MP155E

V-273 VC Linear Actuator

User Manual

Version: 1.1.5 Date: 01.03.2024

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

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Contents

1 About this Document

In this Chapter

1.1 Objective and Target Audience of this User Manual

This manual contains information on using the V-273 as intended.

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:

DANGER

Immediate threat of danger
Failure to comply could lead to death or serious injury.

➢ Measures for avoiding the risk.

CAUTION

Dangerous situation
Failure to comply could lead to minor injury.

➢ Precautionary measures for avoiding the risk.

NOTICE

Dangerous situation
Failure to comply could cause damage to equipment.

➢ Precautionary measures for avoiding the risk.

INFORMATION

Information for easier handling, tricks, tips, etc.

Symbol/ Label	Meaning
1. 2.	Action consisting of several steps with strict sequential order
➢	Action consisting of one or more steps without relevant sequential order
▪	Lists
p. 5	Cross-reference to page 5
RS-232	Label on the product indicating an operating element (example: RS-232 interface socket)
	Warning signs attached to the product referring to detailed information in this manual.

1.3 Definition of Terms

Term	Explanation
VC linear actuator / VC linear drive	VC = Voice Coil 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.
Max. push/pull force	Maximum force in the direction of motion. Position or velocity control: 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. 37), displacements or changes in velocity can occur.

Term	Explanation
Max. push/pull force	Force control: 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. 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).
Incremental position sensor	Sensor (encoder) for detecting 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, referencing must be done before absolute target positions can be commanded and reached.

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 separate manuals.

Product	Document
C-413 PIMag® Controller	MS224E User Manual
PIMikroMove	SM148E Software Manual

1.6 Downloading Manuals

INFORMATION

If a manual is missing or problems occur with downloading:

➢ Contact our customer service department (p. 35).

Downloading manuals

1. Open the website **www.pi.ws**.
2. Search the website for the product number (e.g., V-273).
3. In the search results, select the product to open the product detail page.

4. Select ***Downloads***.

   The manuals are shown under ***Documentation***. Software manuals are shown under ***General Software Documentation***.

5. For the desired manual, select ***ADD TO LIST*** and then ***REQUEST***.

6. Fill out the request form and select ***SEND REQUEST***.

   The download link will be sent to the email address entered in the form.

2 Safety

In this Chapter

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.

- Use the V-273 for its intended purpose only, and only when it is in perfect technical condition.
- Read the user manual.
- Eliminate any malfunctions that may affect safety immediately.

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

2.3 Organizational Measures

User manual

- Keep this user manual with the V-273 always.
  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.
- Always work according to the complete user manual. If your user manual is incomplete and is therefore missing important information, damage to equipment can result.
- Install and operate the V-273 only 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

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.

Model	Dimension	Force sensor present?
V-273.440	200 mm × 53 mm × 37.2 mm	No
V-273.441	205.5 mm × 53 mm × 37.2 mm	Yes

➢ For further technical data, see the specifications (p. 37).

