LCOS-SLM

X15213 Series

OPERATION MANUAL

・Please read this operation manual carefully before using this device.
・Failure to follow the instructions in this manual
may result in a serious accident.
・Keep this manual in a convenient location at all times.

Doc. No. LEJ-B60002

First edition Mar. 18, 2021

1. *Introduction*

Be sure to read it.

- Be sure to read "Safety Precautions" before use.
- Read this operation manual carefully before using the product.
- Keep this manual in a safe place and read it when necessary.

2. *Before using the device*

- When using this equipment, observe the equipment specifications and precautions. Our company makes every effort to improve the quality and reliability of this product, but does not guarantee the integrity of this product. Do not use the product in any way that could harm human life, body or property. Our company is not responsible for such use.

- Unpack the device and check the contents. If the equipment is damaged or there is a shortage of accessories, contact our company without operating the product.

- The information in this manual must not be reproduced or copied without the permission of our company Corporation.

Included Items

LCOS-SLM Controller	1
LCOS-SLM Head	1
Relay board	1
Relay board cover	
Cover plate	2
Fixed foot	4
Fixing screw	4
Rubber Foot for Controller	1
Power cable	1
AC Adapter	1
DVI-D cable	1
LCOS-SLM Certificate of Inspection	1
DVD	1

(The DVD contains the instruction manual (this book), distortion correction patterns, and control software.)

This product does not include PCs. Be prepared by the user.

3. *Safety Precautions*

Please be sure to follow the rules.

This device is a Class II device specified in the IEC 61010 -1 standard (Safety requirements for measurement, control and laboratory electrical equipment) (Equipment with protective grounding terminal). In order to use the device correctly and safely, observe the following safety precautions when operating the device. Our company assumes no responsibility or warranty for any damage caused by using the FOMA terminal in contravention of these precautions.

The following symbols are used in this manual.

DANGER	Indicates an imminently hazardous situation which if not avoided, will result in death or serious injury. This signal word is to be limited to the most extreme situations.
WARNING	Indicates a potentially hazardous situation which if not avoided, could result in death or serious injury.
CAUTION	Indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury.

3.1 Warning

■Handling the Power Cable
Turn off the power before installing or removing cables, and then hold the connectors.
Do not operate the product with wet hands or mount or remove the cable. There is a risk of electric shock or malfunction and it is very dangerous.

■Cables
Do not damage, or place heavy objects on cables. Doing so may damage cables, resulting in electric shock or fire.

■ground grounding of the power supply
To prevent electric shock or malfunction, always plug the power cord into a socket with a grounding terminal using a 3-wire cord. 3 When connecting to a 2-wire power supply using the -2 adapter, be sure to ground the ground wire.

■Location
To prevent fire, install the device in a well-ventilated area free of dust, water, and fire.

■Removing the LCOS-SLM Controller Cover
Do not remove the LCOS-SLM controller cover. There is a risk of electric shock and it is very dangerous. Do not disassemble or modify the product. Removing the cover is not covered by product warranty.

■Be careful of reflected light
LCOS-SLM modulates the phase of light incident from a laser or other light source, reflects it, and outputs it. Be careful where the reflected light of the LCOS-SLM goes. In some cases, it may affect human body such as blindness. Take appropriate measures such as using a beam damper to block light or wearing protective glasses to prevent light from entering the eyes.

■Watch out for the diffracted light
LCOS-SLM generates unwanted reflected light due to the effect of pixel diffraction. Pay particular attention to the effects of diffracted light when a high-intensity laser is incident on the LCOS-SLM.
In some cases, it may affect human body such as blindness. Take appropriate measures such as cutting diffracted light and wearing protective glasses corresponding to the wavelength used.

■If you notice anything unusual
Do not use the product in a condition where smoke, odor, abnormal sound, or heat is generated. Doing so may cause fire or electric shock. If this happens, turn off the power switch immediately. Please contact our company after confirming that there is no abnormality. Please do not repair by yourself as it is dangerous.

■Do not apply vibration or impact
Excessive vibration or shock may damage components or cause misalignment, resulting in fire or electric shock.

■Use only the supplied AC adapter/power cable
This device is designed to be connected through the AC adapter and power cable supplied with the product. Otherwise, fire or electric shock may result. For details, see "Power Cable/AC Adapter" on page 13.

■Do not let foreign objects or water get inside
Fire or electric shock may result if flammable materials, metals, or moisture enter the product.

3.2 Caution

Be sure to read the following precautions before using the product.

■This equipment is a precision optical instrument.

(a) Do not apply excessive vibration or impact.
(b) Do not store or operate in a dusty or wet environment, or at high temperature and humidity.
(c) Do not touch or scratch the opening of the LCOS-SLM. The LCOS-SLM may malfunction or change its properties due to contact with the aperture or impact to the LCOS-SLM. Especially when shipping, please make sure that there is no contact with the opening window.
(d) If by any chance you touch the opening window, wipe it lightly with an ethanol-containing gauze. In addition, wipe with a dry cloth except for the opening window.
(e) There is a risk of damage or deterioration due to static electricity or surge voltage. Handle it with extreme care.

■Connect the connector properly and securely.

Connect the connectors correctly and securely. If you are not connected properly, LCOS-SLM may not work correctly. Failure to do so could damage the LCOS-SLM controller and the customer's system. For precautions on connecting the relay board to the FPC cable (flexible printed circuit board), see page 14 "Connecting/Removing Equipment". The warranty does not cover malfunctions caused by improper connection.

■Pay attention to the image output setting.

DVI control requires a DVI output (Personal computers (hereinafter referred to as PC), etc.). Set the display properties as follows:

Type	X15213 Series
Screen size	1280× 1024 (SXGA)
Refresh Rate	60 Hz
Colors	True Color (32 Bit)

■About warm-up operation.

After the power is turned on, the power is turned on for approximately 20 seconds. During this time, the LCOS-SLM does not run. The LCOS-SLM is also more stable after a 10 minute warm-up period.

■Pay attention to the polarization of the incident light.

Pay attention to the polarization direction of the incident light. For details, see "Polarization direction of the incident light" on page 21.

■Pay attention to the amount of incident light.

The LCOS-SLM may be damaged if a very strong light is applied. If high-intensity or high-peak-power lasers are used, contact our company for assistance. Note that damage caused by the addition of incident light exceeding the light resistance intensity is not covered by the warranty.

■Note the wavelength of the incident light.

Note the wavelength of the incident light. If the wavelength is not set at the time of shipment, the reflectance or light resistance may decrease or the desired operation may not be obtained.

■Do not block the ventilation vents on the LCOS-SLM controller.

Install the LCOS-SLM controller (controller) with an approximately 10 cm clearance around the air cooling fan and ventilation holes. Closing the ventilation holes prevents the heat from diffusing inside the controller, which may cause equipment failure or fire. Note that the warranty does not cover the failure of the controller caused by closing the ventilation port.

Table of Contents

4. Overview

LCOS-SLM is a liquid-crystal on silicon (LCOS) spatial light modulator that can modulate only the phase of incident light. The phase of the incident light can be controlled arbitrarily by generating and displaying an image using a DVI output device (PC, etc.).

LCOS-SLM has the following features:.

- ○ High precision phase modulation characteristics
- ○ High diffraction efficiency
- ○ High light utilization efficiency

Fig. 1 shows the concept of the phase modulation characteristics of the LCOS-SLM. The gradation value of the image displayed on the PC becomes the value input to the LCOS-SLM, and the phase modulation amount changes according to the input gradation value. The LCOS-SLM's non-linear response and phase modulation characteristics, which vary from device to device, are corrected by adjusting parameters at the time of shipment. As shown in Fig. 1, the phase modulation characteristics differ depending on the wavelength used.

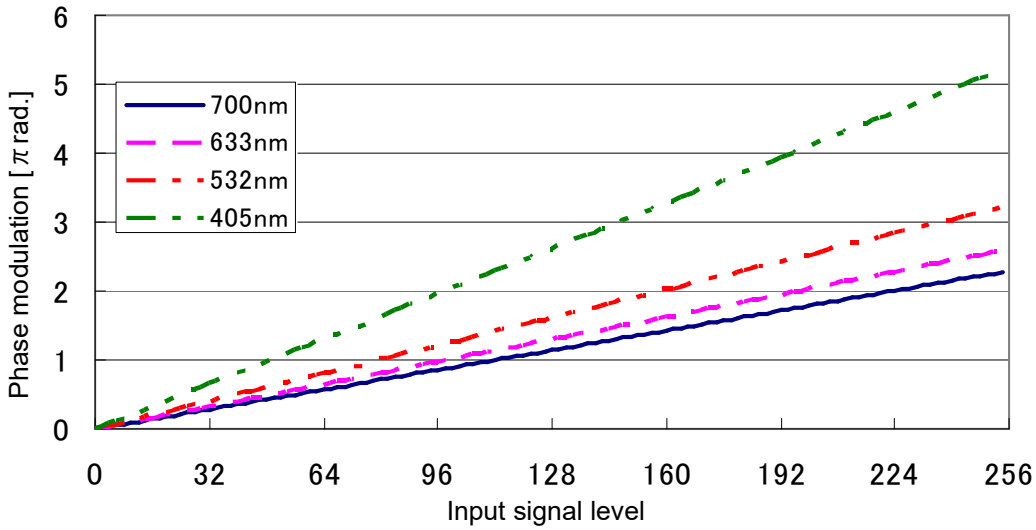


Fig.1 Phase Modulation Characteristics (Typical example)

Multilevel phase gratings can be displayed on LCOS-SLM to diffract light at any position. Please refer to the Product Flyer for the efficiency of light diffracted (diffraction efficiency) at an arbitrary position when a multilevel phase grating is displayed on the LCOS-SLM. Diffraction efficiency depends on the type of LCOS-SLM.

5. *Characteristics*

5.1 Absolute maximum ratings

Parameter	Value	Unit
Operating temperature	+ 10 to + 40 (no condensation)	°C
Storage temperature	-20 ~ + 55 (no condensation)	°C

Note1) Be careful of humidity because humidity can cause characteristic deterioration.

Note2) Since LCOS-SLM is temperature dependent, it is recommended to use it at an ambient temperature of about 25 °C.

5.2 Operating Environment Conditions

Parameter	Value	Unit
Place of use	indoor use	-
Operating altitude	≦2000	m
Degree of pollution	2	-
IP code	IP 20	-
IK code	IK08	-
Recommended Operating Environment Temperature	25	°C
Operating humidity	30～70 (no condensation)	%R.H.
Storage humidity	30～85 (no condensation)	%R.H.
Warm-up time	10	minutes

5.3 LCOS-SLM Head

Parameter	Value	Unit
Number of pixels	1302528 (1272 x 1024)	Pixels
Pixel pitch	12.5	μm
Maximum spatial frequency	40	lp/mm
Effective area	15.9 x 12.8	mm
Fill factor	96	%
Input signal levels	256	level
Weight	150 , 550 (L, R)	g

Note1) “L” and “R” are designed with a water-cooled heat sink (water jacket).

5.4 LCOS-SLM Controller

Parameter	Value	Unit
Input power supply voltage	+24	V
Allowable voltage fluctuation	± 5	%
Current consumption	0.6	A
Input signal	Digital Video Interface (DVI-D) USB-B (2.0 High speed)	-
Weight	0.9	kg

5.5 AC Adapter

Parameter	In/Out	Value	Unit
Power supply voltage	Input	100 AC to 240 AC	V
Frequency	Input	50/60	Hz
Allowable voltage fluctuation	Input	± 10	%
Power consumption	Input	15	W
Overvoltage category	Input	II	-
Output voltage	Output	+24	V
Output voltage fluctuation	Output	± 5	%
Ripple	Output	0.24 (MAX)	V
Output current	Output	2.71 (MAX)	A
Over Voltage Protection	Output	+ 36 (MAX)	V
Plug shape	Output	ϕ 5.5 - ϕ 2.1 - L 9.5	mm

Note1) Do not use anything other than the supplied AC adapter.

Note2) The power consumption indicates the value when connected to the LCOS-SLM controller.

5.6 Optical specifications

Check the data sheet for the applicable wavelength range of each type, light utilization efficiency, and response speed.

