

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)**

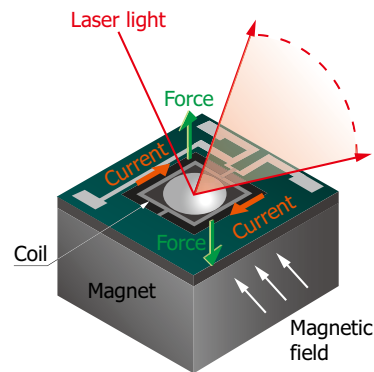
Applications

- **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



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

| Parameter | | Symbol | Condition | Min. | Typ. | Max. | Unit |
|-------------------------|----------------------------|----------------|-----------------------|------|------|------|------|
| First axis | Optical deflection angle*1 | θ_1 max | | -12 | - | +12 | ° |
| | Drive current*2 | I1 | | -20 | - | +20 | mA |
| Second axis | Optical deflection angle*1 | θ_2 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 | | $\phi 1.93$ | $\phi 1.95$ | $\phi 1.97$ | 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 | θ_1 | | -10 | - | +10 | ° |
| | Drive frequency | f1 | | DC*7 | - | 90 | Hz |
| Second axis | Incident angle*5 | - | | -15 | 0 | +15 | ° |
| | Optical deflection angle*6 | θ_2 | | -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 $\phi 1.95$ 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

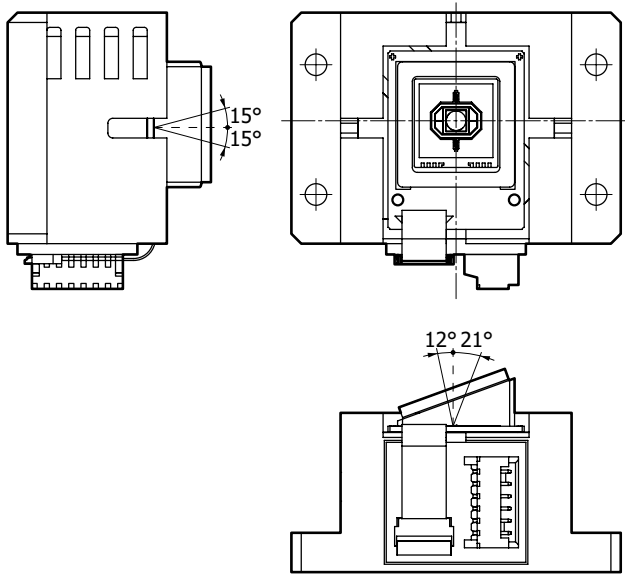
*6: The optical deflection angle is twice the mechanical deflection angle. The light path is offset due to the refraction by the window material. This must be considered during use.

*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



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

| Parameter | Symbol | Condition | Min. | Typ. | Max. | Unit | |
|-------------------------------------|------------------------------------|-----------------------------------|------------------------------------------|------|-------|------|---------------------|
| Reflectance*10 | R | $\lambda=460$ to 640 nm | 80 | - | - | % | |
| Transmittance of window material*11 | T | $\theta_{in}=0$ to 43° *12 | 95^{*13} | - | - | % | |
| First axis | Coil resistance | R1 | I1=0.1 mA I2=0 mA | 125 | 155 | 185 | Ω |
| | Resonant frequency | F1-r | I1=0.12 mAp-p I2=0 mA | 450 | 480 | 510 | Hz |
| | Quality factor | Q1 | I1=0.12 mAp-p I2=0 mA | 100 | 120 | 140 | - |
| Second axis | Coil resistance | R2 | I1=0 mA I2=0.1 mA | 70 | 90 | 110 | Ω |
| | Resonant frequency | F2-r | I1=0 mA I2=0.16 mAp-p | 940 | 1000 | 1060 | Hz |
| | Quality factor | Q2 | I1=0 mA I2=0.16 mAp-p | 140 | 165 | 190 | - |
| Drive current | I1 | f1=f2=DC $\theta_1=+10^\circ$ | 11.5 | 15 | 18.5 | mA | |
| | I2 | $\theta_2=+10^\circ$ | 14 | 18 | 22 | mA | |
| | I1 | f1=f2=DC $\theta_1=-10^\circ$ | -18.5 | -15 | -11.5 | mA | |
| | I2 | $\theta_2=-10^\circ$ | -22 | -18 | -14 | mA | |
| Temperature sensor | Resistance | Rth | I1=I2=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 | %/ $^\circ\text{C}$ |