3.2 Product View

3.2.1 Overview

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

3.2.2 Product Details

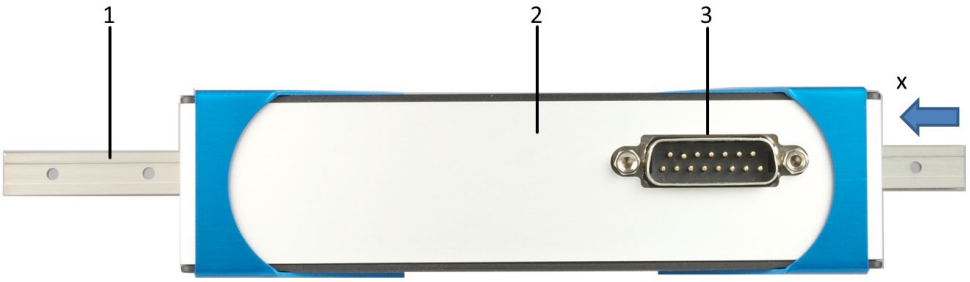


Figure 2: Front side of the linear actuator, here V-273.440

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

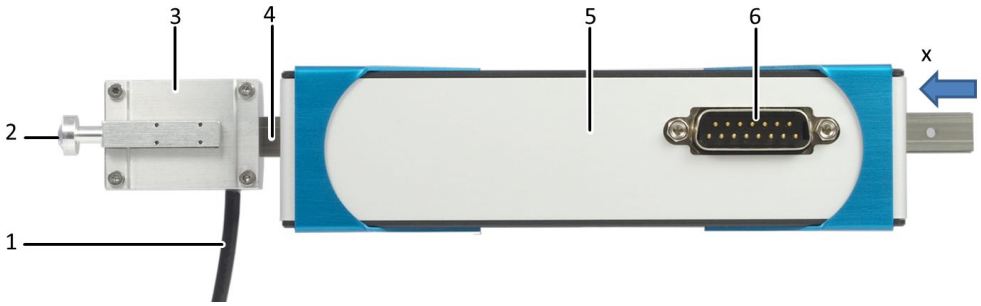


Figure 3: Front side of the linear actuator, here V-273.441

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 Connector for motor cable (panel plug, Sub-D 15)
x Positive direction of motion

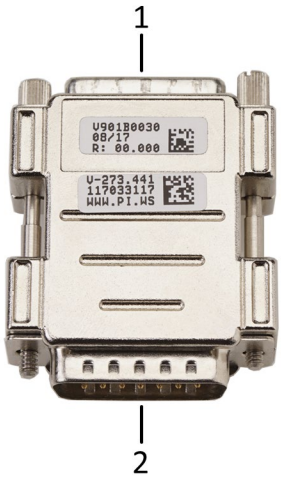


Figure 4: V901B0030 adapter for connecting the motor cable

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

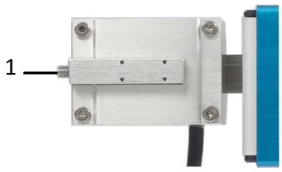


Figure 5: Force sensor

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

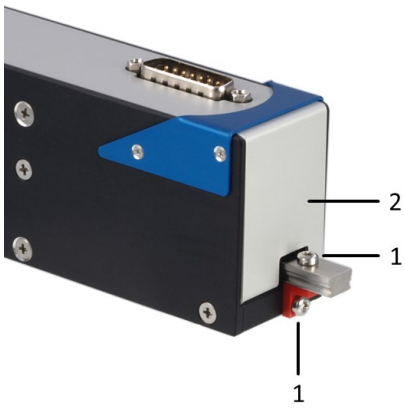


Figure 6: Transport safeguard on the side of the linear actuator V-273.44x, hole pattern and the transport safeguard are identical for the V-273.440 and V-273.441

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

3.2.3 Product Labeling

There is a type plate on the housing of the V-273 that contains the following information:

Labeling	Description
	Data matrix code (example; contains the serial number)
V-273.440	Product name (example), the characters following the period refer to the model
116003601	Serial number (example), individual for each V-273 Meaning of each position (from the left): 1 = internal information, 2 and 3 = year of manufacture, 4 to 9 = consecutive number
	Manufacturer's logo
	Warning sign "Pay attention to the manual!"
	Warning sign "Magnetic Field"
	Prohibition sign for heart pacemakers, defibrillators, and other active implants
	Warning sign "Risk of crushing"
	Old equipment disposal (p. 47)
Country of origin: Germany	Country of origin
WWW.PI.WS	Manufacturer's address (website)
CE	CE conformity mark

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

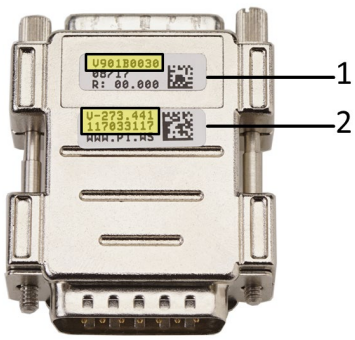


Figure 7: Product labeling of the V901B0030 adapter

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

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

3.4 Optional Accessories

Item number	Component
V273B0045	Contact part of the force sensor

3.5 Suitable Controllers

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

Controller	Description
C-413.20	PIMag® motion controller, 2 channels, OEM board, USB and SPI interface, force control option
C-413.20A	PIMag® motion controller, 2 channels, OEM board, USB and SPI interface, analog inputs, force control option
C-413.2G	PIMag® motion controller, 2 channels, benchtop device, USB and SPI interface, force control option
C-413.2GA	PIMag® motion controller, 2 channels, benchtop device, USB and SPI interface, analog inputs, force control option

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.

Please note that the cable for connecting the V-273 to the electronics must also be ordered separately.

➢ To order, contact our customer service department (p. 35).

3.6 Technical Features

3.6.1 Linear Encoder

The V-273 is equipped with an optical linear encoder. For the resolution, refer to the table in the "Specifications" section (p. 37).

