



Wavefront Shaper

Wavefront shaper is a phase control unit for laser machining and microscopic observations, which is designed to enable you to shape the beam easily.

With this module, you can easily do marking and micro-machining by simultaneous multipoint irradiation, and easily correct spherical aberration appearing in the workpiece.

■ Features

- Easy connections to optical components/systems
- Simple control (with various DLL for control)
- Construction of high functioning laser machining/microscopic observation systems
- Control function (for high power laser machining applications)

■ Applications

- Optical beam shaping
- Optical manipulation
- Optical aberration
- Optical vortex generation
- Repair / trimming
- 3D simultaneous multipoint laser beam generation
- Simultaneous multipoint machining by multibeam interference

The key device gives new values to laser machining

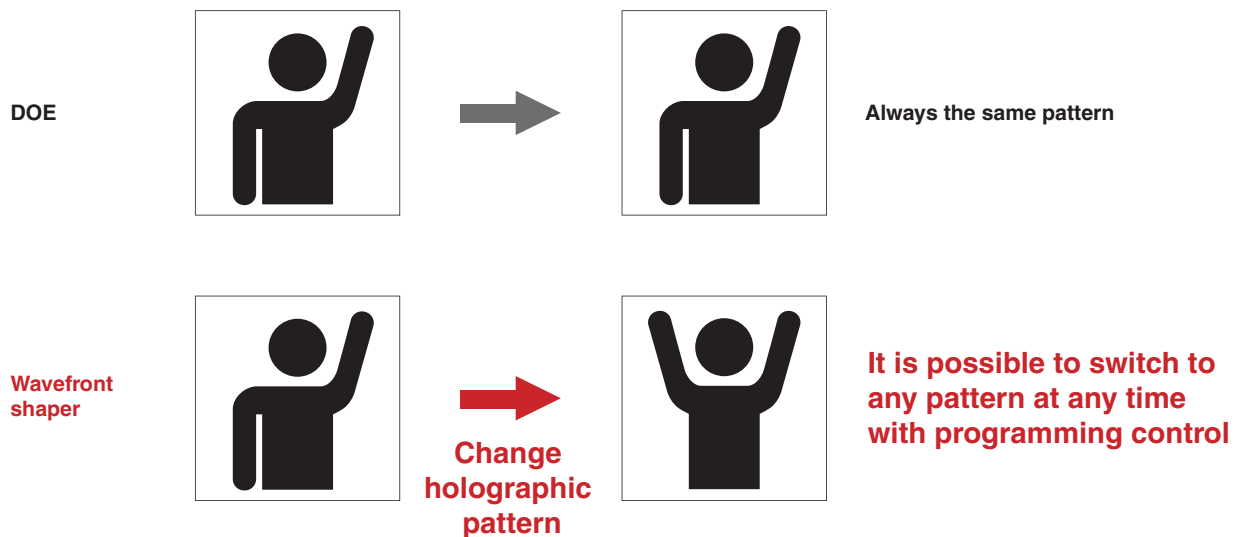
■Phase control of laser

In the field of laser machining, phase control is attracting attention. Phase control enables 2D simultaneous multipoint irradiation, 3D simultaneous multipoint irradiation, aberration correction and so on. By using wavefront shaper, you can control the phase of laser beam with high resolution and precision, then change the beam profile easily and conveniently. Wavefront shaper is the key device which gives new values to laser machining.

Comparison with DOE (Diffractive Optical Element)

DOE (Diffractive Optical Element) is one of optical element which is known as giving similar function: beam shaping.

Though DOE requires dedicated design to shape each pattern, wavefront shaper is able to switch desired beam pattern easily.

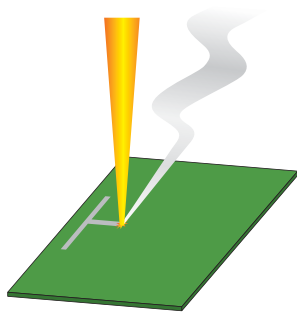


■Phase control technology to improve takt time of machining

It is well known technology to scan laser with galvano mirror to perform micro-machining, however, it is difficult to shorten takt time to scan complex structure. In addition, the energy of laser is focused on irradiated spot when you use the galvano mirror, and it damages the workpieces. Wavefront shaper enable to generate intended beam pattern with single shot irradiation. It achieve to improve takt time and avoid to concentrate energy to only one spot. Therefore wavefront shaper realizes high throughput and less damage machining.

