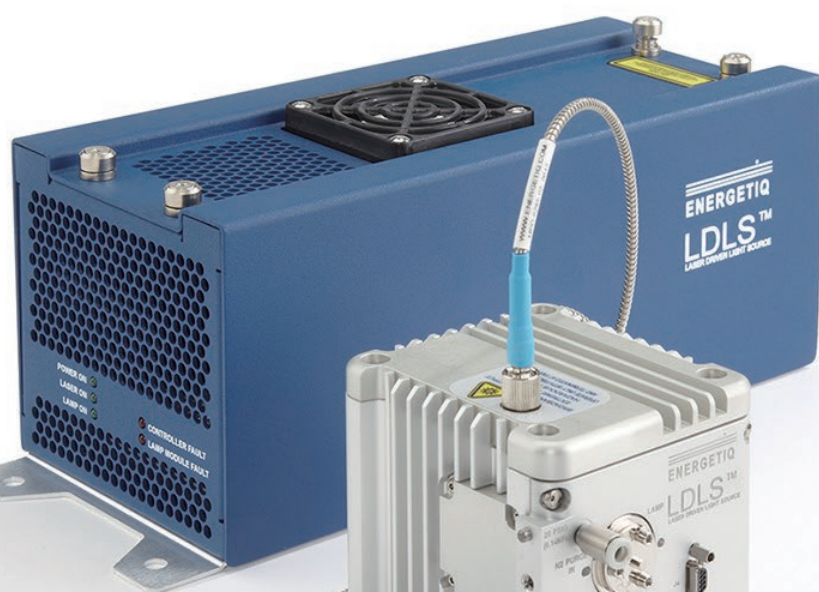


Laser-Driven Light Source LDLS™

ENERGETIQ
A **HAMAMATSU** Company

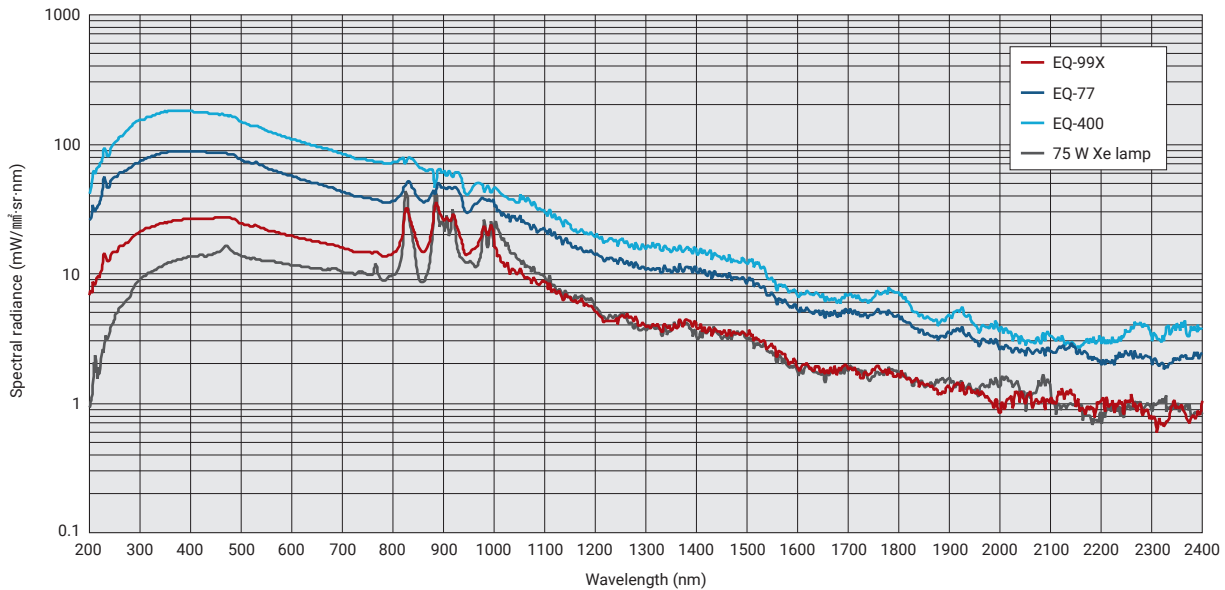


HAMAMATSU
PHOTON IS OUR BUSINESS

Features

Extremely broad wavelength range

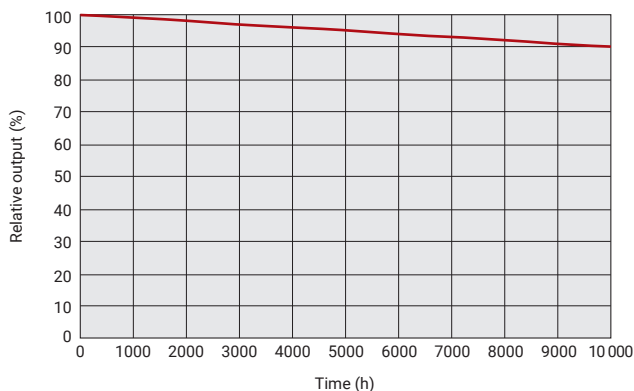
- Broad emission wavelength range from vacuum UV to visible and near-infrared (170 nm to 2500 nm)



* We have confirmed wavelength radiation from 170 nm to 2500 nm, but we have not acquired the wavelength band Less than 200 nm and after 2400 nm for spectral radiance data.

Long lifetime

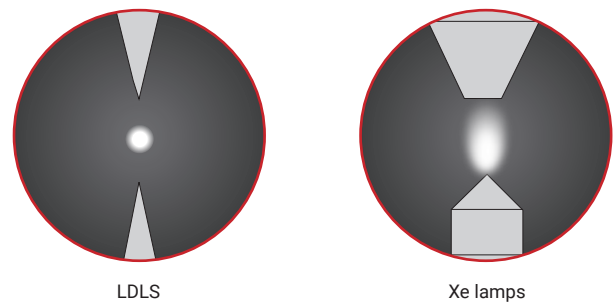
- Lifetime characteristics



* This is the typical lifetime of EQ-99X-QZ-S measured light output at 500 nm.