*10: Using a white light source

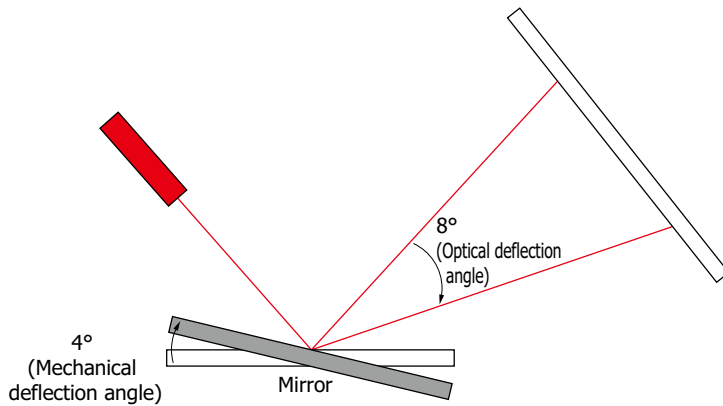
*11: Average window material transmittance of polarized light p and s. Note that, after passing through the window material, the laser light is reflected by the mirror and passes through the window material again.

*12: Incident angle to the window material

*13: Average value of $\lambda=460$ to 640 nm

Optical deflection angle

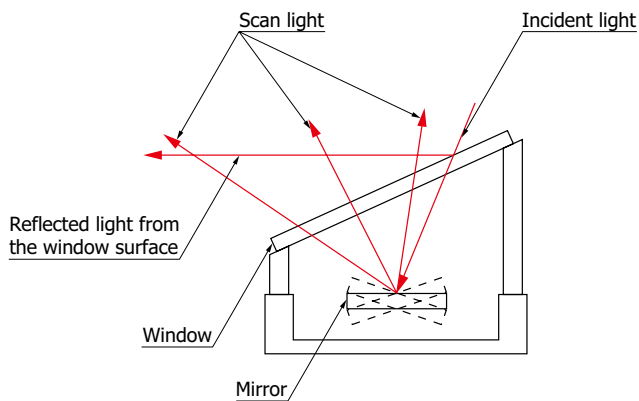
The optical deflection angle is twice the mechanical deflection angle.



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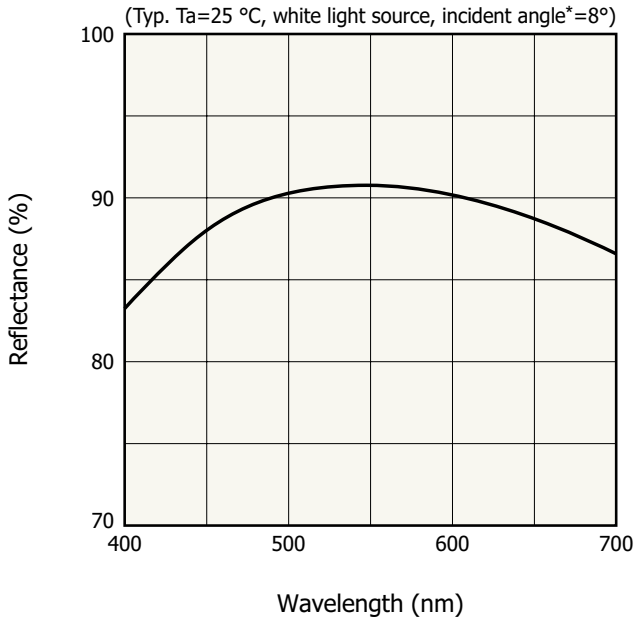
Effect of tilting the window material

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.