5.7 Conformance standard

Safety	IEC 61010 -1: 2010 + AMD1: 2016
EMC	IEC 61326 -1: 2012 Emission limits CISPR 11 Group 1, Class B Immunity requirements - Tables 1

6. *Internal configuration*

As shown in Fig. 2, the LCOS-SLM consists of a glass substrate, a transparent electrode, an alignment film, a liquid crystal layer aligned in parallel, a dielectric multilayer mirror, and a silicon substrate. An active matrix circuit is formed on the silicon substrate to apply voltage to the pixel electrode and the pixel electrode.

The number of pixels of the X15223 series is 1272 × 1024, and arbitrary control is possible for each pixel. The display properties set on the PC are as shown in Fig. 3, and the input signals in the right eight columns are ignored. Therefore, the signal of 1272 × 1024 pixels is displayed from the left.

Phase modulation is performed on the liquid crystal layer. The phase is modulated by the parallel aligned liquid crystal layer, and the phase modulation amount changes according to the applied voltage. Although liquid crystals generally respond non-linearly to input voltages, linear phase modulation is achieved with respect to input values by incorporating a look-up table (LUT: Look-Up Table) within the drive circuit that converts 8 bits of input into 12 bits.

Dielectric multilayer mirrors help to improve light utilization efficiency. The use of a dielectric multilayer mirror makes it possible to achieve a light utilization efficiency of 90% or more in a specific wavelength range, which is higher than that of LCOS-SLM composed of aluminum mirrors. The aluminum mirror type can be used in a wider wavelength range than the type equipped with a dielectric multilayer mirror. However, the light resistance is lower than that with a dielectric multilayer mirror, so be careful when using a high-power light source.

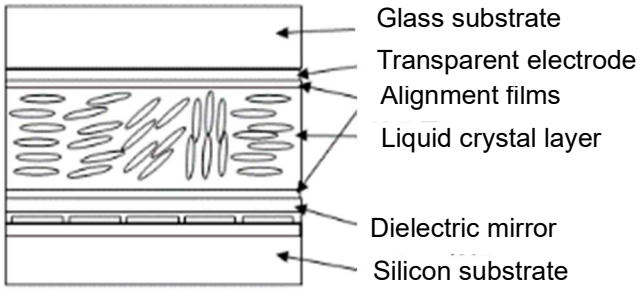


Fig.2 Configuration of LCOS-SLM

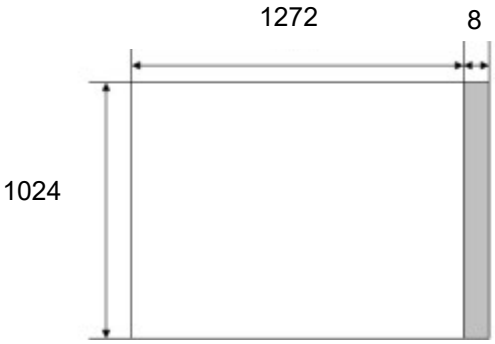


Fig.3 Relationship between LCOS-SLM pixel structure and display properties

(Right 8 columns not used)

7. Names and descriptions of parts

This section describes the names and descriptions of each part of the device and the bundled product.

7.1 LCOS-SLM Head

The LCOS-SLM modulates the phase of the incident light.

⚠	Caution	Do not remove the cover as it may cause damage. If the cover is removed, the product is not covered.

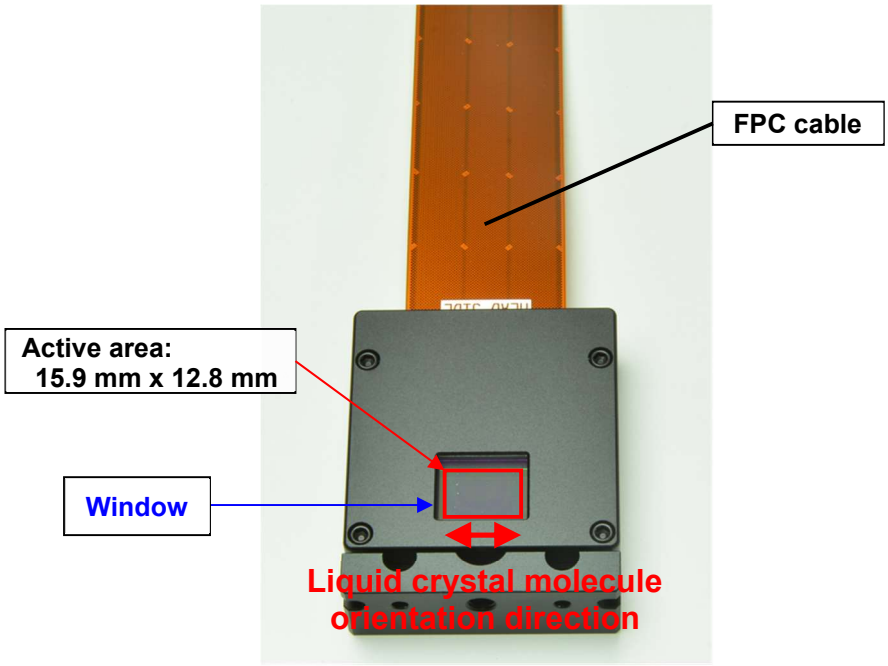


Fig.4 LCOS-SLM Head

Name	Description
Window	When light enters this part, the phase-modulated light is emitted. The sizes are shown below, so please be careful when using. Window Size: 18 mm x 14.4 mm Chip Size: 22 mm x 22 mm LCOS-SLM Active area: Chip Center 15.9 mm x 12.8 mm
FPC cable	Flexible printed circuit board (450mm). Connect to the LCOS-SLM controller using the relay board supplied with the product.

⚠	Caution	Do not pull or bend the FPC cable to prevent damage. Do not lift the LCOS-SLM head with the FPC cable.

7.2 LCOS-SLM Controller

The LCOS-SLM controller includes a circuit to generate data and control signals, an air-cooled fan to cool the circuit heating elements, and a voltage conversion board to drive them. The controller processes the image signals from the PC over the DVI-D cable and sends control signals to the LCOS-SLM.

Fig.5 Back of the controller

- **POWER switch**
  Main power switch
- **DC IN 24 V (Power connector)**
  Connect the supplied power cord to the AC adapter (24 VDC).
- **DVI IN (DVI Connector)**
  Connect your PC to the LCOS-SLM controller using a DVI-D cable to control the output pattern of the LCOS-SLM head. This document focuses on DVI control.
- **USB-B connector**
  Connect your PC to the LCOS-SLM controller using the USB 2.0 HighSpeed standard.
  Using the USB connection, you can control the output pattern of the LCOS-SLM head and know the status of the controller more freely. For details, refer to "USB Control Manual" on the DVD.
  The USB cable is not included with the product.
- **LED (POWER)**
  Lights when the power switch is on.

An FPC cable (Approx. 65 mm protruding) is connected to the LCOS-SLM controller.

⚠	Caution	Do not pull or bend the FPC cable to prevent damage. Do not lift the LCOS-SLM controller with the FPC cable.

7.3 Relay board／Relay board cover

The relay board is used to connect the LCOS-SLM head to the LCOS-SLM controller.

See "Connecting/Removing Equipment" on page 14 for connecting.

Caution Be sure to attach a cover to the relay board.
Peripheral devices may be affected.

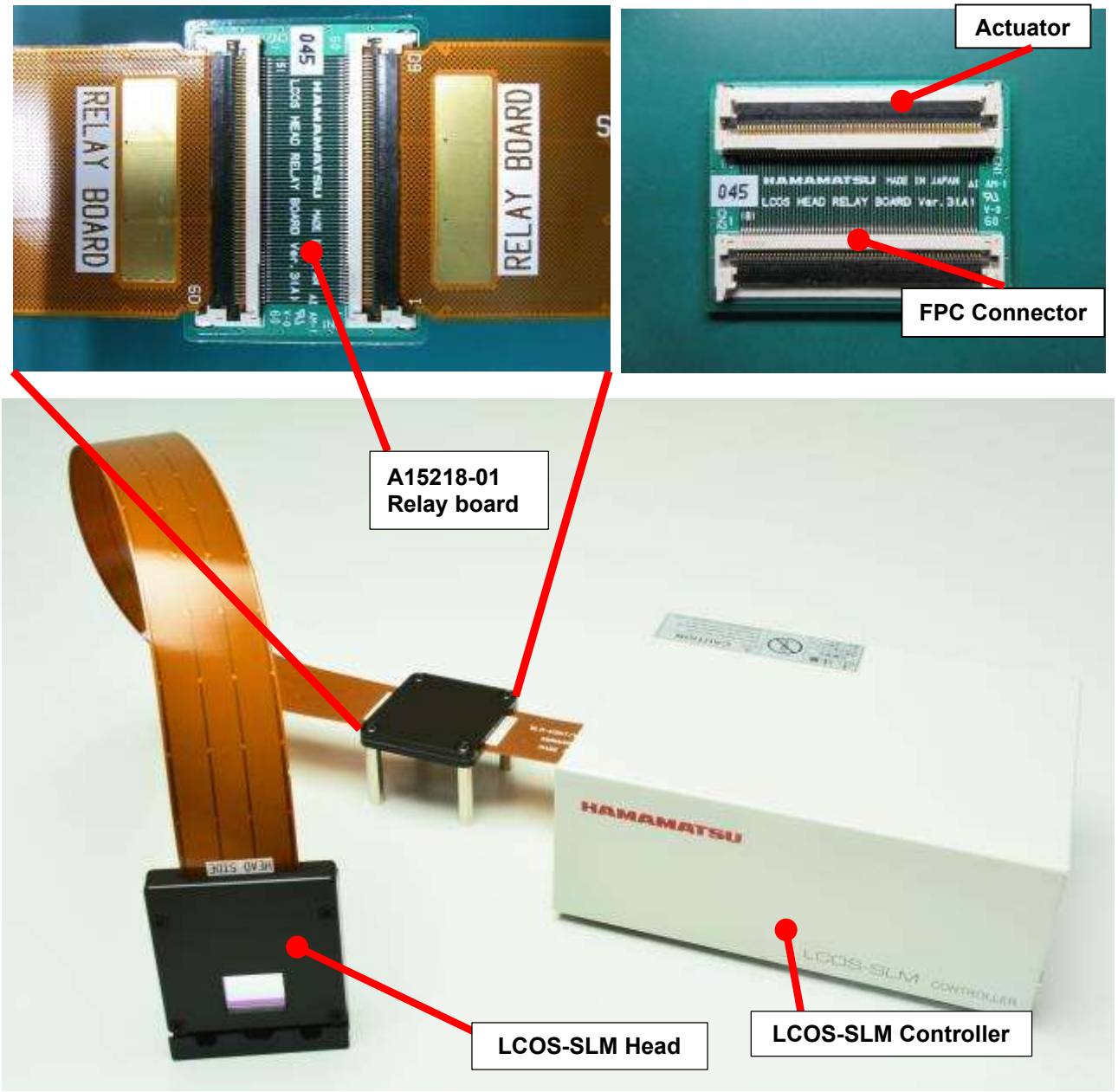


Fig.6 Connecting the relay board

7.4 Power Cable／AC Adapter

Provides external power to the LCOS-SLM controller and LCOS-SLM head.
Use only the supplied AC adapter/power cable to power the LCOS-SLM.

In addition, the AC adapter/power cable of this product may not be shipped with the product because it does not comply with safety standards in certain areas. In this case, prepare an AC adapter that complies with your country's safety standards for 24 V. However, if an overshoot of 40 V or more occurs when the power is turned on, the overvoltage may cause the internal circuit to burn out. Before use, confirm that no overvoltage occurs. The warranty does not cover failures caused by applying an overvoltage.

7.5 DVD (contains distortion correction pattern and control software)

- **Distortion Correction Sample Patterns**

LCOS-SLM mirror planes have an initial geometric distortion that is unavoidable in manufacturing (For details, see "Distortion correction pattern" on page 28.). The DVD contains a pattern to compensate for this distortion. The distortion correction pattern is stored in bitmap format and has a size of 1272 x 1024 pixels.

By adding this pattern to the desired pattern, you can minimize the effect of initial shape distortion and achieve better results. Refer to the "LCOS-SLM phase control method" section of the software operation manual for how to add up.

The shape distortion of the LCOS-SLM may change from the initial state depending on the environmental temperature, storage condition and handling method.

