

S-310 – S-316 Piezo Z/Tip/Tilt Scanner High-Speed System with Clear Aperture



S-310.10, S-316.10
piezo systems for scanning,
optics alignment and mirror shifter alignment

- 10 mm Clear Aperture
- Piezo Tripod Design
- Optical Beam Deflection to 2,4 mrad
- Piston Movement up to 12 μm (phase shifter)
- Sub-Millisecond Response, Sub-Microradian Resolution
- Closed-Loop Versions for Higher Precision
- For Optics, Mirrors or Other Components
- Frictionless, High-Precision Flexure Guiding System
- Parallel Kinematics for Enhanced Dynamics and Better Multi-Axis Accuracy

S-310 to S-316 multi-axis tip/tilt platforms and Z-positioners are fast, compact units based on a piezo tripod design. They offer piston movement up to 12 μm and tilt movement up to 1.2 mrad (2.4 mrad optical beam deflection) with sub-millisecond response and settling. The tri-

pod design features optimum angular stability over a wide temperature range.

The systems are designed for mirrors and optics up to 25 mm in diameter and can be mounted in any orientation; the clear aperture is ideal for transmitted-light applications (e.g. for optical filters).

Application Examples

- Image processing / stabilization
- Interferometry
- Laser scanning / beam steering
- Laser tuning
- Optical filters / switches
- Beam stabilization

Open-Loop and Closed-Loop Operation

In open-loop mode, the tip/tilt angle is roughly proportional to the applied voltage. The S-310 to S-315 open-loop models are ideal for high-speed, high resolution applications where the absolute angular position is of secondary importance (e.g. for tracking) or

where feedback is provided by an external sensor (e.g. CCD, PSD). The S-316.10 model is equipped with high-resolution strain gauge sensors and provides absolute position control, high linearity and high repeatability.

Available Versions

■ S-310.10, S-314.10

Open-loop Z-platforms; all three piezo linear actuators are electrically connected in parallel, providing vertical positioning (piston movement) of the top ring. Only one drive channel is required.

■ S-311.10, S-315.10

Open-loop Z/tip/tilt positioners; all three piezo linear actuators can be driven individually (or in parallel) by a three-channel amplifier. Vertical (piston movement) positioning and tip/tilt positioning are possible.

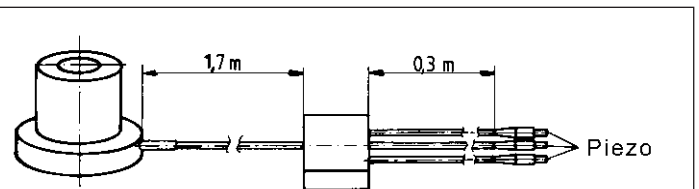
■ S-316.10

Closed-loop Z/tip/tilt positioner. All three piezo linear actuators are equipped with strain gauge position feedback sensors and can be driven individually (or in parallel) by a three-channel am-

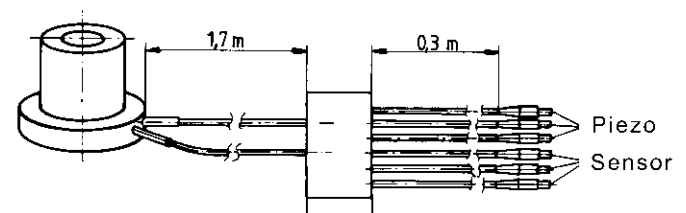
Ordering Information

- S-310.10**
Piezo Actuator, Clear Aperture, 6 μm , LEMO Connector
- S-311.10**
Piezo Z/Tip/Tilt Platform, Clear Aperture, 600 μrad , 6 μm , LEMO Connector
- S-314.10**
Piezo Actuator, Clear Aperture, 12 μm , LEMO Connector
- S-315.10**
Piezo Z/Tip/Tilt Platform, Clear Aperture, 1.2 mrad, 12 μm , LEMO Connector
- S-316.10**
Piezo Z/Tip/Tilt Platform, Clear Aperture, 1.2 mrad, 12 μm , SGS, LEMO Connector
- S-316.10D**
Piezo Z/Tip/Tilt Platform, Clear Aperture, 1.2 mrad, 12 μm , SGS, Sub-D Connector

plifier with a position servo-controller. Vertical positioning (piston movement) and tip/tilt positioning are possible. The integrated position feedback sensors provide sub-microradian resolution and high repeatability.



