tool changer (See Figure 1.3)
- Disable or uninstall other URCaps that use the tool connector
- Install the VG10 URCap
 - Insert the supplied USB stick into the UR teach pendant
 - UR Main Menu → Setup Robot → URCaps
 - Press “+”
 - Select USB stick → “VG10-URCap”
 - Press “open”
 - Press “restart”
- Ready
 - Use the dedicated VG10 program structures to control the vacuum
 - Move the four VG10 arms to your preferred angles; simply overcoming the friction by hand
 - Remove and add vacuum cups as you prefer; close unused holes with the blind screws

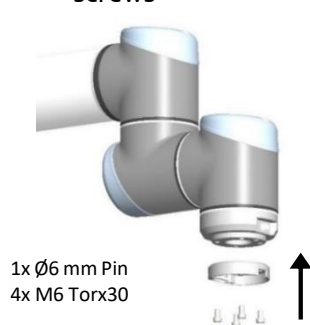


Figure 1.1

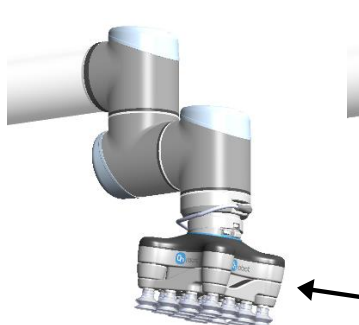


Figure 1.2

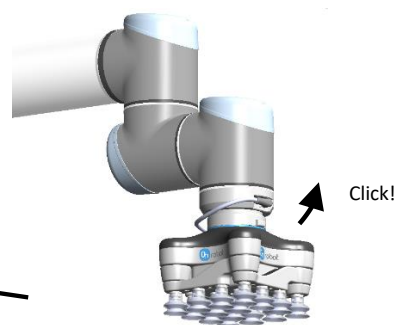


Figure 1.3

Troubleshooting

- If the URCap is installed but the structures “VG10 Grip” or “VG10 Release” do not work, try:
 - Uninstall all URCaps, reboot UR control box and reinstall the VG10 URCap
 - Check that the tool cable is undamaged and mounted correctly
 - Check if a new empty program works
- If URCaps is not supported on the robot, try:
 - Update the UR robot software to version 3.4 or higher
 - Avoid URCap functionality by using the script commands, in the *Script Commands Section*.
 - Avoid URCap functionality by simply activating the tool I/O’s (Default vacuum = 60%)
- If the program periodically stops with the condition “No controller” (i.e. UR controller crash)
 - Consult your local UR robot supplier for troubleshooting

Updating software

The software consists of the URCap and firmware inside the VG10. When an URCap is installed on a robot it automatically includes the compatible firmware for the VG10. Because the URCap and firmware comes as a pair, compatibility between the two is guaranteed.

- Install the new URCap
 - Simply follow the “installation” guide in this manual
- Update VG10 firmware
 - UR main menu → Program Robot → Installation → VG10
 - Wait a few seconds until the current firmware version appears
 - If an “update” button appears: Press the button and wait until the new firmware version is installed
 - If no “update” button appears: The compatible firmware is already installed in the VG10



INFO

- It is recommended to keep all robots in the same facility updated with the same URCap version. By doing so, it is possible to switch between different robots and VG10’s without the need to update any software.
- The newest software is always available www.onrobot.com.

Uninstalling

It is not necessary to uninstall the VG10 URCap to allow the IO's to be used by other URCaps / applications. The VG10 URCap can be activated or deactivated as needed per installation by ticking the "Enable VG10 URCap" in the VG10 installation screen on and off. Please refer to *The Installation screen*.

If needed, the URCap can be permanently uninstalled as described below.

- Uninstall the VG10 URCap
 - UR Main Menu → Setup Robot → URCaps
 - Select "VG10-URCap" on the list
 - Press "-"
 - Press "Restart"
- Remove the tool cable
- Remove the tool changer from the robot
 - Orient the VG10 and robot tool flange for easy access
 - Unclick the VG10
 - Screw out the four Torx T30 bolts

2 Software specification

The most common way to use the VG10 is by use of the URCap functionalities (see *figure 2.1* for Installation tab and *figure 2.2* for the Command tab). However, it is also possible to use the VG10 without use of the URCap, either through urscript commands or by manual I/O control. These three different control modes are described in the following three sections.

URCap

The VG10 URCap allows for convenient and reliable usage of the VG10 with a Universal Robots arm. When installed an installation tab and two program structures is made available in PolyScope.

The Installation Screen

This tab contains general information and settings for the VG10. Serial and revision numbers will automatically be transferred from the VG10 after a few seconds.

The VG10 URCap can be disabled per installation by unchecking the checkbox. This option can be useful when multiple URCaps utilizing the tool IOs are installed on the robot and used in different installations (See how to install in the *Installation Section*).

Tool weight should be set to the total weight including tool changes and other accessories, but **without** the workpieces to be handled (see *figure 2.2*)

The structure tab is used to insert the Grip and Release function in the Robot program structure tree (See *figure 2.2*). In the URCaps tab, you will find the two buttons.

If only the VG10 is mounted on the robot, the default setting of 1.7 kg should not be changed.

An **“Start”** button will appear if a new firmware is available for the VG10. The update time varies but is normally just a few minutes.

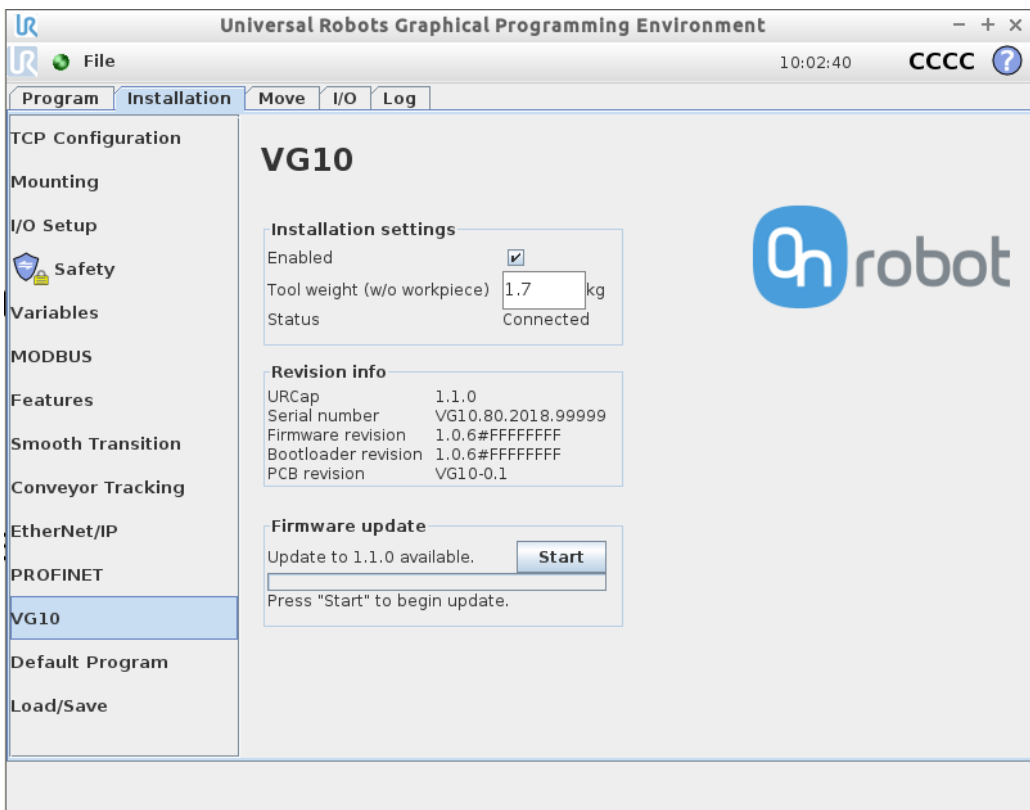


Figure 2.1: VG10 URCap Installation tab screen.

