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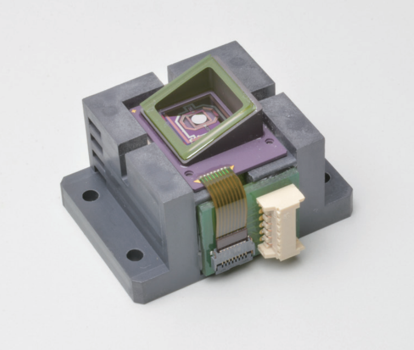
PHOTON IS OUR BUSINESS



MEMS mirror

S13124-01

Miniature, high performance, linear mode Electromagnetically driven two-dimensional laser scanning MEMS mirror

The S13124-01 is an electromagnetically driven mirror that incorporates our unique MEMS (micro-electro-mechanical systems) technology. The device was made smaller by arranging the magnet beneath the mirror. A two-dimensional scanning was achieved in linear mode. Electrical current flowing in the coil surrounding the mirror produces a Lorentz force based on Fleming's rule that drives the mirror. Hamamatsu MEMS mirrors offer a wide optical deflection angle and high mirror reflectivity.

Features

- **Two-dimensional scanning in linear mode**
  Capable of vector scanning and step operation
- **Compact**
- **Low voltage drive: suitable for installation on equipment**
- **With window material: Prevents foreign matter contamination**
- **Evaluation circuit available: C15087 (sold separately)**

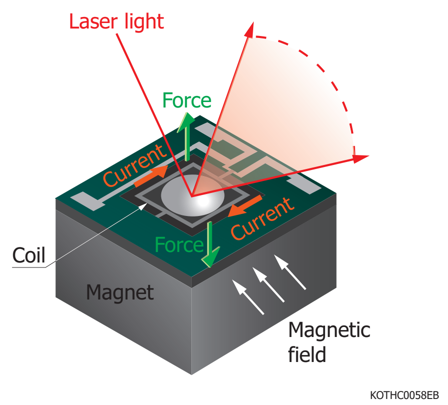
Applications

- **Machine vision**
- **Laser measurement**
- **Laser material processing**
- **Various laser scan units**

Structure and principle

In a MEMS mirror, a metallic coil is formed on a single-crystal silicon, a mirror is formed inside the coil through MEMS processing, and a magnet is arranged beneath the mirror. Within a magnetic field generated by the magnet, electrical current flowing in the coil surrounding the mirror produces a Lorentz force based on Fleming's rule that causes the mirror to tilt. In addition, the mirror can be driven two-dimensionally with the combination of two springs formed by MEMS processing. The path of the laser light incident on the mirror surface is varied in this way to scan and project. Compared to the electrostatic or piezoelectric driven mirrors, electromagnetically driven MEMS mirrors are lower voltage driven and easier to use.

Structure diagram



Absolute maximum ratings (Ta=25 °C unless otherwise noted)

Parameter		Symbol	Condition	Min.	Typ.	Max.	Unit
First axis	Optical deflection angle*1	θ1 max		-12	-	+12	°
	Drive current*2	I1		-20	-	+20	mA
Second axis	Optical deflection angle*1	θ2 max		-12	-	+12	°
	Drive current*2	I2		-25	-	+25	mA
Operating temperature*3		Topr	No dew condensation*4	-20	-	80	°C
Storage temperature*3		Tstg	No dew condensation*4	-40	-	85	°C

*1: Angle at which the torsional stress of the torsion bars becomes large and the service life is shortened

*2: Using the mirror with only one side (positive or negative) of the optical deflection angle is not recommended, as it can shorten the service life.

*3: Ambient temperature

*4: When there is a temperature difference between a product and the surrounding area in high humidity environments, dew condensation may occur on the product surface. Dew condensation on the product may cause deterioration in characteristics and reliability.

Note: Exceeding the absolute maximum ratings even momentarily may cause a drop in product quality. Always be sure to use the product within the absolute maximum ratings.