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.

3.6.2 Reference Switch

The V-273 is equipped with a direction-sensing reference 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 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 Switch Specifications" (p. 39).

3.6.3 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. 20). 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.

3.6.4 Adapter with ID Chip for Connecting to the C-413.2xx Controller

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

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 switch of the linear actuator.
- It can operate 1-phase DC motors with ±1.5 A.

3.6.5 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.

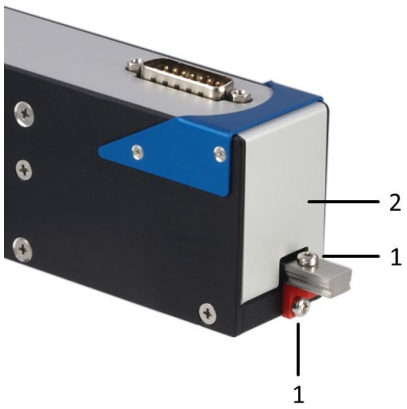


Figure 8: Transport safeguard on the side of the linear actuator V-273.44x, hole pattern and the transport safeguard are identical for the V-273.440 and V-273.441

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

In this Chapter

5.1 General Notes on Installation

DANGER

Strong magnetic fields affect heart pacemakers!

The V-273 contains permanent magnets that could impair the function of heart pacemakers and electronic implants. **The permanent magnet's magnetic fields are also effective when the linear actuator is not connected or switched off.**

- ➢ Make sure that people with heart pacemakers and electronic implants do not have access to the V-273.
- ➢ Make sure that the danger zone is marked.

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.
- ➢ Pay attention to 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 / cm^2 is not exceeded when operating the linear actuator with the maximum specified force (p. 37).

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

Attracting magnetizable objects!

The magnets in the V-273 can attract magnetizable parts, e.g., loose screws. Objects attracted can damage the V-273.

- Make sure that there are no movable, magnetizable objects within a radius of at least 10 cm around the V-273's housing.
- Take appropriate precautions for storage and transport.

NOTICE

Damage to magnetically sensitive objects!

The magnets in the V-273 can damage parts susceptible to magnetic influences, e.g., magnetic data carriers and electronic devices.

- Make sure that there are no magnetically sensitive objects within a radius of at least 10 cm around the V-273's housing.
- Take appropriate precautions for storage and transport.

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 **1,5 m**.
- If you need longer cables, contact our customer service department (p. 35).

INFORMATION

For the positive direction of motion of the runner (X axis), see "Product Details" (p. 8) or the dimensional drawing in "Dimensions" (p. 40).

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.

A suitable contact part is available as optional accessory (p. 11).

Figure 9: Contact part consisting of elastomer buffer, carrier of buffer and threaded pin

Requirements

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

Tools and accessories

- Suitable contact part with M3 internal thread (p. 11)

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 into a Mechanical Mounting

NOTICE

Increased friction due to lateral forces on the runner!
Lateral forces acting 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 wear on the drive components.

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

NOTICE

Excessively long screws!
Screws inserted too deeply will damage the V-273.

➢ Pay attention to the maximum screw-in depth for the mounting holes (p. 40).
➢ Only use screws of the correct length for the respective mounting holes.

NOTICE

Distorting the V-273 when mounted on uneven surfaces!
Fixing the V-273 onto an uneven surface can distort the V-273. Distortion reduces the accuracy.

➢ Fix the V-273 onto an even surface. The recommended flatness of the surface is ≤20 µm.
➢ For applications with large temperature fluctuations:
Only fix 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.

Figure 10: V-273.440: The white arrows mark the holes for affixing the movable part of the mounting to the runner

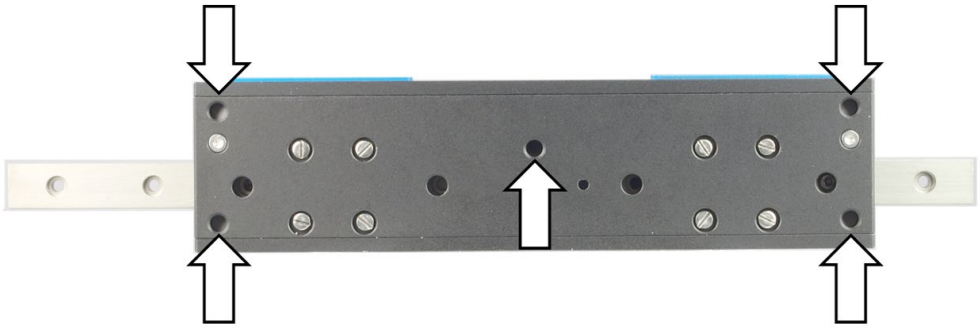


Figure 11: V-273.440: Mounting holes for mounting the V-273 onto a surface, identical for V-273.441

