MP102E

M-230 Linear Actuators

User Manual

Version: 1.1.0 Date: 18.10.2012

This document describes the following linear actuators with limit switches:

- **M-230.10**
  DC Drive, 10 mm Travel Range, High-Resolution
- **M-230.25**
  DC Drive, 25 mm Travel Range, High-Resolution
- **M-230.10S**
  Stepper Motor Drive, 10 mm Travel Range, High-Resolution
- **M-230.25S**
  Stepper Motor Drive, 25 mm Travel Range, High-Resolution
- **M-230.10V**
  DC Drive, 10 mm Travel Range, Vacuum-Compatible
- **M-230.25V**
  DC Drive, 25 mm Travel Range, Vacuum-Compatible

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Contents

1 About this Document

In this Chapter

1.1 Goal and Target Audience of this Manual

This manual contains information on the intended use of the M-230.

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

For updated releases of this user manual, or if you have any questions, contact our customer service department (p. 37).

1.2 Symbols and Typographic Conventions

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

CAUTION

Dangerous situation

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

➢ Actions to take to avoid the 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	Meaning
1. 2.	Action consisting of several steps whose sequential order must be observed
➢	Action consisting of one or several steps whose sequential order is irrelevant
▪	List item
p. 5	Cross-reference to page 5
RS-232	Labeling of an operating element on the product (example: socket of the RS-232 interface)

1.3 Other Applicable Documents

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

For the latest versions of the user manuals contact our customer service department (p. 37).

Controller	Document
C-843 DC-Motor Controller PCI PC Board	MS77E User Manual
C-863.10 DC-Motor Controller	MS173E User Manual
C-863.11 DC-Motor Controller	MS205E User Manual
C-663.10 Stepper Motor Controller	MS138E User Manual
C-663.11 Stepper Motor Controller	MS208E User Manual

2 Safety

In this Chapter

2.1 Intended Use

The M-230 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.

Based on its design and realization, the M-230 is intended for positioning, adjusting and shifting loads in one axis at various velocities.

The intended use of the M-230 is only possible when installed and with a suitable controller (p. 12). The controller is not included in the scope of delivery of the M-230.

2.2 General Safety Instructions

The M-230 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 M-230.

- Only use the M-230 for its intended purpose, and only use it if it is in a good working order.
- Read the user manual.
- Immediately eliminate any faults and malfunctions that are likely to affect safety.

The operator is responsible for the correct installation and operation of the M-230.

2.2.1 Organizational Measures

User manual

- Always keep this user manual next to the M-230.
  If the user manual is lost or damaged, contact our customer service department (p. 37).
- Add all information given by the manufacturer to the user manual, for example supplements or Technical Notes.
- If you pass the M-230 on to other users, also turn over this user manual as well as all other relevant information provided by the manufacturer.
- Only use the device on the basis of the complete user manual. Missing information due to an incomplete user manual can lead to slight injury as well as property damage.
- Only install and operate the M-230 after having read and understood this user manual.

Personnel qualification

The M-230 may only be started up, operated, maintained and cleaned by authorized and qualified staff.

2.2.2 Measures for Handling Vacuum-Compatible Products

When handling the vacuum version of the linear actuator, attention must be paid to appropriate cleanliness. At PI, all parts are cleaned before assembly. During assembly and measurement, powder-free gloves are worn. Afterwards, the linear actuator is cleaned once again by wiping and shrink-wrapped twice in vacuum-compatible film.

- Only touch the linear actuator with powder-free gloves.
- If necessary, wipe the linear actuator clean after unpacking.

2.2.3 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 or squeezed too severely 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-230.

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 1.7 Nm.

The heat produced during operation of the M-230 can affect your application.

- Install the M-230 so that your application is not affected by the dissipating heat.

2.2.4 Safety Measures during Start-Up

A motorized linear actuator can generate powerful forces depending on the gear ratio.

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

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

Faulty motor controllers can cause unintentional motor motion and run the M-230 into the hard stop.

The linear actuator can perform an unintentional motion when connecting it to the motor controller.

- Do not place any objects in areas where they can get caught by moving parts.
- Keep your fingers at a safe distance from the motion range of the M-230.

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 theend 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.

2.2.5 Safety Measures during Operation

For models with DC motors:

Unsuitable settings made to the servo-control parameters can impair the performance of the M-230. The consequences of this can be expressed as follows:

- Oscillations
- Imprecise approach of the position
- Settling time is too long

- If the performance of the M-230 is not satisfactory, check the settings for the servo-control parameters of your controller.

2.2.6 Safety Measures During Maintenance

The M-230 is precisely aligned.

- Do not loosen any sealed screw.

3 Product Description

In this Chapter

3.1 System Overview

The following figure shows an overview of the total system.

