

V-275.430, V-275.431 PIMag® Voice Coil Linear Actuators



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About this Document

This document contains the information needed for the intended use of the V-275.

Basic knowledge of servo systems, drive technologies and suitable safety measures is assumed.

Symbols and Typographic Conventions

The following symbols and typographic conventions are used in this document:

DANGER



Imminently hazardous situation

If not avoided, the hazardous situation will result in death or serious injury.



- Actions to take to avoid the situation

CAUTION



Dangerous situation

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



- Actions to take to avoid the situation.

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.

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
•	List item
p. 5	Cross-reference to page 5

Symbol/Label



Meaning

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

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.

Other Applicable Documents

Product	Document
C-413.1G PIMag® controller	C413T0008 user manual
C-413.2x PIMag® controller	MS224E user manual
PIMikroMove	SM148E software manual

The latest versions of the user manuals are available for download on our website.

Downloading Manuals

INFORMATION

If a manual is missing or problems occur with downloading:

- Contact our customer service department (p. 16).

1. Open the website **www.pi.ws**.
2. Search the website for the product number (e.g., C-413).
3. Click the corresponding product to open the product detail page.
4. Click **Downloads**.

The manuals are shown under Documentation.

5. Click the desired manual and fill out the inquiry form.

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

Intended Use

The V-275 is a laboratory device as defined by DIN EN 61010-1. It is intended to be used in interior spaces and in an environment which is free of dirt, oil, and lubricants.

The V-275 has a voice coil linear drive, a position sensor and, depending on the model, a force sensor as well. The V-275 is intended for positioning, adjusting and shifting loads in one axis at various velocities and with defined forces.

The V-275 is a linear actuator for applications in automation or handling technology.

The V-275 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-275 is only possible when installed and in connection with a suitable controller (p. 8).

Product Description

Model Overview

Two standard versions of the V-275 linear actuator are available. They differ with regard to the force sensor and thus the dimensions:

Model	Dimension	Force sensor present?
V-275.430	129.5 (max) mm x 55 mm x 67.66 mm	No
V-275.431	133.2 mm x 55 mm x 67.66 mm	Yes

Product View

V-275.430

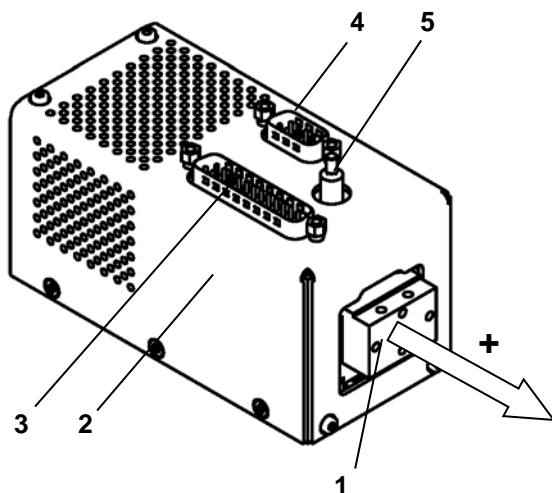


Figure 1: V-275.430

- 1 Pusher with M3 mounting holes
 - 2 Housing
 - 3 Sensor connection (D-sub 25 (m))
 - 4 Motor connection (D-sub 9 (m))
 - 5 M3 Signal Ground pin
- Arrow: Positive direction of motion

V-275.431

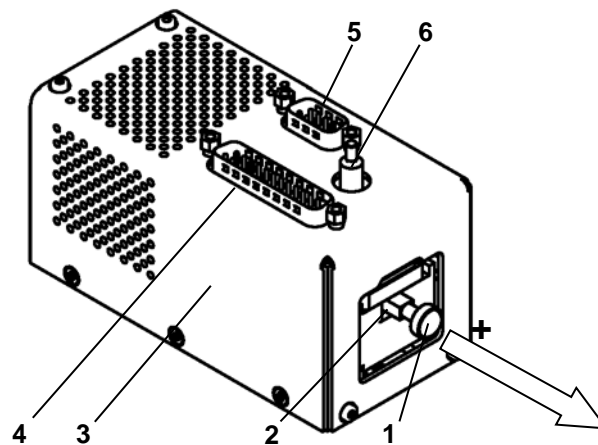






Figure 2: V-275.431

- 1 Contact part (aluminum with elastomer contact part), with M3 thread
 - 2 Pusher with integrated force sensor
 - 3 Housing
 - 4 Sensor connection (D-sub 25 (m))
 - 5 Motor connection (D-sub 9 (m))
 - 6 M3 grounding pin, electrically connected to the contact part (1)
- Arrow: Positive direction of motion