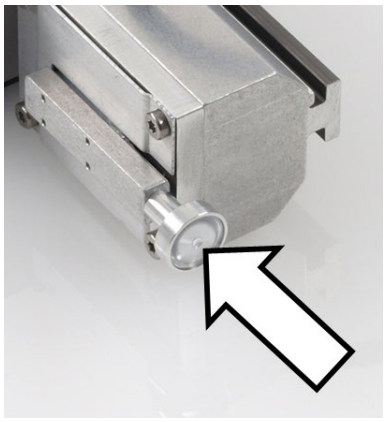


Figure 12: V-273.441: Ideally, the contact part of the force sensor is oriented orthogonally to the counterforce that is exerted on the runner and is measured

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. 40).
  - 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 adhered to (p. 40).
  - 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. 40))
- 3 to 5 M4 screws of suitable length (see "Dimensions" (p. 40)) for attaching the housing of the V-273 to a surface
- Suitable tool for tightening the screws

Fixing 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 are line.
2. Fix the movable part of the mounting to the holes in the runner of the V-273.
3. Check that connected parts are fixed 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. Turn the screws into the mounting holes in the bottom of the underlying surface.

Maximum screw-in depth: 5 mm

Maximum torque: 2.6 Nm

3. Check that the V-273 is fixed 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 optimal positioning accuracy. Replacing the adapter or the V-273 leads to an incorrect positioning and may even lead to oscillations of the servo loop.

➢ When connecting the V-273, pay attention to the assignment of the adapter to the V-273, which is specified 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 D-sub 15 (m/f), included in the scope of delivery (p. 11)
- Motor cable D-sub 15 (m/f), to be ordered separately
- C-413.2xx controller (p. 11)

Connecting the V-273 to the controller

1. Connect the D-sub 15-pole (f) connector of the adapter to the ***Motor &Sensor*** socket of the controller.
2. Connect the connector of the motor cable to the D-sub 15-pole (f) socket of the adapter.
3. Connect the socket of the motor cable to the D-sub 15-pole 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 D-sub 15 (m) connector: Connect the force sensor to the ***Motor & Sensor*** socket of the C-413 that is still free.

6 Startup and Operation

In this Chapter

6.1 General Notes on Startup and Operation

The V-273 is started and operated with the PIMag® C-413 motion controller from PI.

DANGER

Strong magnetic fields affect heart pacemakers!

The V-273 contains permanent magnets that could impair the function of heart pacemakers and electronic implants. **The permanent magnet's magnetic fields are also effective when the linear actuator is not connected or switched off.**

- ➢ Make sure that people with heart pacemakers and electronic implants do not have access to the V-273.
- ➢ Make sure that the danger zone is marked.

NOTICE

Overheating caused by unfavorable nominal current!

The nominal current in the data table (p. 37) only applies when operating at room temperature. The nominal current needed for operating the actuator must be adjusted when the ambient temperature rises. Otherwise the actuator could be damaged by overheating.

- ➢ Calculate the nominal current according to the ambient temperature (p. 28).

NOTICE

V-273 heating up during operation!

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

- ➢ Ensure sufficient ventilation at the place of installation.
- ➢ Make sure that the nominal current and the peak current do **not** exceed (p. 37) the permissible values.

NOTICE

Attracting magnetizable objects!

The magnets in the V-273 can attract magnetizable parts, e.g., loose screws. Objects attracted can damage the V-273.

- Make sure that there are no movable, magnetizable objects within a radius of at least 10 cm around the V-273's housing.
- Take appropriate precautions for storage and transport.

NOTICE

Damage to magnetically sensitive objects!

The magnets in the V-273 can damage parts susceptible to magnetic influences, e.g., magnetic data carriers and electronic devices.

- Make sure that there are no magnetically sensitive objects within a radius of at least 10 cm around the V-273's housing.
- Take appropriate precautions for storage and transport.

NOTICE

Operating voltage too high or incorrectly connected!

Operating voltages that are too high or incorrectly connected can cause damage to the V-273.

- Operate the V-273 only with controllers/drivers and original accessories from PI.
- Do **not** exceed the operating voltage range (p. 38) for which the V-273 is specified.
- Operate the V-273 only when the operating voltage is properly connected; see "Pin Assignment" (p. 43).