- **Control software**

Sample software is available for users who want to use LCOS-SLM easily. For details, refer to the "LCOS-SLM Software Manual" on the DVD.

- **Instruction Manual/ LCOS-SLM Software Manual**

This manual and the operation manual of the control software.

- **USB SLMControl Manual**

This is the instruction manual for USB control.

8. *Connecting／Removing Equipment*

This chapter explains how to connect and disconnect devices.

⚠	Caution	Turn off the power before connecting or disconnecting.
⚠	Caution	Always remove static electricity from the body before touching the equipment.

8.1 Connection procedure

Connect the LCOS-SLM head, LCOS-SLM controller and PC as follows.

(1) Connect the LCOS-SLM head side FPC cable to the LCOS-SLM controller side FPC cable via the FPC connector on the relay board. When connecting the relay board, refer to page 15, "Connecting the relay board" for precautions.

(2) The relay board is placed in the relay board cover. For details, see "relay board cover assembly" on page 17.

(3) Connect a DVI-D cable from the DVI connector on the LCOS-SLM controller to the DVI-capable PC. Please prepare your own PC.

(4) Connect the LCOS-SLM controller to the power supply using the power cable and AC adapter supplied with the controller.

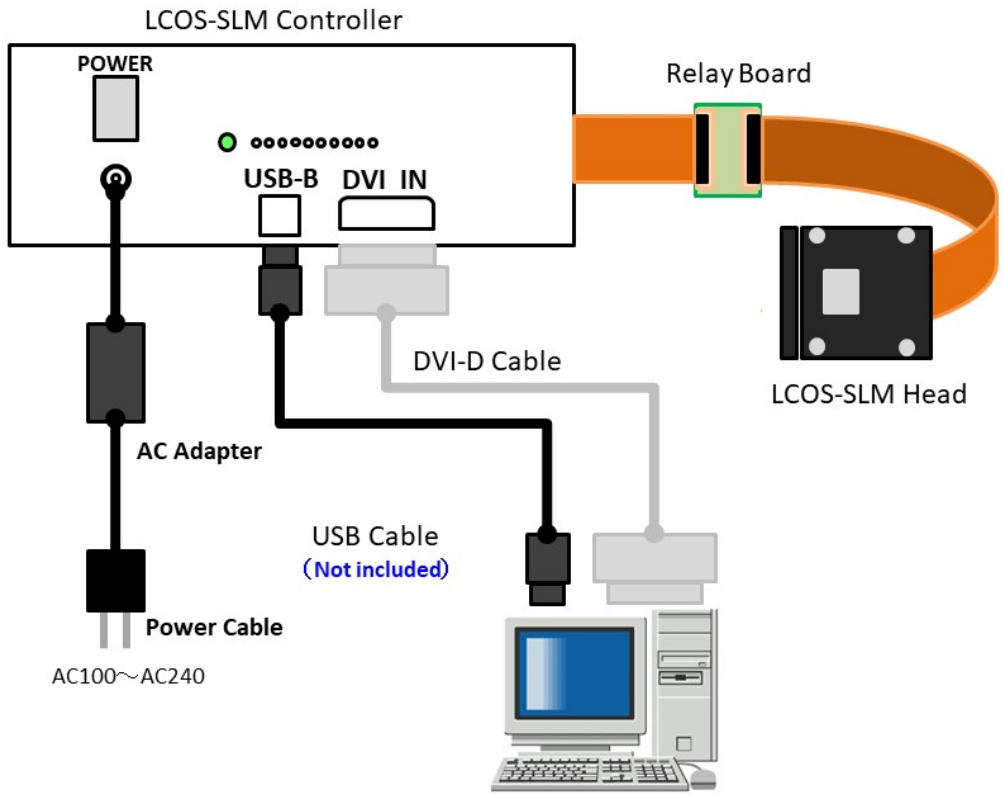


Fig.7 connection diagram

8.2 Connecting the relay board

(1) Connecting method of FPC Cable

The FPC cable can be locked by inserting it deep into the FPC connector and tilting the actuator. The FPC cable can be disconnected by raising the actuator. When tilting the actuator, apply force evenly. When removing, do not use any tools and use your fingertips to lift up the center part.

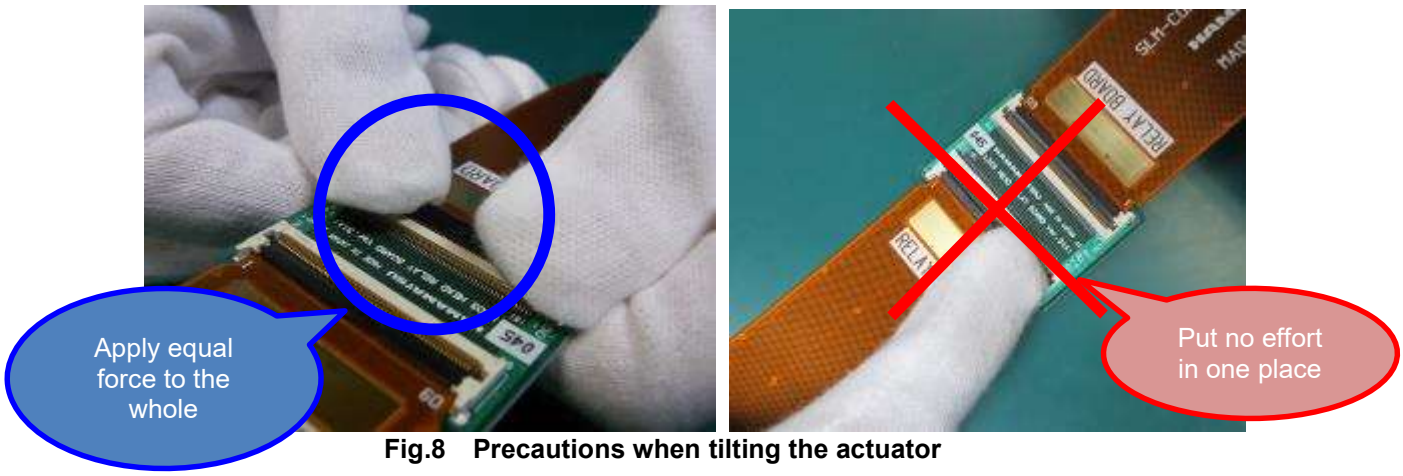


Fig.8 Precautions when tilting the actuator

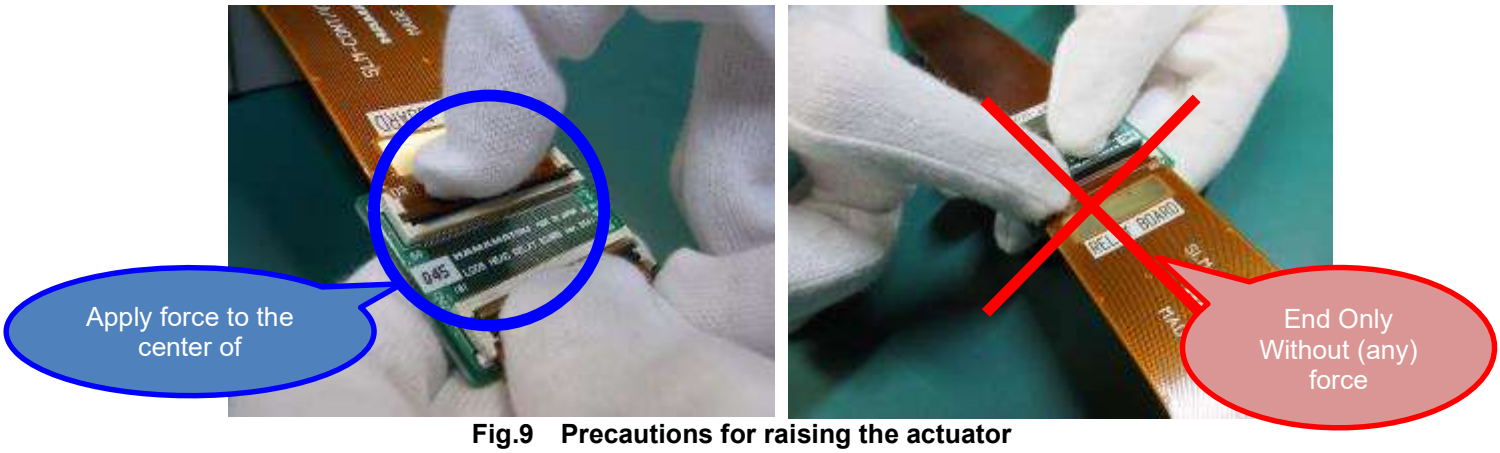


Fig.9 Precautions for raising the actuator

(2) FPC Cable Connection Guidelines

Be careful not to mistake the front and back of the FPC cable. The side written “RELAY BOARD” is the front.

controller side **head side**

Fig.10 FPC Cable Connection Guidelines

Fig. 11 shows the correct connection. The FPC cable on the head side or controller side can be connected to either side of the relay board.

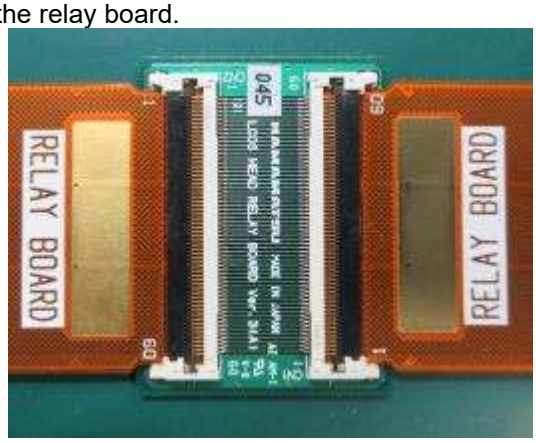


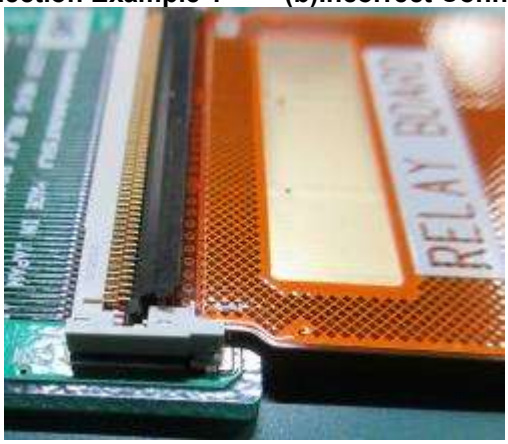
Fig.11 correct connection state

The LCOS-SLM will not function properly if the FPC cable is used with the following incorrect connection.

- Fig. 12 (a) shows the FPC cable connected at an angle.
- Fig. 12 (b) shows that the FPC cable is not fully inserted.
- Fig. 12 (c) shows that the actuator is not locked.

(a)Incorrect Connection Example 1

(b)Incorrect Connection Example 2



(c)Incorrect Connection Example 3

Fig.12 Example of relay board connection

8.3 Relay board cover assembly

Make sure you have all the accessories shown in Fig. 13.

