

# S-310 - S-316

## High-Speed Multi-Axis Tip/Tilt Platforms and Z Positioners

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S-310.10, S-316.10

- 10 mm Clear Aperture
- Piezo Tripod Design Allows Z Motion and Tilt
- Up to 2.4 mrad Optical Beam Deflection
- Piston Movement up to 12 µm
- Closed-Loop Versions for Better Linearity
- For Optics, Mirrors or Other Components
- Zero Friction Guiding Mechanism
- Single-Moving-Platform, Parallel-Kinematics Design: Equal Dynamics for all Axes, Better Linearity & Temperature Stability

S-310 to S-316 multi-axis tip/tilt platforms and Z-positioners are fast and compact units based on a piezo tripod design (see page 3-10 for details and equations). They offer piston movement up to 12 µm and tilt movement up to 1.2 mrad (2.4 mrad optical)

with sub-msec response and settling. The S-310 to S-316 systems are designed for mirrors and optics up to 25 mm diameter; the clear aperture is ideal for transmitted-light applications. The units can be mounted in any orientation.

### Open / Closed-Loop Operation

In open-loop operation, the vertical position / platform angle roughly corresponds to the drive voltage (see the "Tutorial" section for behavior of open-loop piezos). The S-310 to S-315 open-loop models are ideal for applications where the position is controlled by an external loop based on data provided by a sensor (e.g. PSD, quad cell,

CCD chip, ...). The S-316.10 closed-loop version allows absolute position control, high linearity and repeatability based on the internal ultra-high-resolution feedback sensor.

### Working Principle

The S-310 to S-316 tilt platforms are equipped with three long-life, ceramic-encapsulated, high-performance PICMA® piezo drives (see page 3-7 for details and equations).

### Available Versions

Five different versions are available:

- 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. The three piezo actuators are individually matched for equal displacement, providing straight motion with tilt errors of less than 70 µrad over the complete range.

### Ordering Information

- S-310.10**  
Vertical Piezo Positioner with Clear Aperture, 6 µm
- S-311.10**  
Multi-Axis Piezo Tip/Tilt Platform with Clear Aperture, 600 µrad, 6 µm
- S-314.10**  
Vertical Piezo Positioner with Clear Aperture, 12 µm
- S-315.10**  
Multi-Axis Piezo Tip/Tilt Platform with Clear Aperture, 1200 µrad, 12 µm
- S-316.10**  
Multi-Axis Piezo Tip/Tilt Platform with Clear Aperture, 1200 µrad, 12 µm, Closed-Loop

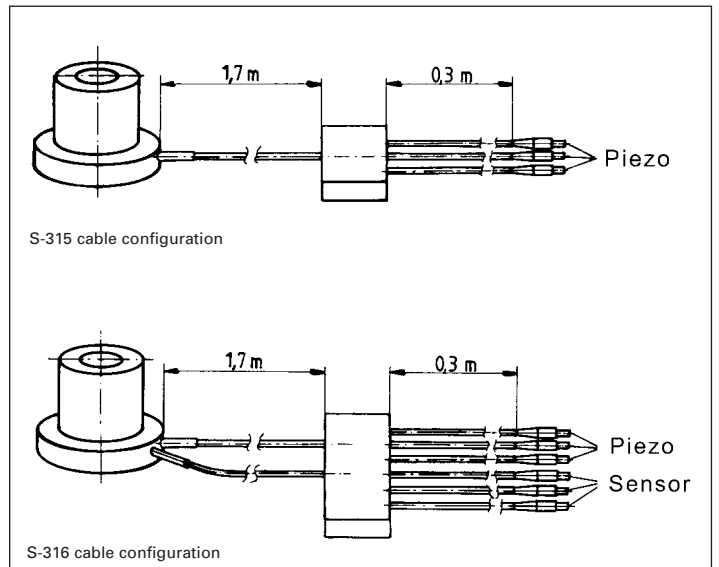
Ask about custom designs!

