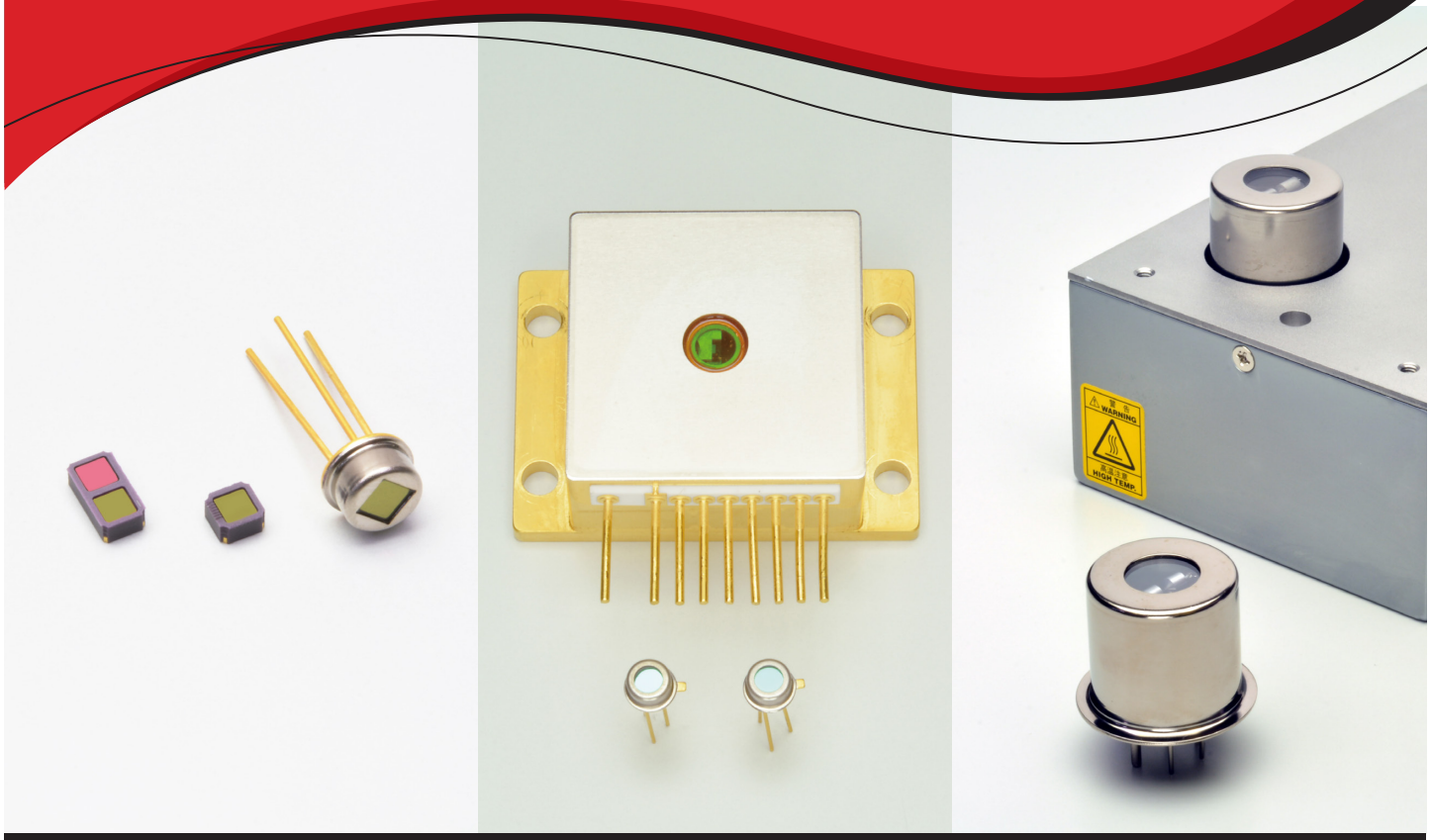
Gas measurement devices



Wide lineup of light sources and detectors mainly in the infrared region suitable for gas measurements
A light source and a detector can be provided as a product set.

