

Fast Steering Mirrors

FSM SERIES



The Fast Steering Mirror Series provides two-axis, high-bandwidth rotation with sub-microradian mechanical resolution using voice-coil technology. Utilizing a unique flexure suspension design to confine the motion of the mirror results in ultra-smooth motion about a gimbal point, very high accuracy, and practically no wear. Newport offers a wide range of 1" field replaceable mirrors.

Versatile and Economical

The FSM is an economical option for widespread commercial use for applications such as laser beam stabilization, laser pointing, tracking, and image stabilization.

FSM vs. Galvanometers

Fast Steering Mirrors offer a more compact package with a unique flexure suspension design used to constrain the motion of the mirror, eliminating bearings with their associated stiction and wear common to XY galvanometers. FSMs eliminate the need to compensate for beam displacement and polarization rotation due to a second reflection. With higher optical performance than galvo scanners, FSMs have larger apertures, lower wavefront distortion, and a broader choice of mirror substrates and coatings. The rotational axes of an FSM intersect at a single pivot point, unlike dual XY galvos, eliminating the displacement jitter and the Pincushion Distortion.

Field Replaceable Mirrors

Newport offers a standard FSM-300 with a 1" (25.4 mm) diameter mirror. A wide range of replaceable 1" mirror assemblies allows the user to field replace the standard mirror with another mirror that best fits the specific application. These additional standard mirrors are available for different wavelength ranging from 250–1700 nm.

- Fast steering on a single pivot point for X and Y rotation
- Steering mirror is suspended on a flexure, eliminating friction
- Angular range $\pm 3^\circ$ and resolution $\leq 2 \mu\text{rad rms}$, optical
- Fast closed-loop control, to 580 Hz
- Field replaceable 1 in. mirror assemblies
- Larger angular range than piezo-driven mirrors
- Eliminates displacement jitter found in dual XY galvo mirror systems

Fast and Accurate Mirror Control

Four voice coil actuators provide fast, high-bandwidth rotation. Utilized in push-pull pairs, the actuators provide smooth, even torque to the mirror. An internal optical-based feedback loop is built into the FSM-300 head to provide position feedback with reference to the support frame for accurate and stable pointing and tracking. When used in combination with Newport's OBP Series Laser Beam Position Sensing Detector, an FSM can quickly lock to the detector for rapid laser beam control and stabilization.

Easy Analog Interface

The FSM-CD300 controller provides a convenient interface between the user and the mirror, allowing analog control voltages to be applied and mirror position to be monitored. The controller incorporates independent gain and DC offset adjustments of both X and Y-axes. This enhancement significantly improves the system performance for Laser Pointing applications, requiring accurately controlled point-to-point movements.

SPECIFICATIONS

Mirror Assembly

Number of Axes	2 (tip-tilt)
Angular Range from ± 10 V (mrad)	± 26.2 ($\pm 1.5^\circ$), Mechanical ⁽¹⁾
Resolution, rms (μ rad)	≤ 1 , Mechanical ⁽¹⁾
Repeatability, rms (μ rad)	≤ 3 , Mechanical ⁽¹⁾
Accuracy from ± 26.2 mrad, 25 °C(1) (mrad)	≤ 0.262 (0.015°), Mechanical ⁽¹⁾
Linearity from ± 26.2 mrad, 25 °C(1)	$\leq 1.0\%$
Closed-Loop Amplitude Bandwidth for small signal inputs (-3 dB)	580 Hz at 10 mV (typical)
Closed-Loop Phase Bandwidth (60° lag)	250 Hz (typical)
Response Flatness(2)	Peaking ≤ 3 dB
Noise Equivalent Angle	≤ 3 μ rad rms
Resolution of Local Position Sensor (μ rad)	≤ 0.5
Operating Temperature Range	0 to 50 °C (32 to 122 °F)
Storage Temperature Range	-20 to 55 °C (-4 to 131 °F)
Sensor Warm-up Time for Mirror Stability at 25 °C	≤ 10 minutes
Mass	1lb (0.45 kg)
Interconnect Cable Length	9.8 ft (3 m)
Dielectric Mirror Substrate Material	Pyrex
Mirror Retaining Mechanism	Mirror bonded to aluminum carrier, field replaceable
Pivot Point of Axes (centered on mirror)	12.19 mm behind mirror surface
Mirror Diameter	25.4 mm
Mirror Thickness	6.0 mm
Mirror Wedge	≤ 5 arc-min
Clear Aperture (at 0° angle of incidence)	≥ 20.3 mm
Clear Aperture (at 45° angle of incidence)	≥ 14.4 mm
Reflectivity ⁽²⁾	Enhanced Aluminum: >93%, 450–700 nm Protected Gold: >96%, 650–1700 nm; >98%, 1.7–2.0 μ m
Surface Flatness ⁽²⁾ (after coating and bonding)	$\leq \lambda/8$ at 632.8 nm over clear aperture
Surface Quality ⁽²⁾	15-5 scratch-dig

¹⁾ Optical angular range is equal to twice the mechanical angular range.

