

VertiDrive V400 Series Robot

User Manual

This is the original English manual to be used by VertiDrive on-site user training certified operators.



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APPLIES TO: VertiDrive V400 Series robot

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FOREWORD

This manual is written to inform you, as a user, how to work safely with our product. The manual provides information on the level of a technical specialist. The system should not be operated by unauthorized personnel or technical specialists without training.

Read and fully understand these instructions before using the equipment. Make sure all security recommendations and precautions have been read and understood. Also, read the security recommendations of complementary supplier's documents. The users remain responsible for supervision and compliance with this manual.

This manual applies to the "V400 Series Robot". Upon request, different tools for the V400 Series robot are available, such as a safety winch system. Contact the support department of VertiDrive B.V. for more information.

As a manufacturer, we strongly recommend to:

- Contact VertiDrive B.V. for urgent questions.
- Keep the manual in a dry, safe, and available place for everyone who is involved.
- Keep all security marks on the system visible, replace them if needed.

Equipment supplied by VertiDrive B.V., to which the machine directive is applicable, complies with the EU declaration of conformity.

Contents of manual

This manual contains the following subjects:

- Product specification.
- Product certification.
- Safety information.
- System description.
- Installation instructions.
- Operation instructions.
- Maintenance instructions.
- Storage and transport instructions.

Notice

All applicable procedures, described in this manual, have been verified by VertiDrive B.V. The provided images are meant to represent the actual product, but the image content may vary from reality.

Revision history

Rev. No.	Issue Date	Description	Created	Checked
1.0	02-06-2023	The first release for the new V400 Series robot	YVE	MVP
1.1	20-06-2023	Minor modification section 9.4 and residual risks implementation	YVE	MVP
1.2	22-08-2023	Vacuum adjustment 8.1.8 updated	MVP	GVE
1.3	27-09-2023	Rearrangement chapter 4	MVP	GVE

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1. CONTACT INFORMATION

1.1. Supplier

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2. TERMS AND DEFINITIONS

The following definitions, abbreviations, and units are used in this manual.

Definition	Description
Emergency shut-off	A stop button that ensures a safe situation when activated.
Jetting area	This is the area where the cleaning is carried out and where people are exposed to the water jets or jetting components.
Nozzle	A head with one or more discharge openings through which the water jet spray emerges.
Ultra-high-pressure water jetting system	A system that consists of a pump, hoses, and high-pressure jetting equipment, which can jet water under ultra-high pressures of more than 2000 bar.
Ultra-high-pressure water blasting	A process of smoothing or cleaning a surface using ultra-high-pressure water jets.
Whip check	A safety cable, used on high-pressure air or water hoses to prevent the hoses from flying around if the connection inadvertently separates.

Abbreviation	Description
CE	Conformité Européenne: CE marking ensures that the product is manufactured according to European standards.
EN	European Norm: A set of unified standards for products, services, testing procedures, or systems recognized by the European Union.
IP	Ingress Protection: The IP code indicates how well a device is protected against water and dust.
LMRA	Last-Minute Risk Analysis: This is a short assessment performed immediately before the start of work to identify and exclude all potential safety, health, and environmental hazards at the workplace.
PPE	Personal Protective Equipment: Anything a worker uses or wears to keep them healthy and safe.
UHP	Ultra-High Pressure: Refers to ultra-high pressure water jetting. Working pressures from 2000 bar and up.

Unit	Description
°C	Degrees Celsius.
°F	Degrees Fahrenheit.
A	Ampere; SI unit of electrical current.
bar	Unit of pressure; 1 bar = 100,000 Pa (pascals).
cm	Centimeter = 0.01m.
dB(A)	Decibels (absolute); a weighted scale for judging loudness that corresponds to the hearing threshold of the human ear.
Hz	Hertz, SI unit of frequency of one cycle per second.
kg	Kilogram.
m	Meter; SI unit for length.
mm	Millimeter = 0.001m.
V	Volt; SI unit for electric potential difference.

3. MACHINE SPECIFICATION

3.1. General specifications

Product description: V400 Series.
Country of origin: The Netherlands.

3.2. CE marking and identification

The product has a CE mark, to indicate that it complies with the fundamental safety and health requirements as written in the EU Declaration of Conformity.

The mark is located on the type plate, placed on the robot at the location shown below as well as on the inside of the door of the control box. The type plate also shows the unique identification number of the robot, the year of manufacture, and the electrical specification.



CE mark V400 Series on robot and control box

3.3. Technical specifications

Robot

Robot dimensions l x w x h: 900 x 990 x 420 mm.
 Weight: 88 kg.
 Payload capacity: 150 kg max.
 Driving speed: max 5 m/min.

Umbilical

Umbilical dimensions: ø18mm, length 50 m.
 Umbilical weight: 25 kg (0.5 kg / m).
 Umbilical extension: Max 100m (use 2nd 322035 umbilical + 323018 extension kit).

Control box (CB4.0)

Dimensions h x w x d: 600 x 600 x 260 mm (600 x 690 x 260 mm with cooling).
 Weight: 35 kg (44 kg for 'high temperature' systems with cooling).

Electrical specifications

Input voltage range:	230V systems: 200-240 VAC, 120V systems: 100-120 VAC.
Input frequency range:	50/60 Hz.
Input current (without cooling):	230V systems: 5A, 120V systems: 10A.
Input current (with cooling):	230V systems: 7A, 120V systems: 14A.
Output voltage to the robot:	70 VDC (motors) and 24 VDC (logic).
Remote control system:	Hetronic Nova XL.
Range remote control:	100 meters.

UHP application specifications

Maximum operating pressure:	3000 bar (43500 psi).
Maximum flow rate:	45 l/min (12 gal/min).
Maximum rotation speed (nozzle cross):	3000 rpm.
Cleaning width:	400 mm.
Vacuum pressure:	-150 to -200 mbar (-2.2 to 2.9 psi) typical, -250 mbar (3.6 psi) max.
Vacuum airflow:	1000 – 1300 m ³ /hr (590 – 765 cfm) typical.

Environmental conditions

Working temperature (without cooling):	-20 to +35°C (0 to +95°F).
Working temperature (with cooling):	-20 to +50°C (0 to +120°F).
Storage temperature:	-40 to +85°C (-40 to +185°F).
IP rating robot:	IP65.
IP rating control box:	IP66.
IP rating remote control:	IP66.

3.4. Documentation

V400 Series robot system (standard)
User Manual VertiDrive V400 Series robot (supplied with robot system).
Control system wiring diagram (supplied with control box).
322025 V400 Series Robot – IPM (Illustrated Parts Manual).
3.4 F-03 Startup Checklist.
3.4 F-04 Inspection and Maintenance Schedule.
V400 Series ancillary equipment (optional)
Optional: Transport frame - User Manual and IPM.
Optional: Vacuum system – User Manual.

4. PRODUCT CONFORMITY AND LIABILITY

4.1. General

The VertiDrive V400 Series fulfills all relevant requirements to be used safely. To achieve this, important safety instructions are described in this manual that must be followed throughout the whole lifecycle of the product.

See the EU Declaration of Conformity, appendix A to this document, for details on directives and standards used. The original Declaration of Conformity (DoC) and the full Technical Construction File (TCF) are held at the manufacturer's office in Rotterdam.

4.2. Intended and non-intended use of the machine

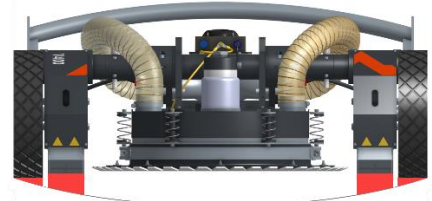
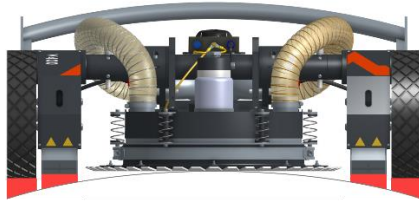
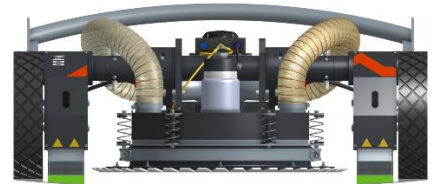
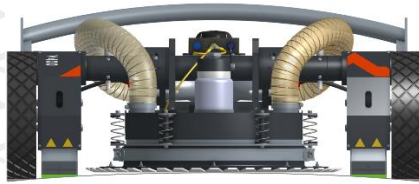
The VertiDrive V400 Series robot is a remote-controlled vehicle that uses powerful permanent magnets to adhere to steel surfaces. This permanent adhesion allows operation on flat or slightly curved steel surfaces at any angle, e.g., vertically to, or underneath a horizontal surface (upside down). The robot is designed for surface treatment. The possibilities and limitations are shown in this document.

By intended use means that the operations on this system must be carried out following the instructions given in this manual and other ancillary equipment manual(s). Tools and materials used for this purpose must be applicable to this product and approved by VertiDrive.

Only trained and certified personnel who are duly qualified are authorized to operate the system. Before the use of the robot, VertiDrive and/or an authorized VertiDrive representative / trainer will demonstrate the product and provide training on the safe use of the robot and equipment. Participants receive a signed and dated certificate of participation, which is obligatory to operate and/or maintain the robot. The minimum operator age is 18.

Maintenance engineers must be instructed by VertiDrive or an authorized VertiDrive representative. VertiDrive maintenance instructions and procedures must be adhered to.

- The robot is explicitly **NOT** suitable for carrying people and/or objects.
- The working **surface must be ferritic** to provide sufficient adhesion of the permanent magnets. The metal thickness of the working surface needs to be a minimum of **8 mm**. Lower values will decrease the holding force of the permanent magnets and increase the risk of the robot getting detached from the surface.
- For optimal adhesion, the distance between the magnets and metal should not exceed the boundary conditions described in this document. VertiDrive advises using the default configuration when possible.
- Coating thickness and/or surface contamination can affect the holding force. Before starting an operation, the holding force of the robot must always be checked.
- The magnets are temperature sensitive and will lose holding force when exposed to elevated temperatures. The robot is **NOT** suitable for applications that result in a magnet temperature above **80° C (175° F)**. Do **NOT** use the robot on hot surfaces (> 80°C) or in applications where the robot is directly exposed to temperatures above the **80°C** limit.
- Pay attention when driving on curved surfaces. The robot is designed for flat and large-radius curved surfaces only. The robot can handle certain curved surfaces as instructed by authorized VertiDrive personnel. The exact limits are application and situation-dependent. Practical instruction on how to avoid and /or cope with curved surfaces is explained during (mandatory) training.



Driving on a surface with a radius

4.3. Responsibilities for owner and user

Any changes made to the VertiDrive V400 Series robot may lead to severe damage and injury to the operator or other personnel in the vicinity of the robot.

The VertiDrive V400 Series robot must not be changed in any way without the written permission of VertiDrive B.V. The risks and consequences related to adaptations are explicitly excluded from the responsibility of VertiDrive B.V.

VertiDrive B.V. cannot be held responsible for failures or any damage caused by improper use of the equipment, or overdue maintenance. Personnel will always remain responsible for their actions and the consequential results.

4.4. Warranty

Delivery takes place according to the delivery terms specified in "Terms and conditions of the Metaalunie," which were applicable during the conclusion of the agreement.