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Gas detection methods and principles

There are two main methods of gas measurement using light. One method uses ultraviolet light, and the other uses infrared light. Gas molecules have unique absorption wavelengths. Gas density is measured by measuring their absorbances. Particularly in the infrared region, there are many absorption wavelengths specific to gas attributable to the vibration of gas molecules. As such, the method is used in various gas measurements, like other detection methods.

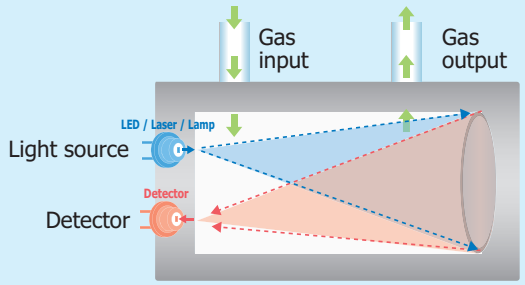
Features	Solid sensor catalytic combustion type	Solid sensor semiconductor type	Electrochemical sensor type	Infrared optical sensor type
Principle	Temperature rise detection during flammable gas combustion	Detection of absorption O_2 ion change on metal oxide semiconductor surfaces	Detection of current changes due to gas electrolysis	Detection of the gas's infrared absorption
Accuracy	☆☆☆	☆☆	☆☆☆	☆☆☆
Service life	☆☆	☆☆☆	☆☆☆	☆☆☆☆
Response	☆☆	☆☆☆	☆☆	☆☆☆
Price	☆☆	☆☆☆	☆☆	☆☆

Unlike other detection methods, infrared optical sensor types allow measurement without the sensor itself making direct contact with the gas. This makes them suitable for inline and high-purity gas measurements. They can even detect gas in remote locations.

There are two types of infrared optical sensors: dispersive and non-dispersive (NDIR). The dispersive type measures by separating the irradiated infrared into wavelength components using a diffraction grating or the like. It can measure various types of gases, but because it requires diffraction grating and the like, the equipment is relatively large. In contrast, the non-dispersive type does not separate infrared into wavelength components. A light source or filter that corresponds to the absorption wavelengths of the relevant gas is required, but it excels in gas selectivity. The infrared optical sensor type (especially the non-dispersive type) allows gas detection with high performance, high sensitivity, high reliability, and long lifetime due to the characteristics of the device that is used.

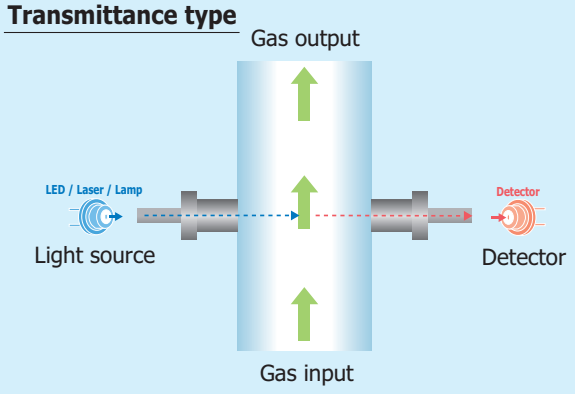
Images of light source and detector combinations

Reflective type



Further minute level of gas can be detected by making the reflection path longer.

