PZ75E

S-340 Tip/Tilt Platform

User Manual

Version: 3.0.1 Date: 02.12.2020

This document describes the following products:

- **S-340.x0L**
  Tip/tilt platform, 2 mrad, open-loop, LEMO connectors
- **S-340.xSL**
  Tip/tilt platform, 2 mrad, SGS, LEMO connectors
- **S-340.xSD**
  Tip/tilt platform, 2 mrad, SGS, D-sub connector

The letter "x" stands for the respective model:
A: Aluminum cover plate
I: Invar cover plate

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Contents

1 About this Document

In this Chapter

1.1 Objective and Target Audience of this User Manual

This user manual contains the information required for using the S-340 as intended.

Basic knowledge of servo systems, drive technologies, and suitable safety measures is assumed.

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 injury.

➢ Precautionary measures for avoiding the risk.

NOTICE

Dangerous situation
Failure to comply could cause damage to equipment.

➢ Precautionary measures for avoiding the risk.

INFORMATION

Information for easier handling, tricks, tips, etc.

Symbol/ Label	Meaning
1. 2.	Action consisting of several steps with strict sequential order
➢	Action consisting of one or more steps without relevant sequential order.
▪	Bullet
p. 5	Cross-reference to page 5
RS-232	Label on the product indicating an operating element (example: RS-232 interface socket)
	Warning signs attached to the product that refer to detailed information in this manual.

1.3 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.

1.4 Other Applicable Documents

The devices and software tools from PI mentioned in this documentation are described in separate manuals.

Product	Document
E-509.S3 sensor/servo controller module	PZ77E User Manual
E-503.00S piezo amplifier module	PZ62E User Manual
E-505.00 piezo amplifier module	
E-505.00S offset voltage source for tip/tilt platforms	
E-501.00 9.5" housing for modular piezo controller system	
E-501.00 19" housing for modular piezo controller system, 1 to 3 channels	
E-518.I3 interface module	E518T0001 User Manual
E-616 multi-channel servo controller for piezo tip/tilt mirrors	PZ219 User Manual PZ200 User Manual
E-727.xF digital multi-channel piezo controller with EtherCAT	E727T0005 User Manual
E-727.x • E-727.xAP digital multi-channel piezo controller	E727T0005 User Manual

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

1.5 Downloading Manuals

INFORMATION

If a manual is missing or problems occur with downloading:

➢ Contact our customer service department (p. 41).

Downloading manuals

1. Open the website **www.pi.ws**.
2. Search the website for the product number (e.g., S-340) or the product family (e.g., tip/tilt platform).
3. Click the corresponding product to open the product detail page.
4. Click the ***Downloads*** tab.

   The manuals are shown under ***Documentation***. Software manuals are shown under ***General Software Documentation***.
5. Click the desired manual and fill out the inquiry form.

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

2 Safety

In this Chapter

2.1 Intended Use

The S-340 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 S-340 is intended for precision positioning and alignment of a mirror in two orthogonal axes with a common pivot point (parallel kinematics). The S-340 is suitable for highly dynamic applications and can be mounted in any orientation.

The S-340 is dispatched without a mirror and is intended to be used for attaching a suitable mirror (p. 25).

The S-340 can only be used as intended in conjunction with suitable electronics (p. 12) available from PI. The electronics are not included in the S-340's scope of delivery.

The electronics must provide the required operating voltages. To operate the S-340.xSx models (p. 7) the electronics must also be able to read out and process the signals from the strain gauge sensors to ensure proper performance of the servo control system.

2.2 General Safety Instructions

The S-340 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 S-340.

- Use the S-340 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 S-340.

2.3 Organizational Measures

User manual

- Always keep this user manual together with the S-340.
  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 S-340 to a third party, include this user manual as well as other relevant information provided by the manufacturer.
- Do the work 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 S-340 only after you have read and understood this user manual.

Personnel qualification

The S-340 may only be installed, started, operated, maintained, and cleaned by authorized and appropriately qualified personnel.

3 Product Description

In this Chapter

3.1 Model Overview

Model	Description
S-340.A0L	Tip/tilt platform, 2 mrad, open loop, LEMO connectors, aluminum cover plate
S-340.ASL	Tip/tilt platform, 2 mrad, SGS, LEMO connectors, aluminum cover plate
S-340.ASD	Tip/tilt platform, 2 mrad, SGS, D-sub connector, aluminum cover plate
S-340.I0L	Tip/tilt platform, 2 mrad, open loop, LEMO connectors, Invar cover plate
S-340.ISL	Tip/tilt platform, 2 mrad, SGS, LEMO connectors, Invar cover plate
S-340.ISD	Tip/tilt platform, 2 mrad, SGS, D-sub connector, Invar cover plate

➢ For further technical data, see the specifications (p. 43).

3.2 Product View

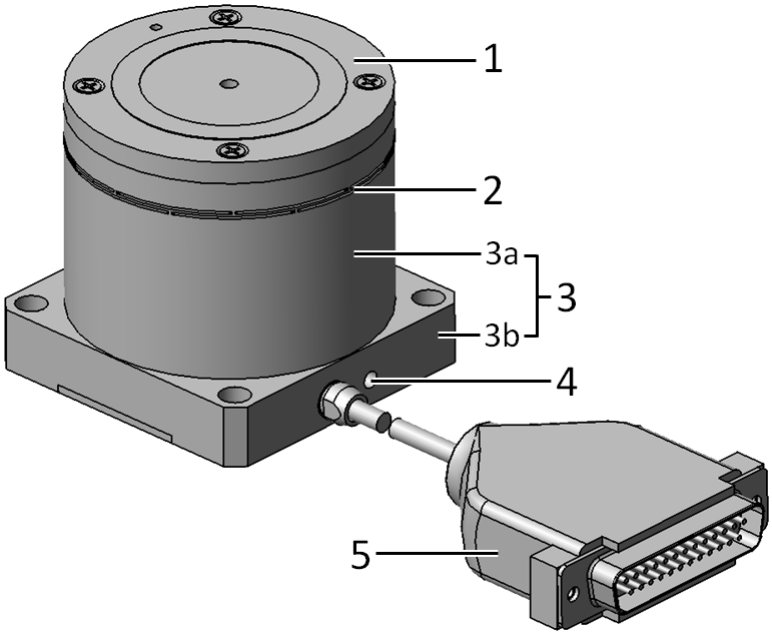

Figure 1: Exemplary product view of an S-340

1 Platform
2 Flexure
3 Housing, consisting of
3a: Housing tube
3b: Base
4 Protective earth connector
5 D-Sub 25 connector

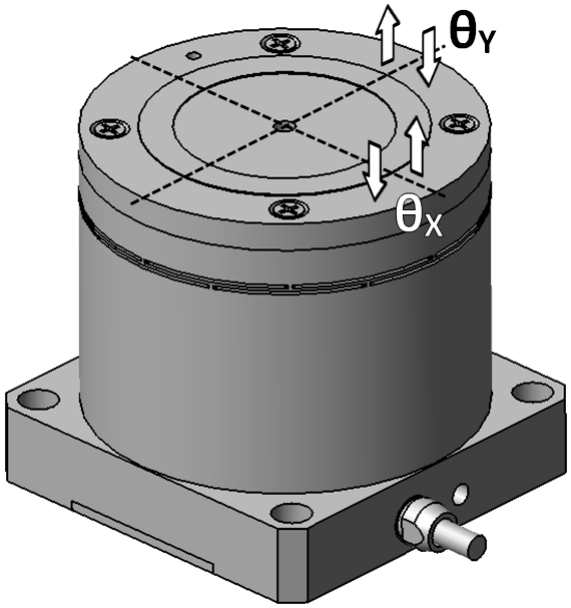

Figure 2: S-340: Schematic view of the motion axes with positive direction of motion

θ_X: Tilt axis 1
θ_Y: Tilt axis 2
The arrows indicate the positive direction of motion of the respective axis.

