

VertiDrive V700 Series Robot

User Manual

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



REVISION: 1.2
ISSUE DATE: 20-06-2023
APPLIES TO: VertiDrive V700 Series robot

VERTIDRIVE B.V.

**Gieterijweg 15
3089JZ, Rotterdam
The Netherlands
Phone: +31(0)10 76 30 200
Website: www.vertidrive.com
E-Mail: sales@vertidrive.com**

Copyright © VertiDrive B.V. All rights reserved. VertiDrive is a trade name of VertiDrive B.V.
No part of this publication may be reproduced, stored in a retrieval system, or transmitted, in any form or by any means, electronic, mechanical, photocopying, recording, or otherwise, without the prior written permission of the manufacturer.

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 specialist 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 only applies to the "V700 Series" modular carrier for various applications and does not describe the complete "VertiDrive" set of equipment with applicable tools. Upon request, different tools for the V700 Series robot are available, such as a safety winch system and specifically designed equipment. 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's 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	25-04-2023	First release for new V700 Series robot	MVP	GVE
1.1	16-05-2023	Improved descriptions regarding safety	RBE	GVE
1.2	20-06-2023	Added new magnet adjustment visuals and descriptions	RBE	GVE

CONTENTS

1.	CONTACT INFORMATION	5
1.1.	Supplier.....	5
1.2.	Support and service.....	5
2.	TERMS AND DEFINITIONS	6
3.	MACHINE SPECIFICATION	7
3.1.	General specifications	7
3.2.	CE marking and identification.....	7
3.3.	Technical specifications	7
3.4.	Applications.....	8
3.5.	Documentation.....	8
4.	PRODUCT CONFORMITY AND LIABILITY	9
4.1.	General	9
4.2.	Intended and non-intended use of the machine	9
4.3.	Responsibilities for owner and user.....	9
4.4.	Warranty	9
4.5.	Liability.....	10
4.6.	Guarantee (= warranty), or other claims	11
5.	SAFETY	12
5.1.	Symbols in this document.....	12
5.2.	Safety signs on the system.....	12
5.3.	General safety instructions.....	13
5.3.1.	Job functions, tasks, certification, and team line-up (UHP and abrasive equipment)	13
5.3.2.	Before starting	13
5.3.3.	During operation	14
5.3.4.	During maintenance / service:.....	14
5.4.	Safety provisions.....	15
5.4.1.	Emergency stop	15
5.4.2.	Wall contact sensor (WCS).....	15
5.4.3.	Whip checks	15
5.5.	Hearing protection	15
5.6.	Risk for personal injury	16
5.6.1.	Electrocution / Electric shock	16
5.6.2.	Electrical safety earth.....	16
5.6.3.	Cuts, injuries on head and feet	16
5.6.4.	Injuries on face and eyes	17
5.6.5.	Hearing damage	17
5.6.6.	Liquid injection by UHP water jet	17
5.6.7.	Crushing hand	17
5.6.8.	Magnetism.....	17
6.	SYSTEM DESCRIPTION	18
6.1.	General	18
6.2.	V700 Series robot.....	18

>	>	>	6.3. > Control box (incl. optional transport frame)	19
<	<	<	6.4. < Remote control	20
>	>	>	6.5. > Umbilical and (optional) extension kit	21
<	<	<	6.6. < Fall arrester and (optional) winch system.....	22
>	>	>	7. > INSTALLATION.....	24
<	<	<	7.1. < General	24
			7.2. Pump / valve control connection.....	24
			7.3. Handling of the Robot	26
			8. OPERATION	27
			8.1. Operating procedure	27
			8.1.1. Magnet distance adjustment	27
			8.1.2. Robot placement	29
			8.1.3. Connection and application setup	30
			8.1.4. Robot operation.....	32
			8.1.5. Application operation	33
			8.1.6. Shutting down	34
			8.1.7. WCS overrule	34
			8.1.8. Recover from an emergency stop.....	35
			9. MAINTENANCE AND CLEANING	36
			9.1. General.....	36
			9.2. Frequency of inspection and maintenance.....	36
			9.3. Inspection and maintenance activities.....	36
			9.4. Part replacement instructions.....	38
			9.5. Cleaning	38
			10. TROUBLESHOOTING	39
			11. STORAGE AND TRANSPORT	42
			11.1. General.....	42
			12. DISMANTLING AND DISPOSAL	42
			12.1. General.....	42
			APPENDIX A - EU DECLARATION OF CONFORMITY	43

1. CONTACT INFORMATION

1.1. Supplier

VertiDrive B.V.

Gieterijweg 15

3089JZ, Rotterdam

The Netherlands

Telephone: +31(0)10 76 30 200

E-Mail: sales@vertidrive.com

1.2. Support and service

VertiDrive B.V.

Gieterijweg 15

3089JZ, Rotterdam

The Netherlands

Telephone: 31(0)10 76 30 200

E-Mail: support@vertidrive.com

2. TERMS AND DEFINITIONS

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

Definition	Description
Abrasive blasting	A process of smoothing or cleaning a surface by forcing solid particles across that surface at high speeds.
Emergency shut-off	A stop button that ensures a safe situation when activated.
High-pressure water jetting system	A system that consists of a pump, hoses, and high-pressure jetting equipment, that can jet water under high pressures between 250 bar and 2000 bar.
High-pressure washing	A process of cleaning a surface using high-pressure water jets.
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, that 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.
HP	High-Pressure: Refers in this manual to high-pressure water jetting. Working pressures from 25 up to 1000 bar.
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: In this manual 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

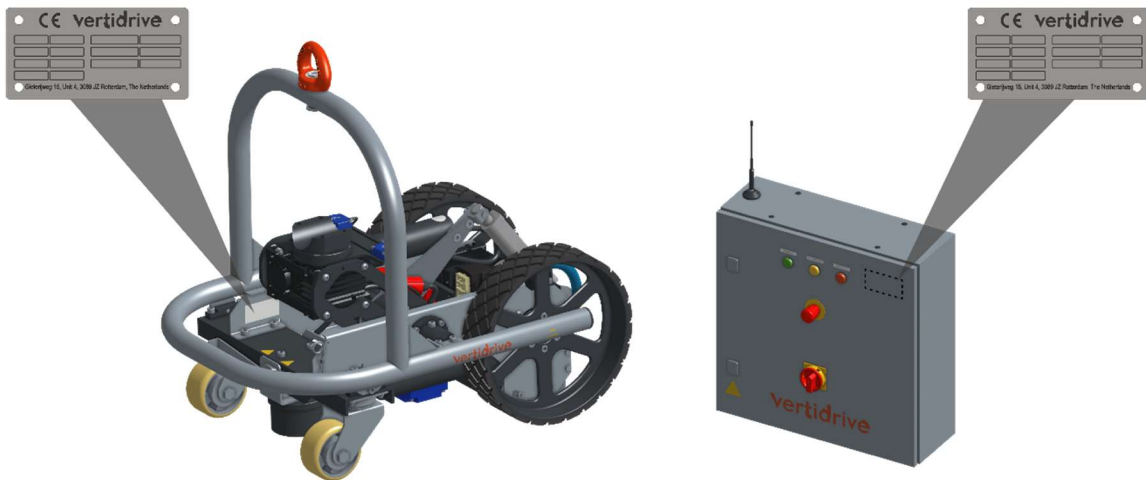
3.1. General specifications

Product description: V700 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 electrical specification.



CE mark V700 series on robot and inside control box

3.3. Technical specifications

Robot

Robot dimensions l x w x h: 750 x 520 x 720 mm.
Weight: 62 kg.
Payload capacity: 180 kg max.
Driving speed: max 4,9 m/min.

Swing arm

Torque capacity (horizontal): max 150 Nm (15 kg at 1m arm length).
Thrust capacity (vertical): max 600 N (60 kg force) at 1m arm length.
Swing arm speed: max 30 °/s.

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.