Structures

The structure tab is used to insert the Grip and Release function in the Robot program structure tree (See figure 2.2 below). At the URCaps tab you will find the two buttons.

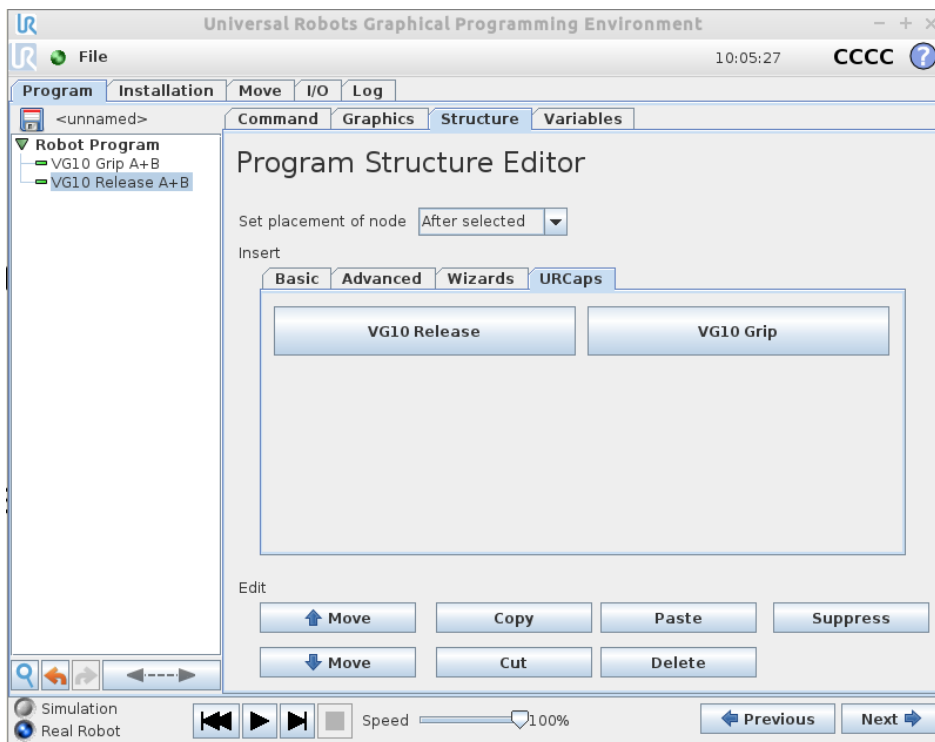


Figure 2.2: URCap Structure tab for VG10 Grip.

VG10 Grip

This structure is used to activate the pump and generate vacuum (see figure 2.3). It is possible to select channel A, B or both (See stickers under the VG10 arms to see which arms channel A is and which is channel B). The higher vacuum percentage the more lifting power.

The VG10 URCap keeps track of total payload, when using the VG10 Grip and VG10 Release nodes along with the tool weight in the installation node to manage payload settings. If, for instance, the tool weight is set to 1.7 kg in the VG10 Installation tab and a payload of 2 kg is picked up on Channel A, using the VG10 Grip node, the total payload is automatically set to $1.7 + 2 = 3.7$ kg. If picking up an additional payload of 4 kg on Channel B, the total payload is automatically set to $1.7 + 2 + 4 = 7.7$ kg. Likewise, payload is removed per channel. If, in the above example, the workpiece on channel A is removed using the VG10 Release structure, the total payload is automatically adjusted to $1.7 + 4 = 5.7$ kg.

The setting “wait for proper grip” means that the program will stay in the *VG10 Grip* structure until commanded vacuum is achieved. The setting “Stop robot on subsequent lost grip” means that the vacuum is monitored continuously and if the vacuum disappears unexpectedly the robot will stop with a popup.

The indicator Actual and Target slide bar shows and defines, respectively, the current and target vacuum in each channel. The 'Grip' button will start the pump and generate vacuum at the selected level on the selected channel(s) to allow for easy verification of the dialed in settings. The Release button makes it convenient to terminate the test-grip and releasing any workpieces that may be held by the selected channel. The Tandem button allows to control both channels at the same time when checked.

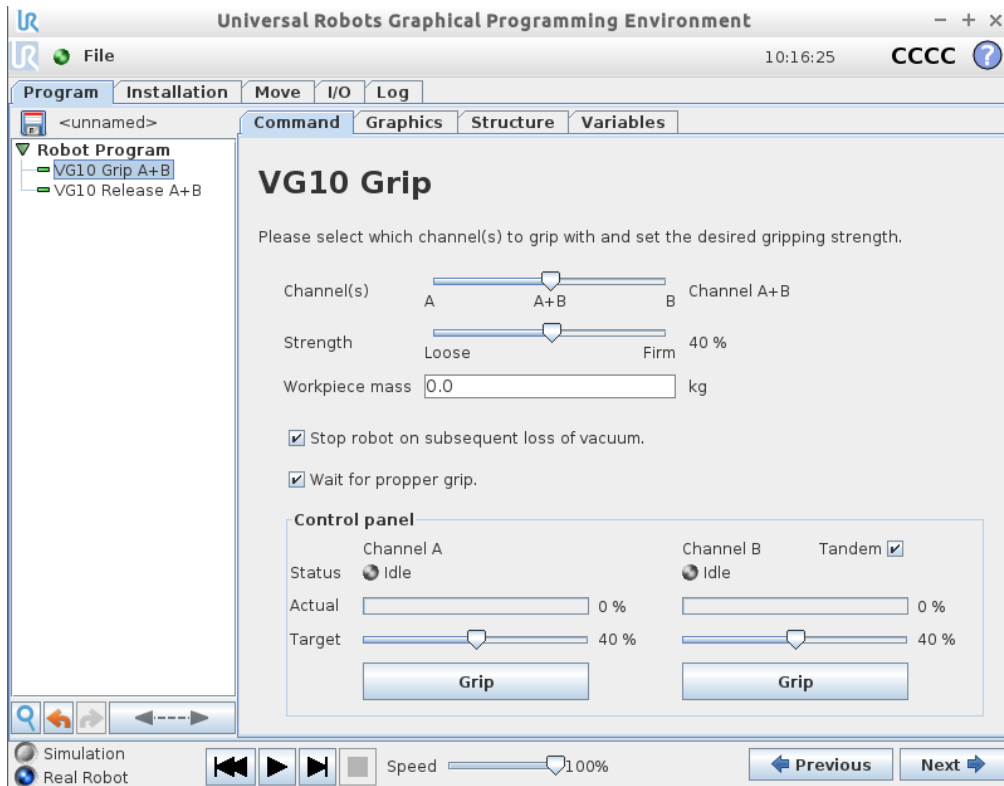


Figure 2.3: URCap Command tab for VG10 Grip.



INFO

- Setting a lower vacuum gives a faster grip with less wear on the vacuum cups. It also reduces the risk of leaving suction marks on delicate work pieces.
- It can take a few seconds when pressing "Play" or "Test" before the robot program starts. This is normal.
- When the two channels are set to different vacuum percentages the VG10 automatically releases air into the channel with lower pressure. This feature is activated when the pressure is more than 20% vacuum over the setting. Releasing air generates a characteristic rumbling sound and change in pumping speed.

