

MP145E

Q-521 Miniature Linear Stage

User Manual

Version: 1.1.3

Date: 29.10.2024



This document describes the following products:

- **Q-521**
Q-Motion miniature linear stage, piezoelectric inertia drive

This document applies to various versions of the Q-521 model. The version of the Q-521 model is coded in the order number by the first two characters after the period. Meaning of each position and applicable values:

First position after the period:

Travel range

1 = 12 mm

2 = 22 mm

3 = 32 mm

Second position after the period:

Sensor resolution

3 = with sensor, sensor resolution 4 nm

4 = with sensor, sensor resolution 1 nm



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Original instructions

First printing: 29.10.2024

Document number: MP145E, KSch, version 1.1.3

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 This manual is superseded by any new release.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.

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1 About this Document

In this Chapter

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1.1 Objective and Target Audience of this User Manual

This manual contains information necessary for the intended use of the Q-521.

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
Failure to comply could lead to minor injuries or damage to equipment.

- Precautionary measures for avoiding the risk.



NOTICE





Dangerous situation
Failure to comply could cause damage to equipment.

- Precautionary measures for avoiding.

INFORMATION

Information for easier handling, tricks, tips, etc.

Symbol/ Label	Meaning
1.	Action consisting of several steps with strict sequential order
2.	
➤	Action consisting of one or more steps without relevant sequential order
▪	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 affixed to the product that refers to detailed information in this manual.

1.3 Definition of Terms

Term	Explanation
Load capacity, horizontal	Maximum load capacity when the positioner is mounted horizontally. The contact point of the load is at the center of the motion platform. The load acts vertically. Specified in kg.
Load capacity, any	Maximum load capacity when the positioner is mounted in any orientation of the motion axis. The contact point of the load is at the center of the motion platform. The load acts vertically. Specified in kg.
Self-locking	Holding force of the drive in a power off condition. Specified in N.
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 from PI mentioned in this documentation are described in their own manuals.

Description	Document
E-873.1AT Q-Motion® controller, 1 channel, TCP/IP, USB and RS-232 Interface, benchtop device (industry)	PZ274E User manual
E-873.10C885 Q-Motion® controller module for PIMotionMaster, 1 axis, for systems with piezoelectric inertia drive	E873T0002 Technical note
PIMikroMove	SM148E Software manual

1.6 Downloading Manuals

INFORMATION

If a manual is missing or problems occur with downloading:

- Contact our customer service department (p. 45).

1. Open the website **www.pi.ws**.
2. Search the website for the product number (e.g., Q-521).
3. In the search results, select the product to open the product detail page.
4. Select **Downloads**.

The manuals are shown under **Documentation**. Software manuals are shown under **General Software Documentation**.

5. For the desired manual, select **ADD TO LIST** and then **REQUEST**.
6. Fill out the request form and select **SEND REQUEST**.

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

2 Safety

In this Chapter

Intended Use	5
General Safety Instructions	5
Organizational Measures	6

2.1 Intended Use

The Q-521 is a laboratory device as defined by DIN EN 61010-1. It is intended for indoor use and use in an environment that is free of dirt, oil, and lubricants.

In accordance with its design, the Q-521 is intended for single-axis positioning, adjusting and shifting of loads at different velocities in interval mode. The Q-521 uses a piezoelectric inertia drive. The drive is self-locking at rest, requires no current, generates no heat, and maintains its position.

The Q-521 can be mounted in any orientation. The specifications of the Q-521 apply to horizontal mounting (p. 47).

The Q-521 is **not** intended for applications in areas where failure would be a considerable risk for people or the environment. For further information on the operating conditions of the Q-521, see "Technical Data" (p. 47).

The Q-521 has a linear encoder for detecting the position directly.

It is only possible to use the Q-521 as intended when it is completely mounted and connected. The Q-521 must be operated with suitable electronics (p. 11). The electronics are not in the Q-521's scope of delivery.

2.2 General Safety Instructions

The Q-521 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 Q-521.

- Use the Q-521 for its intended purpose only, and only when it is in perfect technical condition.
- Read the user manual.
- Eliminate any malfunctions that may affect safety immediately.

The operator is responsible for the correct installation and operation of the Q-521.

2.3 Organizational Measures

User manual

- Keep this user manual with the Q-521 always.
The latest versions of the user manuals are available for download (p. 3) on our website.
- Add all information from the manufacturer to the user manual, for example supplements or technical notes.
- If you give the Q-521 to other users, include this user manual as well as other relevant information provided by the manufacturer.
- Use the device only if the user manual is complete. Missing information due to an incomplete user manual can result in minor injury and damage to equipment.
- Install and operate the Q-521 only after you have read and understood this user manual.

Personnel qualification

The Q-521 may only be installed, started, operated, maintained, and cleaned by authorized and appropriately qualified personnel.

3 Product Description

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Suitable Electronics.....	11
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3.1 Model Overview

The Q-521 is available in the following versions:

Order number	Product name
Q-521.130	Q-Motion® miniature linear stage, piezoelectric inertia drive, 12 mm travel range, linear encoder, 4 nm resolution, 0.6 N drive force, dimensions 21 × 30 × 10 mm (W × L × H)
Q-521.140	Q-Motion® miniature linear stage, piezoelectric inertia drive, 12 mm travel range, linear encoder, 1 nm resolution, 0.6 N drive force, dimensions 21 × 30 × 10 mm (W × L × H)
Q-521.230	Q-Motion® miniature linear stage, piezoelectric inertia drive, 22 mm travel range, linear encoder, 4 nm resolution, 0.6 N drive force, dimensions 21 × 32.2 × 10 mm (W × L × H)
Q-521.240	Q-Motion® miniature linear stage, piezoelectric inertia drive, 22 mm travel range, linear encoder, 1 nm resolution, 0.6 N drive force, dimensions 21 × 32.2 × 10 mm (W × L × H)
Q-521.330	Q-Motion® miniature linear stage, piezoelectric inertia drive, 32 mm travel range, linear encoder, 4 nm resolution, 0.6 N drive force, dimensions 21 × 42.2 × 10 mm (W × L × H)
Q-521.340	Q-Motion® miniature linear stage, piezoelectric inertia drive, 32 mm travel range, linear encoder, 1 nm resolution, 0.6 N drive force, dimensions 21 × 42.2 × 10 mm (W × L × H)

3.2 Product View

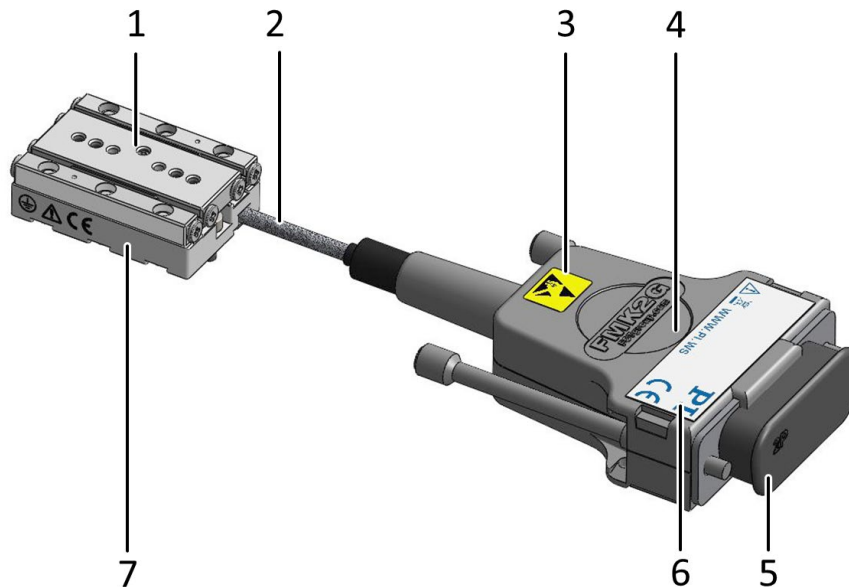


Figure 1: Q-521.240 example

- 1 Motion platform
- 2 Cable exit for connecting the drive and sensor
- 3 Warning sign "Electrostatic sensitive devices"
- 4 Connector for drive and sensor: D-sub 15 (m)
- 5 ESD protection cap
- 6 Type plate p. 9
- 7 Base body

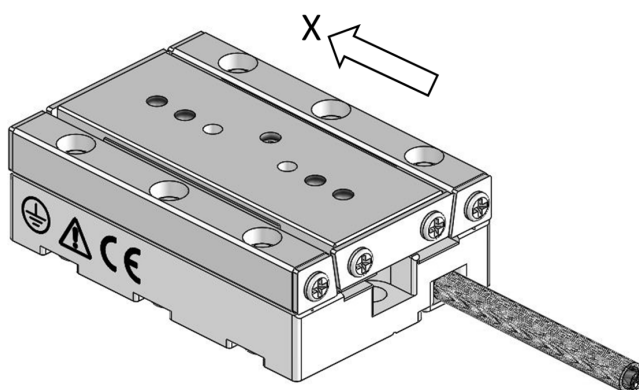


Figure 2: Direction of motion of the Q-521's platform

The arrow in the figure above shows the direction of motion on positive commanding.

3.3 Product Labeling

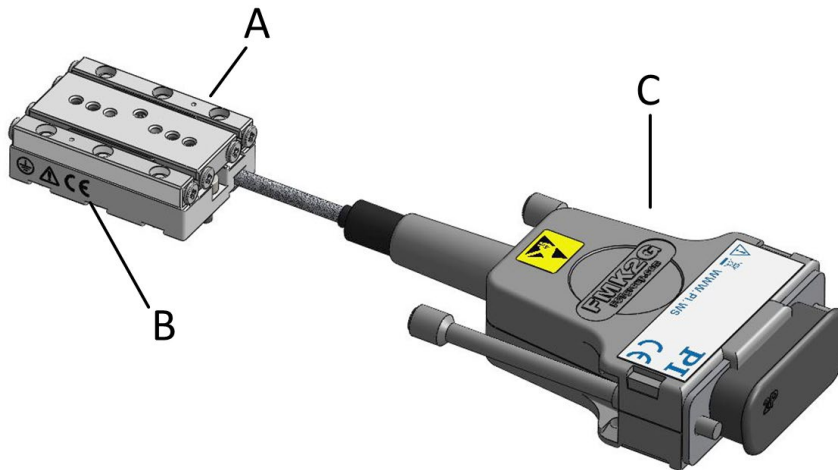






Figure 3: Q-521.240 example: Product labeling and type plate on the positioner

Position	Labeling	Description
A, C	PI	Manufacturer's logo
B		Symbol for the protective earth conductor, marks the protective earth connection of the Q-521 (p. 22)
B, C		Warning sign "Pay attention to the manual!"
B, C	CE	CE conformity mark
C	113064246	Serial number (example), individual for each Q-521 Meaning of each position (from the left): 1 = internal information, 2 and 3 = year of manufacture, 4 to 9 = consecutive number
C	Q-521.240	Product name (example), the characters following the period refer to the model
C		Old equipment disposal
C	WWW.PI.WS	Manufacturer's address (website)
C		Warning sign "Electrostatic-sensitive devices"

3.4 Scope of Delivery

The Q-521 is delivered with the following components:

Item ID	Components
Q-521	Positioner according to order (p. 7)
Q521B0003	Screw set for mounting the Q-521, consisting of: <ul style="list-style-type: none"> ▪ 4 dowel pins, A1 1.5 h8 × 4 ISO 2338 ▪ 2 socket head screws, A2 M2x6 ISO 4762
MP139EK	Short instructions for the Q-5xx / Q-6xx Q-Motion® positioners

3.5 Accessories

Order number	Description
E-873.UHV1	Air-side extension cable from the Q-521 to the electronics, D-sub 15 (f) to D-sub 15 (m), 1 m
E-873.UHV2	Air-side extension cable from the Q-521 to the electronics, D-sub 15 (f) to D-sub 15 (m), 2 m
E-873.UHV3	Air-side extension cable from the Q-521 to the electronics, D-sub 15 (f) to D-sub 15 (m), 3 m
Q-121.80U	Adapter plate for setting up an XY system consisting of two Q-521. Material: Aluminum alloy, uncoated; mass: 4.5 g; including: <ul style="list-style-type: none"> ▪ 2 dowel pins, A1 1.5 h8 × 4 ISO 2338 ▪ 3 machine screws, 1.4567 M2×4
Q-121.10U	Adapter bracket for vertical mounting of a Q-521; for recommended Z combinations, see p. 28. Material: Aluminum alloy, uncoated; mass: 13.5 g / 16.8 g / 26.6 g; each including: <ul style="list-style-type: none"> ▪ 4 dowel pins, A2 1.5 h8 × 5 ISO 2338 ▪ 6 machine screws, 1.4567 M2×8
Q-121.20U	
Q-121.30U	

➤ To order, contact our customer service department (p. 45).