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. Applications

The V700 Series robot can be equipped with different types of applications:

- Swing arm for abrasive blasting (313550);
- Swing arm for high-pressure washing (322006, 322032, 322033 & 322034);
- Swing arm for ultra-high-pressure water blasting (310143);

Contact VertiDrive for detailed information and advice on all available applications.



The procedures for installing and using the different applications are described in the **application** user manuals.

3.5. Documentation

V700 Series robot system (standard)
User Manual VertiDrive V700 Series robot (supplied with robot system).
Control system wiring diagram (supplied with control box).
322027 V700 Series Robot – IPM (Illustrated Parts Manual).
3.4 F-03 Startup Checklist.
3.4 F-04 Inspection and Maintenance Schedule.
V700 Series ancillary equipment (optional)
Optional: Transport frame - User Manual and IPM.
Optional: Swing arm abrasive blasting - User Manual and IPM.
Optional: HP washing arm - User Manual and IPM.
Optional: UHP hydro blasting arm - User Manual and IPM.

4. PRODUCT CONFORMITY AND LIABILITY

4.1. General

The VertiDrive V700 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 V700 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 as a modular carrier for various applications for surface treatment. The robot can ONLY be used on a magnetic surface such as steel as the reaction force of the application can make the robot jump up otherwise.

The magnets will prevent this on a magnetic surface. 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 the relevant application or 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.

4.3. Responsibilities for owner and user

Any changes made to the VertiDrive V700 Series robot may lead to severe damage and injury to the operator or other personnel in the vicinity of the robot.

The VertiDrive V700 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." The warranty applies according to Article 14: 'Guarantee and other claims' from these terms and conditions unless agreed upon in writing otherwise.

In all cases, the Warranty does not cover defects that are the result of:

- normal wear and tear;
- improper use;
- lack of maintenance or maintenance carried out incorrectly;
At all times VertiDrive start-up checklists, inspection- and maintenance checklists, including registration and execution of resulting needed maintenance work, need to be consistently used and stored for reference.
- installation, assembly, modification, or repairs carried out by the Client or third parties;
- faulty or unsuitable goods originating from or prescribed by the Client;
- faulty or unsuitable materials or tools used by the Client.

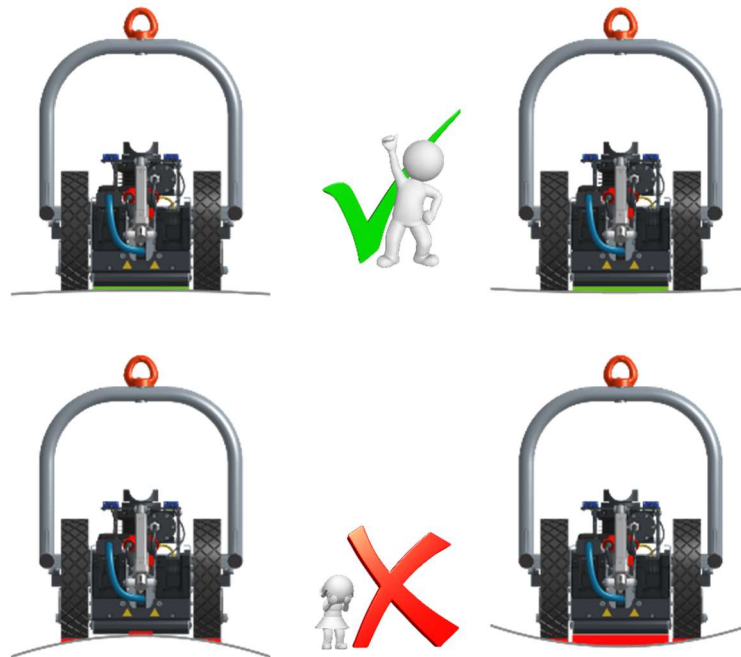
No warranty is given for:

- goods delivered that were not new at the time of delivery;
- inspections and repairs carried out on goods owned by the Client;
- parts that are subject to a manufacturer's guarantee.
- Defects due to use improper use and / or maintenance by uncertified (operations and/or maintenance) personnel.

4.5. Liability

VertiDrive B.V. accepts no liability for unsafe situations, accidents, and / or damage resulting from any of the following points:

- poor or improper inspection and/or maintenance of the product;
- the robot is explicitly **NOT** suitable for carrying people and/or objects;
- it is **NOT** permitted to modify the robot (including ancillaries and applications) in any way without prior consultation and prior written permission from VertiDrive B.V.;
- 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. Prior to starting 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

4.6. Guarantee (= warranty), or other claims

- Unless otherwise agreed in writing, VertiDrive guarantees the proper execution of the agreed delivered product performance for a period of six months after delivery or completion, as detailed in the following paragraphs;
- If the parties have agreed to deviating guarantee conditions, the provisions of this article will remain in full force, unless this is in conflict with those deviating guarantee conditions;
- The Client (=product user) is responsible for sending parts or materials that are to be repaired or replaced by VertiDrive to VertiDrive or a regional VertiDrive partner's business location;
- The following are for the Client's account:
 - All transport or shipping costs;
 - Costs for dismantling and assembly;
 - Travel and subsistence expenses and travel time;
- VertiDrive is only obliged to implement the guarantee if the Client has fulfilled all its obligations;
- The following do not qualify for compensation:
 - consequential damages. Consequential damages include inter alia business interruption losses, loss of production, loss of profit, penalties, transport costs and travel and subsistence expenses;
 - damage to property in the care, custody or control of, but not owned by the insured party. Among other things, this damage includes damage caused by or during the performance of work with the products to goods that are being worked on or to goods that are located in the vicinity of the place where the work is being carried out;
 - damage as a result of intent or willful recklessness by the Clients' staff or Clients' auxiliary staff or non-managerial subordinates;
- The provisions in [4.6](#) apply by analogy to any of the Client's claims based on breach of contract, non-conformity or any other basis whatsoever;
- The Client no longer has the right to invoke a defective part or product if it has not complained to VertiDrive or the regional VertiDrive partner concerned, in writing, within fourteen days after it discovered or should reasonably have discovered the defect;

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 serious 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 possible 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).



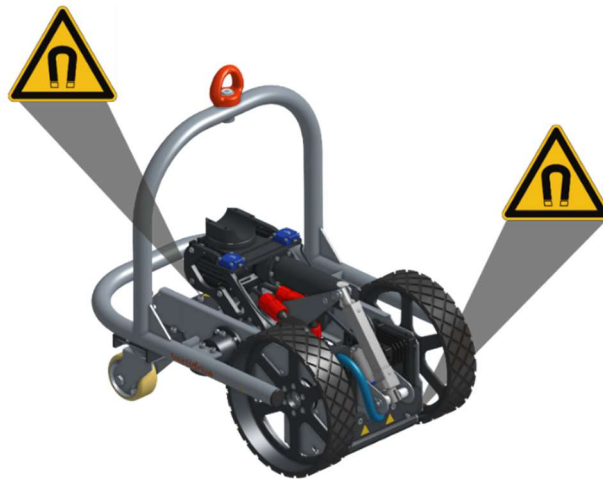
Meaning: Strong magnetic field.
Risk: Magnets produce a far-reaching, strong magnetic field. They could damage any devices that are sensitive to magnetism (e.g., phones, watches, credit cards, etc.)
Location: In between the front and back wheels, see figure below.



Meaning: Pinch point.
Risk: Pinching of hands or fingers due to moving parts.
Location: Near the wheels, 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 V700 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 you are working for. 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.

When an application is installed on the robot, the operator must be VertiDrive (or partner(s)) trained **and** certified to use this additional equipment (e.g., applicable when working with high pressure water jetting equipment). All safety precautions and instructions relevant for the application (HP, UHP or abrasive blasting) must be adhered to insofar applicable for the robot application.

Always observe the following general safety instructions:

5.3.1. Job functions, tasks, certification, and team line-up (UHP and abrasive equipment)

Operator

- Trained, educated, and certified according to local requirements for Robot and application(s) concerned;
- VertiDrive certified (or partner(s)) – **Valid**;
- 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 the 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 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 V700 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.