4.5. Liability

Liability takes place in accordance with the delivery conditions stated in "Terms and conditions of the Metaalunie," which were applicable during the conclusion of the agreement.

5. SAFETY

Safety instructions in this manual are based on risk assessment according to the EU Machine Directive 2006/42/EC and [SIR](#) (Stichting Industriële Reiniging), the Foundation for Industrial Cleaning) guidelines. SIR guidelines are based on the Dutch and Belgian legislation and regulations, plus the European Regulation (EU) 2016/425 of the European Parliament and the Council dated 9 March 2016 regarding personal protection equipment (superseding European directive 89/656/EEC).

5.1. Symbols in this document

Below is an explanation of the symbols used in this document to draw the reader's attention to specific situations.



DANGER OF LIFE!
The life of the user is at risk.



DANGER!
There is a risk that the user gets (seriously) injured and/or the system incurs severe damage. This warning alludes to the risk that occurs if the user does not follow the procedures in this manual carefully.



CAUTION!
The system may be damaged if it is used or operated incorrectly.



ATTENTION!
The remark gives additional information concerning the occurrence of potential problems.



It is important to read these instructions.

5.2. Safety signs on the system



Meaning: High voltage.
Risk: Electrical hazard (electrical shock).
Location: Control box (when opened).



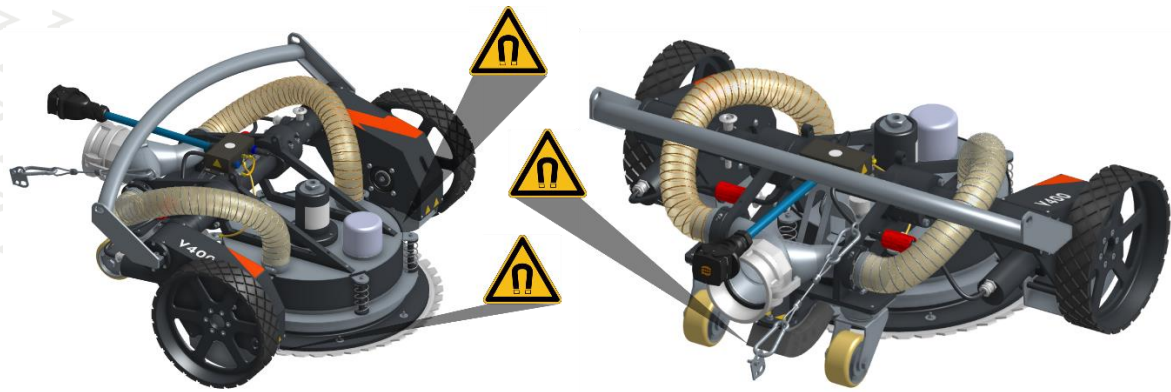
Meaning: Strong magnetic field.
Risk: Magnets produce a far-reaching, strong magnetic field. They could damage any devices that are sensitive to magnetism (e.g., phones, watches, credit cards, etc.)
Location: In between the front and back wheels, see figure below.



Meaning: Pinch point.
Risk: Pinching of hands or fingers due to moving parts.
Location: Near the vacuum shroud tilt brackets, near the front and back magnets.



Meaning: Danger for pacemakers and implanted heart defibrillators
Risk: The strong magnetic field near the robot can affect the functioning of pacemakers and implanted heart defibrillators.
Location: At close distance from the robot.



Locations of the magnetism

5.3. General safety instructions

The V400 Series robot complies with the fundamental safety and health requirements laid down in the relevant European Union guidelines. However, careless, or inexperienced use may lead to dangerous situations.

Always follow the safety rules as defined by local law and/or the company for which you are working. Local safety rules must always be followed in the first place. Please inform your supervisor in case there are contradictions to the safety warnings and instructions given in this user manual.

The operator must be VertiDrive (or partner(s)) trained **and** certified to use the robot. All safety precautions and instructions relevant to UHP hydro-blast equipment must be adhered to.

Always observe the following general safety instructions:

5.3.1. Job functions, tasks, certification, and team line-up

Operator

- Trained, educated, and certified according to local requirements for Robot and UHP hydro-blast equipment.
- VertiDrive certified (or partner(s)).
- Operates the robot from outside the jetting area.
- Operates the emergency shut-off on the robot.

Pump engineer

- Trained, educated, and certified according to local requirements.
- Monitors the proper operation of the pumping unit and supply of high-pressure water.
- Operates the emergency shut-off on the high-pressure system.
- Monitors the jetting area and is in visual and/or audio contact with the operator.

5.3.2. Before starting

Always perform an LMRA in the following three steps:

- **Recognizing potential dangers** that could be present despite all the measures taken.
Employees should first ask themselves if they are risking exposure to these dangers. They must not start the work if they believe the risks are unacceptable.
- **Thinking up solutions or measures** to remove the perceived risks or make them acceptable.
- **Taking measures to let them carry out their work activities safely.** The employee carries out the required control measures to eliminate or control the dangers. If necessary, they should ask for help in achieving this.

An LMRA never stops. It is a continuous awareness of the steps before performing a task or following a procedure. Always secure the robot against falling with appropriate and certified fall arrest equipment.

When the robot does fall it may hit other objects, obstacles, or humans. Any consequent damage, injuries, or cost resulting from inappropriate use and/or falling of the robot is NOT the responsibility of VertiDrive. VertiDrive cannot be held liable for damages, injuries, or costs resulting from inappropriate use.

Before usage, mark an area- with a yellow/black ribbon to ensure a distance to the robot of at least 6 meters. This area should not be entered without the operator's permission and never when the robot is operating. Ensure proper warnings by placing visual signage where necessary.

Caution should be taken when plugging and unplugging the power supply. Appropriate and approved power cables must be used.

Before the use of the VertiDrive V400 Series robot, the user/operator must perform a check, see 3.4 F-03 Startup Checklist. Initial training of users/operators is provided by VertiDrive and or VertiDrive certified trainers, upon delivery of a new robot.

The robot can ONLY be used on a magnetic surface (steel), the reaction force of the application can cause that the robot detaches from the surface! The magnets will prevent this when it is placed on a magnetic surface and allow for safe operation.

The UHP hydro-blast equipment on the robot will make a loud noise. Always use appropriate hearing protection.

To decrease the weight to be carried by the robot, the umbilical cable, and hoses can be attached to a winch safety line. See the VertiDrive transport frame manual for details and safety information.

5.3.3. During operation

- Always keep visual contact with the robot during usage.
- Never enter the area directly underneath the robot, keep a minimum 6-meter distance. **Be aware: If the robot falls it may swing towards the operator and or other people in the vicinity.**
- Always use protective clothing and appropriate facial protection.
- Before approaching the robot or when in close vicinity make sure the power is safely turned off by pushing the red emergency stop button on either the remote control or the control box.
- When the robot system is NOT in use always switch power off (main switch on control box).
- Ensure that the operator is not distracted while operating.
- Keep at least 6 6-meter distance from the robot when activated (yellow system status LED on).
- Always pay attention to the umbilical and hoses on the floor, as these present a risk of tripping.

5.3.4. During maintenance/service

- Always unplug the main power cable to the control box before starting any maintenance or service activity.
- When working on the robot extra caution should be taken to avoid proximity and more specifically direct contact between steel tools and the magnets. The magnets are extremely strong and can result in extremely high attraction forces on the steel tools. When body parts are trapped between the tool and the magnet, this can cause serious injuries. Use non-magnetic tools when possible.
- Ensure a safe distance between the magnets and any sensitive electronic and mechanical equipment like cell phones, watches, and (bank) cards with magnetic strips.

5.4. Safety provisions

5.4.1. Emergency stop

Dangerous or undesirable situations may arise during the usage of the robot. A minimum of two emergency stops are provided to immediately stop the operation and provide a safe situation:

- For the robot system, one emergency stop is available on the remote control and a second emergency stop is placed on the control box. Activating either of these two emergency stops will immediately stop all robot movements and the signal to the pump will be deactivated.
- A separate emergency shut-off must be available on the high-pressure water system.

Depending on the working method and the circumstances, the emergency stops may be operated by the pump engineer, operator, or additional emergency stop operator. Always follow instructions as provided by the equipment supplier.

The emergency stops on the remote control and the control box:

- Stops all movements of the robot.
- The adhesion of the robot to the surface will not be influenced (due to the use of permanent magnets).

The emergency stops on the high-pressure system:

- Shuts off the high-pressure supply to the robot.

5.4.2. Wall contact sensor (WCS)

The robot is equipped with a wall contact switch. In case the robot loses contact with the (steel) surface, the wall contact switch acts as an emergency shut-off for the robot system. For safe operation, this event must trigger the emergency stop of the pump as well. Refer to the chapter "Installation" for how to connect the robot control system to the pump. VertiDrive strongly recommends always integrating the pump control, including safety stop, with the robot control system.

5.4.3. Whip checks



For machine operator protection whip-checks must be used on the UHP hydro-blast hoses to prevent hoses from becoming fully detached from the machine and flying around if the connection inadvertently separates. These whip-checks can be supplied by VertiDrive, or by a third party.

5.5. Hearing protection


The UHP hydro-blast equipment of the V400 Series robot will create significant noise: If the process causes a noise level that exceeds 80 dB(A), the operation and any other personnel in the vicinity of the robot should wear hearing protection.

5.6. Risk for personal injury




5.6.1. Electrocution / Electric shock

Where	When	Precaution	Warning sign / Action sign
Control box.	When the control box is opened for maintenance or troubleshooting.	Always disconnect the main power cord.	
All electric cables.	When moving the cables around.	Always disconnect the main power cord.	


5.6.2. Electrical safety earth

Where	When	Precaution	Warning sign / Action sign
Control box.	Always.	Never make any changes to the control box and ensure the power supply has a proper earth connection.	



5.6.3. Cuts, injuries on head and feet

Where	When	Precaution	Warning sign / Action sign
Near robot.	Always.	Wear safety boots.	
Near/underneath the robot.	During the operation of the robot.	Wear a safety helmet.	
Handling robot.	During the handling of the robot.	Wear protective gloves.	



5.6.4. Injuries on the face and eyes

Where	When	Precaution	Warning sign / Action sign
Near robot UHP hydro-blast equipment.	During operation with UHP hydro-blast equipment.	Keep at least 6 meters distance.	


5.6.5. Hearing damage

Where	When	Precaution	Warning sign / Action sign
Near robot UHP hydro-blast equipment.	During operation with UHP hydro-blast equipment.	Wear hearing protection. Always when the noise level exceeds 80 dB(A).	 



5.6.6. Liquid injection by UHP water jet

Where	When	Precaution	Warning sign / Action sign
Near robot, hoses, and UHP pump.	During operation with UHP hydro-blast equipment.	Wear protective clothing.	 

5.6.7. Crushing hand

Where	When	Precaution	Warning sign / Action sign
Near moving parts of the robot.	During magnet adjustment and robot movement.	Keep clear of all moving parts, and power of system for any maintenance or service activity.	