3.3 Product Labeling

Labeling	Description
S-340.ASD	Product name (example), the characters following the period refer to the model
123456789	Serial number (example), individual for each S-340 Meaning of each position (from the left): 1 = internal information 2 and 3 = year of manufacture 4 to 9 = consecutive number
PI	Manufacturer's logo
Country of origin: Germany	Country of origin
⚠	Warning sign "Pay attention to the manual!"
	Old equipment disposal (p. 53)
CE	CE conformity mark
WWW.PI.WS	Manufacturer's address (website)
⏚	Symbol for the protective earth conductor, marks the protective earth connection of the S-340 (p. 30)

Labeling of the D-sub 25 connector

Figure 3: D-sub 25 connector on the connecting cable of the S-340

"Residual Voltage" warning sign:
Indicates risk of electric shock (p. 5)

Labeling of the S-330.DLS adapter cable for S-340.xSL

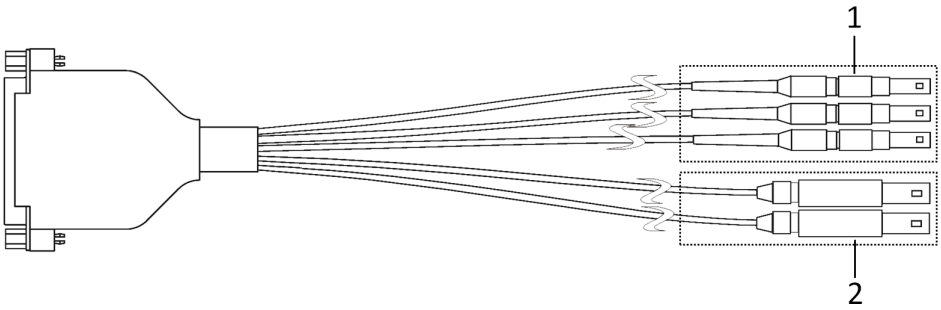

Figure 4: S-330.DLS adapter cable: Piezo connectors [1] and sensor connectors [2]

Piezo connectors:
PZT1: Piezo connector for axis 1
PZT2: Piezo connector for axis 2
PZT3: Piezo connector for 100 V fixed voltage

Sensor connectors:
Sensor 1: Sensor connector for axis 1
Sensor 2: Sensor connector for axis 2

Labeling of the S-330.DL0 adapter cable for S-340.x0L

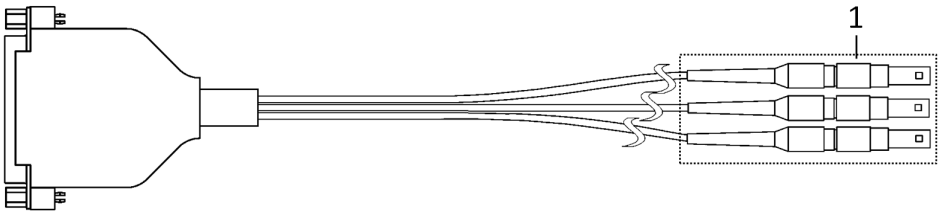

Figure 5: S-330.DL0 adapter cable: Piezo connectors [1]

Piezo connectors:
CH1: Piezo connector for axis 1
CH2: Piezo connector for axis 2
CH3: Piezo connector for 100 V fixed voltage

3.4 Scope of Delivery

Product number	Description
S-340	Tip/tilt platform according to order (p. 7)
000036450	M4 screw set for protective earth, consisting of: ▪ 1 flat-head screw with cross recess, M4x8, ISO 7045 ▪ 2 lock washers ▪ 2 flat washers
PZ277EK	Printed short instructions for S-3xx piezo tip/tilt platforms

Additional scope of delivery of the S-340.xxL models

S-340.xSL models with position sensor:

Product number	Description
S-330.DLS	Adapter cable D-sub 25 to LEMO connectors for piezo tip/tilt mirrors / platforms, tilt axes with differential drive, with SGS

S-340.x0L models without position sensor:

Product number	Description
S-330.DL0	Adapter cable D-sub 25 to LEMO connectors for piezo tip/tilt mirrors / platforms, tilt axes with differential drive

3.5 Accessories

Extension cables for S-340.xxL

Product number	Description
P-891.01	Extension cable for piezo voltage, LEMO connectors, 1 m
P-891.02	Extension cable for piezo voltage, LEMO connectors, 2 m
P-891.03	Extension cable for piezo voltage, LEMO connectors, 3 m
P-891.05	Extension cable for piezo voltage, LEMO connectors, 5 m
P-891.10	Extension cable for piezo voltage, LEMO connectors, 10 m
P-892.01	Extension cable, for strain gauge sensors, LEMO connectors, 1 m
P-892.02	Extension cable, for strain gauge sensors, LEMO connectors, 2 m
P-892.03	Extension cable, for strain gauge sensors, LEMO connectors, 3 m
P-892.05	Extension cable, for strain gauge sensors, LEMO connectors, 5 m
P-892.10	Extension cable, for strain gauge sensors, LEMO connectors, 10 m

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

3.6 Suitable Electronics

Suitable electronics for the S-340.xxD models

Electronics	Description
E-616	Controller for multi-axis piezo tip/tilt mirrors and platforms
E-727.xF*	Digital multi-channel piezo controller with EtherCAT
E-727.x • E-727.xAP*	Digital multi-channel piezo controller

* With E727B0015 adapter, D-sub 25 (f) to D-sub 37 (m) (included in the scope of delivery if you ordered the S-340 as system with E-727)

Suitable electronics for the S-340.xxL models

Electronics	Description
E-500 • E-501	Modular piezo controller

Suitable configurations for E-500/E-501:

Piezo amplifier module	Sensor module (for S-340.xSL only)	Housing	Interfaces
E-503.00S Piezo amplifier module, 2 channels, -30 to 130 V. Customized version, modified for S-330, S-331, S-340 tip/tilt mirror systems, with a fixed voltage of +100 V, two variable voltages	E-509.S3 Sensor / servo controller module, strain gauge sensors, 3 channels	E-501.00 9.5" housing for modular piezo controller system, 1 to 3 channels	Optional: E-518.I3 Interface module, 3 channels, TCP/IP, USB, and RS-232 interfaces
2 × E-505.00 Piezo amplifier module, 2 A, -30 to 130 V, 1 channel 1 × E-505.00S Offset voltage source for tip/tilt platforms, 100 V fixed voltage	E-509.S3 Sensor / servo controller module, strain gauge sensors, 3 channels	E-500.00 19" housing for modular piezo controller system, 1 to 3 channels	Optional: E-518.I3 Interface module, 3 channels, TCP/IP, USB, and RS-232 interfaces

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

3.7 Control

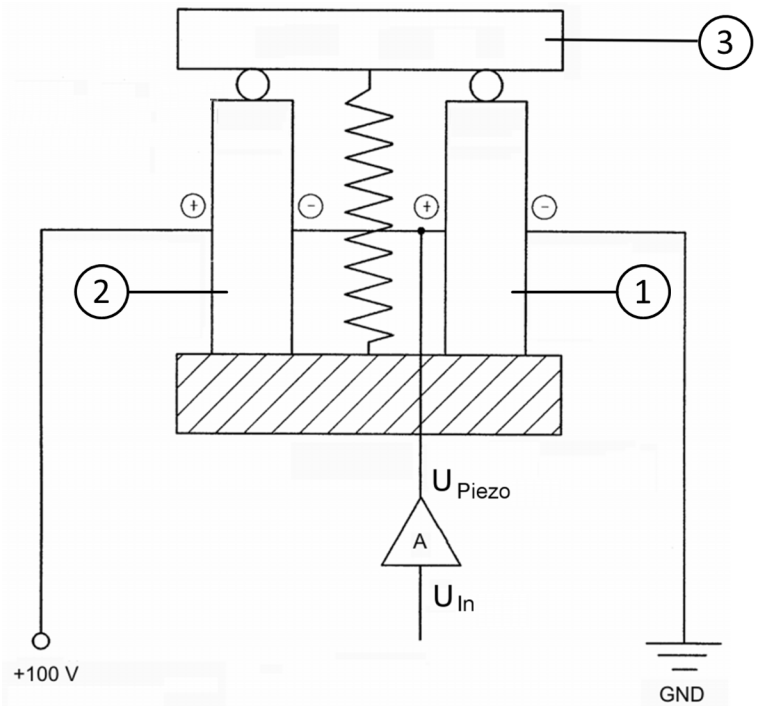

Figure 6: Differential drive of the tip/tilt platform, functional principle using the tilting of a single axis as an example

1 Piezo actuator 1 of the axis
2 Piezo actuator 2 of the axis
3 Platform

The S-340 is a tip/tilt platform with differential piezo drive. Four piezo actuators are interconnected in pairs to realize tip/tilt motion on two axes.