3.6 Suitable Electronics

Order number	Description
E-873.1AT	Q-Motion® controller for piezoelectric inertia drives, 1 axis, benchtop device (industry), SPI, TCP/IP, USB, RS-232, I/O, connector for joystick
E-873.10C885	Q-Motion® controller module for PIMotionMaster, 1 axis, for systems with piezoelectric inertia drive

- To order, contact our customer service department (p. 45).

3.7 Technical Features

3.7.1 Linear Encoder (Sensor)

The Q-521 is equipped with an optical linear encoder. Refer to the table in the "Specifications" section (p. 47) for the encoder resolution.

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.

3.7.2 Reference Switch

The Q-521 also has an optical reference switch.

The commands that use the reference signal are described in the user manual for the controller and/or in the corresponding software manuals.

3.7.3 ID Chip

The Q-521 has an ID chip in the connector.

The following data is stored as parameters on the ID chip:

- Information on the positioner: Type, serial number, date of manufacturer, hardware version
- Settings for the sensor: Interpolation rate, corrections to hysteresis, phase and offset, gain values

When switched on or rebooted, controllers from PI read the data from the ID chip.

For more information on ID chip detection, see the manual for the controller.

4 Unpacking

NOTICE



Electrostatic hazard

Touching the pins on the D-sub 15 connector can damage the Q-521's electrostatic-sensitive (also: ESD) components. For this reason, the Q-521 is supplied with ESD protection.

- Remove the ESD protection from the connection only when you connect the Q-521 to the controller.

1. Unpack the Q-521 with care.
2. If present, do **not** remove the ESD protection from the connection of the Q-521.
3. Compare the contents with the items listed in the contract and the packing list.
4. Inspect the contents for signs of damage. If there is any sign of damage or missing parts, contact PI immediately.
5. Keep all packaging materials and the ESD protection in case the product needs to be returned.

5 Installation

In this Chapter

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5.1 General Notes on Installation

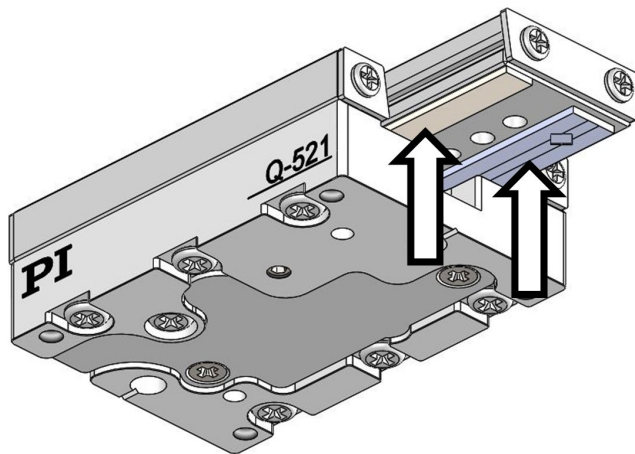


Figure 4: Accessible when the motion platform is driven out: Linear encoder scale and ceramic rail for the drive, Q-521.240 example

NOTICE



Damage from mechanical actions!

The ruler of the linear encoder is scratch-sensitive and can be damaged by mechanical actions, e.g. from pointed objects.

- Treat the ruler with extreme care.

NOTICE**Malfunction due to soiling!**

Any type of soiling, e.g. dust, oil, lubricant or condensation, will render the Q-521 inoperable.

- Keep the Q-521 free from dirt and condensation.
- Avoid touching the ceramic rail and the ruler.

NOTICE**Electrostatic hazard**

Touching the pins on the D-sub 15 connector can damage the Q-521's electrostatic-sensitive (also: ESD) components. For this reason, the Q-521 is supplied with ESD protection.

- Remove the ESD protection from the connection only when you connect the Q-521 to the controller.

NOTICE**Heating up of the Q-521 during operation!**

The heat produced during operation of the Q-521 can affect your application.

- Install the Q-521 so that the application is not impaired by the dissipated heat.
- Ensure sufficient ventilation at the place of installation.
- Make sure that the complete bottom side of the Q-521 is in contact with the surface on which the Q-521 is mounted.

NOTICE**Unwanted changes in position!**

Unwanted changes in position are possible if a force acts on the motion platform (e.g., because of a cable attached to the load or when a heavy load is mounted vertically) that is greater than the self-locking of the drive (p. 47). You will see a definition of self-locking under "Terms" (p. 2).

Unwanted changes in the position of the motion platform can damage the drive, the load or the surroundings.

- Take appropriate measures to ensure that only a force less than the self-locking force acts on the motion platform: For example, cables attached to the load should have sufficient strain relief.

NOTICE**Damage from unsuitable cables!**

Unsuitable cables can damage the electronics.

- Use cables provided by PI only for connecting the Q-521 to the electronics.

INFORMATION

For optimum repeatability, all components must be firmly affixed to each other.

INFORMATION

The positive direction of motion of the axis is specified in the product view (p. 8).

5.1.1 Avoiding Mounting Errors

Mounting the Q-521 onto an underlying surface

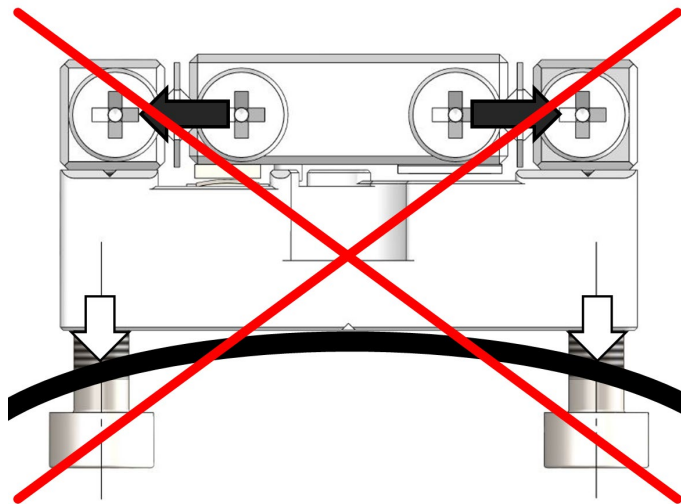


Figure 5: Incorrect mounting on an uneven surface, schematic representation

Line, black:	Uneven underlying surface
Arrows, white:	Effect of force by tightening the screws when fixing to the underlying surface
Arrows, black:	The guide elements are pushed outwards, play occurs between the inner and outer guide elements

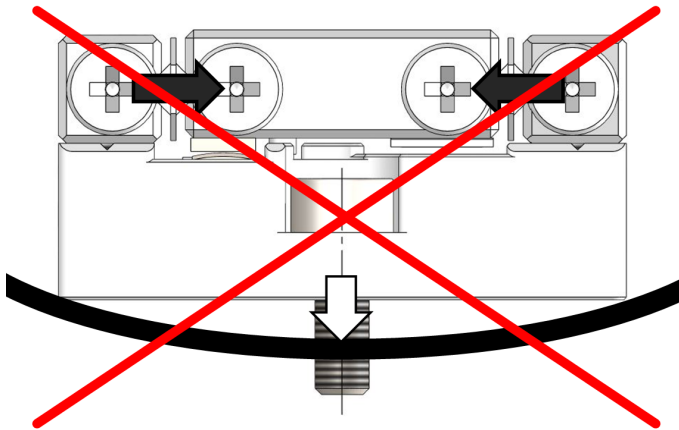


Figure 6: Incorrect mounting on an uneven surface bent downwards, schematic representation

Line, black:	Underlying surface bent downwards
Arrow, white:	Effect of force by tightening the screw when fixing to the underlying surface
Arrows, black:	The guide elements are pushed inwards and increase the preload on the guide

NOTICE



Warping of the Q-521 when mounted on uneven surfaces!

Mounting the Q-521 on an uneven surface could warp the Q-521. Warping reduces the accuracy, the drive force, and the maximum velocity.

- Mount the Q-521 onto a flat surface. The recommended flatness of the surface is $\leq 10 \mu\text{m}$.
- When mounting, do not exceed the maximum torque specified in the instructions.
- For applications with large temperature changes:
Only mount the Q-521 on surfaces that have the same or similar thermal expansion properties as the Q-521.

NOTICE



Protruding screw heads!

Protruding screw heads can damage the Q-521.

- Ensure that the screw heads do not protrude from countersunk holes so that they do not interfere with the motion.

Building a multi-axis system**NOTICE****Unsuitable screws and locating pins!**

Screws and locating pins inserted too deeply and/or excessively thick locating pins will damage the Q-521: Tightening the screws warps the positioner, which leads to play between the inner and outer guide elements.

- Before mounting, make sure that the screws and locating pins have the right length and thickness for the corresponding holes.
- Pay attention to the depth of the mounting holes (p. 51) in the motion platform.
- Pay attention to the maximum depth for inserting locating pins (p. 51) into the motion platform.

NOTICE**Impermissibly high load on the positioners!**

In a multi-axis system, the positioner must also be moved for the Y and/or Z axis. Impermissibly high loads impair the motion and can damage the positioner.

- Include the masses of the positioner and the mounting adapter (p. 10) in the calculation of the load to be moved.
- For all positioners in a multi-axis system: Do **not** exceed the maximum permissible load.

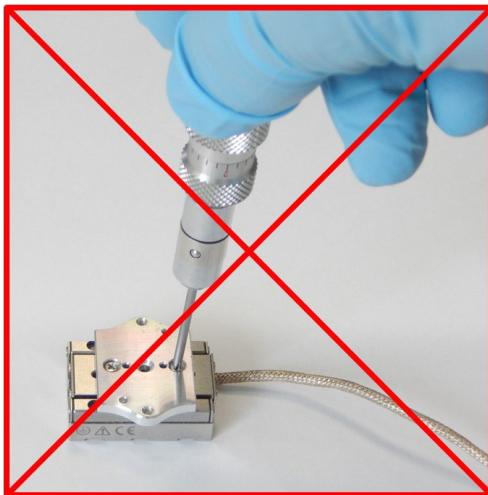
Fixing the load to the Q-521

Figure 7: Incorrect mounting:
Applying torque to the motion platform
damages the positioner



Figure 8: Correct mounting:
Holding the base body and the motion
platform firmly avoids torque on the
motion platform

NOTICE**Impermissible torques and forces!**

Torque and forces on the motion platform could damage the positioner.

- Hold the motion platform firmly to prevent it from moving when tightening the screws.
- Pay attention to the maximum torques specified in the instructions.
- For fixing type and mass of the load, pay attention to the maximum permissible forces according to the specifications (p. 47).
- Avoid tilting torques on the motion platform.

NOTICE**Unsuitable screws and locating pins!**

Screws and locating pins inserted too deeply and/or excessively thick locating pins will damage the Q-521: Tightening the screws warps the positioner, which leads to play between the inner and outer guide elements.

- Before mounting, make sure that the screws and locating pins have the right length and thickness for the corresponding holes.
- Pay attention to the depth of the mounting holes (p. 51) in the motion platform.
- Pay attention to the maximum depth for inserting locating pins (p. 51) into the motion platform.

