This document describes the following products:

- **V-273.440**
  PIMag® voice coil linear actuator, 20 mm, 6 N, linear encoder, 0.01 µm resolution

- **V-273.441**
  PIMag® voice coil linear actuator, 20 mm, 6 N, linear encoder, 0.01 µm resolution, force sensor
1 About this Document

In this Chapter

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1.1 Objective and Target Audience of this User Manual

This manual contains information on the intended use of the V-273.

It assumes that the reader has a fundamental understanding of basic servo systems as well as
motion control concepts and applicable safety procedures.

The latest versions of the user manuals are available for download (p. 3) on our website.

1.2 Symbols and Typographic Conventions

The following symbols and typographic conventions are used in this user manual:

CAUTION

Dangerous situation
If not avoided, the dangerous situation will result in minor injury.

➢ Actions to take to avoid the risk.

NOTICE

Dangerous situation
If not avoided, the dangerous situation will result in damage to the equipment.

➢ Actions to take to avoid the situation.

INFORMATION

Information for easier handling, tricks, tips, etc.
1 About this Document

Symbol/Label | Meaning
---|---
1. | Action consisting of several steps whose sequential order must be observed
2. | Action consisting of one or several steps whose sequential order is irrelevant
• | Lists
p. 5 | Cross-reference to page 5
RS-232 | Labeling of an operating element on the product (example: socket of the RS-232 interface)

Warning sign affixed to the product that refers to detailed information in this manual.

1.3 Definition of Terms

<table>
<thead>
<tr>
<th>Term</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>VC linear actuator / VC linear drive</td>
<td>VC = Voice Coil&lt;br&gt;The feed is generated by the Lorentz force on an energized coil (PIMag® principle) that couples to a runner. The V-273 thus combines a relatively long travel range with a high velocity and a high resolution.</td>
</tr>
<tr>
<td>Max. push/pull force</td>
<td>Maximum force in the direction of motion.&lt;br&gt;Position or velocity control:&lt;br&gt;When a counterforce is exerted on the linear actuator, the linear actuator counteracts it with maximum force to maintain the target position or target velocity. When the counterforce exceeds the specified value of the push/pull force (p. 35), displacements or changes in velocity can occur.&lt;br&gt;Force control:&lt;br&gt;When a counterforce is exerted on the linear actuator, the linear actuator maximally counteracts it with the target force value. If the counterforce exceeds the target force value, displacements are possible.&lt;br&gt;When the servo mode is switched off, the weight force of the moving mass can be compensated for by an AutoZero procedure (see user manual of the C-413 controller).</td>
</tr>
<tr>
<td>Incremental position sensor</td>
<td>Sensor (encoder) for capturing changes of position or changes of angle. Signals from the incremental position sensor are used for axis position feedback. After the controller is switched on, a reference point definition must be performed before absolute target positions can be commanded and reached.</td>
</tr>
</tbody>
</table>
1.4 Figures

For better understandability, the colors, proportions, and degree of detail in illustrations can deviate from the actual circumstances. Photographic illustrations may also differ and must not be seen as guaranteed properties.

1.5 Other Applicable Documents

The devices and software tools from PI mentioned in this documentation are described in their own manuals.

<table>
<thead>
<tr>
<th>Product</th>
<th>Document</th>
</tr>
</thead>
<tbody>
<tr>
<td>C-413 PIMag® Controller</td>
<td>MS224E User Manual</td>
</tr>
<tr>
<td>PIMikroMove</td>
<td>SM148E Software Manual</td>
</tr>
</tbody>
</table>

1.6 Downloading Manuals

**INFORMATION**

If a manual is missing or problems occur with downloading:
- Contact our customer service department (p. 33).

**INFORMATION**

For products that are supplied with software (CD in the scope of delivery), access to the manuals is protected by a password. Protected content is only displayed on the website after entering the access data.
You need the product CD to get the access data.

**For products with CD: Get access data**

1. Insert the product CD into the PC drive.
2. Switch to the Manuals directory on the CD.
3. In the Manuals directory, open the Release News (file including releasenews in the file name).
4. Get the access data for downloading protected content in the "User login for software download" section of the Release News. Possible methods for getting the access data:
   - Link to a page for registering and requesting the access data
   - User name and password is specified
5. If the access data needs to be requested via a registration page:
1 About this Document

a) Follow the link in the Release News.
b) Enter the required information in the browser window.
c) Click \textit{Show login data} in the browser window.
d) Note the user name and password shown in the browser window.

\textbf{Downloading manuals} \\
If you have requested access data for protected contents via a registration page (see above):

- Click the links in the browser window to change to the content for your product and log in using the access data that you received.

\textbf{General procedure:}

1. Open the website \texttt{www.pi.ws}.
2. If access to the manuals is protected by a password:
   a) Click \textit{Login}.
   b) Log in with the user name and password.
3. Click \textit{Search}.
4. Enter the product number up to the period (e.g., P-882) or the product family (e.g., PICMA® Bender) into the search field.
5. Click \textit{Start search} or press the \texttt{Enter} key.
6. Open the corresponding product detail page in the list of search results:
   a) If necessary: Scroll down the list.
   b) If necessary: Click \textit{Load more results} at the bottom of the list.
   c) Click the corresponding product in the list.
7. Click the \textit{Downloads} tab.
   The manuals are shown under \textit{Documentation}.
8. Click the desired manual and save it to the hard disk of your PC or to a data storage medium.
2 Safety

In this Chapter

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General Safety Instructions ............................................................................................................. 5
Organizational Measures .................................................................................................................. 6

2.1 Intended Use

The V-273 is a laboratory device as defined by DIN EN 61010-1. It is intended for indoor use and
use in an environment which is free of dirt, oil, and lubricants.

The V-273 has a VC linear drive (p. 2), a position sensor and, depending on the model, a force
sensor as well. The V-273 is intended for positioning, adjusting and shifting loads in one axis at
various velocities and with defined forces.