5.6.8. Magnetism

Where	When	Precaution	Warning sign / Action sign
Near magnets.	During handling, adjustment & maintenance.	Use non-magnetic tools, when possible, and keep a safe distance from magnets and/or shield magnets with e.g., a wooden cover.	
Near magnets	Always.	Do not approach the robot if you have a pacemaker or implanted heart defibrillator. Keep a minimum 60 cm distance.	

6. SYSTEM DESCRIPTION

6.1. General

The VertiDrive V400 Series robot is a remote-controlled vehicle containing strong permanent magnets that can work on flat or slightly curved steel surfaces at any angle, e.g., vertically, or underneath a horizontal surface (upside down). The robot is equipped with UHP hydro-blast equipment and is typically used for various degrees of surface cleaning and surface preparation. The system consists of the robot, a (50m) umbilical cable, and a control box with a remote control. This chapter describes all system components in detail.

VertiDrive also offers options like a transport frame and a winch system. These products are only briefly mentioned in this manual. For further details, please refer to the respective user manuals.

6.2. V400 Series robot



V400 Series robot

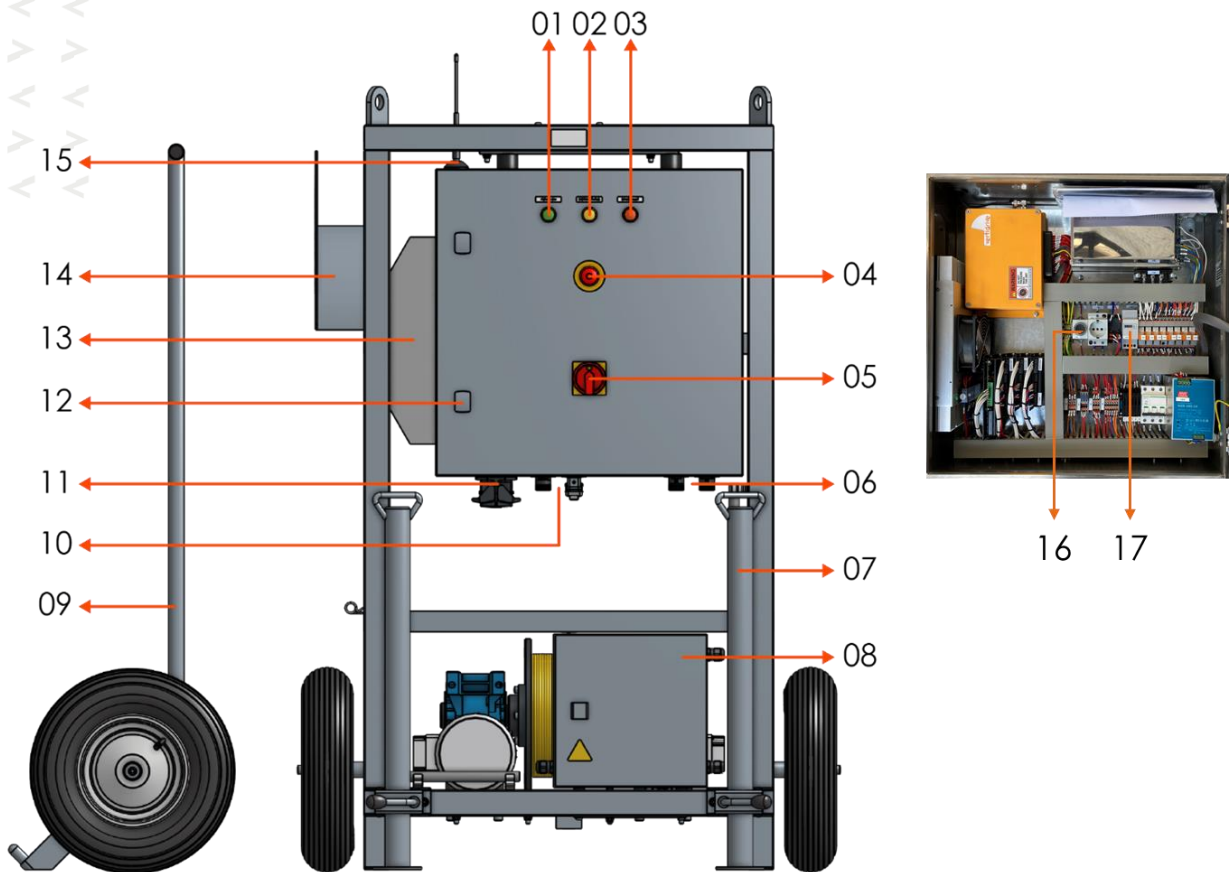
The robot provides the following functionalities:

- Adhesion to the surface by two front magnets located next to the large wheels and a smaller magnet at the back (between the caster wheels).
- High traction and movement over the steel surface by the two large front wheels.
- Controlled movement of the UHP hydro-blast equipment by remote control.
- Protection of the robot by a fall guard, with attachment points for the fall arrester cable.



For a full detailed description of the robot assembly and part identification, see the Illustrated parts manual supplied with the robot (322025 V400 Series Robot – IPM).

6.3. Control box (incl. optional transport frame)



Control box (shown with cooling option and optional transport frame)

#	Part	Description
01	Power indicator	The green light turns on when the system is powered on.
02	System status indicator	The yellow light turns on when the remote is connected and the system is activated (ready for use). Light blinks when the wall contact switch (WCS) does not detect a metal surface (all robot movement stops).
03	Drive fault indicator	The red light turns on when a fault is detected in the motor drive circuit, see the troubleshooting section (chapter 10).
04	Emergency stop	The button to shut off the system in case of emergency stops all movements.
05	Power switch	Switches main power on / off.
06	Winch connectors	Connectors for power and signals to the winch cabinet (optional).
07	Support legs	Supports transport frame and prevents it from tipping over.
08	Winch cabinet	Contains hardware to control the winch motors (optional).
09	Transport frame lever	For moving the transport frame manually.
10	Mains and pump connectors	Connectors for mains power and connector to activate the UHP pump.
11	Robot umbilical connector	For connecting the umbilical to the robot.
12	Door locks	For opening and closing the control box.
13	Cooler module	Cooling unit for use in high-temperature environments (optional).
14	Cable winders	Storage option for the umbilical on the transport frame.
15	Antenna	For working distances up to 100m. Can be extended with an extension kit.
16	WCS overrule	Button to overrule the wall contact switch in case of emergency, see the troubleshooting section.
17	Operation hours counter	The counter shows the hours of operation of the robot system.



For detailed information about the transport frame and/or winch system please consult the user manual for the respective product.

6.4. Remote control

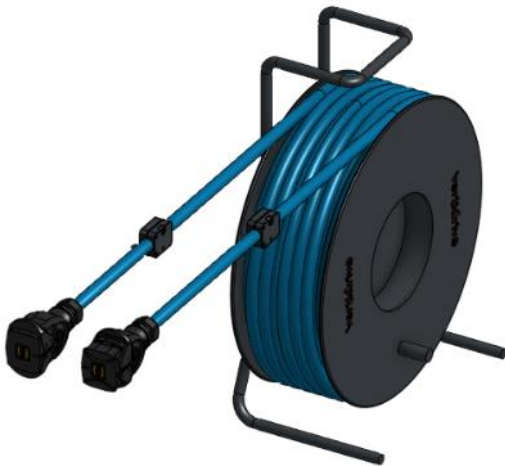
The robot is controlled by a wireless remote with the following functions and controls.



Hetronic Nova XL remote control

#	Control element	Explanation
1	Indicator light	In normal operation a green light blink rapidly, indicating good battery level and communication with the receiver. The light turns red when the battery level is low.
2	Swing arm speed control	N/A for V400 Series
3	Swing arm control on / off	N/A for V400 Series
4	Swing arm control up / down	N/A for V400 Series
5	Step control (off / slow/fast)	N/A for V400 Series
6	Emergency button	Used to immediately stop the complete robot system in case of an emergency. Will stop all robot movements as well as connected ancillary equipment (pump, winch system). To unlock the button, turn clockwise and pull.
7	Drives speed control	To adjust the (maximum) driving speed.
8	Joystick robot control	To control the driving speed and direction of the robot.
9	Drive adjust control	To adjust drive speed left or right, used to compensate for uneven loads on the robot.
10	Pump control	To control the pump connected to the robot control system.
11	Winch selector	To select left/right / both winch(es) – For details check the user manual of the transport frame with winch system (optional).
12	Joystick winches control	To control winches for optimum fall protection and/or umbilical + hose(s) support – For details check the user manual of the transport frame with winch system (optional).
13	Swing arm overrule	N/A for V400 Series
14	Light control on / off	To turn the light on/off (optional LED light on the robot).
15	Activation switch.	To activate the robot control system.
16	On / off switch and safety key.	To turn on the remote control, turn clockwise. It is possible to remove the key to prevent unauthorized use of the system. To do so, put the switch in the off position and pull on the black knob.

6.5. Umbilical and (optional) extension kit



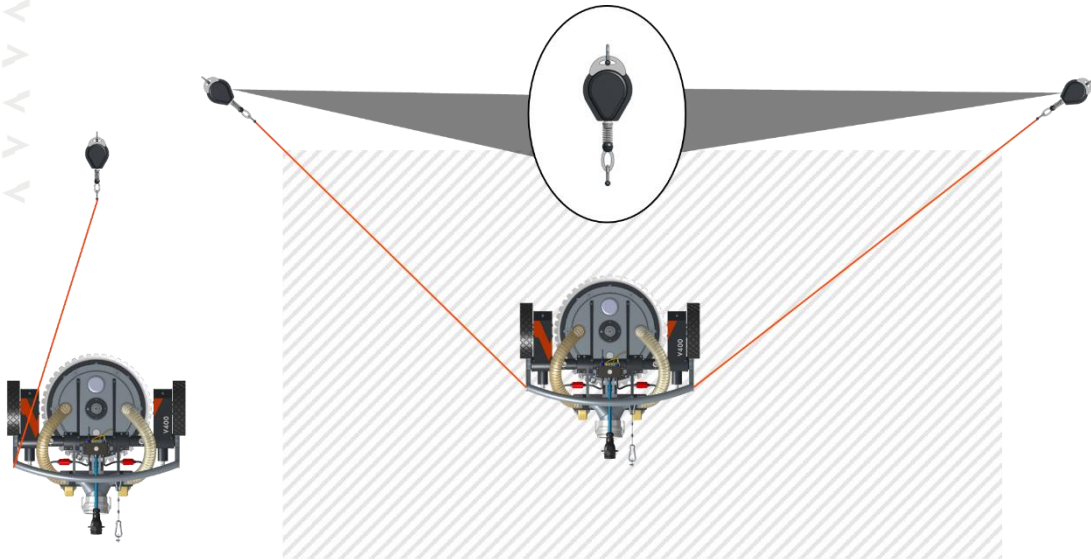
Umbilical CB4 50m on cable reel (322035)



Umbilical CB4 extension kit (323018)

The standard system is supplied with a 50m umbilical cable to connect the robot to the control box. It is possible to extend this length to 100m by connecting a second 50m umbilical cable (part ID 322035). For proper tension relief between the two umbilical cables, an extension kit (part ID 323018) is required. This must be connected as shown above to prevent high tension on the connectors.