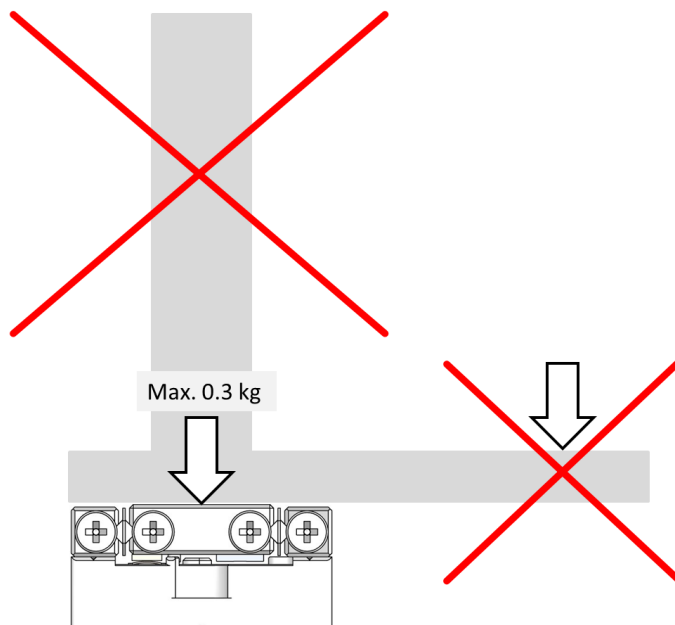


Figure 9: Ideally, the load center is in the middle of the motion platform

NOTICE**Damage due to unfavorable load center!**

A load's center of gravity not at the center of the motion platform subjects the positioner to torque. The torque reduces the accuracy and could damage the positioner.

- Make sure that the gap between the load's center of gravity and the motion platform's center is as small as possible in all directions.
- Pay attention to the maximum permissible load capacity and holding force according to the specifications (p. 47) with respect to the mass and the method of fixing the load.
- Avoid rotary and tilting torques on the motion platform.

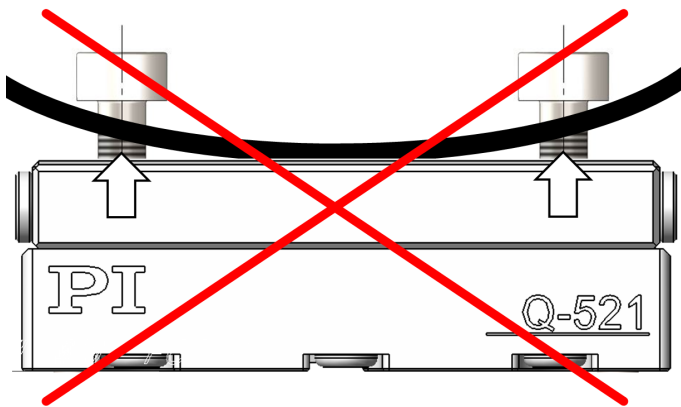


Figure 10: Incorrect mounting of a load; schematic representation

A load with an uneven contact surface (line, black) causes warping of the positioner's motion platform (effect of force shown by the white arrows).

NOTICE**Damage due to mounting a load with uneven contact surface!**

Mounting a load with an uneven contact surface could warp the Q-521. Warping reduces the accuracy, the drive force, and the maximum velocity.

- Fix a load onto the Q-521 only if its contact surface is flat. The recommended flatness for the contact surface is $\leq 10 \mu\text{m}$.
- For applications with large temperature changes:
Fix a load onto the Q-521 only if it has the same or similar thermal expansion properties as the Q-521.

INFORMATION

- To avoid unwanted changes in the position of the motion platform, ensure sufficient strain relief when cables are attached to the load.

5.2 Mounting the Q-521 onto an Underlying Surface and Connecting it to a Protective Earth Conductor

INFORMATION

The electrical contact of the Q-521 to the protective earth conductor is established via the surface, on which the Q-521 is mounted.

- The corresponding contact surfaces must be sufficiently conductive.
- The protective earth conductor is connected to the surface on which the Q-521 is mounted.
- The screws are secured against unintentional loosening; e.g., with thread-locking adhesive.

INFORMATION

- Pay attention to the applicable standards for connecting the protective earth conductor.

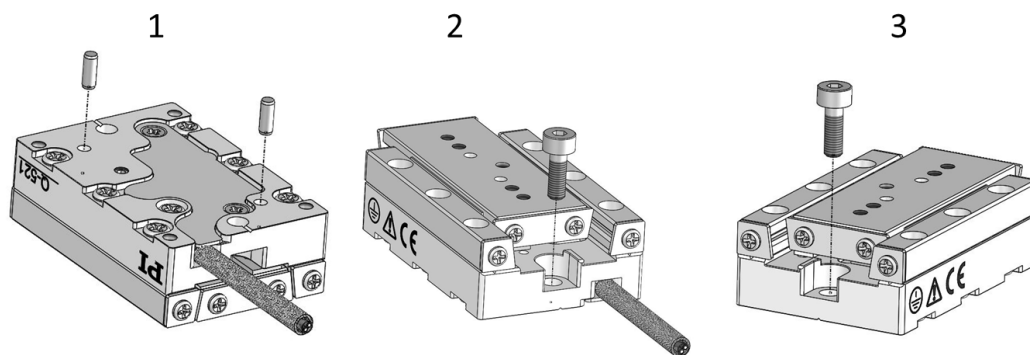


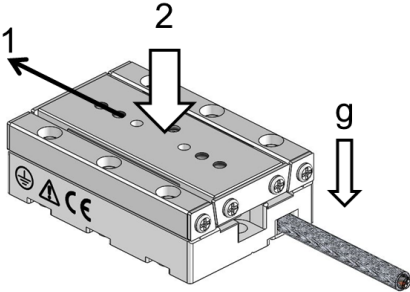
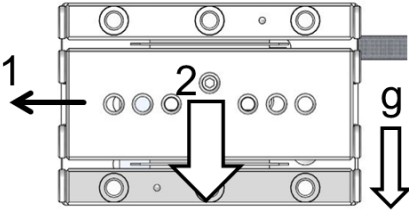
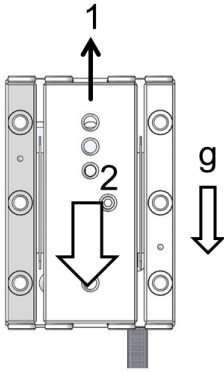
Figure 11: Mounting from above, using a Q-521.2xx as an example

- 1 Optional: Align the positioner (view from below) on the underlying surface with two 1.5 h8 × 4 locating pins.
- 2, 3 Fix the positioner on the underlying surface with two M2x6 screws.

You have the following options for fixing the Q-521:

- From above with 2 M2x6 screws
- From below with 4 M2 screws of suitable length

Possible orientations of the Q-521

Orientation of the motion axis	Influencing factors
Horizontal mounting with horizontal orientation of the motion axis	<div></div> <p>g = gravity 1 = positive direction of the motion axis 2 = load capacity, horizontal (p. 2), max. 0.3 kg</p>
Vertical mounting with horizontal orientation of the motion axis	<div></div> <p>g = gravity 1 = positive direction of the motion axis 2 = load capacity, any (p. 2), max. 0.06 kg</p>
Any orientation of the motion axis; here: Vertical mounting with vertical orientation of the motion axis	<div></div> <p>g = gravity 1 = positive direction of the motion axis 2 = load capacity, any (p. 2), max. 0.06 kg</p>

Requirements

- ✓ You have read and understood the general notes on installation (p. 15).
- ✓ The Q-521 is disconnected from the electronics.
- ✓ You have provided a suitable underlying surface (for the required position and depth of the holes for accommodating the screws and locating pins, see "Dimensions" (p. 51)):
 - The surface must be connected to the protective earth conductor.
 - The contact surfaces to the bottom of the positioner have to be sufficiently conductive to ensure that the protective earth conductor functions properly.
 - The contact resistance at all connection points relevant for attaching the protective earth conductor is $<0.1 \Omega$ at 25 A.
 - For applications with large temperature changes: The surface should have the same thermal expansion properties as the Q-521 (e.g., underlying surface made of steel).
 - The surface flatness is $\leq 10 \mu\text{m}$.
- ✓ You have accounted for the space required to route cables according to regulations and without bending them.

Tools and accessories

- Screws:
 - For mounting from above: 2 M2x6 socket head screws in the scope of delivery (p. 10)
 - For mounting from below: 4 M2 screws of suitable length
- Option: 2 1.5 h8 × 4 locating pins, in the scope of delivery
- Suitable tools for tightening the screws
- Thread-locking adhesive

Mounting the Q-521 onto an underlying surface and connecting it to a protective earth conductor

1. Option: Align the Q-521 on underlying surface with the locating pins.
2. Mount the Q-521 on the surface.
Maximum torque: 35 Ncm
For mounting from above:
 - If necessary, manually move the motion platform of the Q-521 to access the countersunk holes in the base body.For mounting from below:
 - Maximum screw-in depth in the Q-521: 4 mm
3. Secure the screws against unintentional loosening, e.g., with thread-locking adhesive.
4. Check that the Q-521 is fixed firmly.

5.3 Building a Multi-Axis System

The Q-521 can be used in multi-axis systems.

Typical combinations:

- XY system (p. 26)
- Z system (p. 28) (XZ or XYZ combination)

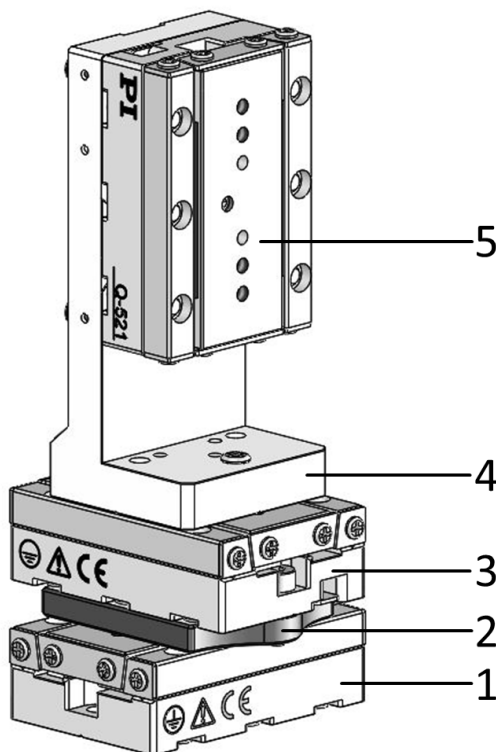


Figure 12: Example of an XYZ system: Three Q-521.240 mounted using an adapter plate and an adapter bracket

- 1 Lower positioner
- 2 Q-121.80U adapter plate
- 3 Middle positioner
- 4 Q-121.x0U adapter bracket
- 5 Upper positioner

5.3.1 General Information on Building a Multi-Axis System

- Install and operate the multi-axis system only after you have read and understood the user manuals for all components of the multi-axis system.
- If you need special mounting adapters, contact our customer service department (p. 45).

5.3.2 Building an XY System

INFORMATION

Any model of the Q-521 can be used as lower or upper positioner.

Designations in these instructions:

- **Lower positioner:** Forms the basis of the multi-axis system (X axis); is mounted onto an underlying surface
- **Upper positioner:** Forms the Y axis of the multi-axis system; is mounted on the lower positioner rotated by 90°

Requirements

- ✓ You have read and understood the general notes on installation (p. 15).
- ✓ You have read and understood the general notes on setting up a multi-axis system (p. 25).
- ✓ The positioners are disconnected from the electronics.
- ✓ You have fixed the lower positioner onto an underlying surface properly and connected (p. 22) it to a protective earth conductor.
- ✓ You have accounted for the space required to route cables according to regulations and without bending them.