Transmittance type

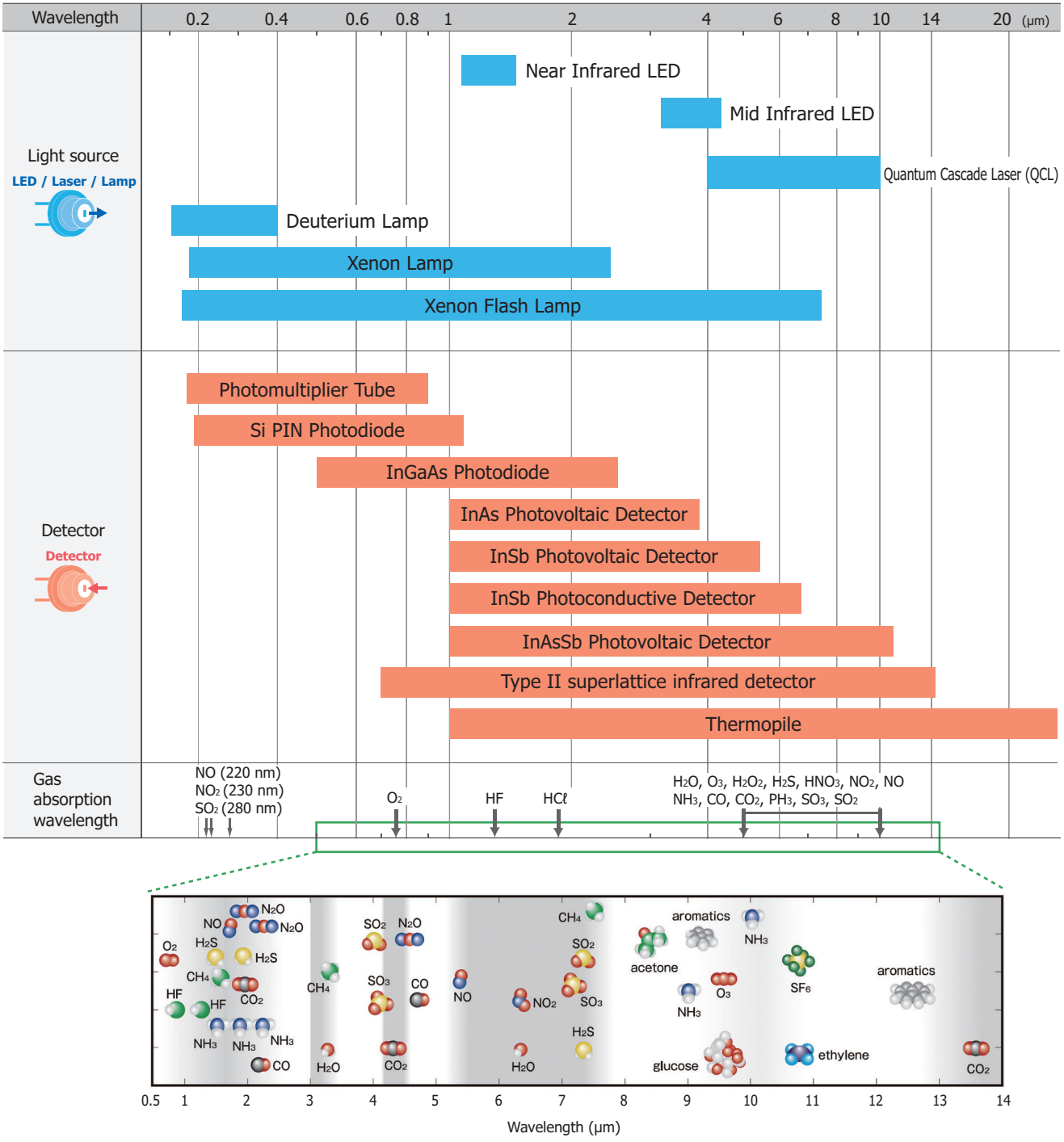


Used to measure relatively high-density gases. As the sensor does not make direct contact with the gas, it is suitable for inline gas measurement.

Light sources and detectors and gas absorption wavelengths

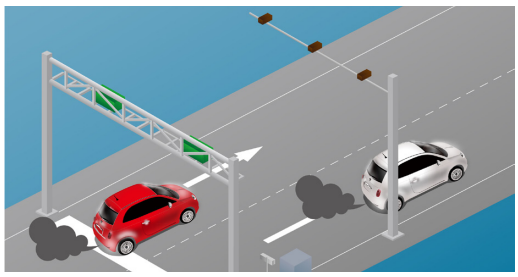
Hamamatsu Photonics provides various light sources and detectors for optical gas measurement from the ultraviolet to the infrared region. We offer optimal combinations according to your application.