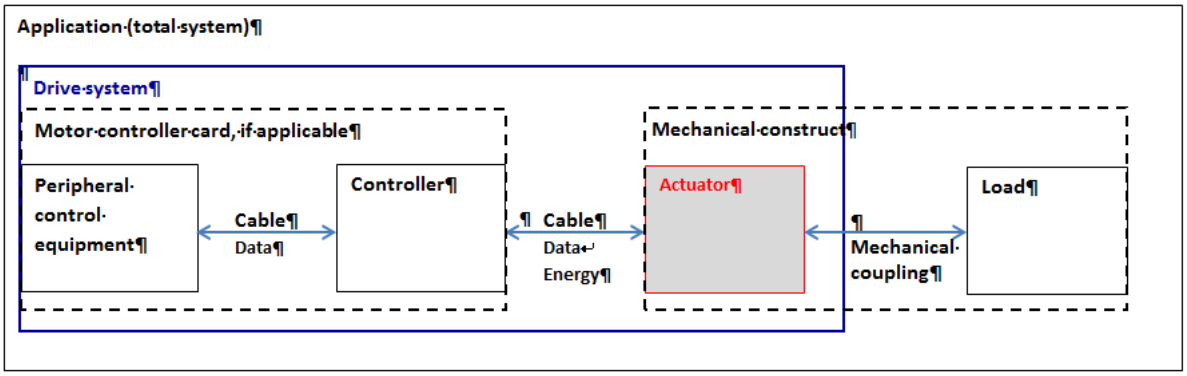

Figure 1: Overall system, overview

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 to the controller (e.g. PC in connection with PC software).	PC software (e.g. PIMikroMove) included in the scope of delivery of PI controllers.
Controller	Controls the motions of the actuator.	Stand-alone device or motor controller card (PC add-on card). Available separately, see section "Suitable Controllers" (p. 12).
Actuator	Produces the motions of the part to be driven or the load in your application.	Here: linear actuator, type M-230. Present product.
Cables	▪ Peripheral control equipment to controller: Ensures the data communication. ▪ Controller to actuator: Ensures the data communication and the power source of the actuator.	▪ Transmission cable between PC and controller. Included in the scope of delivery of PI controllers. ▪ Transmission cable between controller and actuator: Part of the actuator or included in the scope of delivery of the piezo actuator.

Component	Task	Supplied by or available from PI
Mechanical structure	Ensures among other things the secure fixation of the actuator and thus a high repeatability.	Only mounting nut (for mechanical connection) included in the scope of delivery of the actuator.
Mechanical coupling	Establishes the connection between the actuator and the load (pusher with a separate end piece, depending on the model).	Also in case exchangeable parts can be used, all options are included in the scope of delivery of the actuator (e.g. end pieces).
Load	Part to be driven. This is to be moved in your application.	-

If a motor controller card is used, the "controller" component and the connection between the peripheral control equipment and the controller ("cable") are physically inside of the PC.

3.2 Features and Applications

The motorized precision drives of the M-230 series are linear actuators with travel ranges of 10 mm and 25 mm. Using a preloaded DC gear motor with a high-resolution rotary encoder and an extremely low-friction and zero-backlash design, they achieve minimum incremental motions of 50 nm. A design with a stepper motor is also on offer. Vacuum-compatible versions of the M-230 are available on request.

Integrated limit and reference point switches, plus line drivers enable the simple installation in automation solutions and protect the mechanical system of the actuator.

3.3 Model Overview

There are six standard versions of the M-230. All models are high-resolution linear actuators with a limit switch. They differ in terms of:

- Drive type
- Travel range
- Suitability for operation in vacuum

Model	Travel range		Drive Type		Vacuum suitability (up to 10^{-6} hPa)
	10 mm	25 mm	DC gearhead	Stepper motor	
M-230.10	+		+		
M-230.10S	+			+	
M-230.10V	+		+		+
M-230.25		+	+		
M-230.25S		+		+	
M-230.25V		+	+		+

➢ For further technical data, see the specifications (p. 39).

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 necessary, contact our customer service department (p. 37) directly.

3.4 Product View

Figure 2: Product view: M-230 with 25 mm (left) and 10 mm (right) travel range

1 *End piece, replaceable (here: flat)*
2 *Mounting nut for clamp connection*
3 *Window with position display*
4 *Sleeve*
5 *Cable for connecting to the controller*
6 *Mounting shaft*
7 *Thread for mounting nut*
8 *Moving pusher, non-rotating*

3.5 Scope of Delivery

Order Number	Items
M-230	linear actuator according to order (p. 10), with flat end piece (assembled on delivery), spherical end piece and hook wrench
C-815.38	Motor Cable, 3 m, Sub-D, 15-pin (m/f)
MP102E	User manual (this document) in printed form

3.6 Suitable Controllers

The M-230 must be connected to a suitable controller. The following controllers from PI are suitable for the operation of the M-230:

Drive Type	Controller	Axes per Controller	PC-Interface	Multiple Controllers on the Same PC
DC motor	C-843	2 or 4	Internal (PCI bus)	Yes, separate boards
	C-863	1	USB, RS-232, daisy chain	Yes, same interface
Stepper motor	C-663	1	USB, RS-232, daisy chain	Yes, same interface

The required PC software is included in the scope of delivery of the PI controllers. The operation of the controllers is described in the corresponding user manuals.

The operating parameters must be adjusted depending on the version of the M-230 used (p. 27).