Tools and accessories

- Mounting kit from the scope of delivery of the upper positioner (p. 10):
 - 2 locating pins, 1.5 h8 × 4
 - 2 socket head screws, M2x6
- Q-121.80U adapter plate, available as an optional accessory (p. 10), including mounting kit:
 - 2 locating pins, 1.5 h8 × 4
 - 2 machine screws, M2x4
- Suitable tool for tightening the screws

Building an XY system

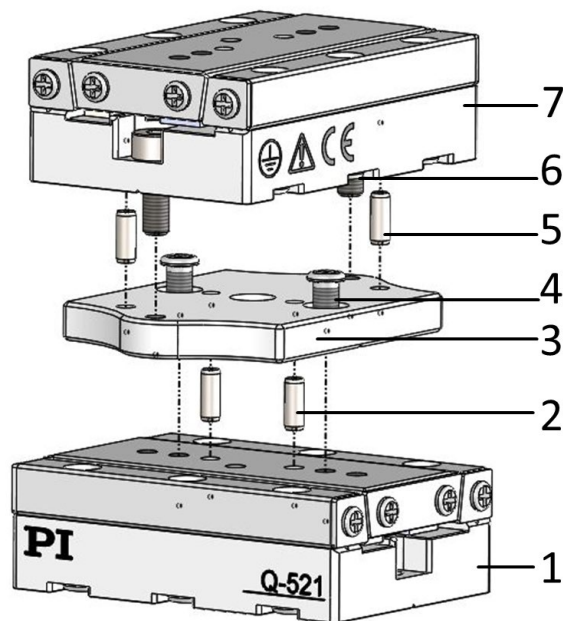


Figure 13: Example: Mounting a Q-521.240 on a Q-521.240

- 1 Lower positioner
- 2 2 locating pins, 1.5 h8 × 4
- 3 Q-121.80U adapter plate
- 4 2 machine screws, M2x4
- 5 2 locating pins, 1.5 h8 × 4
- 6 2 socket head screws, M2x6
- 7 Upper positioner

1. Fix the adapter plate to the lower positioner with locating pins and M2x4 machine screws:
 - The counterbores of the three holes in the middle of the adapter plate point upwards.
 - Maximum torque: 35 Ncm
 - Check that adapter plate is fixed firmly.
2. Mount the upper positioner on the adapter plate with locating pins and M2x6 socket head screws:
 - If necessary, move the motion platform of the upper positioner by hand to access the countersunk holes in the base body.
 - Maximum torque: 35 Ncm
 - Check that the upper positioner is fixed firmly.

5.3.3 Building a Z System with an Adapter Bracket

NOTICE



Unsuitable screws and locating pins!

Screws and locating pins inserted too deeply and/or excessively thick locating pins will damage the Q-521: Tightening the screws warps the positioner, which leads to play between the inner and outer guide elements.

- Before mounting, make sure that the screws and locating pins have the right length and thickness for the corresponding holes.
- Pay attention to the depth of the mounting holes (p. 51) in the motion platform.
- Pay attention to the maximum depth for inserting locating pins (p. 51) into the motion platform.

NOTICE



Warping of the Z system with large temperature changes!

Large temperature changes can warp the Z system because the Q-521 and the adapter bracket for vertical mounting (p. 10) have different thermal expansion properties. Warping reduces the accuracy.

- Avoid large temperature changes for the Z system.
- If it is not possible to avoid large temperature changes: Do not use the locating pins for mounting.

Designations in these instructions:

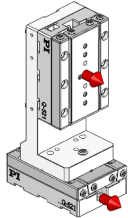
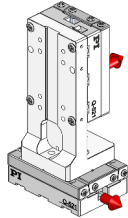
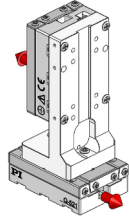
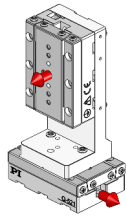
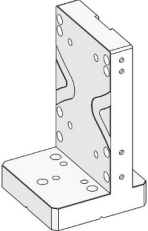
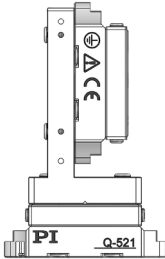
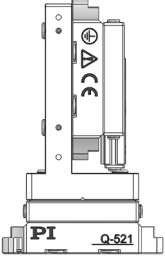
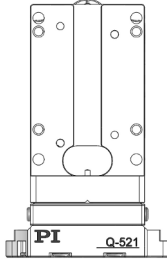
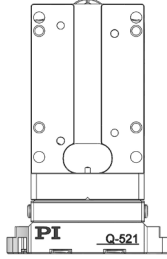
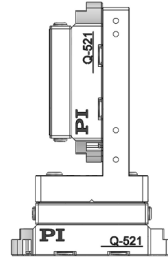
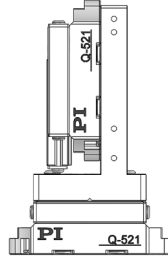
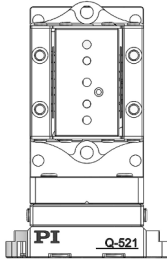
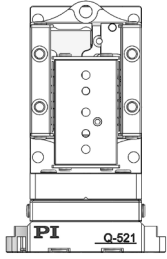
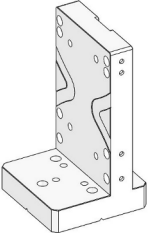
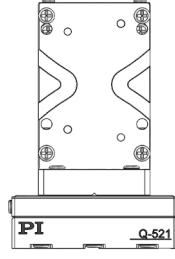
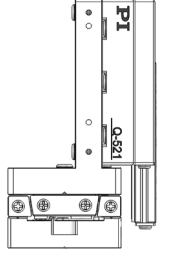
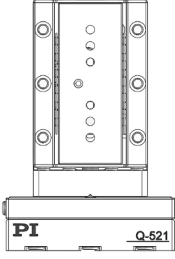
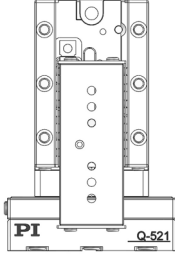
- **Lower positioner:** X axis in an XZ combination; Y axis in an XYZ combination. The positioner to which the upper positioner is mounted with an adapter bracket.
- **Upper positioner:** Forms the Z axis of the multi-axis system; is mounted on the lower positioner in a vertical alignment using an adapter bracket.

Recommended Z systems

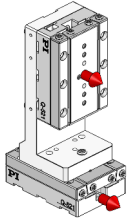
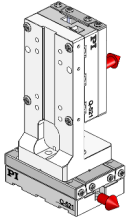
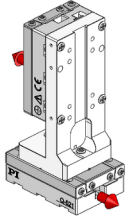
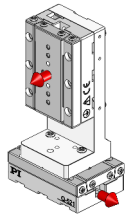
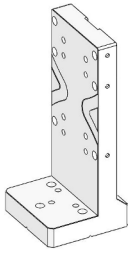
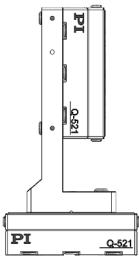
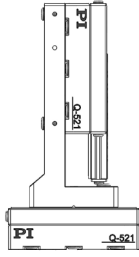
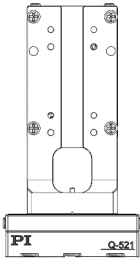
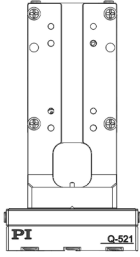
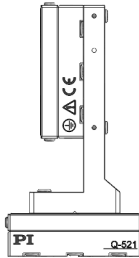
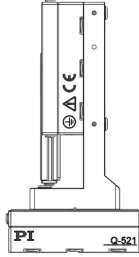
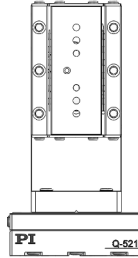
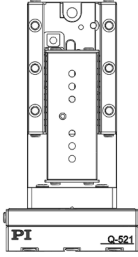
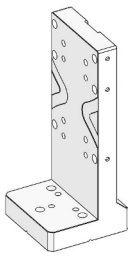
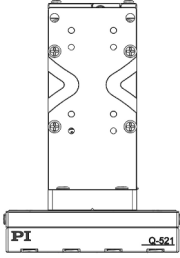
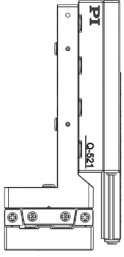
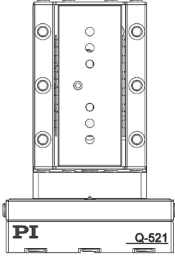
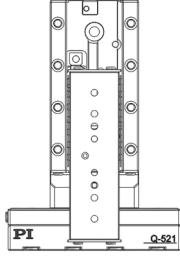
The following tables show recommended combinations of adapter brackets and positioners.

Each upper positioner is shown with the motion platform in the center position and with a platform extended to its maximum.

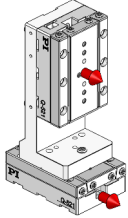
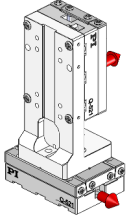
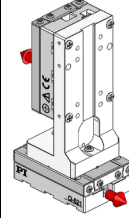
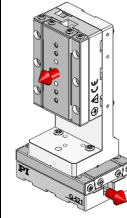

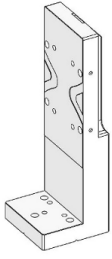
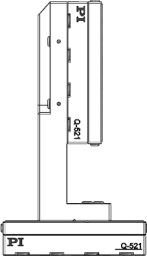
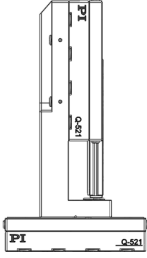
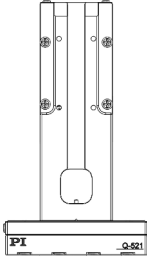
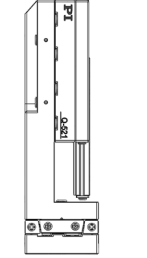
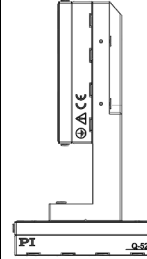
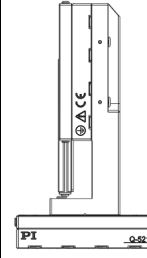
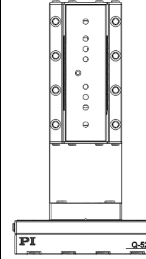
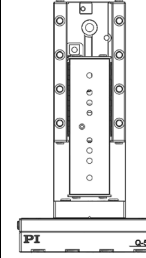
Systems with Q-121.10U adapter bracket

	Orientation of adapter bracket and upper positioner to the lower positioner:			
Combination of positioner and adapter bracket:	0° 	90° 	180° 	270° 
Q-521.1x0 +  Q-121.10U	 	 	 	 
Q-521.2x0 +  Q-121.10U	Not possible. The positioner's motion platforms collide with each other.	 	Not possible. The positioner's motion platforms collide with each other.	 

Systems with Q-121.20U adapter bracket

	Orientation of adapter bracket and upper positioner to the lower positioner:			
Combination of positioners and adapter brackets:	0° 	90° 	180° 	270° 
Q-521.2x0 +  Q-121.20U	 	 	 	 
Q-521.3x0 +  Q-121.20U	Not possible. The positioner's motion platforms collide with each other.		Not possible. The positioner's motion platforms collide with each other.	
		 		 

Systems with Q-121.30U adapter bracket

	Orientation of adapter bracket and upper positioner to the lower positioner:			
Combination of positioners and adapter brackets:	0°	90°	180°	270°
				
Q-521.3x0 +  Q-121.30U	 	 	 	 

Requirements

- ✓ You have read and understood the general notes on installation (p. 15).
- ✓ You have read and understood the general notes on setting up a multi-axis system (p. 25).
- ✓ You have accounted for the space required to route cables according to regulations and without bending them.
- ✓ If you are building an XZ combination: You have mounted the lower positioner onto an underlying surface properly.
- ✓ If you are building an XYZ combination: You have attached the positioners for the X and Y axis (p. 26) properly.

