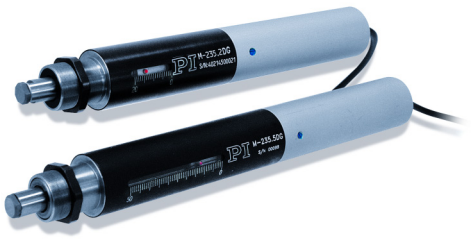
MP106E

M-235 Linear Actuators

User Manual

Version: 1.2 Date: 31.08.2020



This document describes the following high-load precision linear actuators with recirculating ball screws:

- M-235.2DD:
  Travel Range 20 mm, DC Direct Drive
- M-235.2DG:
  Travel Range 20 mm, DC Gear Motor
- M-235.5DD:
  Travel Range 50 mm, DC Direct Drive
- M-235.5DG:
  Travel Range 50 mm, DC Gear Motor

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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-235.

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. 35).

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. 35).

Product	Document
Linear actuators	Short Instructions MP122EK
Suiting controller	User Manual of the applied controller

2 Safety

In this Chapter

2.1 Intended Use

The M-235 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-235 is intended for positioning, adjusting and shifting loads in one axis at various velocities.

The intended use of the M-235 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-235.

2.2 General Safety Instructions

The M-235 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-235.

- Only use the M-235 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-235.

2.2.1 Organizational Measures

User manual

- Always keep this user manual next to the M-235.
  If the user manual is lost or damaged, contact our customer service department (p. 35).
- Add all information given by the manufacturer to the user manual, for example supplements or Technical Notes.
- If you pass the M-235 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-235 after having read and understood this user manual.

Personnel qualification

The M-235 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.

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 Nm.

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-235.

While the end piece is being screwed on or off, the torque is transferred to the drive of the linear actuator via the pusher and can damage the drive.

- Avoid torques to the pusher.
- When screwing an end piece on or off, attach the pusher to the wrench flats using an open-end wrench.

The heat produced during operation of the M-235 can affect your application.

- Install the M-235 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-235 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-235.

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-235. 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-235 is not satisfactory, check the settings for the servo-control parameters of your controller.

2.2.6 Safety Measures during Maintenance

The M-235 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.

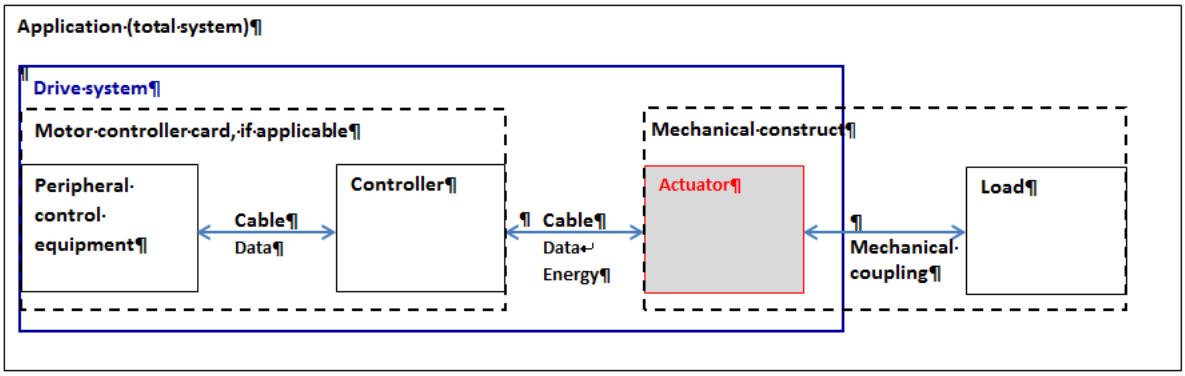


Figure 1: Overall system, overview

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-235. 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-235 series are linear actuators with travel ranges of 20 mm or 50 mm. They stand out thanks to their high positioning resolution, load capacity, velocity and lifetime in industrial applications. Their design with a low-friction and backlash-free ball screw enables loads of up to 120 N to be moved with minimum incremental motions of up to 100 nm (M-235.xxG and M-235.xxS models) or 500 nm (M-235.xxD models). The non-rotating end piece avoids wobbles and supports very uniform motions.