Applications used on the robot such as (U)HP or abrasive blasting equipment will make loud noise. Always use appropriate hearing protection. The robot can ONLY be used on a magnetic surface (steel) as the reaction force of the application can make the robot jump up otherwise! The magnets will prevent this when it is placed on a magnetic surface and allows for safe operation.

To decrease the weight to be carried by the robot, the umbilical cable, and application hose(s) can be attached to a winch or 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 off power (main switch on control box);
- Ensure that the operator is not distracted while operating;
- Keep at least 6 meters distance from the robot when activated (yellow system status LED on);
- Always pay attention to the umbilical and application hose(s) 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 close proximity and more specifically direct contact between steel tools and the magnets. The magnets are extremely strong and can result in very 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 (both drives and swing arm) and the signal to the pump / valve will be deactivated;
- A separate emergency shut-off must be available on the high-pressure water system (HP and UHP applications) or blast pot / machine (abrasive blasting applications).

Depending on the working method, the circumstances, and the variant of the blast machine or high-pressure jetting equipment, 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 on 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 / abrasive blasting system:

- Shuts off the high-pressure supply to the application on 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 it is critical that this event triggers the emergency stop of the application pump / valve as well. Refer to chapter "Installation" for how to connect the robot control system to the pump / valve. VertiDrive strongly recommends always integrating the pump / valve control, including safety stop, with the robot control system.

5.4.3. Whip checks



For machine operator protection whip-checks must be used on all HP, UHP and abrasive blasting 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 as part of an application design, or by a third party.

5.5. Hearing protection


Typical applications used on the V700 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 robot.	During the operation of the robot.	Wear a safety helmet.	
Handling robot.	During handling of the robot.	Wear protective gloves.	



5.6.4. Injuries on face and eyes

Where	When	Precaution	Warning sign / Action sign
Near robot application (HP / UHP / abrasive blasting nozzles)	During operation with HP / UHP / abrasive blasting.	Keep at least 6 meters distance. Wear face protection.	   WARNING Keep 6 meters distance while machine is in operation


5.6.5. Hearing damage

Where	When	Precaution	Warning sign / Action sign
Near robot application (HP / UHP / abrasive blasting nozzles)	During operation with HP / UHP / abrasive blasting.	Wear hearing protection. Always when 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, if a UHP pump is used.	During operation with UHP.	Wear protective clothing.	 

5.6.7. Crushing hand

Where	When	Precaution	Warning sign / Action sign
Near moving parts of the robot.	During magnet adjustment, robot movement and swing arm operation.	Keep clear of all moving parts, power off 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, keep safe distance from magnets and / or shield magnets with e.g., wooden cover.	
Near magnets	Always.	Do not approach the robot if you have a pacemaker or implanted heart defibrillator. Keep minimum 60 cm distance.	

6. SYSTEM DESCRIPTION

6.1. General

The VertiDrive V700 Series robot is a remote-controlled vehicle equipped with 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 designed as a modular carrier for different applications 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 remote control. This chapter describes all system components in detail.

Different applications can be mounted on the robot. 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. V700 Series robot



V700 Series robot

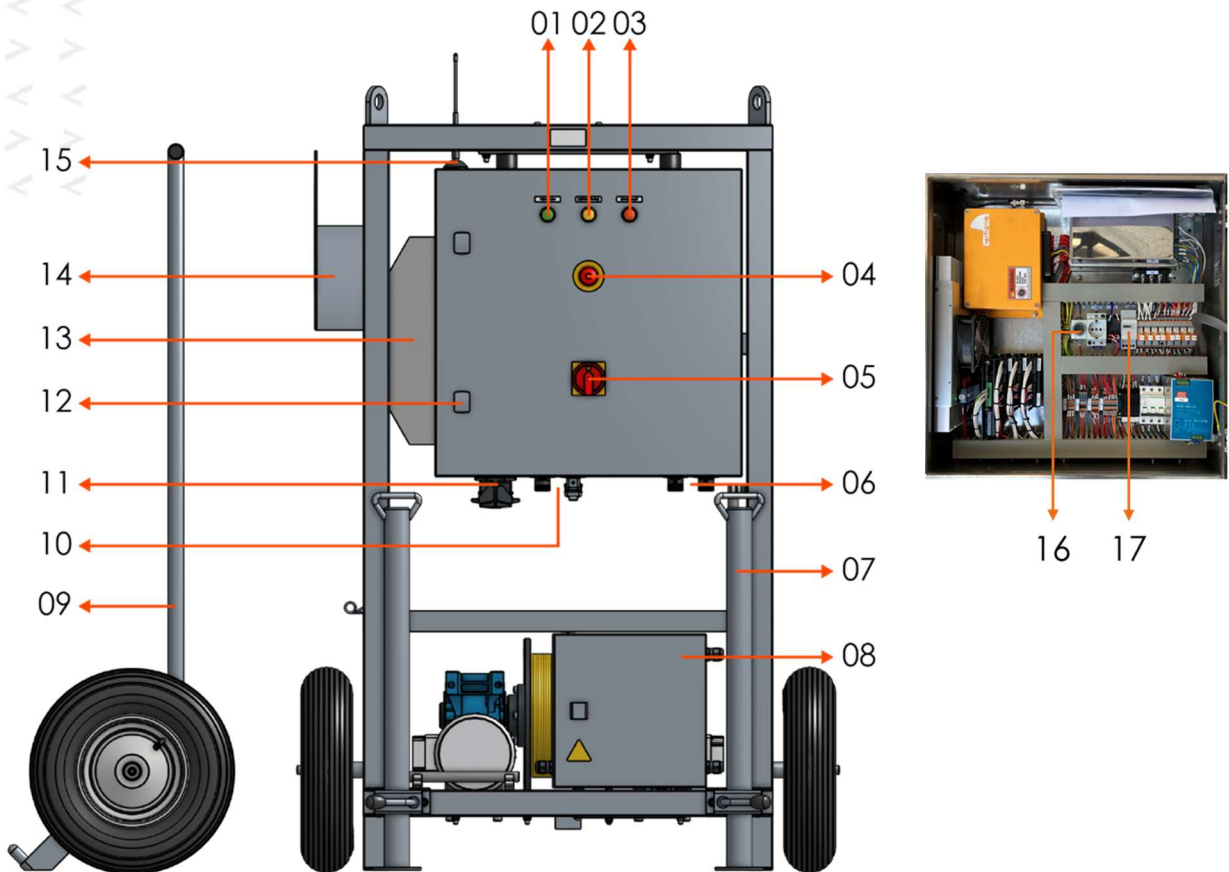
The robot is the modular carrier for the different applications and provides the following functionalities:

- Adhesion to the surface by one big front magnet located between the large wheels and a smaller magnet at the back (between the castor wheels);
- High traction and movement over the steel surface by the two large front wheels;
- Controlled movement of the application mounted on the robot, including actuator-controlled height adjustment;
- Protection of the robot and application by a robust frame and fall guard, with attachment point 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 (322027 V700 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	Yellow light turns on when the remote is connected and the system is activated (ready for use). Light blinks when wall contact switch (WCS) is not detecting a metal surface (all robot movement stops).
03	Drive fault indicator	Red light turns on when a fault is detected in the motor drive circuit, see troubleshooting section (chapter 10).
04	Emergency stop	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 & Pump connectors	Connectors for mains power and connector to activate a pump or valve for the application used with the robot.
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 distance up to 100m. Can be extended with extension kit.
16	WCS overrule	Button to overrule the wall contact switch in case of emergency, see 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 blinks rapidly, indicating good battery level and communication with the receiver. The light turns red when battery level is low.
2	Swing arm speed control	To adjust the swing arm speed.
3	Swing arm control on / off	To turn on the swing arm motion.
4	Swing arm control up / down	To adjust the swing arm / nozzle(s) distance to the surface.
5	Step control (off / slow / fast)	To select drive mode. Off will result in continuous drive mode, slow and fast will set a specific timed forward movement of the robot between swing arm sweeps, to optimize cleaning efficiency.
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 or valve, 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 / valve control	To control a pump, valve or other equipment 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	Used to stop the robot in place and repeat the swing arm sweep in reverse direction; used to pass over a specific spot an extra time.
14	Light control on / off	To turn light on/off (optional LED light on robot).
15	Activation switch.	To activate the robot control system.
16	On / off switch and safety key.	For turning 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 off position and pull on the black knob.