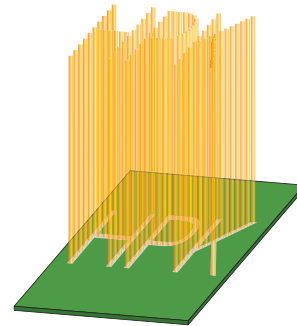
Comparing laser scans and simultaneous irradiations

●Scanning



Workpieces are damaged when using higher power laser

●Simultaneous multipoint irradiation with wavefront shaper



Shortening of improve takt time

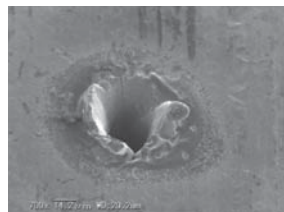
■Utilization of ultra-short pulsed laser

You can perform less-thermal effect processing by irradiating ultra-short pulsed laser which has femtoseconds and/or picoseconds pulse duration. For example, it can be applied to industrial applications such as improving slidability through micro-periodic structures, micro-machining such as drilling and cutting, glass bonding, and dicing. With wavefront shaper, you may achieve high-precision and high-takt machining.

●Nanosecond pulse

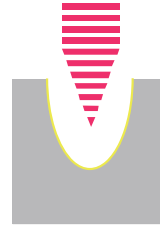


Melting slowly, causing thermal effects on the ambients

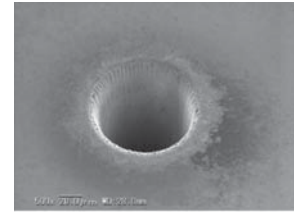


Thermal machining

●Picosecond pulse



Melt and evaporated instantaneously



Non-thermal machining

The most suitable for micro-machining

Expected applications

- Improvement of slidability by making micro-periodic structures
- Micromachining: drilling, cutting
- Industrial applications: glass bonding, optical memory, dicing

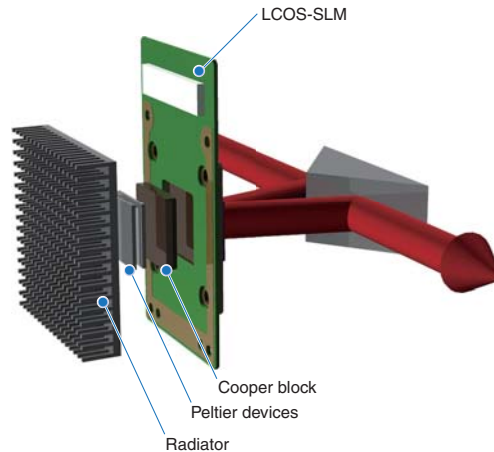
Technical feature: Utilization of high power laser

■Cooling the LCOS-SLM with peltier devices

It is important to control temperature of the LCOS-SLM by peltier device in order to ensure stable operation.

- Expected profit from controlling temperature of LCOS-SLM
 - Preventing unintended phase modulation
 - Improving light resistance to high power laser input *
- * The heat generation by the input of high power laser damage LCOS-SLM, especially liquid crystal.

Heat dissipation design of phase control unit



Controlling the temperature
of the modulation unit stably

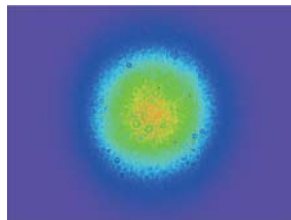


- Stabilizing characteristics
of phase modulation
- Supports high power laser

■Optical density reduction by homogenizer

Homogenizer produces the spacial-uniform intensity within the beam profile. Uniform beam profile enables to use higher power laser with LCOS-SLM effectively. Without homogenizer, typically, the intensity within beam pattern of the laser places gaussian distribution, and the most high intensity point restrict the capability of resistance of LCOS-SLM. On the other hand, uniform beam pattern with homogenizer can reduce the density of irradiated point and relax the concentration of energy. Therefore, it is possible to use higher power laser as the light source of LCOS-SLM, and give great advantage to do simultaneous multi spot processing.