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: Run 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.

NOTICE

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.

NOTICE

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, pay attention to 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 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 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 Temperature Dependency of the Nominal Current: Calculating the Nominal Current

The nominal current in the data table (p. 37) only applies when operating at room temperature. The nominal current needed for operating the actuator must be adjusted when the ambient temperature rises.

Calculating the nominal current

➢ Calculate the nominal current according to the ambient temperature as follows:

$$I(T) = I(T_{ref}) \cdot \sqrt{\frac{T_{max} - T}{T_{max} - T_{ref}}}$$

With:

$I(T)$	=	Nominal current, depending on ambient temperature T
T	=	Ambient temperature
$I(T_{ref})$	=	Nominal current, determined at reference temperature T_{ref}, see specifications
T_{ref}	=	Reference temperature (22 °C)
T_{max}	=	Maximum temperature of actuator components, see specifications

6.3 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. 25).

✓ 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 to the controller have been made (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. 20).

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

- ➢ Start up the axis (see C-413 user manual).
  The startup involves the following steps:
  - 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

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.

8 Troubleshooting

Problem	Possible causes	Solution
Target position is approached too slowly or with overshoot Target position is not kept stable Uncontrolled oscillation of the V-273	▪ 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 control mode; refer to the user manual for the controller. ➢ If necessary, correct the settings of the servo control parameters.
Increased wear Reduced accuracy	▪ Warped housing ▪ Excessive lateral forces on the runner ▪ Excessive velocity ▪ Travel with maximum force to the hard stop	➢ Mount the V-273 on a flat surface. The recommended flatness of the surface is 20 µm. ➢ Make sure that the end of the travel range is approached at low velocity and with low force.
No or limited motion	▪ 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. 35).

If the problem with your system is not listed in the table above or cannot be solved as described, contact our customer service department (p. 35).

9 Customer Service

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

- If you have any questions concerning your system, provide the following information:
  - Product and serial numbers of all products in the system
  - Firmware version of the controller (if applicable)
  - Version of the driver or the software (if applicable)
  - Operating system on the PC (if applicable)
- 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

Subject to change. You can find the latest product specifications on the product web page at www.pi.ws (https://www.pi.ws).

In this Chapter

10.1 Specifications

10.1.1 Data Table

	V-273.440, V-273.441	Unit	Tolerance
Active axes	Z		
Motion and positioning			
Travel range	20	mm	
Integrated sensor	Optical linear encoder		
Sensor resolution	10 (1)	nm	Max.
Minimum incremental motion	100	nm	Typ.
Linearity error, closed loop	1	%	Typ.
Repeatability	±0.5	µm	Typ.
Velocity	100	mm/s	Max.
Force sensor resolution (optional)	1	mN	Max.
Smallest force step (optional)	5	mN	Typ.
Mechanical properties			
Bearing / guide	Recirculating ball bearing guide		
Motion straightness	±20	µm	±5 %
Moved mass without load	100 / 230	g	Typ.
Drive properties			
Motor type	PIMag® voice coil drive, moving coil		
Coil resistance	16	Ω	Typ., at 20°C

	V-273.440, V-273.441	Unit	Tolerance
Coil inductance	6	mH	Typ., at 20°C
Time constant	0.375	ms	
Back EMF	8	V·s/m	
Force constant	8	N/A	Typ.
Motor constant	2	N/(√W)	
Current constant	0.125	A/N	Typ.
Nominal current	375 (2)	mA	Max.
Peak current (max. 3 s)	800	mA	
Average push/pull force	3	N	Nominal
Power dissipation of the coil with 100 % duty cycle	2.25	W	
Maximum push/pull force	6	N	Max.
Permitted temperature for actuator components	60	°C	Max.
Miscellaneous			
Operating temperature range	10 to 60	°C	
Material	Aluminum		
Mass	660 / 790	g	±5 %
Cable length	V-273.441: Force sensor cable: 1	m	
Motor / sensor connector	V-273.440: D-sub 15 (m) V-273.441: 2 × D-sub 15 (m)		
Lifetime	>10^7	cycles	Min.
Recommended controller	C-413.2x		

(1) With C-413 controller.

(2) Do not exceed for continuous operation.

The specifications apply to room temperature (22 °C ±3 °C), specifications may deviate outside of this range.

