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S-303

High-Speed Piezo Phase Shifters with Direct Metrology Option

S-303 closed-loop model (left) and open-loop model (right). Dip switch for size comparison.

- **25 kHz Resonant Frequency for Sub-Millisecond Dynamics**
- **<0.1 Nanometer Resolution**
- **Capacitive Sensor Option for Highest Linearity and Stability**
- **Invar Option for Highest Thermal Stability**
- **Aperture with Open-Loop Versions**
- **3 µm Travel Range**
- **Compact Size: 30 mm Diameter x 10 mm**

S-303 phase shifters are extremely fast and compact systems based on a piezo tripod drive. They offer angstrom level resolution, piston movement up to 3 µm with sub-msec response and settling dynamics. The S-303 is designed for mirrors and optics up to 25 mm diameter and can be mounted in any orientation. Open- and closed-loop versions are available.

S-303.0L: Open-Loop Z-Positioner

The S-303.0L open-loop model is ideal for applications where the position is controlled by an external loop and an external sensor. The platform position corresponds roughly to the drive voltage of the piezo actuators. The clear aperture was integrated for transmitted-light applications.

S-303.CD: Superior Accuracy Through Direct-Motion-Metrology Capacitive Feedback Sensors

The S-303.CD closed-loop models are equipped with non-contact, zero-friction, direct-measuring two-plate capacitive position sensors and were designed for applications requiring nanometer positioning accuracy and stability. Capacitive sensors are absolute-measuring high-bandwidth devices and exhibit no periodic errors. Unlike conventional sensors, direct metrology measures the position of the platform directly rather than the strain in the actuator or guiding system. It improves phase fidelity and permits motion linearity of better than 0.03 % and effective resolution of better than 0.1 nanometers. This technique, combined with the inherent precision of the PI two-plate capacitive sensor and the temperature-compensated design, results in higher linearity scans, and provides superior responsiveness, resolution, repeatability and stability.

Working Principle / Lifetime

S-303 systems were developed for industrial applications where 10^9 motion cycles or more must be performed without failure or performance loss. The S-303 drive units incorporate PICMA® low-voltage multilayer piezo actuators. These highly optimized and ceramic-encapsulated drives are more robust than conventional piezo actuators, and feature superior lifetime in static and dynamic applications. Since drives and sensors in the S-303 are frictionless and not subject to wear and tear, these units offer an exceptionally high level of reliability.

Application Examples

- Interferometry
- Optical path tuning
- Beam stabilization
- Laser physics
- Cavity tuning

Ordering Information

S-303.0L
Piezo Phase Shifter, 3 µm, Open-Loop

S-303.CD
Piezo Phase Shifter, 2 µm, Capacitive Sensor

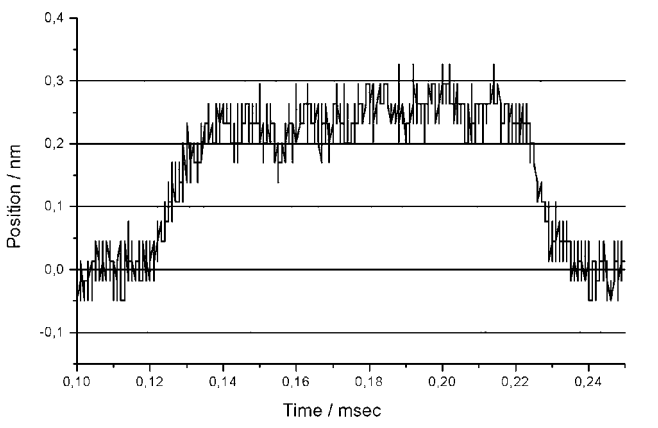
S-303.0Li
Piezo Phase Shifter, 3 µm, Open-Loop, Invar