6.5. Umbilical and (optional) extension kit



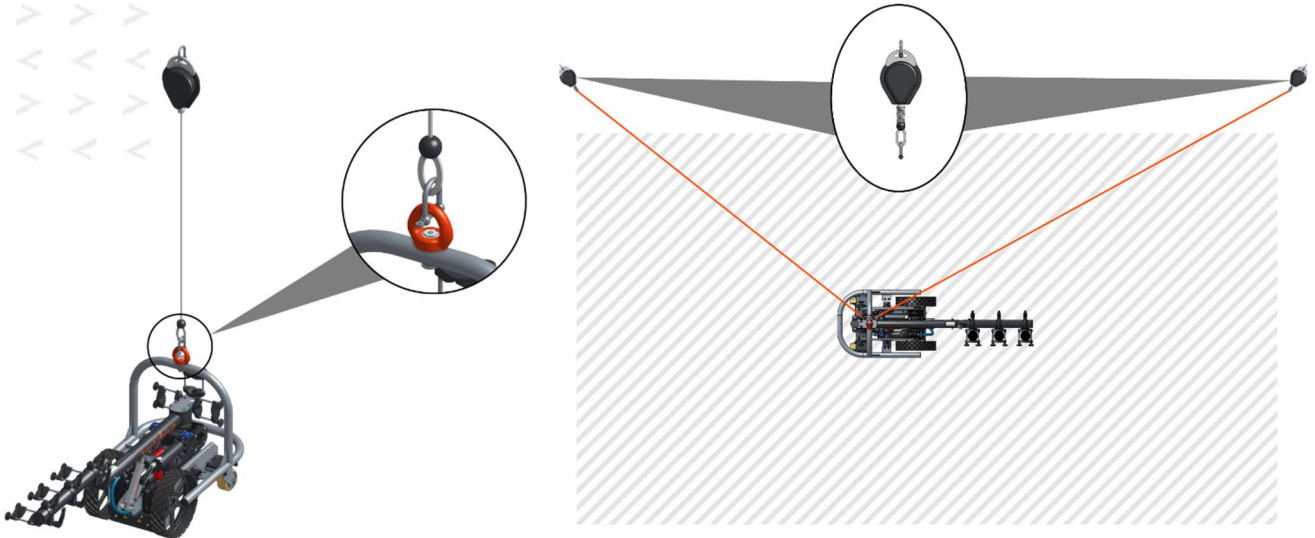
Umbilical CB4 50m on cable reel (322035)



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

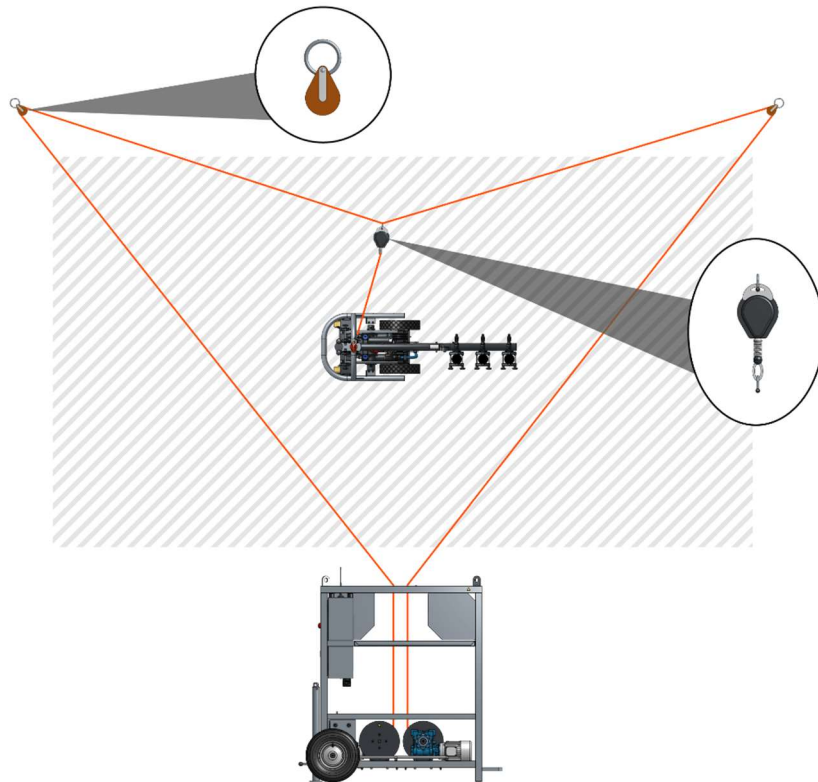


Single fall arrester (left) or dual fall arrester (right) setup for the V700 Series robot.

For worker safety it is mandatory to use a fall arrester attached to the robot as shown above.



It is very 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 in accordance with 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 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 V700 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 in accordance with 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 take into account 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 application pressure. Never connect (U)HP/blasting equipment that has a higher pressure rating than the equipment of the robot or hoses. 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 pin and security clip. When using a transport frame, attach the tension relief on the other side of the umbilical cable to the frame.

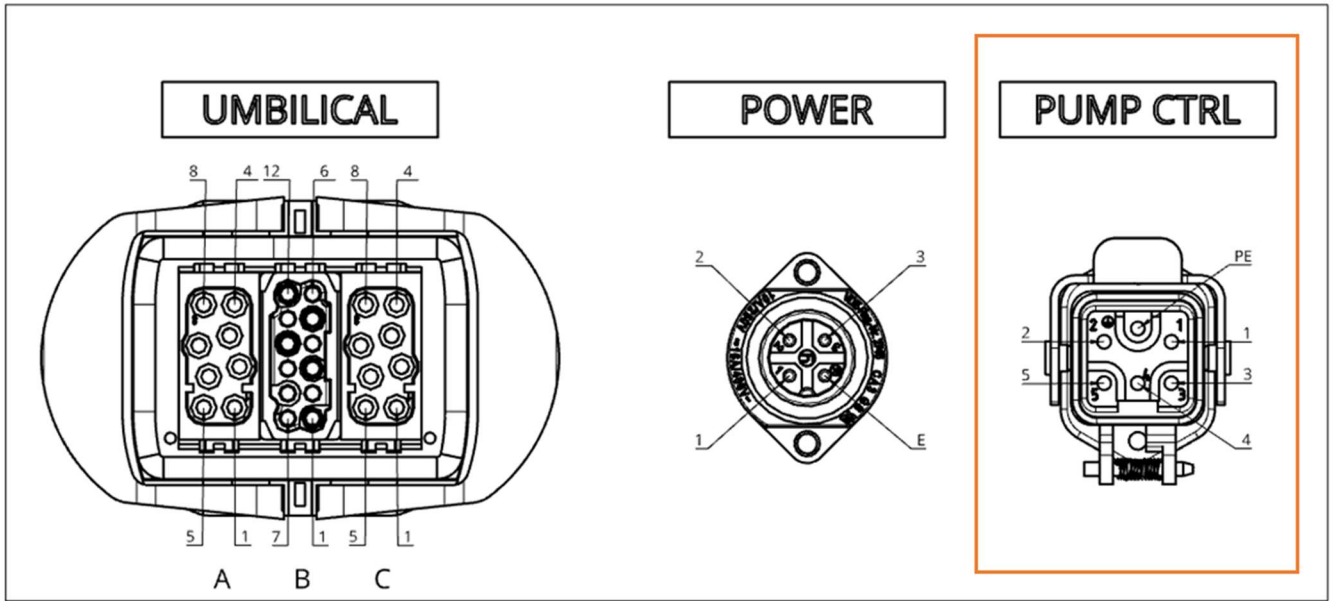


It is important to prevent the umbilical cable from getting tangled or caught between objects. Also, make sure that the power cable is always clear from the robot wheels. It is recommended to tie the umbilical cable and HP / UHP / abrasive blasting hose(s) together using proper cable binders.