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

Ten standard versions of the M-235 are available. All models are high-performance linear actuators with a ball screw. They differ in terms of:

- Travel range
- Drive type

Model	Travel range		Drive type	
	20 mm	50 mm	DC direct	DC gearhead
M-235.2DD	+		+	
M-235.2DG	+			+
M-235.5DD		+	+	
M-235.5DG		+		+

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

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. 35) directly.

3.4 Product View

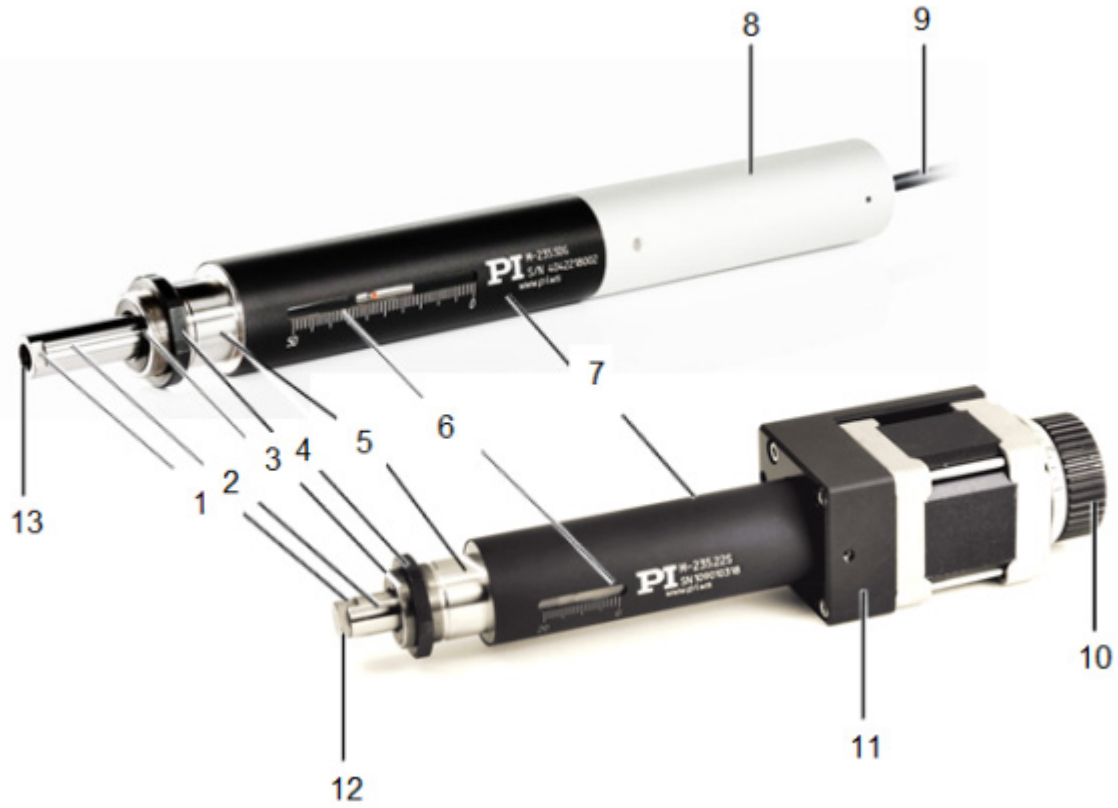


Figure 2: Product view M-235 (in front: M-235.22S versio(no longer available)n, behind: M-235.5DG version)

1 *Wrench flat of the pusher*
2 *Pusher, non-rotating*
3 *M20 thread for mounting nut*
4 *Mounting nut for clamp connection*
5 *Mounting shaft*
6 *Window with position display*
7 *Sleeve for micrometer assembly*
8 *Sleeve for DC motor*
9 *Cable for connecting to the controller*
10 *Hand wheel for manually moving the pusher inwards and outwards*
11 *Stepper motor case with panel plug (not visible here) for connecting to the controller*
12 *End piece, flat*
13 *Hole with M6 thread, 10 mm deep for integrating the end piece*

3.5 Scope of Delivery

Order Number	Items
M-235	Linear actuator according to order (p. 9), with flat end piece (assembled on delivery) and spherical end piece
MP122EK	Short Instructions

3.6 Suitable Controllers

The M-235 must be connected to a suitable controller (see data table, p.37).

