

MP86E M-228 / M-229 Linear Actuators User Manual

Version: 2.1.0

Date: 4/15/2024



This document describes the following products:

- **M-228.10S**
Linear actuator, 10 mm, stepper motor, limit switches
- **M-228.11S**
Linear actuator, 10 mm, stepper motor, direct drive, limit switches
- **M-229.25S**
Linear actuator, 25 mm, stepper motor, limit switches
- **M-229.26S**
Linear actuator, 25 mm, stepper motor, direct drive, limit switches



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Subject to change. This manual is superseded by any new release. The latest respective release is available for download (p. 2) on our website.

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1 About this Document

1.1 Objective and Target Group of this User Manual

This user manual contains the information necessary for using the M-228 / M-229 as intended.

We assume that the user has basic knowledge of closed-loop systems, motion control concepts, and applicable safety measures.

1.2 Symbols and Typographic Conventions

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

CAUTION



Dangerous situation

Failure to comply could result in minor injuries.

- Precautions to avoid the risk.

NOTICE



Dangerous situation

Failure to comply could result in damage to the equipment.

- Precautions to avoid the risk.

INFORMATION

Information for easier handling, tricks, tips, etc.

Symbol/Label	Meaning
1.	Action consisting of several steps with strict sequential order
2.	
➤	Action consisting of one or more steps without relevant sequential order
▪	Bullet point
p. 5	Cross-reference to page 5

Symbol/Label

RS-232

**Meaning**

Label on the product indicating an operating element (example: RS-232 interface socket)

Warning sign on the product referring to detailed information in this manual.

1.3 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.

1.4 Other Applicable Documents

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

Product	Document
C-663.12 Mercury Step stepper motor controller	MS241 User Manual
C-663.12C885 Mercury Step stepper motor controller module	C663T0004 User Manual
PIMikroMove	SM148E Software Manual

1.5 Downloading Manuals

INFORMATION

If a manual is missing or problems occur with downloading:

- Contact our customer service department (p. 33).

Downloading manuals

1. Open the website **www.pi.ws**.
2. Search the website for the product number (e.g., M-228 / M-229).
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

2.1 Intended Use

The M-228 / M-229 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.

In accordance with its design, the M-228 / M-229 is intended to be used for positioning, adjusting and shifting loads in one axis at various velocities.

It is only possible to use the M-228 / M-229 as intended when it is installed, and only with a suitable controller (p. 12). The controller is not included in the scope of delivery of the M-228 / M-229.

2.2 General Safety Instructions

The M-228 / M-229 is built according to state-of-the-art technology and recognized safety standards. Improper use of the M-228 / M-229 may result in personal injury and/or damage to the M-228 / M-229.

- Use the M-228 / M-229 for its intended purpose only, and only when it is in perfect condition.
- Read the user manual.
- Immediately eliminate any faults and malfunctions that are likely to affect safety.

The operator is responsible for installing and operating the M-228 / M-229 correctly.

2.2.1 Organizational Measures

User manual

- Always keep this user manual together with the M-228 / M-229. The latest versions of the user manuals are available for download on our website (p. 2).
- Add all information from the manufacturer such as supplements or technical notes to the user manual.
- If you give the M-228 / M-229 to other users, include this user manual as well as all other relevant information provided by the manufacturer.
- Do the work only if the user manual is complete. Missing information due to an incomplete user manual can result in minor injury and damage to equipment.

- Install and operate the M-228 / M-229 only after you have read and understood this user manual.

Personnel qualification

The M-228 / M-229 may only be installed, started, operated, maintained, and cleaned by authorized and appropriately qualified personnel.

2.2.2 Safety Measures During Installation

A cable break leads to a failure of the linear actuator.

- Install the linear actuator so that the cable is not bent too strongly or crushed during operation.

Lateral forces that affect the pusher of the linear actuator increase the friction on the internal drive components. Increased friction impairs the motion of the pusher and increases wear on the drive components.

- Avoid lateral forces on the tip and on the pusher of the M-228 / M-229.

The motion of the pusher can be hindered by a mounting nut that has been tightened too strongly. This reduces the positioning accuracy.

- Do not overtighten the nut (torque ≤ 15 Nm).

2.2.3 Safety Measures when Starting and Operating

There is a risk of crushing and minor injuries between the moving pusher of the M-228 / M-229 and a stationary part or obstacle.

- Keep your fingers at a safe distance from the motion range of the pusher.
- Do not place any objects in areas where they can get caught by the pusher.

The M-228 / M-229 may move unintentionally when connecting it to the controller. Faulty software and incorrect operation of the software may also cause unintended movements.

- Do not place any objects in areas where they can be caught by moving parts.
- Before connecting the M-228 / M-229, check whether a macro is defined as the startup macro in the controller and cancel the selection of the startup macro if necessary.

Connecting a linear actuator to an unsuitable controller can damage the linear actuator or controller.

- Connect a linear actuator with stepper motor to a stepper motor controller only.

The collision of moving parts with the hard stop (end of travel range), as well as high acceleration, can cause damage to, or considerable wear on the mechanical system.

- In the event of a malfunction of the motor controller, stop the motion immediately.
- Ensure that the end of the travel range is approached at low velocity.
- Set your 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.
- Ensure that the automatic limit switch halt is supported by the controller, or that it is activated in the controller.

2.2.4 Safety Measures During Maintenance

The M-228 / M-229 is precisely aligned.

- Do not loosen any sealed screw.

2.3 European Declarations of Conformity

For the M-228 / M-229, declarations of conformity were issued according to the following European statutory requirements:

EMC Directive

RoHS Directive

The standards applied for certifying conformity are listed below.

EMC: EN 61326-1

Safety: EN 61010-1

RoHS: EN IEC 63000

3 Product Description

3.1 System Overview

The following figure shows an overview of the overall system.