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 a good 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 and / or application, always switch off power first using the main switch on the control box.

7.2. Pump / valve control connection

The robot control system is provided with a double pump / valve control, to allow operation of the application equipment using the robot remote control. Using the pump / valve control connection also integrates the application equipment in 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 equipment pressure supply to the application on the robot is immediately shut off. **It is strongly recommended to always use the pump / valve control connection to ensure worker safety. If the pump / valve control connection is not available, the user is responsible to provide other means to ensure worker safety (e.g., dead man control, separate safety operator, etc.)**



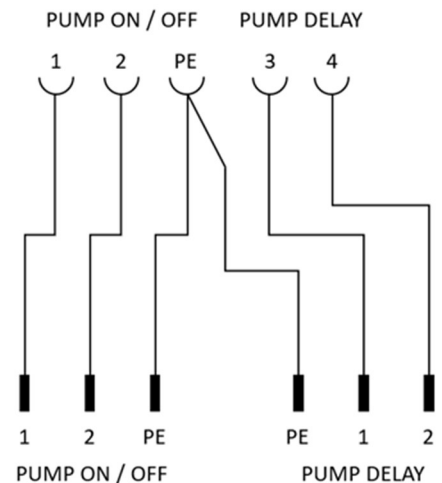
The pump / valve control connection is located on the bottom of the control box. The corresponding male connector is standard supplied with the system (item 223056). The male connector can be fitted with 1 or 2 cables depending on the number of devices connected.

The connection provides two dry contact functions to control the application equipment:

- Pins 1 and 2 provide the dry contact function of the on / off switch and is immediately activated when the pump switch on the remote control is set to "on" (if system status is active);
- Pins 3 and 4 provide the dry contact function of the delay switch and is 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).

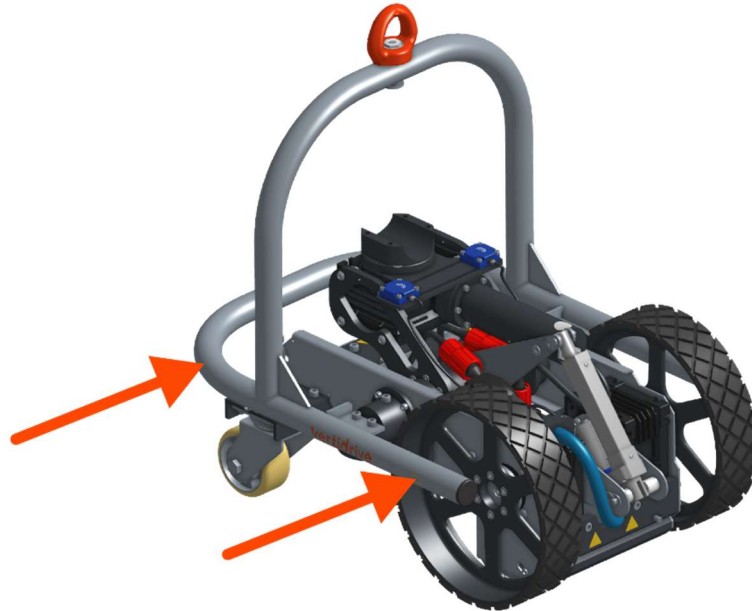
The use of the pump / valve connection is application dependent. HP / UHP pumps often require a primary and a delayed secondary "on" trigger. For abrasive blasting application the delay function is most used in multi-nozzle applications to limit the thrust on the swing arm by opening the valve of the second nozzle a short time after the first. Please refer to 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

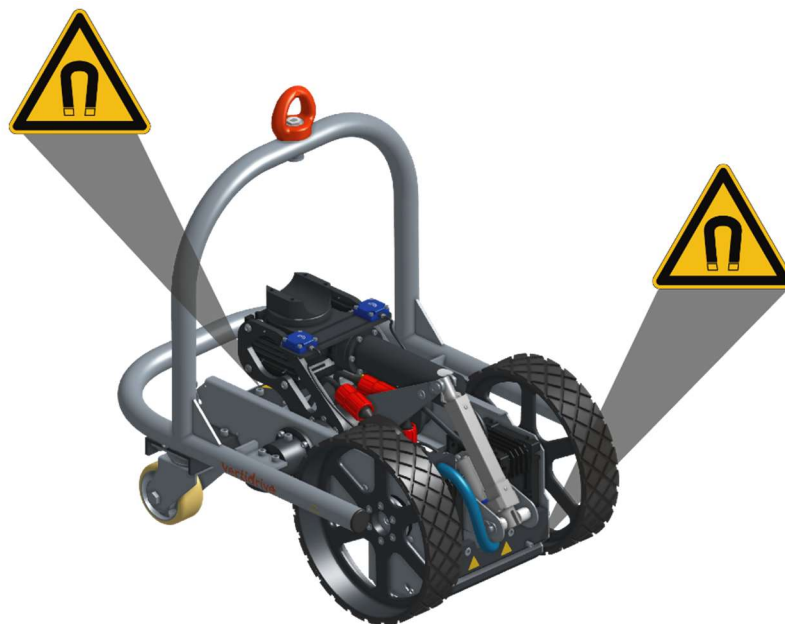
1. Only the protection frame on the robot, as indicated in the image below, should be used to carry or move the robot. Other parts are not suitable for handling / lifting the machine.
2. When carrying and handling the robot, take into consideration the total weight of 62 kg. Always follow local health and safety regulations when handling the robot.



Holding points on protection frame suitable for robot handling.



The robot has very powerful magnets between 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 very 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 very powerful magnets

8. OPERATION

8.1. Operating procedure



This chapter describes the required steps for preparation and setup, operation, and shut down 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 as per local regulations and company guidelines.

The following steps are required when using a V700 Series robot:

1. Optional: magnet distance adjustment.
2. Robot placement on surface.
3. Application setup.
4. Robot operation and application operation.

8.1.1. Magnet distance adjustment

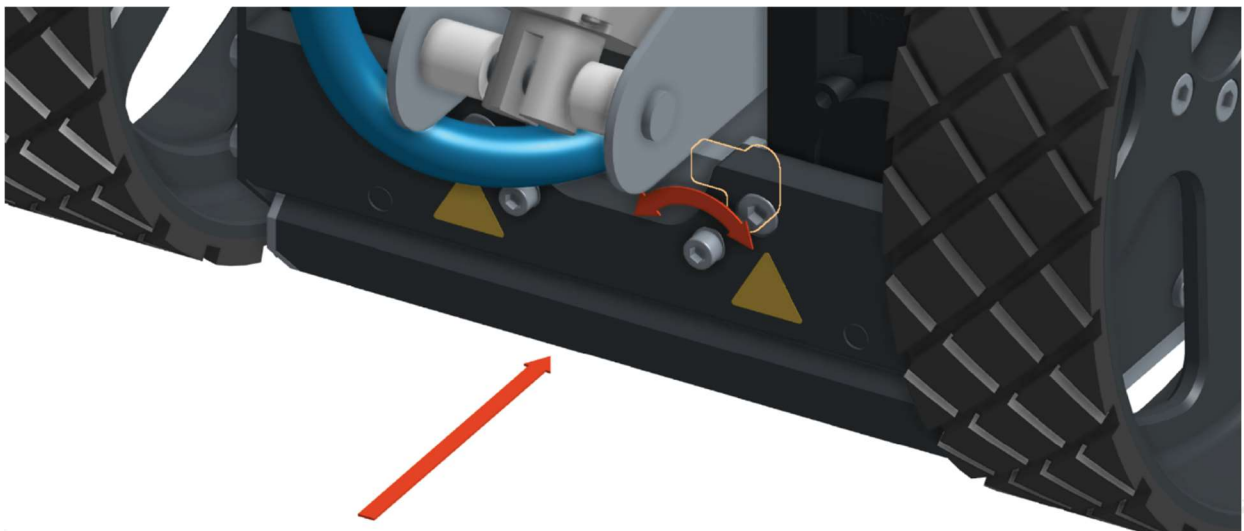
The robot contains two magnets, at the front and rear, used to create holding force to the surface. In the default configuration, these magnets are mounted as low as possible to maximize the holding force. This setting results in the most robust mounting on the surface and provides maximum wheel traction. The clearance between the magnets and the surface is 7mm in this case. If this clearance is not sufficient for the application, the magnet distance can be adjusted. Note that increasing the magnet distance will reduce the holding force and wheel traction. Finding the right balance between clearance and required holding force is application dependent.