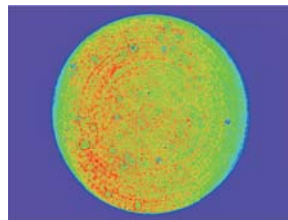
Beam profile of incident light



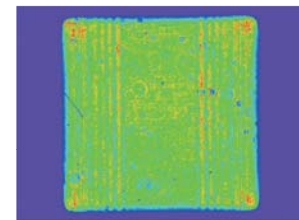
$\phi 1/e^2=8.3 \text{ mm}$



Uniform beam profile

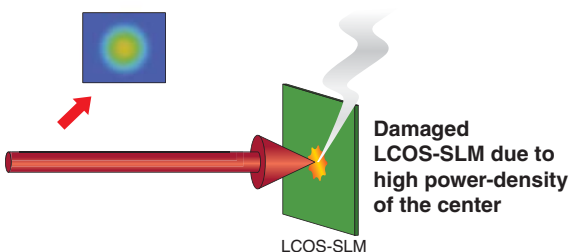


$\phi 1/e^2=11 \text{ mm}$

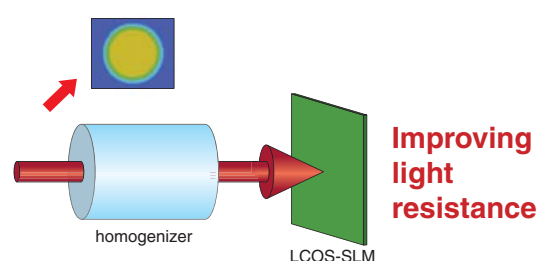
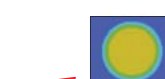


* Compatible with rectangular shapes

●Gaussian beam



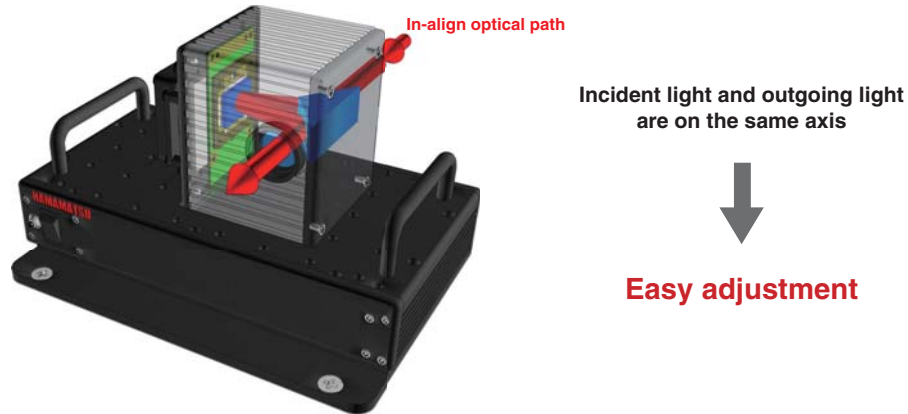
●Flat beam profile (with homogenizer)



Technical feature: Improved usability

■Pseudo-transmissive optical configuration

The dedicated prism type mirror enables in-align optical path for input and output beam. There is no need to do complex optical alignment, and make it easier to install into laser machining instruments.



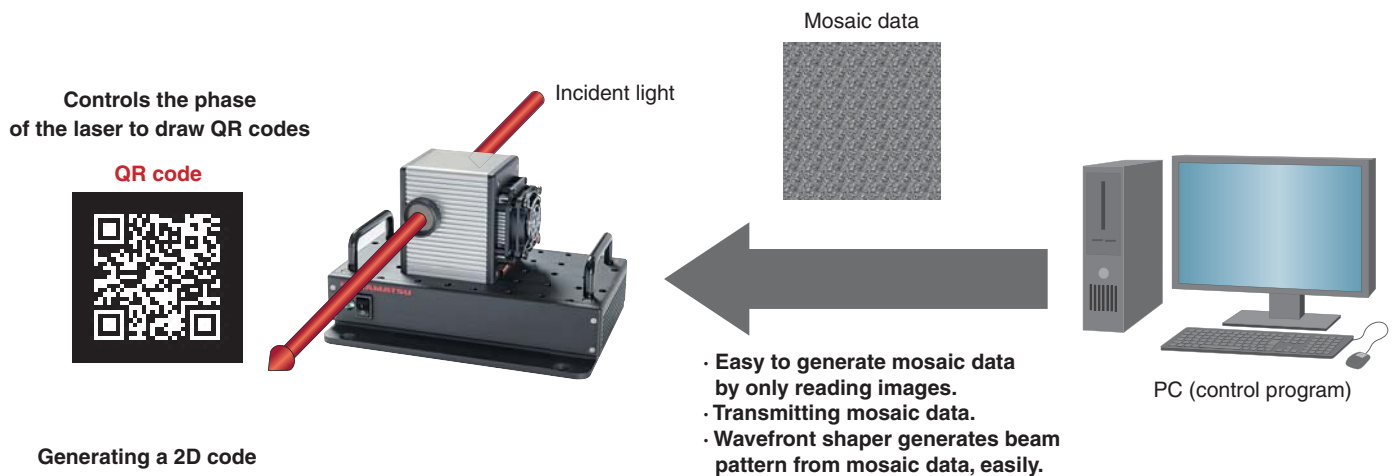
■Control program

There is complex process to achieve phase control with LCOS-SLM, and it is one of major barrier to start to use phase control technology.