Both pairs of actuators are electrically switched so that when piezo voltage U_{Piezo} is changed, the voltage is increased to one actuator of a pair while the voltage to the other actuator is decreased by the same amount. The actuator with the increased voltage expands while the other actuator with the decreased voltage contracts. This produces the tip/tilt motion.

For a simplified representation of the functional principle, only one axis is shown in the figure above. The platform is shown rotated around 0°.

When the control input voltage U_{In} increases, piezo actuator 1 expands and piezo actuator 2 contracts. This produces a tilt in the positive direction.

Because of the way they are interconnected, both actuator pairs always move in opposite directions. It is therefore **impossible** to command linear motion in the Z axis.

The position of the Z axis can change with temperature fluctuations, however: Due to the symmetrical design of the tip/tilt platform, temperature fluctuations do not cause the platform to tilt but cause the length of the piezo actuators to change evenly in the direction of the Z axis.

Most applications are not very sensitive to such deviations as long as the tip/tilt angle does not change.

Each of the four piezo actuators of the S-340 is equipped with a strain gauge sensor. Therefore, in addition to the amplifier channel, a servo loop with a sensor channel must be available for each actuator pair.

Example: Behavior of the tip/tilt platform during operation

The tip/tilt platform is in zero position when the electronics are switched off (tilt = 0 mrad). Switching on the electronics applies a fixed voltage of 100 V, which fully tilts the tip/tilt platform into the negative direction.

The motion of the tip/tilt platform depends on the control voltage:

Control voltage	Behavior of the tip/tilt platform	Tip/tilt angle
<50 V	Tilt to the negative direction	-1 mrad at 0 V
50 V	Zero position (no tilt)	0 mrad at 50 V
>50 V	Tilt to the positive direction	+1 mrad at 100 V

3.8 Dynamic Behavior

The maximum operating frequency of a piezo tip/tilt platform depends on the following factors:

- Bandwidth of amplifier, controller, and sensor
- Resonant frequency of the tip/tilt platform including mirror and where appropriate, mirror holder

The resonant frequency is estimated in two steps:

a) Calculating the moments of inertia for mirror and mirror holder (p. 16)

b) Calculating resonant frequency of the tip/tilt platform including mirror and mirror holder (p. 19)

3.8.1 Calculating Moments of Inertia for Mirror and Mirror Holder

Calculating the distance from the axis through the center of gravity of the mirror to the rotational axis

Before the moment of inertia of the mirror is calculated, it is necessary to calculate the distance from the axis through the center of gravity of the mirror to the rotational axis of the platform. When a mirror holder is used, it must be included in the calculation.

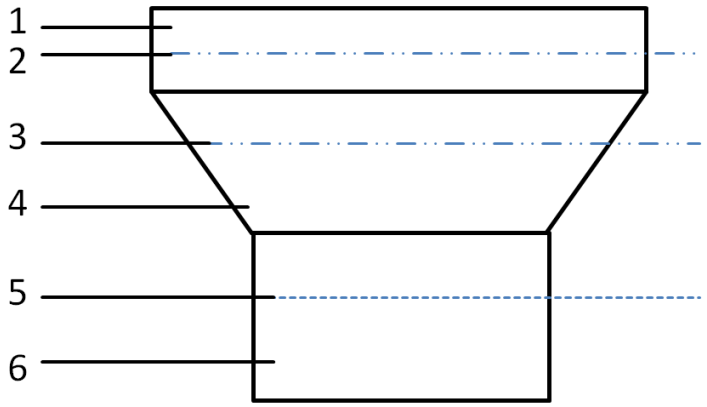

Figure 7: Example diagram: Platform with mirror holder and mirror

1 Mirror
2 Axis through the center of gravity of the mirror
3 Axis through the center of gravity of the mirror holder
4 Mirror holder (example of a geometry)
5 Axis through the pivot point of the platform of the S-340 ("rotational axis")
6 Platform

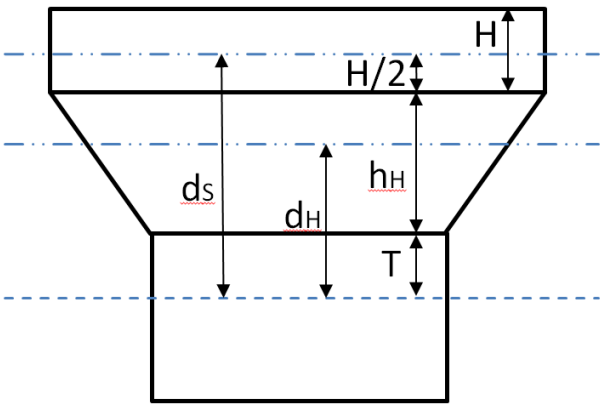

Figure 8: Example diagram: Platform with mirror holder and mirror; here with variables required for calculating the moments of inertia

- d_S Distance from the axis through the center of gravity of the mirror to the rotational axis
- d_H Distance from the axis through the center of gravity of the mirror holder to the rotational axis
- H/2 Half the mirror thickness
- h_H Thickness of the mirror holder
- T Distance from the rotational axis to the platform surface (see "Data Table" (p. 43))
- H Mirror thickness

Formula for calculating the distance from the axis through the center of gravity of the mirror to the rotational axis of the platform:

When a mirror is attached **without** a mirror holder:

$$d_S = \frac{H}{2} + T$$

When a mirror is attached **with** a mirror holder:

$$d_S = \frac{H}{2} + h_H + T$$

with:

d_S = Distance from the axis through the center of gravity of the mirror to the rotational axis [mm]

H = Mirror thickness [mm]

h_H = Thickness of the mirror holder [mm]

T = Distance from the rotational axis to the platform surface [mm], see "Data Table" (p. 43)

Calculating the moment of inertia of the mirror

Formula for calculating the moment of inertia of a rotationally symmetric mirror:

$$I_{S,P} = m_S \left[\frac{3R^2+H^2}{12}+{d_S}^2\right]$$

Formula for calculating the moment of inertia of a rectangular mirror:

$$I_{S,P} = m_S \left[\frac{L^2+H^2}{12}+{d_S}^2\right]$$

with:

$I_{S,P}$ = Moment of inertia of the mirror, in relation to the rotational axis [g•mm²]

m_S = Mirror mass [g]

R = Mirror radius [mm]

L = Mirror length perpendicular to the rotational axis [mm]

H = Mirror thickness [mm]

d_S = Distance from the axis through the center of gravity of the mirror to the rotational axis [mm]; for calculation see separate formulas (p. 16)

Calculating the moment of inertia of the mirror holder

$$I_{H,P} = I_H + m_H * (d_H)^2$$

with:

$I_{H,P}$ = Moment of inertia of the mirror holder, in relation to the rotational axis [g•mm²]

I_H = Moment of inertia of the mirror holder, dependent on the geometry of the mirror holder [g•mm²]

m_H = Mass of the mirror holder [g]

d_H = Distance from the axis through the center of gravity of the mirror holder to the rotational axis of the platform [mm], see above illustration (p. 16)

3.8.2 Calculating the Resonant Frequency of the Tip/Tilt Platform

Mirror without mirror holder

When the mirror is mounted without a mirror holder, the resonant frequency of the system is calculated with the following formula:

$$f' = \frac{f_0}{\sqrt{1 + \frac{I_{S,P}}{I_0}}}$$

with:

f' = Resonant frequency of the S-340 with mirror [Hz]

f_0 = Resonant frequency of the unloaded S-340 [Hz]; see "Data Table" (p. 43)

I_0 = Moment of inertia of the platform of the S-340 [g•mm²], see "Data Table" (p. 43)