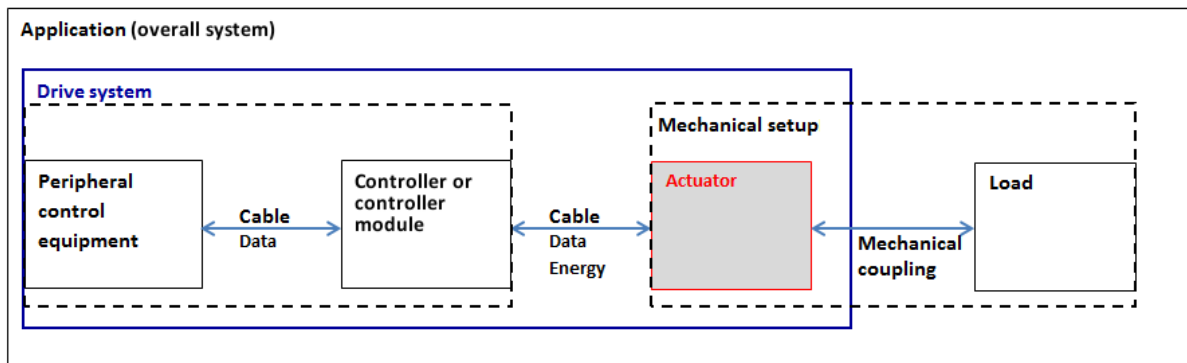


Figure 1: Overall system, overview

To operate the actuator in your application, the following components are necessary:

Component	Task	Supplied by or available from PI
Peripheral control equipment	Loads configurations and control commands into the controller (e.g., PC in conjunction with PC software).	PC software (e.g., PIMikroMove) included in the scope of delivery of the controllers from PI.
Controller	Controls the motion of the actuator.	Stand-alone device or controller module (p. 12).
Actuator	Produces the motion of the part to be driven or the load in your application.	Here: linear actuator, type M-228 / M-229. This product.
Cables	<ul style="list-style-type: none"> Peripheral control equipment to controller: Ensures the data communication. Controller to actuator: Ensures the data communication and the power supply of the actuator. 	<ul style="list-style-type: none"> PC - Controller transmission cable. Controller - actuator transmission cable: Fixed to the M-228 / M-229 cable connected to the controller.

Component	Task	Supplied by or available from PI
Mechanical setup	Ensures among other things that the actuator is fixed securely and therefore high repeatability.	Mounting nut only (for mechanical connection) included in the scope of delivery of the actuator.
Mechanical coupling	Establishes the connection between the actuator and load (pusher).	Flat tip or ball tip (p. 12).
Load	Part to be driven. This is to be moved in your application.	-

3.2 Model Overview

Four standard versions of the M-228 / M-229 are available. All models are high-resolution linear actuators with stepper motor and limit switch. Among other things, they differ in the following respects:

- Travel range
- Drive type
- Velocity
- Step resolution

Model	Travel range		Drive type		Velocity		Step resolution	
	10 mm	25 mm	Gear-head	Direct drive	1.5 mm/s	4 mm/s	24 steps/rev	400 steps/rev
M-228.10S	+		+		+		+	
M-228.11S	+			+		+		+
M-229.25S		+	+		+		+	
M-229.26S		+		+		+		+

- For further technical data, refer to the specifications (p. 35).

PI also produces custom designs upon request. Custom designs can differ from the described standard products in respect to dimensions, characteristics, or other technical data.

- If required, contact our customer service department (p. 33) directly.

3.3 Product View

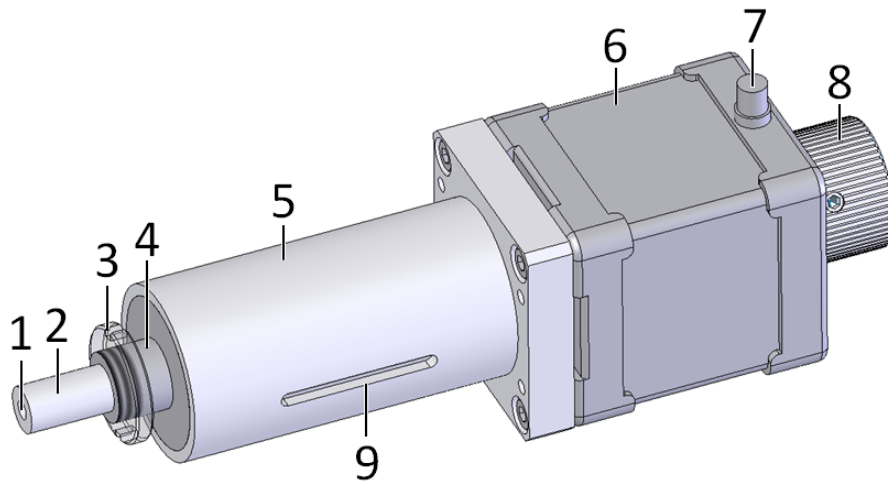






Figure 2: Exemplary product view of an M-229.26S

- 1 M4 hole for fixing the tip to the pusher
- 2 Pusher, nonrotating, with inner hole
- 3 Mounting nut for clamp connection
- 4 Mounting shaft with thread for mounting nut
- 5 Sleeve
- 6 Remote engine (exception: in the case of the M-228.10S and M 229.25S, the motor is integrated in the sleeve.)
- 7 Cable exit
- 8 Handwheel for moving the pusher by hand (M-228.11S and M-229.26S only)
- 9 Window with position indicator

3.4 Product Labeling

Labeling	Description
M-228.11S	Product name (example), the characters following the period refer to the model
123456789	Serial number (example), individual for each M-228 / M-229 Meaning of each position (from the left): 1 = internal information, 2 and 3 = year of manufacture, 4 to 9 = consecutive number
	Warning sign "Pay attention to the manual!"
	Old equipment disposal (p. 45)
WWW.PI.WS	Manufacturer's address (website)

Labeling	Description
	CE conformity mark
	Manufacturer's logo

3.5 Scope of Delivery

Product number	Description
M-228 / M-229	Linear actuator according to order (p. 10)
M23010116*	Flat tip (assembled on delivery)
M23010117	Ball tip
3323	Hook wrench for mounting nut
MP122EK	Short instructions for M-22x / M-23x linear actuators

* M-228.10S and M-229.25S only, included in the scope of delivery.