6.6. Fall arrester and (optional) winch system

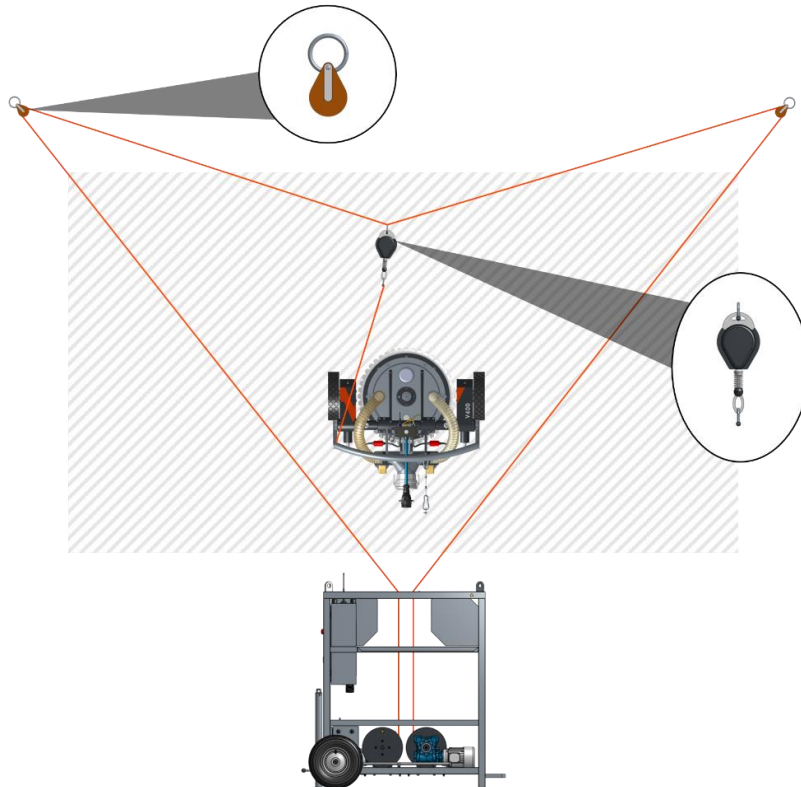


Single fall arrester (left) or dual fall arrester (right) setup of the V400 Series robot.

For worker safety, it is mandatory to use a fall arrester attached to the robot as shown above. VertiDrive recommends using a dual fall arrester setup whenever possible. The fall arresters can be attached to the slotted holes in the side plates of the fall guard using suitable (safety) carabiner hooks or D-shackles.



It is especially important to install the fall arrester before placing the robot on the surface. This will ensure that the robot is always secured, and users are safe in case the robot detaches from the surface for any reason. Always use slings and straps that are under local regulations. Replace slings and straps if any damage is found. Inspect these materials before usage according to the inspection schedule or start-up checklist.



Setup with (optional) transport frame with integrated winch system

> > > A winch system, integrated into a transport frame, is available as an option.

< < < This winch system has a dual purpose:

- > > > > 1. Carry the fall arrest equipment which is attached to the robot and make sure this equipment is in the correct position with the robot. The fall arrester always needs to be in the proximity of the robot (max. 4 meters between the robot & fall arrester). The fall arrester can be easily positioned using the joystick on the remote control.
- > > > > 2. Carry the weight of all the hoses and cables connected to the robot.



< < < For detailed information about the transport frame and winch system please consult the user manual for the transport frame with winch system.



7. INSTALLATION

7.1. General

Before using the robot, it is mandatory to secure the robot with certified and appropriate fall arresters. This equipment is to be supplied by the end-user and should only be installed by an authorized person knowledgeable and trained in the use of this equipment.



The commissioning work must only be carried out by authorized personnel. Before the use of the VertiDrive V400 Series robot, the user/operator must follow operating and safety instructions. Initial training of users/operators is provided by VertiDrive and/or VertiDrive certified trainers, upon delivery of a new robot system.



The customer is responsible for the transport of the complete system and therefore bears all risks of loss, damage, or wear caused during transport.

The environment must meet the following requirements.

Ambient temperature operating : > +3°C (avoid frost) to +35°C (+50°C with cooling)

Commissioning the robot

1. Before usage, mark an area with ribbon (colors under local regulations) to ensure a distance from the robot of at least 6 meters in all cases. This area should not be entered without the permission of the operator and never when the robot is in operation. Always consider the possible swing of the robot when the robot detaches from the surface.
2. Perform the robot inspection procedure before connecting it to power and pressure. Never connect an ultra-high-pressure pump that exceeds the maximum allowed pressure or flow rate capacity. For a full detailed description see **3.4 F-03 Startup Checklist** supplied with the robot.
3. Position the (transport frame with) control box on a flat surface in a suitable location.
4. Attach fall arrester(s) and place the robot on the surface.
5. Connect the robot to the control box.

Unroll the robot umbilical cable entirely. Connect the cable to the robot and the electric control box. Note that the connectors fit together in only one way, change orientation if needed. Fully close the connectors using the securing levers. Attach the tension relief to the robot using the corresponding bolt. When using a transport frame, attach the tension relief on the other side of the umbilical cable to the frame.

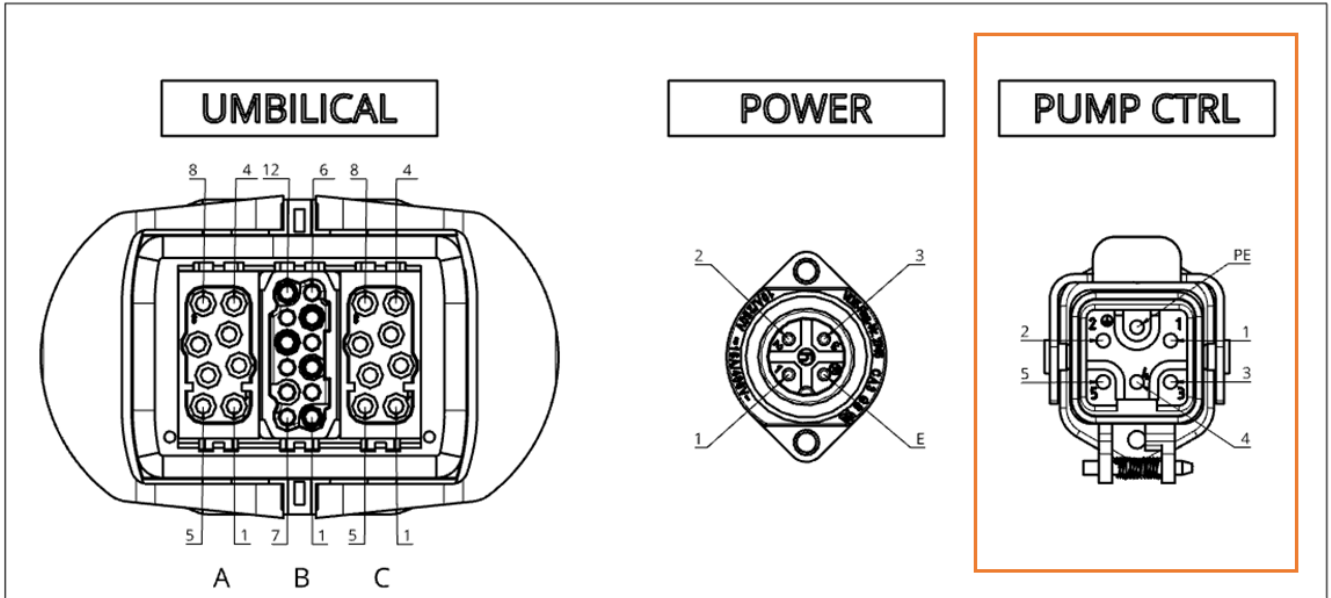


It is important to prevent the umbilical cable from getting tangled or caught between objects. Also, make sure that the power cable is always clear from the robot wheels.

6. Connect the control box to an appropriate power supply. Ensure that the power supply has sufficient amperage, see section 3.3. **IMPORTANT: ensure proper grounding of the control box.**
7. Switch on the power to the system using the main switch on the control box.
8. Find an operator position at a safe distance from the robot, with an unobstructed view of the application area. Always keep a minimum of 6 meters from the robot during operation. Pay attention to also keep a safe distance from any other equipment used.
9. Switch on the remote control and activate the system. Test all functions briefly before using the robot.
10. Always activate the emergency stop on the remote control when it is required to come close to the robot. When performing any kind of service on the robot, always switch off power first using the main switch on the control box.

7.2. Pump control connection

The robot control system is provided with a pump control, to allow activation of the UHP pump using the robot remote control. Using the pump control connection also integrates the UHP pump into the safety system on the robot: if either of the two emergency stops is activated, or when the WCS signal does not detect a metal surface, the pressure supply to the UHP hydro-blast equipment is immediately shut off. **It is strongly recommended to always use the pump control connection to ensure worker safety. If the pump control connection is not available, the user is responsible for providing other means to ensure worker safety (e.g., dead man control, separate safety operator, etc.)**



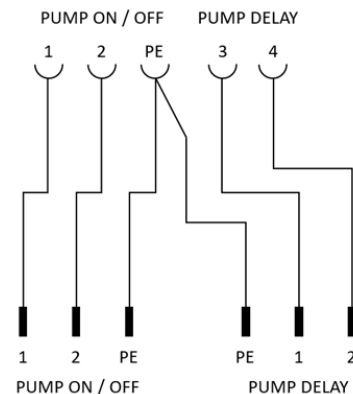
The pump control connection is located at the bottom of the control box. The corresponding male connector is standard supplied with the system (item 223056). The male connector can be fitted with 1 or 2 cables depending on the wiring required for the specific equipment used.

The connection provides two dry contact functions to control the UHP pump:

- Pins 1 and 2 provide the dry contact function of the on / off switch and are immediately activated when the pump switch on the remote control is set to "on" (if the system status is active).
- Pins 3 and 4 provide the dry contact function of the delay switch and are closed with a pre-set delay after the pump "on" is activated. The standard delay time is set to 3s. If needed this can be changed to any value between 0.5 and 10s (see control box wiring diagram, relay 14K6).

The use of the pump/valve connection is equipment dependent. Most UHP pumps require a primary and a delayed secondary "on" trigger. Please refer to the application equipment manuals for details. Contact VertiDrive Service in case of questions.