High radiance from a small plasma

- High radiance emission from a luminous point of 0.1 mm diameter



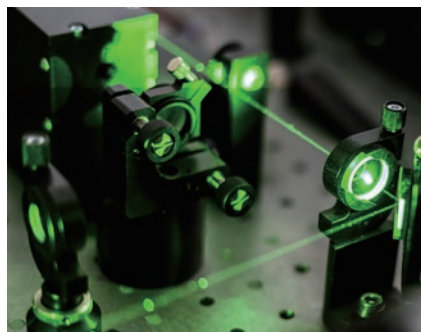
Applications

- UV-visible-NIR spectral measurement



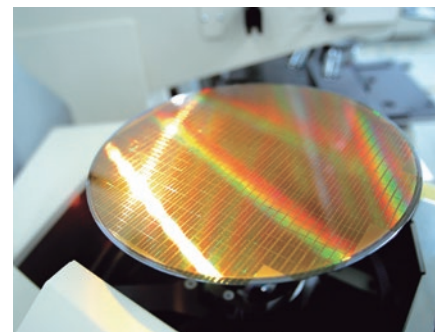
- Absorption measurement, reflected light measurement
- Color measurement (jewels, plastics, polymers)
- Narrow-slit monochromators

- Evaluation of optical products



- Evaluation of optical filters and lenses
- Evaluation of optical fiber transmission
- Evaluation of image sensors

- Film thickness measurement



- Substrate coating inspection
- Deposition measurement

Product Technology

The Laser-Driven Light Sources or LDLS is an innovative light source developed by Energetiq Technology inc. in the US, which is a subsidiary of HAMAMATSU PHOTONICS. LDLS is the only light source in the world that utilizes a focused laser beam to generate and maintain plasma between the discharge electrodes in the xenon gas filled bulb.

High technology supported by a number of proprietary patents

The unique laser-driven technology which is the basic principle behind LDLS is supported by patents owned by Energetiq. The related patent numbers are as follows:

(US 7435982, 7786455, 8525138, 8969841, 9048000, 9185786; Japan 5410958, 5628253; Korea 10-1507617; UK GB2450045.)

For more detailed information, please refer to the following site.

<https://www.energetiq.com/patents>

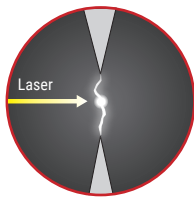
High-temperature plasma sustained by laser

The high-temperature plasma sustained by the laser emits a nearly flat spectrum that spans the UV to near-infrared region and has much higher brightness than xenon lamps.

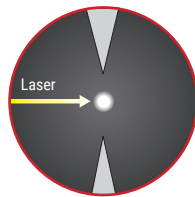
Light emission technology that causes no wear on the discharge electrodes

LDLS utilizes its two discharge electrodes in the bulb only to ignite the plasma. After that, there is absolutely no wear and tear on the electrodes while plasma is sustained between them. This means the bulb has a very long service lifetime compared to traditional light sources that fully use and consume the electrodes during operation.

LDLS: Utilizes electrodes ONLY during ignition

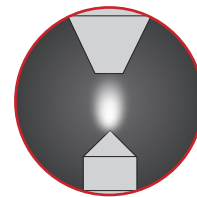


Pulse discharge during ignition



Plasma is sustained only by laser beam

Xenon lamps: Utilizes electrodes during operation

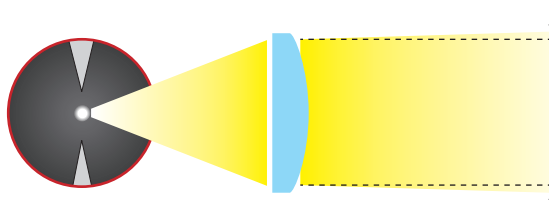


Arc discharge

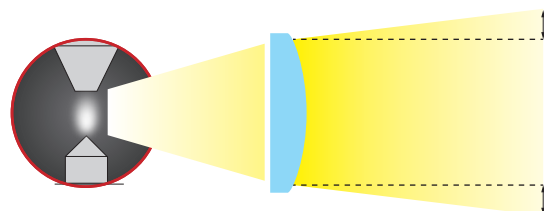
Very small emitting point

Because light emission occurs only at the laser-focused point, the emitting point is very small compared to that of xenon lamps. This offers many benefits such as focusing light onto a small point, efficient utilization of light, and suppression of stray light.

LDLS: Allows forming ideal parallel light







Xenon lamps: Large divergence angle compared to LDLS



When collimating light from traditional light sources, the beam divergence or widening angle usually becomes a problem.

LDLS allows forming ideal collimated light with a smaller divergence angle than xenon lamps. The small emitting point is also advantageous for efficiently focusing the light onto a very small area.

Selection guide

		Standard model (EQ-99X series) → P.5	Fiber-coupled model (EQ-99X-FC series) → P.7	High brightness model (EQ-77 series) → P.9	Highest brightness model (EQ-400 series) → P.11	Unit
Appearance						
Properties	Optical interface	Diverging beam	Fiber coupled output	Diverging beam (with retroreflector)	Diverging beam (with retroreflector)	-
	Plasma size (typ.)	100 × 180	100 × 180	125 × 320	370 × 800	μm
	Numerical aperture (NA)	0.47	0.22 (Output fiber)	0.5	0.5	-
	Laser class	Class 1	Class 1	Class 1	Class 4	-
Typical performance	Spectral radiance ^①	25	-	75	110	mW/mm ² ·sr·nm
	Broadband optical power	0.75 W	95 mW ^②	2.75 W	15 W	-
Rating	Input voltage (AC)	100 to 240	100 to 240	100 to 240	200 ~ 240	V
	Power frequency	50 / 60	50 / 60	50 / 60	50 / 60	Hz
	Power consumption	175	175	350	1700	W
Physical specifications	Lamphead dimensions (W×H×D)	76 × 83 × 76	76 × 83 × 76	206 × 125 × 93	352 × 148 × 155	mm
	Lamphead weight	0.7	0.7	2.2	2.7	kg
	Controller dimensions (W×H×D)	111 × 107 × 301	111 × 107 × 301	298 × 155 × 132	482 × 133 × 575	mm
	Controller weight	1.4	1.4	2.9	18.8	kg
Facility requirements	Cooling	No auxiliary cooling required	No auxiliary cooling required	Water cooling	Water cooling	-
	Nitrogen purge	Recommended. Grade 4.8 or higher, filtered to 5 μm. 20 psiG ±2 psiG	Recommended. Grade 4.8 or higher, filtered to 5 μm. 20 psiG ±2 psiG	Required. Grade 4.8 or higher, filtered to 5 μm. 20 psiG ±2 psiG	Required. Grade 4.8 or higher, filtered to 5 μm. 20 psiG ±2 psiG	-
	Operating temperature range	15 to 35	15 to 35	15 to 35	15 to 35	°C

① Measurement wavelength: 500 nm
② Measured using a 230 μm core fiber.