Note that the extension cable or adapter for connecting the M-228 / M-229 with the electronics must be ordered separately.

3.6 Suitable Controllers

The M-228 / M-229 must be connected to a suitable controller. The following devices from PI are suitable for operation of the M-228 / M-229:

Product number	Description
C-663.12	Compact Mercury Step stepper motor controller, 1 axis, closed-loop and open-loop operation, HD D-sub 26, 48 V
C-663.12C885	Mercury Step stepper motor controller module, 1 axis, HD D-sub 26, for PIMotionMaster, closed-loop and open-loop operation, support of external sensors

The required 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.

- To order, contact our customer service department (p. 33).

3.7 Accessories

Product number	Description
C-815.AA42	Plug adapter for D-sub 15 (f) to HD D-sub 26 (m)
C-815.38	Motor cable for DC motors, D-sub 15 (m/f), 3 m

- To order, contact our customer service department (p. 33).

3.8 Technical Features

3.8.1 Limit Switches

The M-228 / M-229 is equipped with noncontact, Hall effect limit switches.

Each limit switch sends an overrun signal on a dedicated line to the controller. The controller then stops the motion. If the controller does not stop the motion in time, the linear actuator runs into the hard stop.

Refer to "Limit Switch Specifications" (p. 38) for more information.

3.8.2 Reference Switch

The M-228 / M-229 is equipped with a reference switch positioned at approx. the midpoint of the travel range. The reference switch transmits an index pulse (TTL) when being passed.

In order to use the reference switch signal for reference moves, the controller must support the reference signal type "index pulse" (refer to the user manual for the controller).

For more information, see "Reference Switch Specifications" (p. 39).

4 Unpacking

1. Unpack the M-228 / M-229 with care.
2. Compare the contents with the scope of delivery according to the contract and the delivery note.
3. Inspect the contents for signs of damage. If any parts are damaged or missing, contact our customer service department immediately (p. 33).
4. Keep all packaging materials in case the product needs to be returned.

5 Installing

5.1 General Notes on Installation

NOTICE

**Cable break!**

A cable break leads to failure of the M-228 / M-229.

- Install the M-228 / M-229 so that the cable is not bent too strongly or crushed.

NOTICE

**Increased friction!**

Lateral forces acting on the pusher of the linear actuator increase the friction of the internal drive components. Increased friction impairs the motion of the pusher and increases wear on the drive components.

- Avoid lateral forces on the tip and on the pusher of the M-228 / M-229.

INFORMATION

Dissipating heat could influence temperature-dependent applications during operation.

- If your application depends on the temperature, consider the heat dissipating during operation before installing the M-228 / M-229.

5.2 Changing the Tip

INFORMATION

A tip makes it possible to realize different mechanical connections to a load:

- A flat tip allows a wide-area connection to a load.
- A ball tip allows a punctiform connection to a load.

To achieve optimal repeatability:

- Use a tip.
- Make sure that the selected tip is completely screwed in and does not have any backlash.

The M-228.10S and M-229.25S are delivered with a preassembled flat tip. A ball tip is supplied for all models.



Figure 3: Mounted flat tip (example illustration)

- 1 Tip (flat)
- 2 Wrench flat of the tip
- 3 Pusher

Requirements

- ✓ You have read and understood the General Notes on Installation (p. 17).
- ✓ You have made the M-228 / M-229 accessible for changing the tip.
- ✓ The pusher is extended so far that you can comfortably reach the tip.
In the delivery condition, the pusher is extended far enough.

Tools and Accessories

- Tip (p. 13) supplied
- Open-end wrench AF 5

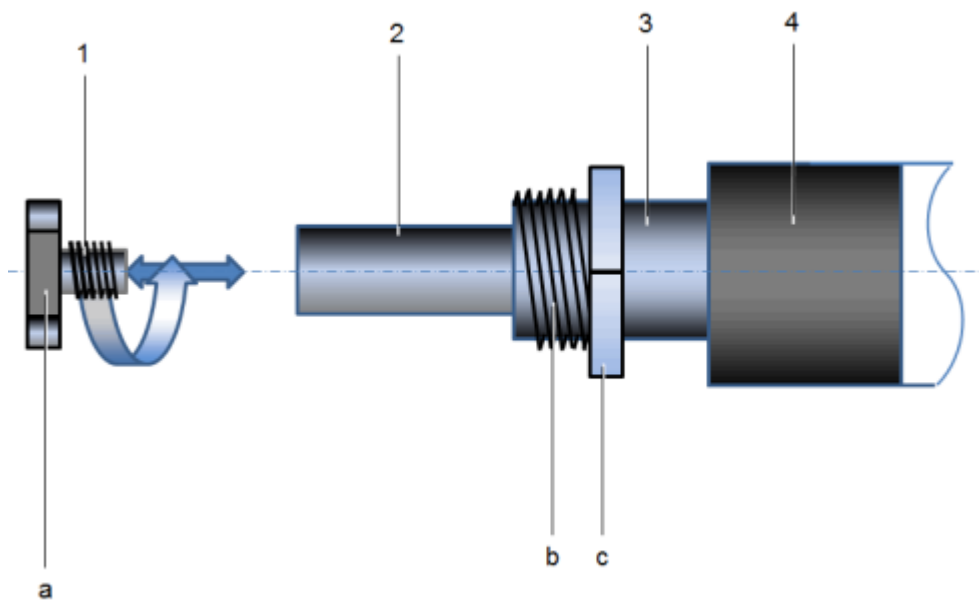


Figure 4: Changing the tip, schematic

- 1 Tip (flat) with
(a) wrench flat
- 2 Pusher, nonrotating
- 3 Mounting shaft with
(b) Thread for clamp connection
(c) Mounting nut
- 4 Sleeve

Changing the tip

1. Unscrew the tip to be replaced from the pusher of the M-228 / M-229 by hand. If this is not successful, use an AF 5 open-end wrench.
2. Screw the new tip into the pusher of the M-228 / M-229 by hand.
3. Use the AF 5 open-end wrench to tighten the tip with a torque of 2 Nm.
4. If necessary, secure the screw with a thread-locking adhesive.