- 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



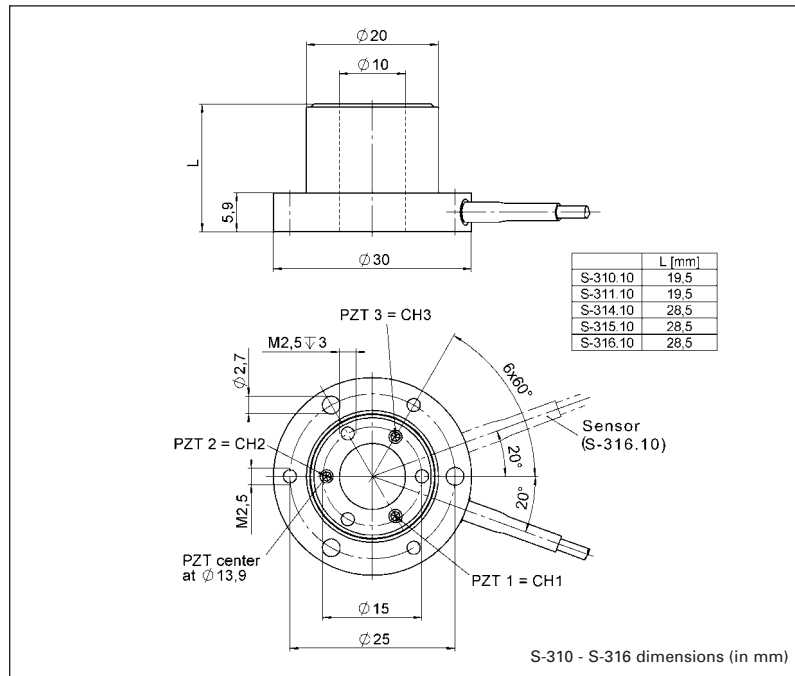
S-315 cable configuration

S-316 cable configuration

strain gauge position feedback sensors and can be driven individually (or in parallel) by a three-channel amplifier/position servo-controller. Vertical positioning (piston movement) and tip/tilt positioning are possible. The integrated position feedback sensors provide sub-micron resolution and repeatability.

### Higher Performance Through Parallel Kinematics

S-31x series tip/tilt systems feature a single moving platform, parallel-kinematics design. Compared to stacked, multi-axis systems, the parallel-kinematics design provides faster response and better linearity with equal dynamics for all axes in a smaller package.



### Technical Data

Models	S-310.10	S-314.10	S-311.10	S-315.10	S-316.10	Units	Notes see page 3-26
Active axes	Z	Z	Z, $\theta_x$ , $\theta_y$	Z, $\theta_x$ , $\theta_y$	Z, $\theta_x$ , $\theta_y$		
* Open-loop tilt angle @ 0 to 100 V	-	-	600	1200	1200	$\mu\text{rad} \pm 20\%$	
* Closed-loop tilt angle	-	-	-	-	1200	$\mu\text{rad}$	A3
Open-loop linear travel @ 0 to 100 V	6	12	6	12	12	$\mu\text{m} \pm 20\%$	A5
Closed-loop linear travel	-	-	-	-	12	$\mu\text{m}$	A6
Integrated feedback sensor	-	-	-	-	3 x strain gauge		B
** Closed-loop angular resolution	-	-	-	-	$\pm 0.05$	$\mu\text{rad}$	C1
** Closed-loop / open-loop linear resolution	- / 0.1	- / 0.2	- / 0.1	- / 0.2	0.4 / 0.2	nm	C1
Stiffness (Z)	20	10	20	10	10	$\text{N}/\mu\text{m} \pm 20\%$	D1
Electrical capacitance	0.7	1.4	3 x 0.23	3 x 0.45	3 x 0.45	$\mu\text{F} \pm 20\%$	F1
*** Dynamic operating current coefficient (DOCC)	15	15	3 x 5	3 x 5	3 x 5	$\mu\text{A}/(\text{Hz} \times \mu\text{m})$	F2
Unloaded resonant frequency ( $f_0$ )	9.5	5.5	9.5	5.5	5.5	$\text{kHz} \pm 20\%$	G2
Resonant frequency w/ $\phi$ 15 x 4 mm glass mirror	6.5	4.4	5.5	4.1	4.1	$\text{kHz} \pm 20\%$	G3
Resonant frequency w/ $\phi$ 20 x 4 mm glass mirror	6.1	4.2	6.1	3.4	3.4	$\text{kHz} \pm 20\%$	G3
Distance, pivot point to platform surface (T)	-	-	5	5	5	mm	
Platform moment of inertia	-	-	150	150	150	$\text{g} \cdot \text{mm}^2$	
Operating temperature range	- 20 to 80	- 20 to 80	- 20 to 80	- 20 to 80	- 20 to 80	$^{\circ}\text{C}$	H2
Voltage connection	1 x VL, 2 m cable	1 x VL, 2 m cable	3 x VL, 2 m cable	3 x VL, 2 m cable	3 x VL, 2 m cable		J1
Sensor connection	-	-	-	-	3 x L, 2 m cable		J2
Weight (w/o cables)	45	55	45	55	55	$\text{g} \pm 5\%$	
Material (case / platform)	N-S / N-S	N-S / N-S	N-S / N-S	N-S / N-S	N-S / N-S		L
Recommended amplifier/controller (codes explained p. 3-9)	G, C	G, C	G, C	G, C	H, D		

\* Mechanical tilt, optical beam deflection is twice as large.  
For maximum tilt range, all three piezo actuators must be biased at 50 V. Linear travel and tilt angle are interdependent. The values quoted here refer to pure linear / pure angular motion. See piezo tripod drive equation on page 3-10 for more information.

\*\* For calibration information see p. 3-7.  
Resolution of PZT tip/tilt platforms is not limited by friction or stiction. Noise equivalent motion with E-503 amplifier.

\*\*\* Dynamic Operating Current Coefficient in  $\mu\text{A}$  per Hz and  $\mu\text{m}$  (per actuator). Example S-314.10: Sinusoidal scan of 10  $\mu\text{m}$  at 10 Hz requires approximately 1.5 mA drive current.