Product Labeling

On the housing of the V-275, there is a type plate with the following information:

Labeling	Description
	Data matrix code (example; contains the serial number)
V-275.431	Product name (example), the characters following the period refer to the model
116003601	Serial number (example), individual for each V-275 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"

Labeling	Description
	Prohibition sign for heart pacemakers, defibrillators, and other active implants
	Warning sign "Risk of crushing"
	Old equipment disposal (p. 25)
Country of origin: Germany	Country of origin
WWW.PI.WS	Manufacturer's address (website)
	CE conformity mark

Scope of Delivery

Item number	Component
V-275	Linear actuator according to your order
MP162EK	Short instructions for PIMag® linear actuators, in printed form

Suitable Controllers

Controller	Description
C-413.1G	PIMag® motion controller, 1 channel, TCP/IP interface, bench-top device, force control option

Please note that the cables for connecting the V-275 to the electronics must also be ordered separately.

- To order, contact our customer service department (p. 16).

Installation

General Notes on Installation

DANGER



Strong magnetic fields affect heart pacemakers!

The V-275 contains permanent magnets that could impair the function of heart pacemakers and other active implants. With a distance of 10 cm between actuator and pace maker or active implant, the magnetic flux density of the actuator (housing not removed) is significantly below 1 mT. **However, the magnetic fields are also effective when the V-275 is not connected to the controller/electric power.**

- Make sure that people with heart pacemakers and / or other active implants do not have access to the V-275.
- If people with heart pacemakers and /or other active implants cannot be excluded from handling the V-275 a minimum distance of 20 cm between actuator and person is recommended.
- Ensure that hazardous areas are marked correspondingly.

CAUTION



Risk of cuts and crushing!

The V-275 linear actuator can generate high forces at high velocities. When a contact part with a small contact surface is installed on the pusher of the linear actuator, the pressure exerted by the pusher on a fixed part or obstacle during operation may be very high. If fingers or limbs get caught between the pusher 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 seized 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. 17).

NOTICE



Attraction of magnetizable objects!

The magnets in the V-275 can attract magnetizable objects such as loose screws. Objects attracted can damage the V-275.

- Make sure that there are no movable, magnetizable objects within a radius of at least 10 cm around the housing of the V-275.
- Apply corresponding precautions also for storage and transport of the V-275.

NOTICE



Damage to magnetically sensitive objects!

The magnets in the V-275 can damage magnetically sensitive objects such as 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 housing of the V-275.
- Apply corresponding precautions also for storage and transport of the V-275.

NOTICE



Damage due to mechanical overload of the pusher!

Excessive torque or forces on the pusher (p. 7) can damage the V-275 linear actuator.

- Do **not** exceed a maximum screw-in depth of 5 mm when mounting a contact part (V-275.431) or a load (V-275.430).
- Do **not** exceed a maximum force of 11 N both in the positive and the negative direction of motion of the pusher.
- V-275.431 only: Do **not** exceed a maximum torque of 15 Ncm when changing the contact part. Use a torque wrench to tighten the contact part.
- V-275.431 only: Do **not** exceed the maximum lateral force acting on the contact part, which is calculated using the following formula:

$$F_{\max} = \frac{\text{Maximum torque [in Ncm]}}{\text{Maximum lever length [in cm]}} = \frac{15 \text{ Ncm}}{\text{Contact part length [in cm]} + 2.2 \text{ cm}}$$

(Contact part length: Overall length of the contact part excluding the mounting thread)

- V-275.430 only: Do **not** exceed a lateral force of 10 N acting on the pusher.

Optional: Installing a Load on a V-275.430

INFORMATION

- If you install a load on the pusher, you may have to adapt the settings of the controller due to the changed mass.