The V-273 is a linear actuator for applications in automation or handling technology. The V-273
is not intended for applications in areas in which a failure would present severe risks to human
beings or the environment.

The intended use of the V-273 is only possible when installed and in conjunction with a suitable
controller (p. 11). The controller is not included in the scope of delivery of the V-273.

2.2 General Safety Instructions

The V-273 is built according to state-of-the-art technology and recognized safety standards.
Improper use can result in personal injury and/or damage to the V-273.

➢ Only use the V-273 for its intended purpose, and only use it if it is in a good working
order.

➢ Read the user manual.

➢ Immediately eliminate any faults and malfunctions that are likely to affect safety.

The operator is responsible for the correct installation and operation of the V-273.
2.3 Organizational Measures

User manual

➢ Always keep this user manual available when using the V-273. The latest versions of the user manuals are available for download (p. 3) on our website.

➢ Add all information given by the manufacturer to the user manual, for example supplements or technical notes.

➢ If you give the V-273 to other users, also include this user manual as well as other relevant information provided by the manufacturer.

➢ Only use the device on the basis of the complete user manual. If your user manual is incomplete and is therefore missing important information, damage to equipment can result.

➢ Only install and operate the V-273 after you have read and understood this user manual.

Personnel qualification

The V-273 may only be installed, started up, operated, maintained, and cleaned by authorized and appropriately qualified personnel.
3 Product Description

In this Chapter

Model Overview ..................................................................................................................................... 7
Product View .................................................................................................................................. 7
Scope of Delivery ............................................................................................................................ 11
Suitable Controllers ...................................................................................................................... 11
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3.1 Model Overview

Two standard versions of the V-273 linear actuator are available. They differ with regard to the force sensor and therefore the dimensions.

<table>
<thead>
<tr>
<th>Model</th>
<th>Dimension</th>
<th>Force sensor present?</th>
</tr>
</thead>
<tbody>
<tr>
<td>V-273.440</td>
<td>200 mm x 53 mm x 37.2 mm</td>
<td>No</td>
</tr>
<tr>
<td>V-273.441</td>
<td>205.5 mm x 53 mm x 37.2 mm</td>
<td>Yes</td>
</tr>
</tbody>
</table>

➢ For further technical data, see the specifications (p. 35).

3.2 Product View

3.2.1 Overview

Figure 1: V-273.440 (left) and V-273.441 (right)
3.2.2 Product Details

Figure 2: Front side of the linear actuator, here V-273.440

1. Runner (= guide rail)
2. Housing
3. Connection for motor cable (panel plug, Sub-D 15)
   x Positive direction of motion

Figure 3: Front side of the linear actuator, here V-273.441

1. Cable exit of the force sensor
2. Exchangeable contact part of the force sensor
3. Force sensor
4. Runner (= guide rail)
5. Housing
6. Connection for motor cable (panel plug, Sub-D 15)
   x Positive direction of motion
3 Product Description

Figure 4: V901B0030 adapter for the connection of the motor cable

1 Connection for motor cable (socket, Sub-D 15)
2 Connection for controller (connector, Sub-D 15)

Figure 5: Force sensor

1 M3 threaded bolt for screwing the contact part onto the force sensor
3 Product Description

Figure 6: Transport safeguard on the side of the linear actuator V-273.44x, hole pattern and the transport safeguard are identical for the V-273.440 and V-273.441

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Transport safeguard (bracket with 2 M3x8 screws)</td>
</tr>
<tr>
<td>2</td>
<td>Housing</td>
</tr>
</tbody>
</table>

3.2.3 Product Labeling

On the housing of the V-273, there is a type plate with the following information:

<table>
<thead>
<tr>
<th>Labeling</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>V-273.440</td>
<td>Product name (example), the characters following the period refer to the model</td>
</tr>
<tr>
<td>116003601</td>
<td>Serial number (example), individual for each V-273</td>
</tr>
<tr>
<td></td>
<td>Meaning of the places (counting from left): 1 = internal information, 2 and 3 = year of manufacture, 4 to 9 = consecutive numbers</td>
</tr>
<tr>
<td>PI</td>
<td>Manufacturer's logo</td>
</tr>
<tr>
<td>!</td>
<td>Warning sign &quot;Observe manual!&quot;</td>
</tr>
<tr>
<td>🗑️</td>
<td>Old equipment disposal (p. 45)</td>
</tr>
<tr>
<td>Country of origin: Germany</td>
<td>Country of origin</td>
</tr>
<tr>
<td><a href="http://WWW.PI.WS">WWW.PI.WS</a></td>
<td>Manufacturer's address (website)</td>
</tr>
<tr>
<td>CE</td>
<td>CE conformity mark</td>
</tr>
</tbody>
</table>
**3 Product Description**

V901B0030: Labeling of the Sub-D 15 (m/f) adapter

![Labeling of V901B0030 adapter](image)

1. Label with product name of the adapter
2. Label with product name and serial number of the actuator for which the adapter is intended

**3.3 Scope of Delivery**

<table>
<thead>
<tr>
<th>Item number</th>
<th>Component</th>
</tr>
</thead>
<tbody>
<tr>
<td>V-273</td>
<td>Linear actuator according to order (p. 7)</td>
</tr>
<tr>
<td>V273E0023</td>
<td>Transport safeguard consisting of:</td>
</tr>
<tr>
<td></td>
<td>▪ 1 bracket, 9.5 mm x 6 mm</td>
</tr>
<tr>
<td></td>
<td>▪ 2 screws, A2 M3x8, ISO 4762</td>
</tr>
<tr>
<td>V901B0030</td>
<td>Sub-D 15 (m/f) adapter for the connection of the motor cable</td>
</tr>
<tr>
<td>C-815.18</td>
<td>Sub-D 15 (m/f) motor cable, 1 m</td>
</tr>
<tr>
<td>MP162EK</td>
<td>Short instructions in printed form</td>
</tr>
</tbody>
</table>