Options

● Changing the output window material

Supported LDLS series EQ-99X series, EQ-77 series, EQ-400 series



The window material of LDLS with a diverging-beam optical interface can be changed from standard quartz glass. Changing the window material will also change the radiant wavelength range in the UV region.

Selectable window materials	Quartz (Standard)	MgF ₂	YAG	BK7
Wavelength (nm)	170 to 2500	170 to 2500	190 to 2500	350 to 2500
EQ-99X series	✓	✓	✓	✓
EQ-77 series	✓		✓	✓
EQ-400 series	✓			✓

● Controller (EQ-99 Manager) for control from PC

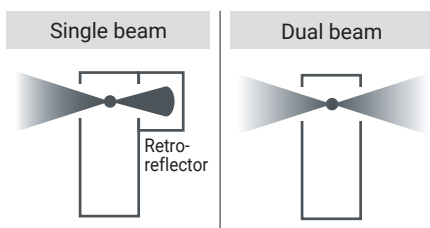
Supported LDLS series EQ-99X series



The EQ-99 Manager connects to a PC for smooth and easy control of the EQ-99X series LDLS. The front panel display allows monitoring the status of the EQ-99X LDLS including bulb operation hours. When needed, an optional shutter can be connected for advanced shutter control.

● Dual-beam output mode

Supported LDLS series EQ-77 series, EQ-400 series



A retroreflector is attached to the lamphead (standard feature) on the EQ-77 series and EQ-400 series LDLS for single-beam output mode.

Light reflecting from the retroreflector combines with the light directly emitted from the bulb to enhance the output in one direction.

Removing the retroreflector allows light emission in two directions for dual-beam output mode.

● Shutter

Supported LDLS series

for EQ-99X series (The EQ-99 Manager is required)



The shutter unit directly connected to the light output window can be controlled with the EQ-99 Manager.

■ Cycle rate: 2 Hz
(Exposure time is 500 ms)

* The cycle rate cannot be changed.

● Optical mounting bracket

Supported LDLS series

EQ-99X series

Use this bracket to mount the lamphead onto a commercially available optical component.

● Chiller-kit

Supported LDLS series

for EQ-77 series / EQ-400 series

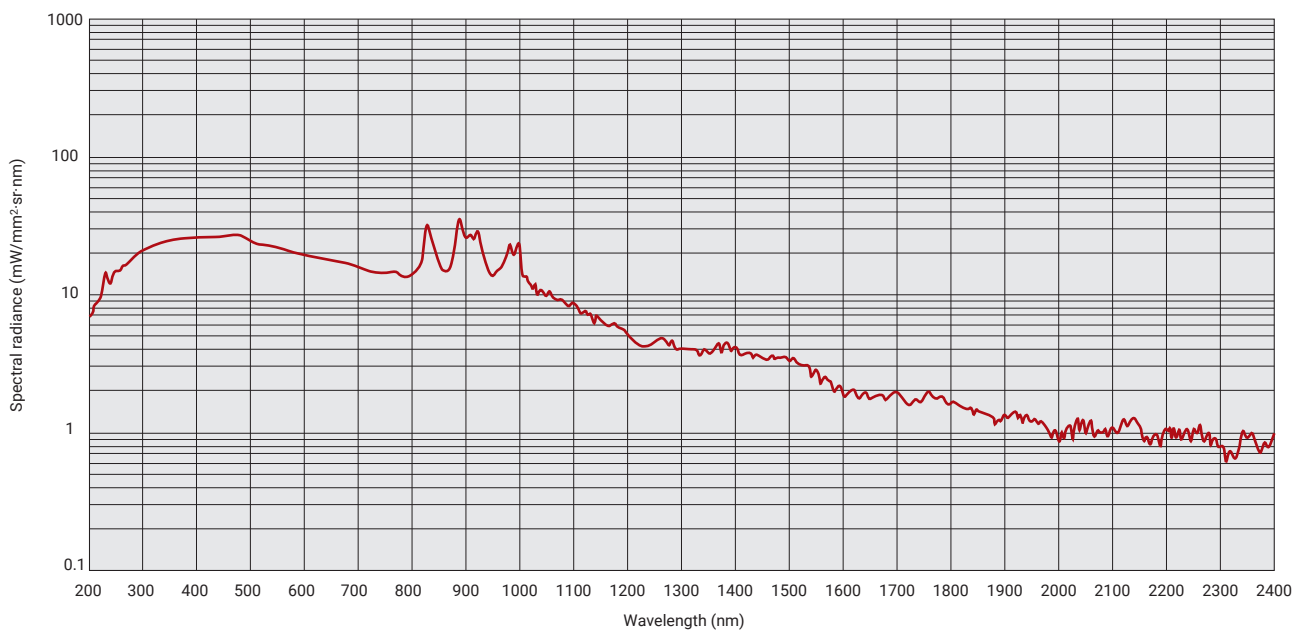
The lamphead of the EQ-77 series and the lamphead and controller of the EQ-400 require active water cooling. Hamamatsu provides chillers optimized to match their ratings.

EQ-99X-QZ-S

The EQ-99X-QZ-S is a standard LDLS model with a diverging-beam optical interface. It has a compact lamphead with lower heat generation that makes it ideal for experiments in cramped spaces or for installation into equipment. The lamphead is designed to cool by natural convection thus eliminating vibrations caused by cooling fans and ensuring a highly stable light output.



● Spectral radiance



Product standard specifications

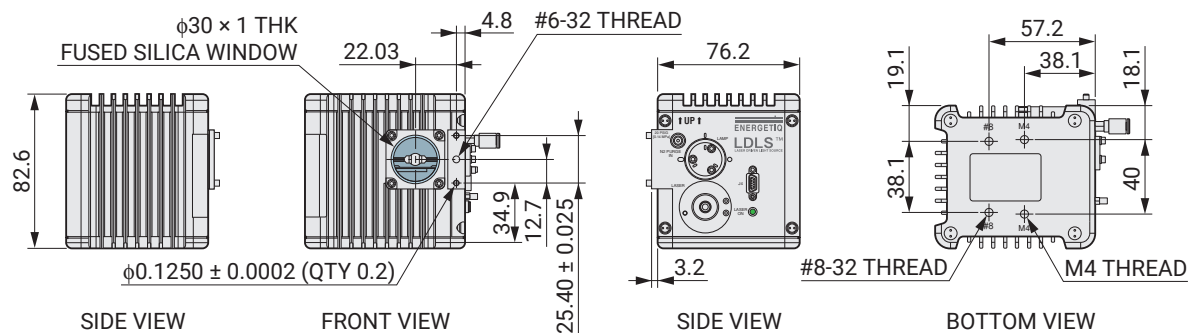
Parameter		Description / Value	Unit
Optical interface		Diverging beam	-
Wavelength range		170 to 2500	nm
Plasma size (FWHM)	Typ.	100 × 180	μm
Numerical aperture	NA	0.47	-
Lifetime ①	Typ.	10 000	h
Warm-up time		30	min
Laser class		Class 1	-
Spectral radiance(at 500 nm)	Typ.	25	mW/mm ² ·sr·nm
Broadband optical power	Typ.	0.75	W
Output window size		Φ22	mm
Window material ②		Quartz	-
Cooling method		No auxiliary cooling required	-
Nitrogen purge		Recommended. Grade 4.8 or higher, filtered to 5 μm. 20 psiG ±2 psiG	-
Applicable standards		EN 61010-1, EN 61326-1, IEC 60825-1, IEC 62471, EN 50581	-
Device configuration		Lamphead, Power supply controller, Remote control, AC adapter, Necessary cables	-
Power rating	Input voltage (AC)	100 to 240	V
	Power frequency	50 / 60	Hz
	Power consumption	175	W