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.

3.7 Accessories

Order Number	Description
C-842.AP1	Adapter box PWM analog to operate M-235 linear actuators with PWM signals

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

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-235 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. 39) for more information.

3.8.3 Reference Point Switch

The M-235 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. 37).

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-235 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

Torque on pusher!

While the end piece is being screwed on or off, the torque is transferred to the drive of the linear actuator via the pusher and can damage the drive.

- ➢ Avoid torques to the pusher.
- ➢ When screwing an end piece on or off, attach the pusher to the wrench flats using an open-end wrench.

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-235.

NOTICE

Heating up of the M-235 during operation!

The heat produced during operation of the M-235 can affect your application.

➢ Install the M-235 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.

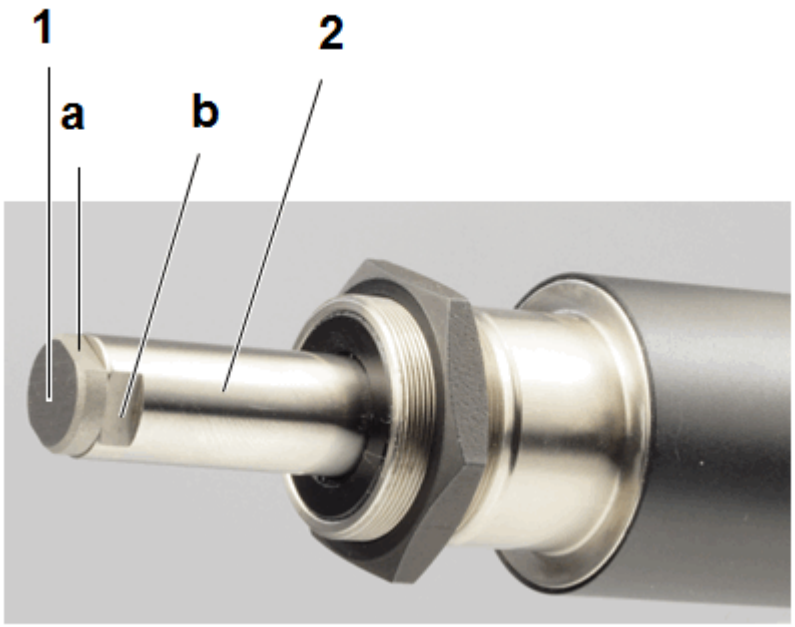


Figure 3: Mounted end piece (flat)

1 End piece with (a) wrench flat
2 Pusher with (b) wrench flat

Prerequisites

- ✓ You have read and understood the General Notes on Installation (p. 17).
- ✓ You have made the M-235 accessible for changing the end piece.
- ✓ The pusher has been moved out so far that you can easily reach the wrench flat with a open-end wrench. Upon delivery, the pusher has been moved out far enough.