**3.4 Suitable Controllers**

The V-273 must be connected to a suitable controller. The following controllers from PI are suitable for the operation of the V-273:

<table>
<thead>
<tr>
<th>Controller</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>C-413.20</td>
<td>PIMag® motion controller, 2 channels, OEM board, USB and SPI interface, force control option</td>
</tr>
<tr>
<td>C-413.20A</td>
<td>PIMag® motion controller, 2 channels, OEM board, USB and SPI interface, analog inputs, force control option</td>
</tr>
</tbody>
</table>
### 3.5 Technical Features

#### 3.5.1 Linear Encoder

The V-273 is equipped with an optical linear encoder. For the resolution, refer to the table in the "Specifications" section (p. 35).

Optical linear encoders measure the actual position directly (direct metrology). Therefore, errors occurring in the drivetrain such as nonlinearity, backlash or elastic deformation, cannot influence the measurement of the position.

#### 3.5.2 Reference Point Switch

The V-273 is equipped with a direction-sensing reference point switch, which is located at about the midpoint of the travel range. This sensor transmits a TTL signal that indicates whether the linear actuator is on the positive or negative side of the reference point switch.

See the controller user manual and/or associated software manuals for the commands that make use of the reference point signal.

For more information, see "Reference Point Switch Specifications" (p. 37).

#### 3.5.3 Force Sensor

The V-273.441 is equipped with a force sensor. The force sensor is mounted on the runner (p. 8).

The force sensor allows application of a defined force and measurement of the counterforce that is applied orthogonally to the contact part of the sensor (p. 19). Forces up to 10 N can be measured and forces up to 6 N can be applied, each with an open-loop resolution of 1 mN.

The force sensor works as an incremental sensor. When the controller is switched on or rebooted, the connected force sensor always measures 0 N, regardless of the actual force exerted on the force sensor.

#### 3.5.4 Adapter with ID Chip for the Connection to the C-413.2xx Controller

The V901B0030 adapter is adapted at the factory to the V-273 to achieve optimum positioning accuracy.

---

<table>
<thead>
<tr>
<th>Controller</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>C-413.2G</td>
<td>PIMag® motion controller, 2 channels, benchtop device, USB and SPI interface, force control option</td>
</tr>
<tr>
<td>C-413.2GA</td>
<td>PIMag® motion controller, 2 channels, benchtop device, USB and SPI interface, analog inputs, force control option</td>
</tr>
</tbody>
</table>

PC software is included in the scope of delivery of the controllers from PI. The operation of the controllers is described in the corresponding user manuals.
The adapter has an ID chip on which the following data is stored:

- Information on the linear actuator:
  - Type
  - Serial number
- Coefficients of the polynomial for mechanics linearization
- Settings for the sensor: E.g. interpolation rate, corrections of hysteresis, phase and offset, gain values
- Data for checking the validity when the contents of the ID chip are read out

When switched on or rebooted, controllers from PI read the data from the ID chip. For more information on the ID chip recognition, see the manual of the controller used.

**INFORMATION**

The V901B0030 adapter must not be used if a controller other than a PI controller is to be used.

In addition, the following conditions must be met by the controller:

- It can process differential sin/cos encoder signals.
- It has digital inputs for the differential signals of the reference point switch of the linear actuator.
- It can operate 1-phase DC motors with ±1.5 A.

**3.5.5 Guiding**

The V-273.44x models are equipped with a recirculating ball bearing. This makes the motion of the runner insensitive to lateral forces and torques.
4 Unpacking

**NOTICE**

**Mechanical overload from incorrect handling!**
An impermissible mechanical load on the V-273 due to transportation without a transport safeguard and incorrect handling, can damage the runner of the V-273 as well as cause loss of accuracy.

- Only ship the V-273 in the original packaging and with the transport safeguard attached.
- Only hold the V-273 by the housing

The V-273 is delivered with a transport safeguard attached.

![Transport safeguard on the side of the linear actuator V-273.44x, hole pattern and the transport safeguard are identical for the V-273.440 and V-273.441](image)

Figure 8: Transport safeguard on the side of the linear actuator V-273.44x, hole pattern and the transport safeguard are identical for the V-273.440 and V-273.441

1. Housing
2. Transport safeguard (bracket with 2 M3x8 screws)

**Tools and accessories**
- Hex key AF 2.5

**Unpacking the V-273**
1. Unpack the V-273 with care.
2. Compare the contents with the items listed in the contract and the packing list. If parts are incorrectly supplied or missing, contact PI immediately.
3. Inspect the contents for signs of damage. If you notice signs of damage, contact PI immediately.

4. Remove the transport safeguard:
   a) Loosen and remove both M3 screws.
   b) Remove the bracket.

5. Keep all packaging materials and the transport safeguard in case the product needs to be transported later.
5 Installation

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Installing the V-273 in a Mechanical Mounting ........................................................................... 19
Connecting the V-273 to the Controller .......................................................................................... 22

5.1 General Notes on Installation

CAUTION

Risk of cuts and crushing!
The V-273 linear actuator can generate high forces at high velocities. When a contact part with a small contact surface is installed on the runner of the linear actuator, the pressure exerted by the runner on a fixed part or obstacle during operation may be very high. If fingers or limbs get caught between the runner of the linear actuator and a fixed part or obstacle during operation, there is a risk of minor injury from cuts and crushing.

➢ Use protective structures to keep limbs away from areas in which they could be caught by moving parts.
➢ Observe the safety distances in accordance with the applicable standards when installing protective structures.
➢ If possible, use contact parts with a sufficiently dimensioned contact area, so that a pressure of 50 N / cm² is not exceeded when operating the linear actuator with the maximum specified force (p. 35).