VG10 Release

This structure is used to release the grip of the workpiece by removing vacuum. By selection the appropriate channel setting it is possible to release the workpiece on either channel or both.

When the payload is properly set in the preceding VG10 Grip node(s), the robot payload is corrected once the workpiece has been released. If, for instance, a workpiece of 1 kg is held by Channel A and one of 2 kg by Channel B, the robot payload is changed depending on the channel selection. Releasing channel A will set the payload to 2 kg + tool weight whilst releasing channel B will set the payload to 1 kg + tool weight. Releasing channel A+B will set the robot payload to the tool weight alone. Please refer to *The Installation screen* for details on the tool weight.

The option to close the valves after the workpiece is released will turn off the power to the release-valves to save power. The power will be removed when the robot has traveled 5cm away from the release position. This option is especially suitable for situation where multiple work pieces are handled, as turning off the valve will free up power to the pump to improve vacuum levels and cycle times.

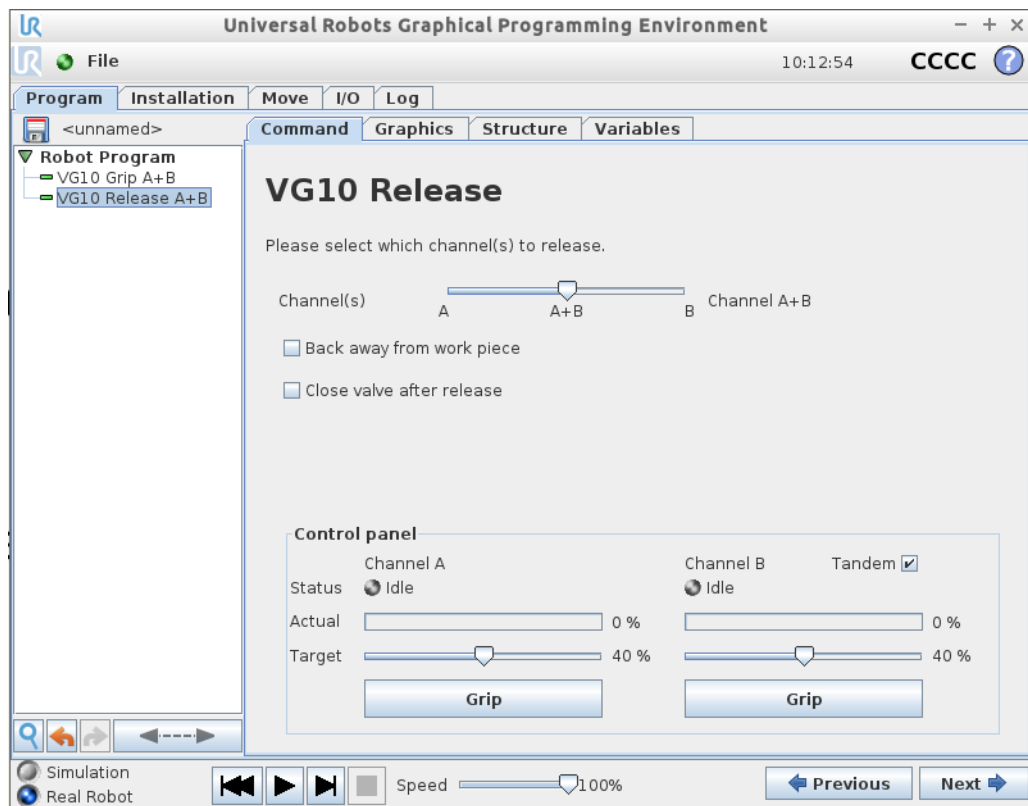


Figure 2.4: URCap Command tab for VG10 release.

Script commands

Script commands are available independently of the URCap and they also work on older versions of the UR robots (Regarding old UR robots, follow the guide in the folder "Script Commands" on the USB stick).

Script commands are available for both UR robots with the URCap installed and for older robots without URCAP support. For the VG10 script commands to become available on an UR robot, one of the following must be done:

- Install the VG10 URCap, or
- Follow the guide in the folder "Script Commands" on the USB stick, or
- Follow the guide found on www.onrobot.com/support.

VG10_grip(channel, vacuum, timeout, alert)

Commands the VG10 to perform a grip.

- **channel:** Tells which channel to be gripped with.
 - 0 = Channel A
 - 1 = Channel B
 - 2 = Channel A and Channel BIf not set, this parameter defaults to 2 (A and B).
- **vacuum:** Tells how hard to grasp in the range of 0% to 80 % vacuum.
 - 60 = 60% vacuum. A typical firm grip
 - 30 = 30% vacuum. A typical soft gripIf not set, this parameter defaults to 60%.
- **timeout:** Tells how long to wait for commanded vacuum to be achieved. If vacuum is not achieved, an air leakage at the workpiece or vacuum cups is reported in a popup and the robot program stops.
 - 0 = The function will not wait for vacuum, but return immediately after the command is sent
 - >0 = Waiting time [s]. Floating point numbers can be used. E.g. 0.6 = 600 ms.If not set, this parameter defaults to 5 seconds.
- **alert:** Whether the grip should be monitored after vacuum (grip) is established. If vacuum is lost while handling a workpiece, a popup warning is shown, and the robot program stops. This setting cannot be used without a proper **timeout** setting, see above.
 - False = Vacuum is not monitored
 - True = Vacuum is continuously monitored. Popup warning enabledIf not set, this parameter defaults to True.

VG10_release(channel, timeout, autoidle)

Commands the VG10 to perform a release.

- **channel:** Tells which channel to be released.
 - 0 = Channel A
 - 1 = Channel B
 - 2 = Channel A and Channel BIf not set, this parameter defaults to 2 (A and B).

VG10 User Manual 1.1.1

- **timeout:** Tells how long to wait for vacuum to be removed.
 - 0 = The function will not wait, but return immediately after the command is sent
 - >0 = Waiting time [s]. Floating point numbers can be used. E.g. 0.6 = 600ms. If not set, this parameter defaults to 5 seconds.
- **autoidle:** Tells if the release valve should automatically be turned off when the release is completed and the robot has moved 5cm away from the release position. If not set, this parameter defaults to True.

VG10_get_vacuum(channel)

Returns current vacuum in the selected channel.

- **channel:** Tells which channel value to return.
 - 0 = Channel A
 - 1 = Channel B

VG10_calibrate_ain()

Runs a calibration process improving accuracy of the script commands **VG10_get_vacuum()** and **VG10_grip()**, by compensating out tolerances of the UR robot analog inputs. Typically, this takes 200 ms and is done once in the beginning of a program if using the VG10 URcap.

VG10_idle(channel)

Commands the VG10 to idle the selected channel. When a channel is in idle, the power consumption is slightly lower, but parts may 'stick' to the suction cup as the air return channel is closed.

- **channel:** Tells which channel to be in idle.
 - 0 = Channel A
 - 1 = Channel B
 - 2 = Channel A and Channel B

MODBUS RTU

The VG10 supports MODBUS RTU. MODBUS RTU is a well proven and easy to use fieldbus, which is supported by a vast amount of industrial equipment. MODBUS RTU uses RS485 as the physical layer. For further details on the protocol, please refer to modbus.org's *MODBUS over Serial Line Specification and Implementation Guide*¹ and *MODBUS Application Protocol Specification*²

Settings

Both 24V I/O data line and MODBUS RTU line is enabled at power-up. If the VG10 detects a command on the 24V I/O data line before receiving a MODBUS RTU frame, it will disable MODBUS RTU and use the shared MODBUS RTU line (RS485) for analog outputs (Vacuum %).