PUMP CTRL wiring (CB connection)		
Connection	Function	Voltage
1	Pump on/off 1	MAX 250V IN
2	Pump on/off 2	MAX 250V IN
3	Pump delay 1	MAX 250V IN
4	Pump delay 1	MAX 250V IN
5	None	-
PE	PE	GND



7.3. Handling of the Robot

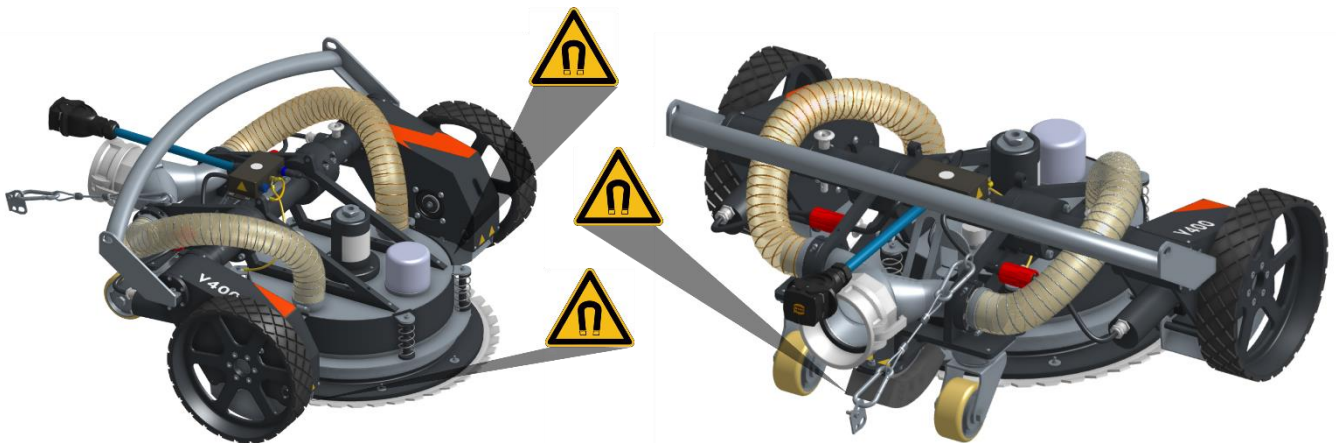
1. Only the fall guard and wheel rims of the robot, as indicated in the image below, should be used to carry or move the robot. Other parts are not suitable for handling/lifting the machine.
2. When carrying and handling the robot, take into consideration the total weight of 88 kg. The use of suitable lifting means is recommended to help place the robot on the working surface. Always follow local health and safety regulations when handling the robot.
3. The slotted holes in the side plates of the fall guard can be used to fasten appropriate lifting means.



Holding points suitable for robot handling.



The robot has powerful magnets next to the front wheels and at the back. Always keep your hands clear from these areas to avoid getting caught between metal objects and the magnets! Be careful that the magnets never get close to any loose metal objects (e.g., tools) or construction parts that can move or are not rigidly attached to the surface.



Locations of the powerful magnets

8. OPERATION

8.1. Operating procedure



This chapter describes the required steps for preparation and setup, operation, and shutdown of the robot system. Make sure to read and understand the safety instructions in Chapter 5 before operating the system. Use appropriate personnel protective equipment (PPE) as per local regulations and company guidelines.

The following steps are required when using a V400 Series robot:

1. Optional: magnet distance adjustment.
2. Vacuum shroud positioning.
3. Robot placement on the surface.
4. Connection.
5. Robot operation.

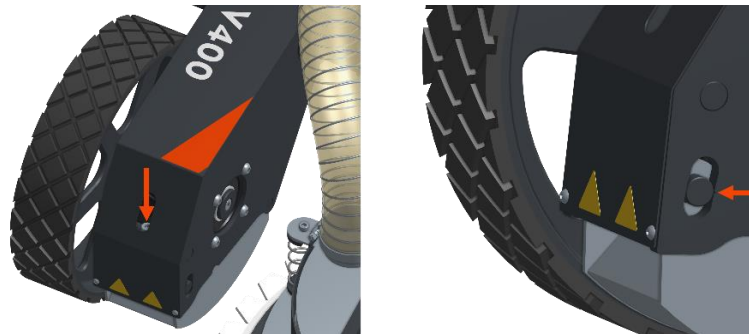
8.1.1. Magnet distance adjustment

The robot contains three magnets, two at the front and one at the rear, used to create holding force to the surface. In the default configuration, these magnets are positioned to create adequate holding force and wheel traction for robust mounting whilst maintaining sufficient clearance. If the holding force is insufficient for the application, the front magnets can be lowered. *Visa versa*, if the clearance is insufficient for the application, the distance of the front magnets to the surface can be increased. Note that decreasing the magnet distance will result in less clearance, whereas increasing the magnet distance will reduce the holding force and wheel traction. Finding the right balance between clearance and required holding force is context dependent.

It is strongly recommended to perform the height adjustment of the magnets before operation when the robot is not placed on a metal surface. Small adjustments can be made when the robot is placed on the working surface.

Front magnets:

The height of the front magnets can be adjusted using the screws below the drive covers, indicated in the left image below. Turn the screws clockwise (CW) to increase the magnet distance and counterclockwise (CCW) to reduce the distance. The magnet height is indicated through the relative position of the black pin within the corresponding slot, shown in the right image. Note that the set position of both magnets must be equal to ensure proper alignment.



Default configuration (7mm distance): the front magnet default configuration is indicated through the slight notch within the pin slot indicated above. Whenever the magnet is positioned in this default configuration, the center of the pin is aligned with this marking.

Increase or decrease height (4mm minimum and 12mm maximum distance): to increase or decrease the height of the front magnet, tighten (rotate CW), or loosen (rotate CCW) the previously indicated screw, respectively. Reminder: maintain an equal alignment for both magnets.

	Distance to surface (mm)	Approximate magnet force (kg)*
Minimum magnet height	4	650 – 800
Default configuration	7	500 – 650
Maximum magnet height	12	350 – 450

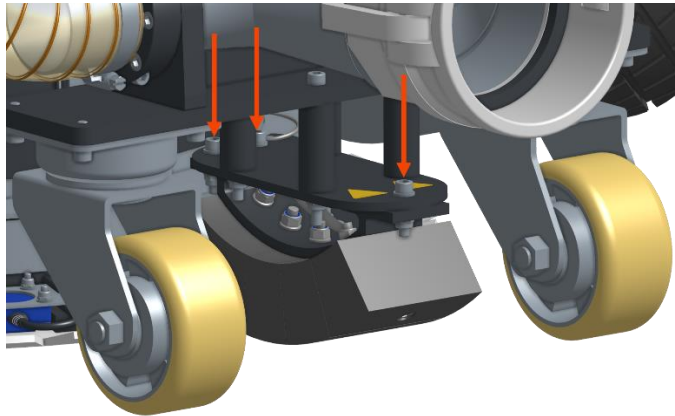
* Note: magnet force depends on the exact material and thickness of the surface

Rear magnet:

Standard the rear magnet position is fixed at a 15mm distance to the surface. In this configuration, an approximate magnet force of 150 – 200 kg is achieved, depending on the exact material and thickness of the surface.

In the default position, the magnet holder must be mounted flush with the bracket and the 3 screws indicated below must be fully tightened. **It is important to check to correct magnet position before operation.**

For special applications, it is possible to increase the holding force of the rear magnet by lowering the magnet. Contact VertiDrive for further details and advice. If a lower rear magnet position is used, **always ensure full thread engagement of the screws with the self-retaining nuts** and that the magnet holder is parallel to the bracket.


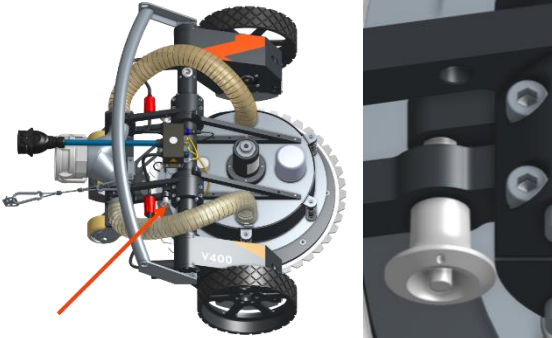
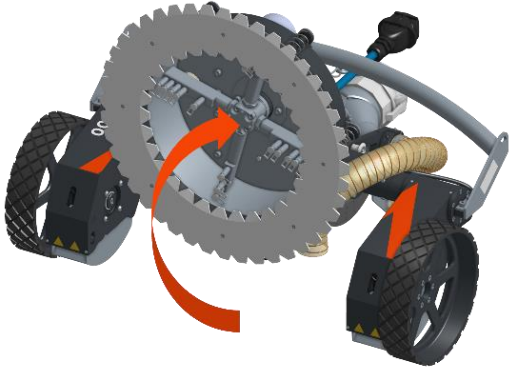
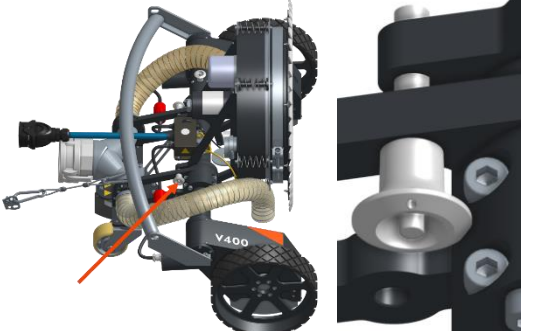


8.1.2. Vacuum shroud positioning

The vacuum shroud can be positioned downwards or upwards. Only use the points indicated below for handling the shroud to change its position. For operation, the shroud must always be in a downward position. The upwards position is used to place the robot on the surface and to access the nozzle cross for cleaning or maintenance. **For operator safety, always switch off the pump completely before putting the shroud in an upward position!**



Always lift the vacuum shroud to the upward position before placing the robot on the surface, follow the instructions below.

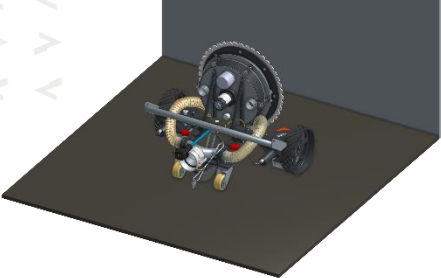
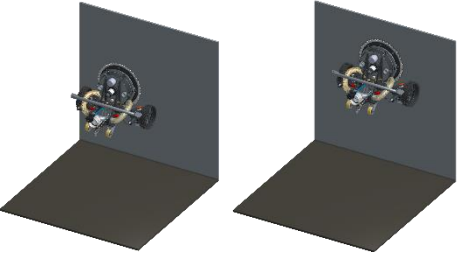
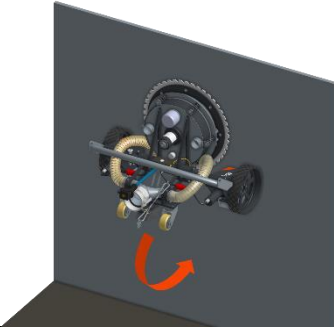
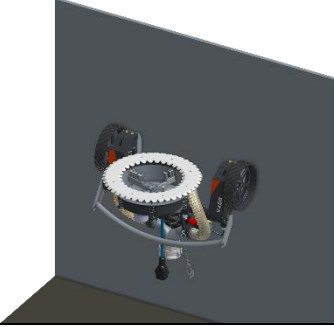
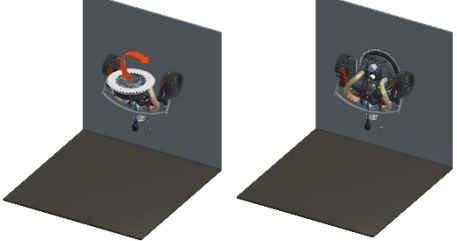
	<ol style="list-style-type: none"> 1. Starting position, vacuum shroud down. This position is locked by pins in the brackets on both sides.
	<ol style="list-style-type: none"> 2. Remove both lock pins. Push the knob on the lock pin and remove it from the bracket. If needed, slightly move the vacuum shroud to improve alignment and facilitate removal. Repeat for the second lock pin on the opposite side.
	<ol style="list-style-type: none"> 3. Move the vacuum shroud to an upward position. Be careful to avoid trapping of hands and/or fingers when moving the shroud!
	<ol style="list-style-type: none"> 4. Align holes in the bracket and insert lock pins to hold the shroud in upwards position (note: knob on the lock pin must be pushed in to insert). Repeat for the second lock pin on the opposite side.