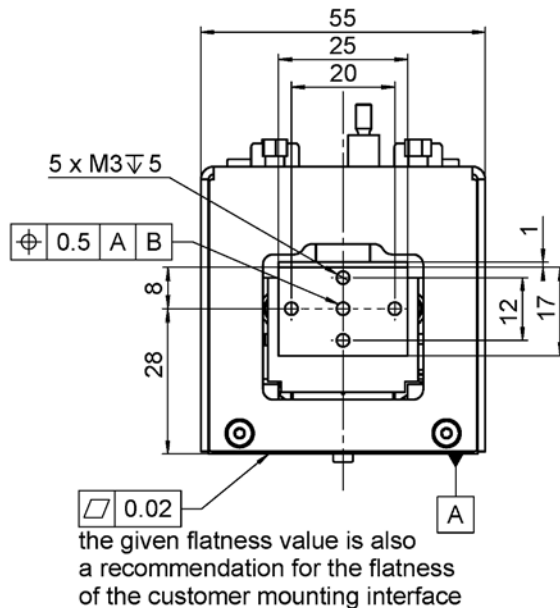


Figure 3: Installing a load with M3 screws

Tools and accessories

- Suitable torque wrench
- At least one screw M3 of suitable length

Requirements

- ✓ You have read and understood the general notes on installation (p. 9).

Optional: Installing a load

- Screw the load onto the pusher of the V-275.430.

When doing so, do **not** exceed a maximum screw in depth of 5 mm, and do **not** mechanically overload the pusher (see the safety instructions on p. 9 for the maximum permissible stress and load capacities).

Pay attention to a maximum torque of 110 Ncm.

Optional: Changing the Contact Part of a V-275.431

INFORMATION

- If you change the contact part of the pusher, you may have to adapt the settings of the controller due to the changed contact part mass and/or contact stiffness.
- Via the internal thread of the pusher, the contact part is electrically connected to the M3 grounding pin of the V-275.431.

Tools and accessories

- Torque wrench

Requirements

- ✓ You have read and understood the general notes on installation (p. 9).

Optional: Changing the contact part

1. Unscrew the supplied contact part from the pusher of the V-275.431 with a maximum torque of 15 Ncm.
2. Screw the new contact part onto the pusher of the V-275.431, maximum torque: 15 Ncm.

Removing the Transport Lock

The V-275 is delivered with a transport lock installed.

NOTICE



Damage from transport lock that has not been removed!

Damage can occur to the V-275 if the transport lock has not been removed and a motion is commanded.

- Remove the transport lock from the V-275 before you start up the V-275 with the controller.

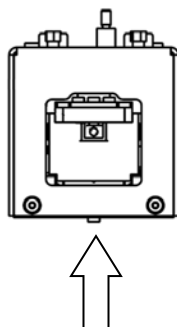


Figure 4: Transport lock of the V-275

- Remove the transport lock using a suitable tool (hex key for M2 screws).

Mounting the V-275 on a Surface

NOTICE



Screws that are too long!

Screws that are inserted too deeply can damage the V-275 linear actuator.

- Observe the depth of the mounting holes in the housing of the V-275 linear actuator.
- Only use screws of the correct length for the mounting holes:

Mounting option 1 (M3x5 mounting holes): Maximum screw-in depth is 5 mm

Mounting option 2 (M4x8 mounting holes): Maximum screw-in depth is 8 mm

You have the following mounting options:

Mounting option 1:
4 × M3x5

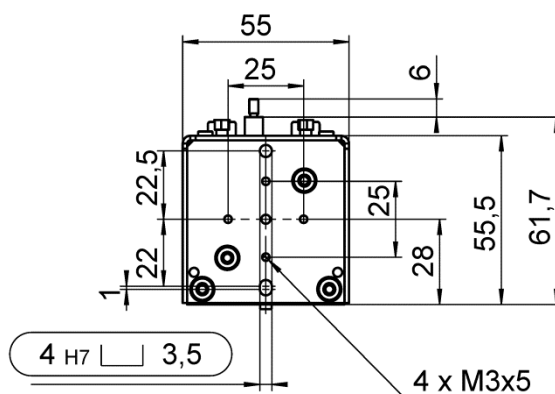


Figure 5: Mounting with four M3x5 screws

Mounting option 2:
4 × M4x8

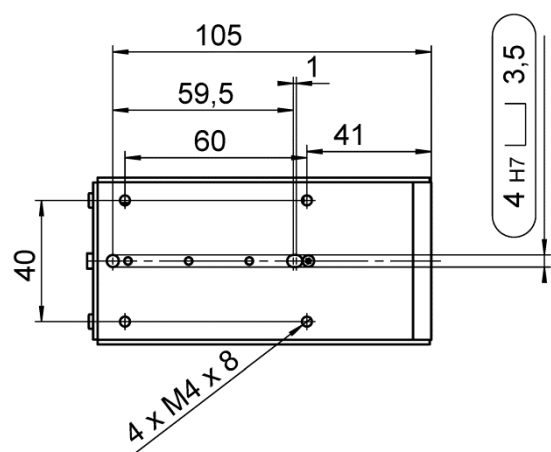


Figure 6: Mounting with four M4x8 screws

- To mount the V-275 linear actuator on a surface, use the four mounting holes of the selected option with suitable screws, see figures above.
- Tighten the screws with a maximum torque of 110 Ncm (M3 screws) or 260 Ncm (M4 screws).