Upon reception of the first valid MODBUS frame, the VG10 will lock to this interface and disables the 24V I/O data line.

The table below states the settings to be used when communicating with the VG10 over MODBUS RTU. See *Electrical Characteristics* for physical connection details.

| <i>Setting</i> | <i>Value</i> |
|--------------------|-------------------------|
| Baudrate [bit/sec] | 115200 |
| Start bits | 1 |
| Data bits | 8 |
| Parity | Even |
| Stop bits | 1 |
| Slave address | 65 (0x41) |
| CRC Check | 16 bit (MODBUS default) |
| CRC Polynomial | 0xA001 (MODBUS default) |

Function codes

The VG10 currently supports the function codes listed below. The VG10 will respond with an appropriate exception code, if the function is not executed correctly. Please refer to *MODBUS Application Protocol* for detailed description of the different exception codes. Note that the VG10 will provide no response, if the serial settings, slave address or CRC code is not correct.

3 / 0x03, Read Holding Registers:

Use this function code to read out one or multiple consecutive registers. Please refer to *MODBUS Application Protocol* for frame and response details.

6 / 0x06, Write Single Register:

Use this function code to set the value of a single register. Please refer to *MODBUS Application Protocol* for frame and response details.

¹ http://www.modbus.org/docs/Modbus_over_serial_line_V1_02.pdf

² http://www.modbus.org/docs/Modbus_Application_Protocol_V1_1b.pdf

16 / 0x10, Write Multiple Registers:

Use this function code to set the values of multiple consecutive registers. Please refer to *MODBUS Application Protocol* for frame and response details.

23 / 0x17, Read/Write Multiple Registers:

Use this function code to set the values of- and read out one or multiple consecutive registers. Note that the registers to be set are set before the registers to be read are read. Please refer to *MODBUS Application Protocol* for frame and response details.

Registers

The table below provides an overview of the available MODBUS registers in the VG10. All writable registers can be accessed using function codes 6, 16 or 23. All readable registers can be accessed using function codes 3 or 23.

| <i>Address</i> | <i>Register</i> | <i>Access</i> |
|----------------|-------------------------|---------------|
| 0 0x0000 | Channel A Control | Read + Write |
| 1 0x0001 | Channel B Control | Read + Write |
| 2 0x0002 | Current limit | Read + Write |
| 18 0x0012 | Channel A actual vacuum | Read only |
| 19 0x0013 | Channel B actual vacuum | Read only |
| 20 0x0014 | Supply current | Read only |
| 21 0x0015 | Supply voltage | Read only |
| 22 0x0016 | Internal 5V voltage | Read only |
| 23 0x0017 | Temperature | Read only |
| 24 0x0018 | Pump speed | Read only |

0 / 0x0000, Channel A Control (Read + write)

This register allows for control of channel A. The register is split in two 8-bit fields:

| <i>Bits 15-8</i> | <i>Bits 7-0</i> |
|------------------|-----------------|
| Control mode | Target vacuum |

The control mode field must assume one of these three values:

0 / 0x00, Release. Commands the channel to release any work item and stop the pump, if not required by the other channel.

1 / 0x01, Grip. Commands the channel to build up and maintain vacuum on this channel.

2 / 0x02, Idle. Commands the channel to neither release nor grip. Workpieces may 'stick' to the channel if physically pressed towards its vacuum cups, but the VG10 will use slightly less power.

The target vacuum field sets the level of vacuum to be build up and maintained by the channel. It is used only when the control mode is 1 (0x01) / Grip. The target vacuum should be provided in % vacuum. It should never exceed 80.

Examples:

Setting the register value 0 (0x0000) will command the VG10 to release the work

item.

Setting the register value 276 (0x0128) will command the VG10 to grip at 20 % vacuum.

Setting the register value 296 (0x0128) will command the VG10 to grip at 40 % vacuum.

Setting the register value 331 (0x014B) will command the VG10 to grip at 75 % vacuum.

Setting the register value 512 (0x0200) will command the VG10 to idle the channel.

1 / 0x0001, Channel B Control (Read + write)

This register allows for control of channel B. See *0: Channel A Control* above.

2 / 0x0002, Current limit (Read + write)

Set and read the current limit. The limit is provided and must be given in mA (milliamperes). The limit is 500mA per default and should never be set above 1000 mA.

18 / 0x0012, Channel A actual vacuum (Read only)

Reads the actual vacuum on Channel A. The vacuum is provided in permille (1/1000) absolute vacuum. Please note that this differs from the setpoint given in percent, as extra accuracy is desirable on the actual vacuum.

19 / 0x0013, Channel B actual vacuum (Read only)

Same as 18, but for Channel B.

20 / 0x0014, Supply current (Read only)

Reads the actual supply current in mA (milliamperes). Use this reading for diagnostics only. Should never be used for process control.

21 / 0x0015, Supply voltage (Read only)

Reads the actual supply voltage in mV (millivolts). Use this reading for diagnostics only. Should never be used for process control.

22 / 0x0016, Internal 5V supply voltage (Read only)

Reads the actual voltage of the internal 5V supply in mV (millivolts). Use this reading for diagnostics only. Should never be used for process control.

23 / 0x0017, Temperature (Read only)

Reads the actual internal temperature in 1/100 degrees Celsius. Use this reading for diagnostics only. Should never be used for process control.

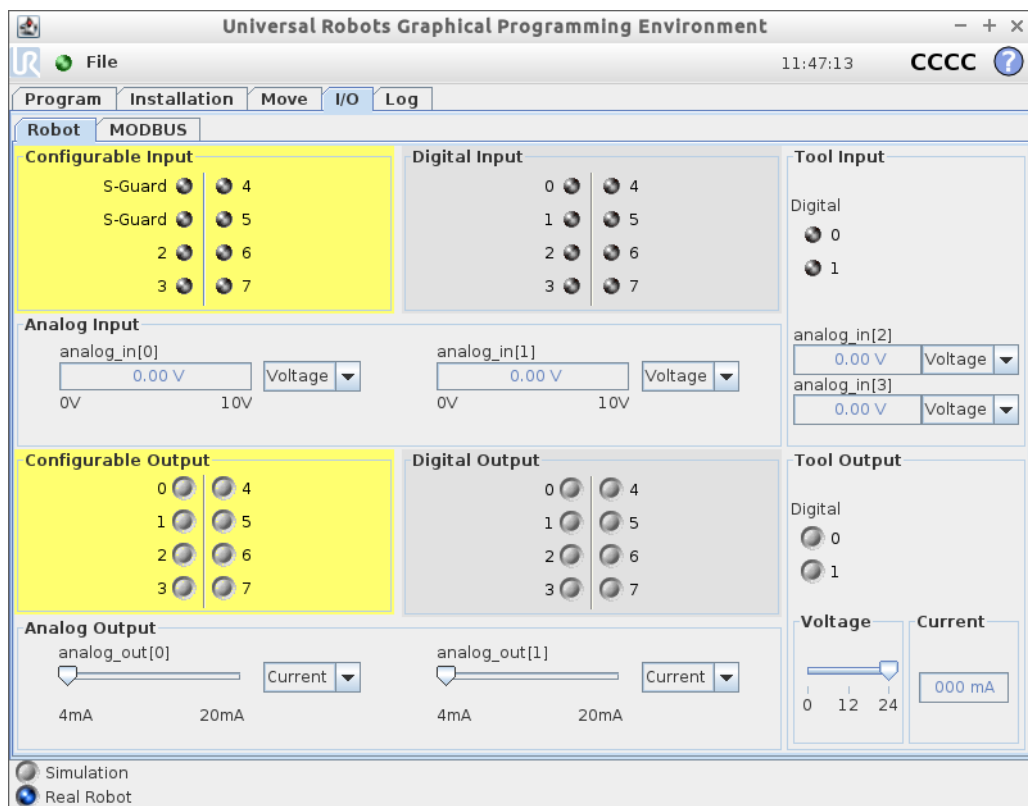
24 / 0x0018, Pump speed (Read only)

Reads the current pump motor speed in RPM (rotations per minute). Use this reading for diagnostics only. Should never be used for process control.