S-303.CDi
Piezo Phase Shifter, 2 µm, Capacitive Sensor, Invar

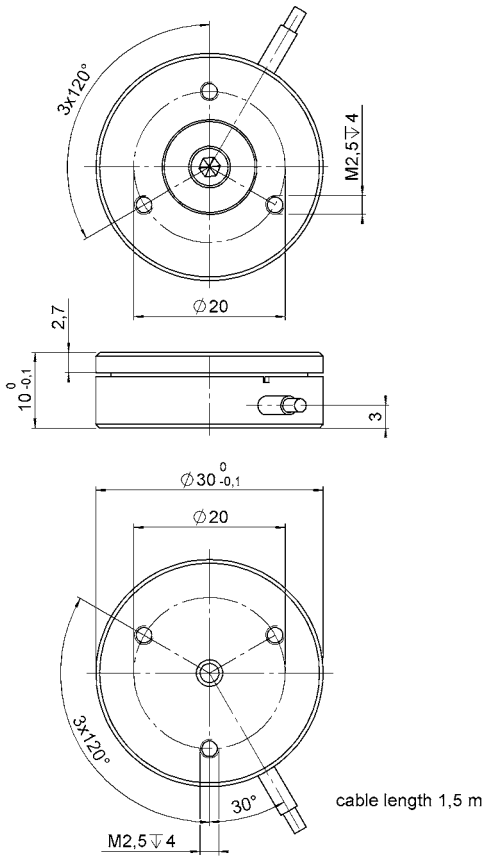
Ask about custom designs!

Notes

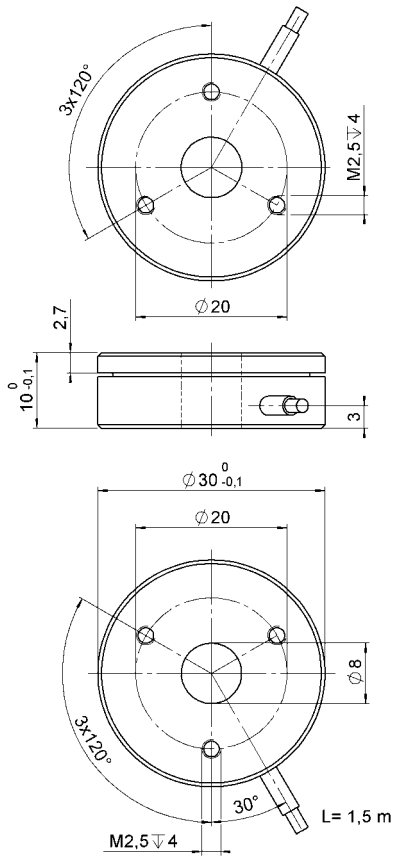
See the "Selection Guide" on p. 3-8 for comparison with other steering mirrors.



A 250 picometer step (0.25 nm) of the S-303 platform, controlled by an E-503 amplifier module and an E-509.C1A servocontroller module. Measured with special ultra-high-resolution capacitive gauge, ±0.02 nm resolution.



Dimensions of the S-303.CDx in mm



Dimensions of the S-303.0Lx in mm

Technical Data

Models	S-303.CDx	S-303.0Lx	Units	Notes see page 3-26
Active axes	Z	Z		
Min. Open-loop travel @ -20 to +120 V	3	3	µm ±20%	A2
Closed-loop travel	2	-	µm	A5
Integrated feedback sensor	capacitive	-		B
* Closed-loop / open-loop resolution	0.03 / 0.03	- / 0.03	nm	C1
** Closed-loop linearity (typ.)	1.0	-	%	
Full-range repeatability (typ.)	0.7	-	nm	C
Stiffness			N/µm ±20%	D1
Max. (±) normal load	0.5	0.5	N	D4
Electrical capacitance	0.9	0.9	µF ±20%	F1
*** Dynamic operating current coefficient (DOCC)	50	50	µA/(Hz x µm)	F2
Unloaded resonant frequency	25	25	kHz ±20%	G2
Operating temperature range	-20 to 80	-20 to 80	°C	H2
Voltage connection	D	VL		J1
Sensor connection	D	-		J2
Mass	100	30	g ±5%	
Body material	Al, Invar optional	Al, Invar optional		L
Recommended Amplifier/Controller (codes explained page 3-9)	F, M	G, C		

* For calibration information see p. 3-7. Resolution of PZT Nanopositioners is not limited by friction or stiction. Noise equivalent motion with E-503, E-710.

** With digital controller, analog controllers will provide a linearity of typ. 1 nm.

*** Dynamic Operating Current Coefficient in µA per Hz and µm. Example: Sinusoidal scan of 1 µm at 10 Hz requires approximately 0.5 mA drive current.

