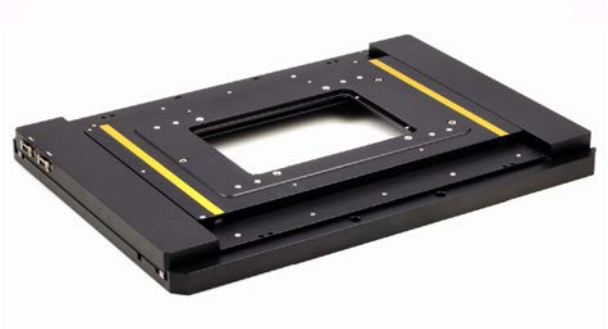
MP100E

M-687.UN XY Stage

User Manual

Version: 1.1.0 Date: 14.02.2014



This document describes the following product:

- **M-687.UN**
  XY Microscope Stage for Inverted Nikon Microscopes, 135 mm × 85 mm, Self-Locking, PILine® Linear Drives, 0.1 µm Linear Encoder

Physik Instrumente (PI) GmbH & Co. KG · Auf der Römerstr. 1 76228 Karlsruhe, Germany
Phone +49 721 4846-0 · Fax +49 721 4846-1019 · E-mail info@pi.ws

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Germany: DE102004024656A1, DE102004044184B4, DE102004059429B4, DE102005010073A1, DE102005039357B4, DE102005039358A1, DE102006041017B4, DE102008012992A1, DE102008023478A1, DE102008058484A1, DE102010022812A1, DE102010047280A1, DE102010055848, DE102011075985A1, DE102011082200A1, DE102011087542B3, DE102011087542B3, DE102011087801B4, DE102011108175, DE102012201863B3, DE19522072C1, DE19938954A1

Europe: EP0789937B1 EP1210759B1, EP1267425B1, EP1581992B1, EP1656705B1, EP1747594B1, EP1812975B1, EP1861740B1, EP1915787B2, EP1938397B1, EP2095441B1, EP2130236B1, EP2153476B1, EP2164120B1, EP2258004B1, EP2608286A2

USA: US2010/0013353A1, US5872418A, US6765335B2, US6806620B1, US6806620B1, US7218031B2, US7598656B2, US7737605B2, US7795782B2, US7834518B2, US7973451B2, US8253304B2, US8344592B2, US8482185B2

Japan: JP2011514131, JP2011522506, JP3804973B2, JP4377956, JP4435695, JP4477069, JP4598128, JP4617359, JP4620115, JP4648391, JP4860862, JP4914895, JP2013539346

China: ZL200380108542.0, ZL200580015994.3, ZL200580029560.9, ZL200580036995.6, ZL200680007223.4, ZL200680030007.1, ZL200680042853.5

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Subject to change without notice. This manual is superseded by any new release. The latest release is available for download (p. 3) on our website.

Contents

1 About this Document

In this Chapter

1.1 Goal and Target Audience of this User Manual

This manual contains information on the intended use of the M-687.UN.

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

The latest versions of the user manuals are available for download (p. 3) on our website.

1.2 Symbols and Typographic Conventions

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

CAUTION

Dangerous situation

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

➢ Actions to take to avoid the situation.

NOTICE

Dangerous situation

If not avoided, the dangerous situation will result in damage to the equipment.

➢ Actions to take to avoid the situation.

INFORMATION

Information for easier handling, tricks, tips, etc.

Symbol/Label	Meaning
1. 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)
	Warning sign on the product which refers to detailed information in this manual.

1.3 Definition

Term	Explanation
Load capacity	Maximum load capacity in the vertical direction when the XY stage is mounted horizontally. The contact point of the load is in the center of the platform.
Linear encoder	The linear encoder is an incremental sensor for capturing changes in position. Signals from the sensor are used for axis position feedback. After switching on the controller a reference point definition must be performed before absolute target positions can be commanded and reached.

1.4 Figures

For better understandability, the colors, proportions and degree of detail in illustrations can deviate from the actual circumstances. Photographic illustrations may also differ and must not be seen as guaranteed properties.

1.5 Other Applicable Documents

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

Device	Document
C-867.262 controller	MS196E User Manual C-867.262 PILine® Controller
PILine® stages	MP121EK Short Instructions

1.6 Downloading Manuals

INFORMATION

If a manual is missing on our website or if there are problems in downloading:

➢ Contact our customer service department (p. 39).

The current versions of the manuals are found on our website. For some products (e.g. Hexapod systems and electronics that are delivered with a CD), access to the manuals is password-protected. The password is stored on the CD.

Download freely accessible manuals

1. Open the website **http://www.pi-portal.ws**.
2. Click ***Downloads***.
3. Click the corresponding category (e.g. ***M Hexapods / Micropositioning***)
4. Click the corresponding product code (e.g. ***M-687***).
5. Click ***Documents***.

   The available manuals are displayed.
6. Click the desired manual and save it on the hard disk of your PC or on a data storage medium.

Download password-protected manuals

1. Carry out steps 1 to 5 of the download process for freely accessible manuals.
2. Insert the product CD in the PC drive.
3. Switch to the ***Manuals*** directory on the CD.
4. In the ***Manuals*** directory, open the Release News (file including ***releasenews*** in the file name).
5. Find the user name and password in the ***User login for software download*** section in the Release News.
6. In the ***User login*** area on the left margin in the website, enter the user name and the password in the corresponding fields.
7. Click ***Login***.

   The available manuals are displayed.
8. Click the desired manual and save it on the hard disk of your PC or on a data storage medium.

2 Safety

In this Chapter

2.1 Intended Use

The M-687.UN 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 and realization, the M-687.UN is intended for positioning, adjusting and shifting of loads in two axes at different velocities in interval operation. The M-687.UN is **not** intended for applications in areas in which a failure would present severe risks to human beings or the environment.

The M-687.UN is only intended for horizontal mounting.

The intended use of the M-687.UN is only possible when completely mounted and connected.

The M-687.UN uses PILine® ultrasonic piezo linear motors as a drive and must be operated with a suitable controller (p. 12). The controller is not included in the scope of delivery of the M-687.UN.

2.2 General Safety Instructions

The M-687.UN 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-687.UN.

- Only use the M-687.UN 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-687.UN.

Piezomotors are driven by piezo actuators. After being disconnected from the electronics, piezo actuators can stay electrically charged for several hours. Temperature changes can also induce charges in piezo actuators. Touching charged parts of the M-687.UN can cause slight injuries from electric shock.

- Do **not** open the M-687.UN.
- Do **not** touch the contacts in the connector of the M-687.UN.

If a protective earth conductor is not or not properly connected, dangerous touch voltages can occur on the M-687.UN in the case of malfunction or failure of the system. If touch voltages exist, touching the M-687.UN can result in minor injuries from electric shock.

- Connect the M-687.UN to a protective earth conductor (p. 18) before start-up.
- Do **not** remove the protective earth conductor during operation.
- If the protective earth conductor has to be removed temporarily (e. g. in the case of modifications), reconnect the M-687.UN to the protective earth conductor before starting it up again.