²⁾ Optical parameters apply to central 80% of mirror aperture.

Controller/Driver

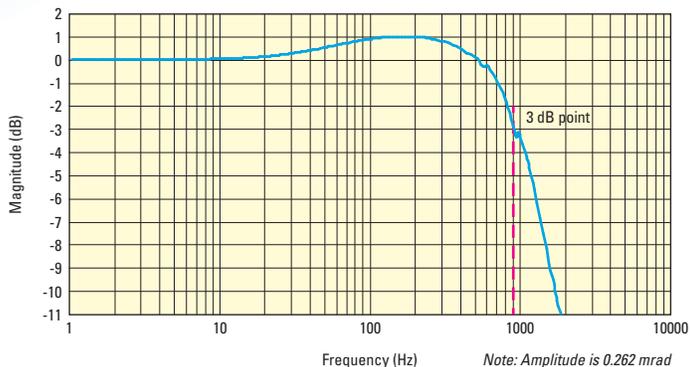
Command Input and Position Output	Analog, ± 10 V yields ± 26.2 mrad
Peak Operating Power to Mirror (W)	30
Continuous Maximum Operating Power to Mirror (W)	15
Thermal Protection	60 °C at mirror coil
Current Protection	3 A
Operating Temperature Range	0 to 50 °C (32 to 122 °F)
Storage Temperature Range	-20 to 55 °C (-4 to 131 °F)
Power	100–240 Vac $\pm 10\%$, 47–63 Hz
Mass	5.45 lb (2.5 kg)
Envelope, w x h x d [in (mm)]	9 x 3.45 x 10 (229 x 88 x 254)

Note: Performance data is based upon well-defined, smooth, D-A sine wave inputs. Contact Newport regarding alternate inputs (square waves, triangle waves, low resolution D-A sine waves), which may adversely effect system performance.

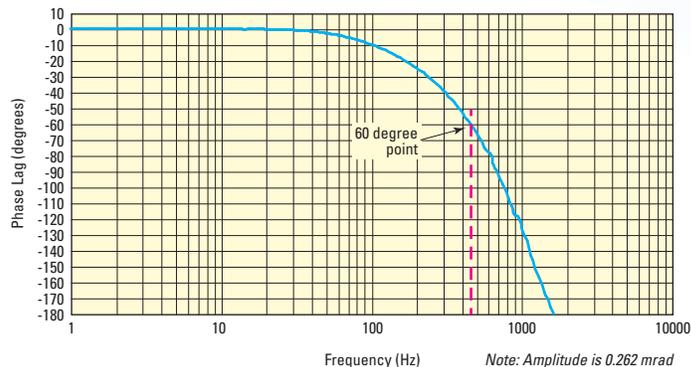


Bode Plots for Typical FSM

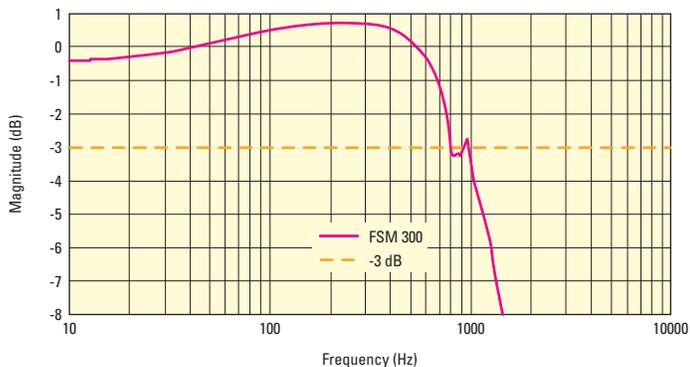
Typical Gain Response for Small-Angle Excitation



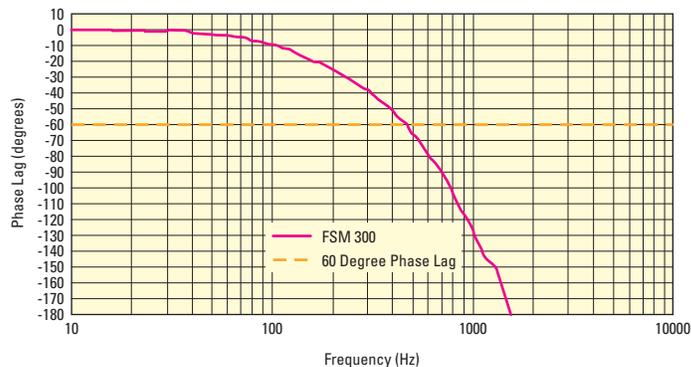
Typical Phase Response for Small-Angle Excitation