5.3 Providing a Suitable Mechanical Mounting and Installation Environment

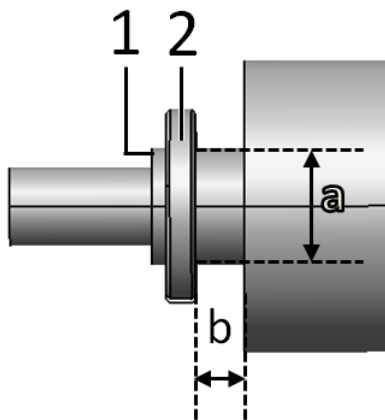


Figure 5: Relevant components and dimensions for installation in the mechanical mounting (schematic)

- 1 Mounting shaft with
 - (a) Diameter: 9.5 mm (M-228) or 12 mm (M-229)
 - (b) Clamping width: 6 mm
- 2 Clamping nut

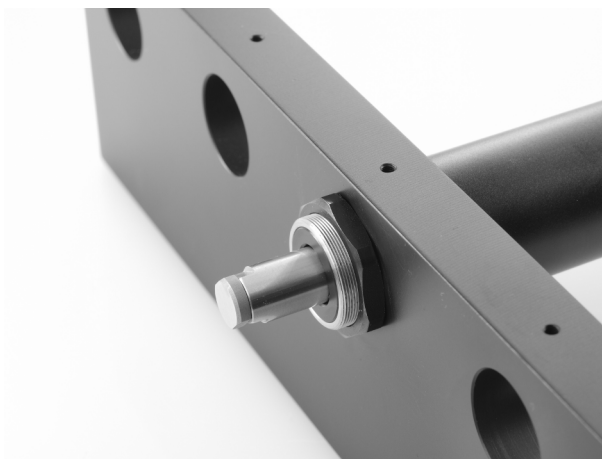


Figure 6: Example of installing a linear actuator (here: M-235)

A suitable mechanical mounting and installation environment are necessary for the proper use of the actuator.

- Make sure that the following conditions have been met:
 - Material and statics of the mounting are designed so that the static and dynamic forces that occur can be safely and continuously managed.

- The dimensions of the mounting are adapted to the dimensions of the actuator (see above figures and "Dimensions" (p. 39)).
- The intended motion of the pusher and the load must not be inhibited by the dimensions of the installation environment.
- Take into account the following specifications as well when planning the application and installing the actuator:
 - Dimensions of the selected tip (see "Dimensions" (p. 39))
 - Travel range: Maximum 10 mm (M-228) or 25 mm (M-229)
 - Space requirements for bend-free and proper guiding of the connecting cable and if applicable, additional cables
 - Length of the connecting cable and if applicable, additional cables
 - Position of the actuator position indicator, if it is to be read during operation
- If the limit switches of the actuator cannot be reached with the planned minimum and maximum displacements: Make sure that the actuator and the load **only move within the planned range**. Suitable measures:
 - Corresponding programming of the controller
 - Emergency off switch
 - Automatic shutdown systems
- In accordance with the legal regulations, avoid or label danger areas resulting from the installation of the actuator and from use (e.g., risk of crushing in the case of heavy moving loads, fast actuator motion and/or high drive torques).

You can obtain all dimensions of the actuator and relevant individual parts in the section "Dimensions" (p. 39).

5.4 Installing the M-228 / M-229 in a Mechanical Mounting

NOTICE



Incorrect tightening torque of the mounting nut!

The motion of the pusher can be hindered by a mounting nut that has been tightened too strongly. This reduces the positioning accuracy.

- Tighten the mounting nut to a maximum torque of 15 Nm.

INFORMATION

To achieve an optimal repeatability, the mounting shaft must not have any backlash.

- When assembling, make sure that the actuator and the mechanical mounting have been connected perfectly.

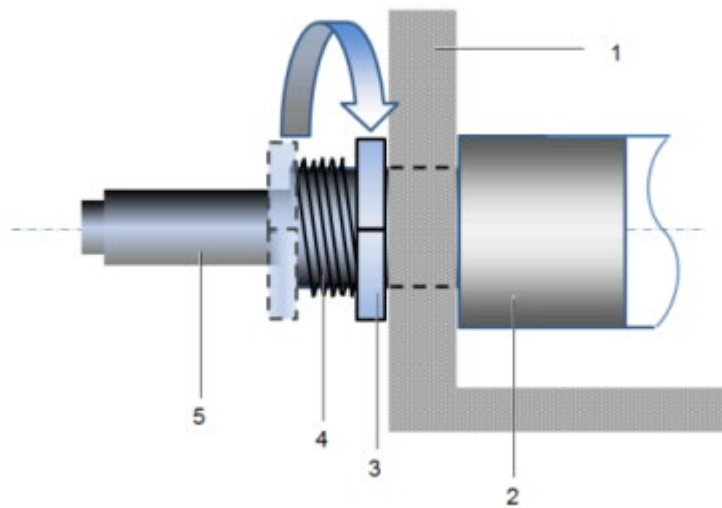


Figure 7: Clamp connection (schematic)

- 1 Mechanical mounting
- 2 Sleeve
- 3 Mounting nut
- 4 Mounting shaft with thread
- 5 Pusher with tip (flat)

We recommend installing the actuator in the mechanical mounting with a clamp connection. The following instructions refer to this case.

Requirements

- ✓ You have read and understood the General Notes on Installation (p. 17).
- ✓ You have provided your application with a suitable mounting for the mounting shaft of the actuator.

Tools and accessories

- Supplied hook wrench (p. 12)

Installing the M-228 / M-229 in a mechanical mounting

1. Loosen the mounting nut on the mounting shaft of the actuator.
2. Position the actuator in the mounting of your application.
3. If necessary, put a suitable flat washer or a suitable spring washer onto the mounting shaft.
4. Turn the mounting nut a few times by hand into the thread of the mounting shaft.

5. To clamp the actuator in the mounting, tighten the mounting nut using the supplied hook wrench until you feel a resistance. The torque may **not** exceed 15 Nm!
6. Check that the actuator is correctly fitted in the mounting.