Structure

Parameter		Min.	Typ.	Max.	Unit
Mirror size		ϕ1.93	ϕ1.95	ϕ1.97	mm
Mirror material		Aluminum alloy			-
Operation mode	First axis, second axis	Linear mode			-

Recommended operating conditions

Parameter		Symbol	Condition	Min	Typ.	Max.	Unit
First axis	Incident angle*5	-		-12	+20	+21	°
	Optical deflection angle*6	θ1		-10	-	+10	°
	Drive frequency	f1		DC*7	-	90	Hz
Second axis	Incident angle*5	-		-15	0	+15	°
	Optical deflection angle*6	θ2		-10	-	+10	°
	Drive frequency	f2		DC*7	-	90	Hz
Operating temperature*8		Topr	No dew condensation*9	-20	+25	70	°C

*5: Incident angle at which a ϕ1.95 mm collimated laser beam is incident on the mirror positioned at an optical deflection angle of 0° and at which the laser is within the effective area of the window material when scanning is performed at the recommended optical deflection angle

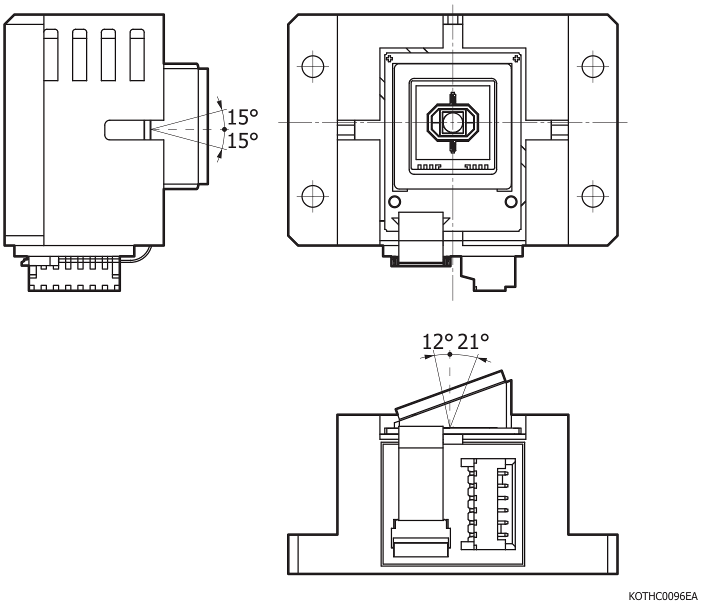
*6: The optical deflection angle is twice the mechanical deflection angle. The light path is offset due to the refraction by the window material. This must be considered during use.

*7: Using the mirror with only one side (positive or negative) of the optical deflection angle is not recommended, as it can shorten the service life.

*8: Ambient temperature. Recommended operating conditions: When used in this temperature range

*9: When there is a temperature difference between a product and the surrounding area in high humidity environment, dew condensation may occur on the product surface. Dew condensation on the product may cause deterioration in characteristics and reliability.

■ Definition of incident angle



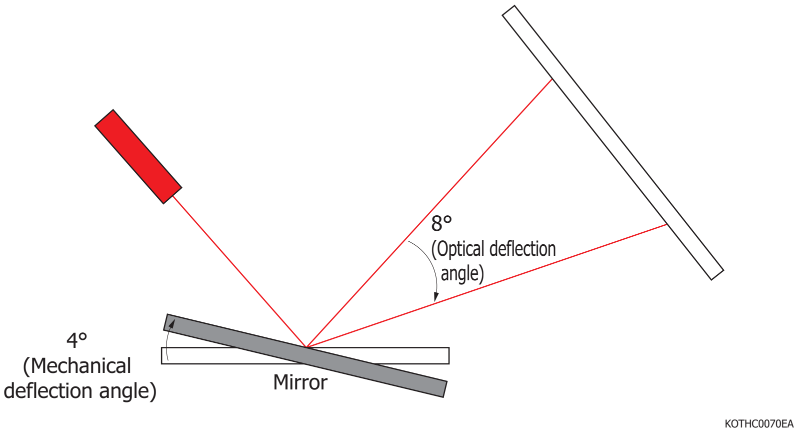
Electrical and optical characteristics (recommended operating conditions unless otherwise noted)