Manual control

It is possible to use the VG10 completely without URCAP and script commands. This is done by controlling the UR tool I/O directly, see UR tool I/O tab on the right side of the screenshot below.

The UR I/O tab provides some basic manual features:



- TAI0 = Analog_in[2] = Vacuum in channel A (1V per 10% vacuum)
- TAI1 = Analog_in[3] = Vacuum in channel B (1V per 10% vacuum)
- TO0 = Tool_digital_out[0] = On/Off control channel A (vacuum preset to 60%)
- TO1 = Tool_digital_out[1] = On/Off control channel B (vacuum preset to 60%)
- TI0 = Tool_digital_input[0] = Vacuum present channel A (Vacuum > 40%)
- TI1 = Tool_digital_input[1] = Vacuum present channel B (Vacuum > 40%)

To use the basic manual features, the following must be observed:

- Tool digital I/O **only** works **without** the URCap installed
- The tool analog input range must be set to voltage [0-10V]
- The tool voltage must be set to 24V
- Reset the VG10 by turning the tool voltage off (0V) and then on again (24V)

3 Hardware specification

General product details and environmental conditions are found in the Technical Sheet on page 4.

The arms of the VG10 can be folded to the preferred position simply by pulling in the arms. The torque needed to overcome the friction in the rotatable joints of the arm is high (6 N/m) to ensure that the arms do not move when handling 10 kg payloads.

The VG10 suction cups are grouped into two independent channels (see figure 3.1).

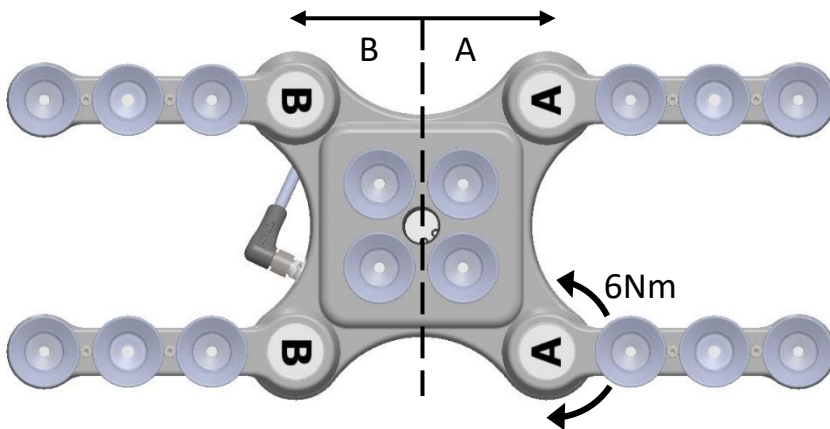


Figure 3.1: Independent vacuum zones A and B shown.

When the four arms are adjusted to preferred angles, it is recommended to add the accompanied arrow stickers. This allows for easy realignment and exchanging between different work items.



Figure 3.2: Arrow sticker shown for easy alignment.

Vacuum cups and fittings

It is possible to change suction cups simply by pulling them off the fittings. Unused holes can be blinded using a blind screw, and each fitting can be changed to a different type to match the desired suction cup. Use a 3 mm Allen key for changing to blind screws or another type of fitting (See figure 3.3 below).

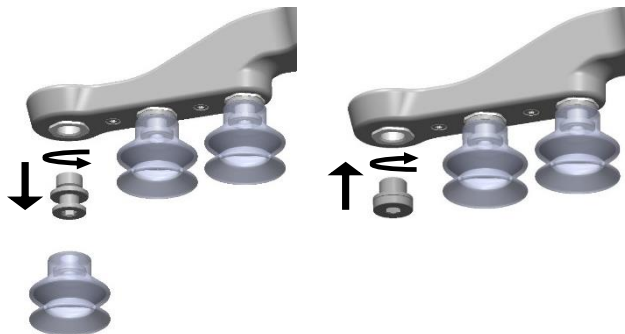


Figure 3.3: G1/8 thread behind the existing fitting.
Changing to another fitting or blind is possible.

The thread size is the commonly used G1/8"; allowing for standard fittings, blinders and extenders to be fitted directly to the VG10 arms and housing, see mechanical details in the *Mechanical Dimensions Section*.

Choosing the right vacuum cups for your application is essential. The VG10 comes with common 30 mm silicone vacuum cups which are good for hard and flat surfaces, but not good for uneven surfaces and it might leave microscopic traces of silicone on the workpiece which can cause issues with some types of painting processes afterwards. Below is a list with general recommendations.

| <i>Workpiece surface</i> | <i>Vacuum cup shape</i> | <i>Vacuum cup material</i> |
|-----------------------------|--------------------------|----------------------------|
| Hard and flat | Normal or dual lip | Silicone or NBR |
| Soft plastic or plastic bag | Special plastic bag type | Special plastic bag type |
| Hard but curved or uneven | Thin dual lip | Silicone or soft NBR |
| To be painted afterwards | Any type | NBR only |
| Varying heights | 1.5 or more bevels | Any type |

Table: Choosing a vacuum cup type



INFO

It is recommended to consult a vacuum cup specialist to find the optimal vacuum cup where the standard types are insufficient.

Payload, vacuum and air flow

The lifting capacity (payload) of the VG10 depends primarily on the following parameters:

- Suction area
- Vacuum
- Air flow

These three parameters are explained in the following subsections.

Suction area

The higher suction area, the higher lifting capacity. Be aware that the actual suction area is smaller than the outer diameter of your vacuum cups, as the vacuum cup lips forms around the workpiece, the actual suction area is reduced (see figure 3.4).

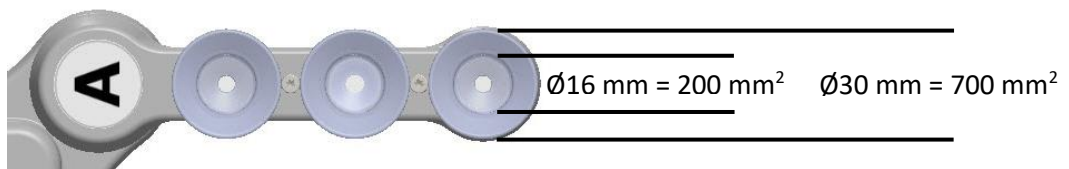


Figure 3.4: Available suction cup area for the standard Ø30 mm suction cup.

With a typical vacuum of 60% and one vacuum cup with a 200 mm² suction area, the lifting force is:

$$F_{cup} = p \cdot A = [\Delta Pa] \cdot [m^2] = 60\% \cdot 101.3kPa \cdot 10^3 \cdot 200 \text{ mm}^2 \cdot 10^{-6} = 12.2 \text{ N}$$

With this force per vacuum cup, to lift 10 kg and accelerate with 2g's, this many vacuum cups are needed:

$$\text{Number of cups} = \frac{m \cdot a}{F_{cup}} = \frac{[kg] \cdot [m/s^2]}{[N]} = \frac{10 \cdot 2 \cdot 9.81}{12.2} = 16 \text{ vacuum cups}$$

It is often a good idea to use more vacuum cups than needed, to accommodate for vibrations, leaks and other unexpected conditions. However, the more vacuum cups, the more air leakage (air flow) is expected and the more air is moved in a grip resulting in longer gripping times.