3.7 Accessories

Order Number	Description
C-842.AP1	Adapter box PWM analog to operate M-230 linear actuators with PWM signals
C-815.83	Motor cable 10 m, Sub-D, 15-pin (m/f)
C-815.38V	Motor cable vacuum, 3 m, sub-D, 15-pin (m/f)
C-815.VF	Vacuum feedthrough, sub-D, 15-pin (m/f)

To order, contact our customer service department (p. 37).

3.8 Technical Features

3.8.1 Rotary Encoder

The models with DC motors are equipped with a rotary encoder. A rotary encoder, also called an incremental or incremental rotary encoder, is implemented at a rotating point in the drivetrain, e.g. the motor shaft. To determine the relative position, the controller counts the encoder signals, the so-called impulses.

3.8.2 Limit Switches

The M-230 is equipped with non-contact, Hall-effect limit switches.

Each limit switch sends an overtravel 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.

See "Limit Switch Specifications" (p. 41) for more information.

3.8.3 Reference Point Switch

The M-230 is equipped with a direction-sensing reference point switch, which is located at about the midpoint of the travel range. This sensor sends a TTL signal indicating whether the linear actuator is on the positive or negative side of the reference point switch.

The rising or falling edge of this signal can be used to indicate a known reference position. The difference in the reference points when approached from the positive or the negative side is about 0.2 mm to 0.4 mm.

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

For further details, refer to the "Specifications" section (p. 39).

4 Unpacking

INFORMATION

When handling the vacuum version of the linear actuator, attention must be paid to appropriate cleanliness. At PI, all parts are cleaned before assembly. During assembly and measurement, powder-free gloves are worn. Afterwards, the linear actuator is cleaned once again by wiping and shrink-wrapped twice in vacuum-compatible film.

- Only touch the linear actuator with powder-free gloves.
- If necessary, wipe the linear actuator clean after unpacking.

1. Unpack the M-230 with care.
2. Compare the contents against the items covered by the contract and against the packing list.
3. Inspect the contents for signs of damage. If parts are missing or you notice signs of damage, contact PI immediately.
4. Keep all packaging materials in case the product needs to be returned.

5 Installation

In this Chapter

5.1 General Notes on Installation

NOTICE

Cable break!

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

➢ Install the linear actuator so that the cable is not bent or squeezed too severely during operation.

NOTICE

Increased friction!

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-230.

NOTICE

Heating up of the M-230 during operation!

The heat produced during operation of the M-230 can affect your application.

➢ Install the M-230 so that your application is not affected by the dissipating heat.

INFORMATION

Linear actuators with DC gear motors are equipped with integrated signal drivers for cable lengths of ≤10 m between linear actuator and motor controller.

5.2 Changing the Tip

INFORMATION

The supplied end pieces make it possible to realize different mechanical connections to a load:

- A flat end piece allows a wide-area connection to a load.
- A spherical end piece allows a punctiform connection to a load.

To achieve optimum repeatability:

➢ Use an end piece.

Make sure that the selected end piece is completely screwed in and does not have any backlash.

The end piece is used to establish contact with the load. A flat end piece is delivered pre-assembled; a spherical end piece is also provided.

Figure 3: Mounted end piece (flat)

1 (Flat) end piece with (a) wrench flat
2 Pusher

Prerequisites

- ✓ You have read and understood the General Notes on Installation (p. 17).
- ✓ You have made the M-230 accessible for changing the end piece.
- ✓ The pusher is extended so far that you can comfortably reach the end piece. In the delivery condition, the pusher is extended far enough.

Tools and accessories

- Supplied end piece (p. 12)
- Open-end wrench SW 5

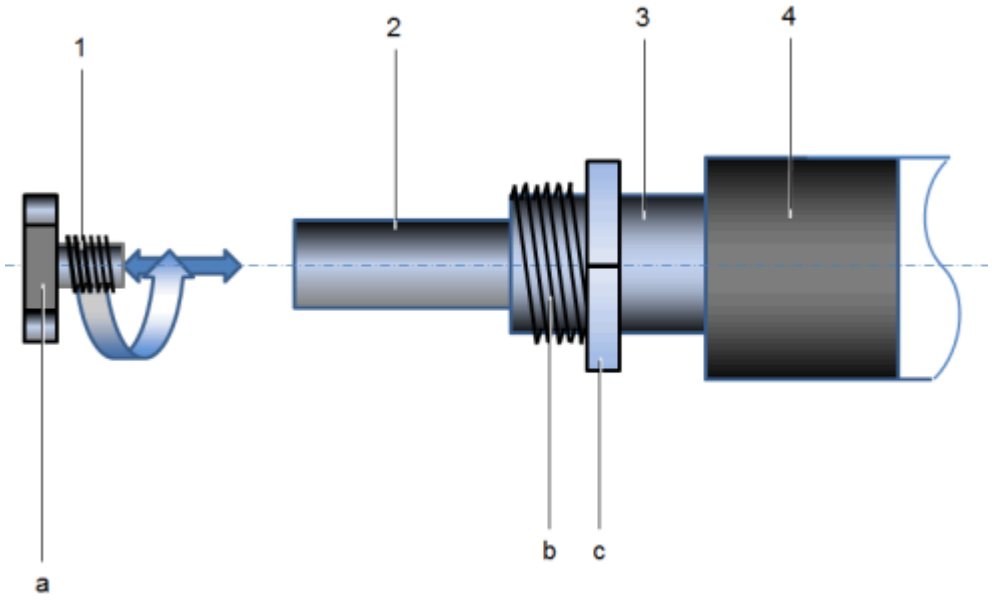

Figure 4: Changing the end piece, schematic

1 (Flat) end piece with
(a) wrench flat
2 Pusher, non-rotating
3 Mounting shaft with
(b) thread (for clamp connection, 3/8-40)
(c) mounting nut
4 Sleeve

Changing the end piece

1. Manually unscrew the end piece to be replaced from the pusher of the M-230. If this is not successful, use an AF 5 open-end wrench.
2. Manually screw the new end into the pusher of the M-230.