Tools and accessories

- Supplied end piece (p. 12)
- Two AF 8 open-end wrenches

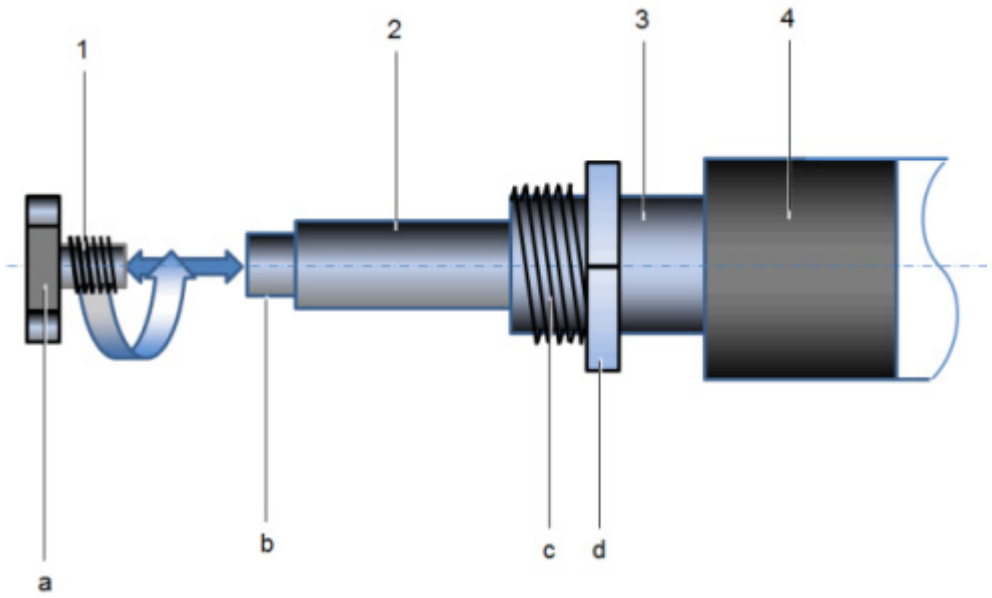


Figure 4: Changing the end piece, schematic

1 End piece (flat) with
(a) wrench flat
2 Non-turning pusher with
(b) wrench flat
3 Mounting shaft with
(b) thread (for clamp connection, M20)
(c) mounting nut
4 Sleeve

Changing the end piece

1. Attach the pusher: apply an AF 8 open-end wrench to the wrench flats of the pusher.
2. Manually unscrew the end piece to be replaced from the pusher of the M-235. If this is not successful, use a second AF 8 open-end wrench.
3. Screw the new tip by hand into the pusher of the M-235.
4. Remove the pusher from the open-end wrench.

5.3 Providing a Suitable Mechanical Mounting and Installation Environment

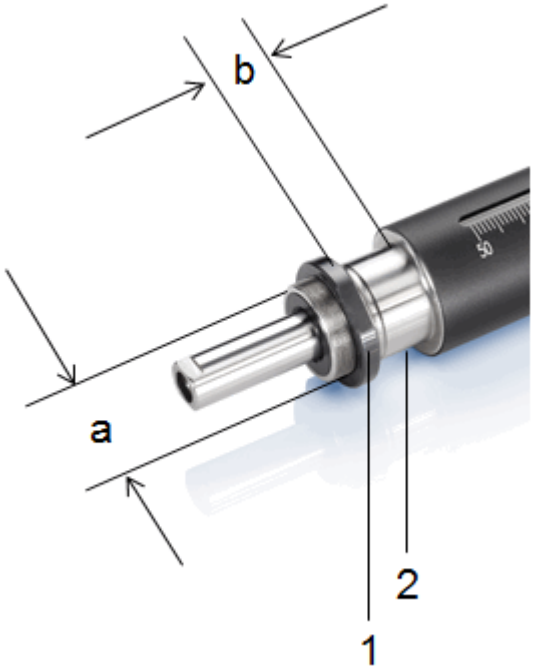


Figure 5: Relevant components and dimensions for installation in the mechanical mounting (schematic)

1 Mounting nut, M20

2 Mounting shaft with
(a) diameter: 20 mm
(b) clamping width: 12 mm to 18 mm usable

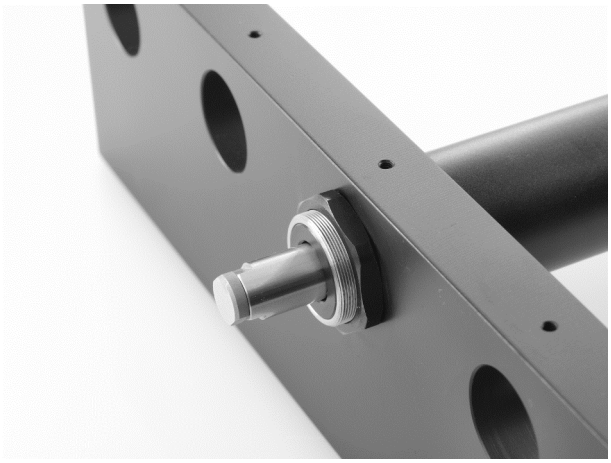


Figure 6: Example for the installation of a linear actuator (here: an M-235)

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. 40)).
  - 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. 40))
  - Travel range: maximum 20 mm (M-235.**2xx** models) or 50 mm (M-235.**5xx**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. 40).

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 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.