Mechanical forces can damage or misalign the M-687.UN.

- Avoid impacts that affect the M-687.UN.
- Do **not** drop the M-687.UN.
- Do **not** exceed the maximum permissible stress and load capacities according to the specifications (p. 41).

2.3 Organizational Measures

User manual

- Always keep this user manual available by the M-687.UN.
  The latest versions of the user manuals are available for download (p. 3) on our website.
- Add all information given by the manufacturer to the user manual, for example supplements or Technical Notes.
- If you pass the M-687.UN on to other users, also turn over this user manual as well as 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 result in minor injury and property damage.
- Only install and operate the M-687.UN after having read and understood this user manual.

Personnel qualification

The M-687.UN may only be installed, started up, operated, maintained and cleaned by authorized and appropriately qualified personnel.

3 Product Description

In this Chapter

3.1 Product View

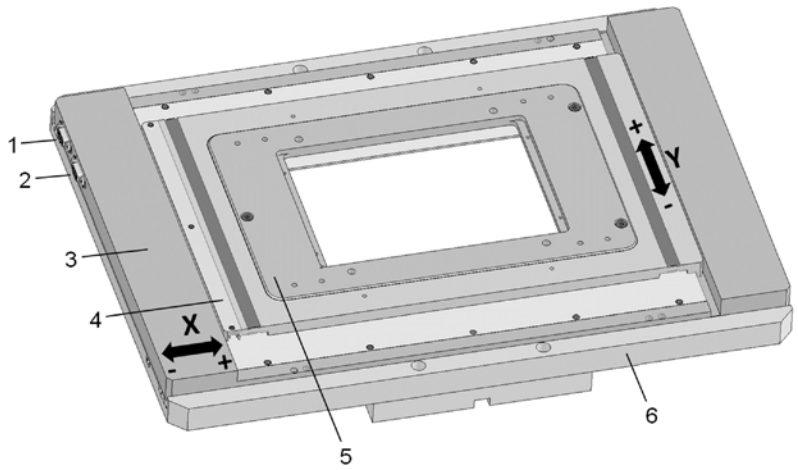


Figure 1: M-687.UN product view

1 Connection for controller cable (Y axis)
2 Connection for controller cable (X axis)
3 Lower platform (X axis)
4 Upper platform (Y axis)
5 000029788 adapter plate (110 mm x 160 mm)
6 Base body
X: Directions of motion of the X axis
Y: Directions of motion of the Y axis

3.2 Product Labeling

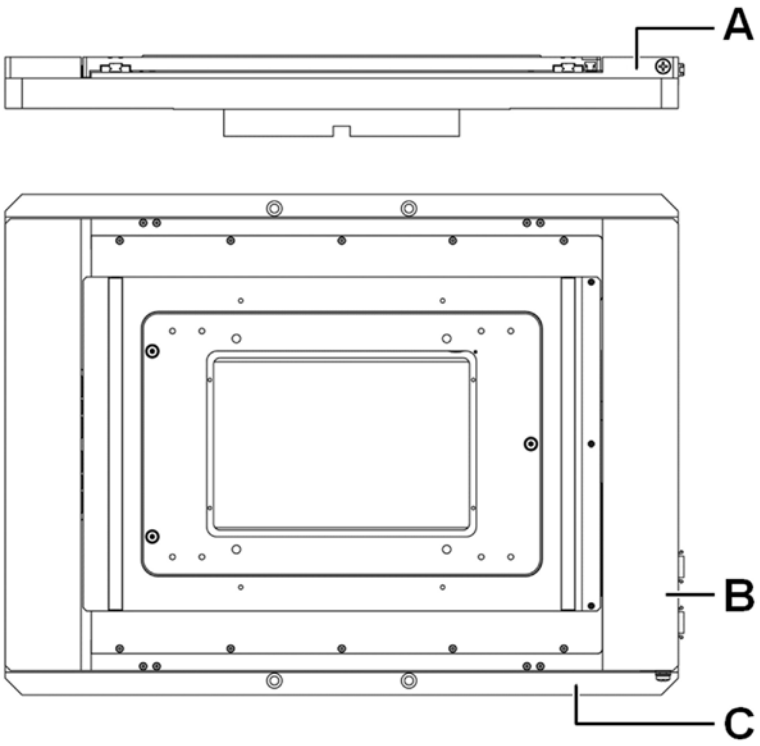


Figure 2: M-687.UN: Position of the product labeling (example view)

Position	Labeling	Description
A	⏚	Symbol for the protective earth conductor, marks the protective earth connection of the M-687.UN
B	Axis X	Controller connection for the X axis
B	Axis Y	Controller connection for the Y axis
C	M-687.UN	Product name
C	113065565	Serial number (example), individual for each M-687.UN Meaning of the places (counting from left): 1 = internal information 2 and 3 = manufacturing year 4 to 9 = consecutive numbers

Position	Labeling	Description
C		Warning sign "Observe manual!"
C		Old equipment disposal (p. 49)
C	Country of origin: Germany	Country of origin
C	WWW.PI.WS	Manufacturer's address (website)
C		Manufacturer's logo
C		CE conformity mark
C	PILine®	Brand name

3.3 Scope of Delivery

The M-687.UN can be part of a system. The system has the order number M26821LNJ. Further system components are the C-867.262 controller, whose scope of delivery is listed in the MS196E User Manual, as well as the C819B0002 USB joystick.

Scope of delivery of the M-687.UN

Item ID	Quantity	Name
M-687.UN	1	XY microscope stage for inverted Nikon microscopes, 135 mm × 85 mm, self-locking, PILine® linear drives, 0.1 µm linear encoder
000031657	1	Screw set for fastening the M-687.UN, consisting of: ▪ 5 M5x35 hex-head cap screws ISO 4762 ▪ 1 Allen wrench
000036450	1	M4 screw set for protective earth, consisting of: ▪ 1 M4x8 flat-head screw with cross recess, ISO 7045 ▪ 2 safety washers ▪ 2 flat washers
000029788	1	Adapter plate, 110 mm x 160 mm (with spring and M2x5 threaded pin), pre-assembled
K060B0073	2	Cable, MDR 14, male/male, 1:1, 1.5 m, for connection to the C-867.262 controller
MP121EK	1	Short instuctions for PILine® stages

3.4 Suitable Controllers

Product code	Description
C-867.262	High-precision piezomotor controller with drive electronics, 2 channels, for PILine® systems

➢ To order, contact our customer service department (p. 39).