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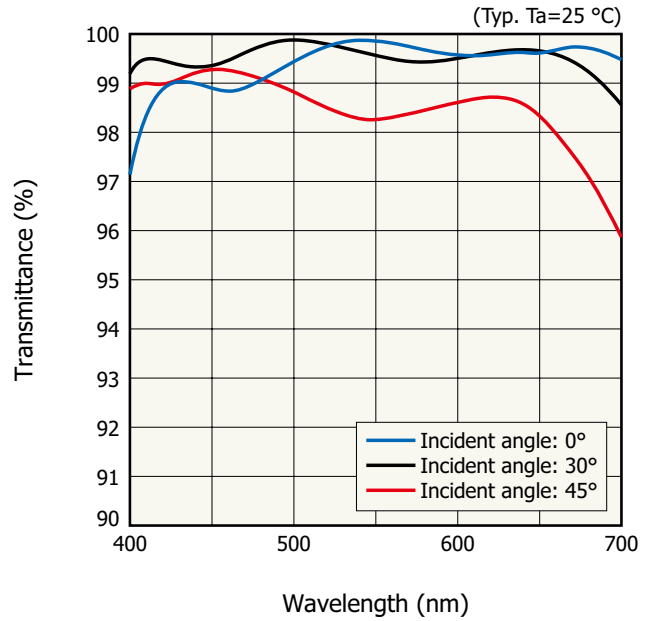
Reflectance vs. wavelength



* Incident angle of light to the mirror

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Spectral transmittance of window material

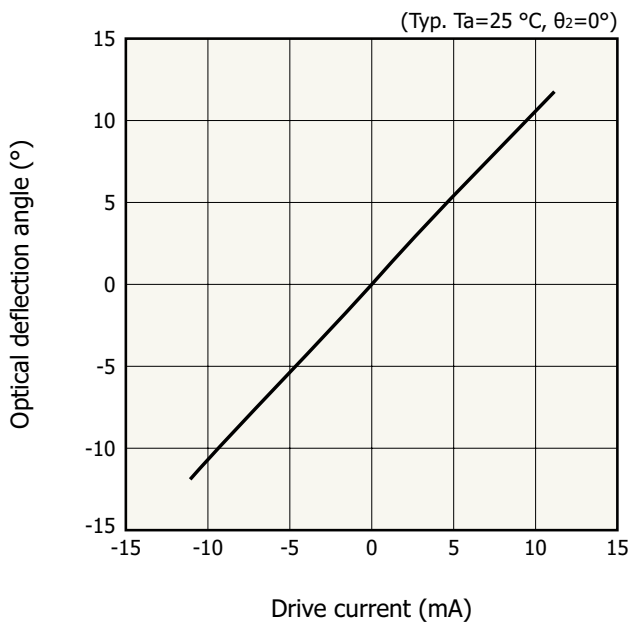


Note: Incident angle
=Angle of incidence of light on window material

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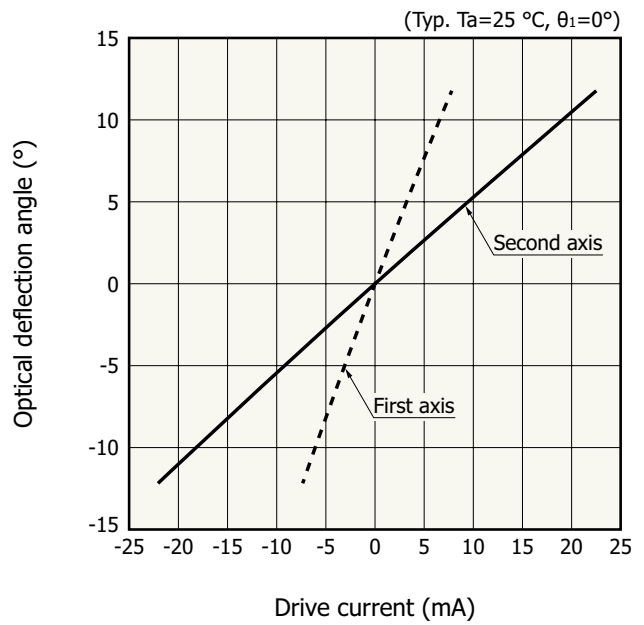
Optical deflection angle vs. drive current