Tools and accessories

- Suitable adapter bracket; for combination options, see "Recommended Z Systems" p. 28. Available as optional accessories (p. 10):
 - Q-121.10U adapter bracket
 - Q-121.20U adapter bracket

- Q-121.30U adapter bracket

For the diameter and position of the holes in the adapter bracket, see "Dimensions" (p. 51)

- Mounting kit from the scope of delivery of the adapter bracket:
 - 4 locating pins, 1.5 h8 × 5
 - 6 machine screws M2x8
- Suitable tools for tightening the screws

Building a Z system with an adapter bracket

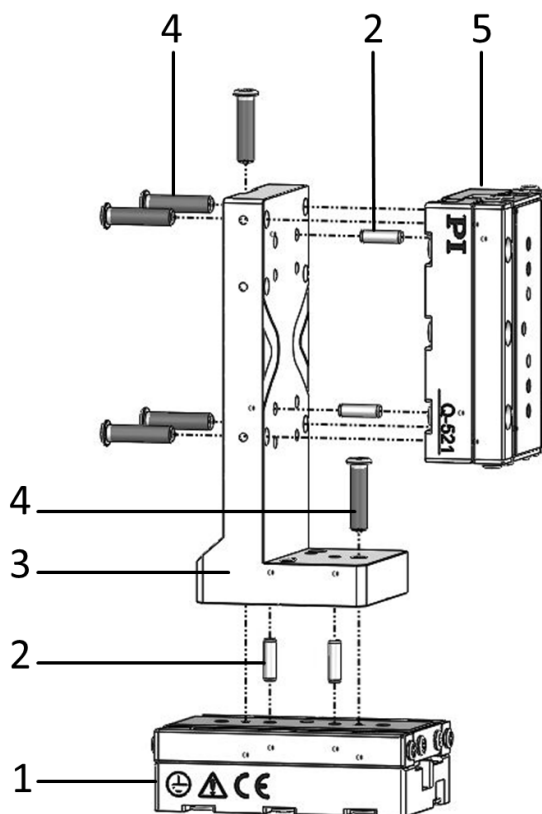


Figure 14: Example: Building an XZ system consisting of two Q-521.240 and a Q-121.20U adapter bracket

- 1 Lower positioner
- 2 4 locating pins, 1.5 h8 × 5
- 3 Q-121.20U adapter bracket
- 4 6 machine screws M2x8
- 5 Upper positioner

1. Fix the upper positioner to the long side of the adapter bracket:
 - Align the upper positioner so that the cable exit points away from the origin of the sides of the adapter bracket; i.e., upwards in the Z system.

- Maximum torque: 35 Ncm.
- 2. Fix the short side of the adapter bracket to the motion platform of the lower positioner:
 - Permissible alignments, see "Recommended Z Systems"
 - Maximum torque: 35 Ncm
- 3. Check that the adapter bracket and the upper positioner are fixed firmly.

5.4 Fixing the Load to the Q-521

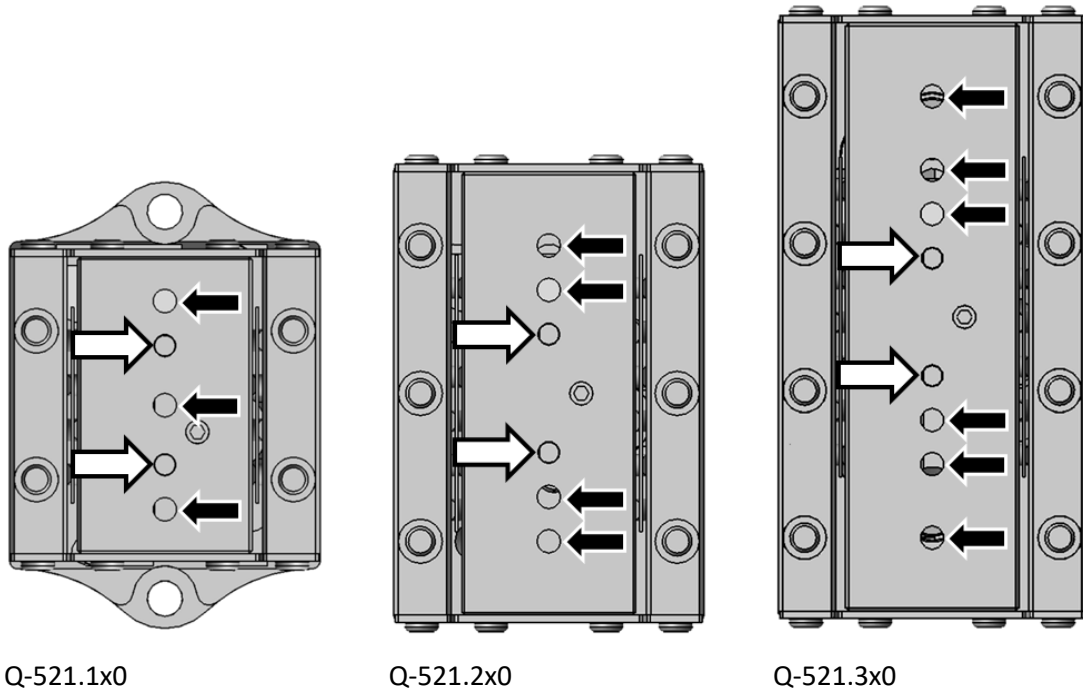
Requirements

- ✓ You have read and understood the general notes on installation (p. 15).
- ✓ You have mounted the positioner onto an underlying surface (p. 22) properly or on a Q-521 (p. 25).
- ✓ The positioner is disconnected from the electronics.
- ✓ You have prepared the load so that it can be fixed to the motion platform:
 - The gap between the center of gravity of the load and the center of the motion platform is as small as possible in all directions.
 - At least three points are provided for fixing the load on the motion platform.

Tools and accessories

- At least three M2 screws of suitable length (p. 51)
- Suitable tool for tightening the screws
- Option: 2 1.5 h8 × 4 locating pins, in the scope of delivery

Fixing the load to the Q-521



The arrows mark the mounting holes in the motion platform of the Q-521:

For aligning the load:

White arrows: Locating holes \varnothing 1.5 mm H7, depth 3 mm

For fixing the load:

Black arrows: M2 threaded holes, depth 3 mm

1. Option: Align the load on the Q-521 with the locating pins.
2. Fix the load using the screws.
 - Maximum torque: 35 Ncm
3. Check that load is fixed firmly.

5.5 Connecting the Q-521 to the Electronics

INFORMATION

The Q-521 and the electronics can be delivered as a preconfigured system.

- If a connection assignment is given on the labels of the Q-521 and/or electronics, pay attention to this assignment when connecting the Q-521.

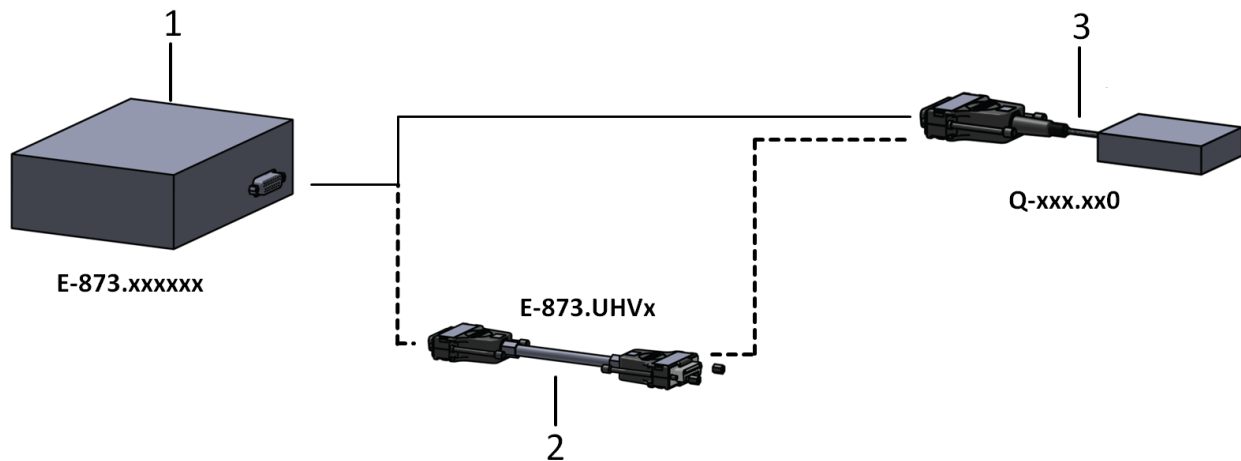


Figure 15: Connecting the Q-521 to suitable electronics

- 1 Controller
- 2 Extension cable
- 3 Mechanics

Requirements

- ✓ You have read and understood the general notes on installation (p. 15).
- ✓ You have installed the electronics.
- ✓ You have read and understood the user manual for the electronics.
- ✓ The electronics are **not** connected to the supply voltage.

Connecting the Q-521 to the electronics

1. Remove the ESD protection from the Q-521's connector.
2. Connect the electronics to the Q-521.
3. Take suitable measures to prevent the extension cable from being disconnected accidentally.

6 Startup and Operation

In this Chapter

General Notes on Startup and Operation	37
Starting and Operating the Q-521.....	39

6.1 General Notes on Startup 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 Q-521 in the case of malfunction or failure of the system. If there are touch voltages, touching the Q-521 can result in minor injuries from electric shock.

- Connect the Q-521 to a protective earth conductor (p. 22) before startup.
- 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 Q-521 to the protective earth conductor before restarting.

CAUTION



Burning from hot surface!

The surface of the Q-521 and its vicinity can heat up during operation. Touching the Q-521 and surrounding parts can result in minor injuries from burning.

- Cool the Q-521 so that the temperature of its surface and surrounding parts does **not** exceed 65 °C.
- If sufficient cooling is not possible: Make sure that the hot Q-521 and its surrounding parts **cannot** be touched.
- If sufficient cooling and protection against contact are not possible: Mark the danger zone in accordance with the legal regulations.

NOTICE



Overheating during continuous operation!

The highest velocity is achieved at maximum operating frequency; however, the Q-521 can overheat during continuous operation as a result.

- Pay attention to the recommended operating time according to the operating frequency in step mode (p. 50).
- Ensure sufficient ventilation at the place of installation.

NOTICE**Operating voltage too high or incorrectly connected!**

Operating voltages that are too high or incorrectly connected can cause damage to the Q-521.

- Operate the Q-521 only with controllers/drivers and original accessories from PI.
- Do **not** exceed the operating voltage range (p. 49) for which the Q-521 is specified.
- Operate the Q-521 only when the operating voltage is properly connected; see "Pin Assignment" (p. 58).

NOTICE**Operating frequency too high!**

An excessively high operating frequency can cause damage to the Q-521.

- Operate the Q-521 only with controllers/drivers and original accessories from PI.
- Do **not** exceed the operating frequency range (p. 49) specified for the Q-521.

NOTICE**Reduced lifetime of the piezo actuator due to permanently high voltage!**

Applying a high static voltage to piezo actuators continuously reduces the lifetime of the piezo ceramic.

- If the Q-521 is not used for a longer period of time, e.g., several days, switch the electronics off.

NOTICE**Destruction of the piezo actuators due to electric flashovers!**

Using the Q-521 in environments that increase the electrical conductivity can lead to the destruction of the piezo actuators of the drive by electric flashovers. Electric flashovers can be caused by moisture, high humidity, liquids and conductive materials (e.g. metal dust). In addition, electric flashovers can also occur in certain air pressure ranges due to the increased conductivity of the air.

- Avoid operating the Q-521 in environments that can increase the electrical conductivity.
- Operate the Q-521 only under permissible ambient conditions and classifications (p. 49).

NOTICE**Damage due to collisions!**

Collisions can damage the positioner, the load to be moved, and the surroundings.

- Make sure that no collisions are possible between the positioner, the load to be moved, and the surroundings in the motion range of the positioner.
- Do not place any objects in areas where they can be caught by moving parts.
- Stop the motion immediately if an electronics malfunction occurs.

NOTICE**Considerable wear due to high operating frequency!**

A high operating frequency in step mode can cause considerable wear on the mechanics.

- Reduce the operating frequency of the electronics in step mode (step frequency) respectively the velocity, see the user manual for the electronics.
- Reduce the operating time with a high operating frequency (p. 50).
- Stop the motion immediately if an electronics malfunction occurs.

NOTICE**Increased wear due to small working range!**

Using a small working range permanently increases the wear in this area.

- If possible: Select another part of the travel range for the working range in regular intervals.

INFORMATION

The Q-521's parameters can be adapted. Changing parameter values can cause undesirable results.

- Create a backup copy on the PC before changing the parameter settings; see "Saving Parameter Values in a Text File" in the user manual for the electronics. You can then restore the original settings at any time.
- You can find information on adapting the parameter values under "Adapting Settings" in the user manual for the electronics.