It is strongly recommended to perform the height adjustment of the magnets before starting the application, when the robot is not placed on a metal surface. Small adjustments can be made when the robot is placed on the working surface, but this is more difficult and requires much more force.

Front magnet:

The height of the front magnet can be adjusted by twisting the two screws in the front plate. Push the magnet all the way backward and turn the screws to set the lock plates (highlighted) to one of the three available positions (low, middle, high).

Note that the set position of both lock plates (left and right) must be equal to ensure the magnet is parallel to the surface.



Default configuration (lowest position, 7mm clearance): both lock plates positioned upward. Stop rotation when lock plates hit the gearboxes. The magnet can now reach the end stop and will not exert force on the lock plates.

Increase height (higher position up to maximum 13mm clearance): to increase the height of the front magnet, push the magnet backward and turn the lock plates either 90 degrees (middle position) or 180 degrees (high position) after turning the bolt with lock plates, let the magnet slide back down onto the lock. Reminder: both lock plates should be in the same position.

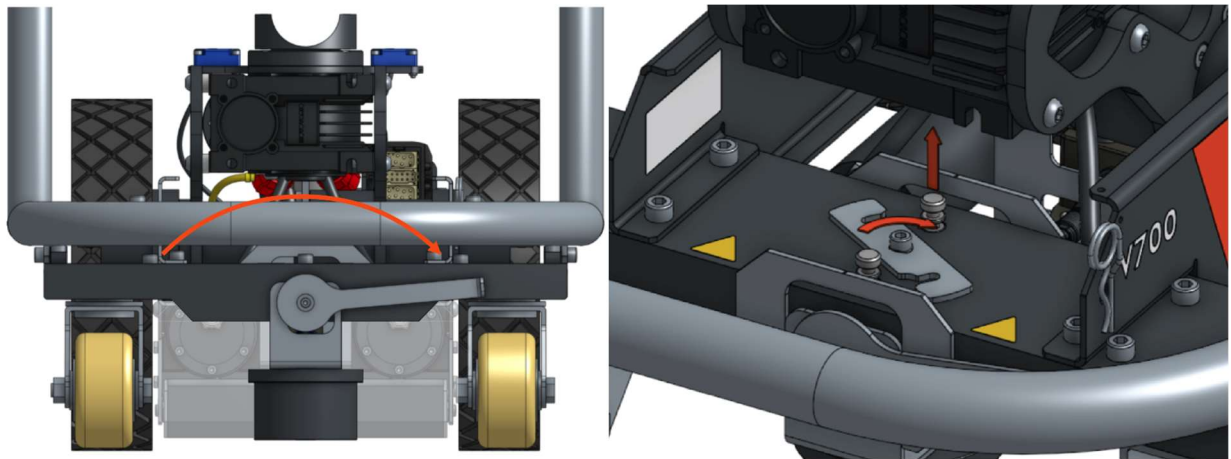
	Distance to surface (mm)	Approximate magnet force (kg)*
Default configuration	7	700 - 900
Maximum magnet height	13	300 - 400

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

Rear magnet:

The working height adjustment of the rear magnet is done with the 2 pins in the middle of the caster wheel bracket, highlighted in the picture below. The rear magnet is also provided with a lift mechanism for robot placement on the surface: in the lowest position the holding force of the magnet is very high (150 - 200kg) and it is very hard to detach the robot from the surface. By lifting the magnet (lever moved in CCW direction), the holding force is significantly reduced (to 50-60kg), greatly facilitating removal of the robot.

For height adjustment the rear magnet must be in the lowest position (lever moved in CW direction fully to the right, as shown below). The lock plate can now be rotated to unlock the pins. The magnet can be pushed up to the 'high' position which exposes the second groove in the pins. The lock plate can now be rotated back into place, locking the magnet in its position. For the 'low' position, this procedure is reversed.

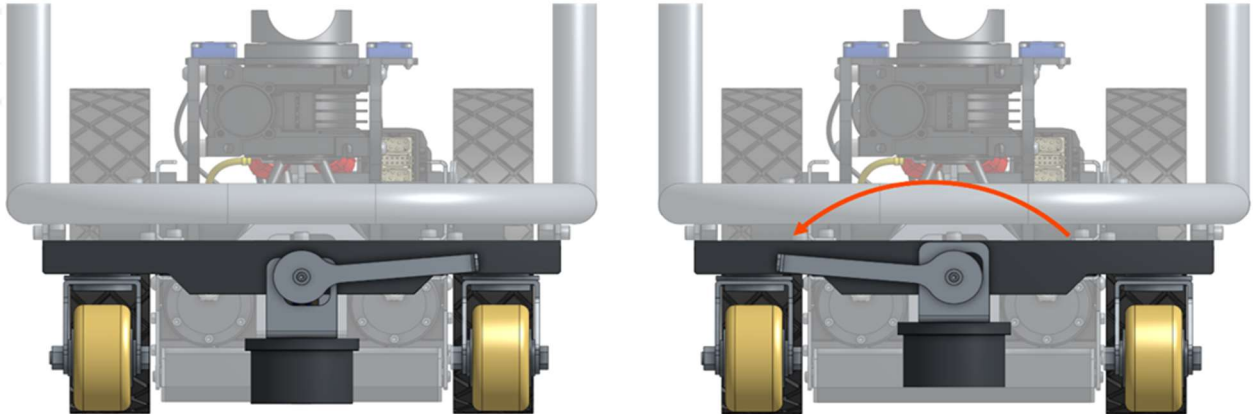


	Distance to surface (mm)	Approximate magnet force (kg)*
Default configuration	7	150 - 180
Maximum magnet height	13	100 - 120

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

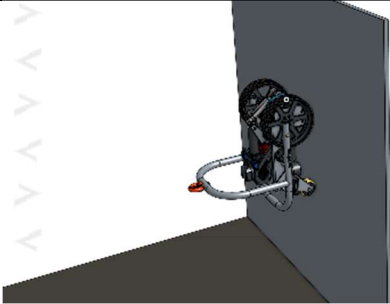
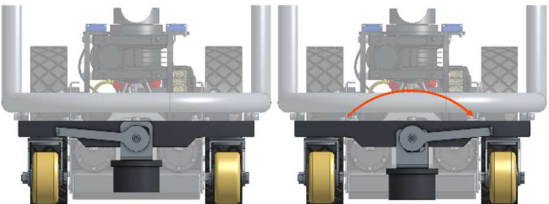
8.1.2. Robot placement

Always lift the rear magnet to the high position before placing the robot on the surface:



Only use the protection frame for handling the robot (see section 7.3). Placement of the robot on the surface must be done without the application (swing arm) mounted on the robot.