$I_{S,P}$ = Moment of inertia of the mirror, in relation to the rotational axis, [g•mm²]; calculation see separate formulas (p. 18)

Mirror with mirror holder

When the mirror is mounted with a mirror holder, the resonant frequency of the tip/tilt platform is calculated with the following formula:

$$f' = \frac{f_0}{\sqrt{1 + \frac{(I_{S,P} + I_{H,P})}{I_0}}}$$

with:

f' = Resonant frequency of the S-340 with mirror and mirror holder [Hz]

f_0 = Resonant frequency of the unloaded S-340 [Hz], see "Data Table" (p. 43)

I_0 = Moment of inertia of the platform of the S-340 [g•mm²], see "Data Table" (p. 43)

$I_{S,P}$ = Moment of inertia of the mirror, in relation to the rotational axis, [g•mm²]; for calculation see separate formulas (p. 18)

$I_{H,P}$ = Moment of inertia of the mirror holder, in relation to the rotational axis, [g•mm²]; calculation see separate formula (p. 18)

Further information on dynamic or static operation can be found in the PI catalog (CAT 130), in the section "Fundamentals of Piezo Technology". The catalog can be downloaded from our website **http://www.pi.ws** under **Service > Downloads > Catalogs, Brochures & Certificates**.

4 Unpacking

1. Unpack the S-340 with care.
2. Compare the contents with the scope of delivery according to the contract and the delivery note.
3. Inspect the contents for signs of damage. If any parts are damaged or missing, contact our customer service department (p. 41) immediately.
4. Keep all packaging materials in case the product needs to be returned.

5 Installation

In this Chapter

5.1 General Notes on Installation

CAUTION

Dangerous voltage and residual charge in piezo actuators!

The S-340 is driven by piezo actuators. Temperature changes and compressive stresses can induce charges in piezo actuators. After disconnection from the electronics, piezo actuators can remain charged for several hours. Touching or short-circuiting the contacts in the connector of the S-340 can lead to minor injuries from electric shock. The piezo actuators can be destroyed by an abrupt contraction.

- Do **not** open the S-340.
- Discharge the piezo actuators before installing the S-340 (p. 35).
- Do **not** pull the plug connector out of the electronics during operation.

Touching the contacts in the connector could lead to an electric shock (max. 120 V DC) and minor injuries.

- Do **not** touch the contacts in the plug connector.
- If possible, use screws to secure the S-340's connector against being pulled out of the electronics.

NOTICE

Heating up of the S-340 during operation!

The heat produced during operation of the S-340 can affect your application.

- Install the S-340 so that the application is not impaired by the dissipated heat.
- Ensure sufficient ventilation at the place of installation.
- Make sure that the entire bottom of the S-340 is in contact with the surface on which the S-340 is mounted.

NOTICE

Destruction of the piezo actuator due to electric flashovers!

Using the S-340 in environments that increase the electrical conductivity can lead to the destruction of the piezo actuator 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 S-340 in environments that can increase the electric conductivity.
- ➢ Operate the S-340 only within the permissible ambient conditions and classifications (p. 45).

NOTICE

Destruction of the piezo actuator due to short-circuiting without a discharge resistor!

When a charged piezo actuator is short-circuited without a discharge resistor, this can lead to a contraction shock and thus to the destruction of the piezo ceramic.

- ➢ Only discharge the S-340 according to the instructions in "Discharging the S-340" (p. 35).

NOTICE

Distorting the S-340 when mounted on uneven surfaces!

Fixing the S-340 onto an uneven surface can distort the S-340. Distortion reduces the accuracy.

- ➢ Fix the S-340 onto an even surface. The recommended flatness of the surface is ≤30 µm.
- ➢ For applications with large temperature fluctuations:
  Only fix the S-340 onto surfaces that have the same or similar thermal expansion properties as the S-340 (e.g., surfaces made of aluminum).

NOTICE

Damage due to unsuitable cables!

Unsuitable cables can damage the S-340 and the electronics.

- ➢ Use cables provided by PI only to connect the S-340 to the electronics.

5.2 Mounting the Mirror on the S-340

You have the following options for mounting the mirror on the platform of the S-340:

- Gluing the mirror
- Clamping a suitable mirror holder

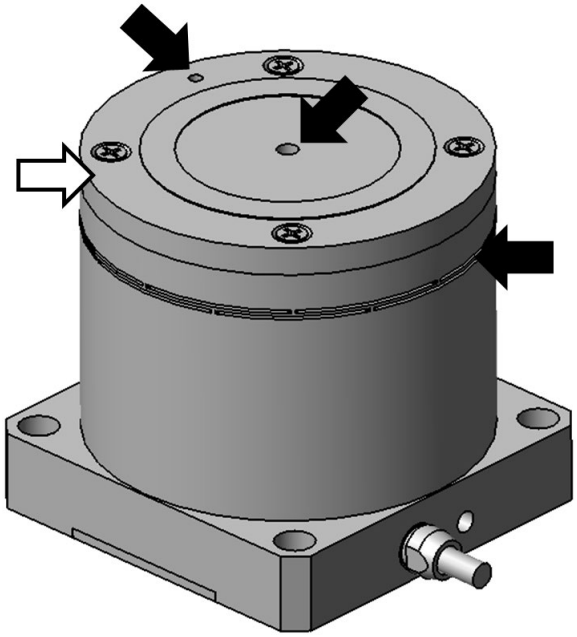

Figure 9: Gluing the mirror to the S-340

White arrow: Platform of the S-340
Black arrows: Adhesive must **not** penetrate here!

NOTICE

Damage due to falling or tipping over!
Despite its massive and robust appearance, the S-340 is a very sensitive and fragile system. The piezo actuators and joints can be damaged if the S-340 is allowed to fall or tip over.

- ➢ Do not allow the S-340 to fall or tip over.
- ➢ Avoid subjecting the S-340 to force or torque.

NOTICE

Impermissibly high forces and torques!
Impermissibly high forces and torques acting on the platform could damage the S-340.

- ➢ Avoid high forces and torques on the platform when mounting the mirror.
- ➢ If you use a mirror holder: Clamp the mirror holder above the flexure only.

NOTICE

Reduced positioning accuracy due to improper mounting!
Improper mounting can reduce the positioning accuracy of the tip/tilt platform.

- Avoid distorting the mirror:
  - To glue the mirror, choose an adhesive that hardens at room temperature and contracts as little as possible during drying and hardening. Recommendation: Two-component adhesive made of epoxy resin that hardens in 24 hours at a temperature above 25 °C and is resistant to shearing forces.
  - In the case of applications with large temperature fluctuations:
    Make sure that the mirror and, if necessary, the mirror holder have the same or similar thermal expansion properties as the platform of the S-340.
- Prevent adhesive from penetrating the housing of the S-340 and running into the holes of the platform (see figure above).

INFORMATION

If the mirror is to be interchangeable, it is recommended to mount it with a mirror holder.

- Take the moment of inertia of the mirror holder into account when calculating the resonant frequency of the piezo tip/tilt platform (p. 19).

INFORMATION

Recommended characteristics of the mirror:

- Diameter: ≤75 mm
- Thickness: ≤22 mm
- Material: Glass, e.g., borosilicate crown glass (BK7), whose moment of inertia matches the application (details see "Dynamic Behavior" (p. 15)) and whose thermal expansion coefficient is similar to the material of the platform.

INFORMATION

The following aids are recommended for gluing the mirror (not included in the scope of delivery):

- Suitable template for applying the adhesive
- Suitable centering aid for aligning the mirror

For examples, see figures below. Suitable centering aids are available on request.