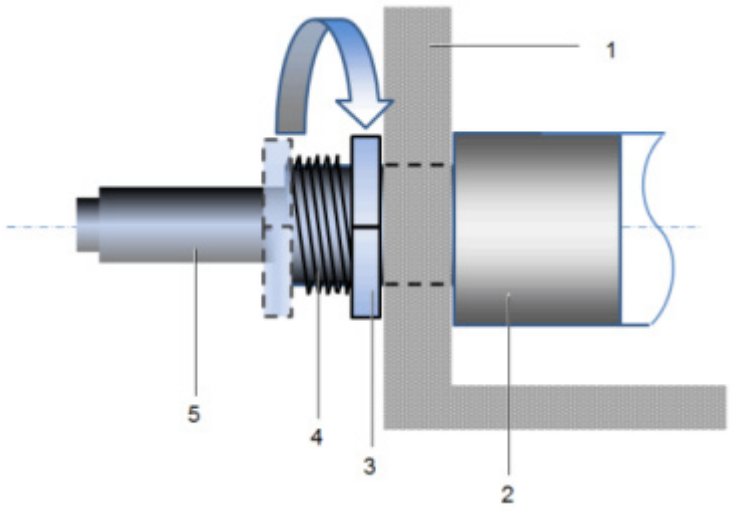


Figure 7: Clamp connection (schematic)

1 Mechanical mounting
2 Sleeve
3 Mounting nut, M20
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 (p. 21).

Tools and accessories

- Open-end wrench SW 24

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 open-end wrench until you feel a resistance. The torque must **not** exceed 1 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-235 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-235. 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-235 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. 27).

✓ 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 (extension/adapter) cable from PI.

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.
   – If you use a controller from another manufacturer: Enter the parameters in the corresponding PC software that precisely match the actuator version used.
7. Start a few motion cycles for testing purposes (see user manual of the controller).

6.2.1 M-235 Entries in the Stage Database of PI

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.

7 Maintenance

In this Chapter

7.1 General Notes on Maintenance

NOTICE

Damage due to improper maintenance!

The M-235 can become misaligned as a result of improper maintenance.

- ➢ Do not loosen any sealed screws.

7.2 Lubricating the M-235

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-235 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-235 without consulting our customer service department (p. 35).
- ➢ To lubricate, follow the instructions given in the maintenance manual which you can obtain from our customer service department.

7.3 Cleaning the M-235

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 Nm.
	Drive damaged due to torque on pusher	➢ Contact our customer service department
Functional impairment after system modification	▪ Controller has been replaced ▪ M-235 has been replaced with another model	Controller from PI: ➢ Load the parameters from the stage database that correspond to the combination of controller and M-235 model (p. 29). 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 connecting cable.
	Lateral forces are affecting the pusher	Lateral forces increase the friction on the internal drive components. ➢ Avoid lateral forces on the tip and on the pusher of the M-235.
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.
The mechanical system did not stop in time and ran into the hard stop	▪ Velocity is too high (see chapter Limit Switches p. 12) ▪ Limit switch is defective ▪ 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 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. 35).

9 Customer Service

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

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

Motion and positioning	M-235.2DG / M-235.5DG	M-235.2DD / M-235.5DD	Unit	Tolerance
Motion and positioning				
Travel range	20 / 50	20 / 50	mm	
Integrated sensor	Rotary encoder	Rotary encoder		
Sensor resolution	2048	2048	cts./rev.	
Design resolution	0.016	0.5	µm	typ.
Minimum incremental motion	0.1	1.5	µm	typ.
Backlash	2	2	µm	typ.
Unidirectional repeatability	±0.1	±0.5	µm	typ.
Velocity	2	30	mm/s	max.
Mechanical properties				
Gear ratio	29.6:1	–		
Push/pull force	120	50	N	max.
Permissible lateral force	8	8	N	max.
Drive properties				
Motor type	DC gear motor	DC motor		
Operating voltage	0 to ±12	0 to ±12	V	
Motor power	4	17	W	nominal
Reference and limit switches	Hall effect	Hall effect		

Motion and positioning	M-235.2DG / M-235.5DG	M-235.2DD / M-235.5DD	Unit	Tolerance
Miscellaneous				
Operating temperature range	-20 to 65	-20 to 65	°C	
Material	Aluminum anodized, chrome steel	Aluminum anodized, chrome steel		
Mass	0.55 / 0.7	0.5 / 0.65	kg	±5 %
Cable length	0.5 m	0.5 m	m	±10 mm
Connector	D-sub 15 (m), incl. encoder driver	D-sub 15 (m), incl. encoder driver		
Recommended controllers / drivers	C-863 C-884	C-863 C-884		