① Windows may need to be replaced depending on the extent of contamination and usage conditions.

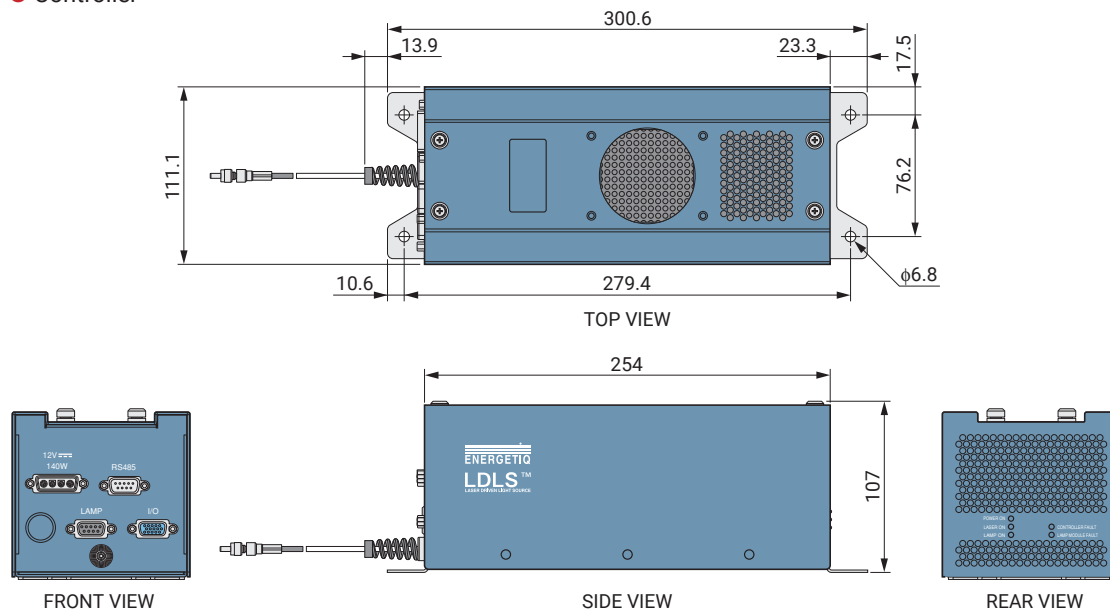
② MgF₂ (170 nm to 2500 nm), YAG (190 nm to 2500 nm) and BK7 (350 nm to 2500 nm) windows are also selectable as options.

Dimensional outlines (Unit: mm)

Lamphead



Controller



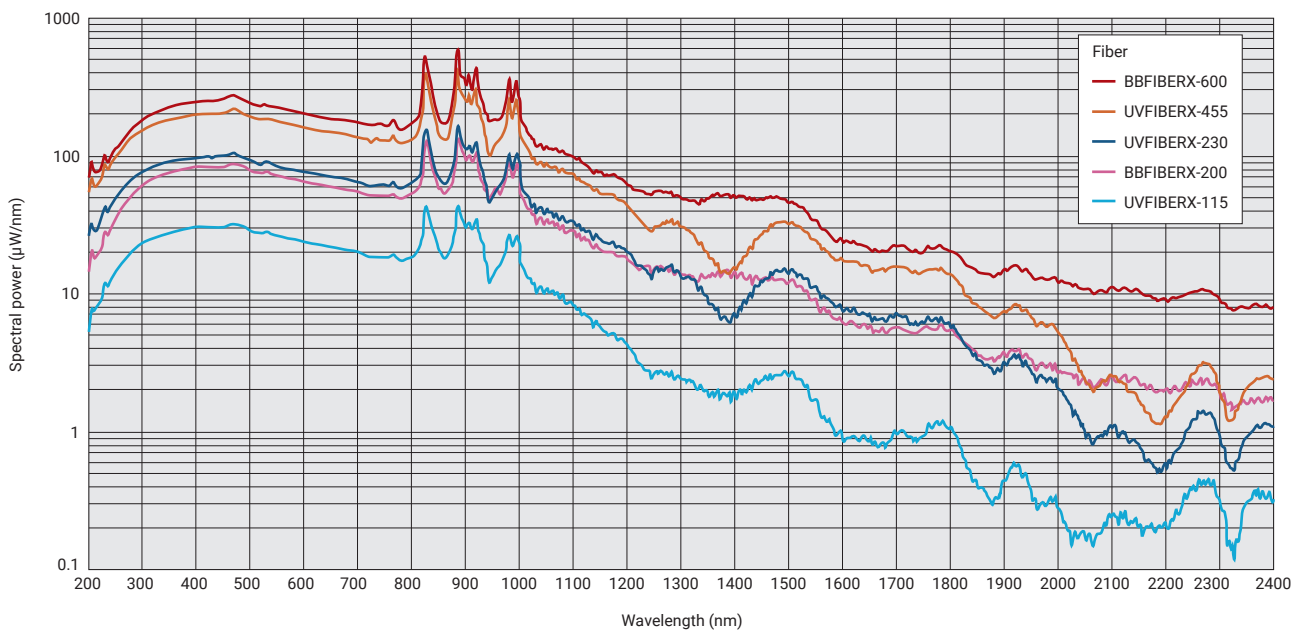
EQ-99X-FC-S

The EQ-99X-FC-S is a fiber-coupled LDLS.

Two types of optical fibers are available for selecting a wavelength range that matches your application. The lamphead of the EQ-99X-FC-S is compact and generates lower heat, making it ideal for experiments in cramped spaces or for installation into equipment. The lamphead is designed to cool by natural convection thus eliminating vibrations caused by cooling fans and ensuring a highly stable light output.