Connecting Motor Cable and Sensor Cable to the V-275

Requirements

- ✓ You have read and understood the general notes on installation (p. 9).
- ✓ Motor cable and sensor cable are **not** connected to the controller.

Tools and accessories

- D-sub 9 (m/f) motor cable, to be ordered separately (p. 16)
- D-sub 25 (m/f) sensor cable, to be ordered separately (p. 16)

Connecting the motor cable and sensor cable to the V-275

1. Connect the cable:
 - Connect the connector (f) of the motor cable to the 9-pin D-sub panel plug (m) of the V-275.
 - Connect the connector (f) of the sensor cable to the 25-pin D-sub panel plug (m) of the V-275.
2. Secure the connectors (f) with the integrated screws against being accidentally pulled out of the V-275.

Startup and Operation

General Notes on Startup and Operation

DANGER



Strong magnetic fields affect heart pacemakers!

The V-275 contains permanent magnets that could impair the function of heart pacemakers and other active implants. With a distance of 10 cm between actuator and pace maker or active implant, the magnetic flux density of the actuator (housing not removed) is significantly below 1 mT. **However, the magnetic fields are also effective when the V-275 is not connected to the controller/electric power.**

- Make sure that people with heart pacemakers and / or other active implants do not have access to the V-275.
- If people with heart pacemakers and /or other active implants cannot be excluded from handling the V-275 a minimum distance of 20 cm between actuator and person is recommended.
- Ensure that hazardous areas are marked correspondingly.

NOTICE



Overheating caused by selecting unfavorable nominal current!

The nominal current as specified in the data table (p. 17) applies when operating at room temperature: As the ambient temperature rises, adjust the nominal current that is driving the actuator.

Otherwise the actuator could be damaged by overheating.

- Calculate the nominal current according to the ambient temperature (p. 15).
- Adapt your application (acceleration, velocity, load) so that the calculated nominal current is not exceeded. If you have any questions, contact our customer service department (p. 16).

INFORMATION

Since the drive of the V-275 linear actuator does not have any self-locking, an internal return mechanism is implemented (return / pulling force is approx. 2.8 N). This return mechanism pulls the pusher of the V-275 in the negative direction of motion (towards the actuator housing) when switching off or rebooting the controller. The return motion is stopped by an integrated soft stop.

When the controller is switched on but the servo mode for the axis is switched off, the weight force of the moving mass is compensated for by the controller (see "AutoZero Procedure for Weight Force Compensation" in the C-413 user manual (MS224E)).

Temperature Dependency of the Nominal Current: Calculating the Nominal Current

The nominal current as specified in the data table (p. 17) applies when operating at room temperature: As the ambient temperature rises, adjust the nominal current that is driving the actuator.

Calculating the nominal current

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

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

With:

$I(T)$ = Nominal current, depending on ambient temperature T

T = Ambient temperature

$I(T_{\text{ref}})$ = 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

Starting Up the V-275 with the C-413.1G Controller

Requirements

- ✓ You have read and understood the following sections:
 - General Notes on Installation (p. 9)
 - General Notes on Operation (p. 14)
- ✓ You have properly installed (p. 8) the actuator.
- ✓ You have read and understood the user manual of the controller.
- ✓ You have read and understood the manual of the PC software.
- ✓ 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 V-275 is connected via the motor cable and sensor cable).

Starting up the V-275 with the C-413.1G controller

- Start up the actuator (see user manual of the controller).

Maintenance

The V-275 is maintenance-free.

NOTICE



Damage from opening the V-275!

Opening the housing causes damage to the V-275.

- Only loosen screws according to the instructions in this document.
- Do **not** open the V-275.

Cleaning

- Before cleaning, make sure that you have disconnected the V-275 linear actuator from the controller.
- When necessary, clean the surfaces of the V-275 linear actuator with a cloth lightly dampened with a mild cleanser or disinfectant.

Customer Service

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

If you have questions concerning your system, have the following information ready:

- Product codes and serial numbers of all products in the system
- Firmware version of the controller (if present)
- Version of the driver or the software (if present)
- Operating system on the PC (if present)

If possible: Take photographs or make videos of your system that can be sent to our customer service department if requested.

