MP141E

L-509 Linear Stage

User Manual

Version: 1.8 Date: 6/15/2023

This document describes the following linear stages:

- L-509.x0DG10:
  with DC gear head motor and rotary encoder
  with A/B quadrature signal transmission
- L-509.x0SD00:
  With 2-phase stepper motor, without encoder
- L-509.xASD00:
  with 2-phase stepper motor and linear encoder
  with sin/cos signal transmission
- L-509.x0AD10:
  with Active Drive and rotary encoder
  with A/B quadrature signal transmission
- L-509.x4AD00:
  with Active Drive and linear encoder
  with A/B quadrature signal transmission
- L-509.0x3111:
  with DC motor and linear encoder
  with sin/cos signal transmission
- L-509.0x3132:
  with DC motor and rotary encoder
  with A/B quadrature signal transmission
- L-509.0x3132:
  with BLDC motor and rotary encoder
  with A/B quadrature signal transmission

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Contents

1 About this Document

1.1 Objective and Target Group of this User Manual

This user manual contains the information required for the intended use of the L-509.

Basic knowledge of closed-loop systems, motion control concepts, and applicable safety measures is assumed.

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

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.

➢ Measures for avoiding the risk.

NOTICE

Dangerous situation

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

➢ Measures for avoiding the risk.

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
▪	Lists
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	Maximum load capacity in the vertical direction when the stage is mounted horizontally. The contact point of the load is in the center of the platform.
Max. push/pull force	Maximum force in the direction of motion. Some stages may have higher forces but with limited lifetimes. In the case of vertical mounting, the specified value (see 43) for models without a gearhead and brake only applies when the servo mode is on.
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 the controller is switched on, a reference point definition must be performed before absolute target positions can be commanded and reached.

1.4 Pictures

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 that are mentioned in this documentation are described in separate manuals.

Product	Document
Stages with electric motors	MP146EK Short Instructions
C-663.12 Stepper Motor Controller	MS241E User Manual
C-863.12 DC Motor Controller	MS249E User Manual
C-884.xDC DC Motor Controller	MS243E User Manual
C-891 PIMag® Motor Controller	MS251E User Manual
G-910.RC0102x00	G910M0002EN UserManual
G-910.RC0242x00	G910M0001EN UserManual
G-910.RC0302200	G910M0003EN UserManual
C-885	C885T0002 User Manual
C-891.11C885	C891T0005 User Manual
C-663.12C885	C663T0004 User Manual
C-863.20C885	C863T0005 User Manual
PIMikroMove	SM148E Software Manual

2 Safety

2.1 Intended Use

The L-509 is a laboratory device as defined by DIN EN 61010. It is intended for indoor use and use in an environment which is free of dirt, oil, and lubricants.

In accordance with its design, the L-509 is intended for single-axis positioning, adjusting and shifting of loads at different velocities. The L-509 is **not** intended for applications in areas, in which a failure would represent severe risks to human beings or the environment.

The L-509 is intended for horizontal or vertical mounting. For the load limits with vertical mounting, see "General Notes on Installation". (p. 15).

The intended use of the L-509 is only possible when completely mounted and connected.

The L-509 must be operated with a suitable controller (p. 10). The controller is not in the scope of delivery of the L-509.

2.2 General Safety Instructions

The L-509 is built according to state-of-the-art technology and recognized safety standards. Improper use of the L-509 may result in personal injury and/or damage to the L-509.

- Only use the L-509 for its intended purpose, and only use it if it is in perfect condition.
- Read the user manual.
- Eliminate any faults and malfunctions that are likely to affect safety immediately.

The operator is responsible for correct installation and operation of the L-509.

2.3 Organizational Measures

User manual

- Always keep this user manual available when using the L-509.
  The latest versions of the user manuals are available on our website (p. 3) for download.
- Add all information from the manufacturer such as supplements or technical notes to the user manual.
- If you give the L-509 to other users, also include this user manual as well as all other relevant information provided by the manufacturer.
- Only use the device on the basis of the complete user manual. Missing information due to an incomplete user manual can result in minor injury and damage to equipment.
- Only install and operate the L-509 after you have read and understood this user manual.

Personnel qualification

The L-509 may only be installed, started up, operated, maintained, and cleaned by authorized and appropriately qualified personnel.

3 Product Description

3.1 Model Overview

Product number	Description	Travel range
L-509.023111	Precision linear stage; DC motor; 100 N load capacity; 50 mm/s maximum velocity; ball screw; incremental linear encoder, 20 µm sensor signal period, sin/cos, 1 V peak-peak	26 mm
L-509.033111		52 mm
L-509.053111		102 mm
L-509.023132	Precision linear stage; DC motor; 100 N load capacity; 50 mm/s maximum velocity; ball screw; incremental rotary encoder, A/B quadrature, RS-422	26 mm
L-509.033132		52 mm
L-509.053132		102 mm
L-509.025132	Precision linear stage; brushless DC motor; 100 N load capacity; 50 mm/s maximum velocity; ball screw; incremental rotary encoder, 20000 counts/rev sensor resolution, A/B quadrature, RS-422	26 mm
L-509.035132		52 mm
L-509.055132		102 mm
L-509.10AD10	Precision linear stage; DC motor with ActiveDrive; 100 N load capacity; 50 mm/s maximum velocity; ball screw; incremental rotary encoder, 16384 counts/rev sensor resolution, A/B quadrature, RS-422	26 mm
L-509.20AD10		52 mm
L-509.40AD10		102 mm
L-509.14AD00	Precision linear stage; DC motor with ActiveDrive; 100 N load capacity; 50 mm/s maximum velocity; ball screw; incremental linear encoder, 0.05 nm sensor resolution, A/B quadrature, RS-422	26 mm
L-509.24AD00		52 mm
L-509.44AD00		102 mm
L-509.10DG10	Precision linear stage; DC gear motor; 100 N load capacity; 3 mm/s maximum velocity; ball screw; incremental rotary encoder, 4096 counts/rev sensor resolution, A/B quadrature, RS-422	26 mm
L-509.20DG10		52 mm
L-509.40DG10		102 mm
L-509.10SD00	Precision linear stage; 2-phase stepper motor; 100 N load capacity; 20 mm/s maximum velocity; ball screw	26 mm
L-509.20SD00		52 mm
L-509.40SD00		102 mm
L-509.1ASD00	Precision linear stage; 2-phase stepper motor; 100 N load capacity; 20 mm/s maximum velocity; ball screw; incremental linear encoder, 20 µm sensor signal period, sin/cos, 1 V peak-peak	26 mm
L-509.2ASD00		52 mm
L-509.4ASD00		102 mm

3.2 Product View

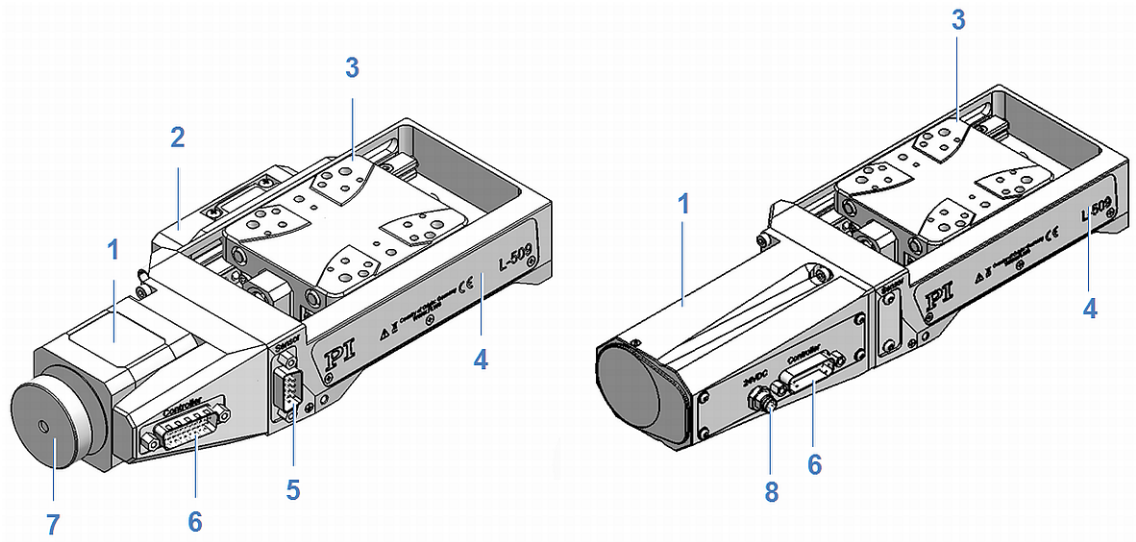


Figure 1: Elements of the L-509

1 Motor
2 Sensor unit (L-509.x4AD00 and L 509.0x3111 models only)
3 Motion platform
4 Base body
5 Sensor connector (D-Sub 9 panel plug; L-509.xASD00 and L 509.0x3111 models only)
6 Motor connector
(for L-509.x0SD00 / L-509.xASD00 / L-509.x0DG10/ L-509. 0x3111/ L-509. 0x3132/ L-509. 0x5132: HD D-Sub 26 panel plug;
for L-509.x0AD10 / L-509.x4AD00: D-Sub panel plug 15)
7 Vibration absorber (L-509.x0SD00 and L-509.xASD00 models only)
8 Power adapter connector (L-509.x0AD10 and L-509.x4AD00 models only)

3.3 Direction of Motion

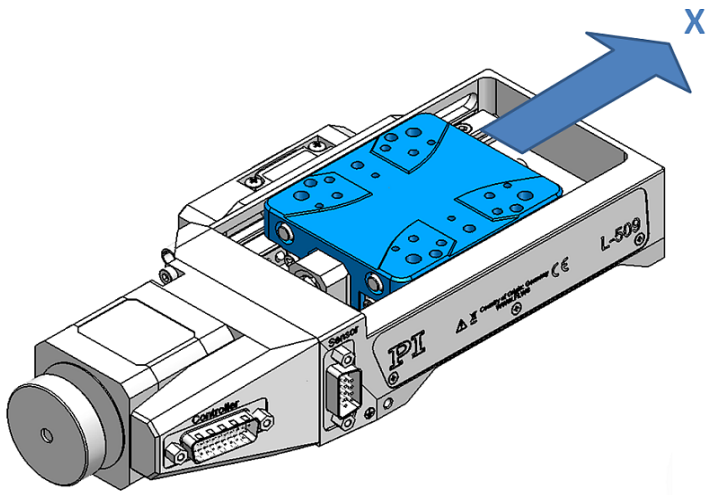


Figure 2: Direction of motion of the platform on positive command

3.4 Product Labeling

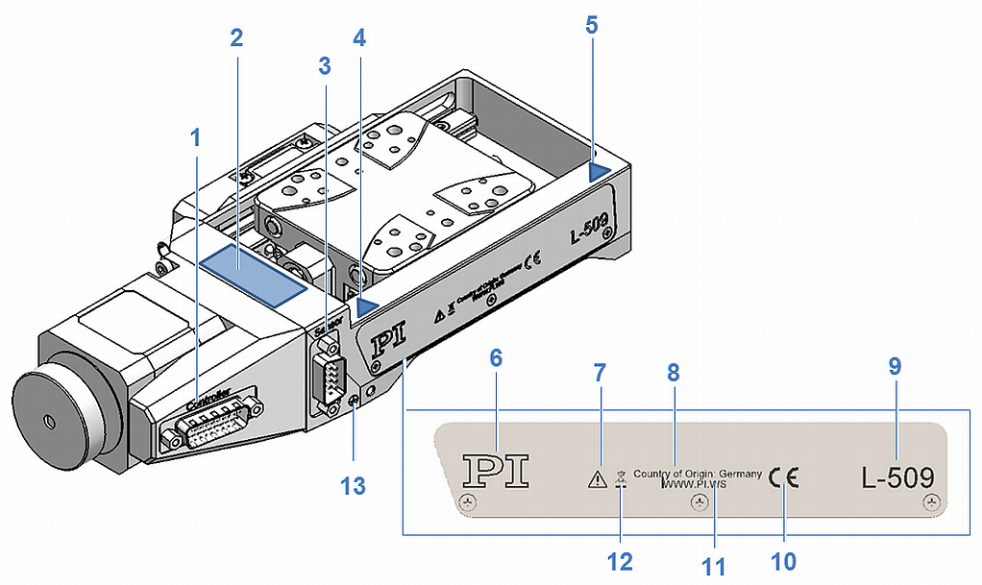


Figure 3: Product labeling

Position	Labeling	Description
1	Controller	Motor connector
2	L-509.20SD00	Product name (example), the characters after the period refer to the model
	415002159	Serial number (example), individual for each L-509 Meaning of the places (counting from left): 1 = internal information, 2 and 3 = year of manufacture, 4 to 9 = consecutive numbers
2, 6	PI	Manufacturer's logo
2, 7	⚠	Warning sign "Observe manual!"
2, 8	Country of origin: Germany	Country of origin
2, 10	CE	CE conformity mark
2, 11	WWW.PI.WS	Manufacturer's address (website)
2, 12		Old equipment disposal
3	Sensor	Linear encoder connector (L-509.x4AD00, L-509.xASD00, L 509.0x3111 models only)
4, 5		Warning sign "Risk of crushing": Reference to dangerous forces (p. 31)
9	L-509	Product series
13	⏚	Protective earth symbol, marks the protective earth connection of the L-509 (p. 19)