Lineup of light sources and detectors



Applications

Exhaust gas measurement (automobile)

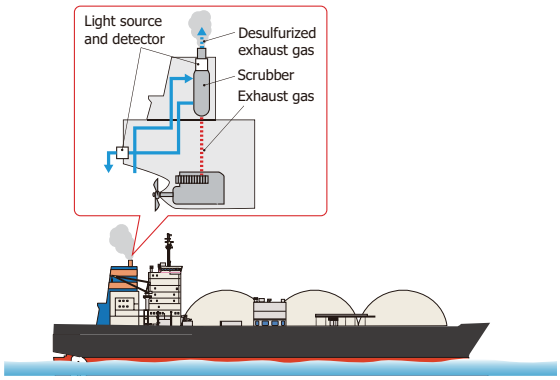


Real-time monitoring of automotive exhaust gas

CO_2 measurement in plant factories

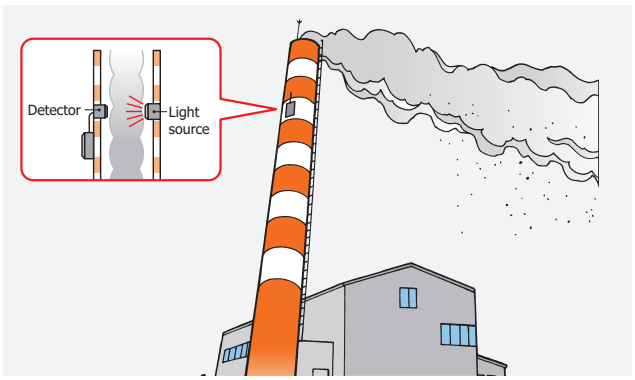
Concentration measurement of CO_2, which is required in the photosynthesis of plants

Exhaust gas measurement (ship)



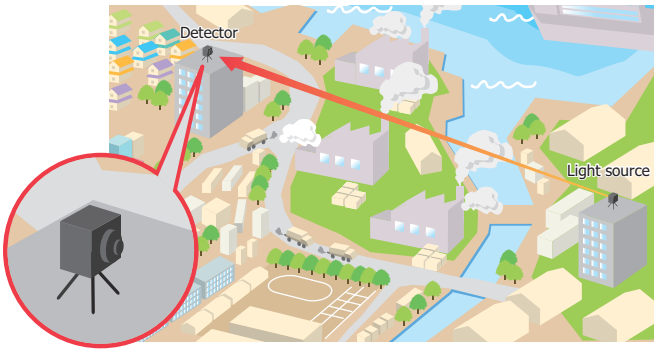
Concentration monitoring of SOx included in ship exhaust gas

Flue monitor



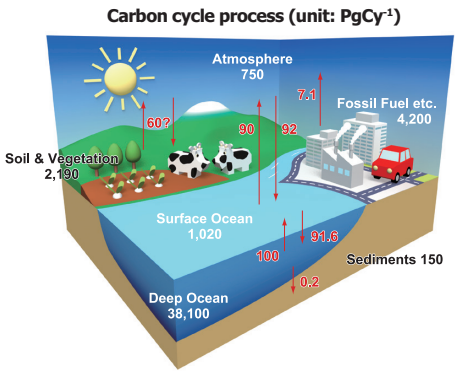
Analysis of SOx and NOx in gases emitted from factories and the like

Air quality monitoring (SOx, NOx, etc.)



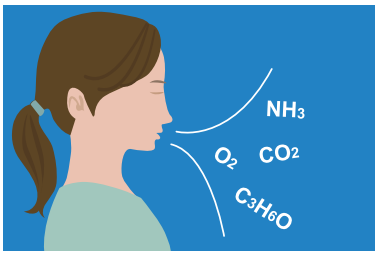
Analysis of pollutant gases in the atmosphere

Isotope analysis for carbon dating



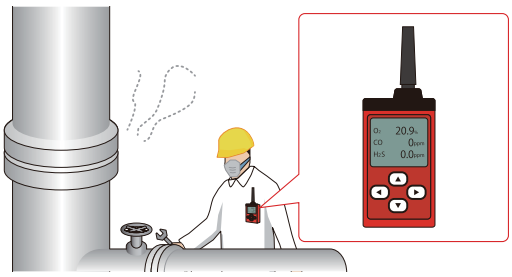
CO_2 isotope analysis using the cavity ring-down method

Exhaled breath analysis



Early detection of lifestyle disease and other health problems through exhaled air analysis