Technical Data

Specifications

	V-275.430, V-275.431	Unit	Tolerance
Active axes	Z		
Motion and positioning			
Travel range	10	mm	
Integrated sensor	Optical linear encoder		
Sensor resolution ¹	10	nm	max.
Min. incremental motion	100	nm	typ.
Linearity error, closed-loop	1	%	typ.
Repeatability	±0.5	µm	typ.
Velocity	600	mm/s	max.
Force sensor resolution ²	1	mN	max.
Smallest force step ³	5	mN	typ.
Mechanical properties			
Bearing / guide	Linear recirculating ball bearing		
Motion straightness	±5	µm	±5 %
Moved mass without load	150	g	typ.
Return / pulling force	2.8	N	typ.
Drive properties			
Motor type	PIMag® voice coil drive, moving coil		
Coil resistance	5.7	Ω	typ., at 20°C
Coil inductance	3.75	mH	typ., at 1 kHz
Time constant	0.65	ms	
Back EMF	10	Vs/m	
Force constant ³	10	N/A	typ.
Motor constant	4.2	N/W ^{1/2}	
Current constant	0.1	A/N	typ.
Nominal current ⁴	700	mA	max.
Peak current (max. 3 s)	1500	mA	

	V-275.430, V-275.431	Unit	Tolerance
Average push / pull force	7	N	nominal
Power dissipation of the coil with 100 % duty cycle	4	W	
Maximum push / pull force	15	N	max.
Permitted temperature for actuator components	60	°C	max.
Miscellaneous			
Operating temperature range	10 to 60	°C	
Material	Aluminum		
Mass	800	g	±5 %
Motor connector	D-sub 9 (m)		
Sensor connector	D-sub 25 (m)		
Lifetime	> 10 ⁷	cycles	min.
Recommended controller	C-413.1x		

¹ With C-413 controller. Interpolated resolution.

² Refers to V-275.431 only. Interpolated resolution with C-413 controller.





³ Refers to V-275.431 only

⁴ Do not exceed for continuous operation.

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

Maximum Ratings of V-275

The voice coil drive of the V-275 linear actuator is designed for the following operating data.

Maximum Operating Voltage	Operating Frequency	Maximum Current (3 s)	Maximum Nominal Current	Maximum Continuous Power Consumption
				
48 V	==	1.5 A	0.7 A	4 W

Ambient Conditions and Classifications of V-275

The following ambient conditions and classifications must be observed for the V-275 linear actuator:

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

Dimensions V-275.430

Dimensions in millimeters.