10.1.2 Ambient Conditions and Classifications

The following ambient conditions and classifications must be observed for the M-235:

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

10.2 Dimensions

10.2.1 Actuator

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

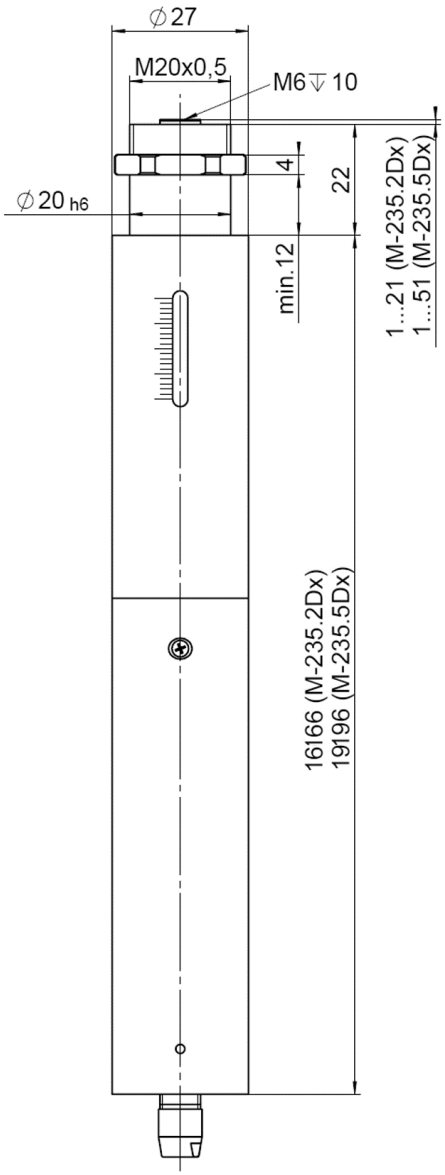


Figure 8: M-235.xDx and M-235.xVx, dimensions in mm

10.2.2 End Pieces

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

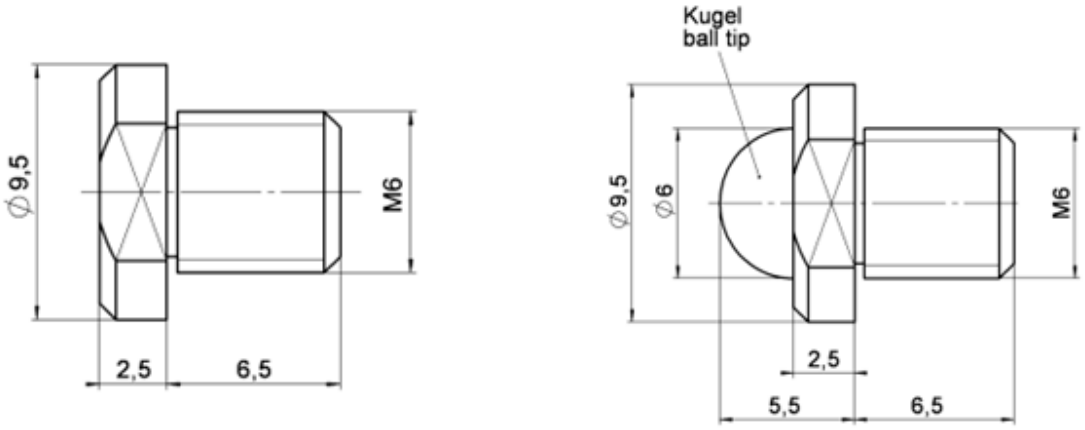
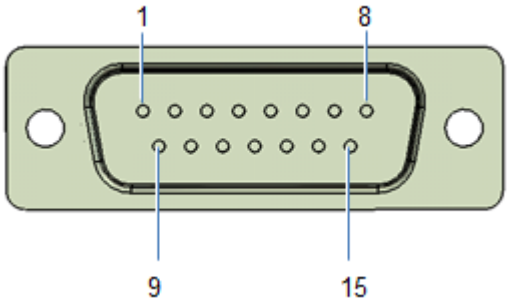


Figure 9: Low-profile top piece (left) and spherical end piece (right)

10.3 Pin Assignment D-Sub 15 (Male) Connector



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 (-)

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.