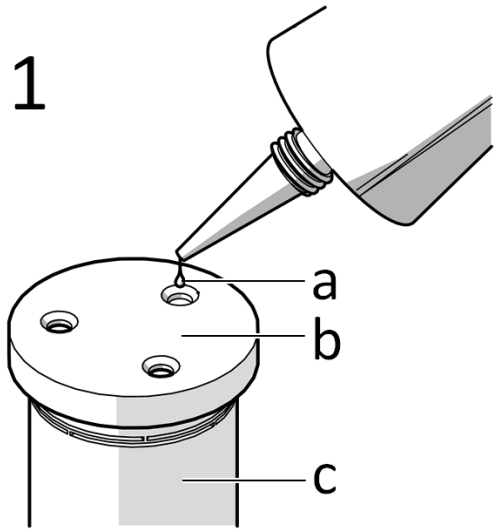

Figure 10:
Example: S-340 with template for applying the adhesive to three points

a: Adhesive
b: Template
c: S-340 tip/tilt platform

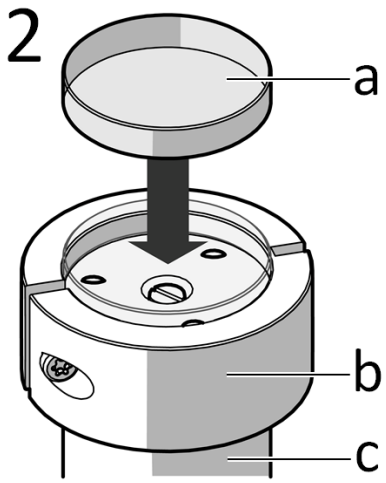

Figure 11:
Example: S-340 with centering aid for aligning the mirror

a: Mirror
b: Centering aid
c: S-340 tip/tilt platform

Requirements

- ✓ You have read and understood the general notes on installation (p. 23).
- ✓ The S-340 is **not** connected to the electronics.

Tools and accessories

- Suitable mirror, see above and "Dynamic Behavior" (p. 15)
- When the mirror is glued to the platform:
  - Suitable adhesive, see above
  - Optional:
    - Suitable template for applying the adhesive to three points
    - Suitable centering aid for aligning the mirror
  - Cotton swab
  - Isopropyl alcohol
- If the mirror is mounted with a mirror holder:
  - Suitable mirror holder for clamping
- Powder-free gloves

Gluing the mirror to the S-340

1. Clean the platform of the S-340 with a cotton swab and isopropyl alcohol.
2. Apply the adhesive to the platform:
   a) If you use a template: Carefully align the centering aid on the platform of the S-340 and fix it appropriately.
   b) Put a small amount of adhesive onto three suitable points or into the three template recesses in the platform. Only apply a pinhead-sized amount to each point.
   c) If you use a template: Remove the template.
3. Fix the mirror to the platform:
   a) If you use a centering aid: Carefully align the centering aid on the S-340 and fix it appropriately.
   b) Place the mirror carefully in the appropriate orientation or into the centering aid on the platform of the S-340. Avoid touching the mirror surface.
   c) Carefully and briefly press the mirror onto the platform with a cotton swab.
   d) If necessary, remove the adhesive residue with a cotton swab and isopropyl alcohol.
   e) Allow the adhesive to harden according to the instructions of the adhesive manufacturer.
   f) If you use a centering aid: Remove the centering aid.

Fixing a mirror holder to the S-340

- Use clamps to fix the mirror holder to the platform.
- Fix the mirror to the mirror holder appropriately.

5.3 Mounting the S-340

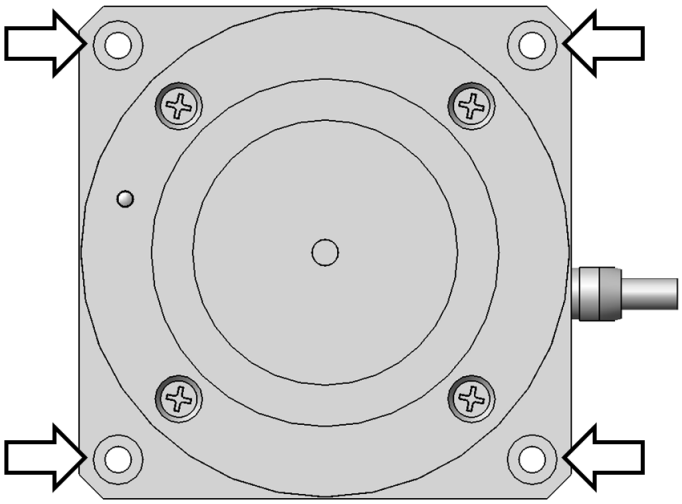

Figure 12: Mounting holes in the base of the S-340 (view from above)

Requirements

- ✓ You have read and understood the general notes on installation (p. 23).
- ✓ The S-340 is **not** connected to the electronics.
- ✓ You have accounted for the space required to route cables according to regulations and without bending them.

Tools and accessories

- You have provided a suitable surface (for the required position and depth of the holes for accommodating the screws, refer to "Dimensions" (p. 46)):
  - When mounting from above: Four M3 holes are provided with a thread depth of at least 5 mm.
  - When mounting from below: Four through holes for M4 screws are provided.
  - The surface flatness is ≤30 µm.
  - For applications with large temperature changes: The surface should have the same thermal expansion properties as the S-340 (e.g., underlying surface made of aluminum).
- Four screws of suitable length (p. 46)
  - When mounting from above: Four M3 screws
  - When mounting from below: Four M4 screws
- Suitable tools

Mounting the S-340 onto an underlying surface

1. Align the S-340 on the underlying surface so that the corresponding mounting holes in the base and the underlying surface are in line.
2. Mount the S-340 on the underlying surface from above or from below:

   Mounting from above with four M3 screws:

   a) Insert the screws from above into the countersunk holes in the base of the S-340.

   b) Tighten each screw with at least four turns to the torque (p. 48) specified for the screws.

   c) Make sure that the screw heads do not protrude from the countersunk holes.

   Mounting from below with four M4 screws:

   a) Insert the screws from below into the base through the holes of the underlying surface of the S-340.

   b) Tighten each screw with at least four turns to the torque (p. 48) specified for the screws.
3. Check that the S-340 is fixed firmly.

5.4 Connecting the S-340 to the Protective Earth Conductor

INFORMATION

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

The S-340 has an M4 hole for attaching the protective earth conductor. This hole is marked with the symbol for the protective earth conductor ⏚ (see "Dimensions" (p. 46)).

Requirements

✓ You have read and understood the general notes on installation (p. 23).

✓ The S-340 is **not** connected to the electronics.

Tools and accessories

- Suitable protective earth conductor: Cable cross section ≥ 0.75 mm^2
- M4 protective earth screw set (p. 11) supplied for connecting the protective earth conductor
- Suitable screwdriver

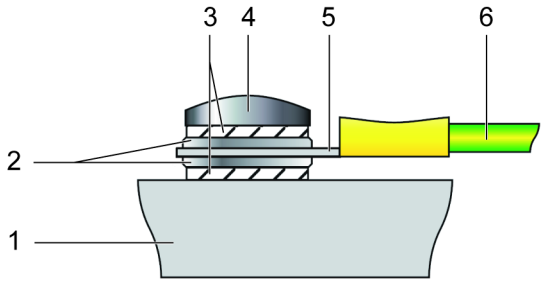

Figure 13: Connecting the protective earth conductor (profile view)

1 Base of the S-340
2 Flat washer
3 Lock washer
4 Screw
5 Cable lug
6 Protective earth conductor

Connecting the S-340 to the protective earth conductor

1. If necessary, attach a suitable cable lug to the protective earth conductor.
2. Use the M4 screw (together with the flat and lock washers) to attach the cable lug of the protective earth conductor to the threaded hole in the S-340 as shown in the profile view.
3. Tighten the M4 screw with a torque of 1.2 Nm to 1.5 Nm.
4. Make sure that the contact resistance at all connection points relevant for connecting the protective earth conductor is <0.1 Ω at 25 A.

5.5 Connecting the S-340 to the Electronics

INFORMATION

Systems consisting of an S-340 and controller are calibrated at the factory to achieve optimum performance.

➢ Pay attention to the assignment of the axes to the controller channels as specified on the calibration label of the piezo servo controller.

Requirements

✓ You have read and understood the general notes on installation (p. 23).
✓ You have installed suitable electronics (p. 12).
✓ You have read and understood the user manual for the electronics.
✓ The electronics are switched off.
✓ Only applicable for connections to E-727: The E727B0015 adapter is connected to the D-sub 37 socket of the E-727 controller.