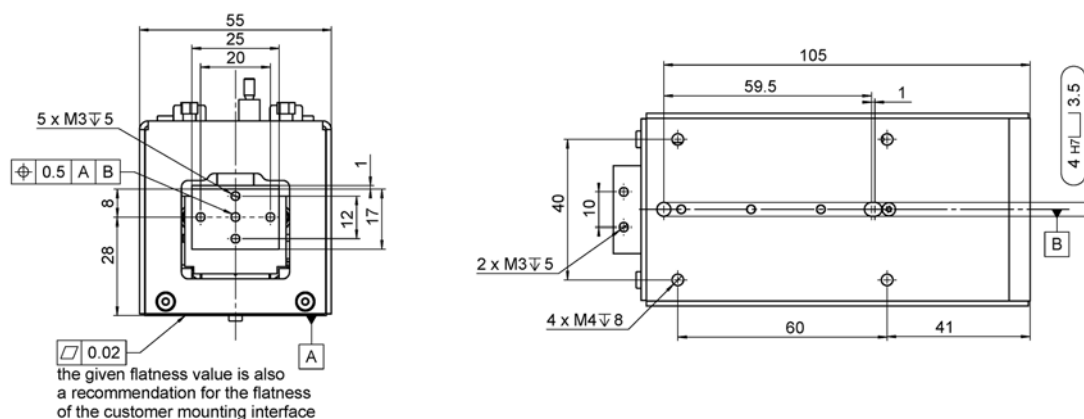


Figure 7: V-275.430; Left: Side with pusher, right: View from below

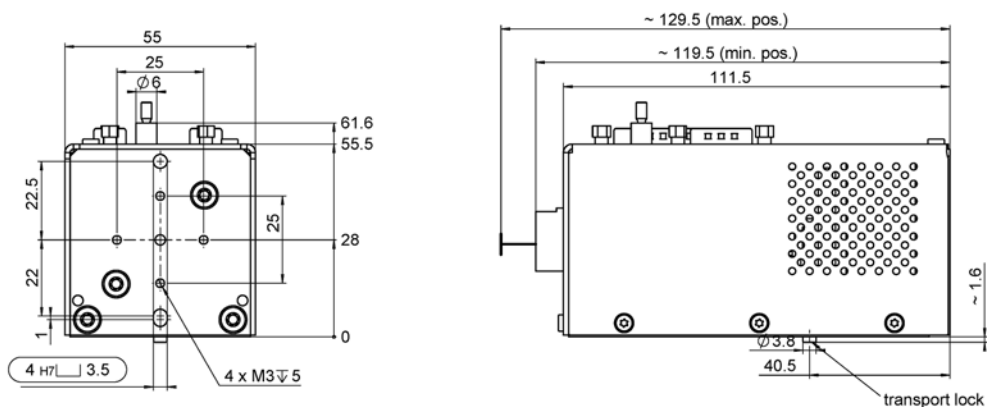


Figure 8: Lateral views of V-275.430

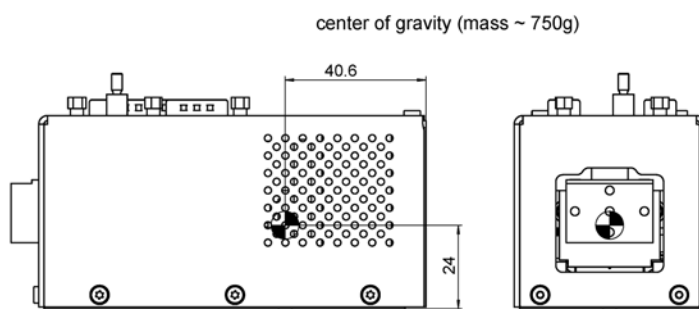


Figure 9: Location of center of gravity of V-275.430

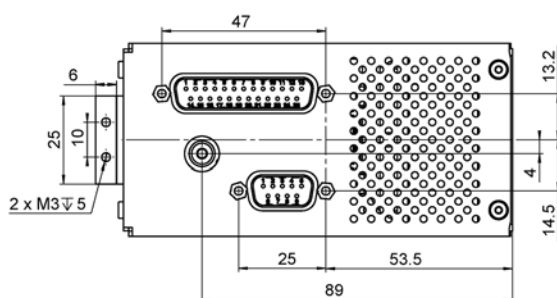


Figure 10: Top view of V-275.430

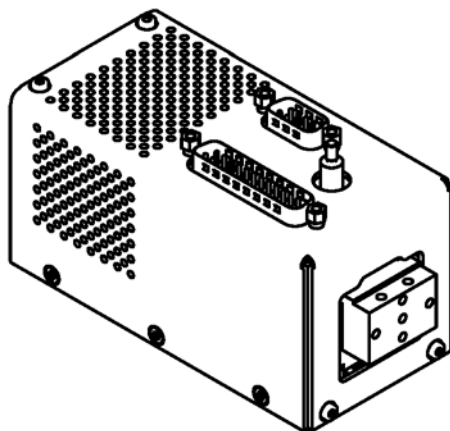


Figure 11: 3-dimensional view of V-275.430

Dimensions V-275.431

Dimensions in millimeters.