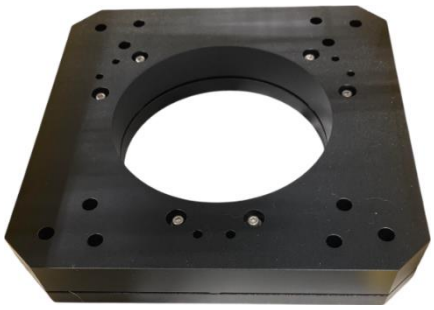
Piezo Phase Shifters for Optics

High-Resolution Piezo Z / Z-Tip-Tilt Stages for Interferometry, Nanopositioning & Scanning Applications

S-312

- Piezo Z- and Z-Tip-Tilt Stage for Horizontally or Vertically Mounted Optics
- 5 Clear Apertures to Choose from: 53mm (2in) to 311mm (12in)
- Low Profile, from 28mm
- Tripod Piezo Design provides High Stiffness Z-Travel with optional Tip/Tilt Correction
- Analog Voltage-Driven (0-100 V; 10V ≙~1.5µm, 100V ≙~15µm)
- Custom Versions Available, i.e. Closed Loop, or Different Sizes / Apertures

Preliminary Datasheet



S-312.04, Ø4" piezo phase shifter stage

S-312.02-L, Ø2" piezo phase shifter stage with Lemo connector

Product Overview

The S-312 piezo stages are designed for optical phase-shifting applications, where nanometer-level motion alters the phase of light waves traveling through a lens mounted on the stage. These stages are typically integrated into interferometers but are also suitable for use in a variety of optical circuits. Thanks to their high-stiffness design, they enable sub-nanometer steps with millisecond response times—ideal for rapid fringe shifting.

Operation

S-312 nanopositioning stages utilize three open-loop, long-life PICMA® piezo actuators, driven in parallel via an external analog amplifier. Displacement is proportional to the analog drive voltage—for example, a 10V signal provides approximately 10% of the maximum travel achieved at 100V. Custom phase shifters are available with closed-loop control (integrated position sensors) and in different form factors. The 0.5 m cable is offered with both connector and pigtail options to maximize configuration flexibility.

Available Sizes / Apertures

Part Number	Clear Aperture Diameter	Description
S-312.02	Ø2" (53mm)	Piezo Stage, Phase Shifter, 15µm, Ø2" (53mm) Clear Aperture
S-312.04	Ø4" (108mm)	Piezo Stage, Phase Shifter, 15µm, Ø4" (108mm) Clear Aperture
S-312.06	Ø6" (158mm)	Piezo Stage, Phase Shifter, 15µm, Ø6" (158mm) Clear Aperture
S-312.08	Ø8" (208mm)	Piezo Stage, Phase Shifter, 15µm, Ø8" (208mm) Clear Aperture
S-312.12	Ø12" (311mm)	Piezo Stage, Phase Shifter, 15µm, Ø12" (311mm) Clear Aperture
***-L**	All sizes	For Lemo Connector
-	All sizes	Pigtail Cable Endings for Direct Control of all 3 Piezo Actuators (Z-Tip-Tilt)

Accessories and options

- LEMO 1-Pin Electrical connector included for Z-motion (LEMO FFA.00.250.CTAC22)
- Pigtails for individual actuator control (Z with Tip-Tilt correction configuration)
- Compatible with the E-836 amplifier (not included)
- Optional cables include P-890 for pigtail to LEMO and P-891 for extension cables

Application fields

The stage is ideally suited for interferometer or optical circuit applications where small nanometer steps and/or high dynamics are needed. The solid state piezo and flexure design provides billions of cycles of lifetime and can be configured for both vacuum and clean room applications.

Specifications

Models	S-312.04	S-312.06	Unit	Tolerance
Active axes	Z, in the direction of the optical axis with Tip-Tilt Correction			
Nominal Clear Aperture	4	6	inches	
Clear Aperture	108	158	mm	
Nominal Open Loop Travel at 0 to 100V	15		µm	±15%
Resolution, open loop[1]	0.5		nm	
Maximum Payload[2]	15	15	kg	
Payload Max Offset[3]	50	75	mm	Max.
Natural Frequency with Max. Payload[4]	70	45	Hz	
Natural Frequency with No Payload[4]	560	320	Hz	
Electrical Capacitance[5]	4.5 (1.5 per Piezo)		µF	±20%
Maximum Voltage Range	-20 to +120		Volt	
Operating Temperature Range	-20 to +80		°C	
Mass (without cable)	1.8	2.5	kg	
Body Material	Aluminum			
Recommended Amplifier	E-836			
Cable Length	0.5		m	

Footnotes:

[1]Resolution is limited by the noise floor of the amplifier. Value shown assumes typical PI amplifier.