6.2 Starting and Operating the Q-521

INFORMATION

If the parameters of the electronics are not adapted to the Q-521 and the application (load, orientation of the Q-521), the Q-521 will either not move or not move satisfactorily.

- Only operate the Q-521 when the parameters of the electronics have been correctly set.
- Pay particular attention to the velocity in closed-loop operation.

INFORMATION

The inertia drive generates noise in step mode. The noise generation depends on the current step frequency.

INFORMATION

If you use the software from the scope of delivery of the electronics, the operating parameters can be loaded from *PISTAGES3.DB*. The records in the positioner database are updated regularly.

- Install the PI Update Finder from the product CD for the electronics onto your PC and update *PISTAGES3.DB* on your PC.

Further information can be found in the user manual for the electronics.

Requirements

- ✓ You have read and understood the general notes on startup and operation (p. 37).
- ✓ You have installed (p. 15) the positioner correctly.
- ✓ You have read and understood the user manual for the electronics.
- ✓ You have read and understood the manual for the PC software.
- ✓ The electronics and the required PC software have been installed. All connections to the electronics have been made (see user manual for the electronics).

Starting and operating the Q-521

1. Start and operate the positioner (see user manual for the electronics).
Startup includes the following steps:
 - Selecting the positioner type
 - Defining the reference point of the axis
 - Commanding of first motion for testing
2. If necessary: Adapt the parameters for the operating frequency in step mode or the velocity (see the user manual for the electronics) to your application (see also "General Notes on Startup and Operation" (p. 37) and "Operating Time" (p. 50)).

PIMikroMove is used in the user manual for the electronics to describe startup and operation.

7 Maintenance

In this Chapter

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7.1 General Notes on Maintenance

NOTICE

**Damage due to improper maintenance!**

Improper maintenance can lead to misalignment and failure of the Q-521.

- Only loosen screws according to the instructions in this manual.

7.2 Performing a Maintenance Run

The maintenance run must cover the entire travel range.

- Perform the maintenance run after every 10 million steps.

7.3 Cleaning the Q-521

Requirements

- ✓ You have disconnected the positioner from the electronics.

Cleaning the positioner

- When necessary, clean the surfaces of the positioner with a cloth that is lightly dampened with a mild cleanser or disinfectant.

8 Troubleshooting

Problem	Possible causes	Solution
Function impairment after system modification	<ul style="list-style-type: none"> ▪ The electronics were replaced ▪ The positioner was replaced 	<ul style="list-style-type: none"> ➤ Load the parameter set from the positioner database that corresponds to the Q-521 model. ➤ If necessary: Set the parameters for the electronics in PIMikroMove so that they correspond to the application (load, orientation) of the Q-521 model (see the user manual for the electronics).
No or limited motion	The cable is not connected correctly or is defective	➤ Check the connecting cable(s)
	Excessive load	➤ Reduce the load. Pay attention to the information in the "Technical Data" section (p. 47).
	Parameters of the electronics incorrectly set	➤ See the "Function impairment after system modification" problem in this table.
	Operating voltage too low	➤ Provide an operating voltage of 48 V.
	Unfavorable operating frequency for step mode	➤ Adapt the operating frequency for step mode (for details, see "Starting and Operating the positioner" (p. 39) and manual for the electronics).
	Warped base body	<ul style="list-style-type: none"> ➤ Pay attention to the maximum torque when fixing the positioner. ➤ Avoid tilting torques when fixing the positioner and load: Hold the base body of the positioner. ➤ Mount the Q-521 on a flat surface. The recommended flatness of the surface is 10 µm. ➤ As specified in the instructions (p. 22), use locating pins with a suitable length and thickness only when fixing the positioner
	Unfavorable load mounting	<ul style="list-style-type: none"> ➤ Pay attention to the maximum torque when mounting the load (p. 33). ➤ Keep the gap between the center of gravity of the load and the center of the motion platform as small as possible in all directions. ➤ As specified in the instructions (p. 33), use locating pins with a suitable length and thickness only when aligning the load
	Unsuitable ambient conditions	➤ Operate the Q-521 in a clean environment only and only under permissible ambient conditions (p. 49).

Problem	Possible causes	Solution
	Drive wear	➤ Replace the Q-521 and make sure that the operating parameters of the electronics are adapted to the positioner.
	Drive is blocked	➤ Release the blockage by carefully moving the motion platform back and forth by hand. ➤ Contact our customer service department (p. 45).
Limitation in accuracy, drive force, and maximum velocity	Play between the inner and outer guide elements due to warped base body or motion platform	➤ For possible causes, see "Warped base body" and "Unfavorable load mounting" in this table.
Unwanted motion	<ul style="list-style-type: none"> ▪ The cables attached to the load can exert pull forces on the positioner. ▪ The self-locking force could be exceeded. 	<ul style="list-style-type: none"> ➤ Make sure that the cables attached to the load have sufficient strain relief ➤ Make sure that you do not exceed the maximum permissible load. The value of the maximum permissible load depends on the orientation of the motion axes (p. 47).

If the problem with your system is not listed in the table above or cannot be solved as described, contact our customer service department (p. 45).

9 Customer Service

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

- If you have any questions concerning your system, provide the following information:
 - Product and serial numbers of all products in the system
 - Firmware version of the controller (if applicable)
 - Version of the driver or the software (if applicable)
 - Operating system on the PC (if applicable)
- If possible: Take photographs or make videos of your system that can be sent to our customer service department if requested.

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

10 Technical Data

Subject to change. You can find the latest product specifications on the product web page at www.pi.ws (<https://www.pi.ws>).

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10.1 Specifications

10.1.1 Data Table

Motion and positioning	Q-521.130 / Q-521.140	Q-521.230 / Q-521.240	Q-521.330 / Q-521.340	Unit
Active axis	X	X	X	
Travel range	12	22	32	mm
Maximum velocity, closed loop*	6	6	6	mm/s
Minimum incremental motion	Q-521.130: 50 Q-521.140: 30	Q-521.230: 50 Q-521.240: 30	Q-521.330: 50 Q-521.340: 30	nm
Linearity	3.5	3.5	3.5	μm
Integrated sensor	Linear encoder	Linear encoder	Linear encoder	
Sensor resolution	Q-521.130: 4 Q-521.140: 1	Q-521.230: 4 Q-521.240: 1	Q-521.330: 4 Q-521.340: 1	nm
Reference switch	Optical	Optical	Optical	

Drive properties	Q-521	Unit
Drive type	Q-Motion® piezo motor	
Drive force	0.6	N

Mechanical properties	Q-521	Unit
Self-locking	1.3	N
Max. load capacity, any	0.06	kg
Max. load capacity, horizontal	0.3	kg
Guide	Crossed roller guide	

Miscellaneous	Q-521.1xx	Q-521.2xx	Q-521.3xx	Unit
Operating temperature	0 to 40	0 to 40	0 to 40	°C
Cable length	1	1	1	m
Motor / sensor connector	D-Sub 15 (m)	D-Sub 15 (m)	D-Sub 15 (m)	
Mass without cable and connector	24	34	48	g
Mass incl. cable and connector	110	126	135	g
Material	Stainless steel	Stainless steel	Stainless steel	
Dimensions	30 mm × 21 mm × 10 mm	31.6 mm × 21 mm × 10 mm	42.2 mm × 21 mm × 10 mm	
Recommended electronics	E-873.1AT, E-873.10C885			

* Typical velocity at a control frequency of 20 kHz




Specifications tested with E-873.1AT

The specifications were determined on an underlying surface with a flatness of 2 µm.

At PI, technical data is specified at 22 ±3 °C. Unless otherwise stated, the values are for unloaded conditions. Some properties are interdependent. During the final inspection of a product, only selected properties are analyzed, not all. Please note that some product characteristics may deteriorate with increasing operating time.

10.1.2 Maximum Ratings

The Q-521 positioner is designed for the following operating data:

Maximum operating voltage 	Maximum operating frequency 	Maximum power consumption 
48 V	20 kHz	10 W

10.1.3 Ambient Conditions and Classifications

Pay attention to the following ambient conditions and classifications for the Q-521:

Area of application	For indoor use only
Maximum altitude	2000 m
Air pressure	1100 hPa to 0.1 hPa
Relative humidity	Highest relative humidity 80 % for temperatures up to 31 °C Decreasing linearly to 50 % relative humidity at 40 °C
Operating temperature	0 °C to 40 °C
Storage temperature	-20 °C to 70 °C
Transport temperature	-20 °C to 70 °C
Overvoltage category (according to EN 60664-1 / VDE 0110-1)	II
Protection class (according to EN 61140 / VDE 0140 1)	I
Degree of pollution (according to EN 60664 1 / VDE 0110 1)	1
Degree of protection(acc. to IEC 60529)	IP20

10.2 Operating Time

The velocity and duration of motion affect the lifetime of the positioner. In order to prevent overheating and increased wear, the duration of motion at the specified velocity may not exceed the values specified in the following table.

Velocity in mm/s	Maximum duration of motion in s ^{1, 2}	Idle time in s
6	10	10
5	20	10
3	Any	0

¹ With the following restraints: Without load, at 20 °C, 48 V, and ± 0.2 A

² It is essential to install effective thermal transfer in order to reach the specified duration of motion.

10.3 Velocity and Force

The following figure illustrates which combinations of velocity and drive force can be generated by the Q-521.

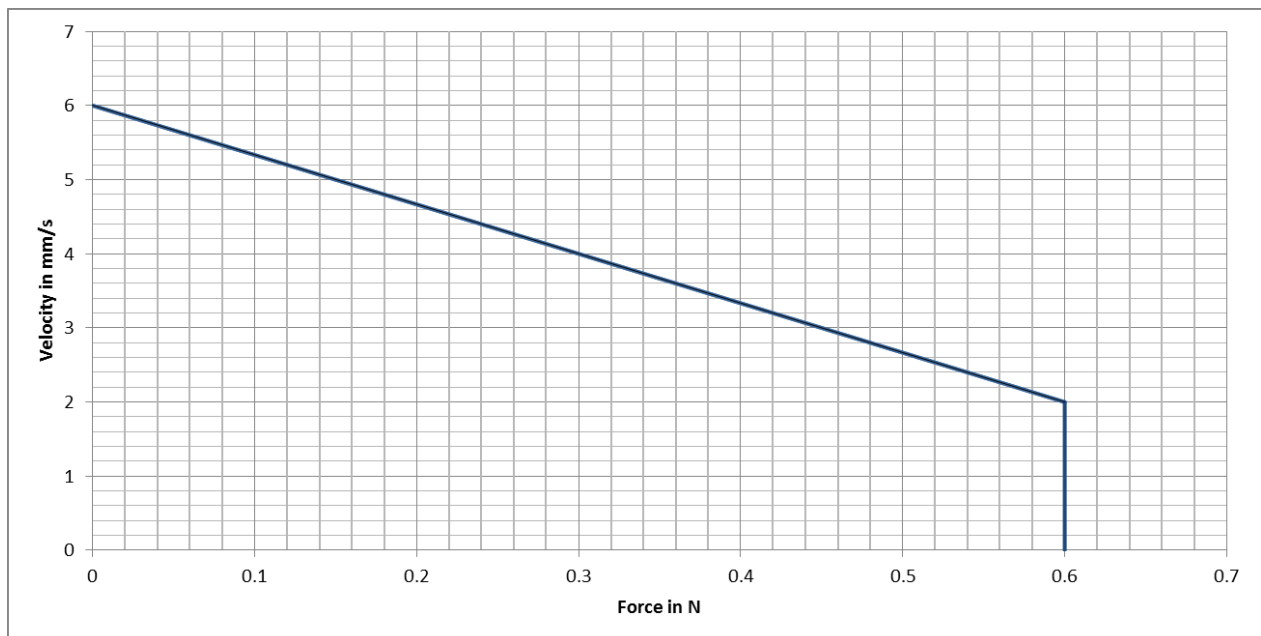


Figure 16: Relation between velocity and force of the Q-521

10.4 Dimensions

10.4.1 Q-521.1x0

Dimensions in mm. Note that a comma is used in the drawings instead of a decimal point.

The dimensions of the Q-521.130 and Q-521.140 models are identical.

