

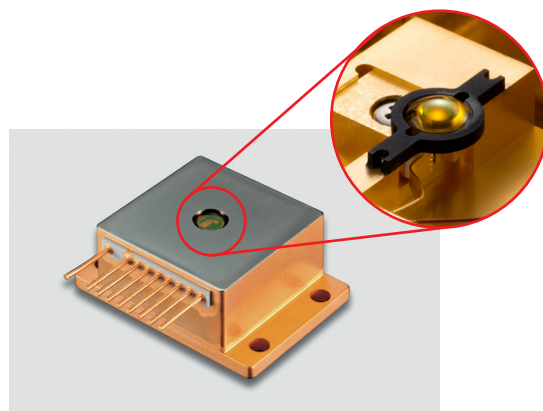
## ■ Features

- Emission wavelength: 4.57  $\mu\text{m}$  (Typ.)
- Output power: 20 mW (Min.)
- Built-in aspherical collimation lens eliminates the need for optical alignment
- Low-reflectivity beam exit window (ZnSe)

\* Please contact a Hamamatsu sales office for the availability of the other wavelength above.

## ■ Applications

- Trace gas analysis ( $\text{N}_2\text{O}$ , CO)



## ■ Outline

The lens integrated package for DFB-CW type QCL is sealed and collimated housing. Internal lens provides collimated output beam radiation. TEC (peltier) and thermistor for temperature stabilization of QCL-laser chip are inside the housing. The lens integrated package allows to use under good usability without beam alignment of invisible mid-infrared laser.

## ■ Absolute maximum rating

$T_{\text{op}(qcl)} = +20\text{ }^{\circ}\text{C}$ , unless otherwise specified.

Characteristic	Symbol	Rating	Unit
Forward current <sup>*1)</sup>	$I_{f\text{max}}$	This product has individual difference. Confirm data sheet attached to a product <sup>*2)</sup>	A
Forward voltage <sup>*1)</sup>	$V_{f\text{max}}$		V
Reverse voltage <sup>*1)</sup>	$V_r$	0.0	V
Rise time of forward current <sup>*3)</sup>	$t_r$	>400	$\mu\text{s}$
Fall time of forward current <sup>*4)</sup>	$t_f$	>400	$\mu\text{s}$
TEC current (cooling mode) <sup>*5)</sup>	$I_c$	+3.7	A
TEC current (heating mode) <sup>*5)</sup>		-1.5	A
TEC voltage	$V_c$	$\pm 13.0$	V
Operating temperature (case) <sup>*6) *7)</sup>	$T_{\text{op}(c)}$	+10 to +60	$^{\circ}\text{C}$
Operating temperature (QCL) <sup>*6) *8)</sup>	$T_{\text{op}(qcl)}$	+5 to +55	$^{\circ}\text{C}$
Change speed of operating temperature <sup>*9)</sup>	-	10 <sup>*10)</sup>	$^{\circ}\text{C}/\text{min}$
Storage temperature <sup>*6)</sup>	$T_{\text{stg}}$	-20 to +65	$^{\circ}\text{C}$

\*1) Confirm data sheet attached to a product. Sensitive to electrical surges and instability. Reverse current/voltage cause damage in laser specifications and out of warranty.

\*2) Necessary specifications of power supply :  $I_r \geq 1.3\text{ A}$ ,  $V_r \geq 16\text{ V}$

\*3) Rise time from sub-threshold to 90 % of the absolute maximum rating of ( $I_{f\text{max}}$ ).

Using this product when rise time of forward current is faster than 400  $\mu\text{s}$  from sub-threshold to 90 % of the absolute maximum rating of ( $I_{f\text{max}}$ ) may cause serious and irreparable damage to this product.

\*4) Fall time from 90 % of the absolute maximum rating of ( $I_{f\text{max}}$ ) to sub-threshold.

Using this product when fall time of forward current is faster than 400  $\mu\text{s}$  from 90 % of the absolute maximum rating of ( $I_{f\text{max}}$ ) to sub-threshold may cause serious and irreparable damage to this product.