● Broadband optical power



Product standard specifications

Parameter		Description / Value	Unit
Optical interface		Fiber coupled output	-
Wavelength range ①		190 to 2500	nm
Plasma size (FWHM)	Typ.	100 × 180	μm
Numerical aperture	NA	0.22	-
Lifetime	Typ.	10 000	h
Warm-up time		30	min
Laser class		Class 1	-
Broadband optical power ②		95	mW
Output termination		FC or SMA 905	-
Cooling method		No auxiliary cooling required	-
Nitrogen purge		Recommended. Grade 4.8 or higher, filtered to 5 μm. 20 psiG ±2 psiG	-
Applicable standards		EN 61010-1, EN 61326-1, IEC 60825-1, IEC 62471, EN 50581	-
Device configuration		Lamphead, Power supply controller, Remote control, AC adapter, Necessary cables	-
Power rating	Input voltage (AC)	100 to 240	V
	Power frequency	50 / 60	Hz
	Power consumption	175	W

① The optical fiber should be selected according to wavelength range required for the application.

② Optical power from the optical fiber (UVFIBERX-230) was measured with a thermopile.

Fiber

Optical fibers can be selected with the following core diameters, lengths and connector terminations.

Parameter	UV type						Broadband type								Unit
Type	UV FIBERX						BB FIBERX								-
Recommended wavelength range	190 to 900						350 to 2500 ③								nm
Broadband optical power	30		95		195		25		80		180		215		mW
Core size	115		230		455		100		200		400		600		μm
Length	1	2	1	2	1	2	1	2	1	2	1	2	1	2	m
Termination	FC-FC or FC-SMA														-

* The model number of each optical fiber is determined by fiber type, core diameter, length and connector termination.

Example: UVFIBERX-230-1M-FC-SMA (UV type, fiber core diameter: 230 μm, length: 1 m, connector: FC-SMA)

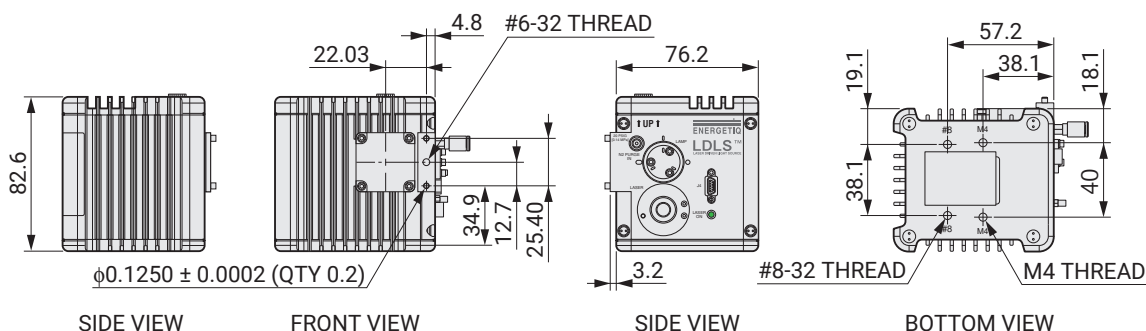
* The EQ-99X-FC must use the above dedicated optical fibers.

Attempting to use any other optical fibers will cause optical fiber connector problems, damage to the lamphead and will affect performance.

③ Although light at wavelengths shorter than 350 nm also passes through the broadband type optical fiber, the fiber transmittance within that wavelength range will drop within a short time. For applications that require UV output, we strongly recommend selecting the UV type optical fiber as they are optimized for that wavelength range.

Dimensional outlines (Unit: mm)

Lamphead



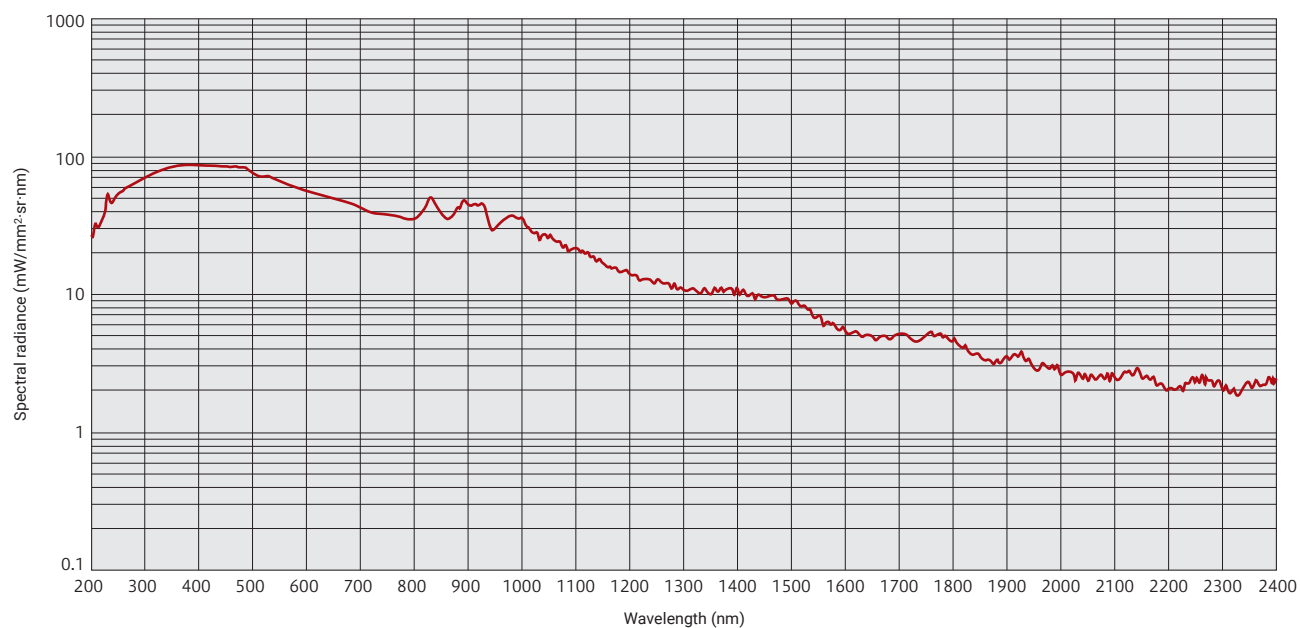
*The controller is same to EQ-99X-QZ-S (P.06).

EQ-77-QZ-S

The EQ-77-QZ-S is a high output power LDLS that produces radiance about 3 times higher than the standard model EQ-99X LDLS. To maintain its high output power, the lamphead requires nitrogen purging and connection to a water cooling chiller.