NOTICE

Heating up of the V-273 during operation!
The heat produced during operation of the V-273 can affect your application.

➢ Install the V-273 so that the application is not affected by the dissipated heat.
➢ Ensure sufficient ventilation at the place of installation.
➢ Make sure that the complete bottom side of the V-273 is in contact with the surface on which the V-273 is mounted.
NOTICE

Damage due to collisions!
Collisions can damage the linear actuator, the load to be moved, and the surroundings.

- Make sure that no collisions are possible between the linear actuator, the load to be moved, and the surroundings in the motion range of the linear actuator.

NOTICE

Lubricants, dirt, condensation!
Dirt, oil, lubricants and condensation will render the motor/drive inoperable.

- Keep the V-273 free from lubricants.
- Keep the V-273 free from dirt and condensation.

INFORMATION

If unsuitable cables are used, interference can occur in the signal transmission between the linear actuator and the controller.

- Only use original PI parts to connect the linear actuator to the controller. The maximum cable length is 1 m.
- If you need longer cables, contact our customer service department (p. 33).

INFORMATION

For the positive direction of motion of the runner (X axis), see "Product Details" (p. 8) or the dimensional drawing in "Dimensions" (p. 38).

5.2 Optional: Changing the Contact Part of the Force Sensor on the V-273.441

INFORMATION

The mechanical coupling of the runner to a surface is achieved using the contact part of the force sensor. A contact part made of aluminum and plastic is installed by default.

- If you change the contact part, you may have to adapt the parameter settings of the C-413 controller to the changed contact stiffness.

Requirements

- The linear actuator is not connected to the controller.

Tools and accessories

- Suitable contact part with M3 internal thread
Changing the contact part of the force sensor on the V-273.441 model

1. Manually unscrew the contact part to be changed from the force sensor of the V-273.441.
2. Manually screw the new contact part onto the M3 threaded bolt of the force sensor. Maximum torque: 15 Ncm.

5.3 Installing the V-273 in a Mechanical Mounting

**NOTICE**

**Increased friction due to lateral forces on the runner!**
Lateral forces that act on the runner of the V-273 increase the friction between the runner and internal drive components. Increased friction impairs the motion of the runner and increases the wear of the drive components.

- Avoid lateral forces on the runner of the V-273.

**NOTICE**

**Screws that are too long!**
Screws that are inserted too deeply damage the V-273.

- Observe the maximum screw-in depth for the mounting holes (p. 38).
- Only use screws of the correct length for the respective mounting holes.

**NOTICE**

**Warping of the V-273 due to mounting on uneven surfaces!**
Mounting the V-273 onto an uneven surface can warp the V-273. Warping reduces the accuracy.

- Mount the V-273 onto an even surface. The recommended evenness of the surface is ≤20 µm.
- For applications with large temperature changes: Only mount the V-273 onto surfaces that have the same or similar thermal expansion properties as the V-273 (e.g., surfaces made of aluminum).

**INFORMATION**

V-273.440 model: The moving part of the mechanical mounting can be connected to the runner of the linear actuator.
5 Installation

Figure 9: V-273.440: The white arrows mark the holes for affixing the movable part of the mounting to the runner

Figure 10: V-273.440: Mounting holes for mounting the V-273 onto a surface, identical for V-273.441

Figure 11: V-273.441: Ideally, the contact part of the force sensor is oriented orthogonally to the counterforce that is exerted on the runner and is measured

Requirements

✓ You have read and understood the general notes on installation (p. 17).
✓ You have designed the mechanical mounting, in which the V-273 is installed, so that collisions are not possible.
When a V-273.441 is used, the mechanical mounting also meets the following conditions:

- When the controller is switched on or rebooted, **no** force is applied to the contact part of the connected force sensors.
- The contact part of the force sensor (see figure) is oriented orthogonally to the counterforce that is applied to the runner.

You have provided a suitable surface on the fixed part of the mechanical mounting for attaching the housing of the V-273:

- At least three M4 mounting holes are present. For the required position of the holes, see "Dimensions" (p. 38).
- The thickness of the surface, the depth of the mounting holes and counterbores, as well as the length of the screws used, are matched so that the maximum screw-in depth in the V-273 is observed (p. 38).
- The flatness of the surface is ≤20 µm.
- For applications with large temperature changes: The surface has the same thermal expansion properties as the V-273.

You have accounted for the space required to route cables without bending and according to regulations.

The linear actuator is **not** connected to the controller.

**Tools and accessories**

- If the movable part of the mechanical mounting is to be connected to the runner of the V-273.440: 1 to 2 M2 screws of suitable length (see "Dimensions" (p. 38))
- 3 to 5 M4 screws of suitable length (see "Dimensions" (p. 38)) for attaching the housing of the V-273 to a surface
- Suitable tool for tightening the screws

**Affixing the movable part of the mounting to the V-273.440 model**

1. Align the runner of the linear actuator in the mounting so that the corresponding mounting holes in the mounting and the runner overlap.
2. Affix the movable part of the mounting to the holes in the runner of the V-273.
3. Check that connected parts are affixed firmly.

**Attaching the V-273 to the fixed part of the mounting**

1. Align the linear actuator or surface so that the corresponding mounting holes in linear actuator and surface overlap.
2. Screw the screws into the mounting holes on the bottom side of the surface.
   - Maximum screw-in depth: 5 mm
   - Maximum torque: 2.6 Nm
3. Check that the V-273 is affixed firmly to the surface.
5.4 Connecting the V-273 to the Controller

**INFORMATION**

The V901B0030 adapter is adapted at the factory to the V-273 to achieve optimum positioning accuracy. Replacing the adapter or the V-273 leads to an incorrect positioning and may even lead to oscillation of the servo loop.

- When connecting the V-273, observe the assignment of the adapter to V-273, which is given on the label of the adapter.