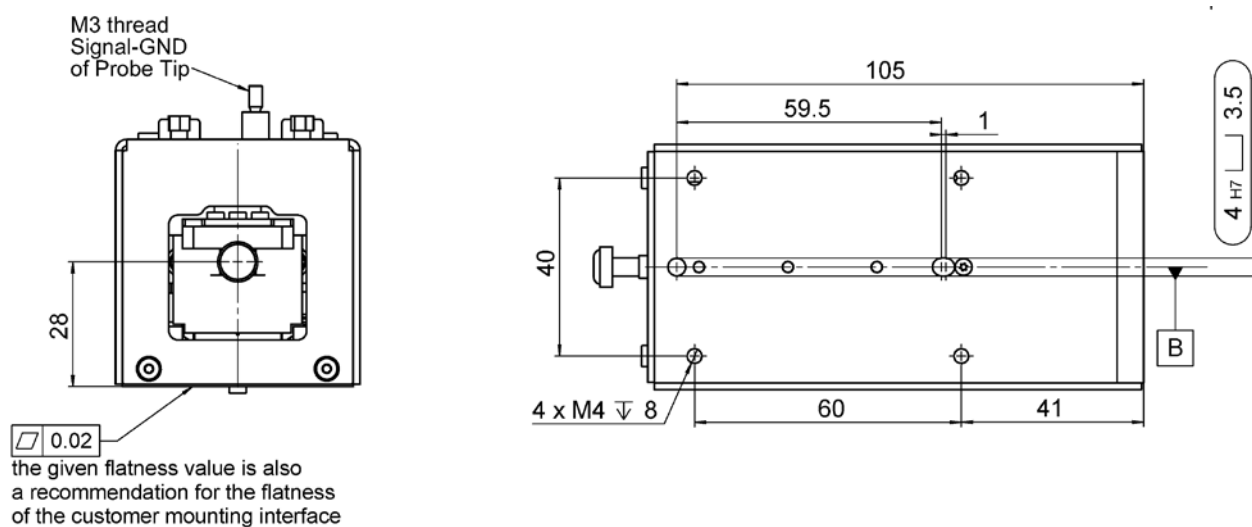


Figure 12: V-275.431; Left: Side with pusher with integrated force sensor and contact part, right: View from below