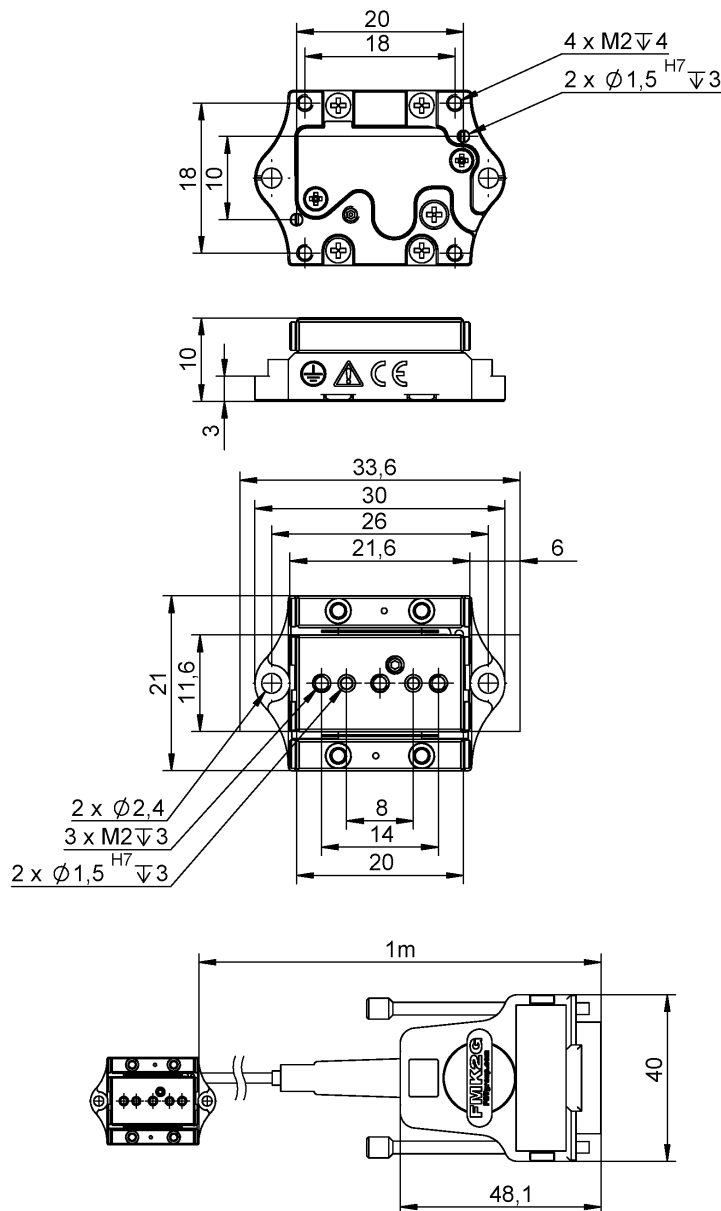


Figure 17: Q-521.1x0

10.4.2 Q-521.2x0

Dimensions in mm. Note that a comma is used in the drawings instead of a decimal point.

The dimensions of the Q-521.230 and Q-521.240 models are identical.

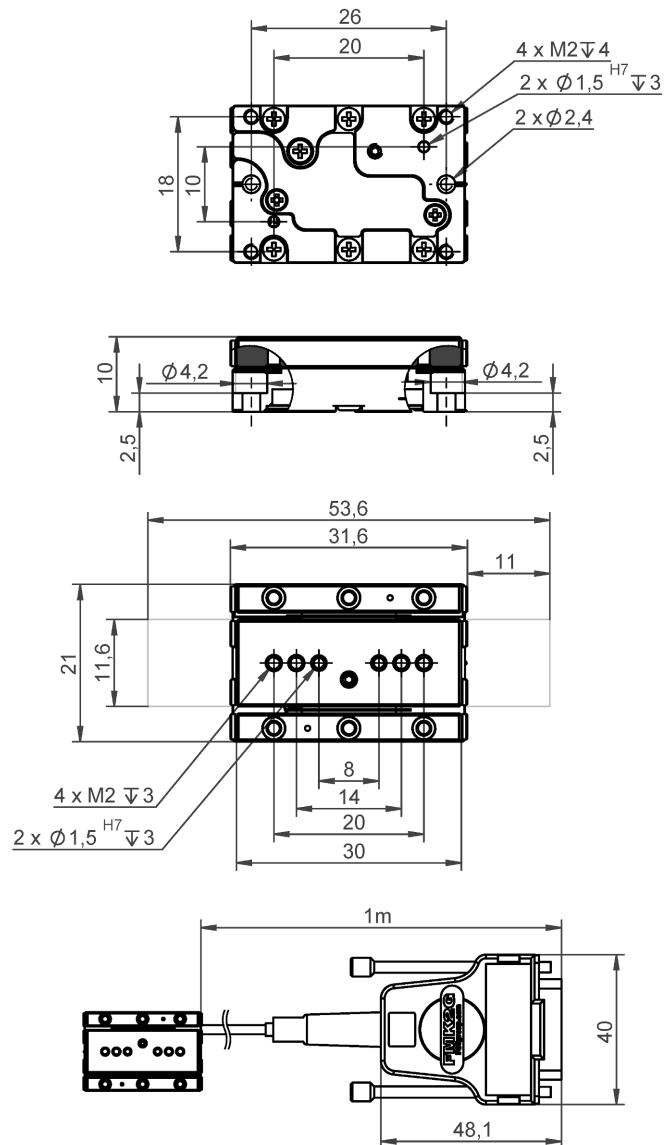


Figure 18: Q-521.2x0

10.4.3 Q-521.3x0

Dimensions in mm. Note that a comma is used in the drawings instead of a decimal point.

The dimensions of the Q-521.330 and Q-521.340 models are identical.