3.5 Scope of Delivery

Item number	Component	L-509 model.	
		x0AD10 x4AD00	x0DG10 x0SD00 xASD00 0x3111 0x3132 0x5132
L-509.xxxxxx	Stage according to the order (p. 7)	x	x
MP146EK	Short instructions for stages with electric motors	x	x
62345070 or 62345016 (depending on the positioner)	Screw set for mounting the positioner ▪ 4 (or 8) socket head screws, ISO 4762 M4x14 ▪ 2 dowel pins, ISO 2338 - 4 m6 x 12	x	x
7300900006-0180	Power supply set, consisting of: ▪ C-663.PS wide input range power supply, 24 V / 120 W ▪ K050B0003 adapter for power adapter connection; barrel connector to M8 4-pin connector (f) ▪ K351000037 snap-on ferrite	x	
K322000047 or K322000074	EU or US power cord, depending on country of order	x	

3.6 Accessories

Order number	Description
L-500.AV3	Mounting adapter included for vertical mounting of L-509 positioners ▪ 4 socket head screws, ISO 4762 M6x12 ▪ 2 dowel pins, ISO 2338 - 4 h8 x 12 ▪ 2 dowel pins, ISO 2338 - 3 h8 x 12

To order, contact the customer service department (p. 41).

3.7 Suitable Controllers

	L-509.xXSD00	L 509.x0DG10	L 509.x4ADx0	L 509.0x31xx	L-509.0x5132
C-663.12 / C-885 with C-663.12C885	x				
C-863.12 / C-885 with C-863.20C885		x	x	x	
C-884.4DC / C-884.6DC		x	x	x	
C-891.130300 / C-885 with C-891.11C885					x
G-910	x	x		x	x
G-901	x	x		x	x

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

3.8 Technical Features

3.8.1 Encoder

The L-509.x0SD00 models are not equipped with an encoder.

Linear encoder

The L-509.xASD00 and L-509.0x3111 models are equipped with an optical linear encoder. For the encoder resolution, refer to the table in the "Specifications" section (p. 43).

Optical linear encoders measure the actual position directly (direct metrology). Errors occurring in the drive, such as nonlinearity, backlash or elastic deformations cannot influence measuring of the position.

Rotary encoder

The L-509.x0AD10, L-509.x0DG10 , L-509.0x3132, L-509.0x5132 models are equipped with an incremental rotary encoder.

A rotary encoder, also called an incremental rotary encoder, is implemented at a rotating point in the drivetrain, e.g., the motor shaft.

3.8.2 Limit Switches

The L-509 is equipped with optical limit switches.

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

See "Limit Switch Specifications" for more information" (p. 48).

3.8.3 Reference Switch

The stage is equipped with one direction-sensing reference switch that is located at about the midpoint of the travel range. This sensor provides a TTL signal indicating whether the stage is on the positive or negative side of the 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.

3.8.4 Integrated PWM Amplifier

The L-509.x0AD10 und L-509.x4AD00 models with direct drive are equipped with a PWM amplifier ("ActiveDrive Concept"). The motor and PWM amplifier are installed in a common housing and therefore optimally integrated and shielded. The PWM amplifier only receives the control signals from the controller, whereas the supply voltage is provided via an external power adapter. The ActiveDrive concept allows high motor power and dynamics at low power loss.

4 Unpacking

1. Unpack the L-509 with care.
2. Compare the contents with the items listed in the contract and the packing list.
3. Inspect the contents for signs of damage. If there is any sign of damage or missing parts, contact PI immediately.
4. Keep all packaging materials in case the product needs to be returned.

5 Installation

5.1 General Notes on Installation

NOTICE

Unwanted changes in position with vertical mounting!

If the load exceeds the self-locking of the drive when the positioner is mounted vertically, unintentional changes in the position of the motion platform will occur. Unwanted changes in the position of the motion platform can damage the drive, the load or the environment.

- ➢ When a positioner is mounted vertically, make sure that the installed load is lower than the self-locking of the drive (see specification of the holding force in "Data table" (p. 43)).

NOTICE

Electrostatic hazard

Touching the pins in the connections of the L-509 can damage electrostatic sensitive devices (ESD) of the L-509. For this reason, the L-509 is supplied with ESD protection on all connections.

- ➢ Do not remove the ESD protection from the connections until you connect the L-509 to the controller.

NOTICE

Cable break!

A cable break leads to failure of the positioner.

- ➢ Install the stage so that the cable is not bent too strongly or crushed.

NOTICE

Heating of the L-509 during operation!

The heat produced during operation of the L-509 can affect your application.

- ➢ Install the L-509 so that the application is not impaired by the dissipated heat.

INFORMATION

For optimal repeatability, all components must be connected firmly together.

INFORMATION

The use of locating pins during mounting reduces deviations from the ideal alignment of the positioner.

- If possible, simulate the platform motion with a mounted load or make suitable calculations to detect collisions or unfavorable center of gravity constellations.
- If necessary, take suitable constructive measures to avoid collisions and instability in the overall system.
- Avoid or mark danger zones that result from the installation of the positioner and the application, in accordance with the legal regulations.

5.2 Attaching the L-509 to a Surface

NOTICE

Protruding screw heads!

Protruding screw heads can damage the L-509.

- Make sure that the screws are tightened and recessed completely, and do not interfere with motion of the stage.

NOTICE

Warping of the L-509 due to mounting on uneven surfaces!

Mounting the L-509 on an uneven surface can warp the L-509. Warping reduces the accuracy.

- Mount the L-509 onto an even surface. The recommended flatness of the surface is ≤10 µm.
- For applications with large temperature changes:
  Only mount the L-509 on surfaces that have the same or similar thermal expansion properties as the L-509.

INFORMATION

For mounting onto a surface, the L-509 has mounting holes for M4 screws in its base body. The number of holes available depends on the model:

- L-509.1xxxxx,: **4** mounting holes
- L-509.2xxxxx, L-509.4xxxxx: **8** mounting holes

The correct number of screws and washers is in the scope of delivery of the L-509.

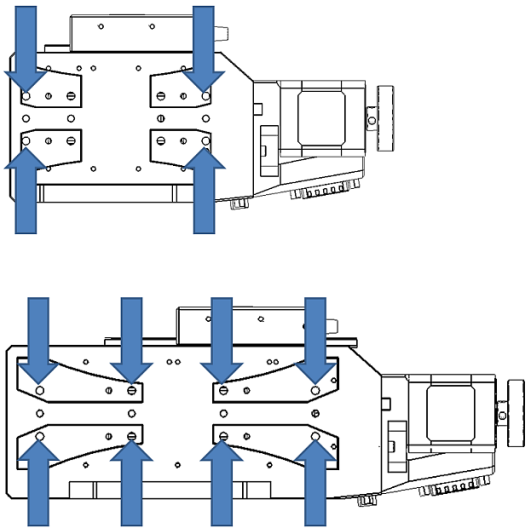


Figure 4: Position of the holes for mounting the positioner

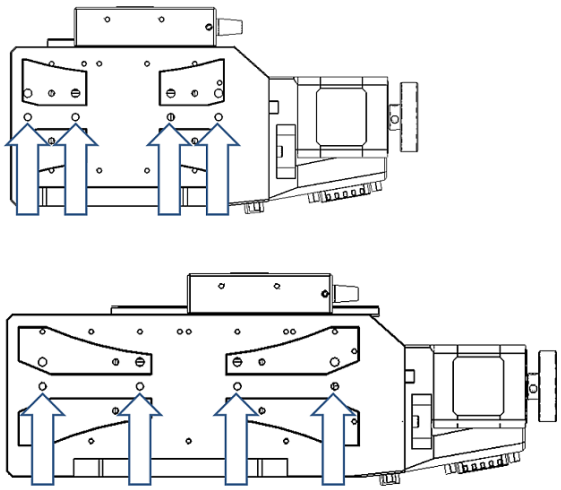


Figure 5: Position of the locating holes for aligning the positioner

Requirements

- ✓ You have read and understood the general notes on installation (p. 15).
- ✓ You have provided a suitable surface (for the required position and depth of the holes for accommodating the screws and locating pins, see "Dimensions" (p. 50)):
  - Four or eight M4 threaded holes are present.
  - If you use locating pins to align the stage: Two 4 mm Ø locating holes are present.
  - The surface flatness is ≤10 µm.
  - For applications with large temperature changes: The surface should have the same or similar thermal expansion properties as the L-509 (e.g., surface made of aluminum).
- ✓ You have accounted for the space required to route cables without bending and according to regulations.

Tools and accessories

- Mounting kit; in the scope of delivery (p. 10)
  - 4 or 8 socket head screws, ISO 4762 M4x14
  - 2 dowel pins, ISO 2338 - 4 h8 × 12, for use as locating pins
- Hex key, AF 3

Mounting the positioner onto a surface

1. Place the positioner on the surface so that the corresponding mounting holes in the positioner and the surface are in line.

   If you use locating pins to align the stage:

   a) Insert the locating pins into the respective holes in the surface.

   b) Place the stage on the surface so that the locating pins are inserted into the corresponding locating holes on the other side.
2. Allow access to the mounting holes in the base body of the positioner. Possible measures:
   - Temporary startup of the positioner (p. 31) and commanding the platform to a suitable position
   - Moving the motion platform by hand (p. 39)
3. Insert the screws into all accessible mounting holes and tighten.
4. Repeat steps 2 to 4 for all available concealed mounting holes.
5. Check that the positioner is affixed firmly to the surface.

5.3 Connecting the L-509 to the Protective Earth Conductor

INFORMATION

It is only necessary to connect the L-509 to the protective earth conductor when both of the following conditions are met:

- The load on the motion platform of the L-509 must be connected to the protective earth conductor, but it is not possible to connect the protective earth conductor directly to the load.

The load and the platform are connected conductively to each other.

INFORMATION

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

An M4 hole for the protective earth conductor connection is marked on the longitudinal side of the L-509. In the following figure, this hole is marked with an arrow.