**Requirements**

- You have read and understood the general notes on installation (p. 17).
- The controller is switched off, i.e., not connected to the power supply

**Tools and accessories**

- V901B0030 adapter Sub-D 15 (m/f), in the scope of delivery (p. 11)
- C-815.18 motor cable Sub-D 15 (m/f), 1 m, in the scope of delivery (p. 11)
- C-413.2xx controller (p. 11)

**Connecting the V-273 to the controller**

1. Connect the Sub-D 15-pin (f) connector of the adapter to the Motor & Sensor socket of the controller.
2. Connect the connector of the motor cable to the Sub-D 15-pin (f) socket of the adapter.
3. Connect the socket of the motor cable to the Sub-D 15-pin panel plug (m) of the linear actuator.
4. Secure the adapter and motor cable with the integrated screws against unintentional disconnection from each other or from the controller and the linear actuator.
5. When the linear actuator has a force sensor with a separate Sub-D 15 (m) connector: Connect the force sensor to the Motor & Sensor socket of the C-413 that is still free.
6 Startup and Operation

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Starting Up the V-273 with the C-413 Controller ..................................................... 26

6.1 General Notes on Startup and Operation

The startup of the V-273 is done with the PIMag® C-413 motion controller from PI.

**NOTICE**

Heating up of the V-273 during operation!
The heat produced during operation of the V-273 can affect your application.
- Ensure sufficient ventilation at the place of installation.
- Ensure that the average continuous current and the peak current do **not** exceed the permissible values (p. 35).

**NOTICE**

Operating voltage too high or incorrectly connected!
Operating voltages that are too high or incorrectly connected can cause damage to the V-273.
- Only operate the V-273 with controllers/drivers and original accessories from PI.
- Do **not** exceed the operating voltage range (p. 36) for which the V-273 is specified.
- Only operate the V-273 when the operating voltage is properly connected; see "Pin Assignment" (p. 41).
6 Startup and Operation

NOTICE

Undesired displacement due to lack of self-locking!
The drive of the V-273 does not have self-locking. Switching off or rebooting the controller or
switching off the servo mode for the axis can therefore lead to undesired displacements of the runner, e.g., due to the weight force of the moving mass. As a result, the runner can move to the hard stop with a high velocity, and/or collisions between the V-273, the load to be moved and the surroundings are possible.

➢ When the motion axis is aligned vertically or tilted: Perform an AutoZero procedure for the axis on the controller so that the weight force of the moving mass is also compensated for when the servo mode is switched off. For details, see the user manual of the C-413.
➢ Before switching off or rebooting the controller, take suitable measures to ensure that no unintentional motion of the runner is possible.
➢ Make sure that no collisions are possible between the linear actuator, the load to be moved, and the surroundings in the motion range of the linear actuator.
➢ Ensure that the end of the travel range is approached at low velocity and with low force.

NOTICE

Damage due to collisions!
Collisions can damage the linear actuator, the load to be moved, and the surroundings.

➢ Make sure that no collisions are possible between the linear actuator, the load to be moved, and the surroundings in the motion range of the linear actuator.
➢ Do not place any objects in areas where they can be caught by moving parts.
➢ Stop the motion immediately if a controller malfunction occurs.
➢ If possible, adapt the travel range limits of your mechanical system in the software that you use for commanding the motion.

NOTICE

Damage due to high velocity and travel to the hard stop with maximum force!
Travel to the hard stop with maximum force or at high velocity can cause damage, excessive heat or considerable wear to the mechanics.

➢ Stop the motion immediately if a controller malfunction occurs.
➢ Ensure that the end of the travel range is approached at low velocity and with low force.
➢ Set the control signal so that the moving part does not stop abruptly or try to continue moving at the end of the travel range.
➢ Determine the maximum velocity for your application.
NOTE

Damage to the V-273 and the load due to oscillation

The optimum values of the servo control parameters of the controller depend on the application and the moved mass. Unsuitable servo control parameter settings of the controller can cause the V-273 to oscillate. Oscillation can damage the V-273 and/or the load affixed to it.

- If the V-273 is oscillating (unusual operating noise), immediately switch off the servo mode for the axis on the controller or switch off the controller.
- Only switch on the servo mode for the axis on the controller after you have modified the servo control parameter settings; see the manual of the controller.

NOTE

Damage from transport safeguard that has not been removed!

Damage can occur to the linear actuator if the transport safeguard (p. 15) of the linear actuator has not been removed and a motion is commanded.

- Remove the transport safeguard before you start up the system consisting of the linear actuator and the controller.

INFORMATION

The C-413 controller and the V-273 are delivered as a preconfigured system.

- If a connection assignment is given on the labels of the controller and/or V-273, observe this assignment when connecting the V-273.

INFORMATION

The C-413 controller sets the control value of the axis to the value of the AutoZeroResult parameter (ID 0x07000A03) when the servo mode is switched off.

After an AutoZero procedure has been successfully performed, the parameter value is set so that the V-273 compensates for the weight force of the moving mass with the corresponding control value (important with a vertically aligned motion axis).

Further information can be found in the user manual of the C-413 controller.

INFORMATION

The repeatability of the positioning is only ensured when the reference point switch is always approached from the same side. Recommended controllers from PI fulfill this requirement with their automatic direction detection for reference moves to the reference point switch.
INFORMATION

The force sensor of the V-273.441 model works as an incremental sensor. When the controller is switched on or rebooted, the connected force sensor always measures 0 N, regardless of the actual force exerted on the force sensor.

- In order to allow absolute force measurement, ensure that no force acts on the contact part of the force sensor when the controller is switched on or rebooted.

6.2 Starting Up the V-273 with the C-413 Controller

NOTICE

Unexpected motion!
The V-273 can perform unexpected motion after the controller is switched on or rebooted. Unexpected motion can lead to damage due to collisions.