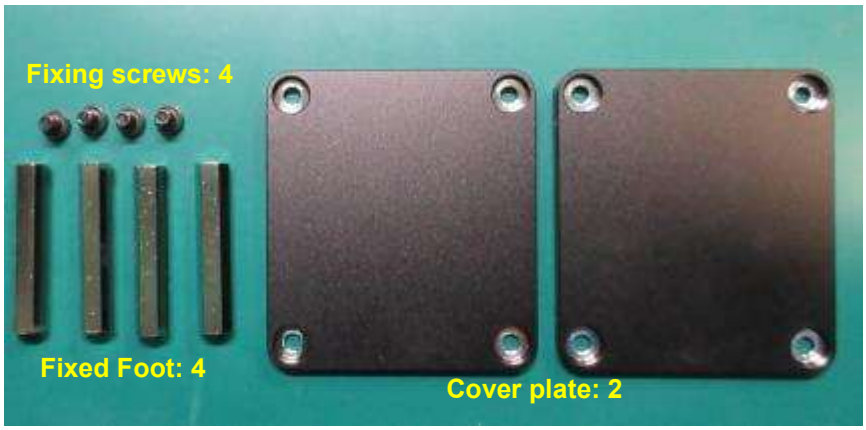


Fig.13 List of all relay board cover accessories

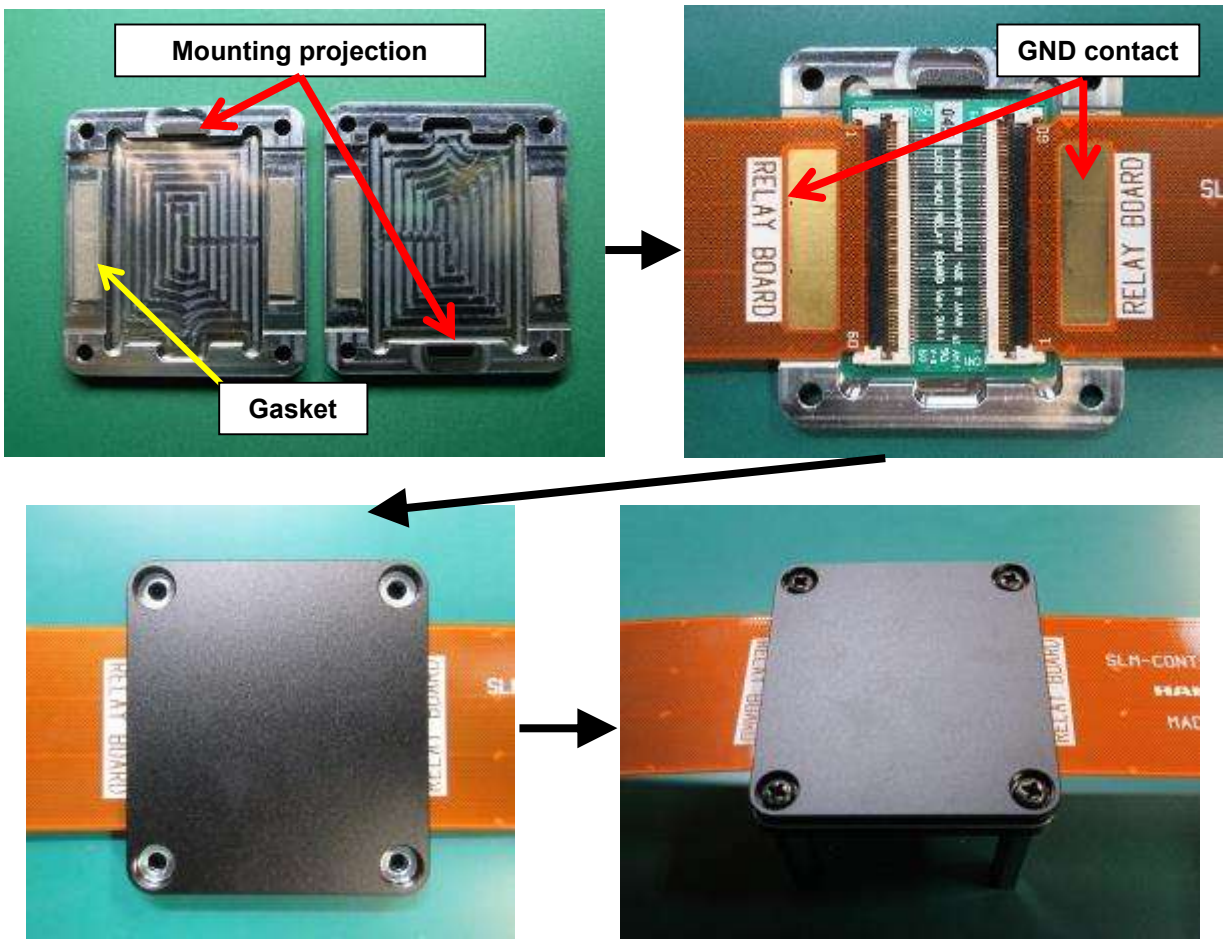


Fig.14 relay board assembly

As shown in Fig. 14, insert the FPC cable vertically so that the GND contact of the FPC cable contacts the gasket of the relay plate cover. Assemble the cover plate so that the mounting projections enter each other's grooves. If you fix it with the attached screw, it will come in firm contact.

8.4 Removal procedure

(1) Turn off the power switch.

(2) Remove the relay board cover screws and remove the cover.

(3) You can remove various cables.

	Caution	The head and the FPC cable connected to the controller cannot be removed. If you try to remove it forcibly, it may cause malfunction. Please be careful.

9. *Setup*

9.1 setup example of the optical system

Fig. 15 and Fig. 16 show examples of optical system setup using LCOS-SLM. Example 1 is an optical system using a half mirror. Example 2 shows a grazing incidence optical system. Example 2 has the advantage of less light loss due to the half mirror than Example 1.

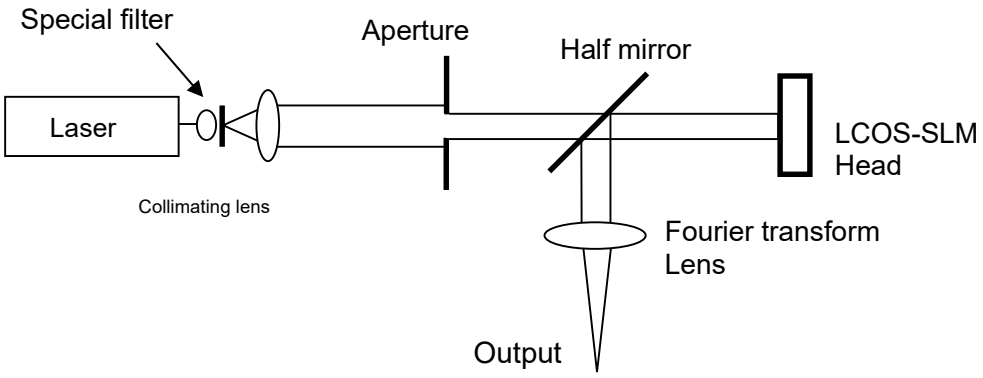


Fig.15 Setup Example 1

Advice: Using an aperture with a circular aperture of Φ = 12 mm or less produces a good focused image.

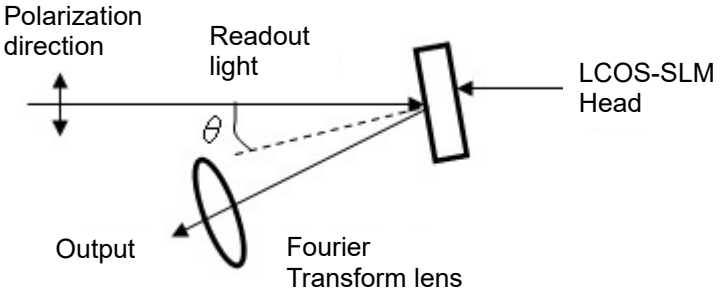


Fig.16 Setup Example 2

Advice: The incidence angle θ of the oblique incidence optical system in Example 2 should be within 5°.
Advice: In the case of the oblique incidence optical system of Example 2, the incident light should be incident with horizontal polarization (Note).

Note) Horizontal polarization is the direction of polarization parallel to a plane containing incident and reflected light.

Advice: Please note that damage caused by the addition of incident light exceeding the light resistance intensity is not covered by the warranty. Contact our company for information on light resistance.

⚠	Warning	Watch out for reflected light.
⚠	Warning	Note the reflected light due to the diffracted light caused by the pixel diffraction.

9.2 Installing the Rod Stand

As shown in Fig. 17, the LCOS-SLM head consists of a head (main body) and an L-shaped adapter. The bottom of the L-shaped adapter has a special hole (M6) for mounting the rod stand.

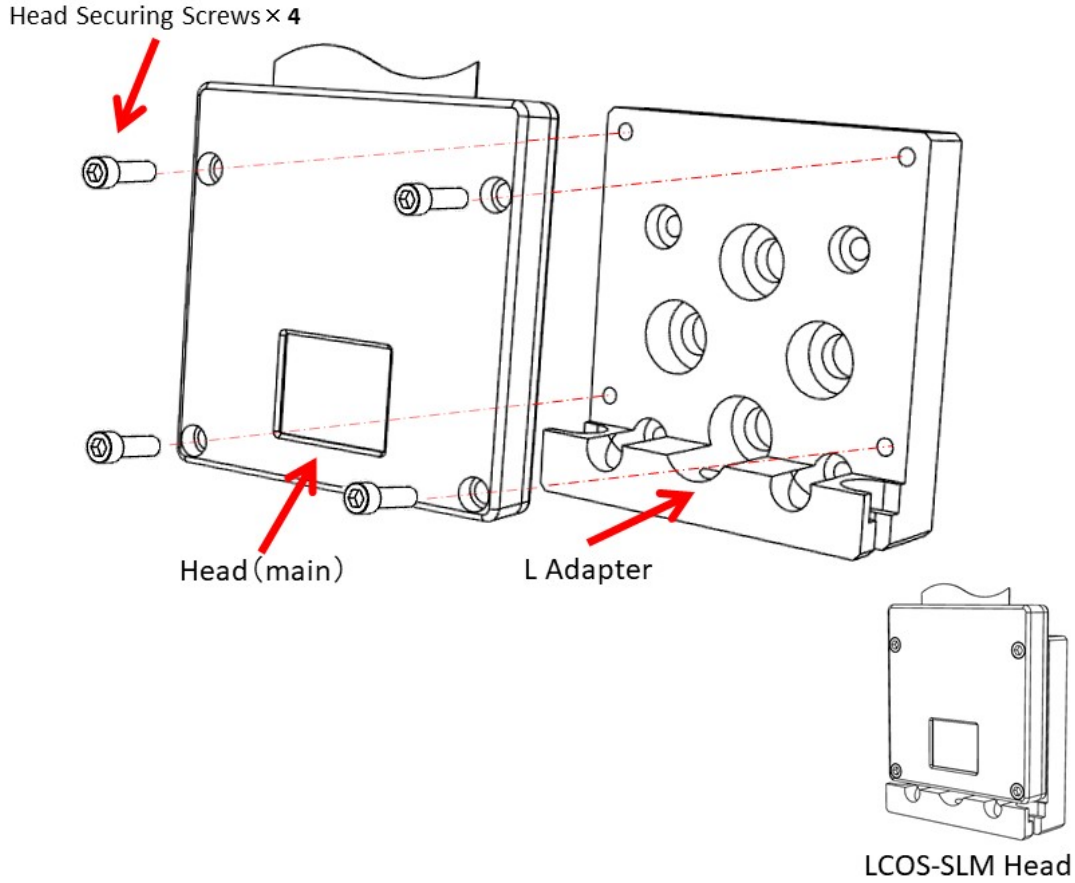


Fig.17 LCOS-SLM Head

The L-shaped adapter has a special hole for mounting various optical adjustment stages. (Fig. 18, A, B, C) By removing the head (main body), the L-shaped adapter can be attached to various optical adjustment stages.

【Removal - Reconnection Procedure】

1. Use a hex wrench to loosen and remove the LCOS-SLM head front securing screws (M3).
2. Separate the head (main body) from the L-shaped adapter, and attach the L-shaped adapter to the various optical adjustment stages.
3. Wipe the surface of the L-shaped adapter and the back of the head (main body) with a dry cloth, etc., and attach the head (main body) with the fixing screw.

⚠	Caution	Do not screw the L-shaped adapter with foreign matter on the surface. When securing the screws, tighten the four screws evenly. If unevenly screwed, the silicon substrate may be damaged due to load. These LCOS-SLM head failures are not covered. Please be careful.
⚠	Warning	Do not remove the screws on the back of the head (main body). The product is not covered by the warranty.