3.5 Accessories

Order Number	Description
P-561 to P-563	PIMars XYZ nanopositioning systems with up to 300 µm travel
P-541.2 and P-542.2	Low-profile microscopy XY scanners
P-541.Z	Low-profile Z/tip/tilt piezo nanopositioning stages for microscopy
P-545.2R7	PInano® XY piezo stage, slide-size aperture, 200 µm × 200 µm, piezoresistive sensors, with USB controller
P-545.3R7	PInano® XYZ piezo stage, slide-size aperture, 200 µm × 200 µm × 200 µm, piezoresistive sensors, with USB controller
PD73Z2CNW	PInano® Z piezo scanner system with clear aperture for well plates, for inverse Nikon microscopes, 220 µm, capacitive sensors with USB digital controller
PD73Z2RNW	PInano® Z piezo scanner system with clear aperture for well plates, for inverse Nikon microscopes, 220 µm, piezoresistive sensors with USB digital controller
P-737.1SL	PIFOC® nanofocusing Z-stage for microscope sample holder, 100 µm, SGS, LEMO connector(s)
P-737.2SL	PIFOC® nanofocusing Z-stage for microscope sample holder, 250 µm, SGS, LEMO connector(s)
M-687.AP1	Microscope universal holder for slides and Petri dishes for PI stages with 160 mm × 110 mm free aperture
M-663.AB	▪ Adapter box, MDR to 15-pin Sub-D, for PILine® stages with long cables ▪ M663T0015 Technical Note for adapter box

Order Number	Description
Extension cables for use with the M-663.AB adapter box:	
M-663.A01 M-663.A03 M-663.A05	Extension cable for PILine®, MDR to 15-pin Sub-D, 1 m Extension cable for PILine®, MDR to 15-pin Sub-D, 3 m Extension cable for PILine®, MDR to 15-pin Sub-D, 5 m Longer cables available on request.

➢ To order, contact our customer service department (p. 39).

3.6 Technical Features

3.6.1 Linear Encoder

The M-687.UN is equipped with one optical linear encoder per axis. For the encoder resolution, refer to the table in the "Specifications" section (p. 41).

Optical linear encoders measure the actual position directly (direct metrology). Therefore, errors occurring in the drivetrain, such as nonlinearity, backlash or elastic deformation, cannot influence the measurement of the position.

3.6.2 Limit Switches

The M-687.UN 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 XY stage runs into the hard stop.

See "Limit Switch Specifications" (p. 42) for more information.

3.6.3 Reference Point Switch

The M-687.UN is equipped with one direction-sensing reference point switch per axis. The switch is located at about the midpoint of the travel range. This sensor transmits a TTL signal that indicates whether the axis is on the positive or negative side of the reference point switch.

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

For more information, see "Reference Point Switch Specifications" (p. 42).

4 Unpacking

1. Unpack the M-687.UN 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

CAUTION

Dangerous voltage and residual charge on piezo actuators!

Piezomotors are driven by piezo actuators. After being disconnected from the electronics, piezo actuators can stay electrically charged for several hours. Temperature changes can also induce charges in piezo actuators. Touching or short-circuiting the contacts in the connector of the M-687.UN can lead to minor injuries from electric shock.

➢ Do **not** touch the contacts in the connector of the M-687.UN.

NOTICE

Lubricants, dirt, condensation!

Dirt, oil, lubricants and condensation will render the motor/drive inoperable.

➢ Ensure that the piezomotors of the M-687.UN do not come into contact with lubricants.

➢ Keep the M-687.UN free from dirt and condensation.

NOTICE

Heating up of the M-687.UN during operation!

The heat produced during operation of the M-687.UN can affect your application.

- ➢ Install the M-687.UN so that your application is not affected by the dissipating heat.

NOTICE

Unsuitable cables!

Unsuitable cables can cause damage to the controller and can affect the performance of the M-687.UN.

- ➢ Only use original PI parts to connect the M-687.UN to the controller.
- ➢ If you need longer cables, use the M-663.AB adapter boxes and extension cables from PI (p. 12).

5.2 Connecting the M-687.UN to the Protective Earth Conductor

INFORMATION

- ➢ Observe the applicable standards for mounting the protective earth conductor.

An M4 hole is located on the M-687.UN near the controller connections, for connecting the protective earth conductor. In the following figure, this hole is marked with an arrow.

Figure 3: M-687.UN: Protective earth connection

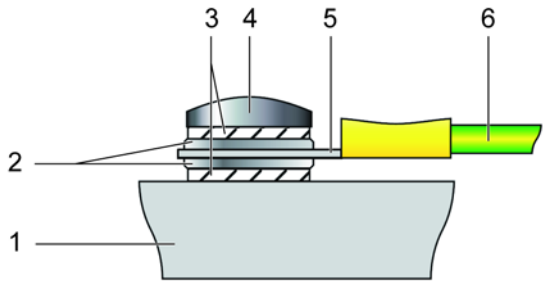


Figure 4: Mounting of the protective earth conductor (profile view)

1 Lower platform of the M-687.UN
2 Flat washer
3 Safety washer
4 Screw
5 Cable lug
6 Protective earth conductor

Prerequisite

✓ You have read and understood the General Notes on Installation (p. 17).

✓ The M-687.UN is **not** connected to the controller.

Tools and accessories

- Suitable protective earth conductor: Cross-sectional area of the cable ≥0.75 mm^2
- Supplied M4 screw set for protective earth (p. 11) for mounting a protective earth conductor
- Suitable screwdriver

Connecting the M-687.UN to the protective earth conductor

1. If necessary, fasten a suitable cable lug to the protective earth conductor.
2. Fasten the cable lug of the protective earth conductor using the M4 screw on the protective earth connection of the M-687.UN as shown in the profile view.
3. Tighten the M4 screw with a torque of 1.2 Nm to 1.5 Nm.
4. Make sure that the contact resistance at all connection points relevant for mounting the protective earth conductor is <0.1 Ω at 25 A.

5.3 Mounting the M-687.UN on a Surface

NOTICE

Protruding screw heads!

Protruding screw heads can damage the M-687.UN.

- ➢ Ensure that the screw heads do not protrude from counter-sunk holes so that they do not interfere with the stage motion.

NOTICE

Warping of the base body!

Incorrect mounting can warp the base body. Warping of the base body will increase wear and reduce accuracy.

- ➢ Mount the M-687.UN on an even surface. The recommended evenness of the surface is 5 µm.
- ➢ For applications with great temperature changes:
  Only fasten the M-687.UN to surfaces that have the same or similar thermal expansion properties as the M-687.UN (e.g. surfaces made of aluminum).