5.5 Connecting the M-228 / M-229 to the Controller

This section describes connecting the M-228 / M-229 to the C-663 controller from PI.

Requirements

- ✓ You have read and understood the General Notes on Installation (p. 17).
- ✓ The controller is **switched off**.
- ✓ You have determined the minimum cable length between the actuator and controller.

Accessories

- C-815.AA42 (p. 13) plug adapter
- If the connecting cable for the M-228 / M-229 needs to be longer: C-815.38 motor cable (p. 13)

Connecting the M-228 / M-229 to the C-663 controller

1. Connect the C-815.AA42 plug adapter to the HD D-sub 26 socket on the C-663 controller.
2. Connect the D-sub 15 (m) on the connecting cable for the M-228 / M-229 to the D-sub 15 (f) on the C-815.AA42 plug adapter. If necessary, use a C-815.38 motor cable to lengthen the cable.
3. Use the integrated screws to secure all connections against accidental disconnection.
4. Eliminate or mark resulting danger zones according to applicable legal regulations and directives.

6 Startup

6.1 General Notes on Startup

CAUTION

**Danger of crushing from moving pusher!**

There is a risk of crushing and minor injuries between the moving pusher of the M-228 / M-229 and a stationary part or obstacle.

- Keep your fingers at a safe distance from the motion range of the pusher.
- Do not place any objects in areas where they could be caught by the pusher.

NOTICE

**Unintentional motion!**

The M-228 / M-229 may move unintentionally when connecting it to the controller. Faulty software and incorrect operation of the software may also cause unintended movements.

- Do not place any objects in areas where they can be caught by moving parts.
- Before connecting the M-228 / M-229, check whether a macro is defined as the startup macro in the controller and cancel the selection of the startup macro if necessary.

NOTICE

**Damage if the wrong controller is connected!**

Connecting a linear actuator to an unsuitable controller can damage the linear actuator or controller.

- Connect a linear actuator with stepper motor to a stepper motor controller only.

NOTICE

**Damage due to the pusher crashing into the hard stop!**

When the limit switches are deactivated, the motion of the pusher is aborted by the hard stop and the M-228 / M-229 could be damaged.

- Do **not** deactivate the limit switches in the software.
- Test the function of the limit switches at low velocities only.

NOTICE**Damage or considerable wear due to high acceleration!**

High acceleration could cause damage to or considerable wear on the mechanics.

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

NOTICE**Damage from unsuitable controllers and PC software!**

Unsuitable controllers and PC software can damage the actuator.

- If you are using controllers and software from other manufacturers, check the technical data to make sure that they are suitable **before** starting and operating the actuator!

INFORMATION

The maximum velocity for a linear actuator with a stepper motor should be determined in the application. If the commanded velocity is too high, the stepper motor might stop without the controller detecting this state.

INFORMATION

Moving the pusher outwards corresponds to the positive direction of motion.

6.2 Starting and Operating the Actuator

In the following, a PC with PC software is used as the peripheral control equipment of the controller.

Requirements

- ✓ You have read and understood the General Notes on Startup (p. 25).
- ✓ You have installed the actuator correctly (p. 17).
- ✓ The controller (p. 12) and the required software have been installed. All connections on the controller have been made (refer to the controller manual).
- ✓ You have read and understood the user manual for the controller.
- ✓ You have read and understood the manual for the PC software.

Starting and operating the actuator

1. Start and operate the controller (refer to the user manual for the controller).
2. Configure the controller using the PC software for the actuator used (refer to the user manual for the controller and the PC software):
 - If you are using a controller from PI: Select the entry in the positioner database that precisely matches the actuator version in use.
 - If you are using a controller from another manufacturer: Enter the parameters in the corresponding PC software that precisely match the actuator version in use; see overview of the operating parameters (p. 27).
3. Start a few motion cycles for testing purposes (refer to the user manual for the controller).

6.3 Operating Parameters

If you are using the software included in the scope of delivery of the C-663 controller, the operating parameters can be loaded from a positioner database.

- Update the positioner database on your PC with the PIUpdateFinder. PIUpdateFinder is included in the software package for the C-663 controller.

For further information on positioner databases, refer to the user manual for the C-663 controller.

Operating parameters for stepper motor controllers from third parties

If you use a stepper motor controller from a third-party supplier, it may be necessary to enter operating parameters to adapt it to the linear actuator used.

Parameter	M-228.11S / M-229.26S (with stepper motor as direct drive)	M-228.10S / M-229.25S (with stepper motor and gearhead)	Unit	Tolerance
Recommended start values:				
Drive screw pitch	0.5	0.5	mm	
Holding torque (motor)	200	6 / 22	mNm	≈
Holding torque (motor), powered down	10	0.51 / 1.47	mNm	≈
Maximum acceleration	20 / 25	5	mm/s ²	
Maximum velocity	4	1.5	mm/s	
Hardware properties:				
Gear ratio	-	256 / 9	-	

Parameter	M-228.11S / M-229.26S (with stepper motor as direct drive)	M-228.10S / M-229.25S (with stepper motor and gearhead)	Unit	Tolerance
Limit switch polarity	Active low	Active low	-	
Full steps	400	24	Steps/revolution	
Full step angle	0.9	15	°	
Phase resistance (20 °C)	2.6	12.5 / 0.9	Ω	±10 %
Phase inductance (1 kHz, 1 V _{rms})	1.9	6.3 / 0.9	mH	±20 %
Continuous current per phase	850	250 / 1000	mA	

7 Maintenance

7.1 General Notes on Maintenance

NOTICE

**Damage due to improper maintenance!**

The M-228 / M-229 can become misaligned as a result of improper maintenance.

- Do not loosen any sealed screws.

7.2 Lubricating the M-228 / M-229

Depending on the operating conditions and the period of use of the linear actuator, the following maintenance measures are required.

Spreading lubricant

- If you move the M-228 / M-229 over a small travel range (<20% of the entire travel range) in continuous industrial operation, do a maintenance run across the entire travel range every 2000 motion cycles.