● Spectral radiance



- ① Dual-beam output mode can be selected as an option. See page 4 for detailed information.
- ② Windows may need to be replaced depending on the extent of contamination and usage conditions.
- ③ YAG (190 nm to 2500 nm) and BK7 (350 nm to 2500 nm) windows are also selectable as options.
- ④ Cooling water conditions Lamphead: ≥ 0.5 L/min, 18 °C to 30 °C, 100 psiG (0.69 MPa) max. inlet pressure Controller: No cooling required
- ⑤ A chiller kit is available as an option.

Technical drawings of the Energetic LDLS™ unit showing dimensions in millimeters (mm).

Side View: Dimensions include 155.2 (height), 131.8 (width), 113 (width of base), and 39.6 (height of base).

Rear View: Dimensions include 241.3 (width) and 56.5 (width of base).

Side View: Dimensions include 78.9 (height) and 56.5 (width of base).

Front View: Dimensions include 298.2 (width) and 7.9 (height of base).

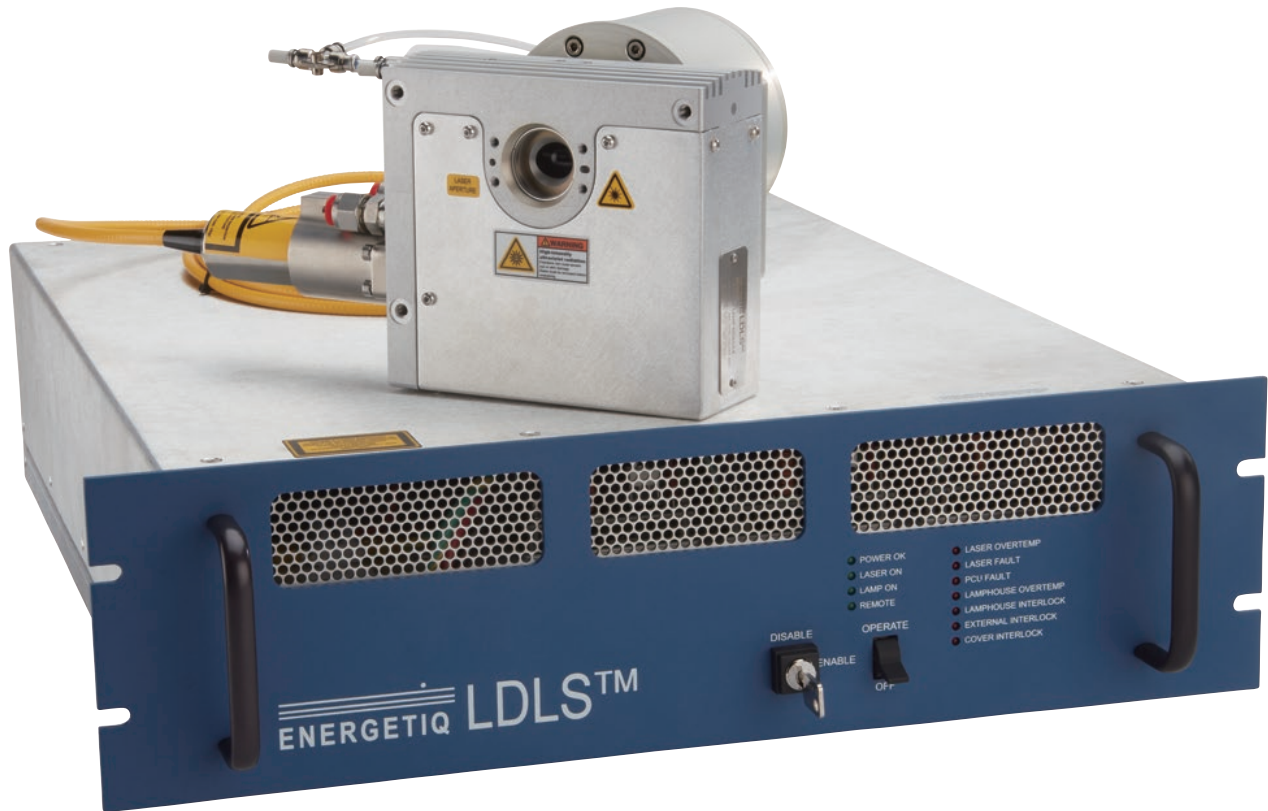
Top View: Dimensions include 249.6 (width) and 113 (width of base).

Bottom View: Dimensions include 279.4 (width), 15.9 (width of base), 28.4 (height of base), 209.6 (width of base), 76.2 (height of base), 9.5 (height of base), 10.2 (height of base), 9.4 (height of base), and 4 x $\phi 6.6$ THRU (mounting holes).

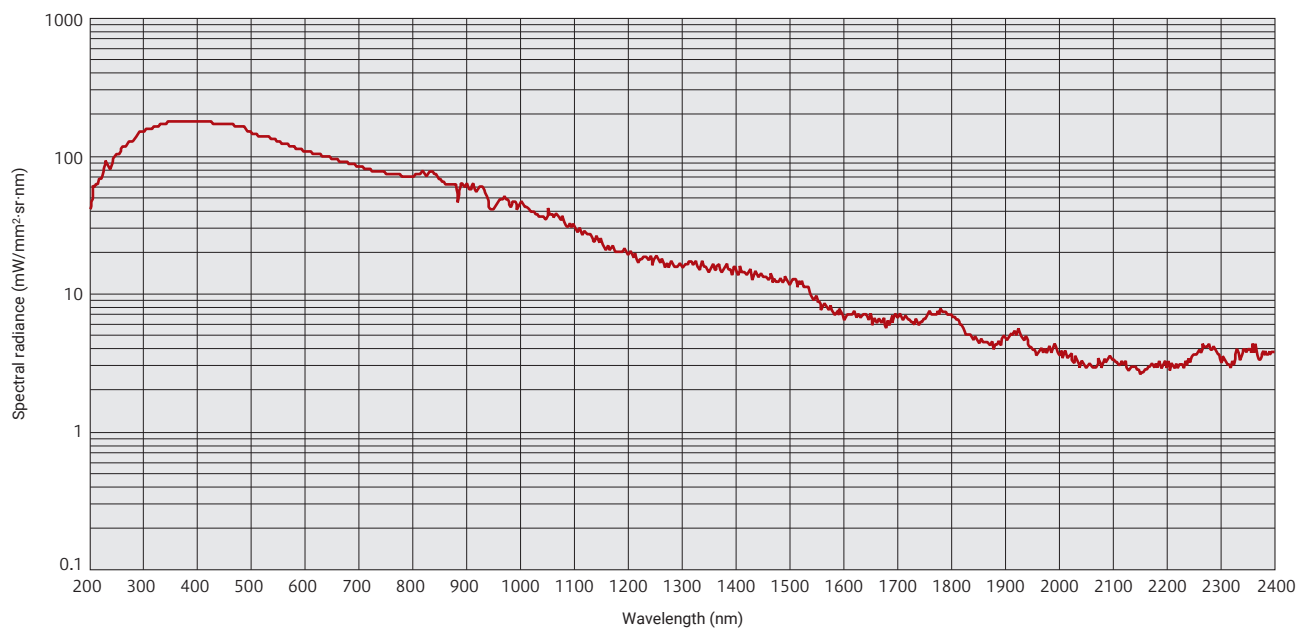
Alternate Mounting: THESE SCREWS AND MOUNTING FEET MAY BE REMOVED TO PROVIDE M5 x 8 DEEP FEMALE THREADS. MAX. TIGHTENING TORQUE NOT TO EXCEED 3.5 N*m