To position the vacuum shroud downwards, follow the steps above in the opposite order. **Always ensure that both lock pins are fully inserted and locked before starting the UHP application.**

8.1.3. Robot placement

Always lift the shroud to the upward position before placing the robot on the surface. Only use the fall guard and wheel rims for handling the robot (see section 7.3).

	<ol style="list-style-type: none"> 1. Place the robot close to the working surface. Secure the robot with certified and appropriate fall arresters. <p>Use only the fall guard and wheel rims for handling/lifting to robot</p>
	<ol style="list-style-type: none"> 2. Lift the robot and place the two front wheels against the steel surface. Note that the total weight is 88 kg, use appropriate lifting means. <p>Avoid entrapment of hands and/or fingers!</p>
	<ol style="list-style-type: none"> 3. Slowly rotate the robot to lower the caster wheels to the surface. <p>Avoid entrapment of hands and/or fingers!</p>
	<ol style="list-style-type: none"> 4. Magnetism will directly hold the robot in place on the surface. Robot frame can now be released.
	<ol style="list-style-type: none"> 5. Rotate the vacuum shroud downwards to the working position (see previous section). <p>Avoid entrapment of hands and / or fingers!</p> <p>Ensure that both locking pins are fully inserted and locked before starting robot operation.</p>

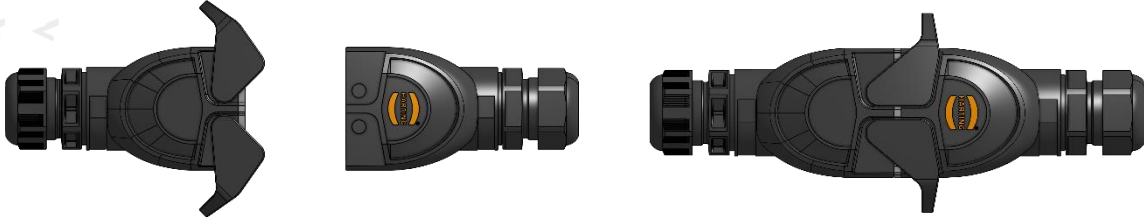
To remove the robot from the surface, follow the steps above in the opposite order. Note that the rear magnet requires 150 – 200kg force to pull from the surface. Use suitable equipment to pull the robot or use a wedge of approx. 300mm (12") length and 30mm (1.2") height underneath one of the caster wheels to increase the magnet distance and reduce the holding force. **Note: to drive the robot on the wedge, the shroud must be in down position (WCS must detect steel surface), but both lock pins must be removed to allow the shroud to tilt a bit.**



8.1.4. Connection

Once the robot is placed on the surface, the umbilical cable can be connected:

1. Unroll the entire umbilical cable to allow for free movement of the robot.
2. Remove the protection caps from the connectors (robot and umbilical cable).
3. Connect the male and female connector and close the locking levers as shown below.



4. Check that tension relief plate is attached to the umbilical. If not, remove the nut from the tension relief plate and attach the tension relief plate to the umbilical as shown below. The tension relief must be 5cm (2") from the connector. Attach the carabine hook as shown. Make sure that the distance is correct and there is no tension on the connector.



5. Connect the other side of the umbilical cable to the control box.



Prevent sharp bends in the umbilical cable when handling to connect and disconnect.

8.1.5. Robot operation

This section describes the required steps for robot operation. **Always keep a safe distance of minimum 6 meters from the robot when activating and operating the robot.**

Startup

1. Power on the system by using the main switch on the control box.
2. Turn on the remote control by rotating the black knob to the "on" position. The remote takes several seconds to start up and establish communication with the receiver. Two short beeps and a fast-blinking green light on the remote control will indicate when the connection is ok.
3. Activate the remote control by pressing the green button on the right side. Note that for safety reasons, system activation is only possible when all power functions on the remote are off:
 - a. Swing arm control: off
 - b. Step control: off
 - c. Pump: off
 - d. Swing arm up / down: off (neutral position)
 - e. Joystick robot control: inactive (neutral position)
 - f. Joystick winches control: inactive (neutral position)
4. Check indicator lights on the control box for system status:
 - a. Green light (constant on): indicates the control system is powered.
 - b. Yellow light (constant on): indicates that the control system is activated and the safety circuit of the WCS is closed; all robot functions are operational.

- c. Yellow light (blinking): indicates that the control system is activated, but the safety circuit of the WCS is not closed; only the non-safety critical functions of the system are operational (but the robot drives, as well as the pump control, will not work).
- d. Red light (constant on): indicates that a fault is detected in one or more motor drive(s), and the corresponding motor on the robot will not function (correctly). Restart the control system by turning the main switch to “off”, wait for 30 seconds and turn the main switch to “on”. If restarting does not solve the problem, refer to chapter 10, troubleshooting.

Basic operation

The V400 Series robot has multiple functionalities, which are briefly explained in this section. The numbers used refer to the controls as indicated in chapter 6, section 6.4:

- Drive
 - The robot is moved across the surface using the joystick (8) on the right side of the remote control. The joystick controls both the speed of the robot and the direction.
 - The maximum driving speed of the robot can be set using the speed control knob (7).
 - If the robot deviates from a straight line due to uneven loads on the robot (most often caused by the umbilical cable and hoses pulling on the robot at an angle), the adjust knob (9) can be used. This function compensates either the left or right drive speed, to achieve the desired straight line. This function is particularly useful when driving horizontally across the surface.
 - The step time control (5) is not applicable for the V400 Series robot. To ensure correct functionality for the V400 Series robot, this switch **must always be in “off” position** (or the robot will not move).
- Winch
 - Use and operation of the winch system is explained in the manual of the transport frame with winch system.
- Light
 - Only applicable if the robot is equipped with the optional LED light: the light can be turned on and off by pressing the light control button (14).
- Pump
 - The pump switch (10) is used to activate the UHP pump to start application pressure supply.
- Estop
 - Press the button (6) in case of emergency to immediately stop all robot movement as well as the winch system (if used) and stop the UHP hydro-blast pressure supply (if the pump control is connected, see section 7.2). To resume working, pull out the emergency button while turning clockwise. Press the activate button (15) on the right side to reactivate the system.

8.1.6. UHP application operation

This section describes the general steps to set up the UHP hydro-blast application.

1. Set the drive speed control to approximately 50%.
2. Check the robot movement by operating the joystick. Use the adjust knob if the robot does not move in a straight line.
3. Turn on the vacuum system.
4. Set pump switch to "on" to activate UHP pump. Keep your hand on the emergency button and push in case of unexpected behavior.
5. Move the robot forward in a straight line and optimize the drive speed settings for optimal performance.
6. Turn on the light when required.
7. To cover the whole surface, move in parallel lanes, either by going back and forth cleaning or cleaning in just one direction, the other direction is then used to move back to a starting point. For the V400 Series robot it is normally recommended to work in both directions, but this is application dependent.
8. Use the joystick to maneuver the robot to the next lane or if a change of robot direction is required during application. To stay parallel to the previous lane either the joystick or the adjust knob can be used.
9. To stop the UHP application at the end of a lane or at the end of the job, always switch off the pressure supply (pump) first and then the vacuum.

8.1.7. Shutting down

To shut down the system, the following steps are required:

1. If not done already, set pump switch to "off" and turn off the vacuum system.
2. Completely switch off the UHP pump (to prevent unintentional activation).
3. Move the robot down to a suitable location for detachment, approx. 50cm (20") above the ground, within easy reach. Disconnect the UHP and vacuum hoses.
4. Recommended: use a wedge (approx. 30cm (12") length & 3cm (1.2") height) underneath one on the caster wheels to decrease the rear magnet holding force and facilitate removal. To drive the caster wheel on the wedge, first remove both lock pins, but keep the vacuum shroud in down position (WCS must detect the steel surface of the robot will not move). Place the wedge behind one of the caster wheels and slowly drive the robot down. Stop at approx. 5cm (2") from the end of the wedge, the magnets will still hold the robot in this position.
5. Turn off the remote control and control box. Ensure the system is completely powered down by turning the main switch on the control box to "off".
6. Disconnect the umbilical cable and attach all protection covers to the connectors.
7. Put the vacuum shroud in upwards position and insert both lock pins.
8. Using only the fall guard and wheel rims for handling, remove the robot from the surface:
 - a. Pull the caster wheels from the surface.
 - b. Rotate the robot until it is in horizontal position (the holding force of the front magnet will rapidly decrease between 30° and 60° angle, allowing the robot to be detached from the surface).
 - c. Pull the robot away from the surface and lower to the ground.

Important: ensure a clear area when taking the robot from the surface. Make sure there are no other metal surfaces or any loose metal items in close vicinity of the robot.

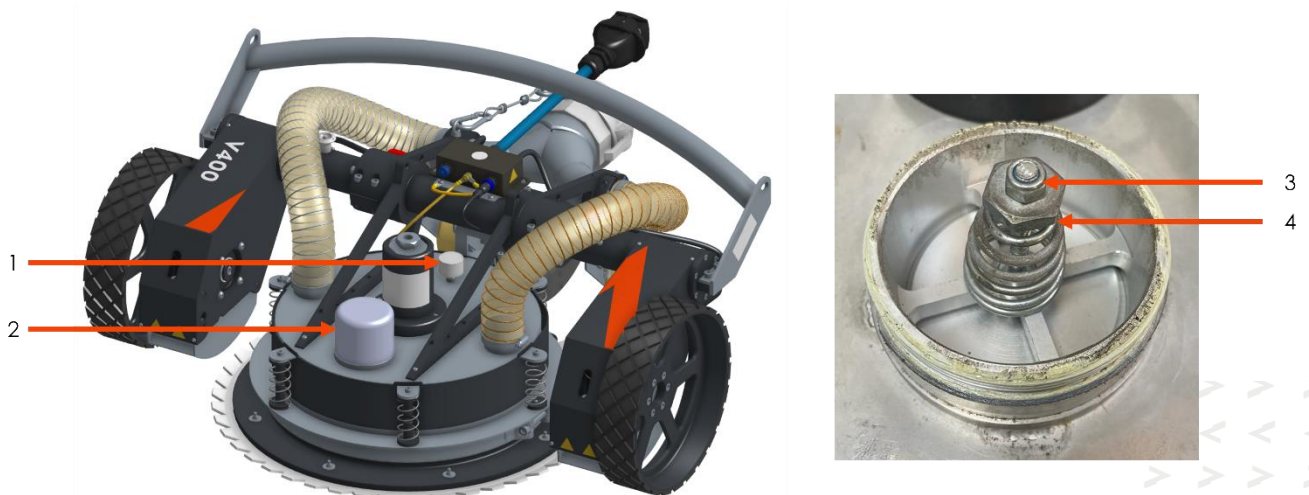
8.1.8. Adjustment of vacuum

This section describes the procedure for adjusting the vacuum system for optimal results in surface treatment, minimum wastewater loss, and maneuverability of the robot. The V400 Series robot vacuum shroud is fitted with a relief valve and vacuum gauge to control the vacuum within the shroud. The relief valve is set to allow 150 - 200 mbar (2.2 – 2.9 psi) of vacuum within the shroud, to ensure collection of all wastewater and debris. If the vacuum is too low, this will result in significant leakage. If too high, the large resulting force will negatively impact the robot maneuverability and put a high strain on the construction that can potentially damage the equipment. **The vacuum pressure inside the shroud must never exceed 250 mbar (3.6 psi).**