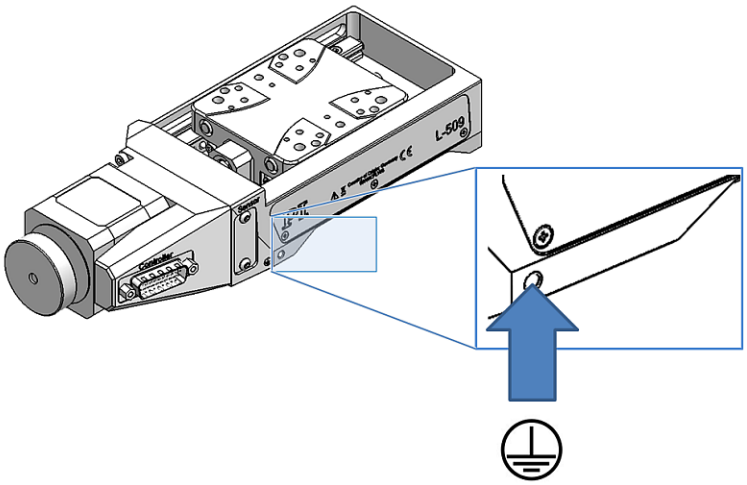


Figure 6: Position of the hole for attaching the protective earth conductor

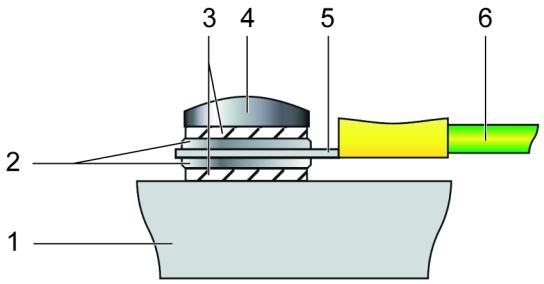


Figure 7: Mounting of the protective earth conductor (profile view)

1 Base body of the L-509
2 Flat washer
3 Safety washer
4 Screw
5 Cable lug
6 Protective earth conductor

Requirements

✓ You have read and understood the general notes on installation (p. 15).

Tools and accessories

- Suitable protective earth conductor: Cable cross section ≥ 0.75 mm^2
- Screw, M4x8, ISO 7045
- 2 washers ISO 7089-4
- 2 safety washers S4
- Suitable screwdriver

Connecting the L-509 to the protective earth conductor

1. If necessary, attach a suitable cable lug to the protective earth conductor.
2. Affix the cable lug of the protective earth conductor using the M4 screw on the protective earth connection of the L-509 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 is <0.1 Ω at 25 A at all connection points relevant for attaching the protective earth conductor.

5.4 Affixing the Load to the L-509

NOTICE

Impermissibly high load on the stage!

An impermissible high load impairs the motion of the platform and can damage the stage.

- ➢ When considering the mass and mounting method of the load, pay attention to the specified maximum permissible forces that may act on the platform (p. 43).

NOTICE

Excessively long screws!

Screws and locating pins that are inserted too deeply can damage the lower stage.

- ➢ Pay attention to the depth of the mounting holes in the motion platform (p. 50) of the lower positioner.
- ➢ Only use screws and locating pins of the correct length for the respective mounting holes.

Requirements

- ✓ You have read and understood the general notes on installation (p. 15).
- ✓ You have mounted the stage onto a surface properly (p. 16).
- ✓ The stage is **not** connected to the controller.
- ✓ You have prepared the load so that it can be affixed to the mounting holes on the motion platform (p. 52):
  - The distance between the center of gravity of the load and the center of the moving platform is as small as possible in all directions.
  - At least two points are provided for mounting the load on the platform (ideally: three or four mounting points).
  - If you use locating pins for aligning the load: You have made two locating holes of Ø 4 mm H7 in the load for accommodating locating pins.

Tools and accessories

- At least 2 screws of suitable length. Options:
  - M4 screws
  - M6 screws
- Suitable tool for tightening the screws
- Optional: 2 dowel pins, ISO 2338 - 4 h8 of suitable length for aligning the load on the L-509.

Affixing the load

1. Align the load so that the selected mounting holes in the motion platform (p. 52) can be used to affix it.

   If you use locating pins to align the load:

c) Insert the locating pins into the locating holes in the platform.

d) Place the load on the platform so that the locating pins are inserted into the corresponding locating holes on the other side.

2. Use the screws to affix the load on the selected mounting holes in the platform.
3. Check that the load is affixed firmly to the platform of the positioner.

5.5 Building a Multi-Axis System

The L-509 can be used in multi-axis systems.

Typical combinations:

- XY system (p. 22)
- Z system (XZ or XYZ combination)

➢ For possible combinations with other positioners, contact our customer service department. (p. 41).

5.5.1 General Notes on Building a Multi-Axis System

NOTICE

Impermissibly high load on the positioners!

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

➢ Include the masses of the stage that is moved and the mounting adapters (p. 10) in the calculation of the load to be moved.
➢ For all stages in a multi-axis system: Do **not** exceed the maximum permissible load.
➢ When the positioner is mounted vertically, make sure that the installed load is lower than the self-locking of the drive.

➢ Only install and operate the multi-axis system 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. 41).

5.5.2 Building an XY System

NOTICE

Excessively long screws!

Screws and locating pins that are inserted too deeply can damage the lower stage.

➢ Pay attention to the depth of the mounting holes in the motion platform (p. 50) of the lower positioner.
➢ Only use screws and locating pins of the correct length for the respective mounting holes.

Designations in these instructions:

- **Lower stage**: Forms the basis of the multi-axis system (X axis), is attached to a surface
- **Upper stage**: Forms the Y axis of the multi-axis system, is attached to the lower stage rotated by 90°

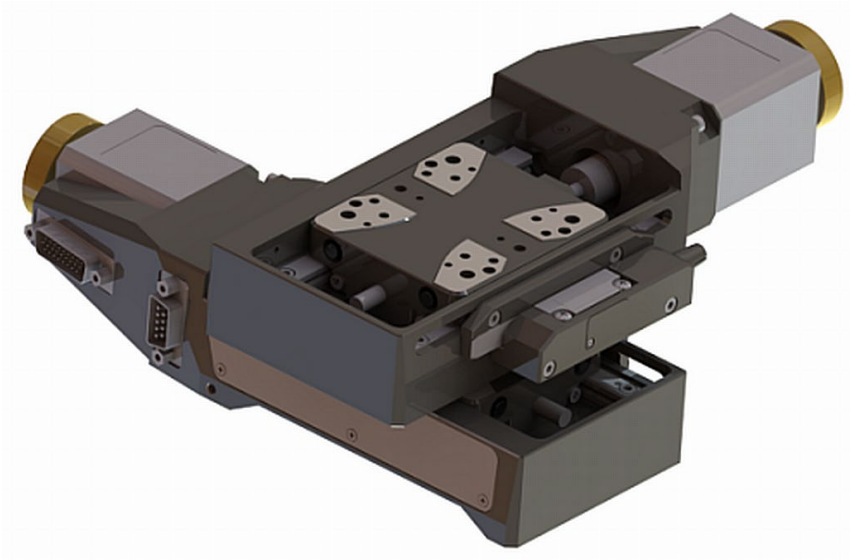


Figure 8: Examples of an XY system consisting of two L-509

Requirements

- ✓ You have read and understood the general notes on installation (p. 15).
- ✓ You have read and understood the general notes on building a multi-axis system (p. 22).
- ✓ You have accounted for the space required to route cables without bending and according to regulations.
- ✓ You have mounted the lower stage onto a surface properly. (p. 16).

Tools and accessories

- 4 screws, ISO 4762 M4x14 from the scope of delivery of the upper positioner
- Hex key, AF 3

Building an XY system

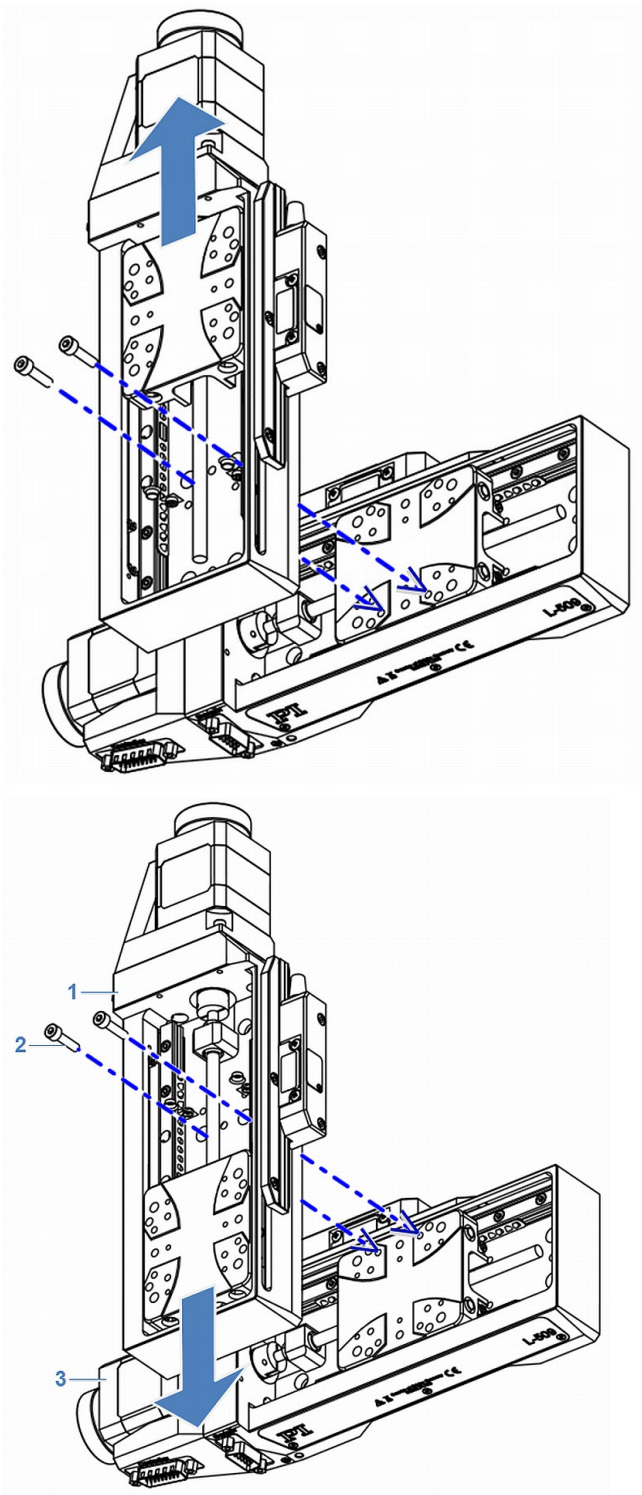


Figure 9: Moving the platform and inserting the screws

1 Lower positioner
2 Upper positioner
3 M4x14 screw

1. Allow access to two of the required mounting holes in the base body of the positioner. Possible measures:
   - Temporary startup of the upper positioner (p. 31) and commanding the platform to a suitable position
   - Moving the motion platform by hand (p. 39)
2. Affix the upper L-509 to both mounting holes made accessible in the lower L-509: Tighten the screws in the mounting holes completely.
3. Repeat steps 1 and 2 for the two other required mounting holes in the base body of the upper positioner.
4. Check that the upper positioner is affixed firmly.

5.5.3 Building a Z System

NOTICE

Excessively long screws!