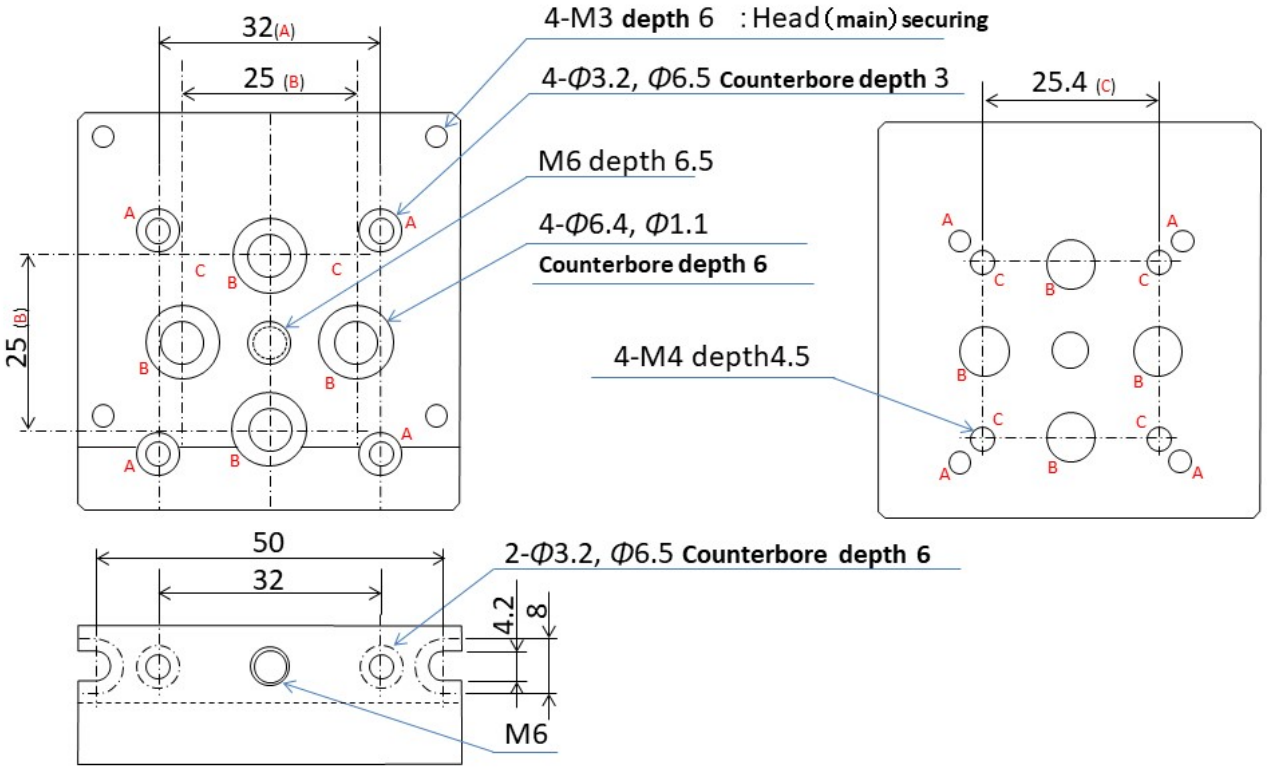


Fig.18 L-Adapter Mounting Hole Drawing

9.3 Polarization direction of the incident light

The LCOS-SLM has a liquid crystal orientation as shown in Fig.19. By making the polarization of the incident light the same as the orientation direction of the liquid crystal, only the phase of the incident light can be modulated.

Fig.19 liquid crystal orientation direction

Advice: Be sure to use horizontally polarized light (Note) when using an optical system with oblique incidence.
Note)... Horizontal polarization is the direction of polarization parallel to a plane containing incident and reflected light.

9.4 How to set DVI video output (PC)

The desired signal for controlling the LCOS-SLM is generated by a PC (Windows ®). The signal generated by the PC is sent to the LCOS-SLM via the DVI port in the same way as the monitor display. A PC with a DVI port is required to drive the LCOS-SLM. Alternatively, provide a display card with a DVI port. Since LCOS-SLM is controlled by 8 bits (8 bits of RGB 24 bits), full color with only 8 bits of grayscale (Same RGB values) or B8 bits set is used as image data sent from PC. In order to send image data from the PC to the LCOS-SLM, it is necessary to set the screen of the PC.

Pixels: 1280 x 1024
Refresh rate: 60 Hz
Colors: True color (32 Bit)

■PC configuration example (2-screen independent mode, desktop example)

Here is an example of PC configuration. Have a desktop PC with 2-port DVI output. The first output signal is connected to the monitor of the PC. The second output signal is connected to the LCOS-SLM driver circuit to drive the LCOS-SLM.

(a) Check that the power supply to the PC and LCOS-SLM driver is turned off. After confirming, connect the PC to the LCOS-SLM driver circuit via DVI-D cable.
(b) Turn on the PC.
(c) Change the display properties. Connect and activate the second screen.
(d) Change the properties of the second screen as follows:

Pixels: 1280 x 1024
Refresh rate: 60 Hz
Colors: True color (32 bit)

(e) LCOS-Turns on the power of the SLM driver circuit.

Advice
Once configured, do not disconnect the DVI-D cable while the PC is on. Settings may change.
If you use an analog RGB monitor and set it to clone mode, the setting will be different from the above. In this case, refer to the operation manual of the graphic board.

10. *How to*

This section describes how to use LCOS-SLM.

1. Status after power up and warm-up time

When the power is turned on, LCOS-SLM will boot for approximately 20 seconds. After a few seconds, the boot process ends and the LCOS-SLM starts operating normally. If the fan does not rotate, page.26 Please refer to "troubleshooting".

The LCOS-SLM provides stable performance by warming up. Do not use the LCOS-SLM for 10 minutes after the boot process is completed.

2. LCOS-SLM Operating method

You can control the phase by creating a phase image and displaying it on the second screen of your PC. This is because the LCOS-SLM controls the phase according to the phase image displayed on the second screen of the PC. View images created in BMP, JPG, or other formats in Full Screen mode. (You can also display it using the sample software included with the product.)

3. Creating a Phase Image

For how to create the phase image, refer to the "LCOS-SLM phase control method" section in the software operation manual.

4. Distortion correction pattern

LCOS-SLM has an initial geometric distortion. This distortion can be corrected using the distortion correction pattern included in the DVD. For distortion correction patterns, see page 28 Refer to "distortion correction pattern".

Add the phase image you want to display and the distortion correction pattern and perform a wrapping process (Note).

Note)

The image can only represent numbers up to 0 ~ 255. Therefore, if the sum of the values for a given pixel exceeds 255, the remainder after dividing by 256 is taken as the value for that pixel. This process is called wrapping process.

Advice

The distortion correction pattern depends on the wavelength of the laser used. If you are creating your own software, please use the distortion correction pattern that corresponds to the wavelength you are using, which is included in the DVD.

11. *LCOS-SLM operation check*

In this chapter, you run LCOS-SLM and display the attached phase image to confirm that LCOS-SLM is operating correctly.

1. Construct the optical system.

The optical system shown in Fig. 20 is constructed. The incidence angle of the laser on the LCOS-SLM head should be within 5° (P. 23). Position the CCD camera 100 mm from the Fourier Transform lens at f = 100 (Fourier plane). Adjust the special filter and collimating lens so that the light incident on the LCOS-SLM head becomes perfectly parallel light.

The following components are required for the following optical systems.

- LCOS-SLM suite
- PC (DVI output: Desktop preferred)
- DVI-D cable
- LASER
- Special filter
- Aperture... φ 12 mm or less
- CCD or CMOS image sensor
- Lens

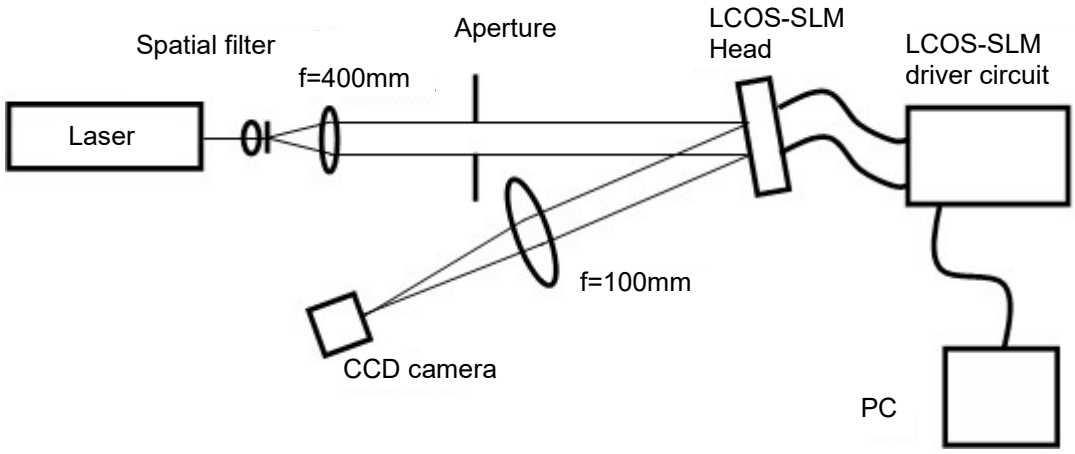


Fig.20 Optical system for checking LCOS-SLM operation

	Warning	Watch out for the reflected light.

	Warning	Note the light reflected by the diffracted light from the pixel diffraction.

Advice

- Use only horizontally polarized light (See page 21) when using a grazing incidence optical system.
- The warranty does not cover damage caused by the addition of incident light exceeding the light resistance.

2. Configure your PC.

See "How to set DVI video output" on page 21.

3. Turn on the LCOS-SLM.

Warm up for about 10 minutes.

4. A computer hologram is input.

Display the attached file sample _ hologram _ hpk _ xxx _ yyynm.bmp (xxx is the LCOS-SLM head S/N, and yyy is the wavelength.) on the 2nd screen. This pattern is a computer generated hologram (CGH) pattern that forms the letters "HPK" on the Fourier plane. The initial shape distortion correction pattern of the LCOS-SLM head is added.

If the camera is operating correctly, an output image as shown in Fig. 21 will be captured by the CCD camera.

If no output is obtained or if a desired output image cannot be obtained, see "Troubleshooting" on page.26.

Fig.21 reconstructed CGH image

12. *Trouble shooting*

- **LCOS-SLM does not work or does not work properly**
  - **Make sure the cables are connected properly.**

  If the cables are not connected correctly, power down the LCOS-SLM controller and reconnect them.

  - **Check your PC's screen settings.**

  The output connected to the controller is active or P.21Check if "How to set up your PC" is set.

  - **Check the polarization direction of the incident light.**

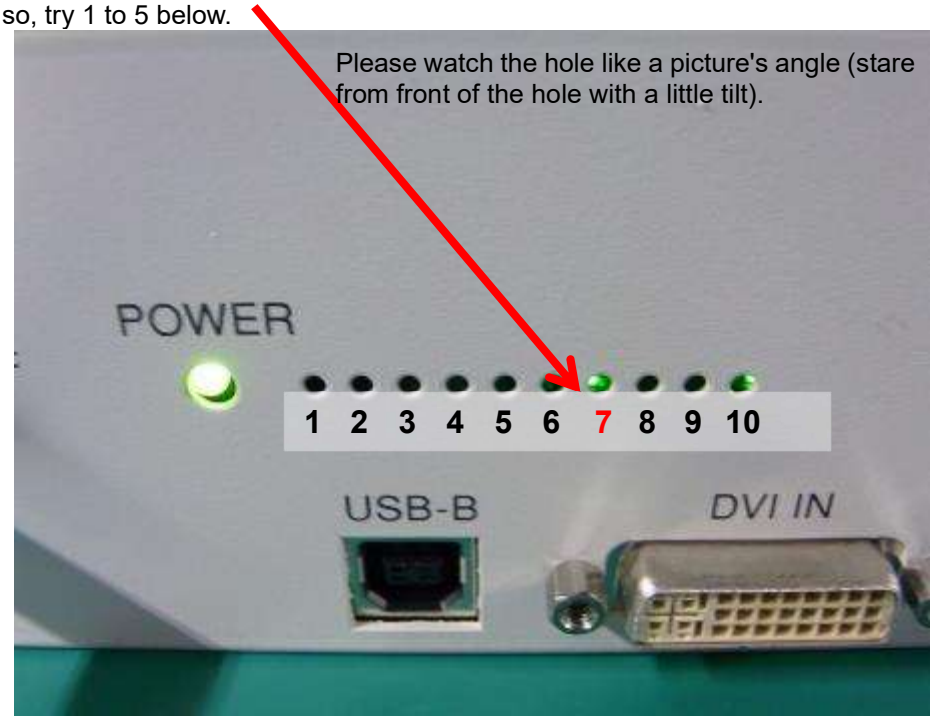
  The LCOS-SLM does not appear to be working for deflected light perpendicular to the orientation direction of the liquid crystal in page.22.

  - **It may not work depending on the type of laptop.**

  In this case, there is a way to check the operation on a desktop PC.