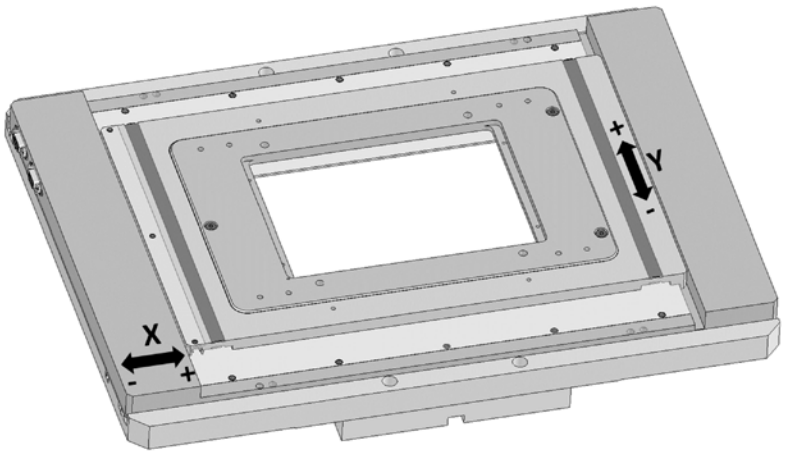


Figure 5: M-687.UN, directions of motion of the X axis and the Y axis

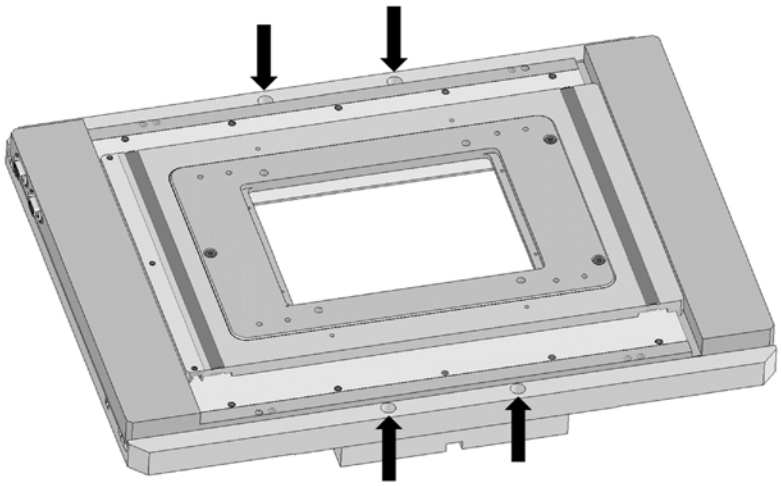


Figure 6: M-687.UN: Mounting holes in the base body

Prerequisite

- ✓ You have read and understood the General Notes on Installation (p. 17).
- ✓ You have provided a suitable surface (for the required position and depth of the holes for accommodating the screws, see "Dimensions", p. 45).
  - Four M5 holes are present.
  - The evenness of the surface is ≤5 µm.
  - For applications with great temperature changes: The surface should have the same or similar thermal expansion properties as the M-687.UN (e.g. surface made of aluminum).
- ✓ You accounted for the space required for cable routing free of kinks and in accordance with regulations.
- ✓ The M-687.UN is **not** connected to the controller.

Tools and accessories

- Mounting accessories in the scope of delivery (p. 11):
  - 4 M5x35 screws
  - Allen wrench

Mounting the M-687.UN on a surface

1. Align the M-687.UN on the surface so that the four holes (see arrows in the figure) in the M-687.UN and the surface overlap.
2. Introduce the four screws into the holes in the base body of the M-687.UN.
3. Tighten the screws with a maximum torque of 5 Nm each.
4. Ensure that the screw heads do not protrude from the counter-sunk holes.
5. Check that the M-687.UN fits on the surface without backlash.
6. If necessary, secure the screws with a thread-locking adhesive.

5.4 Affixing a Stage to the M-687.UN

NOTICE

Impermissibly high load on the XY stage!

An impermissibly high load interferes with the motion of the moving platform and can damage the XY stage.

➢ In respect to the mass and mounting type of the load, observe the maximum permissible forces that are allowed to act on the moving platform according to the specification (p. 41).

NOTICE

Screws that are too long!

The M-687.UN can be damaged by screws that are too long.

➢ Note the depth of the mounting holes in the upper platform (p. 45).

➢ Only use screws of the correct length for the respective mounting holes.

INFORMATION

The upper moving platform of the M-687.UN features an adapter plate (p. 11) which has to be removed before certain stages are mounted (e. g. PD73Z2CNW and PD73Z2RNW).

Prerequisite

- ✓ You have read and understood the General Notes on Installation (p. 17).
- ✓ You have read and understood the user manual of the stage to be affixed.
- ✓ You have properly mounted the M-687.UN (p. 20).
- ✓ The M-687.UN and the stage to be affixed are **not** connected to the respective controller.

Tools and accessories

- Screws of appropriate size and length:

Stage	Suitable Screws
P-561 to P-563	M6x25
P-541.2 and P-542.2	M6x16
P-541.Z	M6x16
P-545.2R7	M4x16
P-545.3R7	M4x16
PD73Z2CNW	M4x12
PD73Z2RNW	M4x12
P-737.1SL	M2.5x8
P-737.2SL	M2.5x8

- Suitable tools for fastening the screws

Affixing a stage to the M-687.UN (with adapter plate)

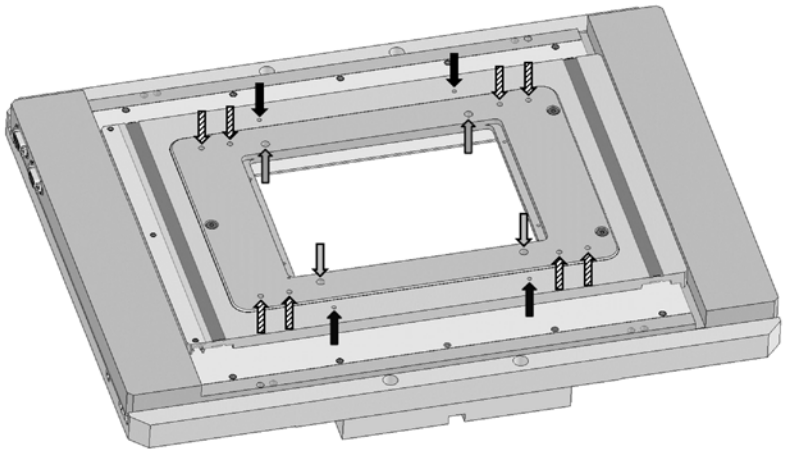


Figure 7: M-687.UN: Threaded holes (hatched arrows = 8 x M4; black arrows = 4 x M3; gray arrows = 4 x M6)

1. Align the stage on the M-687.UN so that the holes to be used in the stage and in the upper platform (Y axis) overlap.
2. Affix the stage with four suitable screws (see table).

Affixing a stage to the M-687.UN (without adapter plate)

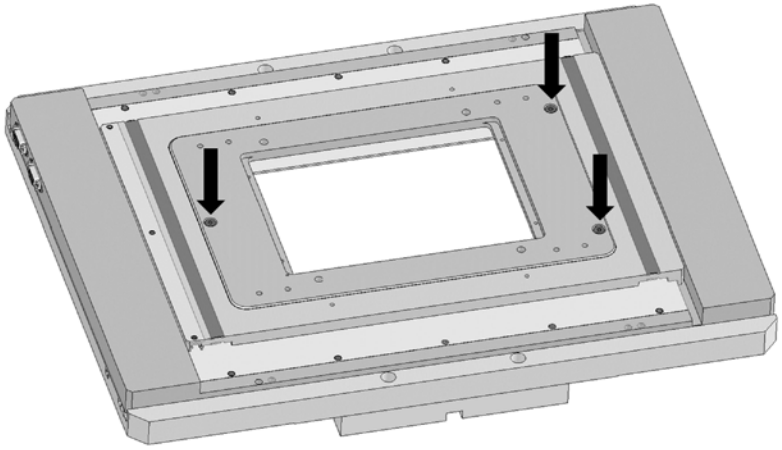


Figure 8: Screws for affixing the adapter plate

1. Loosen the three M4 screws with which the adapter plate is affixed to the M-687.UN (see arrows in the diagram).
2. Remove the adapter plate together with the loosened screws.
3. Align the stage on the M-687.UN so that the holes in the stage overlap with the holes in the upper platform (Y axis) to which the adapter plate was previously affixed.
4. Affix the stage with three suitable screws (see table).