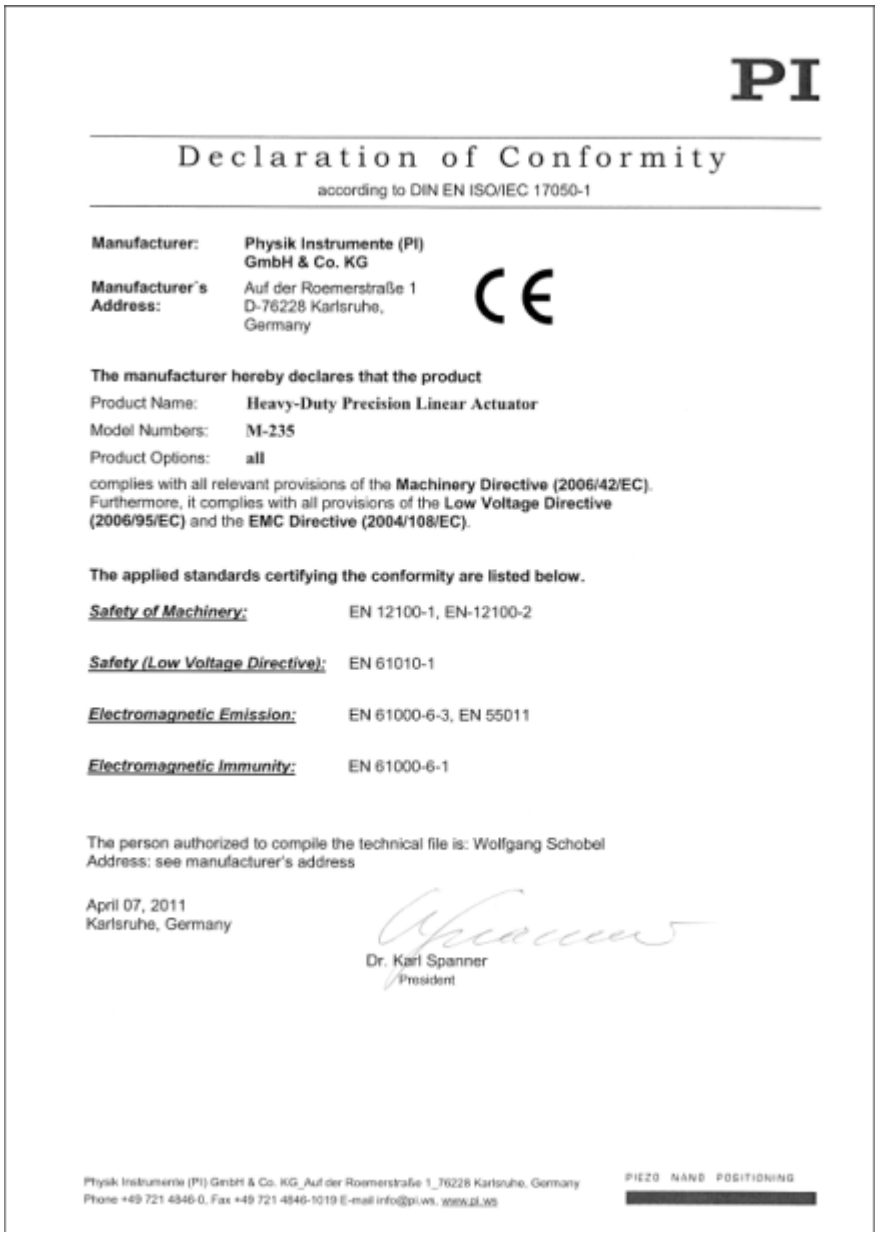
If you have old PI equipment, you can send it postage-free to the following address:

Physik Instrumente (PI) GmbH & Co. KG

Auf der Römerstr. 1

D-76228 Karlsruhe, Germany

12 EU 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: **Heavy-Duty Precision Linear Actuator**

Model Numbers: **M-235**

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 07, 2011
Karlsruhe, Germany

Dr. Karl Spanner
President

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