Portable gas sensor



Gas leak detection at factories and other work sites

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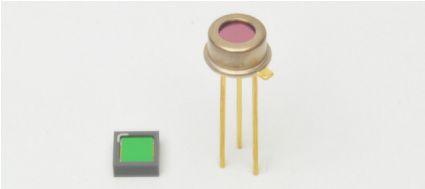
Infrared light sources and detectors

Selection of light sources and detectors

■ Light sources

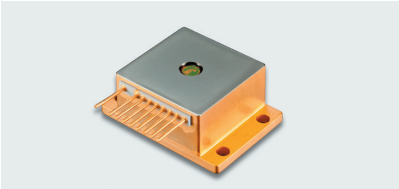
Mid Infrared LED (MWIR-LED)



- Wavelength: 3.3 µm (CH_4), 3.9 µm (reference light), and 4.3 µm (CO_2) are provided.
- Higher reliability, lower power consumption, faster response than lamps

⇒ For relatively simple sensors

Quantum Cascade Laser (QCL)



- Wavelength: 4 µm to 10 µm band
- High resolution, high output, high reliability, high directivity

⇒ For trace gas sensing

Xenon Flash Lamp (Xe-F)

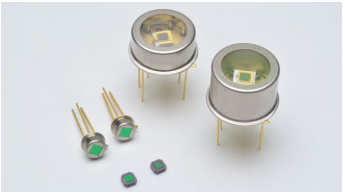
- Wavelength: 0.16 µm to 7.5 µm (continuous spectrum)
- High output pulse emission in the microsecond order
- Long life

⇒ For multiple gas detection

Light source	Wavelength range	Output	Time response characteristics	Power consumption	Lifetime	Price
MWIR-LED	Narrow	☆☆	☆☆☆	☆☆☆	☆☆☆	☆☆☆
QCL	Line spectrum	☆☆☆☆	☆☆☆	☆☆	☆☆	☆
Xe-F	Wide	☆☆☆☆	☆☆	☆	☆☆	☆☆
Filament Lamp	Wide	☆☆	☆	☆	☆☆	☆☆☆☆

■ Detectors

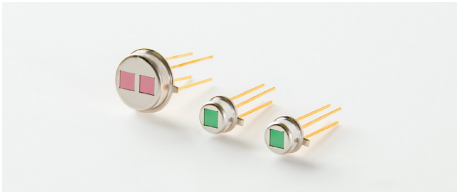
Quantum type detector (InAsSb photovoltaic detector, Type II superlattice infrared detector)



- High sensitivity, high-speed response

⇒ For relatively simple sensors Used in pairs with an LED
For applications that require relatively high accuracy Used in pairs with a QCL

Thermal type detector (thermopile)