Parameter		Symbol	Condition	Min.	Typ.	Max.	Unit
Reflectance*10		R	λ=460 to 640 nm	80	-	-	%
Transmittance of window material*11		T	θin=0 to 43°*12	95*13	-	-	%
First axis	Coil resistance	R_1	I_1=0.1 mA I_2=0 mA	125	155	185	Ω
	Resonant frequency	$F_{1\text{-}r}$	I_1=0.12 mAp-p I_2=0 mA	450	480	510	Hz
	Quality factor	Q_1	I_1=0.12 mAp-p I_2=0 mA	100	120	140	-
Second axis	Coil resistance	R_2	I_1=0 mA I_2=0.1 mA	70	90	110	Ω
	Resonant frequency	$F_{2\text{-}r}$	I_1=0 mA I_2=0.16 mAp-p	940	1000	1060	Hz
	Quality factor	Q_2	I_1=0 mA I_2=0.16 mAp-p	140	165	190	-
Drive current		I_1	f_1=f_2=DC θ_1=+10° θ_2=+10°	11.5	15	18.5	mA
		I_2		14	18	22	mA
		I_1	f_1=f_2=DC θ_1=-10° θ_2=-10°	-18.5	-15	-11.5	mA
		I_2		-22	-18	-14	mA
Temperature sensor	Resistance	Rth	I_1=I_2=0 mA Ith=0.1 mA	215	270	325	Ω
	Resistance temperature coefficient	α	Ith=0.1 mA Tc=0 to 70 °C	0.35	0.38	0.41	%/°C

*10: Using a white light source
*11: Average window material transmittance of polarized light p and s. Note that, after passing through the window material, the laser light is reflected by the mirror and passes through the window material again.
*12: Incident angle to the window material
*13: Average value of λ=460 to 640 nm

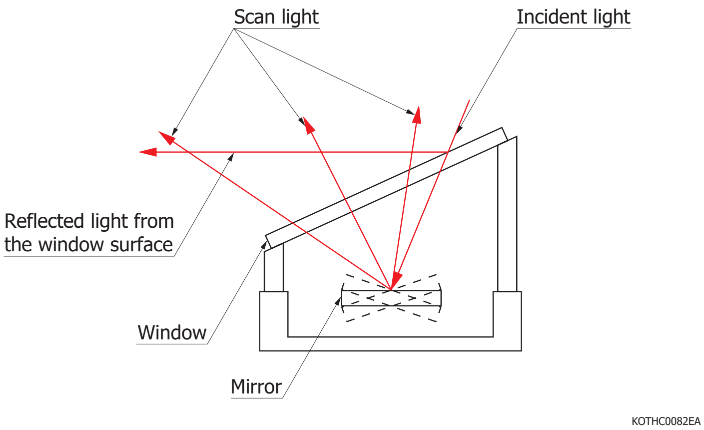
Optical deflection angle

The optical deflection angle is twice the mechanical deflection angle.

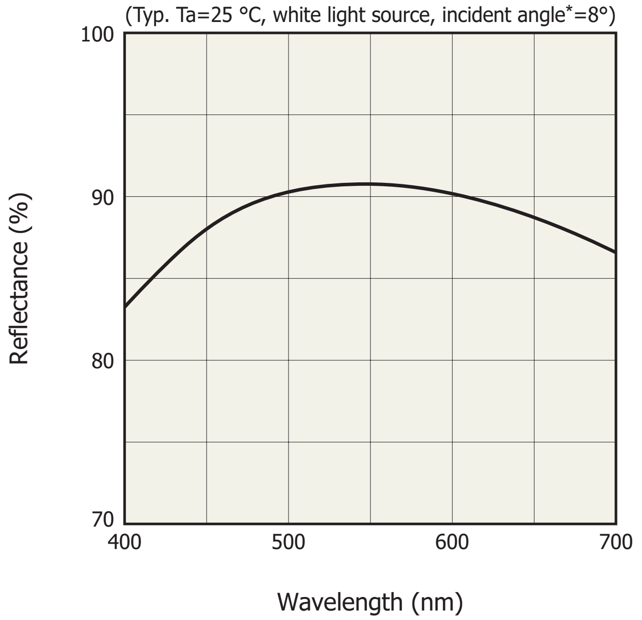


Effect of tilting the window material

The S13124-01 is equipped with the window material in order to prevent foreign matter from adhering to the mirror section. The window material tilt (20° with respect to the first axis scanning direction) is set so that the laser light reflected from the front or rear surface of the window does not enter the mirror scanning projection range.