5.3 Providing a Suitable Mechanical Mounting and Installation Environment

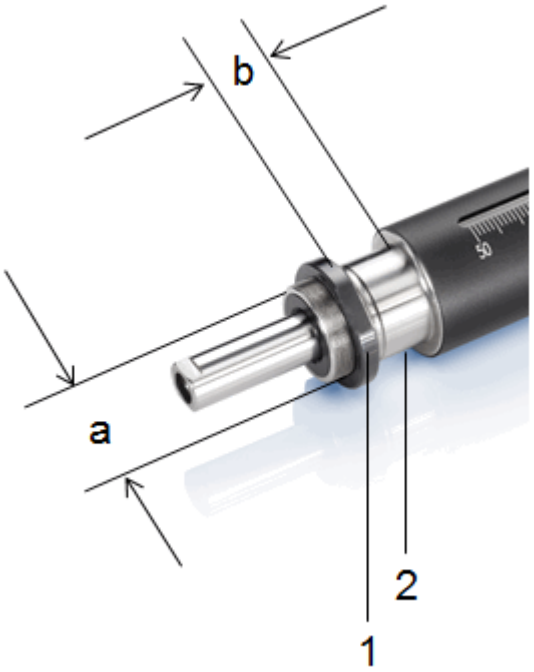

Figure 5: Relevant components and dimensions for installation in the mechanical mounting (schematic)

1 Mounting nut, 3/8 inch

2 Mounting shaft with
(a) diameter: 19 mm
(b) clamping width: 7 mm to 11 mm usable

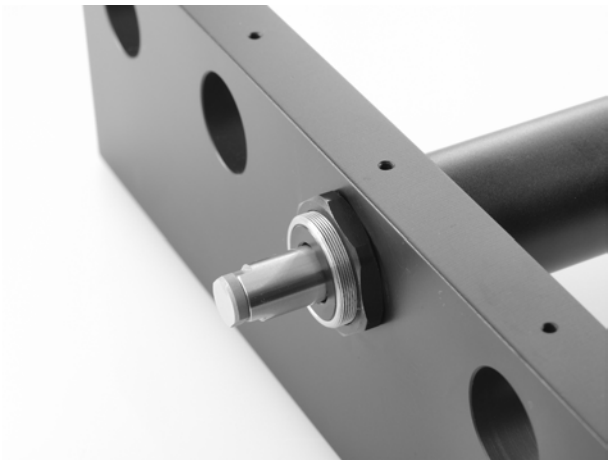

Figure 6: Example for the installation of a linear actuator (here: an M-235)

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. 44)).
  - The intended motions 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 end piece (see Dimensions (p. 44))
  - Travel range: maximum 10 mm (M-230.**10x** models) or 25 mm (M-230.**25x** models)
  - Space requirements for a kink-free and proper guiding of the connection cable and additional motor cables
  - Length of the connection cable (approx. 0.5 m) and additional motor cables (3 m or 10 m)
  - Position of the position display of the actuator when 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
- Avoid or label danger areas that result from the installation of the actuator and from use, in accordance with the legal regulations (e.g. risk of crushing in the case of heavy moving loads, fast actuator motions and/or high drive torques).

The complete dimensions of the actuator and relevant individual parts can be found in the figures in the section “Dimensions” (p. 44).

5.4 Installing the Actuator 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 1.7 Nm.

INFORMATION

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

➢ During mounting, make sure that there is a faultless connection between the actuator and the mechanical mounting.

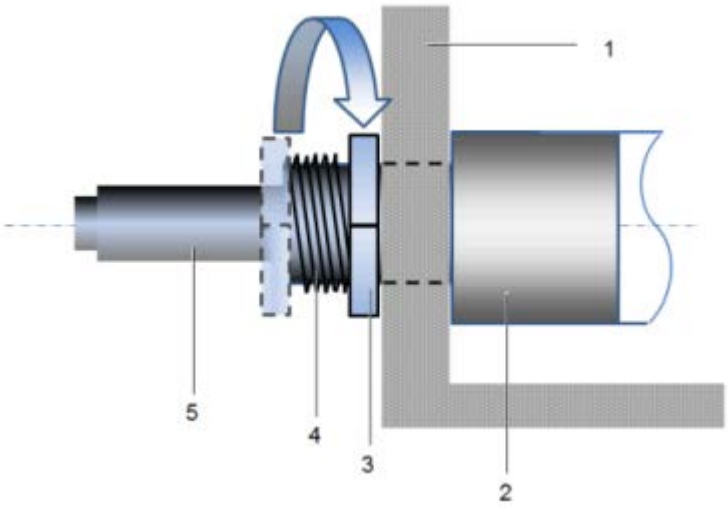

Figure 7: Clamp connection (schematic)