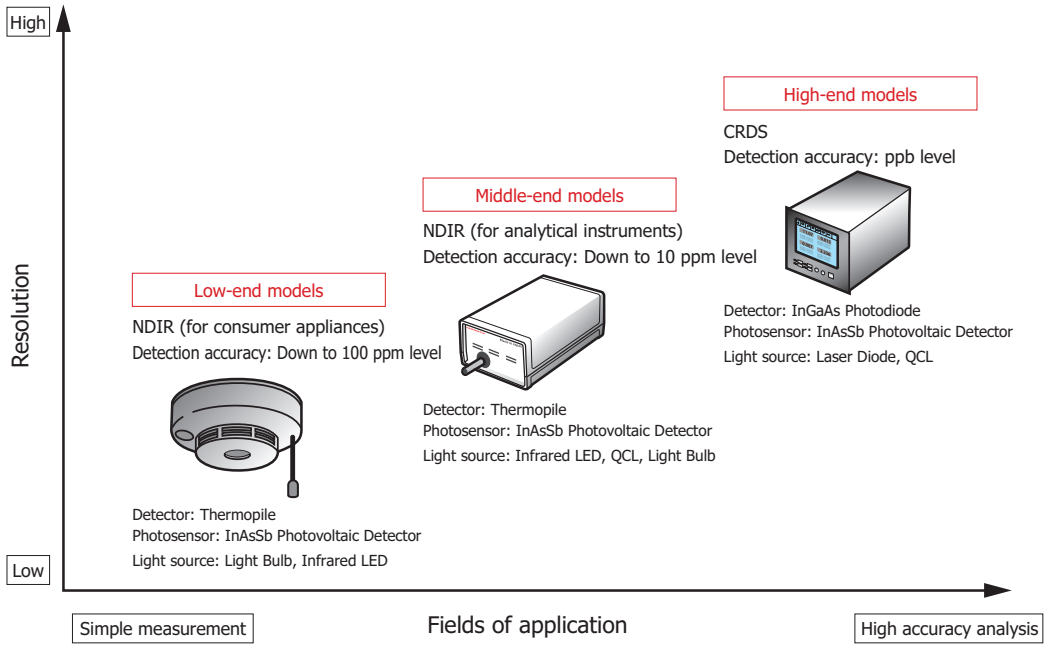


- Covers a wide wavelength range, inexpensive
- Can support band-pass filters for CH_4, CO_2, and reference light

⇒ For relatively low-end applications

Detector	Sensitivity	Wavelength dependence	Time response characteristics	Cooling	Price
Quantum type detector	☆☆☆	Yes	☆☆☆	Cooling (partially not required)	☆☆
Thermal type detector	☆☆	None	☆☆	Non-cooled	☆☆☆

CO_2 gas measuring instrument groups and detector examples



Gas absorption wavelengths and examples of light source (LED, QCL) and detector (InAsSb photovoltaic detector) combinations

■ LED

Wavelength	Gas	LED	Detector
3.3 µm	CH_4	L13771-0330M/C	P13243 series P11120 series
4.3 µm	CO_2	L13201-0430M/C	

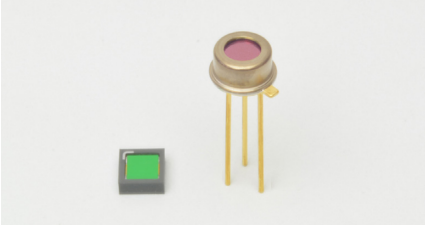
■ QCL

Wavelength	Gas	QCL		Detector
		DFB-CW type	DFB-pulse type	
4.3 µm	$^{12}CO_2/^{13}CO_2$	L12004-2310H-C	-	P13243 series P11120 series
4.48 µm	N_2O, CO, CO_2	-	L12014-2231T-C	
4.53 µm	N_2O	L12004-2209H-C	-	
4.57 µm	N_2O, CO	L12004-2190H-C	-	
5.26 µm	NO	L12005-1900H-C	L12015-1901T-C	
6.13 µm	NO_2	L12006-1631H-C	L12016-1630T-C	P12691-201G
7.18 µm	SO_3	L12007-1392H-C	-	
7.39 µm	SO_2	L12007-1354H-C	-	
7.73 µm	$^{12}CH_4/^{13}CH_4$	L12007-1294H-C	-	
7.82 µm	CH_4, N_2O	-	L12017-1278T-C	
9.0 µm	NH_3	-	-	P13894 series
9.6 µm	O_3	-	-	
10.07 µm	NH_3	-	L12020-0993T-C	

Note: It does not guarantee that detection is possible.

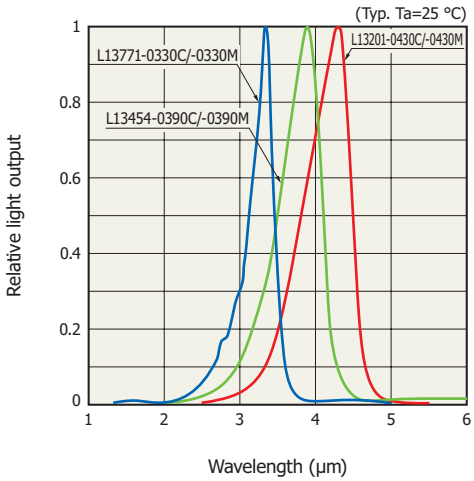
Light source

Mid Infrared LED (MWIR-LED)