EQ-400-RH-QZ-S

The EQ-400-RH-QZ-S is the highest output power model in our LDLS series. The lamphead and the controller requires forced water cooling to ensure stable operation.



● Spectral radiance



Product standard specifications

Parameter		Description / Value	Unit
Optical interface ^①		Diverging beam (Single beam)	-
Wavelength range		170 to 2500	nm
Plasma size (FWHM)	Typ.	370 × 800	μm
Numerical aperture	NA	0.5	-
Lifetime ^②	Typ.	10 000	h
Warm-up time		30	min
Laser class		Class 4	-
Spectral radiance(at 500 nm)	Typ.	110	mW/mm ² ·sr·nm
Broadband optical power	Typ.	15	W
Output window size		Φ22	mm
Window material ^③		Quartz	-
Cooling method		Water cooling ^{④⑤}	-
Nitrogen purge		Required. Grade 4.8 or higher, filtered to 5 μm. 20 psiG ±2 psiG	-
Applicable standards		EN 61010-1, EN 61326-1, IEC 60825-1, IEC 62471, EN 50581	-
Device configuration		Lamphead, Power supply controller, Necessary cables	-
Power rating	Input voltage (AC)	200 to 240	V
	Power frequency	50 / 60	Hz
	Power consumption	1700	W

① Dual-beam output mode can be selected as an option. See page 4 for detailed information.

② Windows may need to be replaced depending on the extent of contamination and usage conditions.

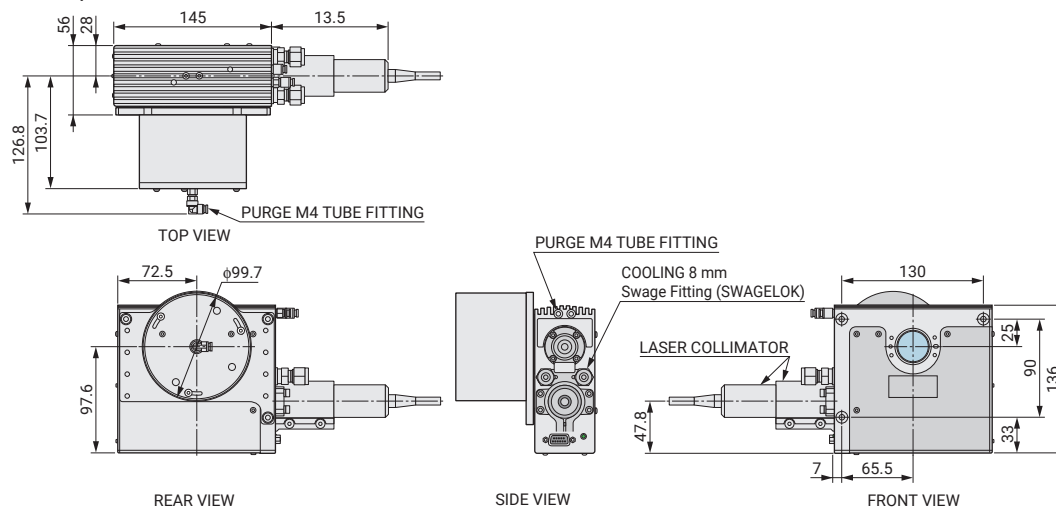
③ BK7 (350 to 2500) windows are also selectable as options.

④ Cooling water conditions Lamphead: 1 L/min, 18 °C to 30 °C, 90 psiG (0.62 MPa) max. inlet pressure
 Controller: 3 L/min to 4 L/min, 18 °C to 24 °C, 90 psiG (0.62 MPa) max. inlet pressure

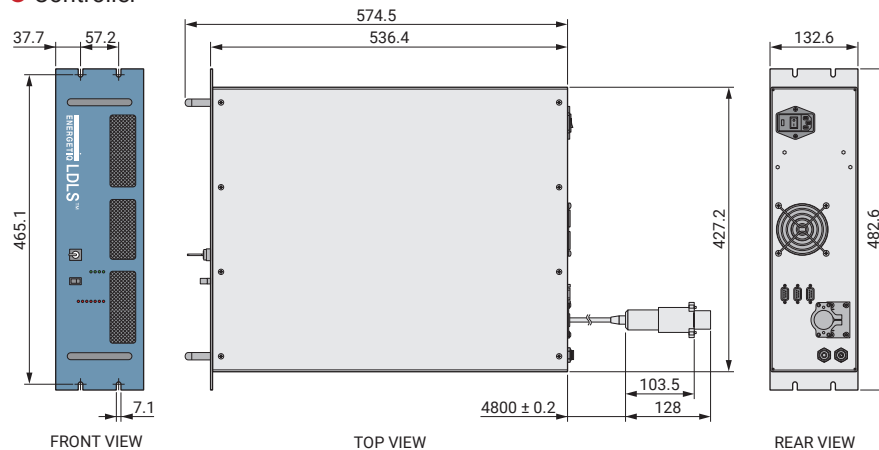
⑤ A chiller kit is available as an option.

Dimensional outlines (Unit: mm)

● Lamphead



● Controller



EQ-99X-CAL-S



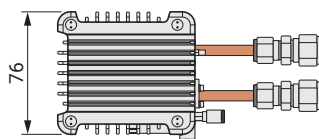
The spectral irradiance of the EQ-99X-CAL-S is calibrated and traced to national standards. Compared to traditional calibrated light sources the EQ-99X-CAL-S features a more stable spectrum and longer lifetime.