- **PC Does Not Recognize LCOS-SLM (Not displayed on the second screen)**
  - **Check if the LED is lit.**

  Check the LEDs on the back of the controller. A hole is provided on the right side of the POWER _ LED for LED checking. If the 7th LED from the left is flashing, the DVI signal is not being recognized by the controller. If so, try 1 to 5 below.



1.Make sure the DVI-D cable is connected properly.

The cable may not be connected properly. Turn off the power to the controller and reconnect it.

2.Disconnect and reconnect the DVI-D cable from the LCOS-SLM to the DVI connection.

When connecting the LCOS-SLM to a desktop PC, etc., if the LCOS-SLM is connected before the monitor, the screen output setting may not be recognized correctly. In this case, disconnect the power to the controller and then disconnect and reconnect the DVI-D cable from the PC.

3.Check the screen settings of the DVI connection device.

Verify that the DVI output connected to the controller is active.
In addition, there are settings such as clone mode and independent mode in the 2-screen output of the PC, so check these settings as well. If an analog RGB monitor is connected to the control monitor of the PC and used in clone mode, be aware of legacy mode.
One way to check is to connect to another monitor instead of LCOS-SLM to see if it is displayed correctly.

4.It may not work depending on the type of laptop.
In this case, there is a way to check the operation on a desktop PC.

5.Review the Windows display settings.
Due to the Windows display settings, LCOS-SLM may not receive DVI input correctly. Set the display scale to 100% from "Scale and layout" in the display settings.

6.Review the display scaling settings.
Due to the display scaling settings, LCOS-SLM may not receive DVI input correctly. In the graphics board control panel settings, Set 2nd screen output (DVI image output to LCOS-SLM) to "Maintain display scaling"

- **Vertical lines appear on the LCOS-SLM head.**
  - **Check that the FPC cable is properly connected to the relay board.**

Vertical lines may appear on the LCOS-SLM head if the FPC cable is not connected properly to the junction board (Left and right half or the entire operating area). After turning off the power to the controller, open the relay board cover and connect the relay board to the FPC cable again referring to page 14 "Connecting/Removing Equipment".

- **The desired diffraction pattern cannot be obtained.**
  - **Check the polarization direction of the incident light.**

In the case of light perpendicular to the alignment direction of the liquid crystal or circularly polarized light, the LCOS-SLM may not operate or the desired diffraction pattern may not be obtained.

  - **Check the wavelength of the readout light.**

If the product is used at wavelengths other than those set at the time of shipment, the desired diffraction pattern may not be obtained, or reflectivity and light resistance may decrease.

  - **Check if the distortion correction pattern is correct.**

Make sure that the addition is done correctly.
Also, check whether the correction pattern is suitable for your laser.

  - **Check that the correct phase image considering the phase modulation characteristic is prepared.**

Make sure the process is done correctly.
It is also necessary to perform wavelength coefficient conversion corresponding to the laser used.

- **The FPC connector on the relay board was damaged.**

If the relay board is damaged due to a factor that is not covered by the warranty, it is recommended to purchase the relay board separately.
Contact your our company sales representative for more information.

13. *Technical explanation*

Distortion correction pattern

Since the silicon substrate of LCOS-SLM is extremely thin compared to the glass substrate, it is difficult to maintain it in a perfect plane, and initial shape distortion of several [μm] remains. Therefore, when a plane wave is made incident to emit the plane wave, the remaining distortion of the silicon substrate, which is the mirror surface, causes wavefront distortion as shown in Fig. 22.

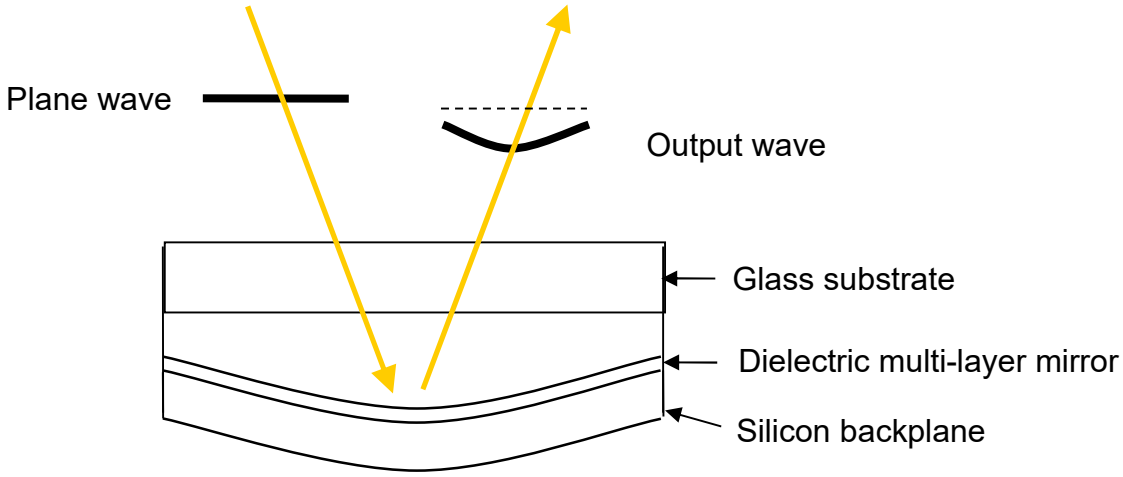


Fig.22 Deformation of the output wavefront due to LCOS-SLM distortion

The distortion correction pattern corrects wavefront distortion caused by distortion of the silicon substrate. The distortion correction pattern is designed to represent the reverse distortion of the silicon substrate in liquid crystal. By adding the distortion correction pattern to the desired phase pattern, an aberration-free result is obtained.

14. *Warranty, repair*

■Guarantee, etc.

- When using the product described in this manual, observe the maximum rating and precautions. Our company makes every effort to improve the quality and reliability of this product, but does not guarantee the integrity of this product. In particular, when the product is used for equipment that may infringe on human life, body or property, it is dangerous unless appropriate safety measures are taken in consideration of possible defects. Our company assumes no responsibility for such use unless the prior written consent of our company such as specifications has been obtained.
- When providing guidance on the operation of the product to end users, the reader is requested to carefully explain the function, performance, and handling of the product and the equipment using the product, and to give appropriate warnings and indications.
- The warranty of the product in this document is limited to repair of the device or delivery of a substitute if the defect is found within 1 year after delivery and our company is notified thereof. Our company assumes no responsibility or liability for damages arising from natural disasters or improper specifications (Modification and violation of various conditions concerning the environment, application field, usage, storage, disposal, etc., described in this document), even within the warranty period.
- The application of this material is intended to illustrate typical uses of the product and does not provide any compensation, including fitness for a particular purpose of use or success or failure of commercial use. Nor does it guarantee or grant any license to enforce any intellectual property rights. Our company assumes no responsibility for any problems arising from the use of this device with respect to third parties or intellectual property rights.
- Export permission from the Government of Japan based on the Foreign Exchange and Foreign Trade Law is required for the export of the products covered in this document.
- Please do not reproduce or reproduce the contents of this document without our company’s permission.

■Repair

If you notice an abnormality, the model name and the serial number (SERIAL No.) and symptom details to our company Sales or your local office (See the end of this book). We will try our best to complete the repair as soon as possible, but please note that we may charge repair fees or refuse repair in the following cases.

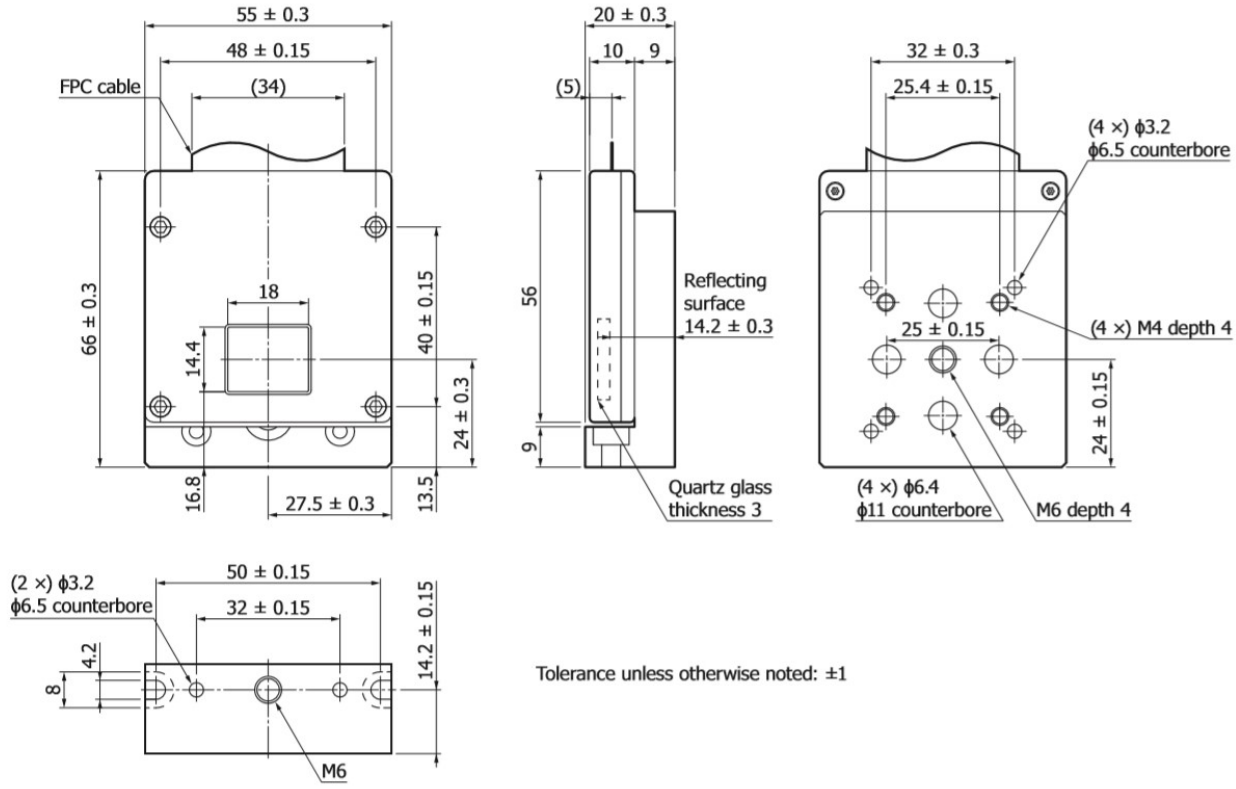
(1) It has been a long time since you purchased it.
(2) When repair parts are discontinued
(3) When modifications have been made
(4) Cases where the damage is found to be significant

15. *Dimensional outline*

Unit: mm Unindicated tolerance: ±1.0

LCOS SLM Head

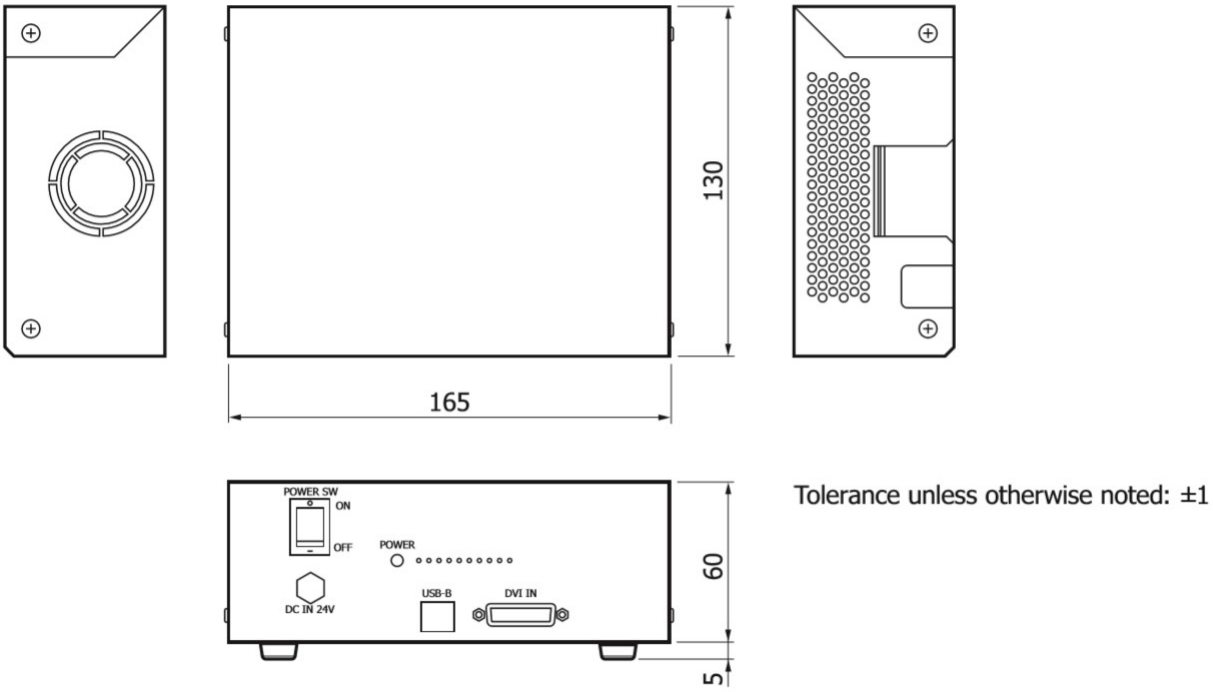
■ X15213-01/-02/-03/-05/-07/-08/-13/-16



Tolerance unless otherwise noted: ±1

Unit: mm Unindicated tolerance: ±1.0

LCOS-SLM Controller



16. *Water-cooled type (L, R Series) handling*

Please refer to this manual for the basic operation of LCOS-SLM. This section is only an excerpt of how to use the water-cooled type.