- Before connecting the V-273, check whether the controller is configured for automatic execution of the reference move or the autozero procedure; see user manual of the controller.

INFORMATION

The type of the connection on the C-413 controller and the parameter settings of the C-413 determine the identifiers that are to be used to command the V-273. Assignment with the default settings of the C-413 controller:

- Motor cable connected to the Motor & Sensor 1 socket using the V901B0030 adapter and - if present - force sensor connected to the Motor & Sensor 2 socket: V-273 is commanded as axis 1; the force sensor can be read out as input signal channel 3 and must be assigned to axis 1 via the Input Channel for Force Feedback parameter (ID 0x07000400).

- Motor cable connected to the Motor & Sensor 2 socket using the V901B0030 adapter and - if present - force sensor connected to the Motor & Sensor 1 socket: V-273 is commanded as axis 2; the force sensor can be read out as input signal channel 1 and must be assigned to axis 2 via the Input Channel for Force Feedback parameter (ID 0x07000400).

Requirements

- You have read and understood the general notes on startup and operation (p. 23).
- You have read and understood the user manual of the controller.
- You have read and understood the manual of the PC software.
- You have properly installed the linear actuator (p. 17).
- The controller and the required PC software have been installed.
- All connections on the controller have been set up (see user manual of the controller; the linear actuator is connected via the V901B0030 adapter, the motor cable and additionally, for the V-273.441, via the cable of the force sensor).
You have installed the linear actuator so that no force is applied to the contact part of the force sensor when the controller is switched on or rebooted (p. 19).

**Starting up the V-273 with the C-413 controller**

- Start up the axis (see C-413 user manual).
  - Defining the reference point of the axis
  - Optional: AutoZero procedure for the axis
  - Optional: Selection of the closed-loop control mode
  - Commanding initial motion in closed-loop operation for testing the mechanical system

In the user manual of the C-413 controller, the startup is described using the PIMikroMove program.
7 Maintenance

In this Chapter

General Notes on Maintenance................................................................................................... 29
Preparing the V-273 for Transport............................................................................................... 29
Cleaning the V-273.......................................................................................................................... 30

7.1 General Notes on Maintenance

NOTICE

Damage from opening the V-273!
The V-273 is maintenance-free. Opening the housing causes damage to the V-273.

- Only loosen screws according to the instructions in this manual.
- Do not open the V-273.

7.2 Preparing the V-273 for Transport

NOTICE

Mechanical overload from incorrect handling!
An impermissible mechanical load on the V-273 due to transportation without a transport safeguard and incorrect handling, can damage the runner of the V-273 as well as cause loss of accuracy.

- Only ship the V-273 in the original packaging and with the transport safeguard attached.
- Only hold the V-273 by the housing

Tools and accessories

- Transport safeguard (bracket with 2 M3x8 screws) (p. 7)
- Hex key AF 2.5

Preparing the V-273 for transport

- Attach the transport safeguard to the housing and runner (p. 7) using two M3 screws.
7.3 Cleaning the V-273

Requirements

✓ You have disconnected the linear actuator from the controller.

Cleaning the linear actuator

➢ When necessary, clean the surface of the linear actuator with a cloth dampened lightly with a mild cleanser or disinfectant.
## Troubleshooting

<table>
<thead>
<tr>
<th>Problem</th>
<th>Possible causes</th>
<th>Solution</th>
</tr>
</thead>
</table>
| Target position is approached too slowly or with overshoot | ▪ Servo control parameters are not optimally set  
▪ Large changes to the load or the alignment of the V-273  
▪ Velocity / acceleration set improperly | ➢ Switch off the servo control system or the controller immediately.  
➢ Check whether the servo control parameter settings correspond to the selected closed-loop control mode; see user manual of the controller.  
➢ If necessary, correct the settings of the servo control parameters. |
| Target position is not kept stable          |                                                                                |                                                                          |
| Uncontrolled oscillation of the V-273       | ▪ Warped housing  
▪ Excessive lateral forces on the runner  
▪ Velocity too high  
▪ Travel with maximum force to the hard stop | ➢ Mount the V-273 on an even surface. The recommended flatness of the surface is 20 µm.  
➢ Ensure that the end of the travel range is approached at low velocity and with low force. |
| Increased wear                              |                                                                                |                                                                          |
| Reduced accuracy                            | ▪ Excessive load  
▪ Excessive counterforces in the direction of motion  
▪ Transport safeguard has not been removed  
▪ After operation without the adapter: The V-273 and/or the controller are damaged. | ➢ Reduce the load and/or counterforces in the direction of motion.  
➢ Remove the transport safeguard.  
➢ Contact our customer service department (p. 33). |

If the problem that occurred with your system is not listed in the table above or cannot be solved as described, contact our customer service department (p. 33).
9 Customer Service

For inquiries and orders, contact your PI sales engineer or send us an email (service@pi.de).

- If you have questions concerning your system, have the following information ready:
  - Product and serial numbers of all products in the system
  - Firmware version of the controller (if available)
  - Version of the driver or the software (if available)
  - Operating system on the PC (if available)
- If possible: Take photographs or make videos of your system that can be sent to our customer service department if requested.