5.5 Inserting and Removing the Microscope Universal Holder

In the clear aperture (160 × 110 mm) of the adapter plate of the M-687.UN, the M-687.AP1 microscope universal holder for slides and petri dishes can be inserted.

Figure 9: M-687.AP1 microscope universal holder

Figure 10: M-687.UN: Clip spring in clear aperture of the adapter plate

Prerequisite

✓ The adapter plate (p. 11) is affixed to the M-687.UN.

Tools and accessories

- M-687.AP1 microscope universal holder, available as an optional accessory (p. 12)

Inserting the microscope universal holder into the aperture

1. Orientate the universal holder so that the red dot on the holder points in the direction of the clip spring of the aperture (see figure).
2. On the side of the clip spring, place the short edge of the universal holder at a flat angle in the middle of the aperture so that it makes contact on two sides.
3. Slowly slide the universal holder towards the clip spring until it reaches the edge and the clip spring is tensioned.
4. On the opposite side, press the universal holder slowly down until it is fully engaged.

   The universal holder is now clamped.

Removing the microscope universal holder from the aperture

➢ Slowly pull the universal holder on one side upwards until it is released.

6 Start-Up and Operation

In this Chapter

6.1 General Notes on Start-Up and Operation

CAUTION

Risk of electric shock if the protective earth conductor is not connected!

If a protective earth conductor is not or not properly connected, dangerous touch voltages can occur on the M-687.UN in the case of malfunction or failure of the system. If touch voltages exist, touching the M-687.UN can result in minor injuries from electric shock.

- Connect the M-687.UN to a protective earth conductor (p. 18) before start-up.
- Do **not** remove the protective earth conductor during operation.
- If the protective earth conductor has to be removed temporarily (e. g. in the case of modifications), reconnect the M-687.UN to the protective earth conductor before starting it up again.

NOTICE

Operating voltage too high or incorrectly connected!

Operating voltages that are too high or incorrectly connected can cause damage to the M-687.UN.

- Only operate the M-687.UN with controllers/drivers and original accessories from PI.
- Do **not** exceed the operating voltage range (p. 42) for which the M-687.UN is specified.
- Only operate the M-687.UN when the operating voltage is properly connected; see "Pin Assignment" (p. 47).

NOTICE

Unintentional motions!

When the M-687.UN is being connected to the controller, it can carry out unintentional motions. Defective software or wrong operation of the software can also result in unintentional motions.

- Do not place any objects in areas where they can get caught by moving parts.
- Before connecting the M-687.UN, check whether a macro is defined as the start-up macro in the controller, and cancel the selection of the start-up macro if necessary.

NOTICE

Damage from collisions!

Collisions can damage the XY stage, the load to be moved and the environment.

- Make sure that no collisions are possible between the XY stage, the load to be moved and the environment in the motion range of the XY stage.
- Do not place any objects in areas where they can get caught by moving parts.
- Stop the motion immediately if a controller malfunction occurs.
- If possible, adapt the travel range limits of your mechanical system in the software that you use for commanding the motion.

NOTICE

Uncontrolled oscillation!

Your application can be damaged by uncontrolled oscillation of the M-687.UN.
If you encounter noise during operation:

- Immediately switch off the servo-control system of the affected axes.
- Check the settings of the servo-control parameters.

NOTICE

Collision of the moving platforms with the hard stop!

Collision of the moving platforms of the M-687.UN with the hard stop can lead to damage or considerable wear on the M-687.UN.

- Prevent motions in open-loop operation.
- If motions in open-loop operation are necessary with the C-867 controller:
  - Set the control value with the `SMO` command so that the axes move with low velocity.
  - Stop the axes in time. For this purpose, use the `#24`, `STP` or `HLT` command, or set the control value to zero with the `SMO` command.
- Ensure that the end of the travel range is approached at low velocity.
- Only make changes to the velocity, acceleration, deceleration and load in small steps.
- Do **not** deactivate the limit switches in the software.
- Test limit switch operation at low velocities only.
- In the event of a malfunction of the limit switches, stop the motion immediately.

INFORMATION

Although in theory the M-687.UN operates quietly, noise levels of up to 50 dB (A) are possible during operation. The ultrasonic drive of the M-687.UN can also generate higher noise levels at frequencies between 100 and 500 kHz.

INFORMATION

The repeatability of the positioning is only ensured when the reference point switch is always approached from the same side. Controllers from PI fulfill this requirement as a result of the automatic direction sensing for reference moves to the reference switch.

INFORMATION

For maximum force generation, a run-in procedure is necessary during the start-up of the M-687.UN and after longer downtimes; see also "Influence of Downtimes on the Static Holding Force" (p. 44). After run-in, the M-687.UN will generate its maximum dynamic force.

- For run-in, command a few motion cycles at low velocity over the entire travel range.

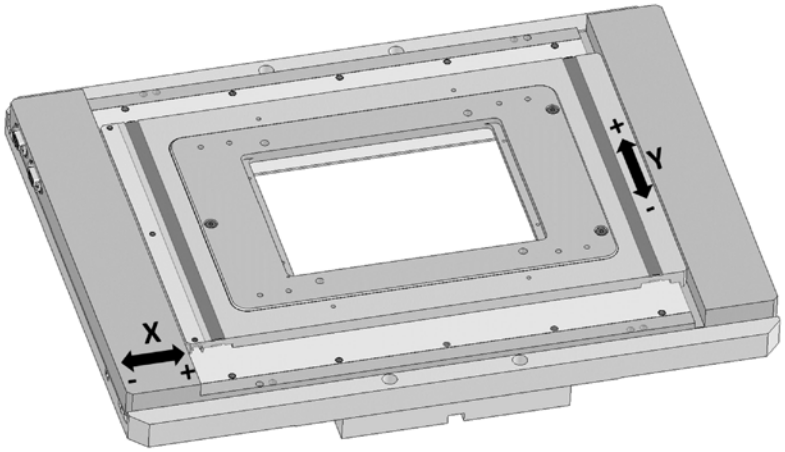


Figure 11: M-687.UN, directions of motion of the X axis and the Y axis

6.2 Starting Up the M-687.UN with the C-867 Controller

NOTICE

Incorrect parameter settings!