Reflectance vs. wavelength



* Incident angle of light to the mirror

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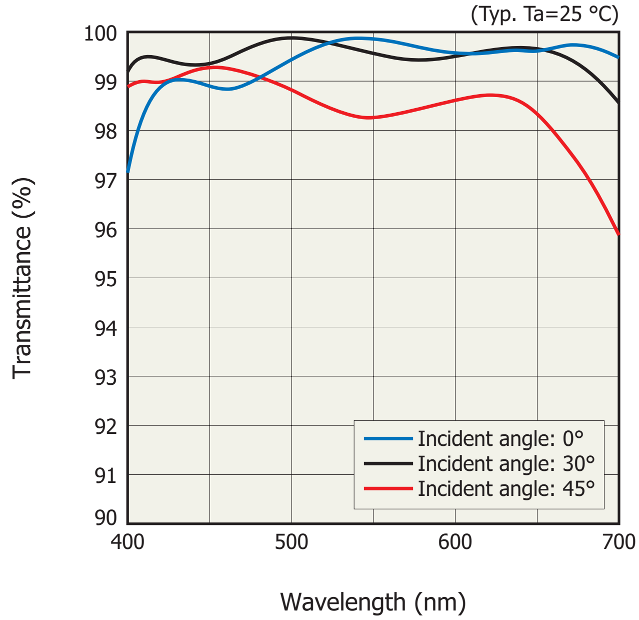
Spectral transmittance of window material



Note: Incident angle
=Angle of incidence of light on window material

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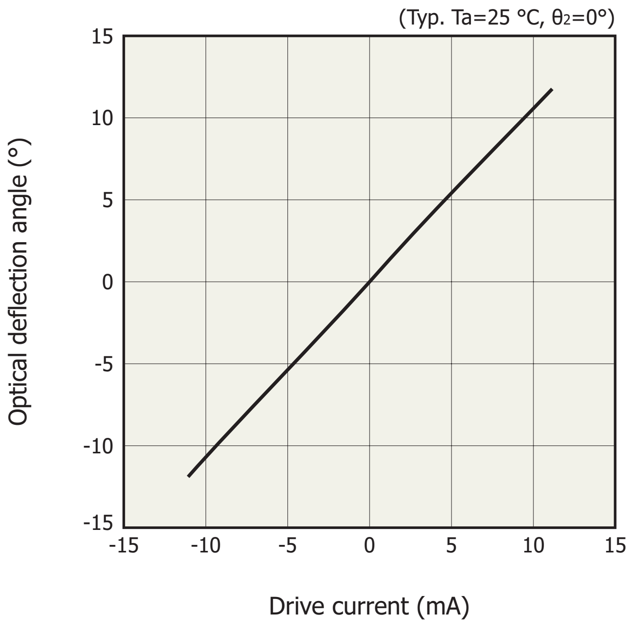
Optical deflection angle vs. drive current

First axis



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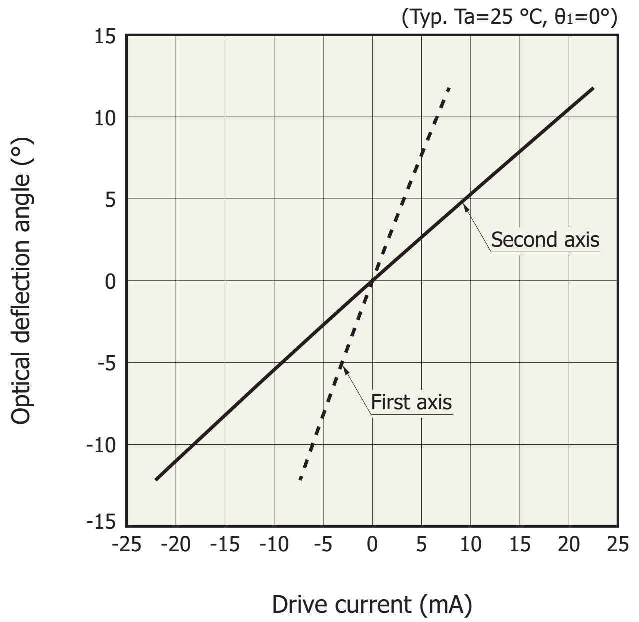
Second axis