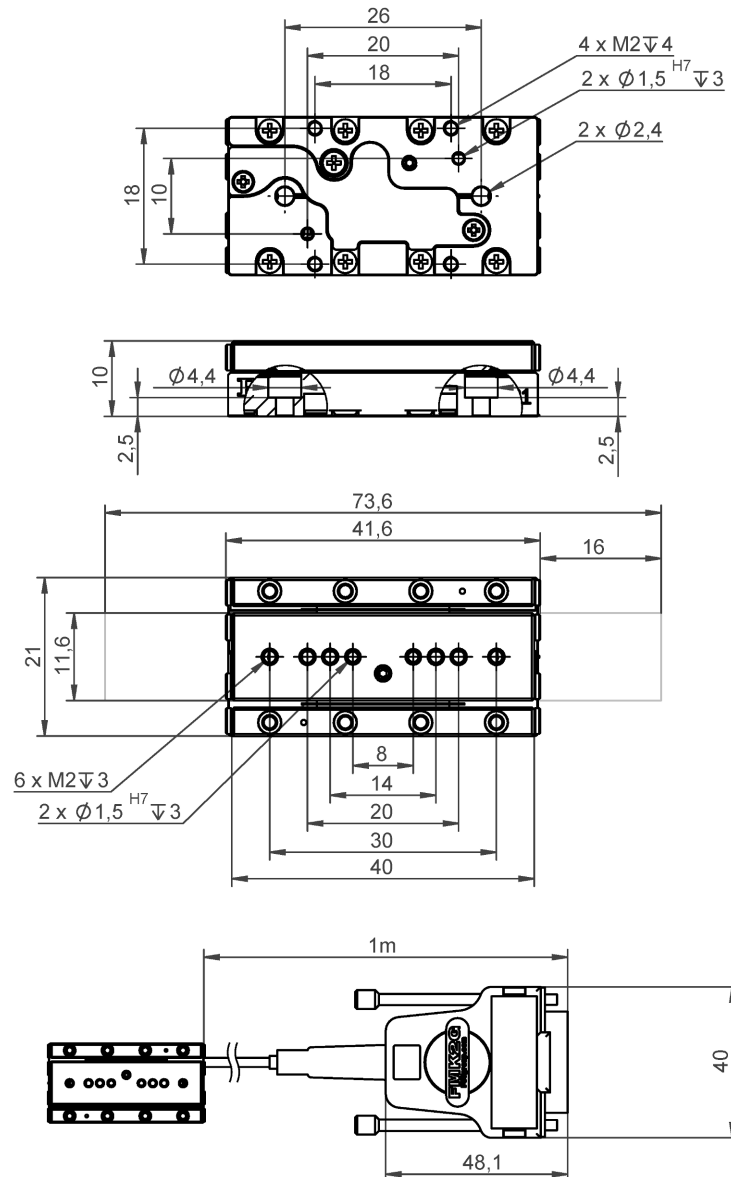


Figure 19: Q-521.3x0

10.4.4 Q-121.80U Adapter Plate

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

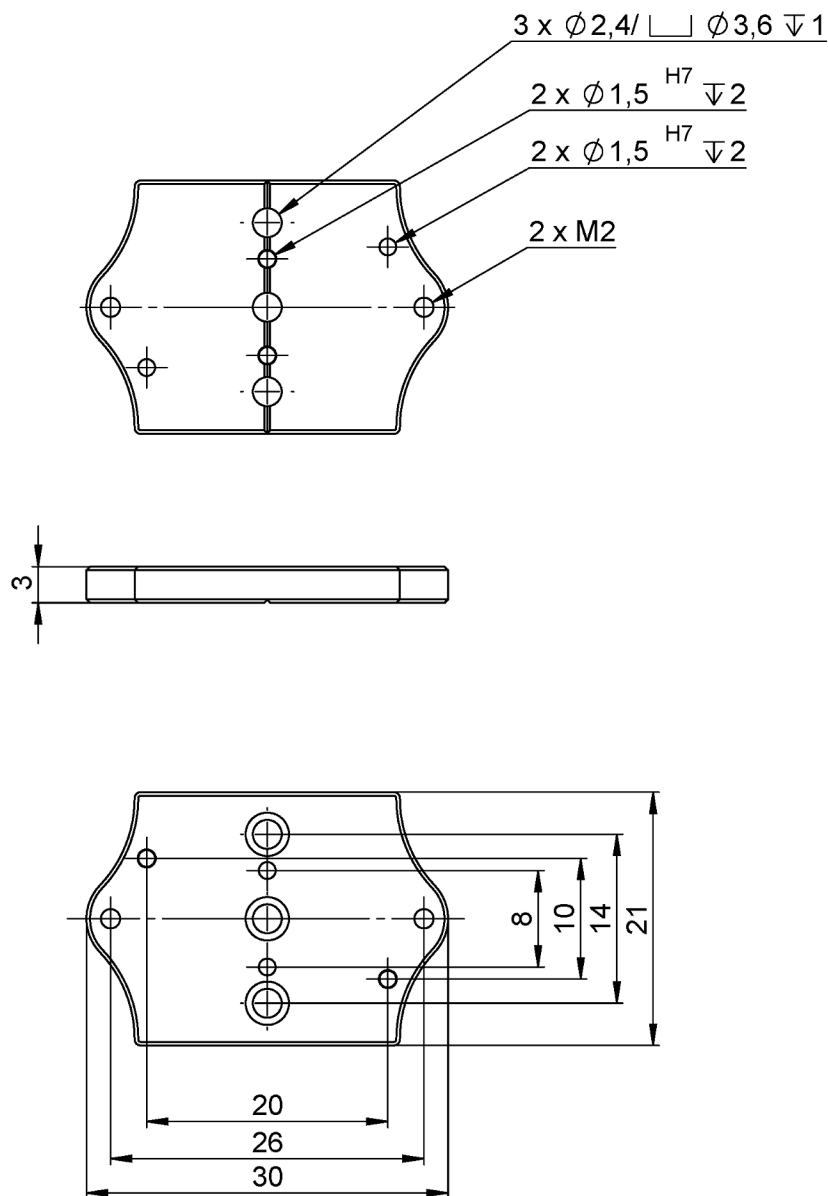


Figure 20: Q-121.80U adapter plate

10.4.5 Q-121.10U Adapter Bracket

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

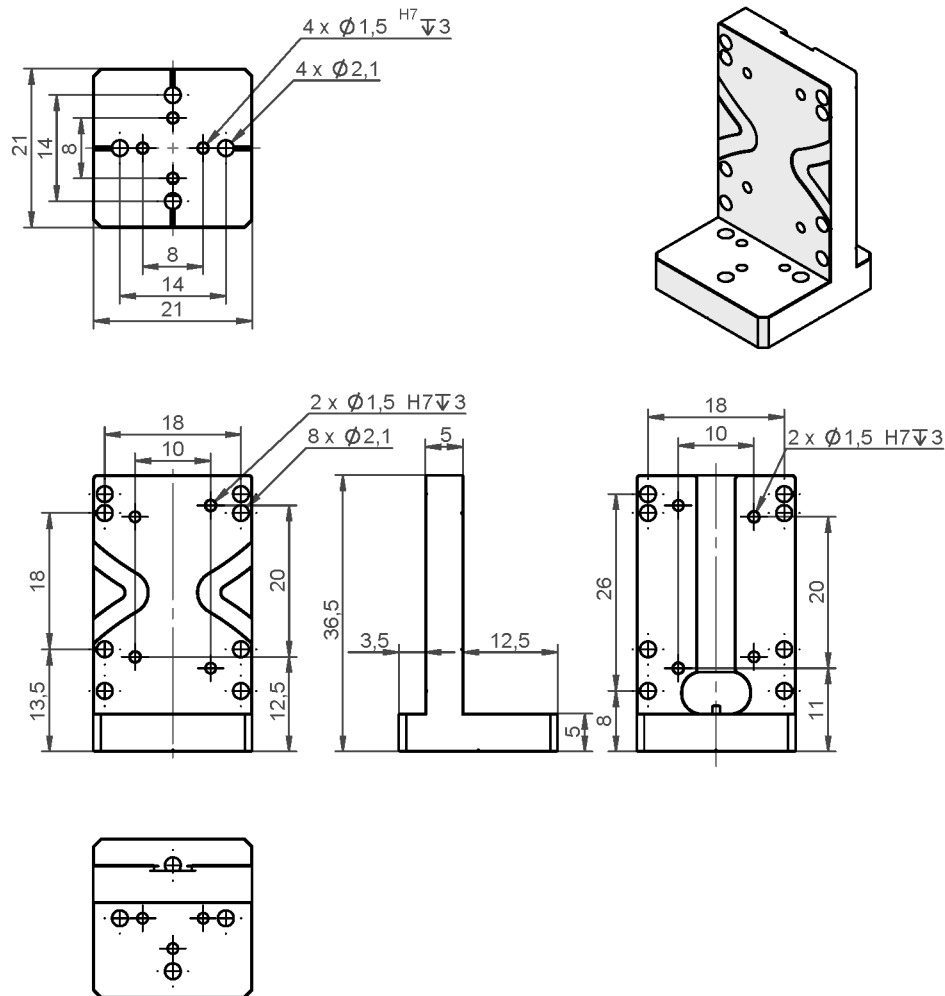


Figure 21: Q-121.10U adapter bracket

10.4.6 Q-121.20U Adapter Bracket

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

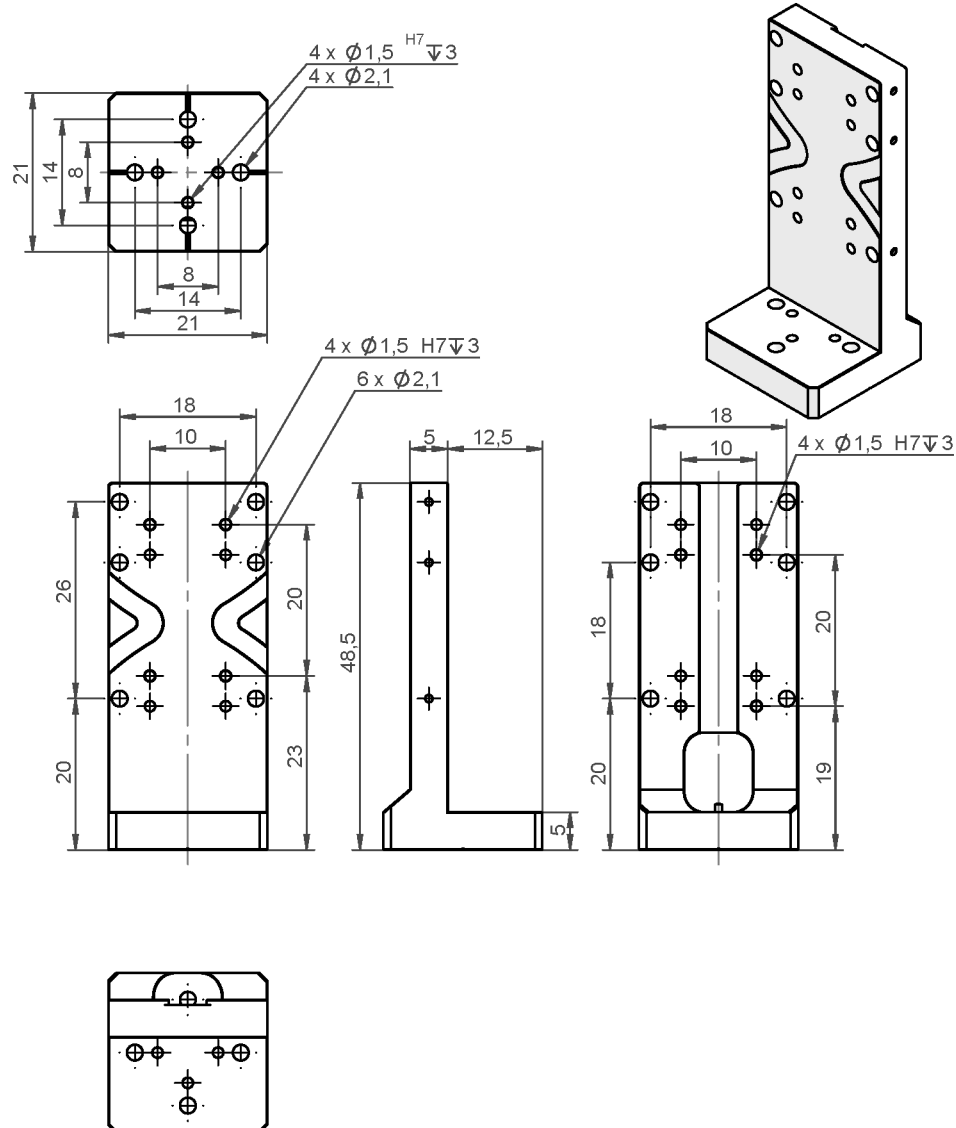


Figure 22: Q-121.20U adapter bracket

10.4.7 Q-121.30U Adapter Bracket

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

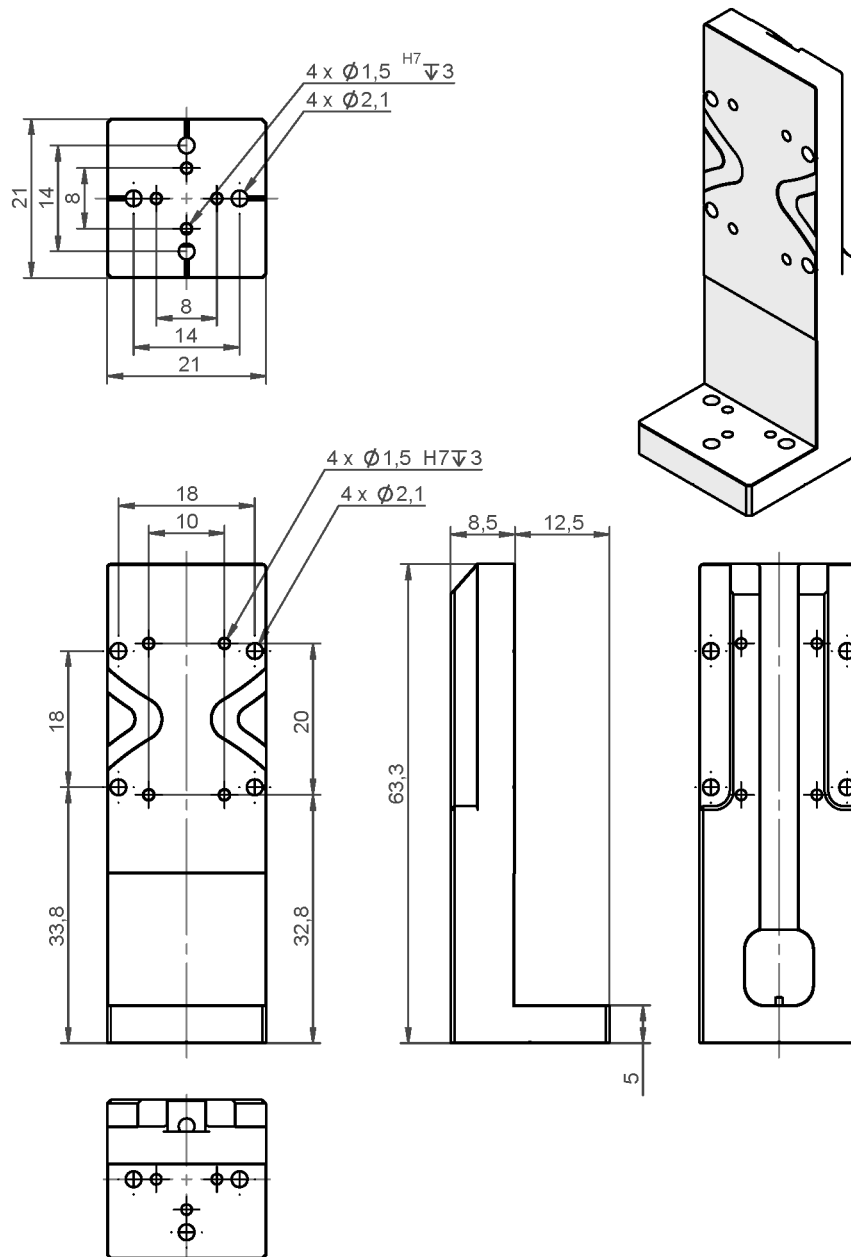


Figure 23: Q-121.30U adapter bracket

10.5 Pin Assignment

Connector: D-sub 15 (m)

The D-sub 15 connector (m) transmits the signals from the drive, the sensor, and the ID chip.

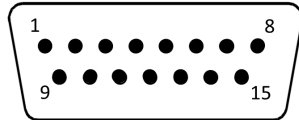


Figure 24: D-sub 15 (m) connector

Pin	Signal*	Function	Direction
1	REF -	Reference signal differential (-)	Output
2	Motor (-)	Motor signal differential (-)	Input
3	Motor (+)	Motor signal differential (+)	Input
4	V _{DD}	Supply voltage (+5 V)	Input
5	-	-	-
6	ID chip data	ID chip data	Output
7	SIN -	Encoder A (-)	Output
8	COS -	Encoder B (-)	Output
9	Motor (-)	Motor signal differential (-)	Input
10	GND	GND	GND
11	Motor (+)	Motor signal differential (+)	Input
12	-	-	-
13	REF +	Reference signal differential (+)	Output
14	SIN +	Encoder A (+)	Output
15	COS +	Encoder B (+)	Output

* The "-" sign indicates that the corresponding pin has not been assigned.

The cable shield is connected to the connector shell.

11 Old Equipment Disposal

In accordance with EU law, electrical and electronic equipment may not be disposed of in EU member states via the municipal residual waste.

Dispose of your old equipment according to international, national, and local rules and regulations.

To fulfill the responsibility as the product manufacturer, Physik Instrumente (PI) SE & Co. KG undertakes environmentally correct disposal of all old PI equipment made available on the market after 13 August 2005 without charge.

Any old PI equipment can be sent free of charge to the following address:

Physik Instrumente (PI) SE & Co. KG
Auf der Römerstraße 1
76228 Karlsruhe, Germany



12 European Declarations of Conformity

For the Q-521, declarations of conformity were issued according to the following European statutory requirements:

Low Voltage Directive

EMC Directive

RoHS Directive

The standards applied for certifying conformity are listed below.

Safety (Low Voltage Directive): EN 61010-1

EMC: EN 61326-1

RoHS: EN IEC 63000