When using the software which is included in the scope of delivery of the C-867 controller, the operating parameters of the M-687.UN can be loaded from a stage database. The stage *PIStages2.dat* database contains the default parameter values of your XY stage for performing initial test motions during start-up. Depending on the application, using the default parameter values (e. g. for P-term, I-term, D-term, acceleration and velocity) can, however, cause damage to the XY stage, especially when operated with heavy loads.

- If possible: Perform the first start-up without a load.
- Always install the latest version of the *PIStages2.dat* stage database on your PC.

For start-up with a load:

- Before start-up, make sure that the M-687.UN has been properly installed (p. 17).
- For optimum performance of the moving axis, adjust the operating parameters of the C-867 (e. g. P-term, I-term, D-term, acceleration, velocity; see C-867 User Manual).
- Save the new parameter values for future use in a stage database on the PC or in the non-volatile memory of the controller (see C-867 User Manual and PIMikroMove User Manual).

INFORMATION

The X and Y axes of the M-687.UN XY stage have different travel ranges. Therefore, for each axis a separate stage type with specially adapted parameters is available in the stage database from which the operating parameters can be loaded.

- ➢ In the PC software, assign the suitable stage type to the axes. The cable connections between the XY stage and the controller determine the assignment of the stage type.

If the M-687.UN is part of a preconfigured system, the suitable parameter sets are already stored in the controller. In this case, it is not necessary to assign a stage type in the PC software. Default configuration when the C-867.262 controller is used:

- For axis 1 of the controller (***Motor 1*** socket), the parameter set for axis X of the XY stage is stored in the controller.
- For axis 2 of the controller (***Motor 2*** socket), the parameter set for axis Y of the XY stage is stored in the controller.

- ➢ Connect the M-687.UN and the controller using the cables so that the assignment given by the parameter sets stored in the controller is observed.

Prerequisites

- ✓ You have read and understood the General Notes on Start-Up and Operation (p. 27).
- ✓ You have read and understood the user manual of the C-867 piezomotor controller/driver.
- ✓ The M-687.UN is installed properly (p. 17).
- ✓ The C-867 piezomotor controller/driver and the required software have been installed. All connections on the C-867 have been established (see C-867 User Manual).

Starting up the M-687.UN with the C-867 controller

1. Start up one axis of the M-687.UN (see C-867 User Manual).
   The start-up procedure involves the following steps:
   - Selecting the stage type
   - Defining the reference point of the axis
   - Commanding motion in closed-loop operation

   The description in the C-867 User Manual assumes that you perform these steps using PIMikroMove.
2. Adjust the servo-control parameters and save them:
   - For optimum performance of the axis, adjust the servo-control parameters of the C-867 (e. g. P-term, I-term, D-term, acceleration, velocity; see C-867 User Manual).
   - Save the new parameter values for future use in a stage database on the PC or in the non-volatile memory of the controller (see C-867 User Manual and PIMikroMove User Manual).
3. Command a few motion cycles for testing and run-in of the mechanical system (velocity <50 mm/s).

   After run-in, the M-687.UN will generate its maximum dynamic force.
4. Carry out steps 1 to 3 for the second axis of the M-687.UN.

7 Maintenance

In this Chapter

7.1 General Notes on Maintenance

NOTICE

Damage due to improper maintenance!

Improper maintenance can result in the failure of the M-687.UN.

- Only loosen screws according to the instructions in this manual.
- Ensure that the piezomotors of the M-687.UN do not come into contact with lubricants.

7.2 Performing a Maintenance Run

Depending on the operating conditions and the period of use of the M-687.UN, the following maintenance measures are required:

Maintenance run

The maintenance run is performed to distribute the existing lubricant on the guidings of the M-687.UN.

- To evenly distribute the existing lubricant on the stage guidings, perform a maintenance run across the entire travel range after 500 hours of operation, or after 1 year at the latest.
- If you move the M-687.UN continuously over a small working range (<20 % of the entire travel range) in industrial operation, perform a maintenance run across the entire travel range every 5000 motion cycles.

Lubrication

Under laboratory conditions, the guidings of the M-687.UN only need to be lubricated in exceptional cases. For continuous industrial use, the lubrication intervals must be defined individually.

- Do not lubricate the guidings of the M-687.UN without consulting our customer service department (p. 39).
- To lubricate the guidings, follow the instructions given in the maintenance manual which you can obtain from our customer service department.
- Ensure that the piezomotors of the M-687.UN do not come into contact with lubricants.

7.3 Cleaning the M-687.UN

Prerequisites

- ✓ You have disconnected the XY stage from the controller.

Cleaning the XY stage

- When necessary, clean the XY stage surface with a cloth lightly dampened with a mild cleanser or disinfectant.
- Do **not** use any organic solvents.

8 Troubleshooting

Problem	Possible Causes	Solution
Noise during operation	Uncontrolled oscillation of the M-687.UN	➢ Immediately switch off the servo-control system of the affected axes. ➢ Check the settings of the servo-control parameters.
XY stage positions inaccurately	Settling window around the target position is too large	➢ Reduce the settling window by changing the parameter values for the settling window limits on the controller. See the controller user manual (p. 3) for details.
Reaching the target position takes too long	Settling window around the target position is too small	➢ Enlarge the settling window by changing the parameter values for the settling window limits on the controller. See the controller user manual (p. 3) for details.
Increased wear Reduced accuracy	Warped base body	➢ Mount the M-687.UN on an even surface. The recommended evenness of the surface is 5 µm. ➢ For applications with great temperature changes: Only mount the M-687.UN on surfaces that have the same or similar thermal expansion properties as the M-687.UN (e.g. surfaces made of aluminum).

Problem	Possible Causes	Solution
Axis does not reach the commanded position	The values of the travel range parameters in the controller do not match the connected axis of the XY stage	➢ Select the suitable stage type in the PC software (separate parameter sets for the axes X and Y of the XY stage). If the M-687.UN is part of a preconfigured system: ➢ Connect the M-687.UN and the controller using the cables so that the assignment given by the parameter sets stored in the controller is observed.

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. 39).

9 Customer Service

For inquiries and orders, contact your PI sales engineer or send us an e-mail (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 user manuals are available for download (p. 3) on our website.