[2]With the optical axis in any direction relative to gravity.

[3]With optical axis horizontal, the max distance the Payload CG may be from the mounting face.

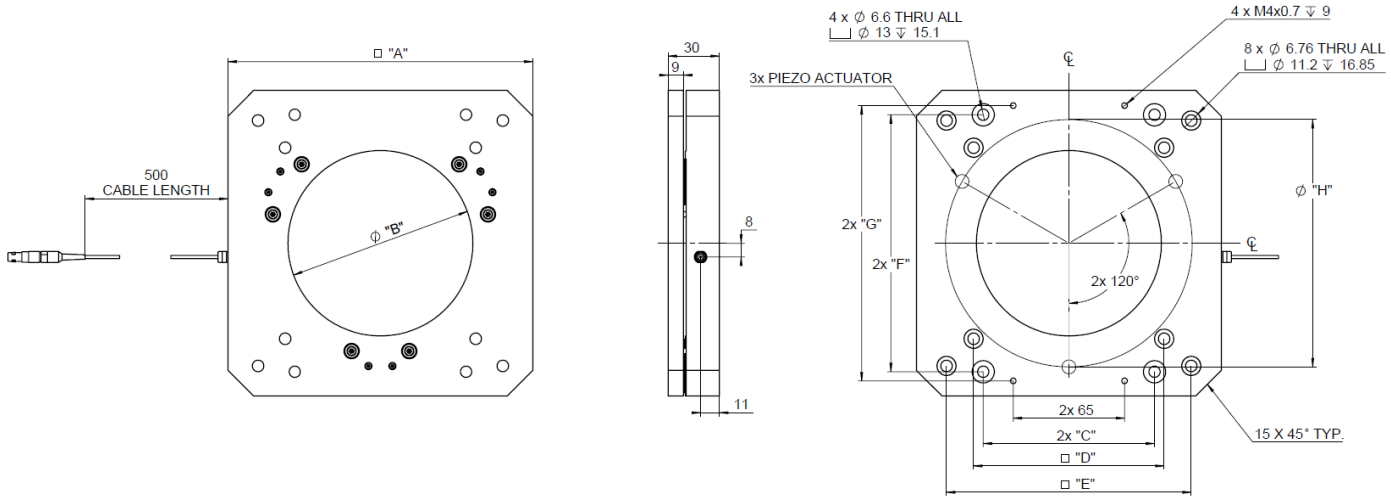
[4]Engineering FEA estimate.

[5]Small signal electrical capacitance: Measured at 1 Vpp, 1 kHz, RT, tolerance ±20 %.

Specifications are continuously updated and are subject to change without notice.

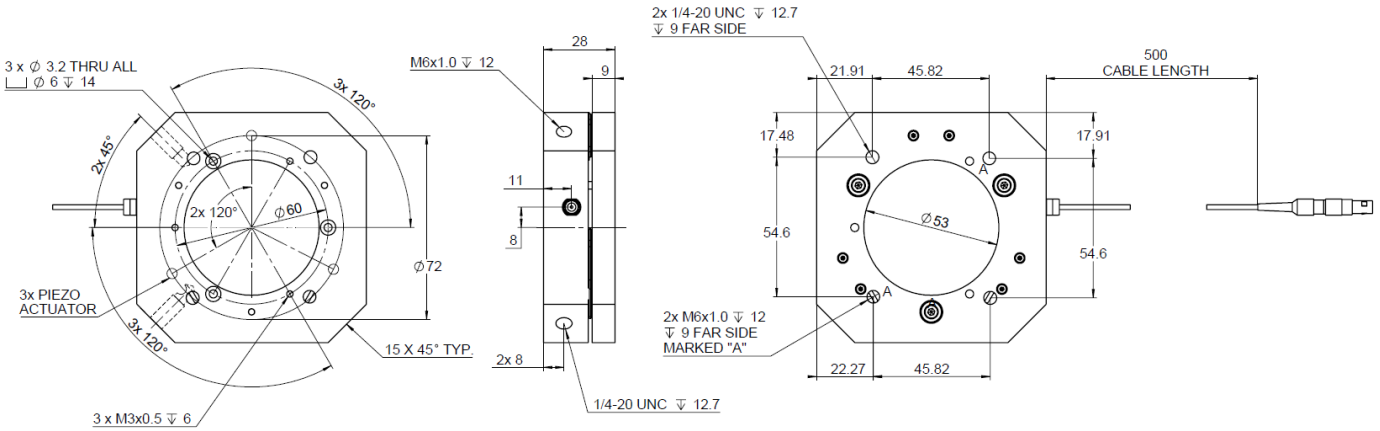
Open loop piezos typically have 15% hysteresis and 3% creep over the first 100s. The stage is design for temporary steps