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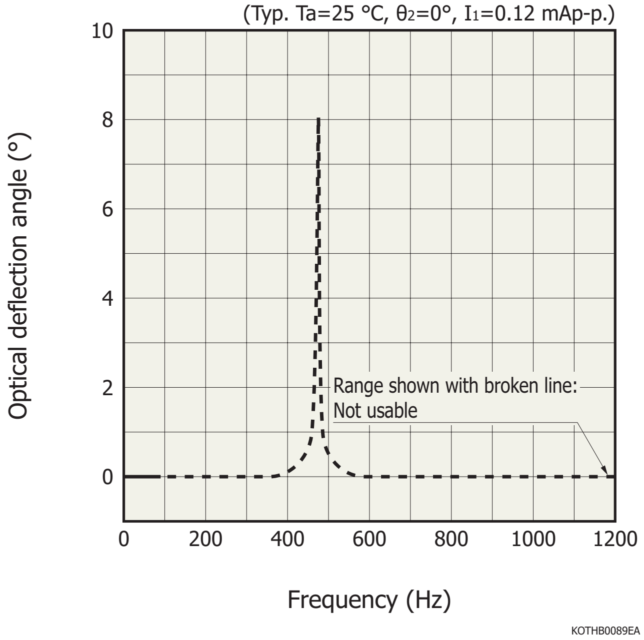
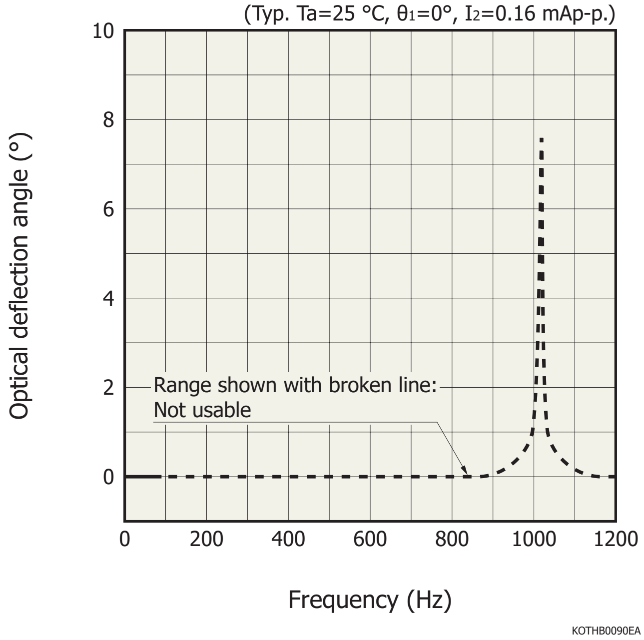
Optical deflection angle vs. frequency