\*5) Even if TEC current ( $I_c$ ) is below the absolute maximum, insufficient heat dissipation from this product may cause damage in laser and TEC specifications and out of warranty.

Especially there are possibilities of damage, degradation and less reliability when TEC is operated in heating mode since heated-up side (laser chip) is thermally isolated from case of package and ambience.

\*6) Avoid water condensation.

\*7) Temperatures of case (body) of HHL-package.

\*8) Temperatures of QCL-laser when operated; should be monitored by the built-in thermistor for  $T_{\text{op}(qcl)}$ .

\*9) Speed when changing the temperature ( $T_{\text{op}(qcl)}$ ) controlled by the built-in TEC.

\*10) In conditions of temperature range of the ( $T_{\text{op}(qcl)}$ )  $\geq 5\text{ }^{\circ}\text{C}$ .

# CW Quantum Cascade Laser L12004-2190H-E

## ■ Specification (laser)

Characteristic	Symbol	Condition	Min.	Typ.	Max.	Unit
Operating temperature (QCL) *1)	$T_{op(qcl)}$	$K^{*2)}=2190\text{ cm}^{-1}$	+10	-	+50	°C
Spectral linewidth *3)	$\Delta K_L$	$K^{*2)}=2190\text{ cm}^{-1}$	-	-	0.2 *4)	cm <sup>-1</sup>
Wavenumber tuning range by forward current *5) *6)	$\Delta K_C$	$10\text{ °C} \leq T_{op(qcl)} \leq 50\text{ °C}$	±0.5	-	-	cm <sup>-1</sup>
Wavenumber tuning range by operating temperature *5) *7)	$\Delta K_T$	$I_{th} < I_f < I_{f\text{ max}}$	±1.0	-	-	cm <sup>-1</sup>
Radiant power	$\phi_e$	$K^{*2)}=2190\text{ cm}^{-1}$	20	-	-	mW
Threshold current	$I_{th}$	$T_{op(qcl)}=+20\text{ °C}$	-	-	1.0	A
Side mode suppression ratio	SMSR	$T_{op(qcl)}=+20\text{ °C}$	25 *4)	-	-	dB

\*1) This product is able to emit the target wavenumber at a certain  $T_{op(qcl)}$  within the specified temperature range.

\*2) K: Emission wavenumber (cm<sup>-1</sup>)

\*3) FWHM.

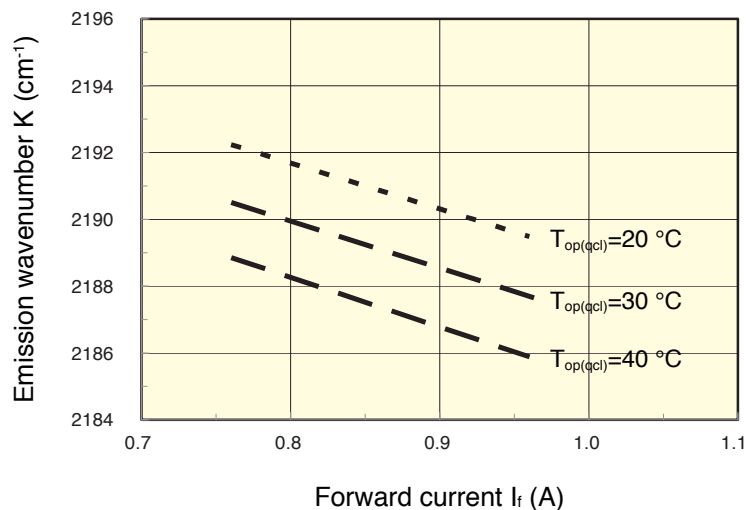
\*4) These values are limited by resolution and signal-to-noise ratio of instrument when tested.

\*5) Center of the tuning range is the emission wavenumber (K).

\*6) At fixed  $T_{op(qcl)}$  specified in the condition. Variable range of  $I_f$  for tuning:  $I_{th} < I_f < I_{f\text{ max}}$ .