The latest versions of the user manuals are available for download (p. 3) on our website.
10 Technical Data

In this Chapter

Specifications ............................................................................................................................... 35
Dimensions .................................................................................................................................. 38
Pin Assignment .......................................................................................................................... 41

10.1 Specifications

10.1.1 Data Table

<table>
<thead>
<tr>
<th></th>
<th>V-273.440</th>
<th>Unit</th>
<th>Tolerance</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Active axes</strong></td>
<td>Z</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Motion and positioning</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Travel range</td>
<td>20</td>
<td>mm</td>
<td></td>
</tr>
<tr>
<td>Integrated sensor</td>
<td>Optical linear encoder</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sensor resolution</td>
<td>10 [1]</td>
<td>nm</td>
<td>max.</td>
</tr>
<tr>
<td>Minimum incremental motion</td>
<td>100</td>
<td>nm</td>
<td>typ.</td>
</tr>
<tr>
<td>Linearity error, closed loop</td>
<td>1</td>
<td>%</td>
<td>typ.</td>
</tr>
<tr>
<td>Repeatability</td>
<td>±0.5</td>
<td>µm</td>
<td>typ.</td>
</tr>
<tr>
<td>Velocity</td>
<td>100</td>
<td>mm/s</td>
<td>max.</td>
</tr>
<tr>
<td>Force sensor resolution (optional)</td>
<td>1</td>
<td>mN</td>
<td>max.</td>
</tr>
<tr>
<td>Smallest force step (optional)</td>
<td>5</td>
<td>mN</td>
<td>typ.</td>
</tr>
<tr>
<td><strong>Mechanical properties</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bearing / guide</td>
<td>Recirculating ball bearings</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Motion straightness</td>
<td>±20</td>
<td>µm</td>
<td>±5 %</td>
</tr>
<tr>
<td>Moved mass without load</td>
<td>100 (230 with force sensor)</td>
<td>g</td>
<td>typ.</td>
</tr>
<tr>
<td><strong>Drive properties</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Motor Type</td>
<td>PIMag® Voice Coil Drive, moving coil</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coil resistance</td>
<td>16</td>
<td>Ω</td>
<td>typ., at 20 °C</td>
</tr>
<tr>
<td>Coil inductance</td>
<td>6</td>
<td>mH</td>
<td>typ., at 20 °C</td>
</tr>
</tbody>
</table>
### 10 Technical Data

<table>
<thead>
<tr>
<th>V-273.440</th>
<th>V-273.441</th>
<th>Unit</th>
<th>Tolerance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time constant</td>
<td>0.375</td>
<td>ms</td>
<td></td>
</tr>
<tr>
<td>Back EMF</td>
<td>8</td>
<td>V·s/m</td>
<td></td>
</tr>
<tr>
<td>Force constant</td>
<td>8</td>
<td>N/A typ.</td>
<td></td>
</tr>
<tr>
<td>Motor constant</td>
<td>2</td>
<td>N/(VW)</td>
<td></td>
</tr>
<tr>
<td>Current constant</td>
<td>0.125</td>
<td>A/N typ.</td>
<td></td>
</tr>
<tr>
<td>Average continuous current</td>
<td>375 (2)</td>
<td>mA</td>
<td>max.</td>
</tr>
<tr>
<td>Peak current (max. 3 s)</td>
<td>800</td>
<td>mA</td>
<td></td>
</tr>
<tr>
<td>Average push/pull force</td>
<td>3</td>
<td>N</td>
<td>nominal</td>
</tr>
<tr>
<td>Power dissipation of the coil with 100% duty cycle</td>
<td>2.25</td>
<td>W</td>
<td></td>
</tr>
<tr>
<td>Maximum push/pull force</td>
<td>6</td>
<td>N</td>
<td>max.</td>
</tr>
</tbody>
</table>

#### Miscellaneous

- Operating temperature range: 10 to 60 °C
- Material: Aluminum
- Mass: 660 (790 with force sensor) g ±5 %
- Cable length: 1 m
- Motor / sensor connection: Sub-D 15 (m), with force sensor: 2 × Sub-D 15 (m)
- Lifetime: >10⁷ cycles min.
- Recommended controller: C-413.2x

(1) With C-413 controller.

(2) Do not exceed for continuous operation.

### 10.1.2 Maximum Ratings

The voice coil drive of the V-273 linear actuator is designed for the following operating data:

<table>
<thead>
<tr>
<th>Maximum Operating Voltage</th>
<th>Maximum Operating Frequency</th>
<th>Maximum Power Consumption</th>
</tr>
</thead>
<tbody>
<tr>
<td>48 V</td>
<td></td>
<td>24 W</td>
</tr>
</tbody>
</table>
10.1.3 **Ambient Conditions and Classifications**

The following ambient conditions and classifications for the V-273 must be observed:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area of application</td>
<td>For indoor use only</td>
</tr>
<tr>
<td>Maximum altitude</td>
<td>2000 m</td>
</tr>
<tr>
<td>Air pressure</td>
<td>1100 hPa to 795 hPa (corresponds to roughly 825 Torr to 596 Torr)</td>
</tr>
<tr>
<td>Relative humidity</td>
<td>Highest relative humidity 80% for temperatures up to 31 °C Decreasing linearly to 50% relative humidity at 40 °C</td>
</tr>
<tr>
<td>Storage temperature</td>
<td>-20 °C to 60 °C</td>
</tr>
<tr>
<td>Transport temperature</td>
<td>-20 °C to 60 °C</td>
</tr>
<tr>
<td>Overvoltage category</td>
<td>II</td>
</tr>
<tr>
<td>Protection class</td>
<td>I</td>
</tr>
<tr>
<td>Degree of pollution</td>
<td>1</td>
</tr>
<tr>
<td>Degree of protection according to IEC 60529</td>
<td>IP20</td>
</tr>
</tbody>
</table>

10.1.4 **Reference Point Switch Specifications**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type</td>
<td>Optical sensor</td>
</tr>
<tr>
<td>Supply voltage</td>
<td>+5 V / GND, supply via the motor connector</td>
</tr>
<tr>
<td>Signal output</td>
<td>TTL level</td>
</tr>
<tr>
<td>Signal logic</td>
<td>Direction sensing by means of different signal levels on the left- and right-hand side of the reference point switch: The signal level changes from 0 to +5 V when the reference point switch is passed.</td>
</tr>
</tbody>
</table>
10.2 Dimensions

10.2.1 V-273.440

Dimensions in mm. Note that the decimal places are separated by a comma in the drawings.