Relubricating

Under laboratory conditions, it is only necessary to relubricate the linear actuator in exceptional cases. For continuous industrial use, the lubrication intervals must be determined individually.

- If you have any questions on relubricating, contact our customer service department (p. 33).

7.3 Cleaning the M-228 / M-229

Requirements

- ✓ You have disconnected the M-228 / M-229 from the controller.

Cleaning the linear actuator

- When necessary, clean the surface of the M-228 / M-229 with a cloth dampened lightly with a mild cleanser or disinfectant.

8 Troubleshooting

Problem	Possible causes	Solution
Reduced positioning accuracy	Mounting nut is too tight	➤ Do not overtighten the nut (torque ≤15 Nm).
Function impairment after system modification	<ul style="list-style-type: none"> Motor controller was replaced M-228 / M-229 was replaced by another model 	<p>Motor controller from PI:</p> <ul style="list-style-type: none"> ➤ Load the parameters from the positioner database that correspond to the combination of motor controller and M-228 / M-229 model. <p>Motor controller from a third-party supplier:</p> <ul style="list-style-type: none"> ➤ Check the operating parameters.
The mechanics do not move	The cable is not connected correctly or is defective	➤ Check the connecting cable.
	Lateral forces are acting on the pusher	<p>Lateral forces increase the friction on the internal drive components.</p> <ul style="list-style-type: none"> ➤ Avoid lateral forces on the tip and on the pusher of the M-228 / M-229.
The mechanics do not move, but generate operating noise	Values for the velocity, acceleration and/or load are too high	<ul style="list-style-type: none"> ➤ Reduce the velocity. ➤ Reduce the acceleration. ➤ Reduce the load on the mechanics.
The mechanics did not stop in time and ran into the hard stop	<ul style="list-style-type: none"> Velocity is too high (see chapter "Limit Switches" p. 13) Limit switch is defective Motor controller ignores the limit switch signal 	<ol style="list-style-type: none"> 1. Stop the motor. 2. Command the mechanics away from the hard stop. 3. Check the settings of the motor controller for the limit switch processing.

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 Department

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

- If you have 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)
 - PC operating system (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 on our website (p. 2).

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>).

10.1 Specifications

10.1.1 Spezifikationen M-228

Bewegen	M-228.10S	M-228.11S	Toleranz
Aktive Achsen	X	X	
Stellweg in X	10 mm	10 mm	
Maximale Geschwindigkeit in X, unbelastet	1,5 mm/s	4 mm/s	

Positionieren	M-228.10S	M-228.11S	Toleranz
Kleinste Schrittweite in X	1 µm	1 µm	typ.
Unidirektionale Wiederholgenauigkeit in X	± 2 µm	± 2 µm	typ.
Umkehrspiel in X	5 µm	10 µm	typ.
Referenzschalter	Hall-Effekt	Hall-Effekt	
Wiederholgenauigkeit des Referenzschalters	1 µm	1 µm	
Endschalter	Hall-Effekt	Hall-Effekt	

Antriebseigenschaften	M-228.10S	M-228.11S	Toleranz
Antriebstyp	2-Phasen-Schrittmotor mit Getriebe	2-Phasen-Schrittmotor	
Betriebsspannung	24 V	24 V	
Nennstrom, effektiv	0,25 A	0,85 A	typ.
Motorauflösung	24 Vollschritte/U	400 Vollschritte/U	
Antriebskraft in X	20 N	50 N	typ.

Mechanische Eigenschaften	M-228.10S	M-228.11S	Toleranz
Spindeltyp	Trapezgewindespindel	Trapezgewindespindel	
Spindelsteigung	0,5 mm	0,5 mm	
Getriebeuntersetzung i	256 : 9	-	
Gesamtmasse	230 g	360 g	
Material	Aluminium, eloxiert; Chromstahl; Messing	Aluminium, eloxiert; Chromstahl; Messing	

Anschlüsse und Umgebung	M-228.10S	M-228.11S	Toleranz
Betriebstemperaturbereich	-20 bis 65 °C	-20 bis 65 °C	
Anschluss	D-Sub 15 (m)	D-Sub 15 (m)	
Kabellänge	0,5 m	0,6 m	
Empfohlene Controller / Treiber	C-663.12 C-885 mit C- 663.12C885	C-663.12 C-885 mit C- 663.12C885	

10.1.2 Spezifikationen M-229

Bewegen	M-229.25S	M-229.26S	Toleranz
Aktive Achsen	X	X	
Stellweg in X	25 mm	25 mm	
Maximale Geschwindigkeit in X, unbelastet	1,5 mm/s	4 mm/s	

Positionieren	M-229.25S	M-229.26S	Toleranz
Kleinste Schrittweite in X	1 µm	1 µm	typ.
Unidirektionale Wiederholgenauigkeit in X	± 2 µm	± 2 µm	typ.
Umkehrspiel in X	10 µm	10 µm	typ.
Referenzschalter	Hall-Effekt	Hall-Effekt	
Wiederholgenauigkeit des Referenzschalters	1 µm	1 µm	
Endschalter	Hall-Effekt	Hall-Effekt	

Antriebs Eigenschaften	M-229.25S	M-229.26S	Toleranz
Antriebstyp	2-Phasen-Schrittmotor mit Getriebe	2-Phasen-Schrittmotor	
Betriebsspannung	24 V	24 V	
Nennstrom, effektiv	1 A	0,85 A	typ.
Motorauflösung	24 Vollschritte/U	400 Vollschritte/U	
Antriebskraft in X	50 N	80 N	typ.