Our product includes the control software, and it gives great insight for the user to use LCOS-SLM. The sample software includes the function to generate CGH (Computer Generated Hologram) to mark 2D pattern at multiple point easily.

Program for data generation

* Operation image



Generating a 2D code

<Compatible standards>

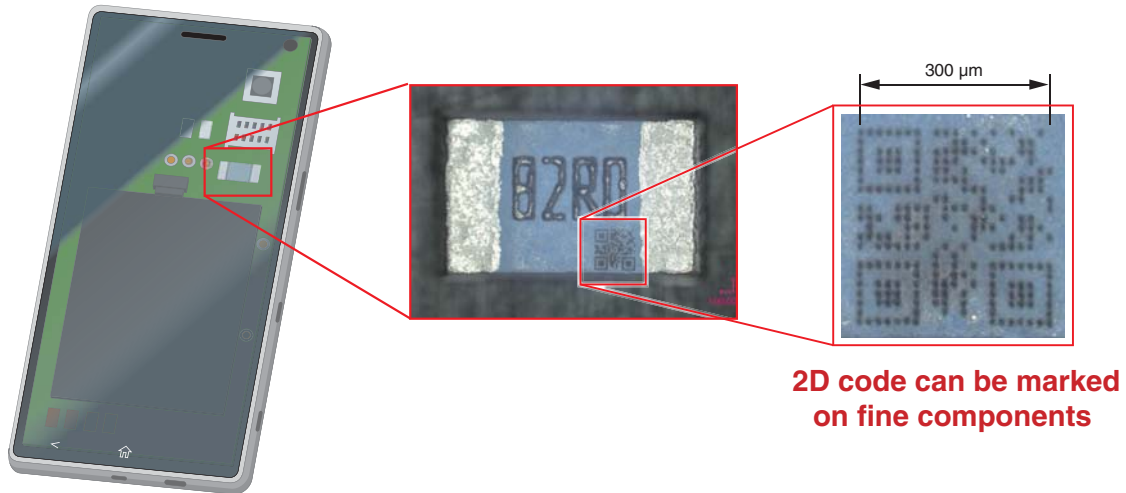
- QR code
- Datamatrix
- Micro QR code: underdevelopment

Applied to machining: Simultaneous multipoint irradiation

■2D simultaneous multipoint irradiation

Minute 2D codes are required to achieve traceability management for such as tiny electro-components. By using wavefront shaper together with short pulsed laser, you can make small workpieces marked finely at once.

QR code marked on the electronic components of the smartphone (image)

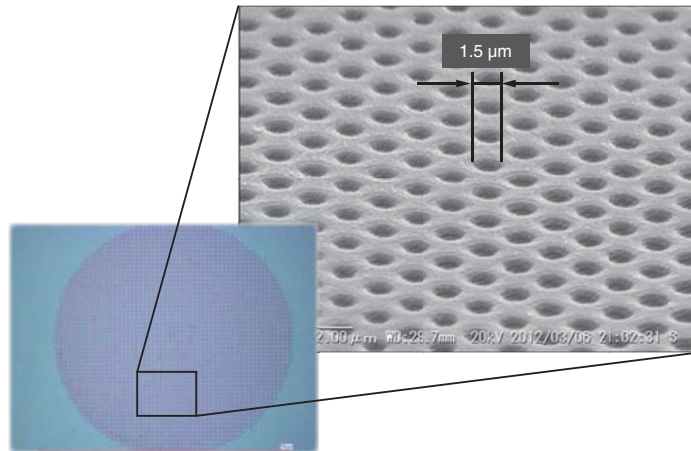


■Holographic interference machining

Wavefront shaper achieves to form fine pitch interferometric structure in the scale of micrometer when combined with ultra-short pulsed laser.

In addition, wavefront shaper helps to improve takt time with simultaneous multi point irradiation.