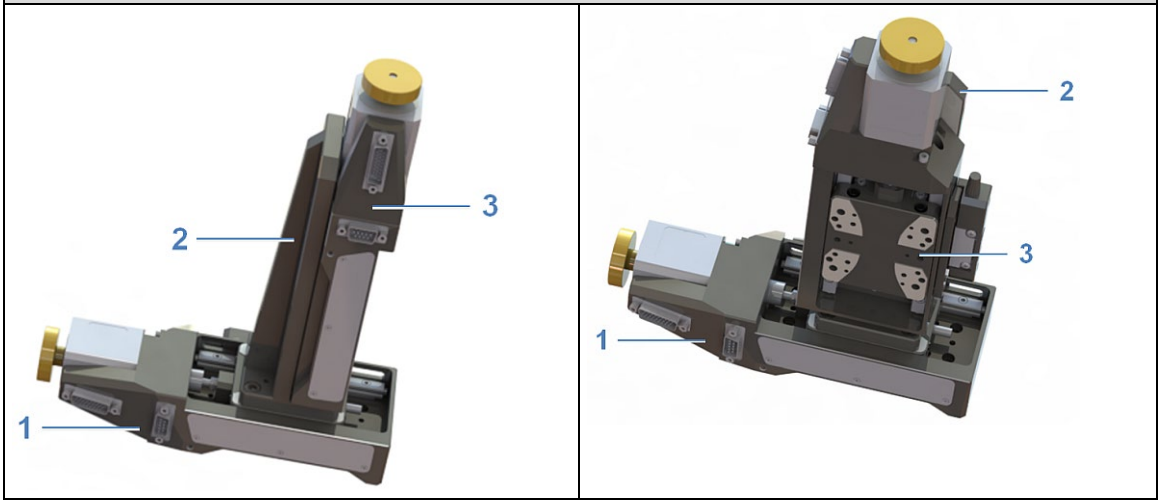
Screws and locating pins that are inserted too deeply can damage the lower stage.

- ➢ Pay attention to the depth of the mounting holes in the motion platform of the lower positioner (p. 50).
- ➢ Only use screws and locating pins of the correct length for the respective mounting holes.

Designations in these instructions:

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

Examples of XZ systems consisting of two L-509 and an adapter bracket



1 Lower positioner
2 Adapter bracket
3 Upper positioner

Requirements

- ✓ You have read and understood the general notes on installation (p. 15).
- ✓ You have read and understood the general notes on building a multi-axis system (p. 22).
- ✓ You have accounted for the space required to route cables without bending and according to regulations.
- ✓ If you build an XZ combination: You have mounted the lower positioner onto a surface properly (p. 16).
- ✓ If you build an XYZ combination: You have attached the stages for the X and Y axis properly (p. 22).

Tools and accessories

- L-500.AV3 adapter bracket, available as optional accessory (p. 10):
- 4 socket head screws, ISO 4762 M4x14 from the scope of delivery of the upper positioner
- 4 socket head screws, ISO 4762 M6x12 from the scope of delivery of the adapter bracket
- Allen wrench AF 5
- Hex key, AF 3

Building a Z system

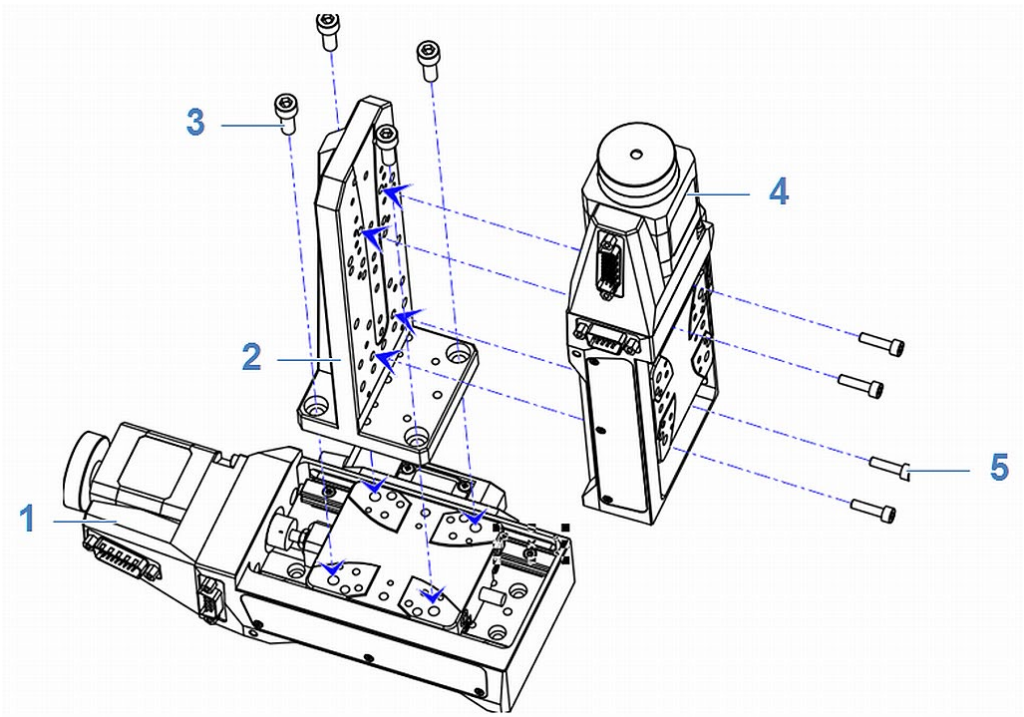


Figure 10: Example of a Z system setup (here with two L-509.2ASD00 positioners)

1 Lower positioner
2 Adapter bracket
3 M6x12 screw
4 Upper positioner
5 M4x14 screw

1. Mount the short side of the adapter bracket onto the motion platform of the lower positioners:
   a) Place the short side of the adapter bracket onto the motion platform of the lower positioner so that the mounting holes in the positioner and the mounting bracket are covered.
   b) Insert four M6x12 screws into the mounting holes of the adapter bracket.
   c) Insert the four screws and tighten.
2. Check that the adapter bracket and the lower stage are affixed firmly.
3. Mount the upper stage to the long side of the adapter bracket:
   a) Align the upper stage so that the motor module points away from the origin of the sides of the adapter bracket; i.e., upwards in the Z system.
   b) Place the stage on the long side of the adapter bracket so that the mounting holes in the stage and the mounting bracket are covered (see figure above).
   c) Insert four M4x14 screws into the mounting holes of the positioner.
   d) Insert the four screws and tighten.
4. Check that the adapter bracket and the upper stage are affixed firmly.

5.6 Connecting the L-509 to a Controller

NOTICE

Damage if an incorrect controller or motor cable is connected!

Connecting a stage to an unsuitable controller or using an unsuitable motor cable can cause damage to the stage or controller.

- ➢ Only connect the stage to a suitable controller (p. 10).
- ➢ Use the cables that were supplied with your order and your specific positioner/controller combination to connect the positioner to the controller.

Requirements

- ✓ You have read and understood the general notes on installation (p. 15).
- ✓ You have installed the controller.
- ✓ You have read and understood the user manual for the controller.
- ✓ The controller is switched off.

Tools and accessories

- Cable according to your order
- Suitable tools for tightening the screws to the connections

Connecting the L-509 to a Controller

1. Remove the ESD protection from all connections of the L-509.
2. Connect the L-509 and the controller to each other.
3. Use the integrated screws to secure the connections against accidental disconnection.

5.7 Connecting the Power Adapter to the L-509

Connecting a power adapter is only necessary for the L-509.xxADxx models.

Requirements

✓ The power cord is **not** connected to the power socket.

Tools and accessories

- Supplied components:
  - 24 V wide input range power supply
  - Adapter for the power adapter connection; barrel connector, 5.5 mm x 2.1 mm to M8 4-pin (f)
  - Snap-on ferrite
  - Power cord
- If one of the components supplied for connecting to the power supply has to be replaced: Use a sufficiently measured and certified replacement component. Details:
  - Power adapter: Output 24 V DC, maximum output current 5 A
  - Snap-on ferrite suppressor: Impedance at 25 MHz: Approx. 176 Ω
  - Power cord: Three wires, cable cross section at least 3 × 0.75 mm^2 (3 × AWG18), maximum length 2 m

Connecting the power adapter to the L-509

1. Attach the snap-on ferrite suppressor to the cable that is attached to the power adapter:
   a) Lay the cable approx. 50 mm from the barrel connector into the opened snap-on ferrite suppressor.
   b) Align the cable so that it is not squeezed when the snap-on ferrite suppressor is closed.
   c) Carefully press the two halves of the snap-on ferrite suppressor around the cable until the lock engages.
2. Connect the M8 connector (f) of the adapter to the M8 panel plug of the L509.
3. Connect the barrel connector of the adapter to the barrel connector socket of the power adapter.
4. Connect the power cord to the power adapter.

6 Startup

6.1 General Notes on Startup

CAUTION

Risk of crushing by moving parts!

Risk of minor injury from crushing between the moving parts of the positioner or the load and a fixed part or obstacle.

- ➢ Use safeguards to protect limbs areas where they could be caught by moving parts.
- ➢ Observe the safety distances in accordance with DIN EN ISO 13857 when installing protective structures.

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 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

Damage if an incorrect controller or motor cable is connected!

Connecting a stage to an unsuitable controller or using an unsuitable motor cable can cause damage to the stage or controller.

- ➢ Only connect the stage to a suitable controller (p. 10).
- ➢ Use the cables that were supplied with your order and your specific positioner/controller combination to connect the positioner to the controller.

NOTICE

Operating voltage excessively high or incorrectly connected!

Operating voltages that are excessively high or incorrectly connected can cause damage to the L-509.

- Do **not** exceed the operating voltage range (p. 48) that is specified for the L-509.
- Operate the L-509 only when the operating voltage is properly connected; see "Pin Assignment" (p. 55).

NOTICE

Damage or considerable wear due to high accelerations!

High accelerations can cause damage to or considerable wear on the mechanics.

- Stop the motion immediately if a controller malfunction occurs.
- Ensure that the end of the travel range is approached at low velocity.
- Determine the maximum velocity for your application.

NOTICE

Unintentional motion!

Unintentional motion of the L-509 is possible when it is connected to the controller. Defective or incorrect operation of the software can also result in unintentional motion.

- Do not place any objects in areas where they can be caught by moving parts.
- Before connecting the L-509, check whether a macro is defined as the startup macro in the controller, and cancel the selection of the startup macro if necessary.

INFORMATION

The maximum velocity for an L-509.x0SD00 should be determined in the application. If the commanded velocity is too high, the stepper motor might stop without the controller detecting this state.

INFORMATION

The repeatability of the positioning is only ensured when the reference 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.

For the L-509.xxADx0, L-509.x0DG10, and L-509.xASD00 models:

INFORMATION

Improper setting of the servo control parameters can impair the performance of the L-509. This can have the following consequences:

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

If the performance of the L-509 is not satisfactory, check the settings for the servo control parameters of your controller.

6.2 Starting and Operating the Positioner

Requirements

- ✓ You have read and understood the general notes on startup (p. 31).
- ✓ When starting and operating with a load or in a multi-axis system: You have installed the stage properly (p. 22).
- ✓ You have read and understood the user manual for the controller used.
- ✓ You have read and understood the manual for the PC software used.
- ✓ The controller and the required PC software have been installed. All connections on the controller have been set up (see "Connecting the L-509 to the Controller" (p. 28) and the user manual for the controller).

Starting and operating the positioner

5. L-509.xxADxx models only: Connect the power cord of the power adapter to the power socket.
6. Start and operate the controller (see user manual for the controller).

   Configure the controller during startup using the PC software for the stage used (see user manual for the controller, and the PC software):

   – If you use a controller from PI: Select the entry in the positioner database that exactly fits the positioner model used (p. 33).

   – If you use a controller from another manufacturer: Enter the parameters into the corresponding PC software that exactly fit the positioner model; see the overview of the operating parameters for DC motor controllers or stepper motor controllers.
7. Start a few motion cycles for testing purposes (see user manual for the controller).

6.2.1 L-509 Entries in the PI Positioner Database

For PI controllers, you can select the connected stage from a stage database in the corresponding PC software. The appropriate operating parameters are therefore loaded to the controller. You can find a detailed description in the user manual for the controller or in the manual for the PC software used.