Mechanische Eigenschaften	M-229.25S	M-229.26S	Toleranz
Spindeltyp	Trapezgewindespindel	Trapezgewindespindel	
Spindelsteigung	0,5 mm	0,5 mm	
Getriebeuntersetzung i	256 : 9	-	
Gesamtmasse	400 g	610 g	
Material	Aluminium, eloxiert; Chromstahl; Messing	Aluminium, eloxiert; Chromstahl; Messing	

Anschlüsse und Umgebung	M-229.25S	M-229.26S	Toleranz
Betriebstemperaturbereich	-20 bis 65 °C	-20 bis 65 °C	
Anschluss	D-Sub 15 (m)	D-Sub 15 (m)	
Kabellänge	0,5 m	0,6 m	
Empfohlene Controller / Treiber	C-663.12 C-885 mit C-663.12C885	C-663.12 C-885 mit C-663.12C885	




Note on minimum incremental motion: with recommended controller

Note on backlash: with preload

Note on nominal current, RMS: per motor phase

10.1.3 Maximum Ratings

The linear actuator is designed for the following operating data:

Model	Maximum operating voltage 	Operating frequency 	Maximum power consumption 
M-228.10S	48 V DC	-	1.75 W
M-228.11S	48 V DC	-	3.744 W
M-229.25S	48 V DC	-	2.8 W
M-229.26S	48 V DC	-	3.744 W

10.1.4 Ambient Conditions and Classifications

Pay attention to the following ambient conditions and classifications for the M-228 / M-229:

Area of application	For indoor use only
Maximum altitude	2000 m
Relative humidity	Highest relative humidity 80 % for temperatures up to 31 °C Decreasing linearly to 50 % relative air humidity at 40 °C
Storage temperature	0 °C to 80 °C
Transport temperature	0 °C to 80 °C
Supply fluctuations	Not more than ± 10 % of the nominal voltage
Overvoltage category	II
Protection class	I
Degree of pollution	2
Degree of protection according to IEC 60529	IP40

10.1.5 Limit Switch Specifications

Type	Magnetic (Hall effect) sensor
Supply voltage	+5 V / ground
Signal output	TTL level
Signal logic	<p>The signal level changes when passing the limit switch. The signal logic is active low. That means:</p> <ul style="list-style-type: none"> ▪ Normal motor operation: high (+5 V) ▪ Limit switch reached: low (0 V)

10.1.6 Reference Switch Specifications

Type	Magnetic (Hall effect) sensor
Supply voltage	+5 V/GND
Signal output	TTL level
Signal logic	Index pulse when passing the reference switch.

10.2 Dimensions

10.2.1 M-228.10S

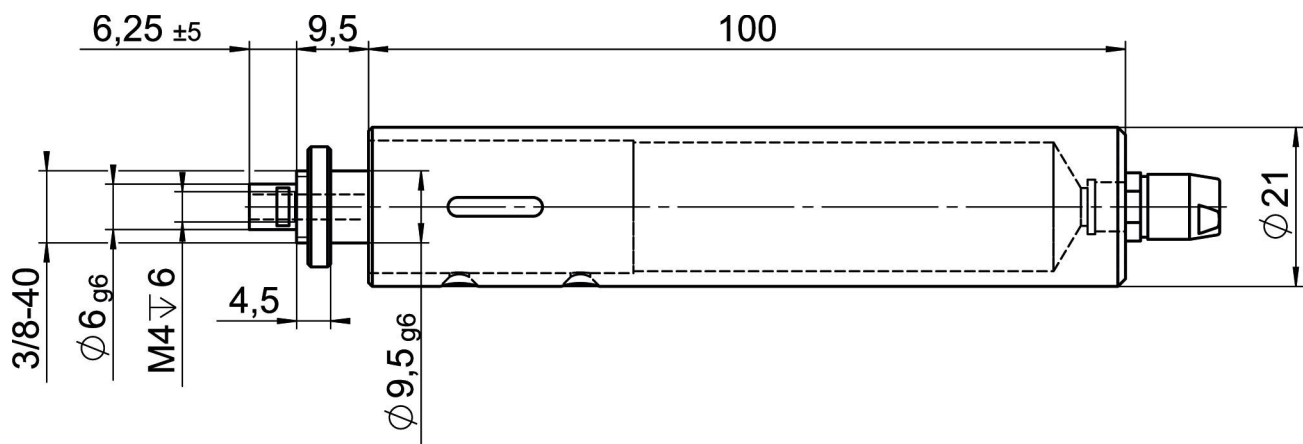


Figure 8: M-228.10S, dimensions in mm. Note that the decimal places are separated by a comma in the drawings.

10.2.2 M-228.11S

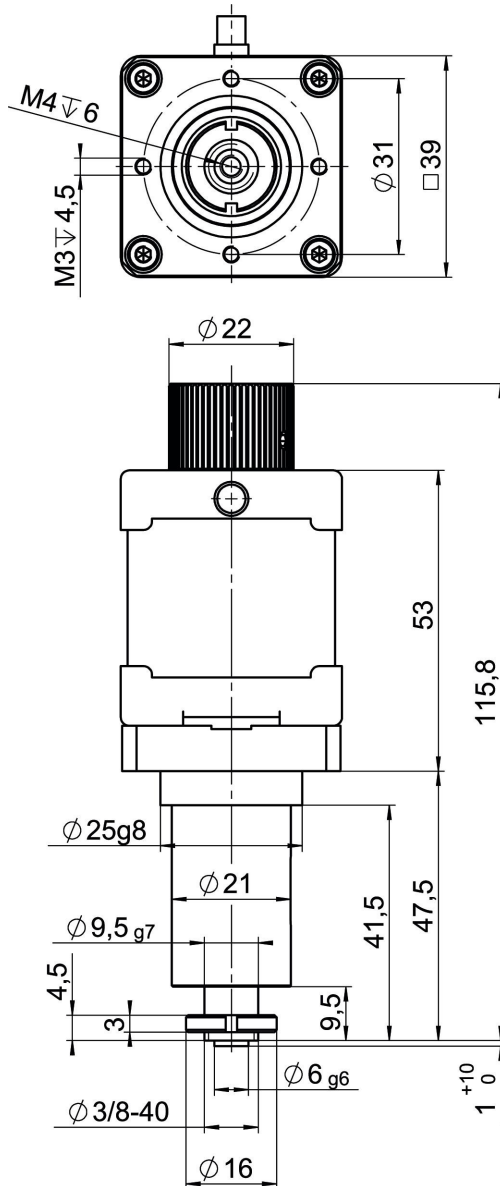


Figure 9: M-228.11S, dimensions in mm. Note that the decimal places are separated by a comma in the drawings.