1 *Mechanical mounting*
2 *Sleeve*
3 *Mounting nut, 3/8 inch*
4 *Mounting shaft with thread*
5 *Pusher with end piece (flat)*

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

Prerequisites

- ✓ 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 actuator

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, stick a suitable flat washer or a suitable spring washer on the mounting shaft.
4. Manually screw the mounting nut into the thread of the mounting shaft with a few rotations.
5. To clamp the actuator in the mounting, tighten the mounting nut using the supplied hook wrench until you feel a resistance. The torque must **not** exceed 1.7 Nm!
6. Check that the actuator is correctly fitted in the mounting.

6 Start-Up

In this Chapter

6.1 General Notes on Start-Up

CAUTION

Unintentional motion of the linear actuator while connecting it to the motor controller!

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

NOTICE

Damage if a wrong motor controller is connected!

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

- ➢ Connect a linear actuator with DC motor to a DC motor controller only.
- ➢ 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-230 can be damaged.

- ➢ Do **not** deactivate the limit switches in the software.
- ➢ Test limit switch operation at low velocities only.

NOTICE

Damage or major wear to the mechanical system as a result of high acceleration!

- ➢ 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.

NOTICE

Damage from unsuitable controllers and PC software!

Unsuitable controllers and PC software can cause damage to the actuator.

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

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 condition.

INFORMATION

The handwheel of a linear actuator with stepper motor can be used to manually retract and extend the pusher. Manually triggered changes in the position of the pusher are **not** recognized by the connected controller.

INFORMATION

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

INFORMATION

For models with DC motors:

Unsuitable settings made to the servo-control parameters can impair the performance of the M-230. The consequences of this can be expressed as follows:

- Oscillations
- Imprecise approach of the position
- Settling time is too long

➢ If the performance of the M-230 is not satisfactory, check the settings for the servo-control parameters of your controller.

INFORMATION

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

6.2 Starting Up the Actuator

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

Prerequisites

✓ You have read and understood the General Notes on Start-Up (p. 25).

✓ You have correctly installed the actuator (p. 17).

✓ You have read and understood the user manual of the used controller.

✓ You have read and understood the manual of the used PC software.

Accessories

- Suitable controller (p. 12) - motor controller card for PC installation or stand-alone device incl. connection cable to PC.
- PC
- PC software for the controller (for PI controllers: included in their scope of delivery)
- If necessary, suitable motor cable from PI, e.g.:
  - Motor cable C-815.38, 3 m, Sub-D, 15-pin (m/f), in the scope of delivery (p. 12).

- Motor cable C-815.83, 10 m, Sub-D, 15-pin (m/f), available as optional accessory (p. 12).

Starting up the actuator

1. If you use a motor controller card (e.g. C-843 from PI), make sure that it is properly installed or install it (see the user manual of the motor controller card).
2. If suitable and current PC software for the controller is not on your PC yet, install the PC software (see the user manual of the controller or the software).
3. If you do **not** use a motor controller card, connect the PC with the external controller using a suitable cable.
   For PI products: the cable required for this is included in the scope of delivery.
4. Connect the actuator with the controller:
   a) Determine the minimum necessary cable length between the actuator and the controller.
   b) Connect the connector of the connection cable with the Sub-D socket of the controller or a corresponding adapter (according to the determined length, see above) either directly or by interposing an additional motor cable.
   c) Secure all connections with the integrated screws against accidental disconnection.
   d) Remove or label resulting danger areas in accordance with the valid legal regulations and directives.
5. Start up the controller (see user manual of the controller).
6. Configure the controller using the PC software for the used actuator (see the user manual of the controller and the PC software):
   - If you use a PI controller: select the entry in the stage database that precisely matches the actuator version used, see the list of available entries (p. 29).
   - If you use a controller from another manufacturer: Enter the parameters in the corresponding PC software that precisely match the actuator version used; see overview of the operating parameters for DC motor controllers (p. 30) or stepper motor controllers (p. 31).
7. Start a few motion cycles for testing purposes (see user manual of the controller).

6.2.1 M-230 Entries in the Stage Database

For motor controllers from PI you can select the connected linear actuator from a stage database in the respective PC software. The appropriate operating parameters are thus loaded into the motor controller. You can find a detailed description in the user manual for the motor controller or in the manual for the PC software used.

The following table shows the linear actuators and their names in the stage database.