7 Maintenance

7.1 General Notes on Maintenance

NOTICE

Damage due to improper maintenance!

Improper maintenance can result in misalignment and failure of the L-509.

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

7.2 Performing a Maintenance Run

Depending on the operating conditions and the period of use of the L-509, the following maintenance measures are required:

Maintenance run

The maintenance run serves the purpose of distributing the existing lubricant.

- After 500 operating hours or at least after 1 year, perform a maintenance run over the entire travel range, in order for the existing lubricant to be distributed evenly.
- If you operate your stage continuously over only a short travel range (<20%of the entire travel range), perform a run across the entire travel range approximately every 2000 motion cycles.

Relubricating

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

- Do not relubricate the L-509 without consulting our customer service department. (p. 41).

7.3 Cleaning the L-509

Requirements

- ✓ You have disconnected the stage from the controller and the power adapter.

Cleaning the positioner

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

8 Troubleshooting

8.1 Possible Causes and Remedies

Problem	Possible causes	Solution
Reduced positioning accuracy	Warped base body	➢ Mount the L-509 onto an even surface. The recommended flatness of the surface is ≤ 10 µm.
	When the L-509 is mounted vertically: The load exceeds the self-locking of the drive.	➢ Reduce the load. Make sure that the self-locking of the drive is not exceeded (see specification of the holding force in the data table, p. 43).
	Increased wear due to small motion over a long period of time	➢ Perform a maintenance run over the entire travel range (p. 35).
Impairment of the function after system modification	▪ Controller was replaced. ▪ The LS509 was replaced by another model.	Controller from PI: ➢ Load the parameters from the positioner database that correspond to the combination of controller and the L-509 model. Controller from a third-party supplier: ➢ Check the operating parameters.
For L-509.x0SD00 models: Actual position deviates from the displayed position.	The motor is overloaded by an external load torque or the mass to be driven in the case of strong acceleration or deceleration.	The motor skips steps. The information on the current position is lost without the controller detecting the state. ➢ Use a stepper motor in the application to determine the maximum velocity for a stage. ➢ Start a new reference move.

Problem	Possible causes	Solution
Mechanical system does not move; no operating noise can be heard.	Controller not correctly connected or defective.	➢ Check all connecting cables. ➢ Check the controller.
	When a PI controller is used: Axis motion error.	Motion error = The difference between the current position and the commanded position exceeds the specified maximum value in closed-loop operation. Motion errors can be caused for example, by malfunctions of the drive or the position sensor of the stage. 1. Read out the error code of the controller in the PC software. If there is a motion error, error code -1024 is output. 2. Check your system and make sure that all axes can be moved safely. 3. Switch on the servo mode for the affected axis in the PC Software. For details, see the user manual for the controller.
	Motion platform has triggered the limit switch.	If you use a controller from PI: 1. Switch on the servo mode for the affected axis again in the PC software. 2. Command an axis motion away from the limit switch in the PC software.

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. 41).

8.2 Moving the Platform by Hand

INFORMATION

It can be necessary to move the platform by hand to provide access to mounting holes for mounting screws in the base body of the positioner.

INFORMATION

Manual movement of the platform is not possible for the L-509.x0AD10 / L-509.x4AD00 / L-509.x0DG10 models.

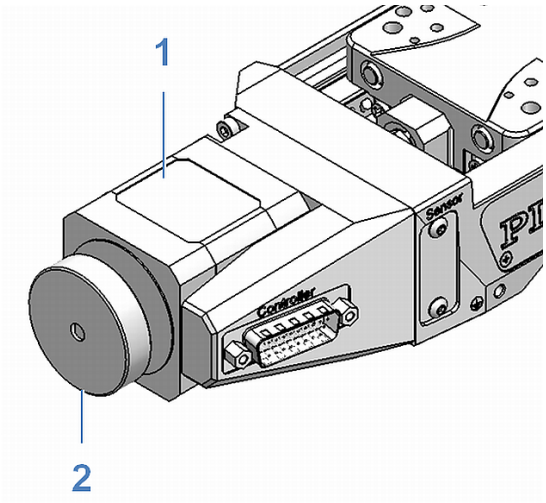


Figure 11: Position of the vibration absorber

1 Motor
2 Vibration absorber

Requirements

The stage is **not** connected to the controller.

Moving the platform by hand

➢ Turn the vibration absorber as far as necessary:
  – Clockwise rotation: Platform moves away from the motor
  – Counterclockwise rotation: Platform moves in the direction of the motor

The rotary motion is transferred directly to the drive screw.

9 Customer Service Department

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

- If you have any questions concerning your system, provide the following information:
  - Product codes 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 on our website (p. 3) for download.

10 Technical Data

10.1 Specifications

10.1.1 Data Table

Motion	Unit	Toleran-ce	L-509. 023111	L-509. 033111	L-509. 053111	L-509. 023132	L-509. 033132	L-509. 053132	L-509. 025132	L-509. 035132
Active axes			X	X	X	X	X	X	X	X
Travel range in X	mm		26	52	102	26	52	102	26	52
Maximum velocity in X, unloaded	mm/s		50	50	50	50	50	50	50	50
Straightness (Linear cross-talk in Y with motion in X)	µm	Typ.	± 1	± 2	± 4	± 1	± 2	± 4	± 1	± 2
Flatness (Linear crosstalk in Z with motion in X)	µm	Typ.	± 1	± 2	± 4	± 1	± 2	± 4	± 1	± 2
Pitch (Rotational crosstalk in θY with motion in X)	µrad	Typ.	± 60	± 90	± 120	± 60	± 90	± 120	± 60	± 90
Yaw (Rotational crosstalk in θZ with motion in X)	µrad	Typ.	± 60	± 90	± 120	± 60	± 90	± 120	± 60	± 90

Positioning	Unit	Toleran-ce	L-509. 023111	L-509. 033111	L-509. 053111	L-509. 023132	L-509. 033132	L-509. 053132	L-509. 025132	L-509. 035132
Integrated sensor			Incremental linear enco- der	Incremental linear enco- der	Incremental linear enco- der	Incremental rotary en-coder	Incremental rotary en-coder	Incremental rotary en-coder	Incremental rotary en-coder	Incremental rotary en-coder
Unidirectional repeatability in X	µm	Typ.	± 0.1	± 0.1	± 0.1	± 0.2	± 0.2	± 0.2	± 0.2	± 0.2
Bidirectional repeatability in X	µm	Typ.	0.2	0.2	0.2	0.5	0.5	0.5	0.5	0.5
Minimum incremental motion in X	µm	Typ.	0.1	0.1	0.1	0.5	0.5	0.5	0.5	0.5
Sensor signal			Sin/cos, 1 V peak-peak	Sin/cos, 1 V peak-peak	Sin/cos, 1 V peak-peak	A/B quadra-ture, RS-422	A/B quadra-ture, RS-422	A/B quadra-ture, RS-422	A/B quadra-ture, RS-422	A/B quadra-ture, RS-422
Sensor signal period	µm		20	20	20					
Reference switch			Optical	Optical	Optical	Optical	Optical	Optical	Optical	Optical
Limit switches			Optical	Optical	Optical	Optical	Optical	Optical	Optical	Optical

Drive Properties	Unit	Toleran-ce	L-509. 023111	L-509. 033111	L-509. 053111	L-509. 023132	L-509. 033132	L-509. 053132	L-509. 025132	L-509. 035132
Drive type			DC motor	DC motor	DC motor	DC motor	DC motor	DC motor	Brushless DC motor	Brushless DC motor
Motor resolution	Full steps/ rev.									
Nominal voltage	V		24	24	24	24	24	24	24	24
Peak voltage	V		48	48	48	48	48	48	48	48
Drive force in negative direction of motion in X	N	Typ.	60	60	60	60	60	60	60	60
Drive force in positive direction of motion in X	N	Typ.	60	60	60	60	60	60	60	60
Resistance phase-phase	Ω	Typ.							0.81	0.81
Inductance phase-phase	mH								0.64	0.64
Back EMF, phase-phase, rotational	V/kRPM	Max.							3.3	3.3
Number of pole pairs									7	7

Mechanical Properties	Unit	Toleran-ce	L-509. 023111	L-509. 033111	L-509. 053111	L-509. 023132	L-509. 033132	L-509. 053132	L-509. 025132	L-509. 035132
Guide			Crossed roller guide	Crossed roller guide	Crossed roller guide	Crossed roller guide	Crossed roller guide	Crossed roller guide	Crossed roller guide	Crossed roller guide
Drive screw type			Ball screw	Ball screw	Ball screw	Ball screw	Ball screw	Ball screw	Ball screw	Ball screw
Drive screw pitch	mm		1	1	1	1	1	1	1	1
Gear ratio i										
Holding force in X, passive	N									
Moved mass in X, unloaded	g		240	240	250	220	220	220	220	220
Permissible push force in Y	N	Max.	50	50	50	50	50	50	50	50
Permissible push force in Z	N	Max.	100	100	100	100	100	100	100	100
Permissible torque in θx	N·m	Max.	30	30	30	30	30	30	30	30
Permissible torque in θY	N·m	Max.	25	25	25	25	25	25	25	25
Permissible torque in θZ	N·m	Max.	20	20	20	20	20	20	20	20
Overall mass	g		1200	1300	1500	1200	1300	1500	1400	1500
Material			Aluminium, Stahl	Aluminium, Stahl	Aluminium, Stahl	Aluminium, Stahl	Aluminium, Stahl	Aluminium, Stahl	Aluminum, steel	Aluminum, steel

Miscellaneous	Unit		L-509. 023111	L-509. 033111	L-509. 053111	L-509. 023132	L-509. 033132	L-509. 053132	L-509. 025132	L-509. 035132
Connector			HD D-sub 26-pin (m)	HD D-sub 26-pin (m)	HD D-sub 26-pin (m)	HD D-sub 26-pin (m)	HD D-sub 26-pin (m)	HD D-sub 26-pin (m)	HD D-sub 26-pin (m)	HD D-sub 26-pin (m)
Sensor connector			D-sub 9-pin (m)	D-sub 9-pin (m)	D-sub 9-pin (m)					
Recommended controllers / drivers			C-863 C-885 mit C-863. 20C885 C-884 G-901 G-910	C-863 C-885 mit C-863. 20C885 C-884 G-901 G-910	C-863 C-885 mit C-863. 20C885 C-884 G-901 G-910	C-863 C-885 mit C-863. 20C885 C-884 G-901 G-910	C-863 C-885 mit C-863. 20C885 C-884 G-901 G-910	C-863 C-885 mit C-863. 20C885 C-884 G-901 G-910	C-891 C-885 with C-891. 11C885 G-901 G-910	C-891 C-885 with C-891. 11C885 G-901 G-910
Operating temperature range	°C		5 bis 40	5 bis 40	5 bis 40	5 bis 40	5 bis 40	5 bis 40	5 to 40	5 to 40

Motion	Unit	Toleran-ce	L-509. 055132	L-509. 10AD10	L-509. 20AD10	L-509. 40AD10	L-509. 14AD00	L-509. 24AD00	L-509. 44AD00	L-509. 10DG10
Active axes			X	X	X	X	X	X	X	X
Travel range in X	mm		102	26	52	102	26	52	102	26
Maximum velocity in X, unloaded	mm/s		50	50	50	50	50	50	50	3
Straightness (Linear crosstalk in Y with motion in X)	µm	Typ.	± 4	± 1	± 2	± 4	± 1	± 2	± 4	± 1
Flatness (Linear crosstalk in Z with motion in X)	µm	Typ.	± 4	± 1	± 2	± 4	± 1	± 2	± 4	± 1
Pitch (Rotational crosstalk in θY with motion in X)	µrad	Typ.	± 120	± 60	± 90	± 120	± 60	± 90	± 120	± 60
Yaw (Rotational crosstalk in θZ with motion in X)	µrad	Typ.	± 120	± 60	± 90	± 120	± 60	± 90	± 120	± 60