First axis



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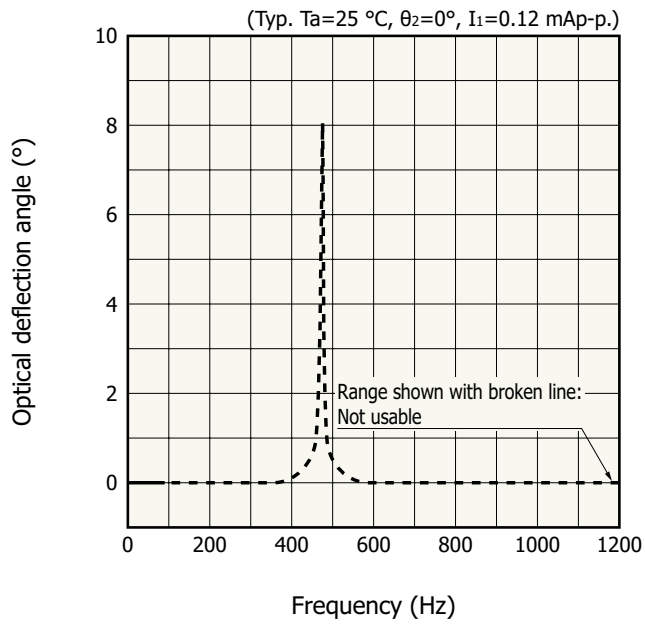
Second axis



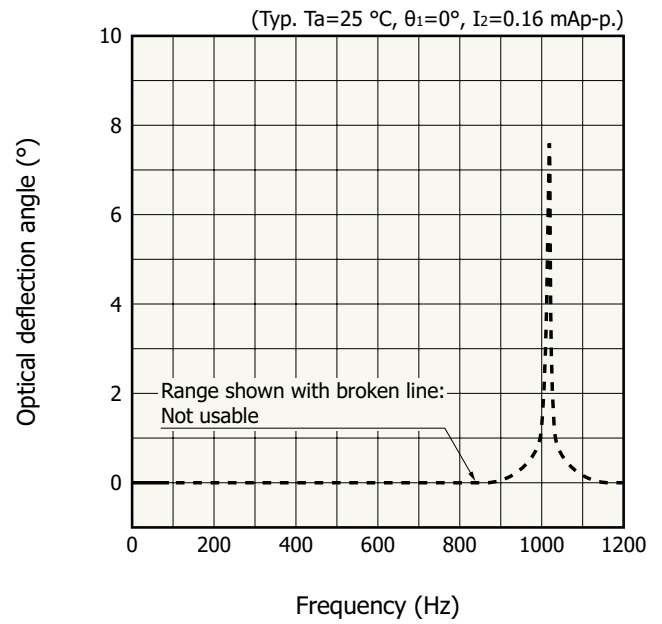
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Optical deflection angle vs. frequency

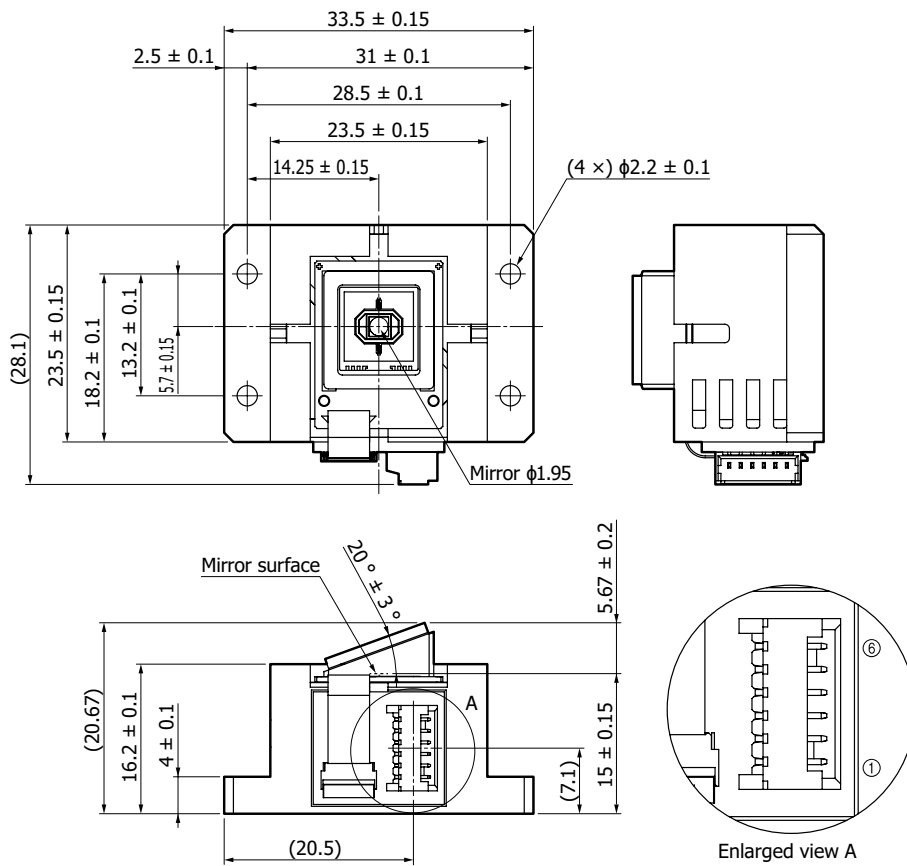
First axis



Second axis



Dimensional outline (unit: mm)