10 Technical Data

In this Chapter

10.1 Specifications

10.1.1 Data Table

	M-687.UN	Unit	Tolerance
	XY stage for Nikon microscopes		
Active axes	X, Y		
Motion and positioning			
Travel range	135 × 85	mm	
Integrated sensor	Linear encoder		
Sensor resolution	0.1	µm	
Bidirectional repeatability	0.4	µm	
Pitch / yaw	±300	µrad	typ.
Velocity	120	mm/s	max.
Reference point switches	Optical, 1 µm repeatability		
Limit switches	Hall-effect		
Mechanical properties			
Load capacity	50	N	max.
Push / pull force	7	N	max.
Miscellaneous			
Operating temperature range	20 to 40	°C	
Material	Al (black anodized)		
Mass	3.8	kg	±5%

10.1.2 Limit Switch Specifications

Type	Magnetic (Hall-effect) sensor
Supply voltage	+5 V/GND, supply via the motor connector
Signal output	TTL level
Signal logic	Active high. When the limit switch is passed, the signal level changes: – Normal motor operation: low (0 V) – Limit switch reached: high (+5 V)

10.1.3 Reference Point Switch Specifications

Type	Optical sensor
Supply voltage	+5 V/GND, supply via the motor connector
Signal output	TTL level
Signal logic	Direction sensing by means of different signal levels on the left and right side of the reference point switch: The signal level changes from 0 to +5 V when the reference point switch is passed.
Hysteresis	Approx. 1µm (when approaching from the positive or negative direction)

10.1.4 Maximum Ratings

M-687.UN XY stages are designed for the following operating data:

Device	**Maximum Operating Voltage** 	**Operating Frequency** 	**Maximum Power Consumption** 
M-687.UN	200 V_{pp} or 71 V_{rms}	152 to 165 kHz	60 W

10.1.5 Ambient Conditions and Classifications

The following ambient conditions and classifications must be observed for the M-687.UN:

Area of application	For indoor use only
Maximum altitude	2000 m
Air pressure	1100 hPa to 0.1 hPa (corresponds to roughly 825 torr to 0.075 torr)
Relative humidity	Highest relative humidity 80 % for temperatures up to 31 °C Decreasing linearly to 50 % relative humidity at 40 °C
Operating temperature	20°C to 40°C
Storage temperature	-20 °C to 75 °C
Transport temperature	-20 °C to 75 °C
Overvoltage category	II
Protection class	I
Degree of pollution	1
Degree of protection according to IEC 60529	IP20

10.2 Influence of Downtimes on the Static Holding Force

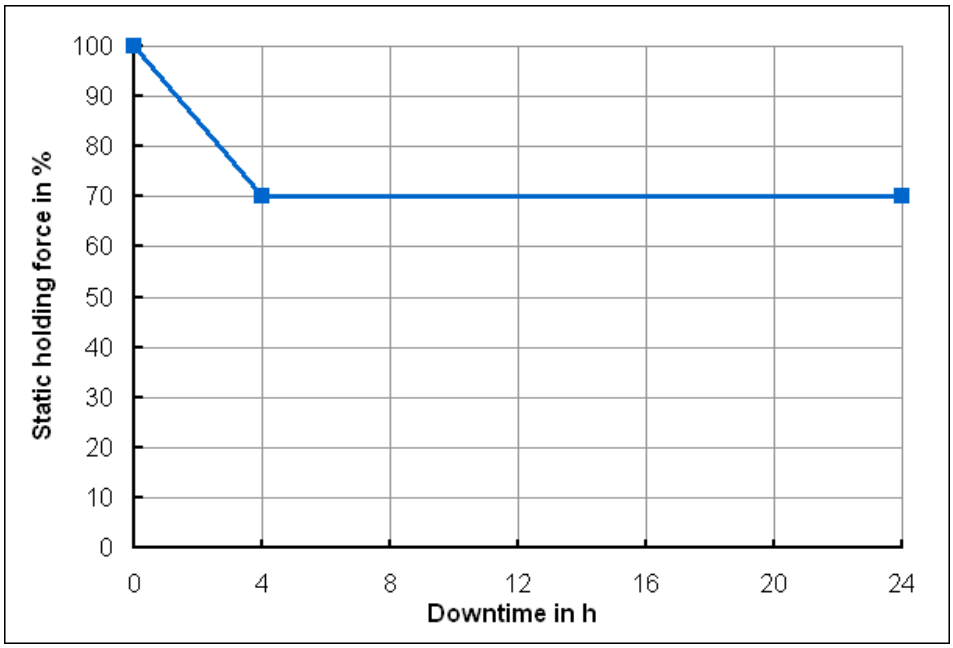


Figure 12: Static holding force of the M-687.UN depending on the downtime of the motor