Positioning	Unit	Toleran-ce	L-509. 055132	L-509. 10AD10	L-509. 20AD10	L-509. 40AD10	L-509. 14AD00	L-509. 24AD00	L-509. 44AD00	L-509. 10DG10
Integrated sensor			Incremental rotary encoder	Incremental rotary encoder	Incremental rotary encoder	Incremental rotary encoder	Incremental linear enco- der	Incremental linear enco- der	Incremental linear enco- der	Incremental rotary encoder
Unidirectional repeatability in X	µm	Typ.	± 0.2	± 0.2	± 0.2	± 0.2	± 0.1	± 0.1	± 0.1	± 0.4
Bidirectional repeatability in X	µm	Typ.	0.5	0.5	0.5	0.5	0.2	0.2	0.2	3

Positioning	Unit	Toleran-ce	L-509. 055132	L-509. 10AD10	L-509. 20AD10	L-509. 40AD10	L-509. 14AD00	L-509. 24AD00	L-509. 44AD00	L-509. 10DG10
Minimum incremental motion in X	µm	Typ.	0.5	0.8	0.8	0.8	0.2	0.2	0.2	0.1
Sensor signal			A/B quadra-ture, RS-422	A/B quadra-ture, RS-422	A/B quadra-ture, RS-422	A/B quadra-ture, RS-422	A/B quadra-ture, RS-422	A/B quadra-ture, RS-422	A/B quadra-ture, RS-422	A/B quadra-ture, RS-422
Sensor signal period	µm									
Reference switch			Optical	Optical	Optical	Optical	Optical	Optical	Optical	Optical
Limit switches			Optical	Optical	Optical	Optical	Optical	Optical	Optical	Optical

Drive Properties	Unit	Toleran-ce	L-509. 055132	L-509. 10AD10	L-509. 20AD10	L-509. 40AD10	L-509. 14AD00	L-509. 24AD00	L-509. 44AD00	L-509. 10DG10
Drive type			Brushless DC motor	DC motor with Active-Drive	DC motor with Active-Drive	DC motor with Active-Drive	DC motor with Active-Drive	DC motor with Active-Drive	DC motor with Active-Drive	DC gear motor
Motor resolution	Full steps/ rev.									
Nominal voltage	V		24	24	24	24	24	24	24	24
Peak voltage	V		48	24	24	24	24	24	24	48
Drive force in negative di-rection of motion in X	N	Typ.	60	60	60	60	60	60	60	60
Drive force in positive di-rection of motion in X	N	Typ.	60	60	60	60	60	60	60	60
Resistance phase-phase	Ω	Typ.	0.81	1.63	1.63	1.63	1.63	1.63	1.63	4.09
Inductance phase-phase	mH		0.64	0.27	0.27	0.27	0.27	0.27	0.27	0.18
Back EMF, phase-phase, rotational	V/kRPM	Max.	3.3	3.95	3.95	3.95	3.95	3.95	3.95	1.68
Number of pole pairs			7							

Mechanical Properties	Unit	Toleran-ce	L-509. 055132	L-509. 10AD10	L-509. 20AD10	L-509. 40AD10	L-509. 14AD00	L-509. 24AD00	L-509. 44AD00	L-509. 10DG10
Guide			Crossed rol-ler guide	Crossed rol-ler guide	Crossed rol-ler guide	Crossed rol-ler guide	Crossed rol-ler guide	Crossed rol-ler guide	Crossed rol-ler guide	Crossed rol-ler guide
Drive screw type			Ball screw	Ball screw	Ball screw	Ball screw	Ball screw	Ball screw	Ball screw	Ball screw
Drive screw pitch	mm		1	1	1	1	1	1	1	1
Gear ratio i										2401 : 81
Holding force in X, passive	N									50
Moved mass in X, unloa-ded	g		220	220	220	220	240	240	250	220
Permissible push force in Y	N	Max.	50	50	50	50	50	50	50	50
Permissible push force in Z	N	Max.	100	100	100	100	100	100	100	100
Permissible torque in θx	N·m	Max.	30	30	30	30	30	30	30	30
Permissible torque in θY	N·m	Max.	25	25	25	25	25	25	25	25
Permissible torque in θZ	N·m	Max.	20	20	20	20	20	20	20	20
Overall mass	g		1700	1400	1500	1700	1400	1600	1800	1400
Material			Aluminum, steel	Aluminum, steel	Aluminum, steel	Aluminum, steel	Aluminum, steel	Aluminum, steel	Aluminum, steel	Aluminum, steel

Miscellaneous	Unit		L-509. 055132	L-509. 10AD10	L-509. 20AD10	L-509. 40AD10	L-509. 14AD00	L-509. 24AD00	L-509. 44AD00	L-509. 10DG10
Connector			HD D-sub 26-pin (m)	D-sub 15-pin (m)	D-sub 15-pin (m)	D-sub 15-pin (m)	D-sub 15-pin (m)	D-sub 15-pin (m)	D-sub 15-pin (m)	HD D-sub 26-pin (m)
Sensor connector										

Miscellaneous	Unit		L-509.055132	L-509.10AD10	L-509.20AD10	L-509.40AD10	L-509.14AD00	L-509.24AD00	L-509.44AD00	L-509.10DG10
Recommended controllers / drivers			C-891 C-885 with C-891.11C885 G-901 G-910	C-863 C-885 with C-863.20C885 C-884	C-863 C-885 with C-863.20C885 C-884	C-863 C-885 with C-863.20C885 C-884	C-863 C-885 with C-863.20C885 C-884	C-863 C-885 with C-863.20C885 C-884	C-863 C-885 with C-863.20C885 C-884	C-863 C-885 with C-863.20C885 C-884 G-901 G-910
Operating temperature range	°C		5 to 40	5 to 40	5 to 40	5 to 40	5 to 40	5 to 40	5 to 40	5 to 40

Motion	Unit	Tolerance	L-509.20DG10	L-509.40DG10	L-509.10SD00	L-509.20SD00	L-509.40SD00	L-509.1ASD00	L-509.2ASD00	L-509.4ASD00
Active axes			X	X	X	X	X	X	X	X
Travel range in X	mm		52	102	26	52	102	26	52	102
Maximum velocity in X, unloaded	mm/s		3	3	20	20	20	20	20	20
Straightness (Linear crosstalk in Y with motion in X)	µm	Typ.	± 2	± 4	± 1	± 2	± 4	± 1	± 2	± 4
Flatness (Linear crosstalk in Z with motion in X)	µm	Typ.	± 2	± 4	± 1	± 2	± 4	± 1	± 2	± 4
Pitch (Rotational crosstalk in θY with motion in X)	µrad	Typ.	± 90	± 120	± 60	± 90	± 120	± 60	± 90	± 120
Yaw (Rotational crosstalk in θZ with motion in X)	µrad	Typ.	± 90	± 120	± 60	± 90	± 120	± 60	± 90	± 120

Positioning	Unit	Tolerance	L-509.20DG10	L-509.40DG10	L-509.10SD00	L-509.20SD00	L-509.40SD00	L-509.1ASD00	L-509.2ASD00	L-509.4ASD00
Integrated sensor			Incremental rotary encoder	Incremental rotary encoder				Incremental linear encoder	Incremental linear encoder	Incremental linear encoder
Unidirectional repeatability in X	µm	Typ.	± 0.4	± 0.4	± 0.3	± 0.3	± 0.3	± 0.1	± 0.1	± 0.1
Bidirectional repeatability in X	µm	Typ.	3	3	1	1	1	0.2	0.2	0.2
Minimum incremental motion in X	µm	Typ.	0.1	0.1	0.1	0.1	0.1	0.02	0.02	0.02
Sensor signal			A/B quadrature, RS-422	A/B quadrature, RS-422				Sin/cos, 1 V peak-peak	Sin/cos, 1 V peak-peak	Sin/cos, 1 V peak-peak
Sensor signal period	µm							20	20	20
Reference switch			Optical	Optical	Optical	Optical	Optical	Optical	Optical	Optical
Limit switches			Optical	Optical	Optical	Optical	Optical	Optical	Optical	Optical

Drive Properties	Unit	Tolerance	L-509.20DG10	L-509.40DG10	L-509.10SD00	L-509.20SD00	L-509.40SD00	L-509.1ASD00	L-509.2ASD00	L-509.4ASD00
Drive type			DC gear motor	DC gear motor	2-phase stepper motor	2-phase stepper motor	2-phase stepper motor	2-phase stepper motor	2-phase stepper motor	2-phase stepper motor
Motor resolution	Full steps/rev.				200	200	200	200	200	200
Nominal voltage	V		24	24	24	24	24	24	24	24
Peak voltage	V		48	48	48	48	48	48	48	48
Drive force in negative direction of motion in X	N	Typ.	60	60	60	60	60	60	60	60
Drive force in positive direction of motion in X	N	Typ.	60	60	60	60	60	60	60	60
Resistance phase-phase	Ω	Typ.	4.09	4.09	3.3	3.3	3.3	3.3	3.3	3.3
Inductance phase-phase	mH		0.18	0.18	2.8	2.8	2.8	2.8	2.8	2.8
Back EMF, phase-phase, rotational	V/kRPM	Max.	1.68	1.68						

Drive Properties	Unit	Toleran-ce	L-509. 20DG10	L-509. 40DG10	L-509. 10SD00	L-509. 20SD00	L-509. 40SD00	L-509. 1ASD00	L-509. 2ASD00	L-509. 4ASD00
Number of pole pairs										

Mechanical Properties	Unit	Toleran-ce	L-509. 20DG10	L-509. 40DG10	L-509. 10SD00	L-509. 20SD00	L-509. 40SD00	L-509. 1ASD00	L-509. 2ASD00	L-509. 4ASD00
Guide			Crossed roller guide	Crossed roller guide	Crossed roller guide	Crossed roller guide	Crossed roller guide	Crossed roller guide	Crossed roller guide	Crossed roller guide
Drive screw type			Ball screw	Ball screw	Ball screw	Ball screw	Ball screw	Ball screw	Ball screw	Ball screw
Drive screw pitch	mm		1	1	1	1	1	1	1	1
Gear ratio i			2401 : 81	2401 : 81						
Holding force in X, passive	N		50	50	50	50	50	50	50	50
Moved mass in X, unloaded	g		220	220	220	220	220	240	240	250
Permissible push force in Y	N	Max.	50	50	50	50	50	50	50	50
Permissible push force in Z	N	Max.	100	100	100	100	100	100	100	100
Permissible torque in θx	N·m	Max.	30	30	30	30	30	30	30	30
Permissible torque in θY	N·m	Max.	25	25	25	25	25	25	25	25
Permissible torque in θZ	N·m	Max.	20	20	20	20	20	20	20	20
Overall mass	g		1600	1900	1400	1500	1700	1400	1600	1800
Material			Aluminum, steel	Aluminum, steel	Aluminum, steel	Aluminum, steel	Aluminum, steel	Aluminum, steel	Aluminum, steel	Aluminum, steel