Connecting the S-340.xxD to the electronics

1. Connect the D-sub 25 connector of the S-340.xxD to the D-sub 25 socket of the electronics (refer to the user manual for the electronics).
2. Use the integrated screws to secure the connectors against accidental disconnection.

Connecting the S-340.xxL to E-50x modules

1. Connect the D-sub 25 connector of the S-340 to the D-sub 25 connector of the S-330.DLx adapter cable.
2. Connect the piezo connectors of the S-330.DLx adapter cable to the corresponding sockets of the module:

   If you use an E-503.00S module:

   - **PZT1** / **CH1** to **PZT** (-30 to 130 V) for channel 1 of the module
   - **PZT2** / **CH2** to **PZT** (-30 to 130 V) for channel 2 of the module
   - **PZT3** / **CH3** to **PZT** (100 V) for channel 3 of the module

   If you use two E-505.00 modules for variable voltages and an E-505.00S module for 100 V fixed voltage:

   - **PZT1** / **CH1** to **PZT** (-30 to 130 V) of an E-505.00 module
   - **PZT2** / **CH2** to **PZT** (-30 to 130 V) for channel 2 of the second E-505.00 module
   - **PZT3** / **CH3** to **PZT** (100 V) for channel 3 of the E-505.00S module
3. Only applicable to S-340.xSL: Connect the sensor connectors of the S-330.DLx adapter cable to the corresponding sockets of the module:
   - **Sensor 1** to **SENSOR** for Servo 1 on the module
   - **Sensor 2** to **SENSOR** for Servo 2 on the module

6 Starting and Operating

In this Chapter

6.1 General Notes on Starting and Operating

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 S-340 in the case of malfunction or failure of the system. If there are touch voltages, touching the S-340 can result in minor injuries from electric shock.

- Before startup, establish contact between the S-340 and the protective earth conductor (p. 30).
- Do **not** remove the protective earth conductor during operation.
- If the protective earth conductor has to be removed temporarily (e.g., for modification), reconnect the S-340 to the protective earth conductor before restarting.

NOTICE

Destruction of the piezo actuator due to electric flashovers!

Using the S-340 in environments that increase the electrical conductivity can lead to the destruction of the piezo actuator 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 S-340 in environments that can increase the electric conductivity.
- Operate the S-340 only within the permissible ambient conditions and classifications (p. 45).

NOTICE

Decreased lifetime due to permanently high voltage!

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

- When the S-340 is not used but the electronics remain switched on to ensure temperature stability, discharge the S-340 (p. 35).

INFORMATION

Systems consisting of an S-340 and controller are set at the factory so that optimum performance can be achieved when a mirror with the recommended characteristics is glued onto the S-340 (p. 25).

- ➢ Only adjust the notch filter and the servo control parameters of the controller when the moved mass and therefore the resonant frequency of the S-340 changes considerably. Possible reasons:
  - The mirror strongly deviates from the recommended characteristics (p. 25).
  - A mirror holder is used.

Only after replacing system components and only for models with LEMO connectors:

- ➢ Perform a recalibration of the axis displacement (see controller manual) or contact our customer service department (p. 41).
- ➢ Adjust the notch filter and servo control parameters of the controller (see controller manual).

INFORMATION

Depending on the amplitude and frequency of the piezo voltage, the S-340 heats up during operation.

- ➢ Select the amplitude and frequency of the piezo voltage so that the maximum permissible operating temperature of the S-340 is not exceeded. Refer to "Recommended Control Signals for Dynamic Operation" (p. 45) for details.

INFORMATION

Sound and vibration (e.g., footfall, knocks) can be transmitted to the S-340 and can affect its performance with regard to position stability.

- ➢ Avoid sound and vibration while the S-340 is being operated.

INFORMATION

The expansion of the piezo actuators depends on the ambient temperature and can vary by up to 10 % in the given temperature ranges (p. 45).

6.2 Operating the S-340

Requirements

- ✓ You have read and understood the general notes on starting and operating (p. 33).
- ✓ You have read and understood the user manual for the electronics (p. 2).
- ✓ You have installed (p. 23) the S-340 correctly.
- ✓ The electronics and the required PC software were installed. All connections to the electronics were made (refer to the user manual for the electronics).

Operating the S-340

➢ Follow the instructions in the manual for the electronics (p. 12) used for startup and operation of the S-340.

6.3 Discharging the S-340

The S-340 must be discharged in the following cases:

- Before Installation
- When the S-340 is not in use but the electronics remain switched on to ensure temperature stability
- Before demounting (e.g., before cleaning and transporting the S-340 and for modifications)

The S-340 is discharged via the discharge resistor inside the electronics from PI.

Discharging a positioner connected to the electronics

In closed-loop operation:

1. Switch off the servo mode on the controller.
2. Set the piezo voltage to 0 V on the controller.

In open-loop operation:

➢ Set the piezo voltage to 0 V on the electronics.

Discharging a positioner not connected to the electronics

➢ Connect the positioner to the switched-off electronics from PI.

7 Maintenance

In this Chapter

7.1 General Notes on Maintenance

NOTICE

Misalignment due to loosening screws!
The S-340 is maintenance-free and achieves its positioning accuracy as a result of the optimal alignment of mechanical components and piezo actuators. Loosened screws cause a loss in positioning accuracy.

- ➢ Loosen screws only when instructed in this manual.
- ➢ Do **not** open the S-340.

7.2 Cleaning the S-340

NOTICE

Damage from ultrasonic cleaning!
Ultrasonic cleaning can damage the S-340.

- ➢ Do **not** do any ultrasonic cleaning.

Requirements

- ✓ You have discharged the piezo actuators of the S-340 (p. 35).
- ✓ You have disconnected the S-340 from the electronics.

Cleaning the S-340

- ➢ Clean the surfaces of the S-340 with a cloth dampened with a mild cleanser or disinfectant (e.g., isopropyl alcohol).

8 Troubleshooting

Problem	Possible causes	Solution
No or uncontrolled motion	▪ Cable not connected correctly ▪ Defective electronics ▪ Defective cable ▪ Piezo ceramic defective after electric flashover	➢ Check the cable connections. ➢ Contact our customer service department (p. 41).
Reduced accuracy	Warped housing	Mount the S-340 onto surfaces with the following characteristics only: ▪ Flatness of at least 30 µm ▪ The thermal expansion properties are similar to those of the S-340 (e.g., surfaces made of aluminum)
	Adhesive has run into the holes of the platform or between the platform and the housing of the S-340	➢ Contact our customer service department (p. 41).
	S-340 or controller has been replaced	It is necessary to recalibrate the axis displacement after replacing the S-340 or controller. ➢ Recalibrate the axis displacement (see controller manual) or contact our customer service department (p. 41).
	Mirror with mirror holder has been replaced	The change of the mass that has to be moved by the S-340 influences the dynamic characteristics such as the resonant frequency of the tip/tilt platform. ➢ Adjust the notch filter and servo control parameters of the controller (see controller manual).
	Operating temperature outside of the permissible range (p. 43)	➢ Contact our customer service department (p. 41).

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. 41).