10.3 Dimensions

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

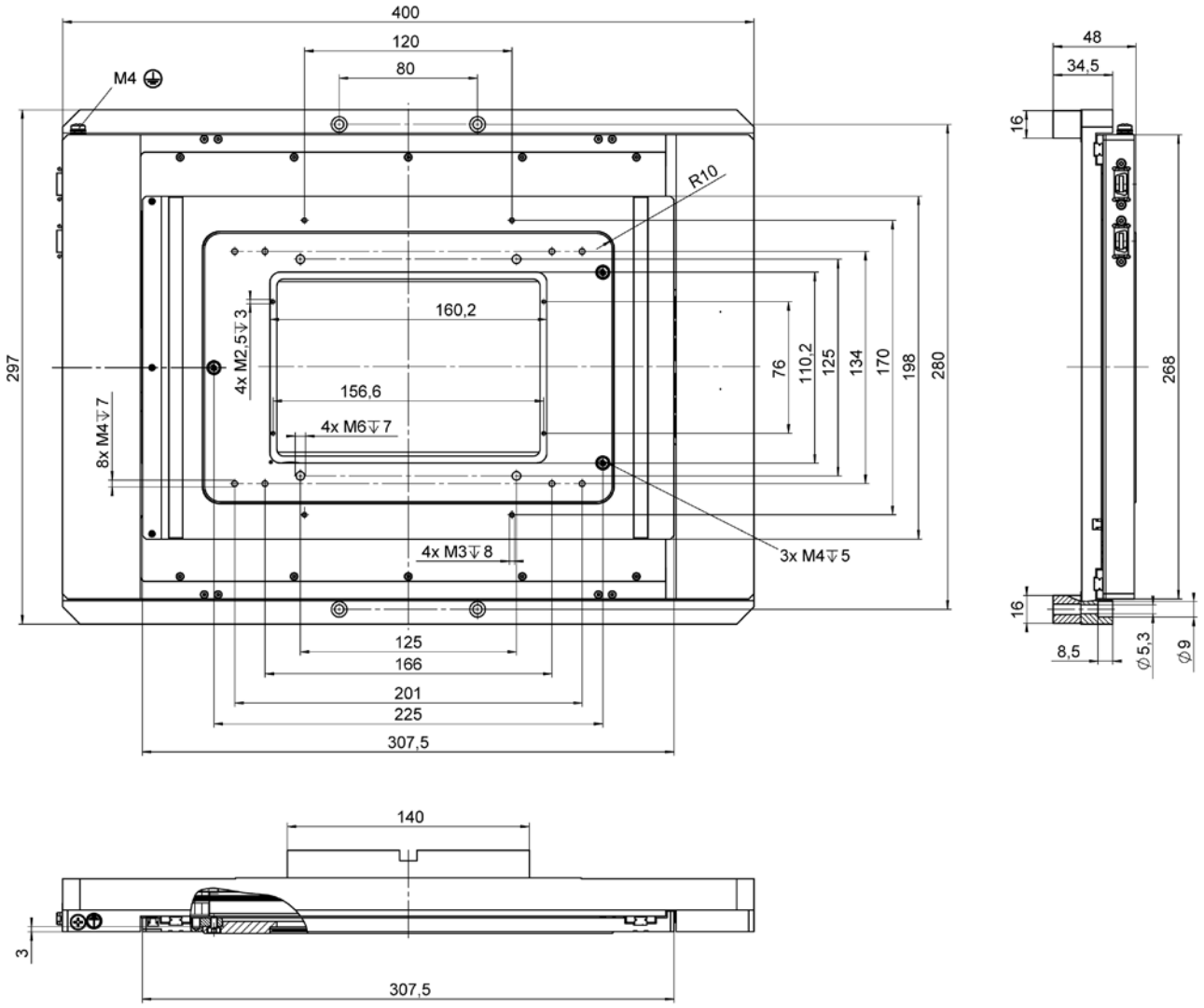


Figure 13: M-687.UN XY stage with installed 000029788 adapter plate

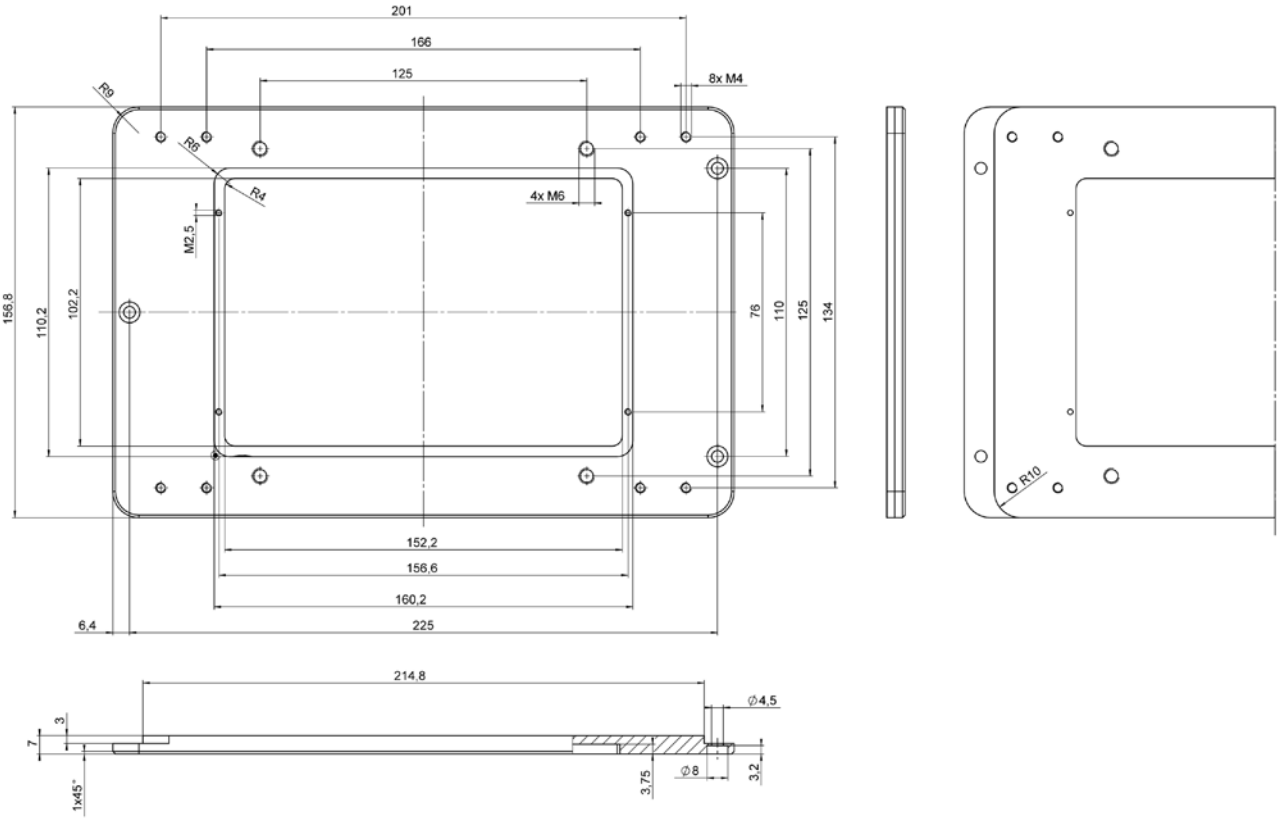


Figure 14: 000029788 adapter plate for M-687.UN

10.4 Pin Assignment

Connector: MDR14, N10214-52B2VC (3M)

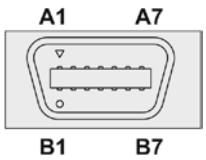


Figure 15: Front view of the MDR14 connector

Pin	Signal	Function
A1	GND	0 V
A2	PSWITCH	Output: Positive-end limit switch, active-high
A3	NSWITCH	Output: Negative-end limit switch, active-high
A4	REFSWITCH +	Output: Reference point switch, TTL, positive
A5	NC	Not connected
A6	VDD	Input: +5 V
A7	USM_P1	Input: Piezo 71 VAC (RMS)
B1	USM_P2	Input: Piezo 71 VAC (RMS)
B2	USM_P3	Input: Piezo 71 VAC (RMS)
B3	ENCA+	Output: Encoder channel A, RS-422
B4	ENCA-	Output: Encoder channel A (inverted), RS-422
B5	ENCB+	Output: Encoder channel B, RS-422
B6	ENCB-	Output: Encoder channel B (inverted), RS-422
B7	REFSWITCH -	Output: Reference point switch, TTL, negative

11 Old Equipment Disposal

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

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

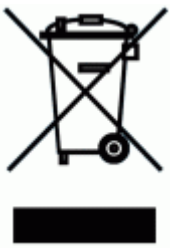
To meet the manufacturer's product responsibility with regard to this product, Physik Instrumente (PI) GmbH & Co. KG ensures environmentally correct disposal of old PI equipment that was first put into circulation after 13 August 2005, free of charge.

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

Physik Instrumente (PI) GmbH & Co. KG

Auf der Römerstr. 1

D-76228 Karlsruhe, Germany



12 EC Declaration of Conformity

PI

Declaration of Conformity

according to DIN EN ISO/IEC 17050-1:2005

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: **XY Microscope Stage for Inverted Microscopes**

Model Numbers: **M-687**

Product Options: **all**

complies with all relevant provisions of the **Machinery Directive (2006/42/EC)**.
Furthermore, it complies with all provisions of the **EMC Directive (2004/108/EC)** as well as the **RoHS Directive (2011/65/EC)**.

The applied standards certifying the conformity are listed below.

Safety of Machinery:	EN 12100:2010
Electrical Safety:	EN 61010-1:2010
Electromagnetic Emission:	EN 61000-6-3:2007, EN 55011:2009
Electromagnetic Immunity:	EN 61000-6-1:2007

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

March 20, 2013
Karlsruhe, Germany

Norbert Ludwig
Managing Director

Physik Instrumente (PI) GmbH & Co. KG, Auf der Roemerstrasse 1, 76228 Karlsruhe, Germany
Phone +49 721 4846-0, Fax +49 721 4846-1019, E-mail info@pi.ws, www.pi.ws

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