Miscellaneous	Unit		L-509. 20DG10	L-509. 40DG10	L-509. 10SD00	L-509. 20SD00	L-509. 40SD00	L-509. 1ASD00	L-509. 2ASD00	L-509. 4ASD00
Connector			HD D-sub 26-pin (m)	HD D-sub 26-pin (m)	HD D-sub 26-pin (m)	HD D-sub 26-pin (m)	HD D-sub 26-pin (m)	HD D-sub 26-pin (m)	HD D-sub 26-pin (m)	HD D-sub 26-pin (m)
Sensor connector								D-sub 9-pin (m)	D-sub 9-pin (m)	D-sub 9-pin (m)
Recommended controllers / drivers			C-863 C-885 with C-863.20C885 C-884 G-901 G-910	C-863 C-885 with C-863.20C885 C-884 G-901 G-910	C-663.12 C-885 with C-663.12C885 G-901 G-910	C-663.12 C-885 with C-663.12C885 G-901 G-910	C-663.12 C-885 with C-663.12C885 G-901 G-910	C-663.12 C-885 with C-663.12C885 G-901 G-910	C-663.12 C-885 with C-663.12C885 G-901 G-910	C-663.12 C-885 with C-663.12C885 G-901 G-910
Operating temperature range	°C		5 to 40	5 to 40	5 to 40	5 to 40	5 to 40	5 to 40	5 to 40	5 to 40

10.1.2 Maximum Ratings

L-509 stages are designed for the following operating data:

Models	Maximum operating voltage	Operating frequency	Maximum power consumption
L-509.x0SD00 L-509.xASD00	48 V	0 Hz	10 W
L-509.x0DG10	48 V	0 Hz	8.5 W
L-509.x4AD00 L-509.x0AD10	24 V	0 Hz	80 W
L 509.0x3111 L 509.0x3132	48 V	0 Hz	
L 509.0x5132	48 V	0 Hz	

10.1.3 Ambient Conditions and Classifications

The following ambient conditions and classifications must be observed for the L-509:

Area of application	For indoor use only
Maximum altitude	2000 m
Relative humidity	Max. 80 % for temperatures up to 31 °C Linearly decreasing to 50 % at 40 °C
Storage temperature	-20 °C to 70 °C
Transport temperature	-20 °C to 70 °C
Supply fluctuations	Max. ±10 % of the nominal voltage
Degree of pollution	2
Degree of protection according to IEC 60529	IP00

10.1.4 Limit Switch Specifications

Type	Optical sensor
Supply voltage	+5 V / ground
Signal output	Open collector
Signal logic	The signal level changes when passing the limit switch. The signal logic is active high. That means: ▪ Normal motor operation: low (0 V) ▪ Limit switch reached: high (+5 V)

10.1.5 Reference Switch Specifications

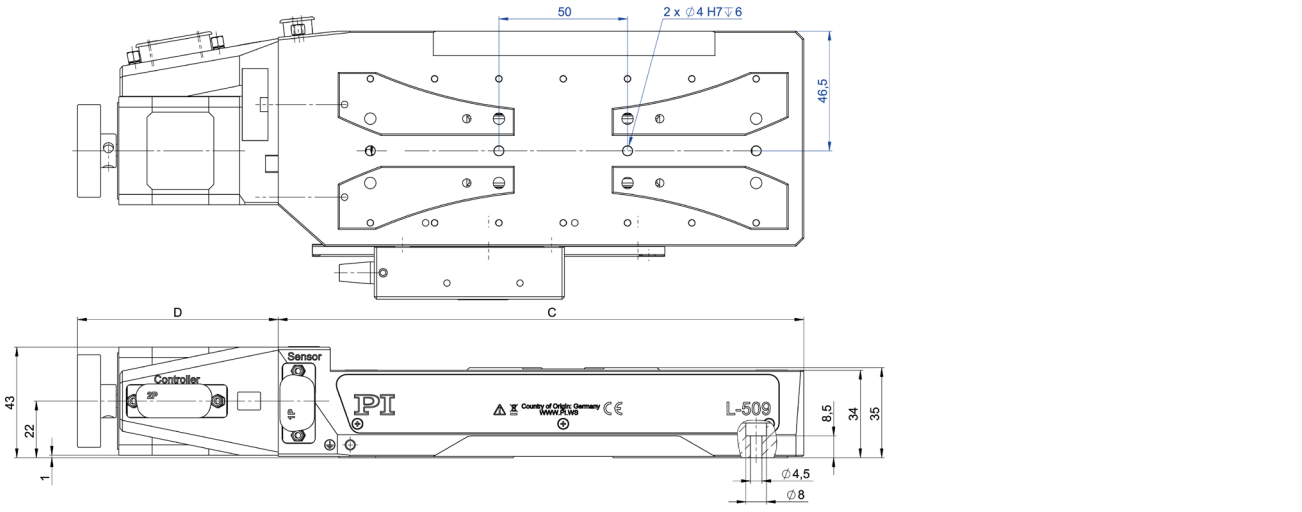
Type	Optical sensor
Supply voltage	+5 V/GND, supplied via the motor connector
Signal output	Open collector
Signal logic	Direction sensing by means of different signal levels on the left and right side of the reference switch: The signal level changes from 0 to +5 V when the reference switch is passed.

10.2 Dimensions

10.2.1 L-509 Positioner

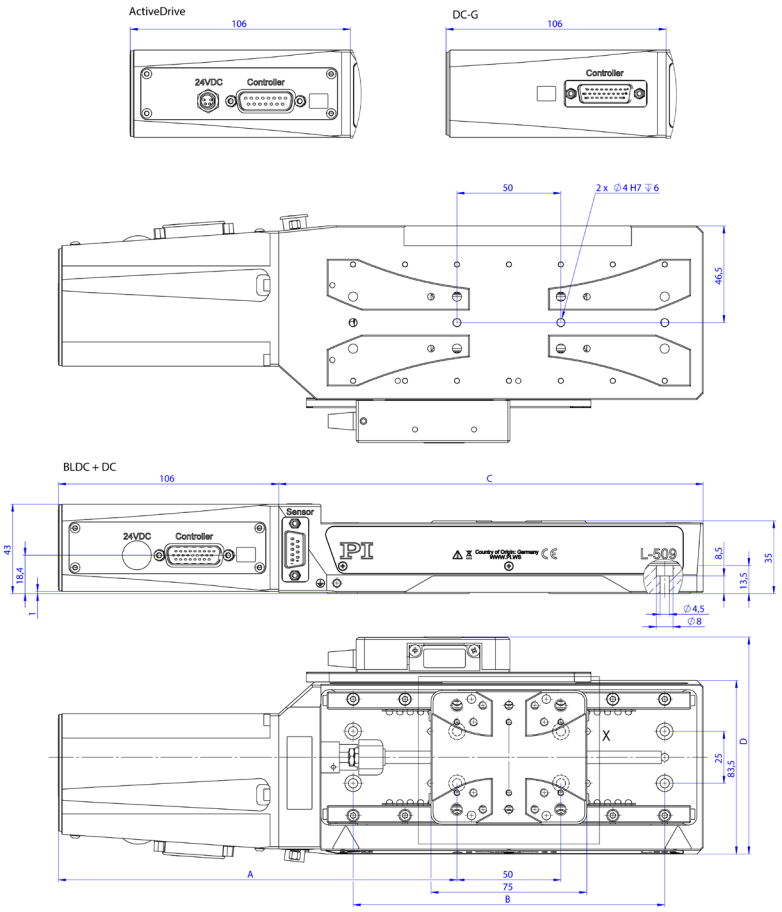
For a detailed view (X) der of the motion platform, see "Hole Patterns of the Motion Platform of the L-509" (p. 52).

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



	A	B	C	D	E
L-509.10SD00	129,3	100	135,3	78	-
L-509.1ASD00	129,3	100	135,3	78	104,2
L-509.20SD00	138,8	100	154,3	78	-
L-509.2ASD00	138,8	100	154,3	78	104,2
L-509.40SD00	163,8	150	204,3	78	-
L-509.4ASD00	163,8	150	204,3	78	104,2

Figure 12: L-509 versions with stepper motor



	A	B	C	D
BLDC + DC				
L-509.023111	157,3	100	135,3	104,2
L-509.023132	157,3	100	135,3	-
L-509.025132	157,3	100	135,3	-
L-509.033111	166,8	100	154,3	104,2
L-509.033132	166,8	100	154,3	-
L-509.035132	166,8	100	154,3	-
L-509.053111	191,8	150	204,3	104,2
L-509.053132	191,8	150	204,3	-
L-509.055132	191,8	150	204,3	-
ActiveDrive DC				
L-509.10AD10	157,3	100	135,3	-
L-509.14AD00	157,3	100	135,3	104,2
L-509.20AD10	166,8	100	154,3	-
L-509.24AD00	166,8	100	154,3	104,2
L-509.40AD10	191,8	150	204,3	-
L-509.44AD00	191,8	150	204,3	104,2
DC-G				
L-509.10DG10	157,3	100	135,3	-
L-509.20DG10	166,8	100	154,3	-
L-509.40DG10	191,8	150	204,3	-