	<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 protection frame 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. <p>Avoid entrapment of hands and / or fingers!</p>
	<ol style="list-style-type: none"> 3. Rotate the robot to lower the caster wheels to the surface. <p>Avoid entrapment of hands and / or fingers!</p>

	<p>4. Magnetism will directly hold the robot in place on the surface. Robot frame can now be released.</p>
	<p>5. Rotate the lever in CW direction to lower the rear magnet to the working position. Guide the handle throughout the entire motion to ensure a smooth transition.</p> <p>Avoid entrapment of hands and / or fingers!</p>

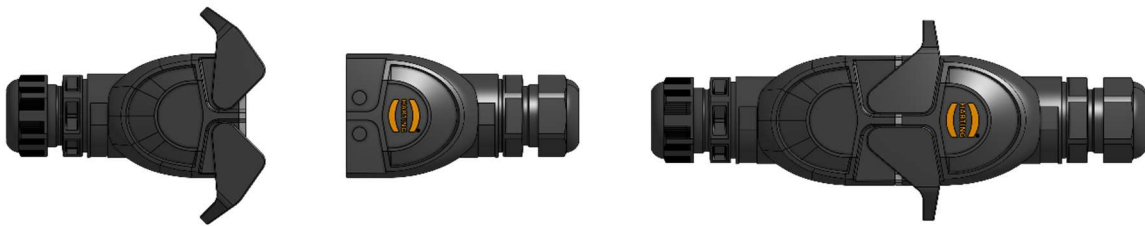


To remove the robot from the surface, lift the rear magnet to the highest position and follow the steps above in the opposite order. **Make sure the application (swing arm) is removed from the robot before removal, otherwise the robot will not be able to rotate sufficiently to detach from the wall.**

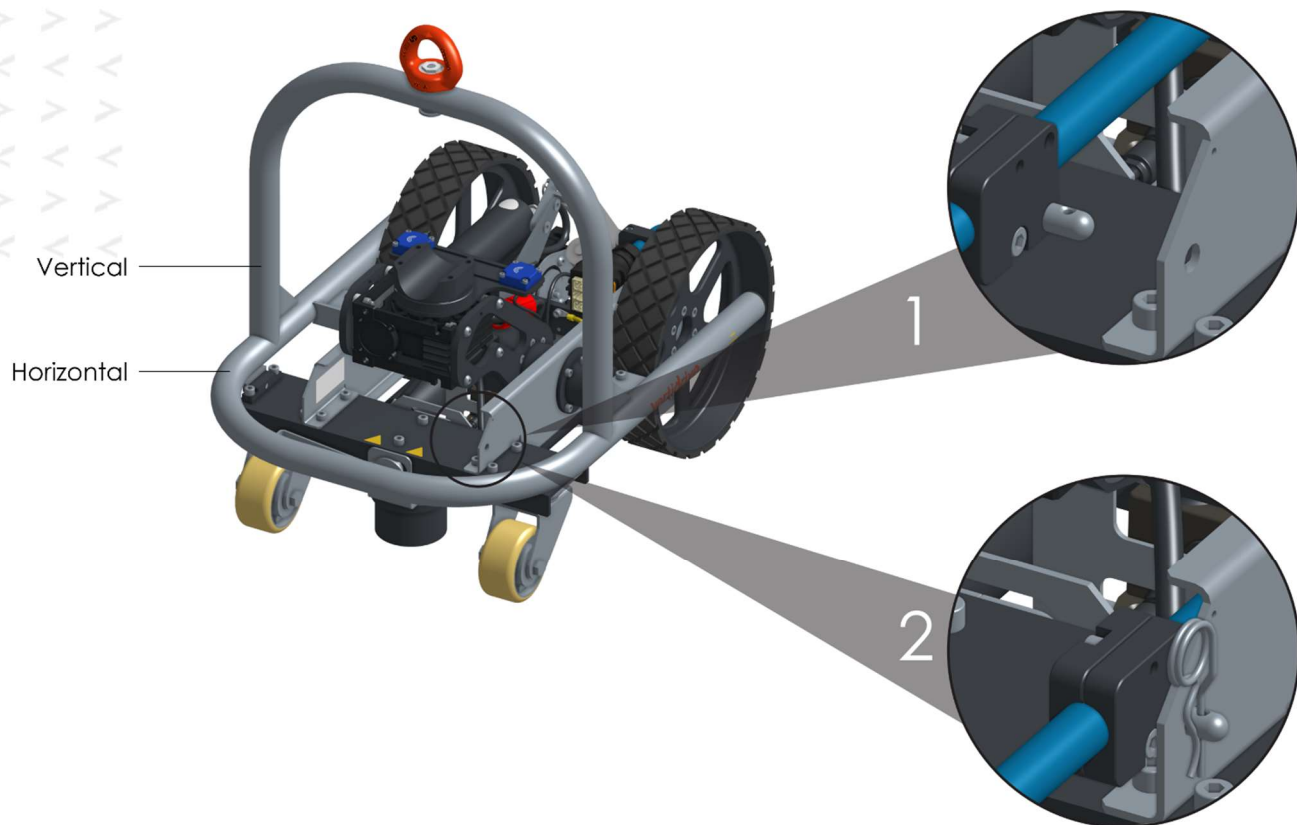
8.1.3. Connection and application setup

Once the robot is placed on the surface, the application (swing arm) can be mounted on the robot and the umbilical cable connected:

1. Mount the swing arm with application to the robot (see application manual for details).
2. Unroll the entire umbilical cable to allow for free movement of the robot.
3. Remove the protection caps from the connectors (robot and umbilical cable).
4. Tilt the connector on the robot up and insert umbilical cable connector. **Important: tilt the connector maximum 45°. Larger angles can damage the cable on the robot.**
5. Connect the male and female connector and close the locking levers as shown below. In the correct orientation, the pin on the tension relief is facing the side plate.



6. Carefully position the umbilical cable within the robotic frame, parallel to the side plate.
7. Put the pin on the tension relief through the hole in the side plate and secure with the locking pin as shown in the picture below.



8. 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. Ensure that the umbilical cable is placed above the horizontal bar of the protection frame and clear from the robot wheels.



8.1.4. 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. Orange 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 and swing arm, as well as the pump / valve 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 V700 Series robot has multiple functionalities, that 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.
 - For optimal application process control, the step time control (5) is used. When selected, the robot will drive a specific distance forward between swing arm sweeps. While the swing arm is performing the application (within the effective range of the swing arm) the robot will not move forward. This function results in a very effective and constant application pattern on the surface. The step time control has two settings, depending on the required distance between application sweeps: the slow setting allows maximum 10cm (4") movement between sweeps, the fast setting allows 20cm (8") movement. It is recommended to use the slow setting whenever possible and only switch to the fast setting when more than 10cm distance between sweeps is required for the application.

- > Swing arm
 - The swing arm on / off switch (3) controls the movement of the swing arm.
 - The swing arm speed can be adjusted with the swing arm speed control (2).
 - By pressing the swing arm overrule button (13) on the left side, the swing arm direction is temporarily changed, and robot forward movement is stopped. This function is used when a single pass of the application is not sufficient to achieve the desired result and an additional pass of the application nozzle(s) over the same spot is needed.
 - The range of the swing arm sweep is determined by the position of the two limit switches. To change, loosen the limit switch screws half a turn and move the switch to the required position, retighten screws (hand tighten only).
 - To change the application distance to the surface, use the swing arm up / down toggle switch (4) to move the swing arm towards or away from the surface. Note that the application pressure supply must be turned off (pump switch (10) "off") for this function to work.
- 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 application pressure supply of connected application equipment.
- 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 application pressure supply (if the pump / valve 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.

8.1.5. Application operation

This section describes the general steps to set up the robot for different applications. See the respective application manuals for more detailed information.

1. Mount the required application on the robot.
2. Install the nozzle(s) and set the correct position and orientation.
3. Adjust the application distance to the surface by moving the swing arm up or down as described in the previous section.
4. Set the swing arm speed control to approximately 50%.
5. Turn on the swing arm movement to test its operation. Keep your hand on the emergency button and push in case of collision or unexpected behavior.
6. Check the swing arm range and adjust if needed by adjusting the position of one or both limit switches as described in the previous section.
7. Set the drive's speed control to approximately 50%.
8. Check the robot movement by operating the joystick. Use the adjust knob if the robot does not move in a straight line.
9. Set pump switch to "on" to activate the pump or open the valve(s) of the blasting equipment.
10. Turn the swing arm on and adjust speed until a good result is achieved.