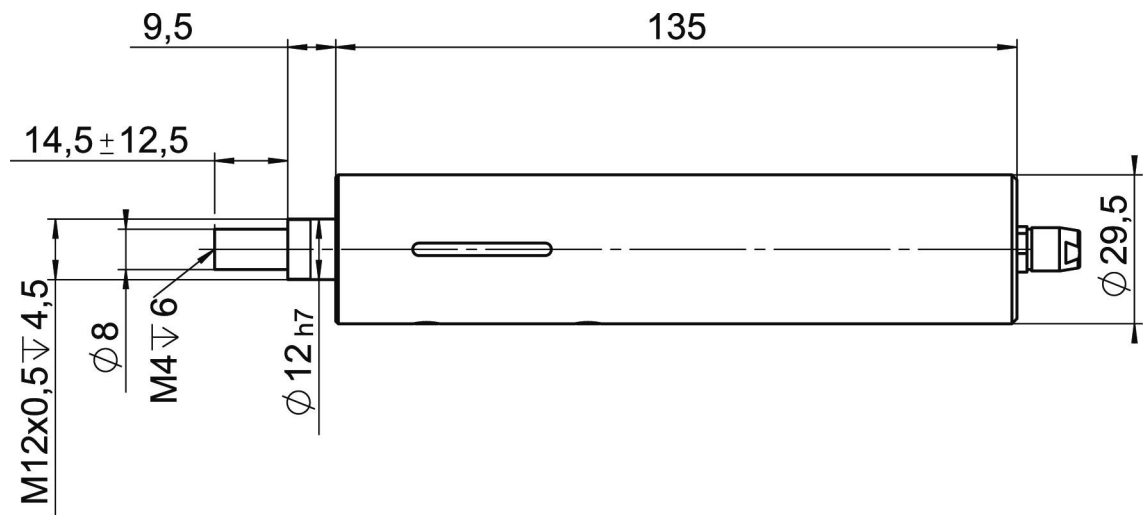
10.2.3 M-229.25S

Figure 10: M-229.25S, dimensions in mm. Note that the decimal places are separated by a comma in the drawings.

10.2.4 M-229.26S

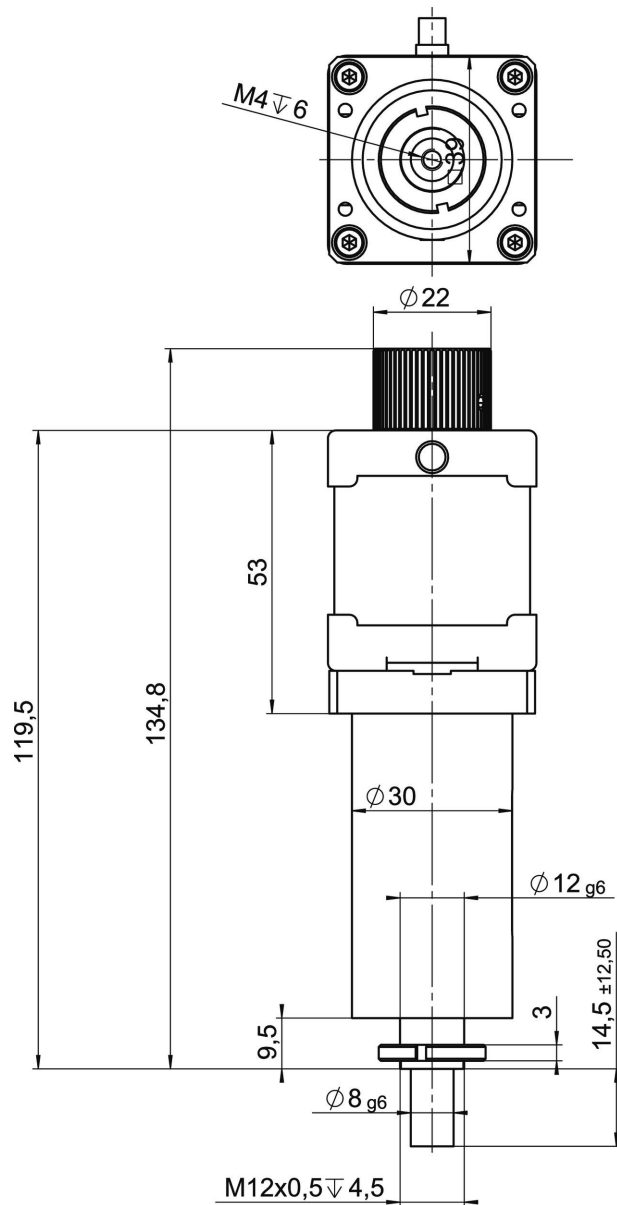


Figure 11: M-229.26S, dimensions in mm. Note that the decimal places are separated by a comma in the drawings.

10.2.5 M23010116 Flat Tip

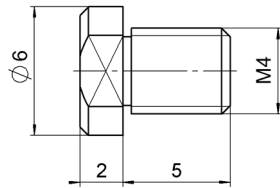


Figure 12: M23010116 flat tip (included in the scope of delivery for M-228.10S and M-229.25S), dimensions in mm

10.2.6 M23010117 Ball Tip

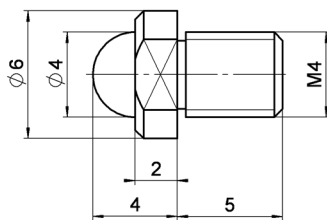


Figure 13: M23010117 ball tip (included in the scope of delivery), dimensions in mm

10.3 Pin Assignment

Connector: D-sub 15 (m)

Pin no.	Function
1	Input: Phase 1a
9	Input: Phase 1b
2	Input: Phase 2a
10	Input: Phase 2b
3	Not connected
11	Not connected
4	Not connected
12	Not connected
5	Not connected
13	Not connected
6	Input: +5 V supply from controller

Pin no.	Function
14	Output: Limit switch signal, positive side
7	GND
15	Output: Reference switch signal
8	Output: Limit switch signal, negative side

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.

To fulfill the 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 Römerstraße 1
76228 Karlsruhe, Germany