10.1.2 Maximum Ratings

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

Maximum Operating Voltage	Maximum Operating Frequency	Maximum Power Consumption
48 V	⎓	24 W

10.1.3 Ambient Conditions and Classifications

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

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

10.1.4 Reference Switch Specifications

Type	Optical sensor
Supply voltage	+5 V / GND, supply via the motor connector
Signal output	TTL level
Signal logic	Direction sensing by means of different signal levels on the left- and right-hand side of the reference switch: The signal level changes from 0 to +5 V when the reference switch is passed.

10.2 Dimensions

10.2.1 V-273.440

Dimensions in mm. Note that a comma is used in the drawings instead of a decimal point.

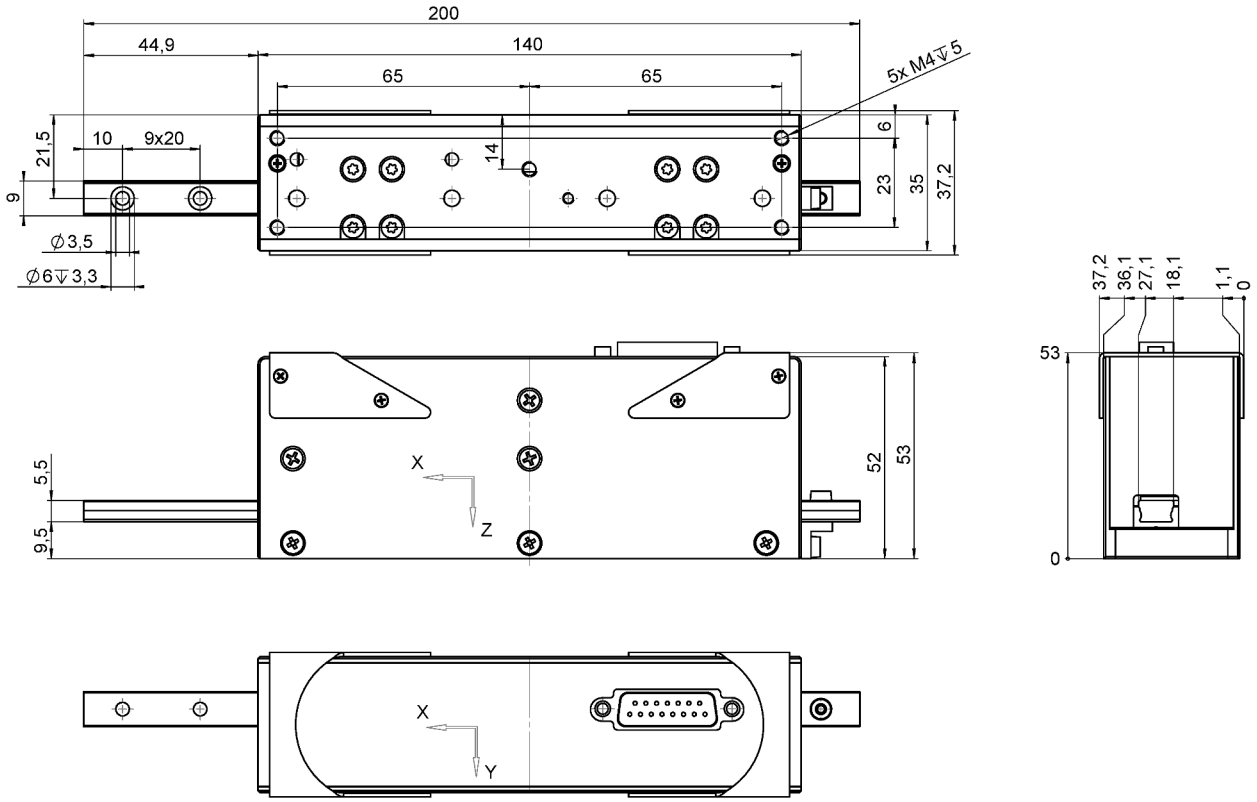


Figure 13: Dimensions of the V-273.440, runner in reference position

10.2.2 V-273.441

Dimensions in mm. Note that a comma is used in the drawings instead of a decimal point.