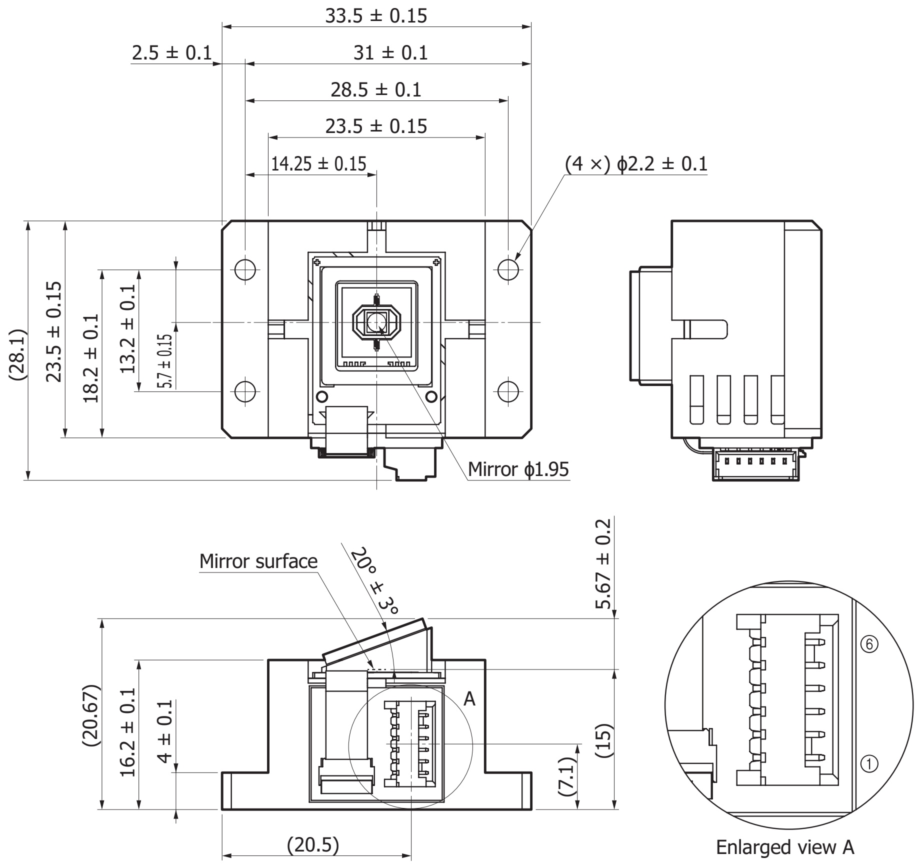
First axis



Second axis



Dimensional outline (unit: mm)



Connector: 53048-0610 (Molex)

Values in parentheses indicate reference values.

Pin no.	Connection
①	Temperature sensor (+)
②	First axis coil (+)
③	Second axis coil (+)
④	First axis coil (-)
⑤	Second axis coil (-)
⑥	Temperature sensor (-)

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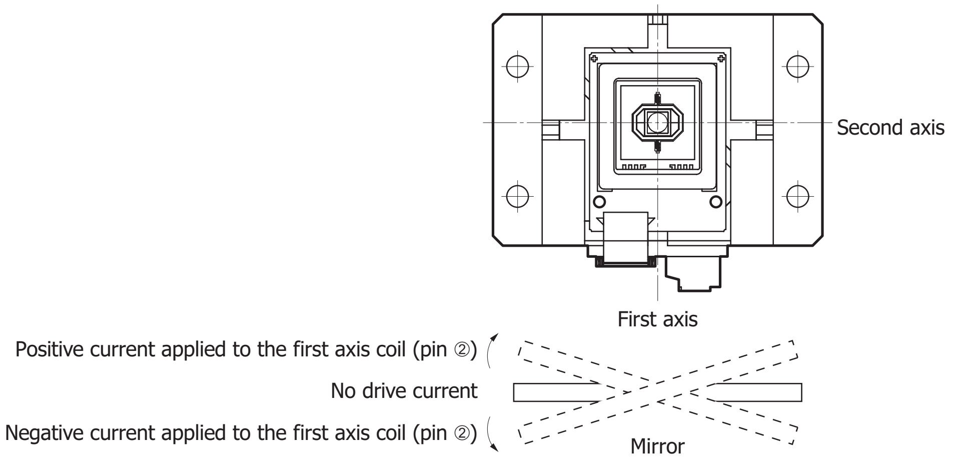
Mechanical deflection direction of mirror due to drive current

The direction of the mirror's mechanical deflection varies depending on the direction of the drive current flowing through the coil as follows.

Note: As the drive frequency of the MEMS mirror increases, the phase lag of the optical deflection angle with respect to the drive current increases.