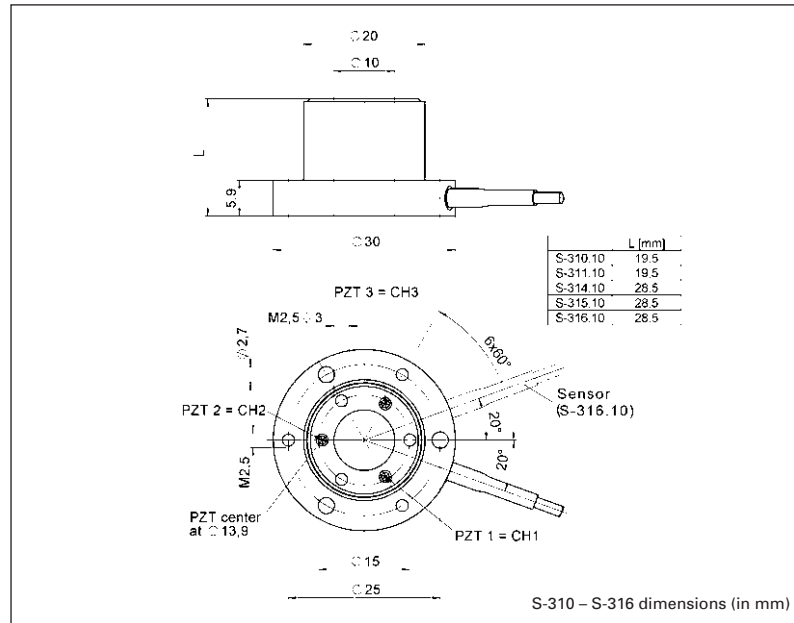
S-315 cable configuration



S-316 cable configuration

High Reliability and Long Life-time

The compact S-310 - S-316 systems are equipped with preloaded PICMA® high-performance piezo actuators which are integrated into a sophisticated, FEA-modeled, flexure guiding system. The PICMA® actuators feature cofired ceramic encapsulation and provide better performance and reliability than conventional piezo actuators. Actuators, guidance and sensors are maintenance-free, not subject to wear and offer extraordinary reliability.



Technical Data

Model	S-310.10	S-314.10	S-311.10	S-315.10	S-316.10	Units	Tolerance
Active axes	Z	Z	Z, θ_x , θ_y	Z, θ_x , θ_y	Z, θ_x , θ_y		
Motion and positioning							
Integrated sensor	-	-	-	-	SGS		
Open-loop travel, 0 to +100 V	6 / -	12 / -	6 / -	12 / -	12 / 12	μm	min. (+20%/-0%)
*Open-loop tilt angle @ 0 to 100 V	-	-	600	1200	1200	μrad	min. (+20%/-0%)
Closed-loop travel	-	-	-	-	12	μm	
*Closed-loop tilt angle	-	-	-	-	1200	μrad	
Open-loop resolution	0.1	0.2	0.1	0.2	0.2	nm	typ.
Open-loop tip/tilt angle resolution	-	-	0.02	0.05	0.05	μrad	typ.
Closed-loop resolution	-	-	-	-	0.4	nm	typ.
Closed-loop tip/tilt resolution	-	-	-	-	0.1	μrad	typ.
Linearity	-	-	-	-	0.2	%	typ.
Mechanical properties							
Stiffness	20	10	20	10	10	N/ μm	$\pm 20\%$
Unloaded resonant frequency (Z)	9.5	5.5	9.5	5.5	5.5	kHz	$\pm 20\%$
Resonant frequency (with 15 x 4 mm glass mirror)	6.5	4.4	6.5	4.1	4.1	kHz	$\pm 20\%$
Resonant frequency (with 20 x 4 mm glass mirror)	6.1	4.2	6.1	3.4	3.4	kHz	$\pm 20\%$
Distance of pivot point to platform surface	-	-	5	5	5	mm	± 1 mm
Platform moment of inertia	-	-	150	150	150	$\text{g} \cdot \text{mm}^2$	$\pm 20\%$
Drive properties							
Ceramic type	PICMA® P-882	PICMA® P-882	PICMA® P-882	PICMA® P-882	PICMA® P-882		
Electrical capacitance	0.39	0.93	0.39	0.93	0.93	μF	$\pm 20\%$
Dynamic operating current coefficient	8	10	8	10	10	$\mu\text{A} / (\text{Hz} \cdot \text{mrad})$	$\pm 20\%$
Miscellaneous							
Operating temperature range	-20 to 80	-20 to 80	-20 to 80	-20 to 80	-20 to 80	$^{\circ}\text{C}$	
Material	Stainless steel	Stainless steel	Stainless steel	Stainless steel	Stainless steel		
Mass	0.045	0.055	0.045	0.055	0.055	kg	$\pm 5\%$
Cable length	2	2	2	2	2	m	± 10 mm
Sensor connection	-	-	-	-	LEMO		
Voltage connection	LEMO	LEMO	LEMO	LEMO	LEMO		