Product standard specifications

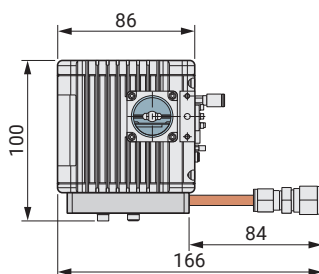
Parameter		Description / Value	Unit
Irradiation wavelength range		170 to 2500	nm
Calibrated wavelength range		200 to 800	nm
Wavelength interval		5	nm
Calibration data		NPL (National Physical Laboratory, UK) traceable	-
Lifetime	Typ.	10 000	h
Laser class		Class 1	-
Recommended recalibration interval		1000 h of operation or 1 year after delivery, whichever comes first	-
Calibration conditions	Lamphead	Nitrogen purge	-
	Cooling method	Water cooling (37 °C)	-
	Irradiation conditions	Diverging beam NA 0.47	-
	Measurement distance	Spectral radiance at a point 200 mm away from the lamphead reference plane	-
Device configuration		Lamphead, Power supply controller, Remote control, AC adapter, Necessary cables	-
Power rating	Input voltage (AC)	100 to 240	V
	Power frequency	50 / 60	Hz
	Power consumption	175	W
Utility	Chiller input voltage	100 ~ 240	V
	Chiller power frequency	50 / 60	Hz
	Chiller power consumption	190	W
Applicable standards		EN 61010-1, EN 61326-1, IEC 60825-1, IEC 62471, EN 50581	-
Nitrogen purge		Recommended. Grade 4.8 or higher, filtered to 5 µm. 20 psiG ±2 psiG	-

Dimensional outlines (Unit: mm)

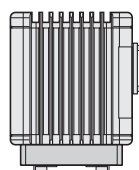
● Lamphead



TOP VIEW



FRONT VIEW



SIDE VIEW

* The controller is same to EQ-99X-QZ-S (P.06).

Precautions for use

● Input ratings

To ensure safe product use, comply with the input ratings and precautions. For instructions on how to operate, refer to the user manual that comes with the product.

● UV light

LDLS emits UV light harmful to eyes and skin. Looking directly at the operating lamp or exposing the skin to light emission may cause inflammation. Always wear light-shielding protective glasses or goggles (JIS T8141 or equivalent safety standards) during operation.

● Ozone

Light emitted from the LDLS output window decomposes oxygen molecules in the air and produces ozone. Provide good ventilation during operation.

● Nitrogen purge

If the LDLS is operated without nitrogen purging, ozone will be generated inside the lamphead. The generated ozone will absorb UV light causing loss of transmittance in the bulb and window thus reducing output in the UV region. Nitrogen purging is strongly recommended and in some cases required for applications that require UV output.

● Replacing the bulb

When the bulb needs to be replaced, return the lamphead along with all other components and accessories to us and we will replace the bulb with a new one (a replacement fee will be charged). Only the bulb in the EQ-99X-QZ-S is replaceable by the customer. Please contact our sales office for detailed information. We do recommend standard maintenance in the form of a bulb and window change once every year or ~10,000 hours.

● Do not disassemble and modify

The internal components of each product are precisely adjusted. Disassembly or modification might not only cause improper operation but also product failure leading to unsatisfactory performance. Never try to disassemble or modify any part of the product.



Warning Caution points regarding laser light exposure

● Laser Class of lasers used in LDLS

Laser-Driven Light Sources (LDLS) listed in this catalog are classified as Class 1 except for the EQ-400 series which is classified as Class 4. Take necessary safety measures according to the laser class of each light source.

● Precautions for exposure to laser light

Before operating the LDLS, confirm the laser product classification defined by IEC 60825-1 (JIS C 6802) and take safety measures that comply with the laser class. Also comply with the latest regulations and safety standards in your own country.

Examples of label

<p>● Class 1 (EQ-99X / EQ-77)</p> <div data-bbox="196 1444 515 1534"><p>CLASS 1 LASER PRODUCT CLASSIFIED PER IEC 60825-1: 2014</p></div> <p>Laser class label</p>	<p>● Class 4 (EQ-400)</p> <div data-bbox="746 1417 989 1563"><p>INVISIBLE LASER RADIATION AVOID EYE OR SKIN EXPOSURE TO DIRECT OR SCATTERED RADIATION CLASS 4 LASER PRODUCT 1070nm 400W CW CLASSIFIED EN/IEC 60825-1: 2014 (2007 USA)</p></div> <p>Laser class label</p> <div data-bbox="1101 1417 1361 1563"><p>CAUTION CLASS 4 INVISIBLE LASER RADIATION WHEN OPEN AND INTERLOCKS DEFEATED, AVOID EYE OR SKIN EXPOSURE TO DIRECT OR SCATTERED RADIATION.</p></div> <p>Warning label</p>
---	---

● Disposal

When disposing of the product, be sure to comply with the local regulations in your country.

Warranty

Products listed in this catalog are warranted for a period of one year from the date of shipment. During the bulb warranty period, we warranty that the light output at 500 nm will not degrade more than 50 % from the initial value under nitrogen purging. The warranty is limited to repair or replacement of the defective product.

Even if within the warranty period this warranty shall not apply to product failures in cases where the product has been misused, altered or damaged by accidents such as due to natural or man-made disasters.

●Manufacturer and seller

LDLS is developed and manufactured by Energetiq Technology, inc. and sold through Hamamatsu sales channel. Please refer to following URL for detailed contacts.
<https://www.energetiq.com/contact-energetiq-and-global-distributors>

Subject to local technical requirements and regulations, availability of products included in this promotional material may vary. Please consult with our sales office.

Information furnished by HAMAMATSU is believed to be reliable. However, no responsibility is assumed for possible inaccuracies or omissions. Specifications are subject to change without notice. No patent rights are granted to any of the circuits described herein. ©2021 Hamamatsu Photonics K.K.

HAMAMATSU PHOTONICS K.K. www.hamamatsu.com

Energetiq Technology

205 Lowell Street, Wilmington, MA, 01887, U.S.A., Telephone: (1) 781-939-0763, Fax: (1) 781-939-0769, E-mail: info@energetiq.com

Electron Tube Division

314-5, Shimokanzo, Iwata City, Shizuoka Pref., 438-0193, Japan, Telephone: (81)539/62-5248, Fax: (81)539/62-2205

U.S.A.: Hamamatsu Corporation: 360 Foothill Road, Bridgewater, NJ 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 Trappu, 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, Jiaxing 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, Section 2, 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

Cat. No.TLSZ1038E01
SEP. 2021 IP