⚠	Caution	The heat sink is very heavy. Please use with sufficient care when moving or moving.

Absolute maximum ratings

Parameter	Value	Unit
WATER pressure	0.3	MPa

When storing the product, make sure to drain the water inside the heat sink and avoid freezing it inside.

Recommended Usage Conditions

Parameter	Recommend condition
Circulating water temperature	25°C
Circulating water quality	Soft water (except for deionized water)
Circulating water flow	0.5 L/min or more
Circulating water hose	Outside diameter φ6mm Inside diameter φ4mm

Name and Description of water-cooled heat sink

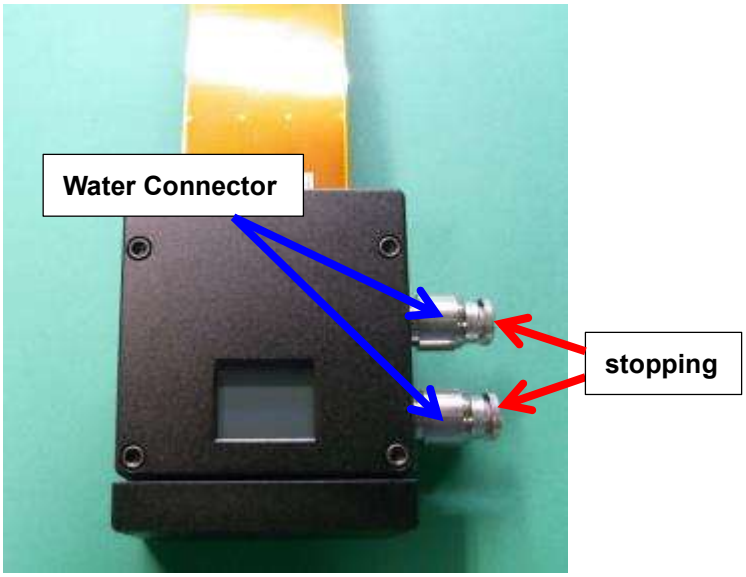


Fig.23 water-cooled type

○ WATER connector

It is a connector to insert a hose to flow water to the heat sink. The outside diameter of the applicable hose is φ6 mm.

○ Stop ring

Stopper for circulating water hose. When you remove the hose, you can remove it by pushing the stop ring to the body side.

Precautions for handling water-cooled heat sinks

Be sure to observe the following precautions and procedures. not safeguarded This can damage the LCOS-SLM and peripherals.

■Handling of circulating water

Be careful not to splash the circulating water on this device. When inserting or removing the circulating water hose, be sure to turn off the power to the device and peripheral devices.

■Circulating water

Please use soft water (Excluding pure water).

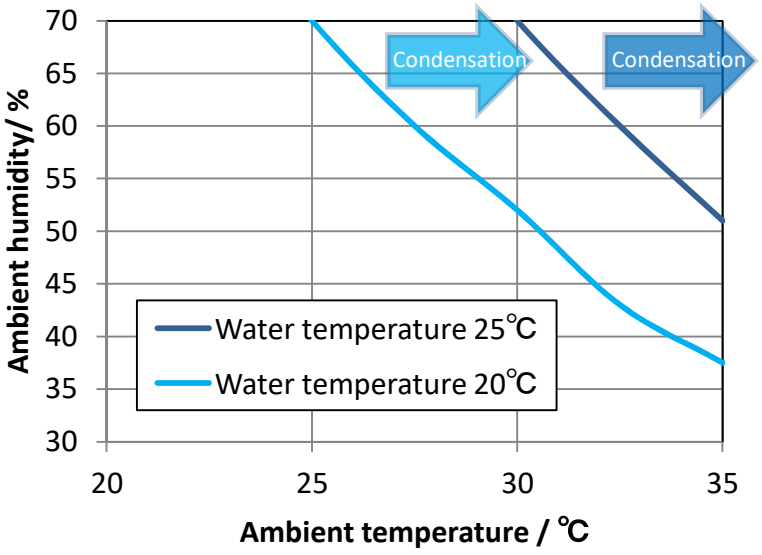
If you use any water other than soft water (antifreeze solution, etc.), please contact our company or our local representative.

■Recommended temperature

Since the properties of LCOS-SLM are temperature dependent, it is recommended to use in an environment where the room temperature is 25 °C and the circulating water temperature is 25 °C. The circulating water controller (chiller, etc.) can be used to maintain the circulating water temperature at 25 °C, or simply, an air-cooled circulating water controller such as a CPU cooler can be used in an environment where the room temperature is 25 °C.

■Condensation

When circulating water is cooled, condensation is likely to occur if both ambient temperature and ambient humidity are high. Use the following graph as a reference when operating in an LCOS or in an environment where the hose does not dew. Since the properties of LCOS-SLM are temperature dependent, it is recommended to use in an environment where the room temperature is 25 °C and the water temperature is 25 °C as described in the recommended temperature.



■Circulating Water Controller

For handling of the circulating water and the circulating water controller, follow the instruction manual of each circulating water controller.

⚠	Caution	The WATER connector withstand voltage specification is 0.3 MPa. Do not exceed the rated value.

■Starting and circulating water

・Check that the circulating water is flowing normally.

・Ensure that the circulating water flow rate is 0.5 L/min. If the flow rate and water pressure cannot be ensured, replace the water circulating hose immediately.

・Do not stop the circulating water during laser irradiation.

	Caution	Do not stop water circulation during high-power laser irradiation. The device may break due to a sudden rise in temperature.

■Hose for circulating water

A hose with an outside diameter of φ6mm can be used.

SMC water hose (For example, TU0604 series) is recommended.

■Installing a water circulation hose

- Check that the circulating water controller is stopped and that the power of the LCOS-SLM is OFF.
- Places the LCOS-SLM head in a stable plane.
- Insert the circulating water hose into the WATER connector.
  - ・Insert the hose into the WATER connector (Direction of the photo arrow).
  - ・Insert the hose securely into the WATER connector until it stops.
- Connect the circulating water hose to the circulating water controller.
- Turn on the circulating water controller and check that there is no water leakage in addition to the circulating water circulating normally.

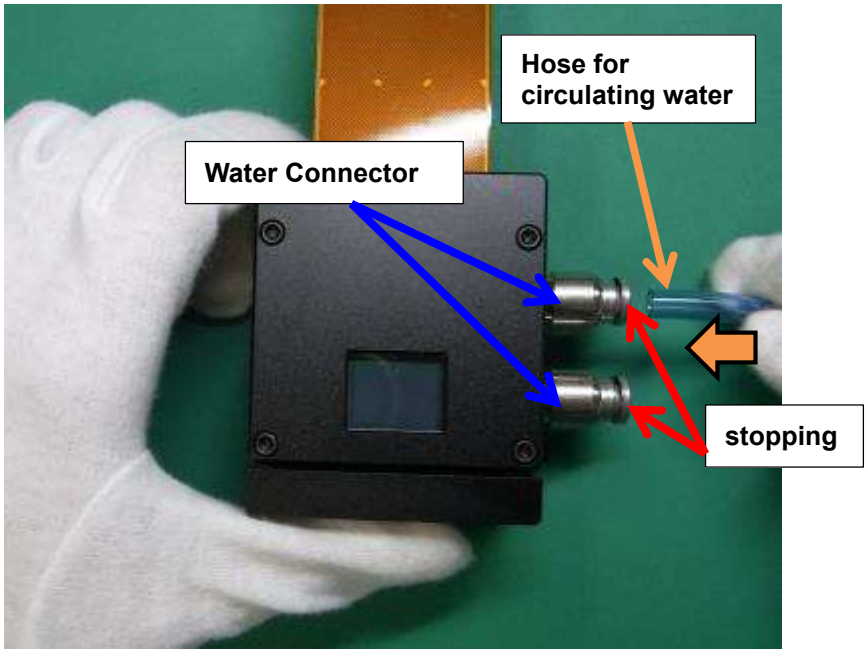


Fig.24　Installing the circulating water hose

■Removing the water circulation hose

- Turn off the LCOS-SLM and peripherals (Include a circulating water controller).
- Check that the circulating water has stopped.
- Remove the circulating water hose on the circulating water controller side.
- Air out the water in the circulating water hose and heat sink.
  - ・Blow air into one side of the hose. Install a water absorption sheet (Wastes, towels, etc.) and a saucer on the outlet side of the hose to prevent splashing of water.
  - ・Please blow air until water stops coming out.
- Places the LCOS-SLM head in a stable plane.
- Remove the hoses from the LCOS-SLM head one at a time to wipe off the water.
  - ・Take care not to splash water, and pull out the hose while pressing the stop ring against the main body.

⚠	Caution	If the medicine is not to be used for a long period of time, remove water and store in a completely dried condition.

■Attaching the Rod Stand to the Optical Adjustment Stage

The water-cooled type has a special hole (M6) for mounting the rod stand as the normal type.

In addition, it can be fixed to the optical stage of 50 mm pitch or 32 mm pitch using the mounting hole of the bottom.

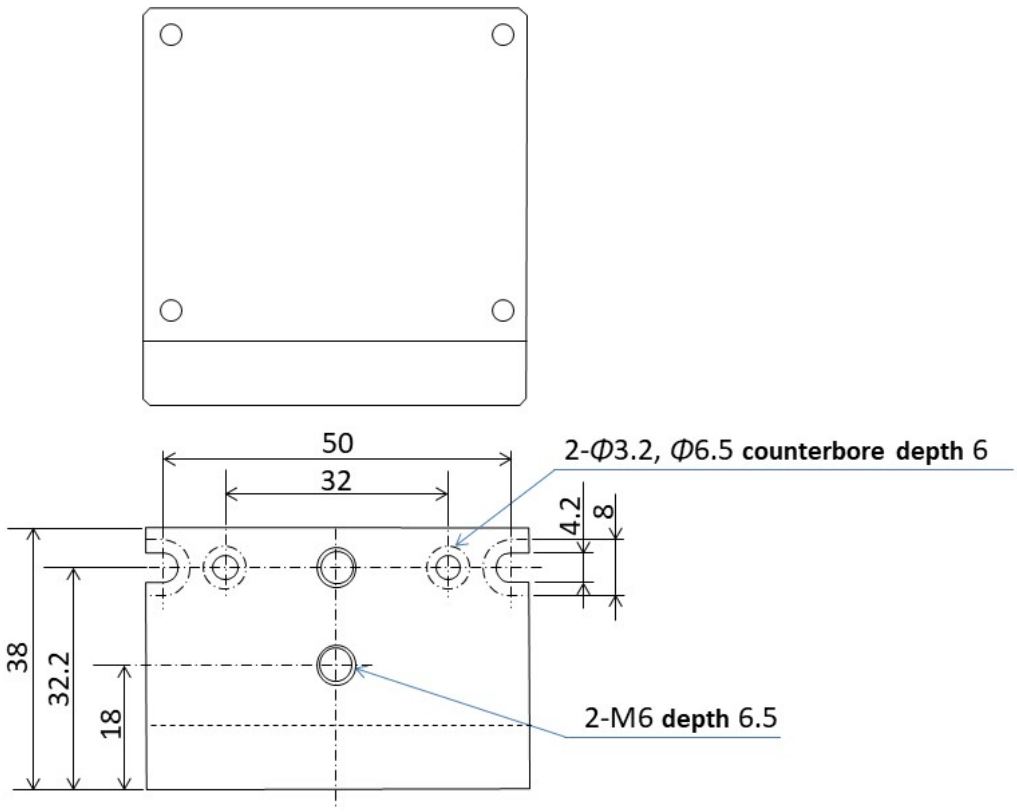


Fig.25　water-cooled L-shaped adapter drawing

If you want to use the mounting holes on the bottom, you must remove the head with the water-cooled heat sink (main body) once.