Linear Actuators & Motors

Nanopositioning/Piezoelectrics

Piezo Flexure Stages / High-Speed Scanning Systems

Linear

Vertical & Tip/Tilt

2- and 3-Axis

6-Axis

Fast Steering Mirrors / Active Optics

Piezo Drivers / Servo Controllers

Single-Channel

Multi-Channel

Modular

Accessories

Piezoelectrics in Positioning

Nanometrology

Micropositioning

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Resolution of PI piezo tip/tilt platforms is not limited by friction or stiction. Noise equivalent motion with E-503 amplifier (p. 2-146).

*Mechanical tilt, optical beam deflection is twice as large. For maximum tilt range, all three piezo actuators must be biased at 50 V. Due to the parallel-kinematics design linear travel and tilt angle are interdependent. The values quoted here refer to pure linear / pure angular motion (equations p. 2-84).

Recommended controller / amplifier
Single-channel (1 per axis): E-610 servo-controller / amplifier (p. 2-110), E-625 servo-controller, bench-top (p. 2-114)

Multi-channel: modular piezo controller system E-500 (p. 2-142) with amplifier module E-503 (three channels) (p. 2-146) or E-505 (1 per axis, high-power) (p. 2-147) and E-509 controller (p. 2-152) (optional), E-517 interface module (p. 2-156) (optional)

S-340 Piezo Tip/ Tilt-Platform

High-Dynamics for Mirrors and Optics with a Diameter of up to 100 mm (4")



S-340 tip/tilt platform for mirrors with a diameter of up to 100 mm

- Resolution up to 20 nrad, Excellent Position Stability
- Optical Beam Deflection to 4 mrad
- Higher Precision and Dynamics via Parallel Kinematics
- Only One Moving Platform with a Fixed Pivot Point Prevents the Change of the Polarization
- Sub-ms Response
- For Mirrors with a Diameter up to 100 mm
- Position-Controlled Versions for Better Linearity
- Excellent Temperature Stability

S-340 tip/tilt platforms allow high-dynamic and precise angular movements of the top platform in two orthogonal axes with a common pivot point (parallel kinematics). The systems are designed for mirrors with a diameter of up to

100 mm and their differential drive enables an outstanding angular stability in a wide temperature range. A variety of top platforms are available to achieve an optimum thermal adaptation to different mirror materials. For operation in closed-loop, the SD versions are equipped with high-resolution strain gauge sensors in a thermally stable circuit. All versions feature a sub- μ rad resolution and a tip/tilt range of 2 mrad (equivalent to 4 mrad optical beam deflection).

Parallel-Kinematic Design for Improved Stability, Linearity and Dynamics

Piezo tip/tilt mirror systems of PI are based on parallel kinematics with a single movable

Ordering Information

S-340.A0L

Piezo Tip/Tilt Platform, 2 mrad, Open-Loop, LEMO Connector, Aluminum Top Plate

S-340.ASL

Piezo Tip/Tilt Platform, 2 mrad, SGS, LEMO, Aluminum Top Plate

S-340.ASD

Piezo Tip/Tilt Platform, 2 mrad, SGS, Sub-D Connectors, Aluminum Top Plate

Various material for the top platforms are available on demand:

S-340.S0L / .SSL / .SSD: High-Grade Steel

S-340.T0L / .TSL / .TSD: Titanium

S-340.i0L / .iSL / .iSD: Invar

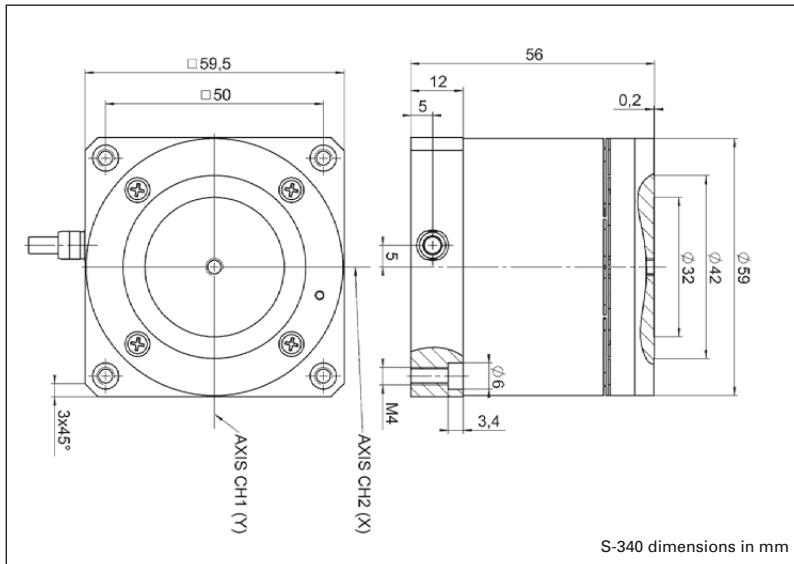
platform for all directions of motion. The four actuators are controlled differentially in pairs depending on the tip/tilt movement of the platform. This results in an excellent stability in linear and angular positioning for a wide temperature range. Compared to systems with an independent positioner per tilt axis, parallel-kinematics offer the advantage of symmetrical dynamic properties of motion for all axes, faster response and better linearity with a compact design. For this kind of design no change of polarization of the reflected light occurs, different than for stacked single axis systems like e. g. galvo scanners.

Ceramic-Insulated Piezo Actuators Provide Superior Lifetime

The highest possible reliability is assured by employing the award-winning PICMA® multi-layer piezo actuators. PICMA® actuators are the only actuators on the market with a ceramic-only insulation which makes them resistant to ambient humidity and leakage-current failures. They are thus far superior to conventional actuators in reliability and lifetime.

Application Examples

- Image processing / stabilization
- Laser scanning / beam steering
- Active and adaptive optics
- Optical filters
- Beam stabilization
- Correction of polygon mirror errors



E-616 OEM steering mirror controller shown with the miniature S-334 tip/tilt mirror system

Technical Data

Model	S-340.ASD/.ASL	S-340.A0L	Units	Tolerance
Active axes	$\theta X, \theta Y$	$\theta X, \theta Y$		
Motion and Positioning				
Integrated sensor	SGS	–		
Open-loop tip / tilt angle, -20 to +120 V	2	2	mrad	min.
Closed-loop tip / tilt angle	2	–	mrad	
Open-loop tip / tilt angle resolution	0.02	0.02	μrad	typ.
Closed-loop tip / tilt resolution	0.2	–	μrad	typ.
Linearity in $\theta X, \theta Y$	0.1	–	%	typ.
Repeatability in $\theta X, \theta Y$	0.15	–	μrad	typ.
Mechanical properties				
Unloaded resonant frequency ($\theta X, \theta Y$)	1.4	1.4	kHz	$\pm 20\%$
Resonant frequency loaded in $\theta X, \theta Y$ (with glass mirror diameter 50 mm, thickness 15 mm)	0.9	0.9	kHz	$\pm 20\%$
Resonant frequency loaded in $\theta X, \theta Y$ (with glass mirror diameter 75 mm, thickness 22 mm)	0.4	0.4	kHz	$\pm 20\%$
Distance of pivot point to platform surface	7.5	7.5	mm	$\pm 1\text{ mm}$
Platform moment of inertia	18000	18000	$\text{g} \cdot \text{mm}^2$	$\pm 20\%$
Drive properties				
Ceramic type	PICMA®	PICMA®		
Electrical capacitance	6/axis	6/axis	μF	$\pm 20\%$
Dynamic operating current coefficient	0.45/axis	0.45/axis	$\mu\text{A}/(\text{Hz} \cdot \text{mrad})$	$\pm 20\%$
Miscellaneous				
Operating temperature range	-20 to 80	-20 to 80	$^{\circ}\text{C}$	
Material case	Aluminum	Aluminum		
Material platform	Aluminum; or optionally Steel, Titanium or Invar	Aluminum; or optionally Steel, Titanium or Invar		
Mass	0.355	0.35	kg	$\pm 5\%$
Cable length	2	2	m	$\pm 10\text{ mm}$
Sensor/voltage connection	Sub-D connector / LEMO	LEMO		

Recommended controller / amplifier

Closed-loop versions with Sub-D connectors: E-616 servo controller for tip / tilt mirror systems s. p. 2-132; with LEMO connector: E-500 System s. p. 2-142.

Open-loop: E-500 System s. p. 2-142.