Drawings and Images

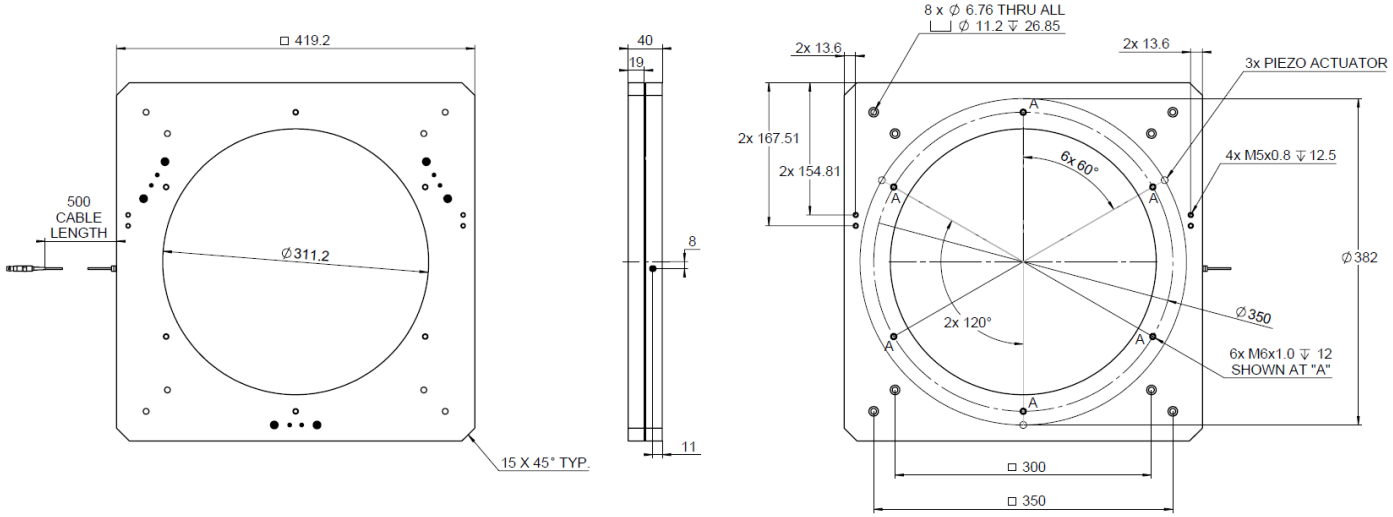


ASSEMBLY	APERTURE	A	B	C	D	E	F	G	H
S-312.04	4 IN	178 MM	108 MM	100 MM	111.25 MM	142.88 MM	149.66 MM	160.27 MM	143 MM
S-312.06	6 IN	228 MM	158 MM	127.78 MM	146.61 MM	178.23 MM	191.24 MM	210.27 MM	193 MM
S-312.08	8 IN	278 MM	208 MM	155.56 MM	181.96 MM	213.59 MM	232.81 MM	260.27 MM	243 MM

Dimensions of the S-312.04, S-312.06, and S-312.08 Piezo Phase Shifters



Dimensions of the S-312.02 Piezo Phase Shifters



Dimensions of the S-312.12 Piezo Phase Shifters

Ordering Information

Variants with Pigtails for Z-Tip-Tilt Motion (Individual Control of all 3 Piezo Stacks)

S-312.02
Piezo stage, phase shifter, 15µm, Ø2" (53mm) Aperture, Pigtail Cable Ends, Control of each Piezo Stack (Z-Tip-Tilt)

S-312.04
Piezo Stage, Phase Shifter, 15µm, Ø4" (108mm) Aperture, Pigtail Cable Ends, Control of each Piezo Stack (Z-Tip-Tilt)

S-312.06
Piezo Stage, Phase Shifter, 15µm, Ø6" (158mm) Aperture, Pigtail Cable Ends, Control of each Piezo Stack (Z-Tip-Tilt)

S-312.08
Piezo Stage, Phase Shifter, 15µm, Ø8" (208mm) Aperture, Pigtail Cable Ends, Control of each Piezo Stack (Z-Tip-Tilt)