M-230	Name in the Stage Database	Specifications in the Stage Database (Selection)
M-230.10	M-230.10	Motor type: DC motor; conservative set of servo-control parameters (adjustable initial values); limit switches active high
	M-230.10-PWM	Like the M-230.10 except for parameters for PWM output, for use with C-842.AP1 PWM-to-analog adapter box
M-230.25	M-230.25	Like the M-230.10 except for parameters for travel range and position of the reference point and limit switches
	M-230.25-PWM	Like the M-230.25 except for parameters for PWM output, for use with C-842.AP1 PWM-to-analog adapter box
M-230.10V	M-230.10V	Like the M-230.10 except for parameters for velocity, acceleration and deceleration
M-230.25V	M-230.25V	Like the M-230.25 except for parameters for velocity, acceleration and deceleration
M-230.10S	M-230.10S	Motor type: stepper motor; parameters for operating current, holding current and holding current delay; limit switches active low
M-230.25S	M-230.25S	Like the M-230.10S except for parameters for travel range and position of the reference point and limit switches

6.2.2 Operating Parameters of the Models with DC Motor

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

Parameter	M-230.10 and M-230.25	M-230.10V and M-230.25V	Unit
Recommended start values:			
P-term	300	300	-
I-term	450	450	-
D-term	400	400	-
I-limit	2000	2000	-
Maximum acceleration	1318521	488107	counts/s²
Maximum velocity	0.8	0.3	mm/s
Maximum velocity	175802	66560	counts/s
Hardware properties:			
Gear reduction	42.92063 / 2704:63	42.92063 / 2704:63	-
Encoder resolution	2048	2048	counts/rev.
Limit switch polarity	Active high	Active high	-

6.2.3 Operating Parameters of the Models with Stepper Motor

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

Parameter	M-230.10S and M-230.25S	Unit
Recommended start values		
Holding current	50	mA
Operating current	250	mA
Holding current delay	500	ms
Maximum motor current	250	mA
Maximum acceleration	17068	steps/s^2
Maximum velocity	1.2	mm/s
Maximum velocity	2048	steps/s
Hardware properties		
Gear reduction	28.44444:1	-
Limit switch polarity	Active low	-
Full steps	24	steps/revolution
Phase resistance	12.5	Ohm
Maximum phase current, bipolar	250	mA

7 Maintenance

In this Chapter

7.1 General Notes on Maintenance

NOTICE

Damage due to improper maintenance!

The M-230 can become misaligned as a result of improper maintenance.

- Do not loosen any sealed screws.

7.2 Lubricating the M-230

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

Spreading lubricant

- If you operate the M-230 continuously on a small travel range (<20% of the entire travel range), perform a maintenance run every 2000 motion cycles across the entire travel range.

Lubrication

Under laboratory conditions, the linear actuator needs extra lubrication in exceptional cases only. For continuous industrial use the lubrication intervals must be defined individually.

- Do not lubricate the M-230 without consulting our customer service department (p. 37).
- To lubricate, follow the instructions given in the maintenance manual which you can obtain from our customer service department.

7.3 Cleaning the M-230

Prerequisites

✓ You have disconnected the linear actuator from the controller.

Cleaning the linear actuator

Only when the linear actuator is **not** used in vacuum:

- When necessary, clean the linear actuator surface with a towel lightly dampened with a mild cleanser or disinfectant.
- Do **not** use any organic solvents.

Only when the linear actuator is used in vacuum:

- Only touch the linear actuator with powder-free gloves.
- If necessary, wipe the linear actuator clean.

8 Troubleshooting

Problem	Possible Causes	Solution
Reduced positioning accuracy	Mounting nut is fastened too tight	➢ Tighten the mounting nut to a maximum torque of 1.7 Nm.
Functional impairment after system modification	▪ Motor controller has been replaced ▪ M-230 has been replaced with another model	Motor controllers from PI: ➢ Load the parameters from the stage database that correspond to the combination of motor controller and M-230 model (p. 27). Motor controller from a third-party supplier: ➢ Check the operating parameters.
The mechanical system does not move	The cable is not connected correctly or is faulty	➢ Check the connector cable.
	Lateral forces are affecting the pusher	Lateral forces increase the friction on the internal drive components. ➢ Avoid lateral forces on the end piece and on the pusher of the M-230.
The mechanical system does not move, but generates operating noise	Values for the velocity, acceleration and/or load are too high	➢ Reduce the velocity. ➢ Reduce the acceleration. ➢ Reduce the load on the mechanical system.

Problem	Possible Causes	Solution
The mechanical system did not stop in time and ran into the hard stop	▪ Velocity is too high (see chapter Limit Switches p. 13) ▪ Limit switch is defective ▪ Motor controller ignores the limit switch signal	1. Stop the motor. 2. Command the mechanical system 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 it cannot be solved as described, contact our customer service department (p. 37).

9 Customer Service

For inquiries and orders, contact your PI sales engineer or send us an e-mail (mailto:info@pi.ws).

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)

The latest versions of the relevant user manuals for your system are available for download on our website (http://www.pi.ws).

10 Technical Data

In this Chapter

10.1 Specifications

10.1.1 Data Table

	M-230.10 / M-230.25	M-230.10S / M-230.25S	Unit	Tolerance
	High-precision, with DC gear motor	With stepper motor		
Motion and positioning				
Travel range	10 / 25	10 / 25	mm	
Integrated sensor	Rotary encoder	–		
Sensor resolution	2048	–	cts./rev.	
Design resolution	0.0046	0.037	µm	typ.
Min. incremental motion	0.05	0.1	µm	typ.
Backlash	2	2	µm	typ.
Unidirectional repeatability	0.1	0.1	µm	typ.
Velocity	0.8	1.2	mm/s	max.
Reference point switch repeatability	1	1	µm	typ.