Vacuum

Vacuum is defined as the percentage of absolute vacuum achieved relative to atmospheric pressure, i.e.:

| % vacuum | Bar | kPa | inHg | Typically used for |
|----------|------------------------|-------------------------|------------------------|---|
| 0% | 0.00 rel. 1.01 abs. | 0.00 rel. 101.3 abs. | 0.0 rel. 29.9 abs. | No vacuum / No lifting capacity |
| 20% | 0.20 rel. 0.81 abs. | 20.3 rel. 81.1 abs. | 6.0 rel. 23.9 abs. | Cardboard and thin plastics |
| 40% | 0.41 rel. 0.61 abs. | 40.5 rel. 60.8 abs. | 12.0 rel. 18.0 abs. | Light workpieces and long suction cup life span |
| 60% | 0.61 rel. 0.41 abs. | 60.8 rel. 40.5 abs. | 18.0 rel. 23.9 abs. | Heavy workpieces and strongly secured grips |
| 80% | 0.81 rel. 0.20 abs. | 81.1 rel. 20.3 abs. | 23.9 rel. 6.0 abs. | Max. vacuum. Not recommended |

The vacuum percentage setting is the target vacuum. The pump will run at full speed until the target vacuum is achieved, and then run at a lower speed necessary to maintain the target vacuum.

The pressure in the atmosphere varies with weather, temperature and altitude. The VG10 automatically compensates for altitudes up to 2km, where the pressure is about 80% of sea level.

Air flow

Air flow is the amount of air that must be pumped to maintain the target vacuum. A completely tight system will not have any air flow, whereas real life applications have some smaller air leakages from two different sources:

- Leaking vacuum cup lips
- Leaking workpieces

The smallest leak under a vacuum cup can be hard to find (see figure 3.5). Choosing the right vacuum cups are essential, (*Table: Choosing a vacuum cup type*).



Figure 3.5: Visualization of leakage possibilities.

Leaking workpieces can be even harder to identify. Things that look completely tight might not be tight at all. A typical example is coarse cardboard boxes. The thin outer layer is often requiring a lot of air flow to create a pressure difference over it (see figure 3.6 below).

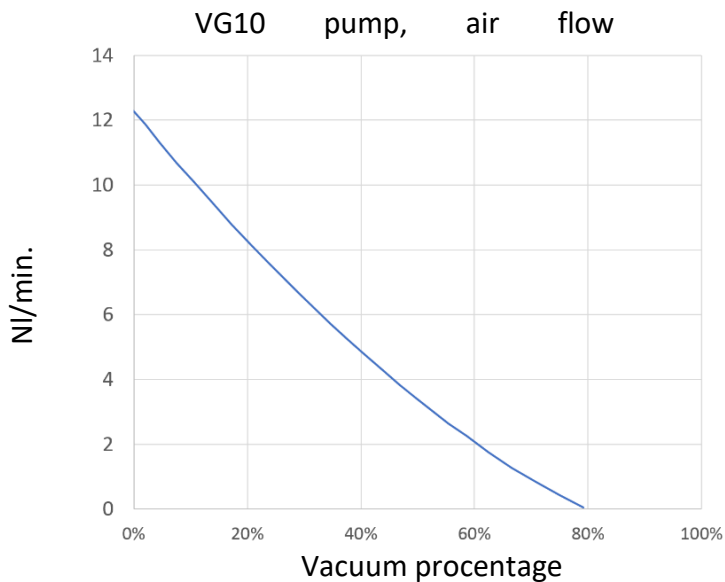


Figure 3.6: Visualization of difference in leakage through workpieces.

Therefore, the users must be aware of the following:

- VG10 **is not suitable** for most uncoated, coarse cardboard boxes.
- Extra attention must be paid to leakages, e.g. vacuum cup shape and surface roughness

The air flow capability of a VG10 is shown in the graph below:



INFO

- The easiest way to check if a cardboard box is sufficiently tight is simply to test it using the VG10.
- A high vacuum percentage setting **does not** give a higher lifting capacity on corrugated cardboard. In fact, a lower setting is recommended, e.g. 20%.
- A low vacuum setting results in less air flow and less friction below the vacuum cups. This means VG10 filters and vacuum cups will last longer.

Maintenance and repair

All maintenance and repairs must be performed in compliance with this manual, including safety instructions.

Only use original spare parts.

Filters

The VG10 is equipped with one filter for each suction cup socket, and one filter for the exhaust. How often the filters need to be changed depends on the nature of the work piece and the working environment. The VG10 automatically de-dust the filters every time a grip is released. However, particles can eventually get stuck and build up inside the filter, lowering the VG10 performance.

A filter service kit is available, which include both new filters and tools needed.

- Filter service kit, PN 17001

Neither use nor power on the VG10 without filters. Dust, hair and larger particles can get stuck in pump membranes and valve seats, causing permanent damage to the VG10.

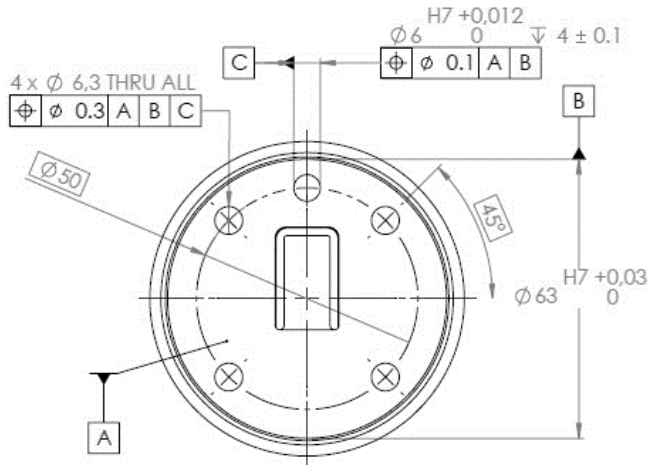


DANGER

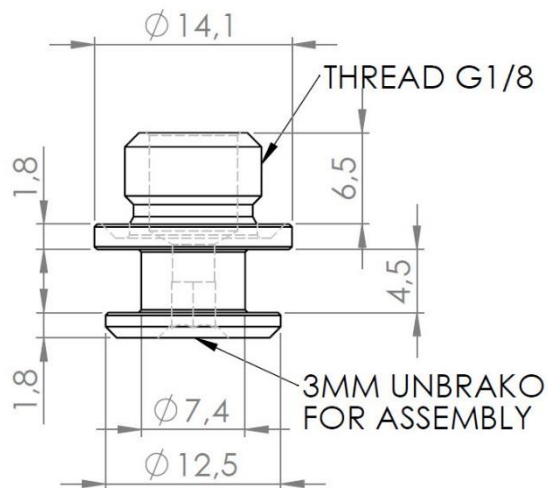
- Identify how often the filters needs service and schedule maintenance with a fixed period short enough to ensure a firm grip at all times.
- An overall inspection of the VG10 must be performed regularly and at least once every 6 months.
- Never power the VG10 without filters or with filters mounted incorrectly. Failure to comply with this precaution can cause irreversible failure of pump or valves.