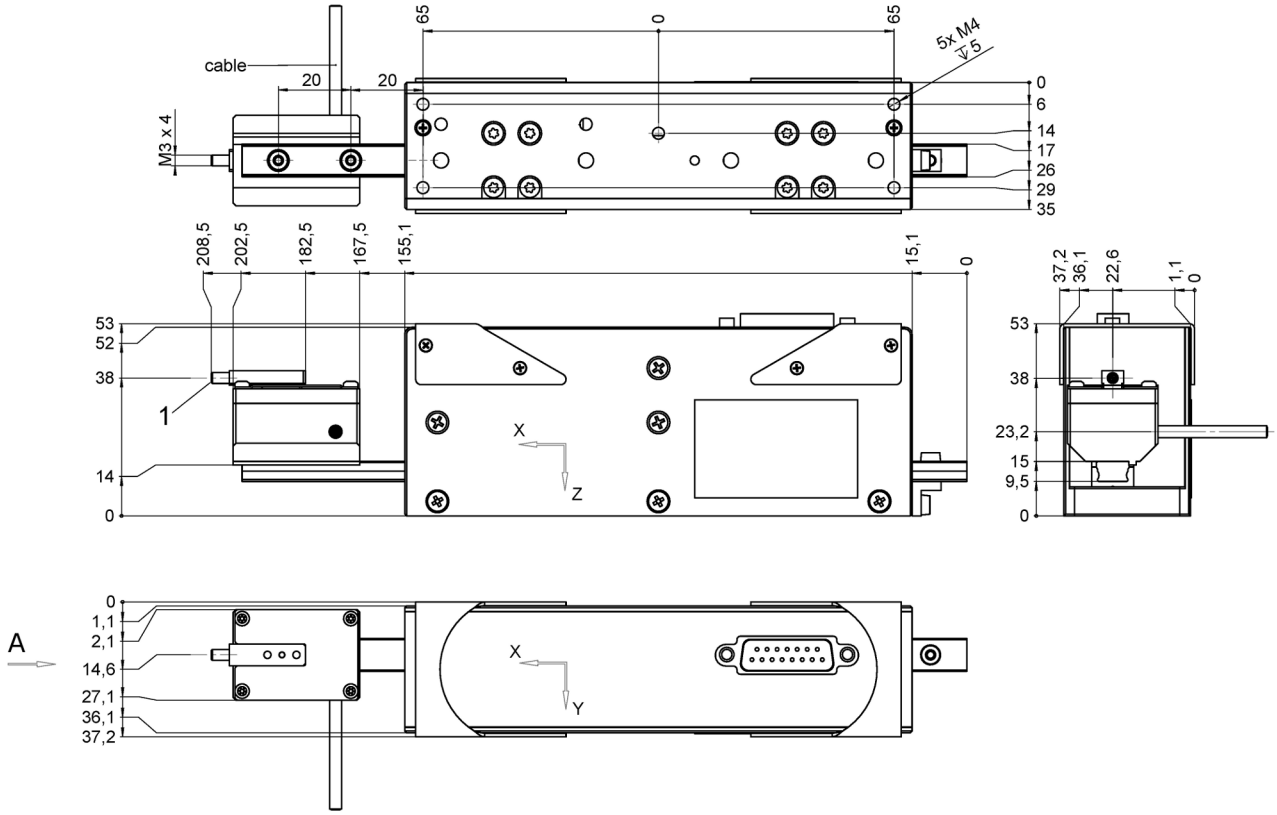


Figure 14: Dimensions of the V-273.441, here without contact part of the force sensor; runner in reference position