First axis coil



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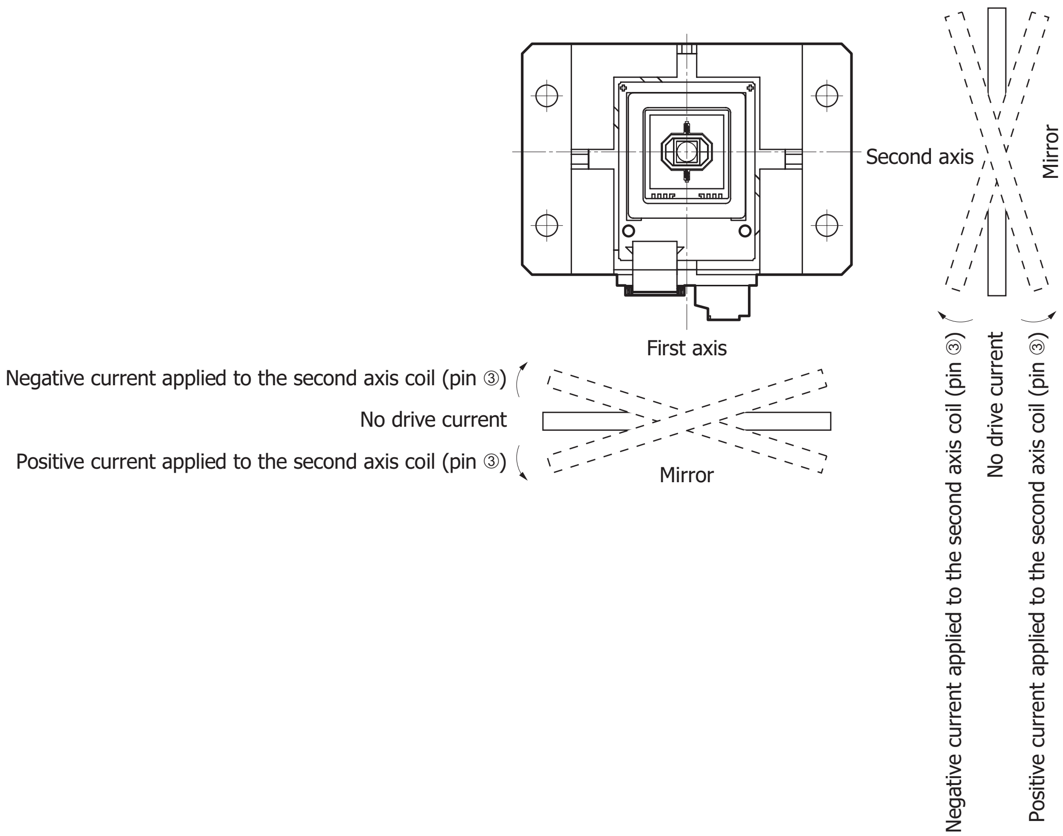
Second axis coil



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Precautions

· See "Metal, ceramic, plastic package products / Precautions."
· A powerful magnet is inside the product. Bringing a magnetic body close to the product may damage the product. Therefore, we recommend using nonmagnetic screws and screwdrivers when fixing the product in place.
· Do not use in a strong magnetic field environment. The operating characteristics of the product may degrade due to the magnetic field.
· When carrying several products together, prevent each product from making contact with each other due to the attraction force of magnets, such as by fixing the products in place with space between them inside the container.
· Bringing the product near a person with electronic medical equipment (e.g., pacemaker) is dangerous. Never do so.
· Do not bring the product near magnetic tapes, prepaid cards, and the like. They may become unusable, or the magnetic recording may be corrupted.
· Bringing the product near electronic control equipment may affect instrument boards or control boards and may lead to failures or accidents. If you want to use the product with electronic control equipment, check that the equipment does not fail or cause accidents due to the magnet inside the product.
· The product may fail due to the damage that it receives when it is mounted. Be sure to inspect the product after mounting, and check that the product is working properly.
· Refer to Packaging Standard 953 in the ITA Dangerous Goods Regulations

Related product

Evaluation circuit for MEMS mirror C15087 (sold separately)

The C15087 is a circuit board designed to simply evaluate linear mode MEMS mirror (1D: S12237-03P, 2D: S13124-01). First axis or second axis (linear mode) is driven with the selection from triangular wave, sine wave, or any chosen wave. A USB 2.0 interface is used to set the driving conditions of the MEMS mirror from the PC. This product can be driven with USB bus power.

Absolute maximum ratings

Parameter	Condition	Value	Unit
Operating temperature	No dew condensation*14	-20 to +70	°C
Storage temperature	No dew condensation*14	-40 to +85	°C
Supply voltage		6	V
Current consumption		0.5	A

*14: When there is a temperature difference between a product and the surrounding area in high humidity environment, dew condensation may occur on the product surface. Dew condensation on the product may cause deterioration in characteristics and reliability.

Note: Exceeding the absolute maximum ratings even momentarily may cause a drop in product quality. Always be sure to use the product within the absolute maximum ratings.

Electrical specifications

Parameter		Min.	Typ.	Max.	Unit
First axis (linear mode)	Output waveform	Triangular wave, sine wave, or arbitrary waveform			-
	Frequency	DC	-	100	Hz
	Output current	-25	-	25	mA
Second axis (linear mode)	Output waveform	Triangular wave, sine wave, or arbitrary waveform			-
	Frequency	DC	-	100	Hz
	Output current	-25	-	25	mA
Supply voltage		4.0	5.0	5.5	V
Current consumption		-	-	0.4	A
Interface		USB 2.0			-

Related information

www.hamamatsu.com/sp/ssd/doc_en.html

- Precautions
- · Disclaimer

Information described in this material is current as of May 2023.

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