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

In this Chapter

10.1 Specifications

10.1.1 Data Table

	S-340.ASD / S-340.ASL	S-340.ISD / S-340.ISL	S-340.A0L	S-340.I0L	Unit	Tolerance
Active axes	θ_X, θ_Y	θ_X, θ_Y	θ_X, θ_Y	θ_X, θ_Y		
Motion and positioning						
Integrated sensor	SGS	SGS	-	-		
Tip/tilt angle in θ_X, θ_Y at -20 to +120V, open loop	2	2	2	2	mrad	Min.
Tip/tilt angle in θ_X, θ_Y, closed loop	2	2	-	-	mrad	
Resolution in θ_X, θ_Y, open loop	0.02	0.02	0.02	0.02	µrad	Typ.
Resolution in θ_X, θ_Y, closed loop	0.2	0.2	-	-	µrad	Typ.
Linearity error in θ_X, θ_Y	0.1	0.1	-	-	%	Typ.
Repeatability in θ_X, θ_Y	0.15	0.15	-	-	µrad	Typ.
Mechanical properties						
Resonant frequency in θ_X, θ_Y, unloaded	1.7	1.1	1.7	1.1	kHz	±20 %
Resonant frequency loaded in θ_X, θ_Y (with glass mirror, Ø 50 mm, thickness 5 mm, 21 g)	1.4	1.0	1.4	1.0	kHz	±20 %
Resonant frequency loaded in θ_X, θ_Y (with glass mirror, Ø 50 mm, thickness 13 mm, 63 g)	1.0	0.85	1.0	0.85	kHz	±20 %
Resonant frequency loaded in θ_X, θ_Y (with glass mirror, Ø 75 mm, thickness 19 mm, 197 g)	0.55	0.5	0.55	0.5	kHz	±20 %
Distance of pivot point to platform surface	7.5	7.5	7.5	7.5	mm	±1 mm
Platform moment of inertia	18000	54000	18000	54000	g × mm²	±20 %
Drive properties						
Ceramic type	PICMA®	PICMA®	PICMA®	PICMA®		
Electrical capacitance	6 / axis	6 / axis	6 / axis	6 / axis	µF	±20 %

Miscellaneous						
Operating temperature range	-20 to 80	-20 to 80	-20 to 80	-20 to 80	°C	
Housing material	Aluminum	Aluminum	Aluminum	Aluminum		
Platform material	Aluminum	Invar	Aluminum	Invar		
Mass	0.355	0.443	0.355	0.443	kg	±5 %
Cable length	2	2	2	2	m	+100 mm / -0 mm
Sensor/voltage connector	ASD version: D-sub 25 (m) ASL version: LEMO	ISD version: D-sub 25 (m) ISL version: LEMO	LEMO	LEMO		
Recommended electronics	E-727	E-727	E-727	E-727		

The resolution of the system is limited only by the noise of the amplifier and the measuring technology because PI piezo nanopositioning systems are free of friction.

All specifications based on room temperature (22 °C ±3 °C).

10.1.2 Maximum Ratings

The models of the S-340 are designed for the following operating data:

Model	Maximum operating voltage	Maximum operating frequency[1] (without load)	Maximum power consumption[2]
S-340.Axx	-20 to +120 V	450 Hz	17.5 W / axis
S-340.Ixx	-20 to +120 V	300 Hz	17.5 W / axis

[1] To ensure stable operation, the maximum operating frequency has been defined as around one third of the mechanical resonant frequency. To calculate the resonant frequency of the system of S-340 and mirror, see "Dynamic Behavior" (p. 15).

[2] The heat that is generated by the piezo actuator during dynamic operation limits the value for maximum power consumption.

Details can be found at the following website:

https://www.physikinstrumente.com/en/technology/piezo-technology/properties-piezo-actuators/electrical-operation/

10.1.3 Ambient Conditions and Classifications

Pay attention to the following ambient conditions and classifications for the S-340:

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
Storage temperature	–20 °C to 80 °C
Transport temperature	–25 °C to 85 °C
Overvoltage category	II
Protection class	I
Degree of pollution	1
Degree of protection according to IEC 60529	IP20

10.1.4 Recommended Control Signals for Dynamic Operation

The maximum permissible operating temperature for the piezo actuators of the S-340 is 80 °C. During dynamic continuous operation of a single axis, this temperature value is achieved at an ambient temperature of approx. 20 °C for the following characteristics of a sinusoidal piezo voltage signal and then remains constant.

Model	Amplitude	Operating frequency
S-340.Axx	20 V_{pp}	0.6 kHz
	50 V_{pp}	0.6 kHz
	100 V_{pp}	0.6 kHz
S-340.Ixx	20 V_{pp}	0.4 kHz
	50 V_{pp}	0.4 kHz
	100 V_{pp}	0.4 kHz

At a higher ambient temperature and when both axes are operated, the maximum permissible operating temperature can already be achieved at a lower amplitude and/or lower operating frequency.

10.2 Dimensions

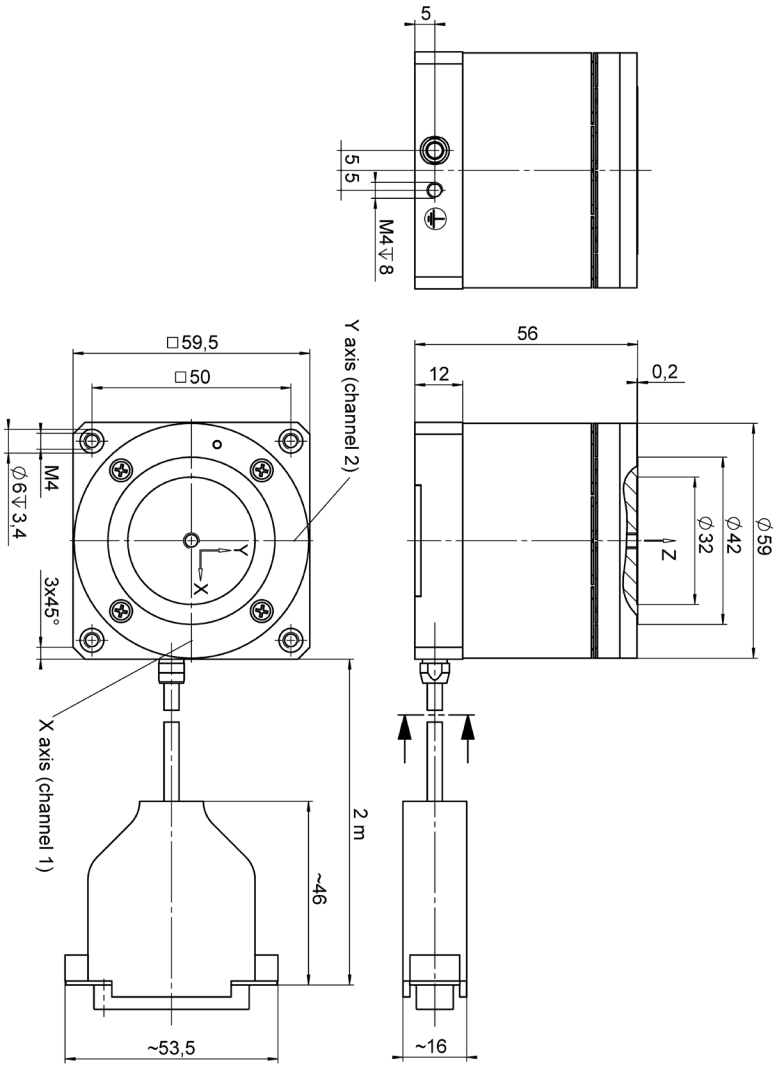

Figure 14: S-340.xxD, dimensions in mm. Note that the decimal places are separated by a comma in the drawings.