Mechanical dimensions

The mechanical mounting interface on the VG10 is a standard robot flange according to ISO 9409-1, Type 50-4-M6. Dimensions and tolerances are noted in mm in the drawing below.



Dimensions of the fitting supplied with the VG10 is shown below. Other suction cups / fittings with G1/8 x 6.5 mm threading is directly compatible with the VG10.



Electrical characteristics

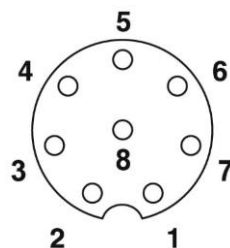
The VG10 supports a wide range of control methods, making it suitable for all of the following:

- Universal Robots – URcap, scripts and manual I/O control
- Other robots – Manual 24 V I/O control and MODBUS RTU (RS485) commands
- PLC – Manual 24 V I/O control and MODBUS RTU (RS485) commands

The connector on the VG10 is an 8-way, coding A, gold contacts as defined in IEC 61076-2-104. The following cables are compliant and recommended:

- OnRobot A/S, 200 mm male-female, PN 10071
- Phoenix contact, 200 mm male-female, PN 1416505
- Phoenix contact, 10 meter open ended PN 1404183

The 24V I/O signals in the VG10 control cable are constructed for reliable communication with robots and PLC's conforming to IEC 61131-2. Below is an overview of the signals and their respective functions:



| Pin | Color | Primary function | Alternate function | Manual function | UR I/O |
|-----|--------|-------------------|--------------------|-----------------|----------|
| 5 | Grey | +24V <600mA | +24V <1500mA | | Power |
| 8 | Red | GND / 0V / Shield | | | 0V/GND |
| 7 | Blue | Data input (npn) | Data input (pnp) | CHA On/Off | DO8/TO 0 |
| 6 | Pink | Data input (npn) | Data input (pnp) | CHB On/Off | DO9/TO 1 |
| 4 | Yellow | Data output (pnp) | | CHA vacuum OK | DI8/TI0 |
| 3 | Green | Data output (pnp) | | CHB vacuum OK | DI9/TI1 |
| 1 | White | Analog output | MODBUS RS485 (-) | CHA vacuum % | AI2 |
| 2 | Brown | Analog output | MODBUS RS485 (+) | CHB vacuum % | AI3 |

By default, the VG10 support basic manual control through simple 24V PLC I/Os, see manual control on page 17. OnRobot A/S continuously improve guidance and features for different robot manufacturers; find more on www.onrobot.com.

4 Safety

The robot integrators are responsible for ensuring that the applicable safety laws and regulations in the country concerned are observed and that any significant hazards in the complete robot application are eliminated. This includes, but is not limited to:

- Performing a risk assessment for the complete robot system
- Interfacing other machines and additional safety devices if defined by the risk assessment
- Setting up the appropriate safety settings in the robot software
- Ensuring that the user will not modify any safety measures
- Validating that the total robot system is designed and installed correctly
- Specifying instructions for use
- Marking the robot installation with relevant signs and contact information of the integrator
- Collecting all documentation in a technical file; including the risk assessment and this manual

Intended use

The VG10 is intended to be used as end-of-arm tooling on industrial robots with payloads up to 10 kg, in industrial pick-and-place, palletizing and machine tending applications. The VG10 should only operate under conditions noted in the *Technical Sheet*.

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

- Use in potentially explosive atmospheres
- Use in medical and life critical applications
- Use before performing a risk assessment
- Use outside the permissible operational conditions and specifications
- Use close to a human's head, face and eye area
- Use as a climbing aid

The VG10 is equipped with features that are only available when integrated with a Universal Robot. Please contact your supplier for additional installation guidance if used with other types of robots.

Risk assessment

The robot integrator must perform a risk assessment on the complete robot application. The VG10 is only a component in a robot application and the safe use of the VG10 rely on the integrators ability to design a safe robot application.

The VG10 is designed with features especially suitable for collaborative applications:

VG10 User Manual 1.1.1

- Smooth and round design without any sharp edges or pinch points. Radius 2 mm or higher.
- Friction clutch in all four arms makes them able to turn under a hard collision. Torque approx. 6 N/m. (Patent pending)
- Valves stays in the grip position under emergency stop, which can prevent a work item from flying out of the VG10. Vacuum is typically lost after a few seconds.
- The build-in tool changer is oversized and based on a redundant locking mechanism. (Patent pending)

In collaborative applications the trajectory of robot can play a significant safety role. The integrator must consider the angle of contact with a human body, e.g. orientate the VG10 and work item so that the contact surface in the direction of movement is as large as possible, and so that tool connectors are pointed in the direction opposite to the movement. It is recommended to orientate the VG10 arms perpendicular to the direction of movement to make them able to move under a hard collision.

OnRobot A/S have identified the potential hazards listed below as significant hazards that must be considered by the integrator:

- Objects flying from the VG10 due to loss of grip
- Objects falling down from the VG10 due to loss of grip
- Injuries due to collisions between humans and work items, VG10, robot or other obstacles
- Consequences due to loosen bolts
- Consequences if the VG10 cable gets stuck to something
- Operation with the robot half of the tool changer mounted, but without the VG10 clicked on

It is recommended that the VG10 is integrated in compliance with in the following guides and standards:

- ISO 10218-2
- ISO 12100
- ISO/TR 20218-1
- ISO/TS 15066

Environmental safety

OnRobot A/S products must be disposed of in accordance with the applicable national laws, regulations and standards.

The product is produced with restricted use of hazardous substances to protect the environment; as defined by the EU RoHS directive 2011/65/EU. These substances include mercury, cadmium, lead, chromium VI, polybrominated biphenyls and polybrominated diphenyl ethers.

Observe national [registration](#) requirements for importers according to EU WEEE Directive 2012/19/EU.



General safety instructions

Generally, all national regulations, legislations and laws in the country of installation must be observed. Integration and use of the product must be done in compliance with precautions in this manual. Particular attention must be paid to the following warnings:



DANGER

- You must read, understand and follow all safety information in this manual, and the robot manual and all associated equipment before initiating robot motion. Failure to comply with safety information could result in death or serious injury.
- Robot applications must be constructed in such way that a loss of grip, for whatever reason, does not result in any injury to humans or animals.
- Identify how often the filters needs service and schedule maintenance with a fixed period short enough to ensure a firm grip at all times. An overall inspection of the VG10 must be performed regularly and at least once every 6 months.
- Bolts that are insufficiently secured or repetitive overloads can cause the product to separate unexpectedly.
- The VG10 must not be used for collaborative applications where the work item itself represents a hazard. Necessary measures must be taken to avoid changes in work items which has not been addressed by the risk assessment.
- The information in this manual does not cover designing, installing and operating a complete robot application, nor does it cover other peripheral equipment that can influence the safety of the complete system. The complete system must be designed and installed in accordance with the safety requirements set forth in the standards and regulations of the country where the robot is installed.
- Any safety information provided in this manual must not be construed as a warranty, by OnRobot A/S, that the robot application will not cause injury or damage, even if robot application complies with all safety instructions.
- OnRobot A/S disclaims any and all liability if the VG10 is damaged, changed or modified in any way. OnRobot A/S cannot be held responsible for any damages caused to the VG10, the robot or any other equipment due to programming errors or malfunctioning of the VG10.

5 Warranties

Patents

The VG10 and other products of OnRobot A/S are protected by several patents; some still in global publication process (Patents pending). All manufacturers of copies and similar products violating any patent claims will be prosecuted.