\*7) At fixed  $I_f$  specified in the condition. Variable range of  $T_{op(qcl)}$  for tuning:  $10\text{ °C} \leq T_{op(qcl)} \leq 50\text{ °C}$ .

## ■ Characteristics examples



Characteristic	Symbol	Condition	Typical value
Temperature coefficient of wavenumber *1)	$\delta K_T$	$I_f$ fixed	-0.18 cm <sup>-1</sup> /°C
Current coefficient of wavenumber *1)	$\delta K_C$	$T_{op(qcl)}$ fixed	-0.015 cm <sup>-1</sup> /mA

\*1) This product has individual difference. Confirm data sheet attached to a product.

## ■ TEC

Characteristic	Symbol	Condition	Specification
Maximum temperature difference	$\Delta T_{\text{max}}$	$T_h=27\text{ °C}$ , in N <sub>2</sub> , $Q_c=0$ , $I_c=+3.7\text{ A}$	>40 °C
Maximum heat pumping capacity	$Q_{c\text{ max}}$	$T_h=27\text{ °C}$ , in N <sub>2</sub> , $I_c=+3.7\text{ A}$ , $\Delta T=0$	>18 W
AC resistance	ACR	$T_h=27\text{ °C}$ , $I_c=0.1\text{ mA}$ , 1 kHz	2.0 Ω±0.4 Ω

Note)  $\Delta T$ : Temperature difference

Q: Heat pumping capacity

I<sub>c</sub>: TEC current

T<sub>h</sub>: Temperature of TEC's hot side surface (TEC: cooling mode)

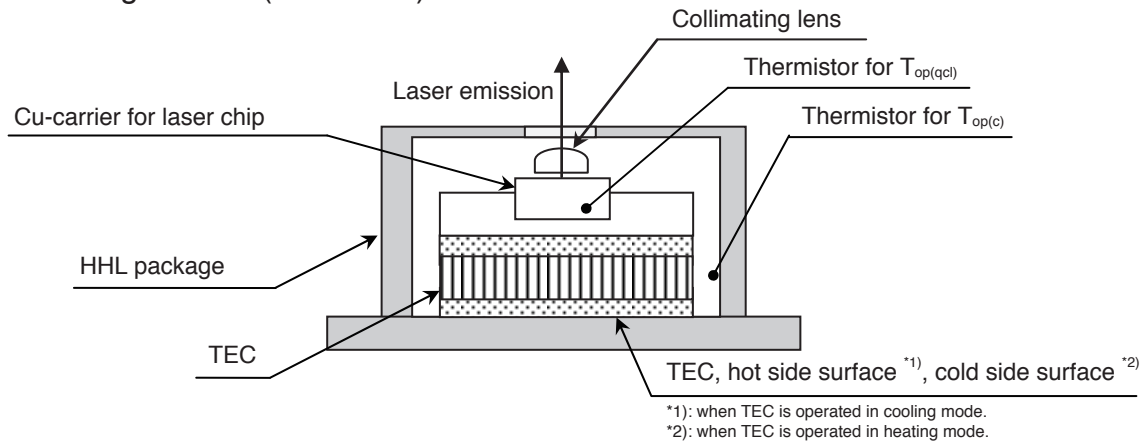
# CW Quantum Cascade Laser L12004-2190H-E

## ■ Thermistor

Characteristic	Symbol	Condition	Specification
Resistance	$R_{25}$	25 °C	10 k $\Omega$ ±2.5 %
Beta value	B	0 °C / 100 °C	3450 K

Note) Same specifications for both thermistors of  $T_{op(qcl)}$  and  $T_{op(c)}$ .