Figure 12: Dimensions of the V-273.440, runner in reference position
10.2.2 **V-273.441**

Dimensions in mm. Note that the decimal places are separated by a comma in the drawings.

![Diagram of V-273.441 actuator](image)

**Figure 13:** Dimensions of the V-273.441, here without contact part of the force sensor; runner in reference position

1. M3 external thread
2. A shows the ideal direction of a force that acts on the force sensor.
Figure 14: Dimensions of the V-273.441, here with contact part of the force sensor; runner in reference position
10.3 Pin Assignment

10.3.1 Connection of the Motor and Position Sensor

Sub-D 15 (m) panel plug

![Sub-D 15 (m) panel plug](image)

Figure 15: Sub-D 15 (m) panel plug

<table>
<thead>
<tr>
<th>Pin</th>
<th>Function*</th>
<th>Direction</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Reference (-)</td>
<td>TTL output</td>
</tr>
<tr>
<td>2</td>
<td>Motor (-)</td>
<td>Input current</td>
</tr>
<tr>
<td>3</td>
<td>AGND</td>
<td>GND</td>
</tr>
<tr>
<td>4</td>
<td>VDD, +5 V</td>
<td>Input</td>
</tr>
<tr>
<td>5</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>6</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>7</td>
<td>SIN (-)</td>
<td>TTL output</td>
</tr>
<tr>
<td>8</td>
<td>COS (-)</td>
<td>TTL output</td>
</tr>
<tr>
<td>9</td>
<td>Motor (+)</td>
<td>Input current</td>
</tr>
<tr>
<td>10</td>
<td>AGND</td>
<td>GND</td>
</tr>
<tr>
<td>11</td>
<td>AGND</td>
<td>GND</td>
</tr>
<tr>
<td>12</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>13</td>
<td>Reference (+)</td>
<td>TTL output</td>
</tr>
<tr>
<td>14</td>
<td>SIN (+)</td>
<td>TTL output</td>
</tr>
<tr>
<td>15</td>
<td>COS (+)</td>
<td>TTL output</td>
</tr>
</tbody>
</table>

* The "-" sign indicates that the corresponding pin has not been assigned.
10.3.2 V901B0030 Adapter

Sub-D 15 (m/f)
Connector side for connection to the controller

![Sub-D 15 (m) connector](image)

Socket side for connection to the actuator

![Sub-D 15 (f) connector](image)

<table>
<thead>
<tr>
<th>Actuator side</th>
<th>Controller side</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pin</td>
<td>Signal</td>
</tr>
<tr>
<td>1</td>
<td>Reference (-)</td>
</tr>
<tr>
<td>2</td>
<td>Motor (-)</td>
</tr>
<tr>
<td>3</td>
<td>AGND</td>
</tr>
<tr>
<td>4</td>
<td>VDD, +5V</td>
</tr>
<tr>
<td>5</td>
<td>-</td>
</tr>
<tr>
<td>6</td>
<td>SIN (-)</td>
</tr>
<tr>
<td>7</td>
<td>COS (-)</td>
</tr>
<tr>
<td>8</td>
<td>Motor (+)</td>
</tr>
<tr>
<td>9</td>
<td>AGND</td>
</tr>
<tr>
<td>10</td>
<td>AGND</td>
</tr>
<tr>
<td>11</td>
<td>AGND</td>
</tr>
<tr>
<td>12</td>
<td>-</td>
</tr>
<tr>
<td>13</td>
<td>Reference (+)</td>
</tr>
<tr>
<td>14</td>
<td>SIN (+)</td>
</tr>
<tr>
<td>15</td>
<td>COS (+)</td>
</tr>
</tbody>
</table>

* The "-" sign indicates that the corresponding pin has not been assigned.
### 10.3.3 V-273.441: Connection of the Force Sensor

**Sub-D 15 connector (m)**

![Sub-D 15 (m) connector](image)

Figure 17: Sub-D 15 (m) connector

<table>
<thead>
<tr>
<th>Pin</th>
<th>Function*</th>
<th>Direction</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>2</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>3</td>
<td>GND</td>
<td>GND</td>
</tr>
<tr>
<td>4</td>
<td>VDD, +5 V</td>
<td>Input</td>
</tr>
<tr>
<td>5</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>6</td>
<td>SPI_CS_EEPROM</td>
<td>TTL input</td>
</tr>
<tr>
<td>7</td>
<td>SPI_MOSI</td>
<td>TTL input</td>
</tr>
<tr>
<td>8</td>
<td>SPI_MISO</td>
<td>TTL output</td>
</tr>
<tr>
<td>9</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>10</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>11</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>12</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>13</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>14</td>
<td>SPI_CLK</td>
<td>TTL input</td>
</tr>
<tr>
<td>15</td>
<td>SPI_CS_SENSOR</td>
<td>TTL input</td>
</tr>
</tbody>
</table>

* The "-" sign indicates that the corresponding pin has not been assigned.
11 Old Equipment Disposal

In accordance with EU law, electrical and electronic equipment may not be disposed of in EU member states via the municipal residual waste.

Dispose of your old equipment according to international, national, and local rules and regulations.

In order to fulfil its responsibility as the product manufacturer, Physik Instrumente (PI) GmbH & Co. KG undertakes environmentally correct disposal of all old PI equipment made available on the market after 13 August 2005 without charge.

Any old PI equipment can be sent free of charge to the following address:

Physik Instrumente (PI) GmbH & Co. KG
Auf der Roemerstr. 1
D-76228 Karlsruhe, Germany
For the V-273, an EU Declaration of Conformity has been issued in accordance with the following European directives:

- EMC Directive
- RoHS Directive

The applied standards certifying the conformity are listed below.

- EMC: EN 61326-1
- Safety: EN 61010-1
- RoHS: EN 50581