For (fine) adjustment of the vacuum pressure, follow these steps:

1. Place the robot on a flat working surface with the vacuum shroud in its downwards position (lock pins inserted). Connect the vacuum hose to the robot.
2. Ensure that the UHP pump is completely off. Vacuum adjustment is done without water pressure / flow.
3. Ensure the vacuum gauge indicates 0 mbar (1) before activating the vacuum system. Note that the vacuum measurement can show an offset due to changes in temperature and / or atmospheric pressure. If this is the case, remove the rubber plug at the side of the gauge housing to recalibrate (needle will move to 0). Replace plug immediately after calibration. A small amount of glycerin may leak out when the plug is removed. This is no problem and can be easily removed with a rag.
4. Turn on the vacuum system and read the vacuum gauge value (1). The increase in vacuum gauge value should be 200-250 mbar to get 150-200 mbar of vacuum during operation with high-pressure water. If the value is not within the 200 – 250 mbar range, the relief valve setting must be adjusted.
5. Turn off the vacuum system.
6. Remove the relieve valve cap (2).
7. Loosen the 10mm locking nut (3).
8. To increase the vacuum, turn the 19mm nut (4) in CW direction, to decrease the vacuum turn the 19 mm nut in CCW direction.
9. Fasten the 10mm locking nut.
10. Repeat steps 3 and 4 to measure the vacuum pressure after modification.
11. Repeat steps 5 – 10 if needed until the vacuum pressure is within the 200 – 250 mbar range.
12. Reposition the relief valve cap (2).

With UHP water flow enabled, the vacuum in the shroud will be reduced by approx. 50 mbar, depending on the operating pressure and flow. Check the vacuum pressure at the start of the application. Adjust if necessary. **Never operate the robot when the vacuum pressure exceeds 250 mbar.**



8.1.9. WCS overrule

The robot system uses a wall contact switch (WCS) for safety, to ensure that the robot is only operational when the robot is correctly attached to the surface. It is possible though that during application the detection of the surface is lost, due to curvature or irregularities in the working surface. If the control box no longer receives an active signal from the WCS in such a situation, all functionalities of the robot are disabled, including the drive motors.

If the robot is still properly attached to the surface and the problem is only with the detection of the surface by the WCS, there is a possibility to temporarily overrule the WCS signal to allow movement of the robot to a place on the surface where the WCS signal is restored, and normal operation can continue.

The WCS overrule button (16) is located inside the control box, see section 6.3. When it is required to move the robot a short distance to restore the WCS signal or to maneuver the robot back to reachable height for inspection and / or removal, this overrule button can be used after taking appropriate safety measures. Note that the WCS overrule is a system intervention, and it is necessary to investigate the cause of the WCS failure immediately.

8.1.10. Recover from an emergency stop

After an emergency stop, the system must return to its starting state. To reset the emergency stop, pull out the knob while turning clockwise. Switch all power functions on the remote control to "off" and activate the system (as described in section 8.1.5, robot operation).



In case the robot has fallen, and the fall arrester is activated it is necessary to lower the robot and release the tension from the fall arrester. The fall arrester needs to be replaced immediately after a fall incident; the activated fall arrester must be inspected before re-use is allowed. Refer to the fall arrester user manual for detailed instructions.

9. MAINTENANCE AND CLEANING

9.1. General



First, read the safety instructions in chapter 5. It is important to read and understand all safety instructions and to use personal protective equipment (PPE) as per local regulations and company policies.



The maintenance of all mechanical and electrical parts must be done according to the maintenance instructions of the supplier / sub-contractor / manufacturer.



Always turn off the power to the equipment when performing maintenance tasks to prevent electric shock. Do not approach the robot if you have a pacemaker or implanted heart defibrillator or any other implanted cardiac device. Keep a minimum distance of 60 cm!



The robot contains three powerful magnets. When working on the robot extra caution should be taken to avoid direct contact between steel tools and the magnets. Use nonmagnetic tools whenever possible. The magnets are strong and entrapment between the magnet (or robot parts) and metal objects can cause serious injuries. The magnets will also affect sensitive electronic and mechanical equipment like cell phones, watches, and (bank) cards with magnetic strips.



Trained and qualified personnel may only perform maintenance!



The customer is held liable for consequential damage or loss such as damaged products, production downtime, etc. by a failure of the system due to inadequate maintenance or lack of maintenance.

9.2. Frequency of inspection and maintenance

3.4 F-04 Inspection and Maintenance Schedule describes the inspection and maintenance intervals and activities.

The common interval for inspection and maintenance is every 250 hours of operation or 6 months, whichever comes first. The hours of operation of the system can be checked with the hours counter inside the control box, see section 6.3.

In general, the robot needs little maintenance besides regular cleaning. The vacuum shroud wear plate and the wheels are the only common wear parts and need replacement after 250 – 1000 hours of operation (note: this is a very rough indication, as the wear varies significantly depending on the surface roughness and loads applied). Other parts only need to be replaced if inspection reveals any issues, either due to damage or mechanical wear. Always replace parts with original components as illustrated in the parts manual.

UHP components (swivel, nozzle cross and nozzles) must be visually inspected for leakage and proper functioning prior to every job.

9.3. Inspection and maintenance activities

The following checks are required for the V400 Series robot (3.4 F-04 Inspection and Maintenance Schedule). See 322025 V400 Series Robot – IPM for explanation and details on robot parts and components:

ROBOT:

- Robot frame: check for damages, clean, check tightness of all screws.
- Fall guard: check for damages, clean, check integrity of lifting eye and tightness of mounting screws, apply suitable anti-seize lubricant (e.g., Loctite LB8156) on (4x) M8 screws for connection to robot frame.
- Front wheels: clean, check tightness of (6x) mounting screws, check rubber for damages and measure profile depth. If profile is < 2mm, the wheels must be replaced.
- Rear (caster) wheels: clean, check for damages and wear, check smooth rotation of bearings. If rotation is not smooth, use pressurized air or low-pressure water jet to clean between surfaces. Replace the caster wheels if the rotation is not smooth or produces grinding sounds.
- Front magnets: clean, check for damages, check magnet height adjustment (full range). Use pressurized air or low-pressure water jet to clean. If the dirt contains metal particles (e.g., residue from the surface cleaning) it can be extremely hard to remove this contamination from the magnet surface. Use a brush or a damp cloth in this case. It might be required to disassemble and remove the magnets for cleaning. **Disassembly and removal of the magnets for cleaning may only be done by VertiDrive or trained and qualified representatives.**
- Rear magnet: clean, check for damages. Use pressurized air or low-pressure water jet to clean. If the dirt contains metal particles (e.g., residue from the surface cleaning) it can be extremely hard to remove this contamination from the magnet surface. Use a brush or a damp cloth in this case.
- Drive motors: clean, check for damages of sleeve and electric cable, check integrity and tightness of cable gland, check tightness of (6x) M6 mounting screws. Check for any abnormal sounds during operation. The motors are completely sealed and supplied with lubricant for life. If inspection reveals any issues with the motor, the complete unit must be replaced.
- Gearboxes: clean, check shaft on play (1-2° maximum), check for oil leakage, check for any abnormal sounds during operation. Note that the gearboxes are supplied complete with lubricant for life and require no regular maintenance. If inspection reveals any issues with the gearbox, the complete unit must be replaced.
- Junction box and connectors: clean, check for damages, check integrity and tightness of all junction box connections (e.g., corrosion, moisture, debris).
- Umbilical connector: clean, check for damages, check tightness of cable gland, check integrity and functionality of locking levers. Replace the locking levers in case of any damage that hampers functionality.
- WCS sensor: clean, check for damages (sensor body and cable), check functionality. Green LED indicator must turn on when powered, the orange LED indicator must turn on when a metal surface is detected.

UHP SWIVEL AND NOZZLE CROSS:

- Swivel: clean and check on leakage, damage, and smooth rotation. See nozzle cross and swivel IPM for details on seal replacement and swivel overhaul.
- Nozzle cross: clean and check on leakage and damage. Check arms are tightly fastened. Note that two arm are at an 8° angle to propel the nozzle cross. This is a factory setting and normally should not be changed. Ensure that angle never exceeds 16° (controlled by the 4 set screws in the hub). See nozzle cross and swivel IPM for details on seal replacement and nozzle cross overhaul.
- Nozzles: clean and check on leakage and damage. Replace nozzle if damaged. When replacing nozzles, always use a wrench to keep the connection piece static (ensure that the connection piece to the arm does not rotate as this will compromise the sealing).

CONTROL BOX:

- Cabinet: clean, check for damages, check integrity of all electrical connection at the bottom, check antenna on damages, check integrity of the door seal.
- Remote control: clean, check for damage (casings, seals on switches, etc.), check integrity and functionality of all controls on the remote, check integrity of both batteries.
- Cooling (optional): clean, inspect the cover and fan on the outside of the cabinet for dust and / or dirt build-up, clean with pressurized air if needed. Check functionality of the cooling fans: set the thermostat located on the inside of the cabinet door to 0°C and switch on mains power. Cooling fans must start moving, check for any abnormal sounds. After the functional test is done, return the thermostat to 30°C setting.

UMBILICAL CABLE:

- Cable: unroll cable, clean, and check entire length of cable on damages
- Connectors: clean (with contact spray if needed), check for damages (casing and seals), check tightness of cable gland, check integrity and functionality of locking levers. Replace the locking levers in case of any damage that hampers functionality.
- Tension reliefs: clean, check for damages, check correct position of tension relief on umbilical cable, check tightness of M6 screws.



Check the applicable user manual(s) for inspection and maintenance instructions for the transport trolley / winch system if used.



9.4. Part replacement instructions

VertiDrive can supply any part of the system as a spare part. See 322025 V400 Series Robot – IPM supplied with the robot for details and part identification. When ordering parts always specify the part number and provide a brief description of the problem and why a part needs to be replaced. VertiDrive will provide instructions for part replacement with the supply of the new parts.

9.4.1. Replacement vacuum shroud wear plate

The procedure for replacement of the wear plate is shown below.

	<ol style="list-style-type: none"> 1. Temporarily remove the WCS holding plate including sensor.
	<ol style="list-style-type: none"> 2. Rotate the vacuum shroud in upward position.
	<ol style="list-style-type: none"> 3. Replace the wear plate by loosening and fastening the (8x) screws and nuts.
	<ol style="list-style-type: none"> 4. Reassemble the WCS holding plate.

9.5. > Cleaning

To ensure proper robot functionality and performance, it is important to keep the robot clean. It is recommended to clean the robot quickly at the end of each working day and thoroughly between jobs. This is especially important for all moving parts (drives, magnet height adjustment and vacuum shroud lift mechanism). Any dirt or other contamination can be removed by using pressurized air, or low-pressure water (max 2 bar).