Example of micro-periodic drilling of ITO (Indium Tin Oxide) thin films deposited on glass substrates



Realizing micro periodic holes with uniform shape and depth over the entire machining area

<Machining conditions>

Number of holes: Approx. 2500 (simultaneous)

Diameter: Approx. 1.5 μm

Interval: Approx 1.5 μm

Laser/Center wavelength: 515 nm

Pulse width: Approx.1 ps

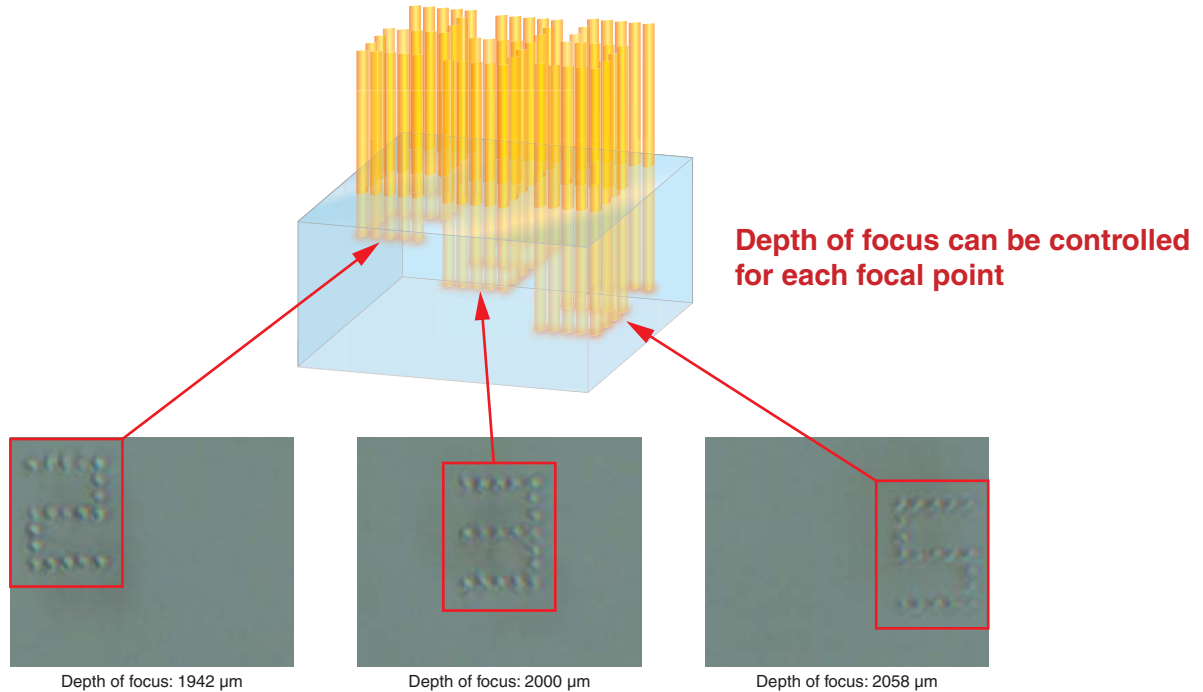
* Using homogenizer together

Applied to machining: stereoscopic/internal machining

3D simultaneous multipoint irradiation

Simultaneous irradiation can be applied to stereoscopic marking with different focal lengths. It is possible to generate multi-point 3D pattern without moving focusing lenses or the workpieces since the phase controlling can achieve to control focal length.

Example and conceptual diagram of multipoint laser beam generation

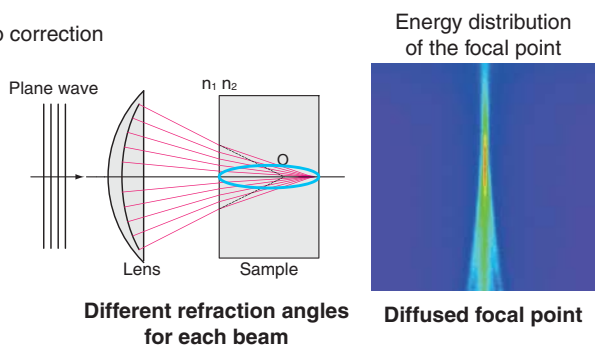


Optical aberration correction for internal machining

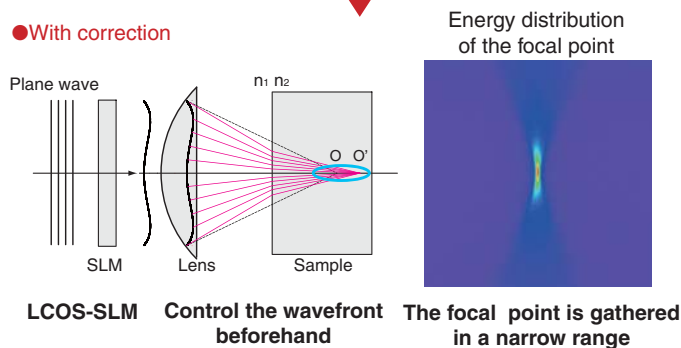
Wavefront shaper can also correct the spherical aberrations that occurs when conducting internal machining for transparent materials.