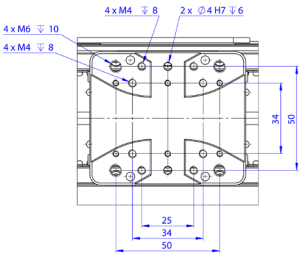


Figure 13: L-509 versions with BLDC, DC, DC gearhead, and ActiveDrive DC motors

10.2.2 Hole Pattern of the Motion Platform of the L-509

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

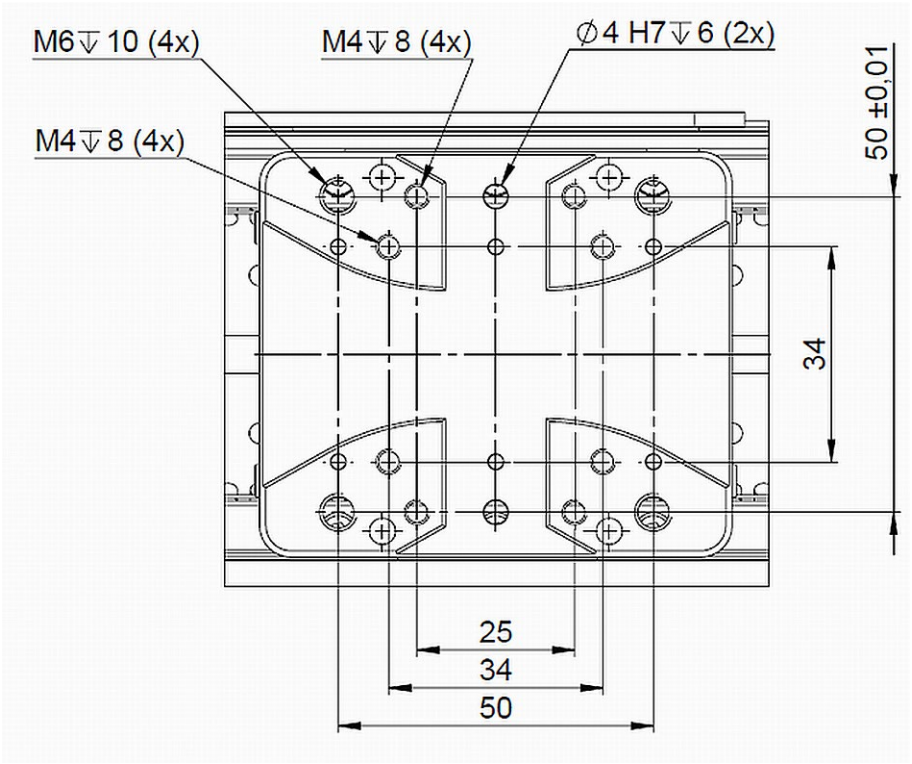


Figure 14: Hole pattern of the platform

10.2.3 L-500.AV3 Adapter Bracket

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

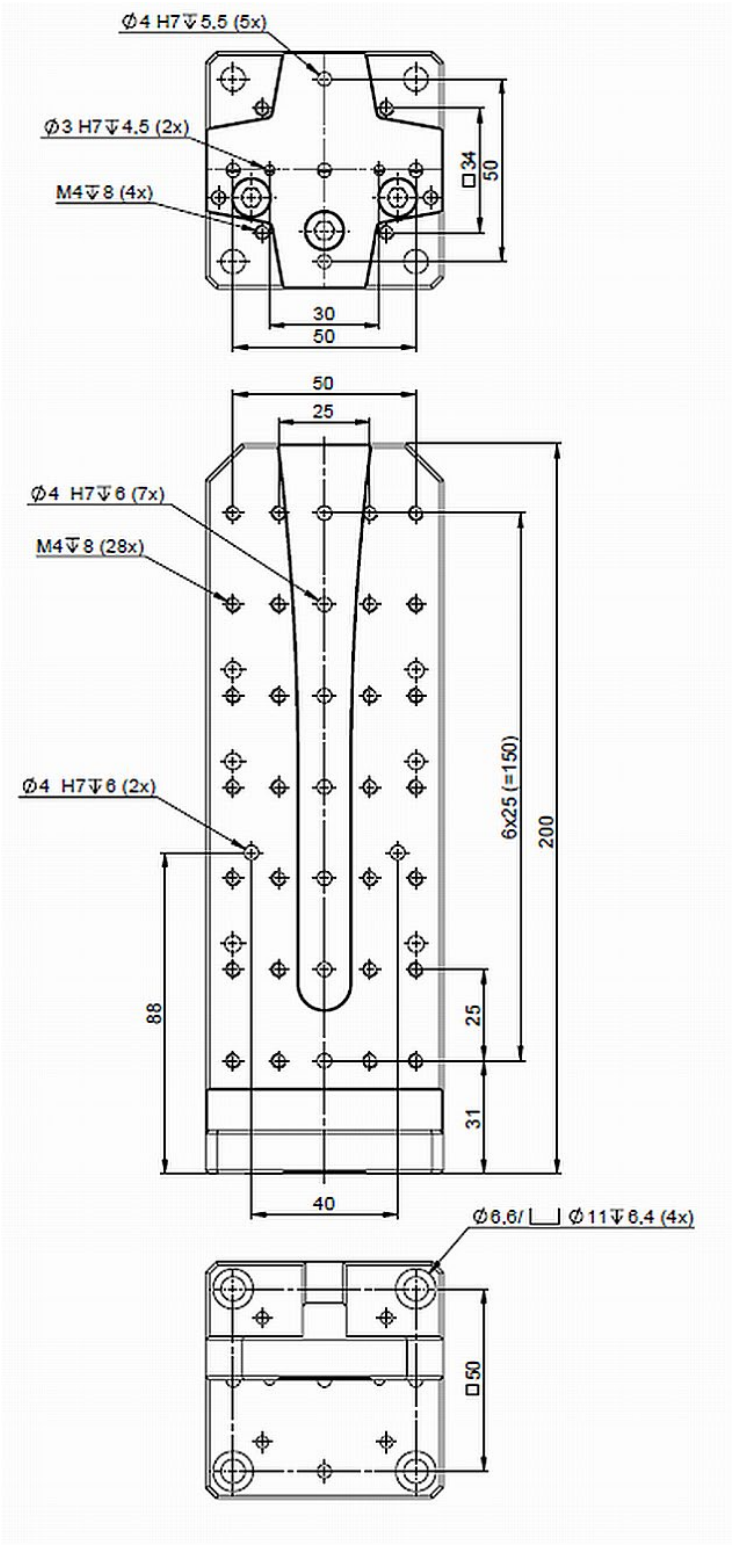


Figure 15: L-500.AV3 adapter bracket

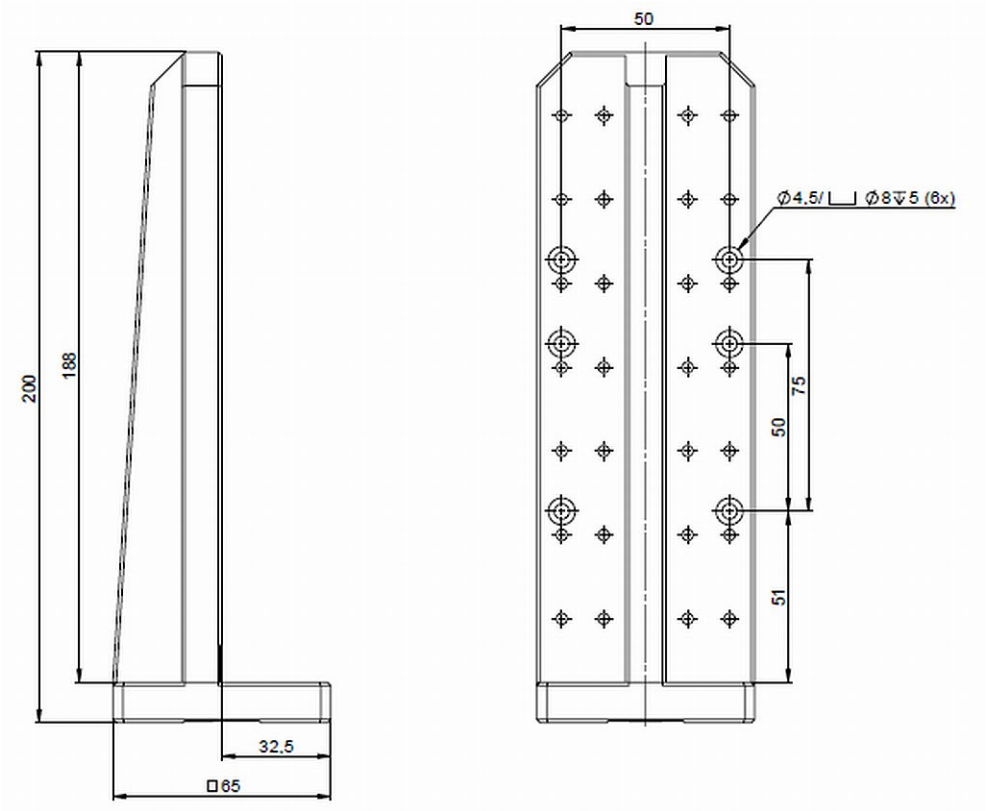


Figure 16: L-500.AV3 adapter bracket

10.3 Tightening Torque for Screws, ISO 4762 - A2

The following tightening torques for screws according to ISO4762 (corresponds to DIN 912) - A2 may not be exceeded.

Value	Maximum tightening torque
M3	1.5 Nm
M4	2 Nm
M5	2.5 Nm
M6	3 Nm

10.4 Pin Assignment

10.4.1 HD D-Sub 26 (Male)

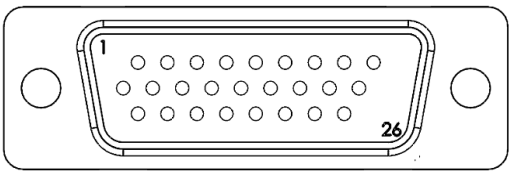


Figure 17: HD D-Sub 26 panel plug

L-509.x0SD00 / L-509.xASD00 models

Pin	Signal	Direction
1	Motor A+	Input
2	Motor A+	Input
3	Motor A-	Input
4	Motor A-	Input
5	Motor B+	Input
6	Motor B+	Input
7	Motor B-	Input
8	Motor B-	Input
9	-	-
10	REF	Output
11	Limit E1 (neg)	Output
12	Limit E2 (pos)	Output
13 - 16	-	-
17	ID	Output
18	Limit Power (5 V)	Input
19 - 24	-	-
25	GND (limit)	-
26	-	-

L-509.x0DG10 / L 509.0x3111 / L 509.0x3132 models

Pin	Signal	Direction
1	Motor +	Input
2	Motor +	Input
3	Motor -	Input
4	Motor -	Input
5 - 9	-	-
10	REF	Output
11	Limit E1 (neg)	Output
12	Limit E2 (pos)	Output
13 - 16	-	-
17	ID	Output
18	Limit Power (5 V)	Input
19	Encoder A+	Output
20	Encoder A-	Output
21	Encoder B+	Output
22	Encoder B-	Output
23	Encoder C+	Output
24	Encoder C-	Output
25	GND (limit, encoder)	-
26	Encoder power (+5 V)	Input

L-509.0x5132 models

Pin	Signal	Direction
1	Phase 1	Input
2	Phase 1	Input
3	Phase 2	Input
4	Phase 2	Input
5	Phase 3	Input
6	Phase 3	Input
7 - 9	-	-
10	REF	Output
11	Limit neg.	Output
12	Limit pos.	Output

Pin	Signal	Direction
13	Hall 1	Output
14	Hall 2	Output
15	Hall 3	Output
16	-	-
17	ID	Output
18	Limit Power (+5 V)	Output
19	Encoder A+	Output
20	Encoder A-	Output
21	Encoder B+	Output
22	Encoder B-	Output
23	Encoder C+	Output
24	Encoder C-	Output
25	GND	-
26	Encoder Power (5 V DC)	Input

10.4.2 D-Sub 15 (Male)

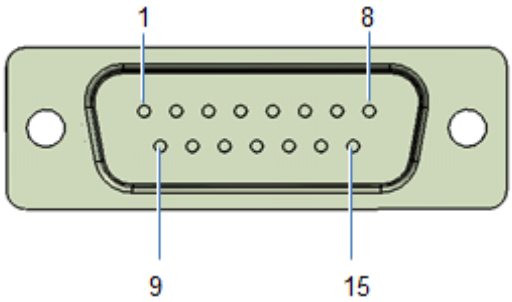


Figure 18: D-Sub 15 panel plug (L-509.x0AD10 and L-509.xAD00 models only)

Pin	Signal	Direction
1	-	-
2	Motor +	Input
3	MAGN	Input
4	Power 5 V	Input
5	Limit pos.	Output
6	ID	Output
7	Encoder A-	Output
8	Encoder B-	Output

Pin	Signal	Direction
9	Motor -	Input
10	GND	-
11	SIGN	Input
12	Limit neg.	Output
13	REF	Output
14	Encoder A+	Output
15	Encoder B+	Output

10.4.3 D-Sub 9 (Male)

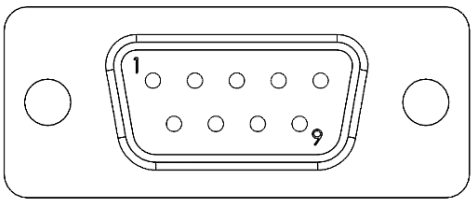


Figure 19: D-Sub 9 panel plug (L-509.xASD00 and L-509.0x3111 models only)

Pin	Signal	Direction
1	Linear encoder A+	Output
2	Linear encoder B+	Output
3	Linear encoder C+	Output
4	Linear encoder GND	-
5	Linear encoder Power (+ 5 V)	Input
6	Linear encoder A-	Output
7	Linear encoder B-	Output
8	Linear encoder C-	Output
9	-	-

10.4.4 M8 4-pin (Male)

Connecting a power adapter is only necessary for the L-509.x0AD10 and L-509.x4AD00 models.

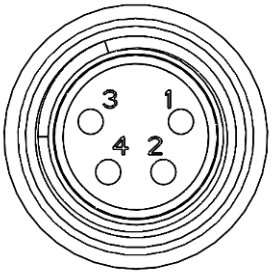


Figure 20: Power adapter connector M8, 4-pin

Pin	Signal	Direction
1	GND	GND
2	GND	GND
3	24 V DC supply voltage	Input
4	24 V DC supply voltage	Input

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.

In order to fulfil the responsibility as the product manufacturer, PI miCos GmbH undertakes environmentally correct disposal of all old PI miCos equipment made available on the market after 13 August, 2005 without charge.

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

PI miCos GmbH

Freiburger Straße 30

79427 Eschbach, Germany

12 EU Declaration of Conformity

An EU Declaration of Conformity has been issued for the L-509 in accordance with the following European directives:

EMC Directive

RoHS Directive

The standards applied for certifying the conformity are listed below.

EMC: EN 61326-1

Safety: EN 61010-1

RoHS: EN 50581