Connector: 53048-0610 (Molex)

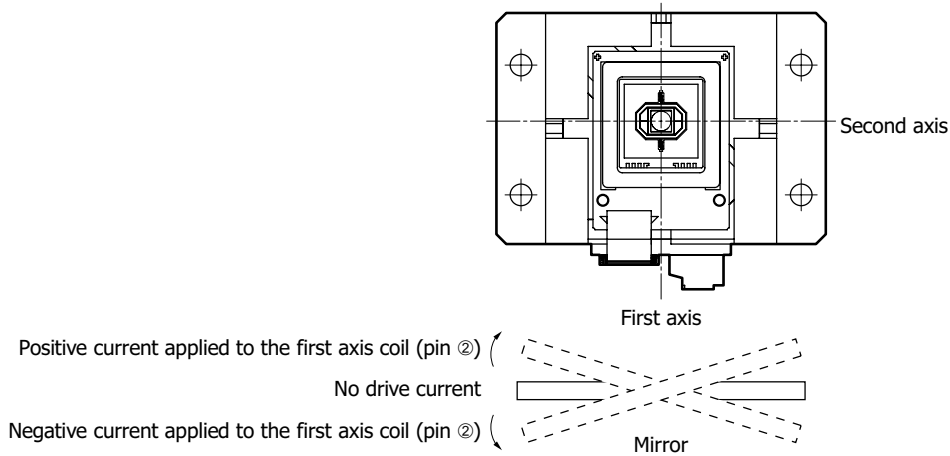
| Pin no. | Connection |
|---------|------------------------|
| ① | Temperature sensor (+) |
| ② | First axis coil (+) |
| ③ | Second axis coil (+) |
| ④ | First axis coil (-) |
| ⑤ | Second axis coil (-) |
| ⑥ | Temperature sensor (-) |

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❏ Mechanical deflection direction of mirror due to drive current

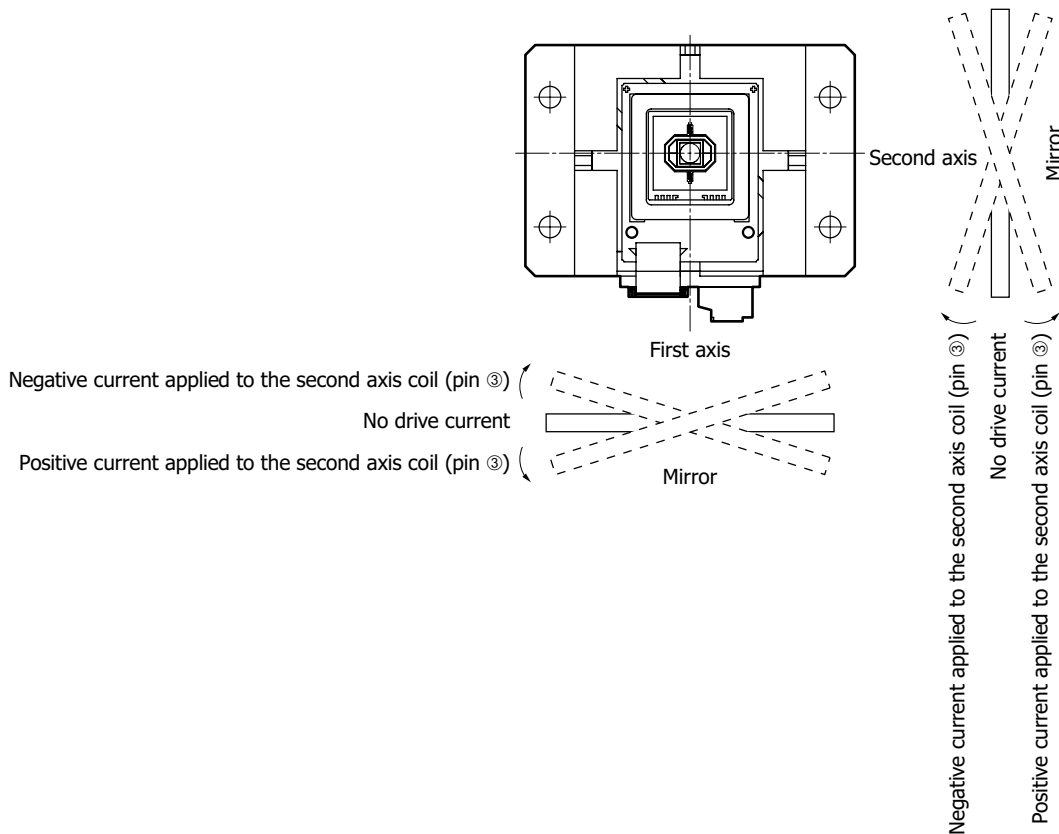
The direction of the mirror's mechanical deflection varies depending on the direction of the drive current flowing through the coil as follows.
 Note: As the drive frequency of the MEMS mirror increases, the phase lag of the optical deflection angle with respect to the drive current increases.