## ■ Thermistors configurations (schematic)



## ■ Window of HHL package

Characteristic		Specification
Material		ZnSe, Plano-Plano
Dimension	Clear aperture *1)	$\phi$ 4.4 mm
	Thickness	0.7 mm
Coating	Coating	BBAR, both surface

\*1) Mechanical aperture of HHL package

## ■ Output beam

Characteristic	Symbol	Condition	Min.	Typ.	Max.	Unit
Beam spread angle *1) *2)	$\theta$	$T_{op(qcl)}=+20$ °C	0	3	5	mrad
Beam waist position *1) *3)	$Z_{w0}$	$T_{op(qcl)}=+20$ °C	50	-	1000	mm
Beam waist width *1) *4)	$W_0$	$T_{op(qcl)}=+20$ °C	0.5	1.5	3	mm

\*1) This product has individual difference. Confirm data sheet attached to a product.

\*2) Half angle. Larger spread angle either vertical direction (vertical to pins of package) or horizontal direction (horizontal to pins of package).

\*3) From package top surface.

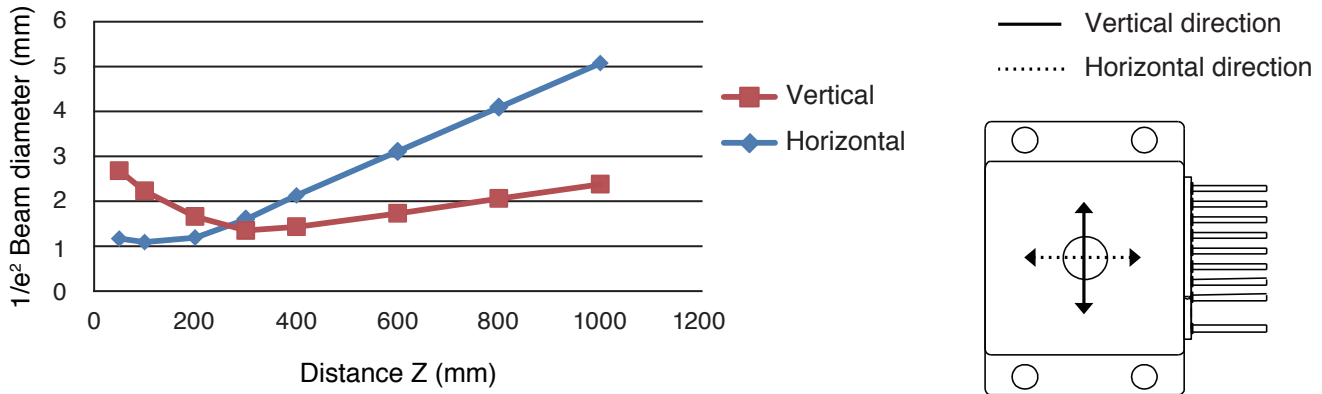
\*4)  $1/e^2$  beam diameter.

## ■ Necessary specifications of power supply for the laser (QCL)

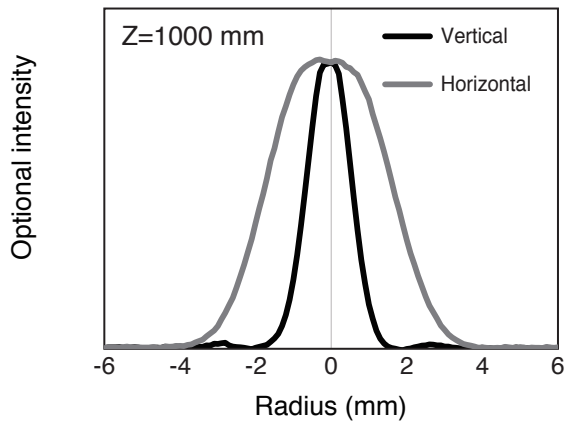
Characteristic	Specification
Output current	$\geq 1.3$ A
Output voltage	$\geq 16$ V
Function	Surge protect
	Constant current control

# CW Quantum Cascade Laser L12004-2190H-E

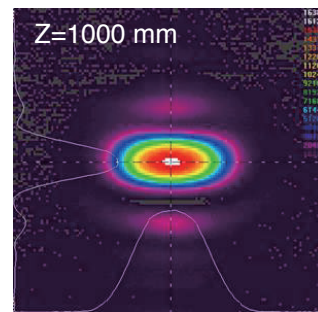
## Example of typical characteristics of beam divergence of output beam