Aberration correction

● No correction

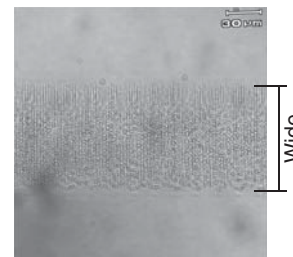


● With correction

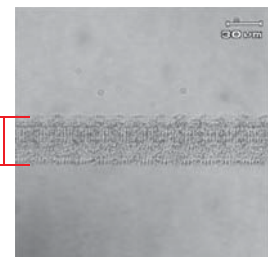


Internal machining of sapphire

● No correction



● With correction



Optical aberration correction allows small pitch machining

<Machining conditions>

Center wavelength: 800 nm

Pulse width: 50 fs

Pulse energy: 45 μJ

Lineup of wavefront shapers

Wavefront shaper C14280 series



This is a phase control unit for laser machining and microscopic observations, that is constructed to enable you to shape the beam easily. It is equipped with prism-type mirrors which simplify the construction of the optical system, and electronic cooling systems that improve the operation stability and the resistance to high power laser of optical phase modulators (LCOS-SLM). In addition, it is also fitted with libraries and applications in the standard to support the design of phase data for beam shaping and phase control.

Specifications

Parameter	Specifications	Unit
Interface	Digital video interface (DVI) *1	—
DVI signal format	SXGA (1280 pixels x 1024 pixels)	—
DVI frame rate	60	Hz
Input signal tone value	256 (8 bits)	levels
Effective aperture	12	mm
Throughput	95 (Typical value)	%
Corresponding wavelength range	See "Corresponding wavelength range" *2	—
Polarization direction	Horizontal	—
Input voltage (AC adapter used)	100 to 230 (50 Hz / 60 Hz)	V
Power consumption	35	VA
Weight	2.5	kg
Operating temperature	20 to 35 *3	°C
Storage temperature	-20 to +55	°C

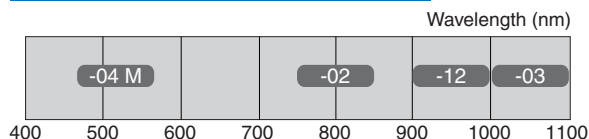
*1 When this product is used, a control PC (with a DVI or HDMI external monitor output terminal) must be prepared separately.

*2 Contact us separately for other wavelengths.

*3 No condensation. Note that the characteristics may change depending on the humidity.

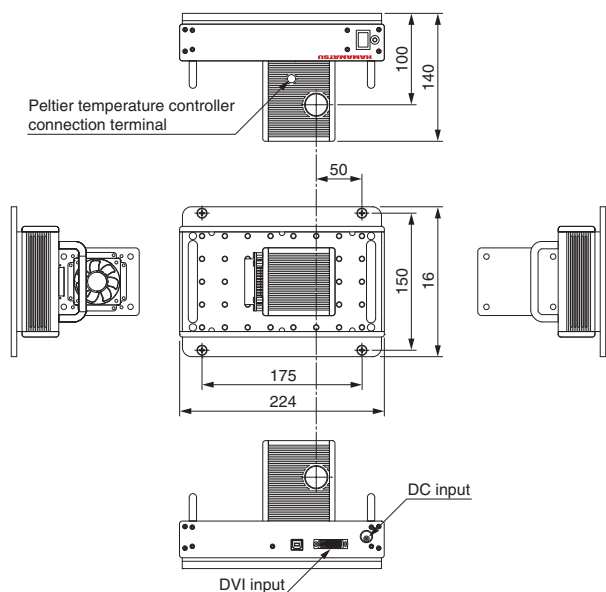
* The TEC-controller C14480 is attached to this product.

Corresponding wavelength range



Type No.	Corresponding wavelength	Unit
C14280-02	750 to 850	nm
C14280-03	1000 to 1100	nm
C14280-04M	460 to 560	nm
C14280-12	850 to 1000	nm

Dimensions (Unit: mm)



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