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 November 2021.

Product specifications are subject to change without prior notice due to improvements or other reasons. This document has been carefully prepared and the information contained is believed to be accurate. In rare cases, however, there may be inaccuracies such as text errors. Before using these products, always contact us for the delivery specification sheet to check the latest specifications.

The product warranty is valid for one year after delivery and is limited to product repair or replacement for defects discovered and reported to us within that one year period. However, even if within the warranty period we accept absolutely no liability for any loss caused by natural disasters or improper product use. Copying or reprinting the contents described in this material in whole or in part is prohibited without our prior permission.

HAMAMATSU

www.hamamatsu.com

HAMAMATSU PHOTONICS K.K., Solid State Division

1126-1 Ichino-cho, Higashi-ku, Hamamatsu City, 435-8558 Japan, Telephone: (81)53-434-3311, Fax: (81)53-434-5184

U.S.A.: Hamamatsu Corporation: 360 Foothill Road, Bridgewater, N.J. 08807, U.S.A., Telephone: (1)908-231-0960, Fax: (1)908-231-1218, E-mail: usa@hamamatsu.com

Germany: Hamamatsu Photonics Deutschland GmbH: Arzbergerstr. 10, 82211 Herrsching am Ammersee, Germany, Telephone: (49)8152-375-0, Fax: (49)8152-265-8, E-mail: info@hamamatsu.de

France: Hamamatsu Photonics France S.A.R.L.: 19, Rue du Saule Trapu, Parc du Moulin de Massy, 91882 Massy Cedex, France, Telephone: (33)1 69 53 71 00, Fax: (33)1 69 53 71 10, E-mail: infos@hamamatsu.fr

United Kingdom: Hamamatsu Photonics UK Limited: 2 Howard Court, 10 Tewin Road, Welwyn Garden City, Hertfordshire AL7 1BW, UK, Telephone: (44)1707-294888, Fax: (44)1707-325777, E-mail: info@hamamatsu.co.uk

North Europe: Hamamatsu Photonics Norden AB: Torshamnsgatan 35 16440 Kista, Sweden, Telephone: (46)8-509 031 00, Fax: (46)8-509 031 01, E-mail: info@hamamatsu.se

Italy: Hamamatsu Photonics Italia S.r.l.: Strada della Moia, 1 int. 6, 20044 Arese (Milano), Italy, Telephone: (39)02-93 58 17 33, Fax: (39)02-93 58 17 41, E-mail: info@hamamatsu.it

China: Hamamatsu Photonics (China) Co., Ltd.: 1201 Tower B, Jiaming Center, 27 Dongsanhuan Beilu, Chaoyang District, 100020 Beijing, P.R.China, Telephone: (86)10-6586-6006, Fax: (86)10-6586-2866, E-mail: hpc@hamamatsu.com.cn

Taiwan: Hamamatsu Photonics Taiwan Co., Ltd.: 8F-3, No. 158, Section2, Gongdao 5th Road, East District, Hsinchu, 300, Taiwan R.O.C. Telephone: (886)3-659-0080, Fax: (886)3-659-0081, E-mail: info@hamamatsu.com.tw