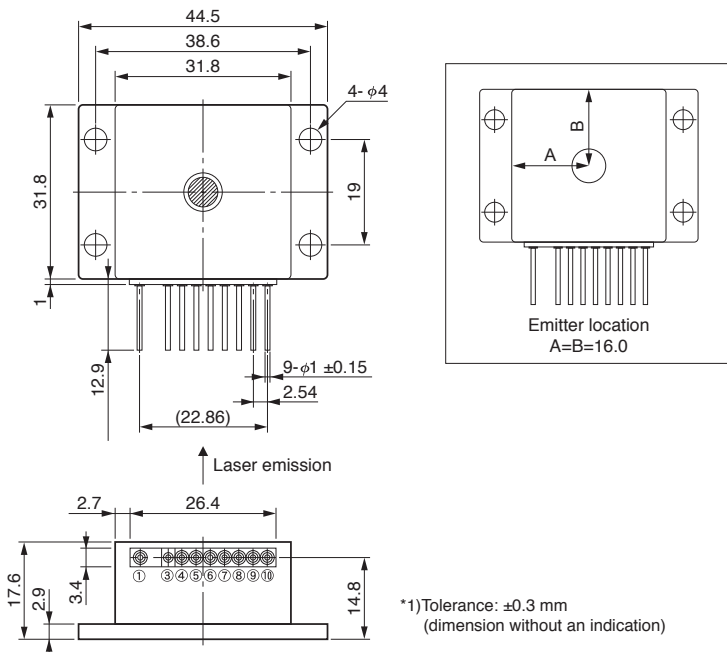
## Example of beam intensity distribution



## Example of typical beam profile



## Dimensional outline (unit: mm)



Pin No. *2)	Function
①	TEC cathode (-)
③	N.C.
④	QCL anode (+)
⑤	Thermistor ( $T_{op(qcl)}$ )
⑥	Thermistor ( $T_{op(qcl)}$ )
⑦	QCL cathode (-)
⑧	Thermistor ( $T_{op(c)}$ )
⑨	Thermistor ( $T_{op(c)}$ )
⑩	TEC anode (+)

\*2) Pin of ③ is electrically connected to the case; package body. Other all pins are floating to the case.

# HAMAMATSU PHOTONICS K.K. [www.hamamatsu.com](http://www.hamamatsu.com)

HAMAMATSU PHOTONICS K.K., Laser Group, Sales Dept.

1-8-3, Shinmiyakoda, Kita-ku, Hamamatsu City, Shizuoka, 431-2103, Japan, Telephone: (81)53-484-1301, Fax: (81)53-484-1302, E-mail: laser-g@lsr.hpk.co.jp

U.S.A.: Hamamatsu Corporation: 360 Foothill Road, Bridgewater, N.J. 08807-0910, 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, D-82211 Herrsching am Ammersee, Germany, Telephone: (49)8152-375-0, Fax: (49)8152-2658 E-mail: info@hamamatsu.de

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

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

North Europe: Hamamatsu Photonics Norden AB: Torshamnsgatan 35 SE-164 40 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, 20020 Arese (Milano), Italy, Telephone: (39)02-93581733, Fax: (39)02-93581741 E-mail: info@hamamatsu.it

China: Hamamatsu Photonics (China) Co., Ltd.: B1201 Jiaming Center, No.27 Dongsanhuan Beilu, Chaoyang District, Beijing 100020, China, Telephone: (86)10-6586-6006, Fax: (86)10-6586-2866 E-mail: hpc@hamamatsu.com.cn

Taiwan: Hamamatsu Photonics Taiwan Co., Ltd.: 8F-3, No.158, Section2, Gongdao 5th Road, East District, Hsinchu, 300, Taiwan R.O.C. Telephone: (886)03-659-0080, Fax: (886)07-811-7238 E-mail: info@tw.hpk.co.jp