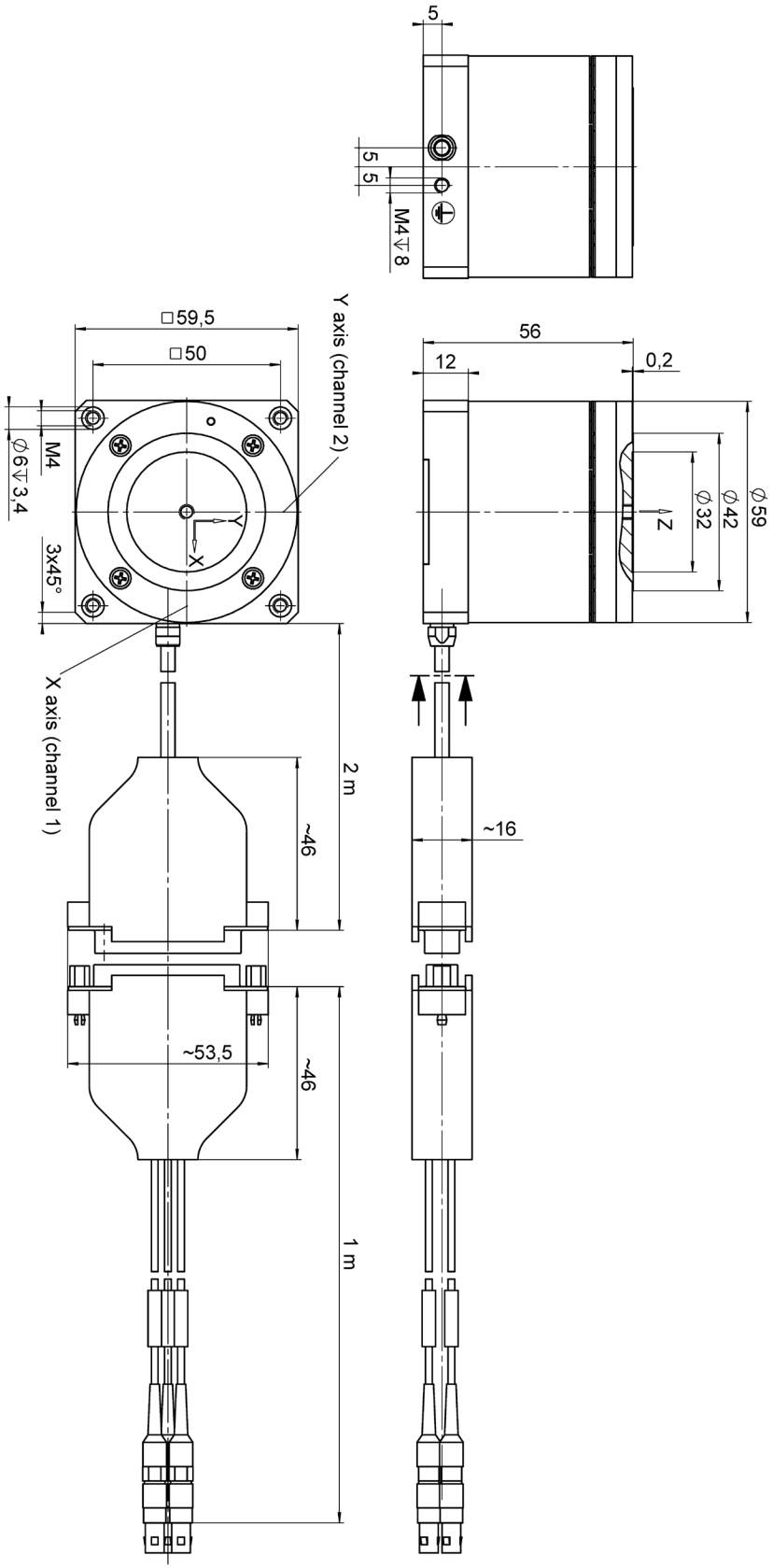

Figure 15: S-340.xxL, dimensions in mm. Note that the decimal places are separated by a comma in the drawings.

10.3 Torque for Stainless Steel Screws (A2-70)

Screw size	Minimum torque	Maximum torque
M6	4 Nm	6 Nm
M5	2.5 Nm	3.5 Nm
M4	1.5 Nm	2.5 Nm
M3	0.8 Nm	1.1 Nm
M2.5	0.3 Nm	0.4 Nm
M2	0.15 Nm	0.2 Nm
M1.6	0.06 Nm	0.12 Nm

➢ Pay attention to the screw-in depth required for the respective material according to the VDI directive 2230.

10.4 Pin Assignment

10.4.1 D-sub 25 Connector (m)

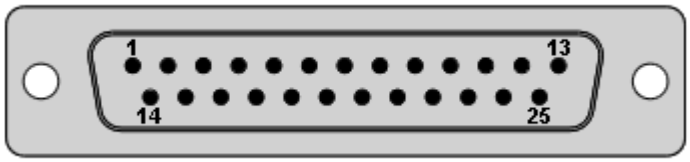

Figure 16: D-sub 25 connector, contact side

Pin	Signal	Function
1	-	-
2	-	-
3*	SGS Y+	SGS signal axis 2 (positive)
4*	SGS Ref Y	SGS reference axis 2
5*	SGS X+	SGS signal axis 1 (positive)
6*	SGS Ref X	SGS reference axis 1
7	-	-
8	-	-
9	-	-
10	GND	Ground
11	PZT X	Piezo voltage axis 1
12	PZT Y	Piezo voltage axis 2
13	100 V fix	100 V fixed voltage

Pin	Signal	Function
14	-	-
15	-	-
16*	SGS Y-	SGS signal axis 2 (negative)
17*	SGS GND Y	Ground SGS signal axis 2
18*	SGS X-	SGS signal axis 1 (negative)
19*	SGS GND X	Ground SGS signal axis 1
20	-	-
21	-	-
22	-	-
23	PZT GND	Piezo voltage ground
24	PZT GND	Piezo voltage ground
25	PZT GND	Piezo voltage ground

* Pin not assigned for models without sensor.

10.4.2 S-330.DLx Adapter Cable (Only for S-340.xxL)

D-sub 25 (f) connector

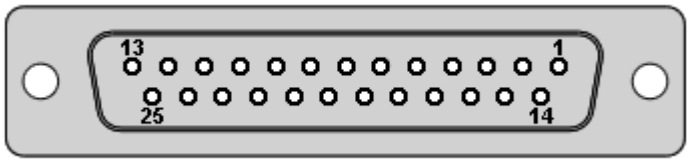

Figure 17: D-sub 25 (f) connector, contact side

Pin*	Signal	Function	
		S-330.DLS adapter cable for S-340.xSL	S-330.DL0 adapter cable for S-340.x0L
1	-	-	-
2	-	-	-
3	SGS Y+	SGS signal axis 2 (positive)	-
4	SGS Ref Y	SGS reference axis 2	-
5	SGS X+	SGS signal axis 1 (positive)	-
6	SGS Ref X	SGS reference axis 1	-
7	-	-	-

Pin*	Signal	Function	
		S-330.DLS adapter cable for S-340.xSL	S-330.DL0 adapter cable for S-340.x0L
8	-	-	-
9	-	-	-
10	-	-	-
11	PZT X	Piezo voltage axis 1	Piezo voltage axis 1
12	PZT Y	Piezo voltage axis 2	Piezo voltage axis 2
13	100 V fix	100 V fixed voltage	100 V fixed voltage
14	-	-	-
15	-	-	-
16	SGS Y-	SGS signal axis 2 (negative)	-
17	SGS GND Y	Ground SGS signal axis 2	-
18	SGS X-	SGS signal axis 1 (negative)	-
19	SGS GND X	Ground SGS signal axis 1	-
20	-	-	-
21	-	-	-
22	-	-	-
23	PZT GND	Piezo voltage ground	Piezo voltage ground
24	PZT GND	Piezo voltage ground	Piezo voltage ground
25	PZT GND	Piezo voltage ground	Piezo voltage ground

* Bridge between pin 4 and 6 as well as between pin 17 and 19.

Voltage connector

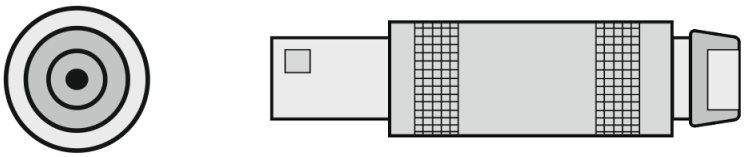

Figure 18: Voltage connection (PZT): LEMO FFS.00.250.CTCE24 coaxial connector

Signal	Function	Connector shell
PZT	Piezo voltage	Ground

Sensor connector (only S-330.DLS adapter cable for S-340.xSL)

Figure 19: Sensor connector (SGS): LEMO FFA.0S.304.CLAC32Y connector, contact side

Pin	Signal	Function
1	SGS Ref	SGS reference
2	SGS-	SGS signal (negative)
3	SGS+	SGS signal (positive)
4	SGS GND	Ground SGS signal

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 its responsibility as the product manufacturer, Physik Instrumente (PI) GmbH & 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) GmbH & Co. KG

Auf der Roemerstr. 1

D-76228 Karlsruhe, Germany

12 EU Declaration of Conformity

For the S-340, an EU Declaration of Conformity has been issued in accordance with the following European directives:

Low Voltage Directive

EMC Directive

RoHS Directive

The applied standards certifying the conformity are listed below.

Safety (Low Voltage Directive): EN 61010-1

EMC: EN 61326-1

RoHS: EN 50581 or EN IEC 63000