S-312.12
Piezo Stage, Phase Shifter, 15µm, Ø12" (311mm) Aperture, Pigtail Cable Ends, Control of each Piezo Stack (Z-Tip-Tilt)

Variants with Lemo Connectors and Z-only Motion

S-312.02-L
Piezo Stage, Phase Shifter, 15µm, Ø2" (53mm) Aperture, LEMO connector

S-312.04-L
Piezo Stage, Phase Shifter, 15µm, Ø4" (108mm) Aperture, LEMO connector

S-312.06-L
Piezo Stage, Phase Shifter, 15µm, Ø6" (158mm) Aperture, LEMO connector

S-312.08-L
Piezo Stage, Phase Shifter, 15µm, Ø8" (208mm) Aperture, LEMO connector

S-312.12-L
Piezo Stage, Phase Shifter, 15µm, Ø12" (311mm) Aperture, LEMO connector

Accessories

Compatible Open Loop Amplifiers

- E-836 Compact Benchtop Piezo Amplifier or OEM Board Module
- E-663 3-Channel Piezo Amplifier

Extension Cables

- P-890 LEMO/Solderable End Cable (Pigtail to LEMO)
- P-891 Extension Cable LEMO/LEMO

E-836 Piezo Amplifier

E-836 OEM Piezo Amplifier

P-890 Cable LEMO / Solderable End

For the pigtail configuration, the three items that are typically bought together are as follows: S-312.xx + E-836 + P-890. For individual piezo control and Tip-Tilt correction, three E-836 amplifiers (or one E-663 amplifier) and three cables are required.

S-323 Piezo Z/Tip/Tilt Platform

High Dynamics & Stability Nanopositioning System with Direct Metrology

The S-323 Z/tip/tilt platform integrates capacitive sensors for highest resolution and stability

- Optical Beam Deflection to 6 mrad
- Sub-µrad Resolution for High Positioning Stability
- Position Servo-Control with Capacitive Sensors
- Frictionless, High-Precision Flexure Guiding System
- System Combination with Digital Controllers for Highest Linearity

Model	Active axes	Travel range	Resolution	Unloaded resonant frequency
S-323.3CD	Z, θ_X, θ_Y	30 µm, ±1.5 mrad	0.1 nm, ±0.05 µrad	1.7 kHz

S-303 Piezo Phase Shifter

Highest Dynamics and Stability with Capacitive Feedback Sensor

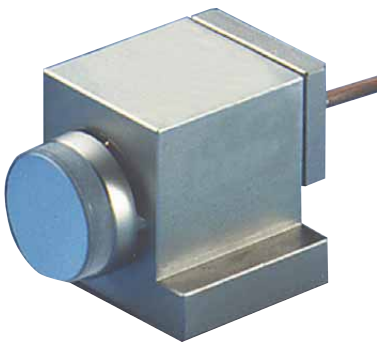
S-303 closed-loop model (left) and open-loop model (right). DIP switch for size comparison

- 25 kHz Resonant Frequency for Sub-Millisecond Dynamics
- Capacitive Sensor Option for Highest Linearity and Stability
- 3 µm Travel Range
- Compact Size: 30 mm Diameter x 10 mm
- Aperture with Open-Loop Versions
- Invar Option for Highest Thermal Stability

Model	Active axes	Closed-loop/ open-loop travel @ -20 to +120V	Closed-loop/ open-loop resolution	Unloaded resonant frequency
S-303.CD (closed-loop)/ S-302.0L (open-loop)	Z	2 / 3 µm	0.03 nm	25 kHz

S-224 – S-226 Piezo Tilt-Mirror

Fast Steering Mirror Combines Highest Dynamics and Compact Design



S-224 Piezo tip/tilt mirror for high-speed beam steering tasks and image stabilization applications

- Optical Beam Deflection to 4.4 mrad
- Sub-µrad Resolution, Sub-Millisecond Response
- Frictionless, High-Precision Flexure Guiding System
- Includes BK7 Mirror
- Optional Position Feedback Sensor
- Outstanding Lifetime Due to PICMA® Piezo Actuators

Model	Active axes	Open-loop tilt angle @ 0 to +100V	Closed-loop/ open-loop resolution	Unloaded resonant frequency
S-224.00 (open-loop)/ S-226.00 (closed-loop)	θ_X	2.0 / 2.2 mrad	0.05 / 0.1 µrad	9 kHz