If there is excessive build-up of dirt on or near the magnets, it can influence the height adjustment mechanism of the magnets. If the dirt contains metal particles (e.g., residue from the surface cleaning) it can be extremely hard to remove this contamination from the magnet surface. Use a brush or a damp cloth in this case. In extreme cases it might be required to disassemble the magnet and remove it for cleaning. **Disassembly and removal of the magnet for cleaning may only be done by VertiDrive or trained and qualified representatives.**

Clean the control box regularly, preferably using pressurized air. In the case of a control box with cooling (optional), inspect the cover and fan on the outside of the cabinet for dust and / or dirt build-up before each job, clean with pressurized air if needed. If the fan stops moving or is making abnormal sounds, shut off the system and clean the cover and fan. If needed, the cover can be removed for better cleaning.

10. TROUBLESHOOTING

This section describes basic troubleshooting steps and corrective actions for the V400 Series robot system. Contact VertiDrive support in case of any questions or when basic troubleshooting does not resolve the problem. Use the problem and solutions codes (e.g., A1 / A1.1) to help explain the problem and the corrective actions that have already been tried.

CONTROL SYSTEM ISSUES			
A1	No system power (green LED on control box does not turn on)	A1.1 A1.2 A1.3 A1.4	Check site power connection. Check power cable to the control box: connector at the bottom of the cabinet must be fully inserted and tightened. Check 10F0 circuit breaker inside the cabinet: lever must be in ON position (up). Check main switch on control box door is set to ON.
A2	No remote-control connection (green light on remote control does not blink rapidly)	A2.1 A2.2 A2.3 A2.4 A2.5	Check if remote control is switched on (black knob on right side). Check if remote control battery, replace with spare battery. Check if antenna is mounted on the control box. Check the distance to the control box. Test the connection by moving close to the control box. Check field of view and obstructions between the remote control and control cabinet.
A3	System activation fails (yellow LED on control box does not turn on)	A3.1 A3.2 A3.3 A3.4 A3.5	Check remote control connection (A2). Check emergency stop on remote control is not activated: turn the emergency button clockwise. Check emergency stop on control box is not activated: turn the emergency button clockwise. Push the activate button on the right side of remote control. Check that switches on the remote control are in OFF position: both joysticks in neutral position, step time control OFF, swing arm movement OFF, swing arm up / down in neutral position, pump OFF.
A4	Safety circuit not closed by WCS (yellow LED on control box is blinking)	A4.1 A4.2 A4.3 A4.4 A4.5 A4.6 A4.7	Check that the robot is attached to a metal surface. Check umbilical cable is properly connected to both robot and control box. Press activate button on right side of remote control again to retry initialization of the control system. Check that the wall contact switch (WCS) is powered: green LED on sensor must be ON (note: the indicator LEDs are placed on the sensor side facing the front magnet and can be hard to see when mounted on the surface). Check that the WCS is detecting the metal surface: orange LED on sensor must be ON. Recalibrate the sensor: place the robot on a non-metal surface and remove the WCS holding plate (see section 9.4.1). Press the teach button on the sensor (located next to the indicator LEDs) for 3 seconds. Green LED will blink 3 times, when it is constant ON the calibration is completed. Place robot on metal surface to test WCS. If A4.4 or A4.6 fails, replace the WCS sensor (item 322013) with a spare unit.
A5	Motor drive fault (red LED on control box is on)	A5.1 A5.2 A5.3	Restart system: turn OFF main switch, wait for 30 seconds, turn main switch ON again. Check fuses 11F2, 11F5 and 11F8 inside the cabinet. Disconnect power, open fuse holder, and remove fuse for visual inspection. Replace the fuse if needed (fuse: 5x20mm 250V 6.3A T). Check motor controllers 11A2, 11A5 and 11A7 inside the cabinet with cabinet power on. Each controller should have a green blinking LED. If no LED is visible, measure the supply voltage of the respective controller with a multimeter (2 pole connector at

		<p>the top, marked + and -), voltage should be approx. 72 VDC. Check connector is fully inserted.</p> <p>A5.4 If a red LED is blinking on one of the controllers, replace the controller with a spare unit (item 223015). Contact VertiDrive support and return the controller for evaluation.</p>
A6	Cooling (optional) is not working	<p>A6.1 Check temperature inside the control box. The cooling is temperature controlled and only turned on when the temperature inside the control box is higher than 30°C.</p> <p>A6.2 Check cooling functionality by temporarily setting the thermostat located on the inside of the cabinet door to 0°C. The cooling should switch on. If not, check fuse 10F4. Replace the fuse if needed. Check 24 VDC power supply to the cooler (10A5). Remember to reset the thermostat to 30° setting after testing has been completed!</p> <p>A6.3 If the fan on the inside of the cabinet is working, but the fan on the outside is not: clean the fan on the outside using pressurized air. The cover can be removed for better access if needed.</p>
ROBOT OPERATION AND CONTROL ISSUES		
B1	Robot not moving	<p>B1.1 Check system is activated, and control circuit closed (yellow LED on control box ON).</p> <p>B1.2 Check there is no motor drive fault (red LED on control box OFF).</p> <p>B1.3 Check step timed mode is not selected.</p> <p>B1.4 Check that the drive speed setting is high enough and joystick is pushed sufficiently away from the neutral position.</p> <p>B1.4 Check magnets have sufficient clearance to surface and wheels are not slipping.</p>
B2	Pump is not triggered when switch is set to ON	<p>B2.1 Check system is activated, and control circuit closed (yellow LED on control box ON).</p> <p>B2.2 Check connection to the UHP pump. Check if relays 14K5 and 14K6 inside the control box are activated by pump switch on remote (orange LED indicator on relays should turn on).</p> <p>B2.3 Check UHP pump for any other reason the pressure supply is not working.</p>
B3	Robot lamp (optional) not working	<p>B6.1 Check if connectors on lamp and on junction box are fully inserted and tightened.</p> <p>B6.2 Check if relay 14K7 inside the control box is activated by the light button on the remote control (orange LED indicator on relay should turn on). If not responding, check fuse 15F3 inside the cabinet. Disconnect power, open fuse holder, and remove fuse for visual inspection. Replace the fuse if needed.</p> <p>B6.3 Measure voltage in control box at terminal X3 between pin 6 (light, 24 VDC) and pin 7 (GND). If 24 VDC is measured, but lamp is not working, replace the lamp with a spare unit.</p> <p>B6.4 Check umbilical cable is properly connected to both robot and control box. Try to disconnect and reconnect umbilical (both sides).</p>
MECHANICAL ISSUES		
C1	Robot detaches from the surface	<p>C1.1 Check if the rear magnet is its correct position.</p> <p>C1.2 Check the distance between the magnets and the surface. Lower the front magnets if more holding force is required.</p> <p>C1.3 Check material and thickness of metal surface. Robot functionality is only guaranteed on bare steel surfaces of minimum 8mm thickness. Coating thickness will reduce magnetic holding force.</p> <p>C1.4 Check surface on sudden large height differences (e.g., welds, bolts, overlaps, etc.) that increase magnet distance and reduce holding force. Lower the magnets to the lowest workable position and / or try to move around these surface irregularities.</p>

C2	Wheels are slipping	C2.1 Check the distance between the magnets and the surface. Lower the front magnets if more traction is required. C2.2 Clean rubber surface of wheels, check profile depth. If profile is <2mm, replace wheels (item 222049).
C3	Caster wheel not rotating (smoothly)	C3.1 Clean bearings and between surfaces. Use pressurized air or low water pressure for cleaning. C3.2 If cleaning does not solve the issue, the caster wheel needs to be replaced by a spare unit (item 113531).
C4	Gearbox makes abnormal sound	C4.1 Check fastener tightness on motor connection flange. C4.2 Replace gearbox by a spare unit (item 322074).
C5	Play on front wheels	C5.1 Check fastener tightness of (6x) wheel mounting screws. C5.2 If play is on gearbox shaft, the gearbox needs to be replaced by a spare unit (item 322074).
C6	Motor makes abnormal sound	C6.1 Check fastener tightness on gearbox connection flange. C6.2 Replace complete motor assembly (assembly of motor and gearbox) by a spare unit (item 322062).

11. STORAGE AND TRANSPORT

11.1. General



First, read the safety instructions in chapter 5. It is important to read and understand all safety instructions and to use personnel protective equipment as per local regulations and company policies.



Do not approach the robot if you have a pacemaker or implanted heart defibrillator. Keep a minimum 60 cm distance!



When handling and transporting the robot, extra caution should be taken to stay clear of the magnets. The magnets are strong and entrapment between the magnet (or robot parts) and metal objects can cause serious injuries. The magnet will also affect sensitive electronic and mechanical equipment like cell phones, watches, and (bank) cards with magnetic strips. Keep sensitive electronic and mechanical equipment at least 50 cm away from the magnets!



When carrying and handling the robot, take into consideration the total weight of 88 kg. Always follow local health and safety regulations when handling the robot.



If the system is stored for a longer time, be sure the place is dry and clean. Make sure all water is drained from the system before storage. It will prevent frost damage and legionella bacteria in the system.



12. DISMANTLING AND DISPOSAL

12.1. General



First, read the safety instructions in chapter 5. It is important to read and understand all safety instructions and to use personnel protective equipment as per local regulations and company policies.

After the useful product's lifetime, the system must be dismantled and disposed of in accordance with local safety and environmental regulations. Only personnel trained and qualified to carry out maintenance may dismantle the system.



All contaminated or harmful parts must be disposed of, following the local statutory requirements.

All magnets need to be demagnetized before disposal.



Appendix A - EU declaration of conformity



EU Declaration of conformity

We,

Company name: VertiDrive B.V.
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Postcode: 3089 JZ
City: Rotterdam
Country: The Netherlands
Telephone number: +31 (0) 10 76 20 300
Email: sales@vertidrive.nl

declare that the declaration of conformity is issued under our sole responsibility and belongs to the following product:

Object of the declaration: VertiDrive Robot for steel surface cleaning
Type: V400 Series Robot
Revision: 1.2

The object of the declaration described above is in conformity with the relevant Union harmonization legislation:

Machine directive 2006/42/EC
EMC directive 2014/30/EU

The following harmonized standards and technical specifications have been applied:

NEN-EN-ISO 12100:2010	Safety of machinery - Risk assessment and risk reduction
EN 60204-1:2018	Safety of machinery - Electrical equipment of machines - Part 1: General requirements
IEC 61000-6-2:2016-RL	Electromagnetic compatibility (EMC) - Part 6-2: Generic standards - Immunity standard for industrial environments (Redline version)
IEC 61000-6-4:2018-RL	Electromagnetic compatibility (EMC) - Part 6-4: Generic standards - Emission standard for industrial environments (Redline version with track changes)

A complete Technical File is held at Vertidrive B.V. in Rotterdam under reference: 600-23-004 V400 Series Robot

Signed for and on behalf of:

Rotterdam

28-09-2023

Place of issue

Date of issue

S.L.M. van Diessen,

Managing director

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In all cases where we act as provider or supplier, our offers, orders placed with us, and agreements concluded with us are subject to the conditions and requirements laid down by the Netherlands Metal Association (the 'Metaalunievoorwaarden'). These conditions and requirements are filed with the registrar of the District Court of Rotterdam.