【Removal - Reconnection Procedure】

1. Use a screwdriver to loosen and remove the L-shaped fixture fixing screw on the back of the LCOS-SLM head water-cooled type.
2. Separate the head with water-cooled heat sink (main body) from the L-shaped adapter for water-cooled type, and attach the L-time adapter to each optical stage.
3. Wipe the front surface of the L-shaped adapter and the back surface of the water-cooled heat sink with a dry cloth, etc., and attach the L-shaped adapter with the fixing screws.

⚠	Caution	Do not screw the L-shaped adapter with foreign matter on the surface. When securing the screws, tighten the four screws evenly. Otherwise, the water-cooled heat sink or LCOS-LLM head can be damaged. These LCOS-SLM head failures are not covered. Please be careful.
⚠	Warning	Do not remove the screws on the back of the head (main body). The product is not covered by the warranty.
⚠	Caution	The heat sink is very heavy. Be careful when removing the L-shaped adapter. The LCOS-SLM head water-cooled type may be damaged or damaged if subjected to a strong impact such as dropping. These LCOS-SLM head failures are not covered. Please be careful.

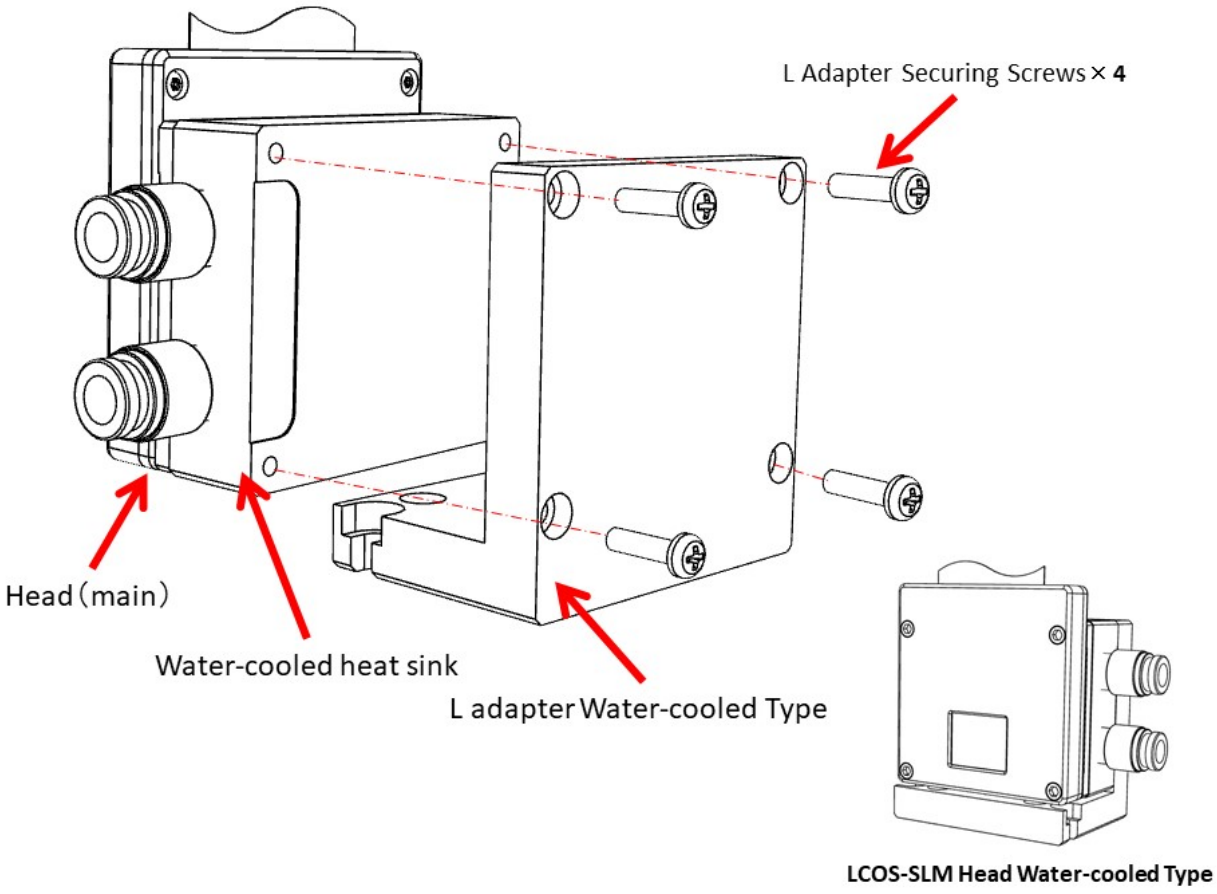


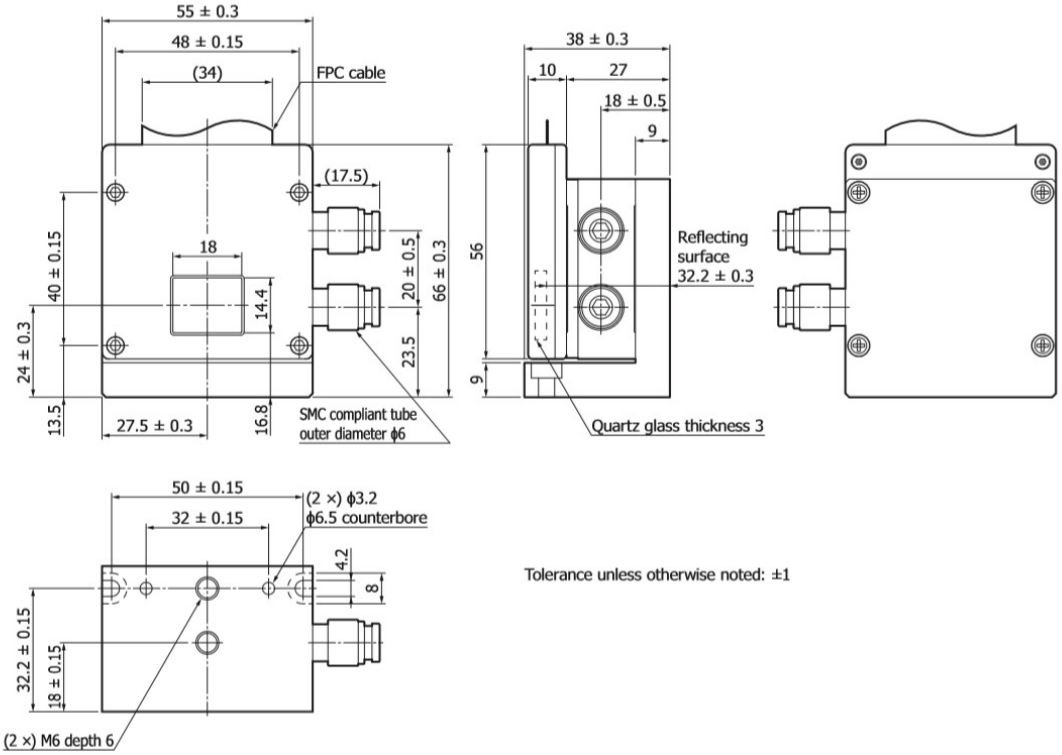
Fig.26　LCOS-SLM Head Water Cooled Type

17. *External Dimensions (water-cooled type)*

Unit: mm Unindicated tolerance: +/- 1.0

LCOS SLM Head (R Series)

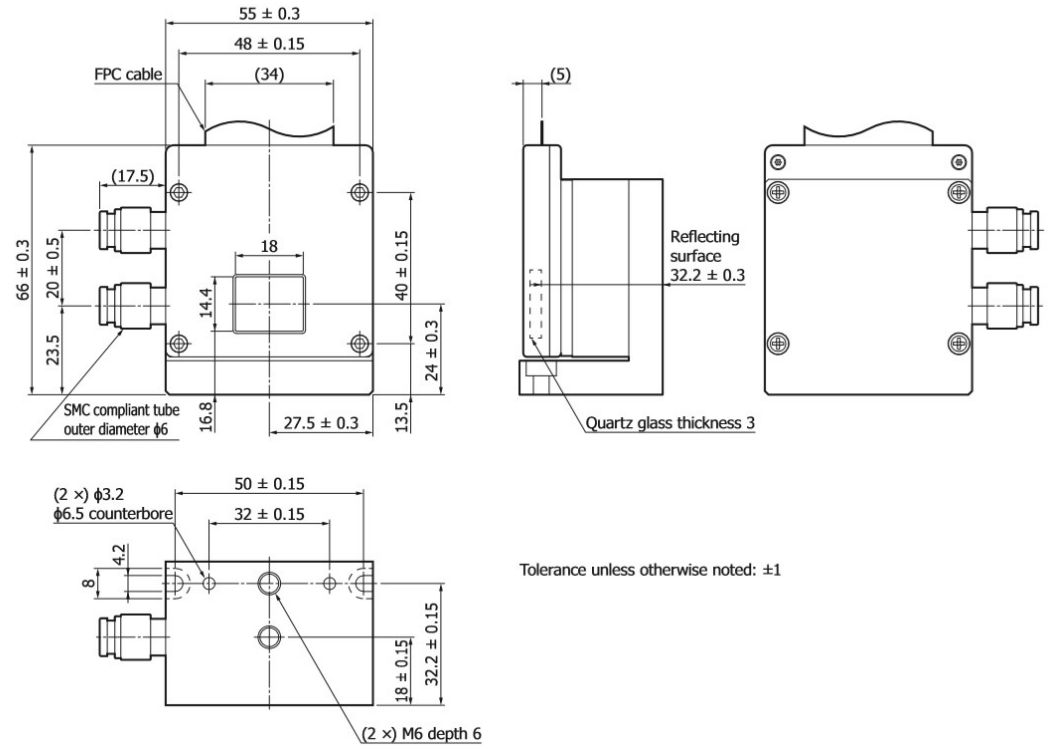
■ X15213-02R/-03R/-16R



Tolerance unless otherwise noted: ±1

LCOS SLM Head (L Series)

■ X15213-02L/-03L/-16L



Tolerance unless otherwise noted: ±1

*1: KQB2S06-01S SMC, Compatible Tube Outer Diameter: ϕ6

Note: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

HAMAMATSU

JAPAN

Hamamatsu Photonics K. K.. Laser Promotion Division
1-8-3, shinmiyakoda, kita-ku, Hamamatsu City, 431-2103, Japan,
Telephone: (81) 53-484-1300, Fax: (81) 53-484-1317

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

Germany

Hamamatsu Photonics Deutschland GmbH
Arzbergerstr. 10, D-82211 Herrsching am Ammersee, Germany,
Telephone: (49) 8152-375-0, Fax: (49) 8152-265-8

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

United Kingdom

Hamamatsu Photonics UK Limited
2 Howard Court, 10 Tewin Road, Welwyn Garden City, Hertfordshire AL7 1BW, United Kingdom,
Telephone: (44) 1707-294888, Fax: (44) 1707-325777

North Europe

Hamamatsu Photonics Norden AB
Torshamnsgatan 35 16440 Kista, Sweden,
Telephone: (46) 8-509-031-00, Fax: (46) 8-509-031-01

Italy

Hamamatsu Photonics Italia S.R.L
Strada della Moia, 1 int. 6, 20020 Arese, (Milano), Italy,
Telephone: (39) 02-935-81-733, Fax: (39) 02-935-81-741

Home page

http://www.hamamatsu.com/