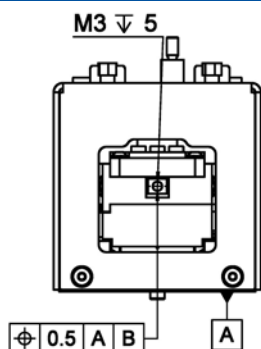


Figure 13: V-275.431, same side as in previous figure, but here without pusher

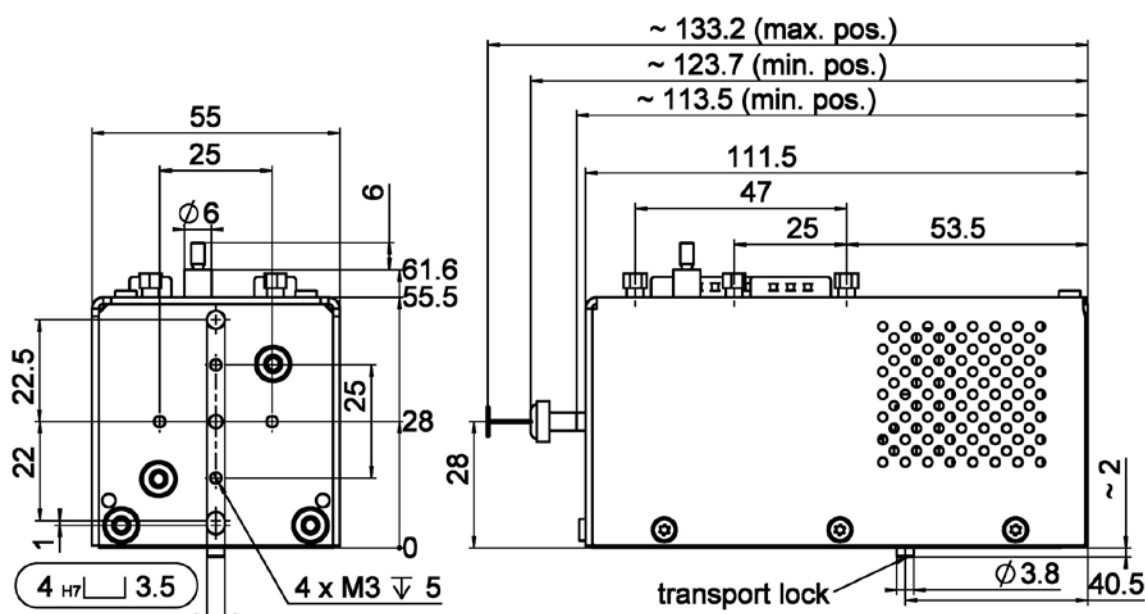


Figure 14: Lateral views of V-275.431

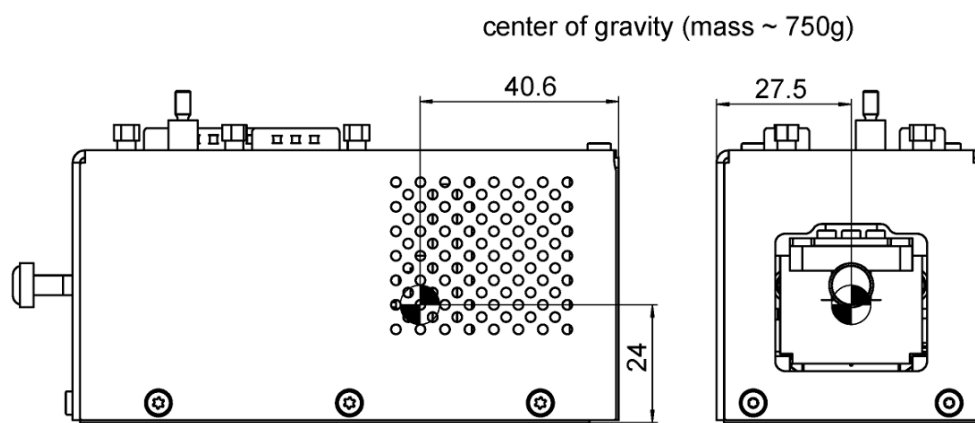


Figure 15: Location of center of gravity of V-275.431

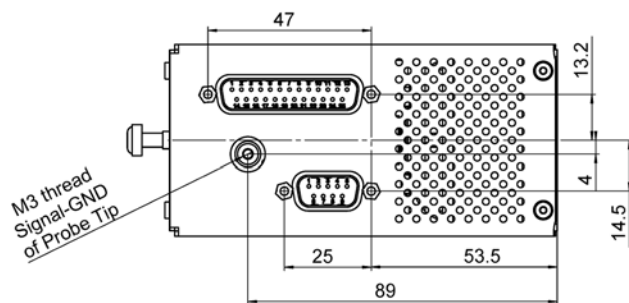


Figure 16: Top view of V-275.431

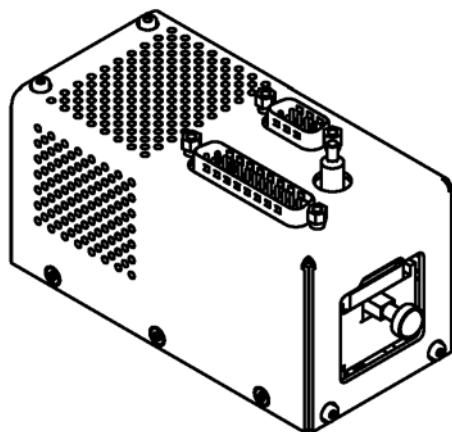


Figure 17: 3-dimensional view of V-275.431

Pin Assignment

Motor

D-sub panel plug, 9-pin, male.

Pin	Signal*
1	Motor P1
2	Motor N1
3	GND
4	NC**
5	NC**
6	Motor P1
7	Motor N1
8	NC**
9	NC**

Recommendations for cable assembly:

- Maximum cable length: 3 m
- The lines on pins 1, 2, 6 and 7 (Motor P1 and Motor N1) should be twisted and shielded together.

* Motor output on C-413.1G: ± 1.5 A, regulated; 24 V max.

** NC: not connected

Sensor

D-sub panel plug, 25-pin, male.

Pin	Signal
1	SPI_CLK+
2	GND
3	SPI_MOSI-
4	SPI_MISO+
5	GND
6	SPI_CS_Sensor1-
7	SPI_CS_Sensor2+
8	GND
9	SPI_CS_Memory1-
10	SPI_CS_Memory2-
11	Reference1-
12	Reference2-
13	5 V Sensor Supply
14	SPI_CLK-
15	SPI_MOSI+
16	GND
17	SPI_MISO-
18	SPI_CS_Sensor1+
19	GND
20	SPI_CS_Sensor2-
21	SPI_CS_Memory1+
22	SPI_CS_Memory2+
23	Reference1+
24	Reference2+
25	5 V Sensor Supply

Recommendations for cable assembly:

- Maximum cable length: 1.5 m
- The lines on the following pins should be implemented as twisted pairs:
 - 1 with 14
 - 3 with 15
 - 4 with 17
 - 6 with 18
 - 7 with 20
 - 9 with 21
 - 10 with 22
 - 11 with 23
 - 12 with 24
- The cable should have a total shield. This shield should be connected to the connector shells (this way, it will be connected to protective GND when connected to the sensor socket of the C-413.1G).

Old Equipment Disposal

In accordance with the applicable EU law, electrical and electronic equipment may not be disposed of with unsorted municipal wastes in the member states of the EU.

When disposing of your old equipment, observe the international, national and local rules and regulations.

To meet the manufacturer's product responsibility with regard to this product, Physik Instrumente (PI) GmbH & Co. KG ensures environmentally correct disposal of old PI equipment that was first put into circulation after 13 August 2005, free of charge.

If you have old PI equipment, you can send it postage-free to the following address:

Physik Instrumente (PI) GmbH & Co. KG

Auf der Römerstr. 1

D-76228 Karlsruhe, Germany