	M-230.10 / M-230.25	M-230.10S / M-230.25S	Unit	Tolerance
Mechanical properties				
Drive screw	Leadscrew	Leadscrew		
Thread pitch	0.4	0.4	mm	
Gear ratio	42.92063:1	28.44444:1		
Motor resolution	–	384*	steps/rev.	
Push / pull force	70	45**	N	max.
Permissible lateral force	30 / 20	30 / 20	N	max.
Drive properties				
Motor type	DC motor, gearhead	2-phase stepper motor*		
Operating voltage	0 to ±12	24	V	
Electrical power	2	–	W	nominal
Limit and reference point switches	Hall-effect	Hall-effect		
Miscellaneous				
Operating temperature range	-20 to 65	-20 to 65	°C	
Material	Aluminum anodized, chrome steel, brass	Aluminum anodized, chrome steel, brass		
Mass	0.3 / 0.35	0.3 / 0.35	kg	±5%
Cable length	0.5 m + 3 m extension cable (included)		m	±10 mm
Connector	15-pin sub-D, incl. encoder driver	Sub-D, 15-pin		
Recommended controller/driver	C-863 single-axis C-843 for up to 4 axes	C-663 single-axis		

Specifications for vacuum versions can differ.

Ask about custom designs!

* Max. 0.25 A/phase; 24 full steps/rev., motor resolution with C-663 stepper motor controller.

** At a velocity of up to 1 mm/s.

10.1.2 Ambient Conditions and Classifications

The following ambient conditions and classifications must be observed for the M-230:

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 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
Degree of pollution	2
Degree of protection according to IEC 60529	IP40

10.1.3 Limit Switch Specifications

Type	Magnetic (Hall-effect) sensor
Supply voltage	+5 V/ground
Signal output	TTL level
Signal logic	The signal level changes when passing the limit switch. The signal logic depends on the model type: ▪ Models with DC motor: **active high**. That means: – Normal motor operation: low (0 V) – Limit switch reached: high (+5 V) ▪ Models with stepper motor: **active low**. That means: – Normal motor operation: high (+5 V) – Limit switch reached: low (0 V)

10.1.4 Reference Point Switch Specifications

Type	Magnetic (Hall-effect) sensor
Supply voltage	+5 V/GND
Signal output	TTL level
Signal logic	Direction sensing by means of different signal levels on the left and right side of the reference point switch: The signal level changes from 0 to +5 V when the reference point switch is passed

10.1.5 Specifications for Vacuum-Compatible Versions

The specifications of the vacuum-compatible versions M-230.10V and M-230.25V correspond respectively— with the following exceptions — to the specifications of the versions M-230.10 and M-230.25.

Drive	
Motor	Manufacturer: Faulhaber Motor type: 1524 012SR Gear: 16/7 Ratio: 42.92063:1 (2704/63) Encoder: IE2-512
Design resolution	0.0046 µm
Maximum velocity	66560 counts/s 0.3 mm/s
Thread pitch	0.4 mm

Materials used	
Base body	Aluminum alloy (AlMgSi1) + chromium plated machining steel
Bearing	Steel
Drivetrain elements	Lead screw: Steel
Electrical components	Cable insulation: Teflon (PTFE) Shrink tubing: Kynar Solder: SnCu0.7Ni Connector: AMP HD20, Lemo Connector housing: die-cast zinc, chemically nickel coated
Grease	Klüberalfa 83-301, Klüber Barrierta I EL - Fluid
Sealing compound	From Varian (Torr Seal) or Huntsmann (Araldite 2014)
Other	
Bakeout temperature	80 °C (176 °F)