1 M3 external thread

A shows the ideal direction of a force acting on the force sensor

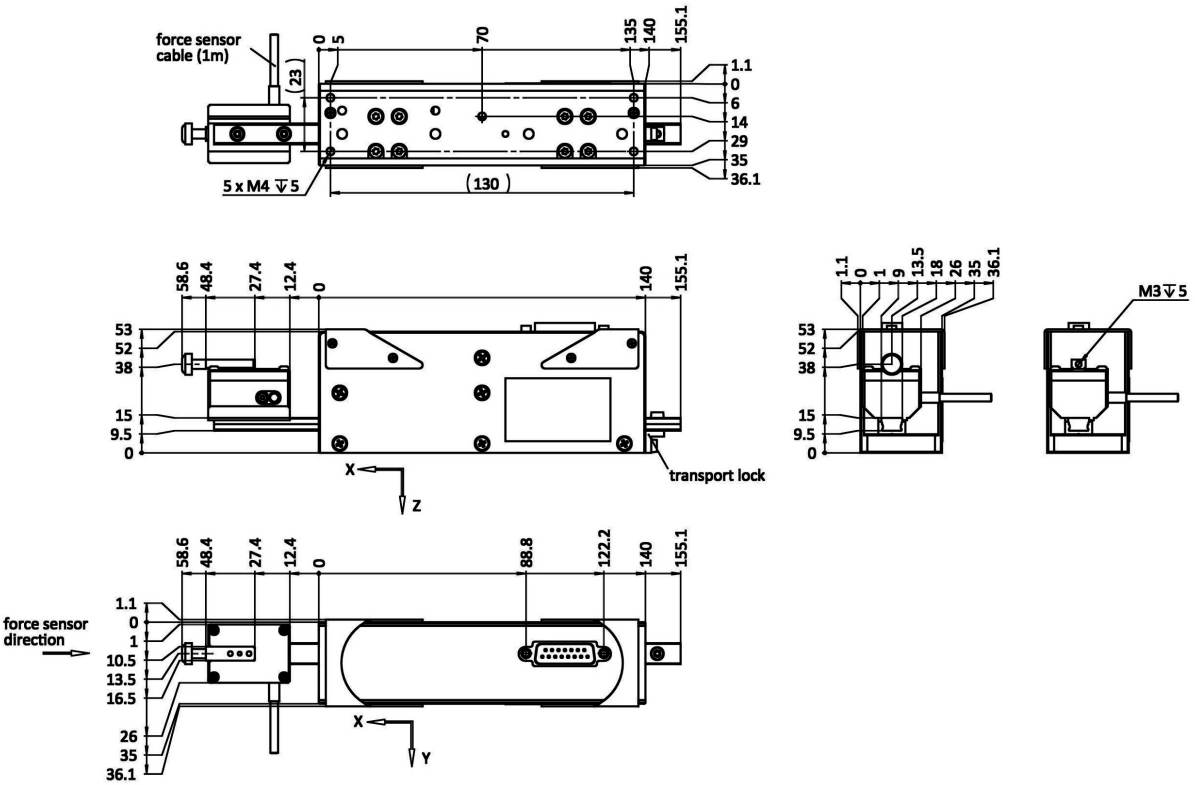
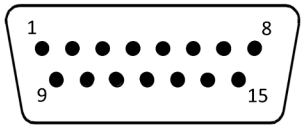


Figure 15: Dimensions of the V-273.441, here with contact part of the force sensor; runner in reference position

10.3 Pin Assignment

10.3.1 Motor and Position Sensor Connector

D-sub 15 (m) panel plug



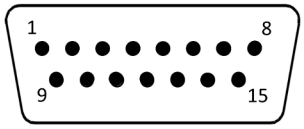
Pin	Function*	Direction
1	Reference (-)	TTL output
2	Motor (-)	Input current
3	AGND	GND
4	VDD, +5 V	Input
5	-	-
6	-	-
7	SIN (-)	TTL output
8	COS (-)	TTL output
9	Motor (+)	Input current
10	AGND	GND
11	AGND	GND
12	-	-
13	Reference (+)	TTL output
14	SIN (+)	TTL output
15	COS (+)	TTL output

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

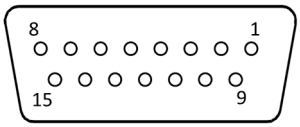
10.3.2 V901B0030 Adapter

D-sub 15 (m/f)

Connector side for connecting to the controller



Socket side for connecting to the actuator

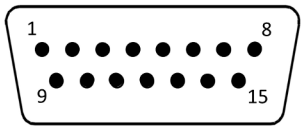


Actuator side		Controller side	
Pin	**Signal**	**Pin**	**Signal**
1	Reference (-)	1	-
2	Motor (-)	2	Motor (-)
3	AGND	3	AGND
4	VDD, +5V	4	VDD, +5V
5	-	5	-
6	-	6	CS_EEPROM_1
7	SIN (-)	7	SPI_MOSI
8	COS (-)	8	SPI_MISO
9	Motor (+)	9	Motor (+)
10	AGND	10	AGND
11	AGND	11	AGND
12	-	12	-
13	Reference (+)	13	Reference
14	SIN (+)	14	SPI_CLK
15	COS (+)	15	TW8_CS_1

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

10.3.3 V-273.441: Force Sensor Connector

D-sub 15 connector (m) panel plug



Pin	Function*	Direction
1	-	-
2	-	-
3	GND	GND
4	VDD, + 5 V	Input
5	-	-
6	SPI_CS_EEPROM	TTL input
7	SPI_MOSI	TTL input
8	SPI_MISO	TTL output
9	-	-
10	-	-
11	-	-
12	-	-
13	-	-
14	SPI_CLK	TTL input
15	SPI_CS_SENSOR	TTL input

* 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

12 EU Declaration of Conformity

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 or EN IEC 63000