Typical Gain Response for Small-Angle Excitation

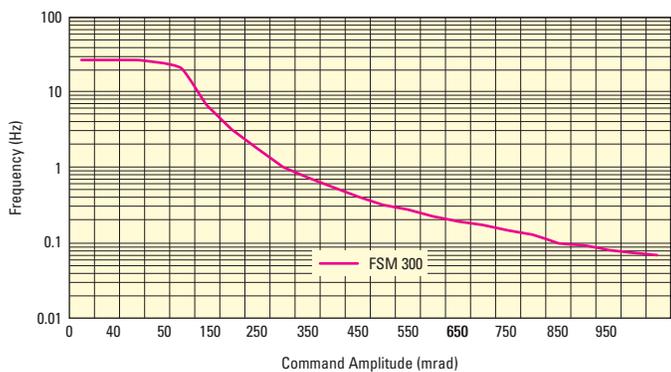


Typical Phase Response for Small-Angle Excitation

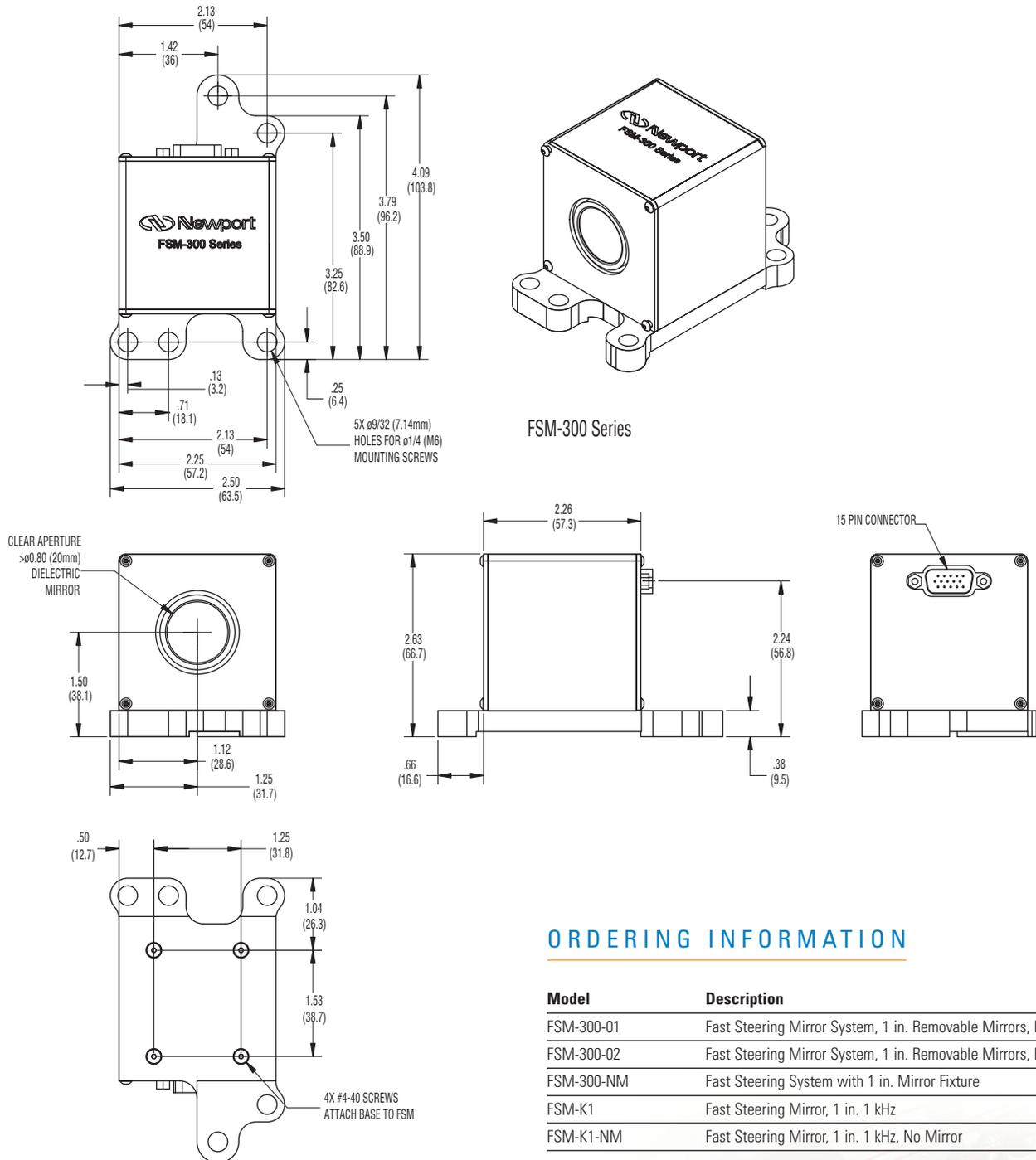


Typical Operating Area for FSM

Typical Safe Operating Area



DIMENSIONS



ORDERING INFORMATION

Model	Description
FSM-300-01	Fast Steering Mirror System, 1 in. Removable Mirrors, ER.1 Coating
FSM-300-02	Fast Steering Mirror System, 1 in. Removable Mirrors, ER.4 Coating
FSM-300-NM	Fast Steering System with 1 in. Mirror Fixture
FSM-K1	Fast Steering Mirror, 1 in. 1 kHz
FSM-K1-NM	Fast Steering Mirror, 1 in. 1 kHz, No Mirror



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