Product warranty

Without prejudice to any claim the user (customer) may have in relation to the dealer or retailer, the customer shall be granted a manufacturer's warranty under the conditions set out below:

In the case of new devices and their components exhibiting defects resulting from manufacturing and/or material faults within 12 months of entry into service (maximum of 15 months from shipment), OnRobot A/S shall provide the necessary spare parts, while the customer (user) shall provide working hours to replace the spare parts, either replace the part with another part reflecting the current state of the art, or repair the said part. This warranty shall be invalid if the device defect is attributable to improper treatment and/or failure to comply with information contained in the user guides. This warranty shall not apply to or extend to services performed by the authorized dealer or the customer themselves (e.g. installation, configuration, software downloads). The purchase receipt, together with the date of purchase, shall be required as evidence for invoking the warranty. Claims under the warranty must be submitted within two months of the warranty default becoming evident. Ownership of devices or components replaced by and returned to OnRobot A/S shall vest in OnRobot A/S. Any other claims resulting out of or in connection with the device shall be excluded from this warranty. Nothing in this warranty shall attempt to limit or exclude a customer's statutory rights nor the manufacturer's liability for death or personal injury resulting from its negligence. The duration of the warranty shall not be extended by services rendered under the terms of the warranty. Insofar as no warranty default exists, OnRobot A/S reserves the right to charge the customer for replacement or repair. The above provisions do not imply a change in the burden of proof to the detriment of the customer. In case of a device exhibiting defects, OnRobot A/S shall not be liable for any indirect, incidental, special or consequential damages, including but not limited to, lost profits, loss of use, loss of production or damage to other production equipment.

In case of a device exhibiting defects, OnRobot A/S shall not cover any consequential damage or loss, such as loss of production or damage to other production equipment.

Disclaimer

OnRobot A/S continues to improve reliability and performance of its products, and therefore reserves the right to upgrade the product without prior warning. OnRobot A/S ensures that the content of this manual is precise and correct but takes no responsibility for any errors or missing information.

6 Certifications

Declarations, certificates and applied standards are listed in this chapter.

Applied standards

Standards applied under development of the product is listed in this section. When an EU Directive number is noted in brackets it indicates that the standard is harmonized under that Directive.

ISO 12100:2010

EN ISO 12100:2010 (E) [2006/42/EC]

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

The product is evaluated according to the principles of these standards.

ISO 10218-2:2011

EN ISO 10218-2:2011(E) [2006/42/EC]

ANSI/RIA R15.06-2012

CAN/CSA-Z434-14

Robots and robotic devices – Safety requirements for industrial robots

Part 2: Robot systems and integration

The product is prepared for compliance with robot system requirements defined in these standards.

ISO/TS 15066:2016

RIA TR R15.606

Robots and robotic devices – Safety requirements for industrial robots – Collaborative operation

This is a Technical Specification (TS), **not** a standard. The product is prepared for easy integration in compliance with provisions in this Technical Specification, see more in the safety chapter.

ISO/TR 20218-1:2018

Robotics – Safety requirements for industrial robots

Part 1: Industrial robot system end of arm tooling (end-effector)

This is a Technical Report (TR), **not** a standard. The product is designed according to principles in this Technical Report.

ISO 9409-1:2004 [Type 50-4-M6]

Manipulating industrial robots – Mechanical interfaces

The flange and tool changer on the VG10 conforms to type 50-4-M6 of this standard. Robots should also be constructed according to this standard to ensure proper fitting.

IEC 60529:2013

EN 60529/A2:2013

Degrees of protection provided by enclosures (IP Code)

This standard defines enclosure ratings regarding protection against dust and water. VG10 is designed and classified with an IP rating according to this standard, see VG10 sticker.

IEC 61131-2:2007 (E)

EN 61131-2:2007 [2004/108/EC]

Programmable controllers

Part 2: Equipment requirements and tests

24V I/O signals in the VG10 control cable are constructed for reliable communication with robots and PLC's conforming to these standards.

IEC 61076-2-104:2014 [8-way, coding A, gold contacts]

EN 61076-2-104:2014 [8-way, coding A, gold contacts]

Connectors for electronic equipment

Part 2-104: Circular connectors – Detail specification for circular connectors with M8 screw- or snap-locking

Both the VG10 connector and the cable conforms to type 8-way, coding A, gold contacts, which is the highest quality rating defined in this standard. Mating operations: 100 times.

ISO 13732-1:2006

EN ISO 13732-1:2008 [2006/42/EC]

Ergonomics of the thermal environment – Methods for the assessment of human responses to contact with surfaces

Part 1: Hot surfaces

The product is designed so that the surface temperature is kept under the ergonomic limits defined in this standard.

IEC 61000-6-2:2005

IEC 61000-6-4/A1:2010

EN 61000-6-2:2005 [2004/108/EC]

EN 61000-6-4/A1:2011 [2004/108/EC]

Electromagnetic compatibility (EMC)

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

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

The product is evaluated according to these standards.

IEC 60068-2-1:2007

IEC 60068-2-2:2007

IEC 60068-2-27:2008

IEC 60068-2-64:2008

EN 60068-2-1:2007

EN 60068-2-2:2007

EN 60068-2-27:2009

EN 60068-2-64:2008

Environmental testing

Part 2-1: Tests - Test A: Cold

Part 2-2: Tests - Test B: Dry heat

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

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

The product is designed to pass tests defined in these standards.

IEC 60664-1:2007

IEC 60664-5:2007

EN 60664-1:2007 [2006/95/EC]

EN 60664-5:2007

Insulation coordination for equipment within low-voltage systems

Part 1: Principles, requirements and tests

Part 5: Comprehensive method for determining clearances and creepage distances equal to or less than 2 mm

The electrical circuitry of the product is designed in compliance with these standards.

UL 1740:2018, edition 4

Standard for Robots and Robotic Equipment

The product is designed to meet the requirements in both this and other relevant UL standards. For more information about UL compliance and field certification in US, contact your supplier.

CE/EU Declaration of incorporation (Original)

According to European Machinery Directive 2006/42/EC annex II 1.B.

The manufacturer:

OnRobot A/S
Teglværskvej 47H
DK-5220, Odense SØ
DENMARK

declares that the product:

| | |
|-------------|--------------------------|
| Type: | Industrial Robot Gripper |
| Model: | VG10 Vacuum Gripper |
| Generation: | G1 |
| Serial: | 1000000000 - 1009999999 |

may not be put into service before the machinery in which it will be incorporated is declared in conformity with the provisions of Directive 2006/42/EC, including amendments, and with the regulations transposing it into national law.

The product is prepared for compliance with all essential requirements of Directive 2006/42/EC under the correct incorporation conditions, see instructions and guidance in this manual. Compliance with all essential requirements of Directive 2006/42/EC relies on the specific robot installation and the final risk assessment.

Technical documentation is compiled according to Directive 2006/42/EC annex VII part B and available in electronic form to national authorities upon legitimate request. Undersigned is based on the manufacturer address and authorized to compile this documentation.

Additionally, the product declares in conformity with the following directives, according to which the product is CE marked:

2014/30/EU — Electromagnetic Compatibility Directive (EMC)
2011/65/EU — Restriction of the use of certain hazardous substances (RoHS)

Relevant essential health and safety requirements of the following EU directives are also applied:

2014/35/EU — Low Voltage Directive (LVD)
2012/19/EU — Waste of Electrical and Electronic Equipment (WEEE)

A list of applied harmonized standards, including associated specifications, is provided in this manual.

Odense, January 2nd, 2019

Corporate Management



Niels Degn
Chief Technology Officer