10.2 Dimensions

10.2.1 M-230.10, M-230.10S and M-230.10V

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

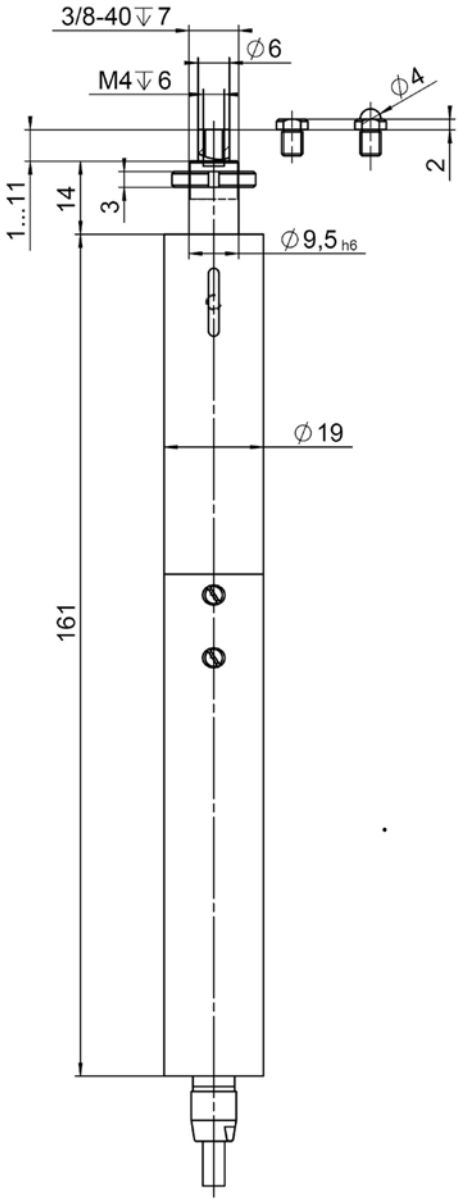

Figure 8: M-230.10, M-230.10S and M-230.10V, dimensions in mm

10.2.2 M-230.25, M-230.25S and M-230.25V

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

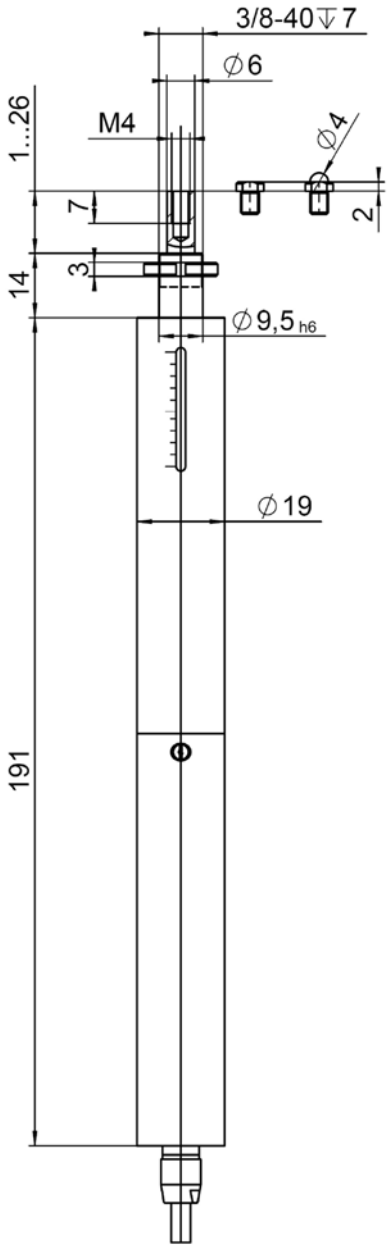

Figure 9: M-230.25, M-230.25S and M-230.25V, dimensions in mm

10.2.3 End Pieces

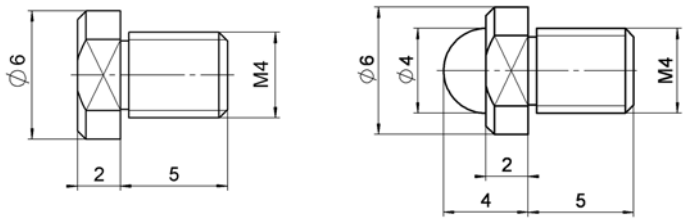

Figure 10: Flat end piece (left) and spherical end piece (right), dimensions in mm

10.3 Pin Assignment

10.3.1 Models with DC Gear Motor

Connector: Sub-D 15-pin (m)

Pin no.	Function
1	Internal
9	Input: Motor (-)
2	Input: Motor (+)
10	Internal
3	Internal
11	Internal
4	Input: +5 V supply from controller
12	Output: Limit switch signal, negative side
5	Output: Limit switch signal, positive side
13	Output: Reference point switch signal
6	GND (limit switch and logic)
14	Output: Encoder A (+)
7	Output: Encoder A (-)
15	Output: Encoder B (+)
8	Output: Encoder B (-)

10.3.2 Models with Stepper Motor

Connector: Sub-D 15-pin (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
14	Output: Limit switch signal, positive side
7	GND
15	Output: Reference point switch signal
8	Output: Limit switch signal, negative side

11 Old Equipment Disposal

Since 13 August 2005, in accordance with the EU directive 2002/96/EC (WEEE), electrical and electronic equipment can no longer be disposed of in the member states of the EU with other wastes.

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

12 EC Declaration of Conformity

PI

Declaration of Conformity

according to DIN EN ISO/IEC 17050-1

Manufacturer: **Physik Instrumente (PI) GmbH & Co. KG**

Manufacturer´s Address: Auf der Roemerstraße 1
D-76228 Karlsruhe,
Germany

CE

The manufacturer hereby declares that the product

Product Name: **Precision Linear Actuator**

Model Numbers: **M-230**

Product Options: **all**

complies with all relevant provisions of the **Machinery Directive (2006/42/EC)**. Furthermore, it complies with all provisions of the **Low Voltage Directive (2006/95/EC)** and the **EMC Directive (2004/108/EC)**.

The applied standards certifying the conformity are listed below.

Safety of Machinery:	EN 12100-1, EN-12100-2
Safety (Low Voltage Directive):	EN 61010-1
Electromagnetic Emission:	EN 61000-6-3, EN 55011
Electromagnetic Immunity:	EN 61000-6-1

The person authorized to compile the technical file is: Wolfgang Schobel
Address: see manufacturer's address

April 06, 2011
Karlsruhe, Germany

Dr. Karl Spanner
President

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