11. Next optimize the step control and drive speed settings for optimal performance with minimum overlap between sweeps whilst maintaining a closed pattern. Start with step timer in slow setting and adjust speed. Switch to fast setting only if maximum speed still gives insufficient forward movement between sweeps.
12. Start application. Use the swing arm overrule if a spot is not sufficiently cleaned and an additional pass over the same spot is required.
13. Turn on the light when required.
14. 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. This choice of operation may depend on the application.
15. 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. Especially in step timer mode it is easier to correct the position using the adjust knob than with the joystick.
16. To stop the application at the end of a lane or at the end of the job, always switch off the pump / valve first to stop the supply of application pressure and then stop the swing arm movement.

8.1.6. Shutting down

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

1. Turn off all remote application functions in the following order:
 - a. Pump / valve off.
 - b. Swing arm off.
 - c. Step control off.
2. Move the robot down to a suitable location for detachment, approx. 1 meter above the ground, within easy reach.
3. 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".
4. Remove the application / swing arm from the robot.
5. Disconnect the umbilical cable and attach all protection covers to the connectors.
6. Lift the rear magnet by turning the lever in CCW direction.
7. Using only the protection frame for handling, remove the robot from the surface in the following order:
 - 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.

8.1.7. WCS overrule


The robot system uses a wall contact switch (WCS) for safety, to ensure that the robot and connected equipment 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.

8.1.8. 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 8.1.4, startup).

 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 2 very 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 very 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.



Maintenance may only be performed by trained and qualified personnel!



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. Always replace parts with original components as illustrated in the parts manual.

In general, the robot needs little maintenance besides regular cleaning. The wheels are the only common wear parts and need replacement in case of worn rubber profile. Other parts only need to be replaced if inspection reveals any issues, either due to damage or mechanical wear.

9.3. Inspection and maintenance activities

The following checks are required for the V700 Series robot (3.4 F-04 Inspection and Maintenance Schedule). See 322027 V700 Series Robot – IPM for explanation and details on robot parts and components:

ROBOT:

- Robot frame: check for damages, clean, check tightness of all screws.
- Protection frame: check for damages, clean, check integrity of lifting eye and tightness of mounting nut, apply suitable anti-seize lubricant (e.g., Loctite LB8156) on (6x) 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.
- Front magnet: 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 very inspect 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 magnet for cleaning. **Disassembly and removal of the magnet for cleaning may only be done by VertiDrive or trained and qualified representatives.**

- Rear magnet: 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 very hard to remove this contamination from the magnet surface. Use a brush or a damp cloth in this case.
- Drive and swing arm 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.
- Swing arm limit switches: 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 the swing arm tube is placed directly over the sensor at maximum 6mm distance.
- Swing arm actuator: clean with compressed air and/or WD40 or similar, check for damages (actuator and cable), move for full range up and down to check functionality. Check for any abnormal sounds during operation. The actuator is completely sealed and supplied with lubricant for life. If inspection reveals any issues with the actuator, the complete unit must be replaced.

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.

(ULTRA) HIGH PRESSURE EQUIPMENT:

- Hoses: unroll hose, clean, and check entire length of hose on damages, replace immediately if damaged.
- Connectors: clean, check for damages (casing and seals), check if no water comes out of leakage holes if pressure is applied.
- Ensure there are functional whip checks on all connections.



Check the applicable user manual(s) for inspection and maintenance instructions for the application and 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 322027 V700 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.

9.5. 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 (swing arm, drives, magnet height adjustment and 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 very 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 V700 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 very 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 turn on its side. Press the teach button on the sensor (located next to the indicator LEDs) for 3 seconds. Green LED will blink 3 times, when it's constant ON the calibration is completed. Place robot on metal surface to test WCS. If A4.4 to A4.6 fail, replace the WCS sensor 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, or if selected that swing arm movement is ON.</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	Swing arm not moving	<p>B2.1 Check system is activated and the control circuit closed (yellow LED on control box ON).</p> <p>B2.2 Check there is no motor drive fault (red LED on control box OFF).</p> <p>B2.3 Check that swing arm speed setting is high enough</p>
B3	Swing arm not reversed by limit switch sensor(s)	<p>B3.1 Check that limit switches are powered: green LED on sensor must be ON.</p> <p>B3.2 Check that limit switches are detecting the swing arm tube: orange LED on the sensor must turn ON when the swing arm is directly above the sensor at max 6mm distance.</p> <p>B3.3 Recalibrate the sensor: remove the swing arm from the robot. Press the teach button on the sensor (located next to the indicator LEDs) for 3 seconds. Green LED will blink 3 times, when it's constant ON the calibration is completed. Put the swing arm above the sensor at max 6mm distance to test the limit switch.</p> <p>B3.4 If B3.1 or B3.2 fails, replace the limit switch with a spare unit (item 322010).</p> <p>B3.5 Check that the gap between the limit switch and the swing arm tube is max 4mm. If the gap is larger, correct the mounting of the swing arm on the robot.</p> <p>B3.6 Check limit switch connectors on the junction box are on the correct side (left sensor on left side) and fully inserted and tightened.</p> <p>B3.7 Check umbilical cable is properly connected to both robot and control box. Try to disconnect and reconnect umbilical (both sides).</p> <p>B3.8 Activate left sensor (orange LED is ON) and measure voltage in control box at terminal X3 between pin 1 (left sensor signal, 24 VDC) and pin 4 (GND), Activate right sensor and measure between pin 3 (right sensor signal, 24 VDC) and pin 4 (GND). Voltage must be >22 VDC. If no voltage is measured, replace umbilical cable with a spare unit (item 322035).</p>

B4	Swing arm up / down actuator not working	<p>B4.1 Check system is activated (yellow LED on control box ON or blinking).</p> <p>B4.2 Check that the pump switch is set to OFF. When the application pressure supply is on (pump switch ON), the actuator is not allowed to move (safety interlock).</p> <p>B4.3 Check if relays 14K8 and 14K9 in the control box are responding to the toggle switch on the remote (orange LED indicator on relays should turn on when activated). If not responding, check fuse 15F5 inside the cabinet. Disconnect power, open fuse holder, and remove fuse for visual inspection. Replace the fuse if needed.</p> <p>B4.4 If relays are responding, but actuator is not moving, replace the actuator with a spare unit (item 322008).</p> <p>B4.5 Check actuator connector on the junction box is fully inserted and tightened.</p> <p>B4.6 Check umbilical cable is properly connected to both robot and control box. Try to disconnect and reconnect umbilical (both sides).</p>
B5	Pump / valve is not triggered when switch is set to ON	<p>B5.1 Check system is activated and control circuit closed (yellow LED on control box ON).</p> <p>B5.2 Check connection to the application equipment. 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>B5.3 Check application equipment for any other reason why the application pressure supply is not working.</p>
B6	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 lowered.</p> <p>C1.2 Check the distance between the magnets and the surface. Lower the 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	<p>C2.1 Check the distance between the magnets and the surface. Lower the magnets if more traction is required.</p> <p>C2.2 Clean rubber surface of wheels, check profile depth. If profile is <2mm, replace wheels (item 222049).</p> <p>C2.3 If the application allows for it, clean the surface in front of wheels to ensure robot is placed on clean / bare steel.</p>

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 323003).
C7	Play on swing arm actuator	C7.1 Replace actuator by a spare unit (item 322008).

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 very 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 62 kg. Always follow local health and safety regulations when handling the robot.



If the system is stored for a longer time, cover the equipment and 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

vertidrive

EU Declaration
of
conformity



EU Declaration of conformity

We,

Company name: VertiDrive B.V.
Postal address: Gieterijweg 15
Postcode: 3089 JZ
City: Rotterdam
Country: The Netherlands
Telephone number: +31 (0) 10 76 30 200
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(s): V700 Series robot
Revision: 1.1

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: 600-23-003 V700 Series robot

Signed for and on behalf of:

Rotterdam

23-05-2023

Place of issue

Date of issue

S.L.M. van Diessen,

Managing director