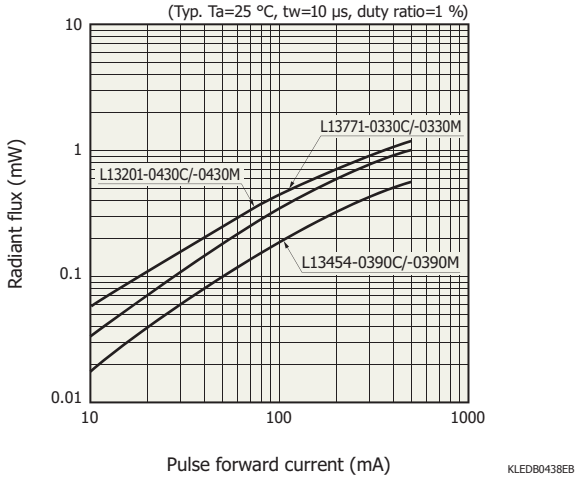


The MWIR-LED is a high output LED with a peak emission wavelength in the middle infrared region. We offer metal packages, and compact ceramic packages for peak emission wavelengths 3.3, 3.9, and 4.3 µm. For detectors, use InAsSb photovoltaic detectors or other quantum type detectors.

Emission spectrum



Radiant flux vs. pulse forward current



L13771-0330C, L13771-0330M (3.3 µm peak emission wavelength)

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
Peak emission wavelength	λp	I_F=50 mA, QCW mode*	3.1	3.3	3.4	µm
Spectral half width	Δλ	I_F=50 mA, QCW mode*	-	300	500	nm
Radiant flux	Φe	I_F=50 mA, QCW mode*	0.15	0.25	-	mW
Forward voltage	VF	I_F=50 mA, QCW mode*	-	2.1	2.5	V
Reverse current	IR	V_R=0.1 V	-	-	500	µA
Rise time	tr	10 to 90%	-	-	1	µs

L13454-0390C, L13454-0390M (3.9 µm peak emission wavelength)

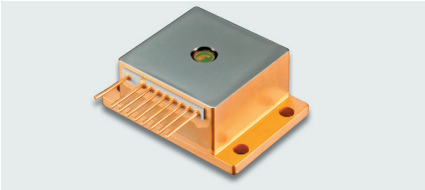
Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
Peak emission wavelength	λp	I_F=80 mA, QCW mode*	3.8	3.9	4.1	µm
Spectral half width	Δλ	I_F=80 mA, QCW mode*	-	500	800	nm
Radiant flux	Φe	I_F=80 mA, QCW mode*	0.1	0.2	-	mW
Forward voltage	VF	I_F=80 mA, QCW mode*	-	1.7	2.1	V
Reverse current	IR	V_R=0.1 V	-	-	1000	µA
Rise time	tr	10 to 90%	-	-	1	µs

L13201-0430C, L13201-0430M (4.3 µm peak emission wavelength)

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
Peak emission wavelength	λp	I_F=80 mA, QCW mode*	4.1	4.3	4.4	µm
Spectral half width	Δλ	I_F=80 mA, QCW mode*	-	700	1000	nm
Radiant flux	Φe	I_F=80 mA, QCW mode*	0.15	0.3	-	mW
Forward voltage	VF	I_F=80 mA, QCW mode*	-	1.6	2.0	V
Reverse current	IR	V_R=0.1 V	-	-	1000	µA
Rise time	tr	10 to 90%	-	-	1	µs

* QCW: Quasi Continuous Wave

CW Quantum Cascade Lasers



HHL package

Quantum Cascade Lasers, which emit single mode mid-IR laser beam under the room temperature by employing Single Phonon Resonance-Continuum Depopulation (SPC) and Distributed Feedback (DFB) structures.
By controlling the chip's operating temperature through the Peltier element installed in the HHL package, it is possible to tune the emission wavelength without mode hopping while keeping longitudinal single mode operation.

Common specifications

Operating temperature (QCL)*1		Line width*2	Tunable range*3	Output power	Threshold current	Side-mode suppression ratio (SMSR)
Min.	Max.	Max.	Min.	Min.	Max.	Min.
+10 °C	+50 °C	0.2 cm^{-1} *4	±1.0 cm^{-1}	20 mW	1.0 A	25 dB
Condition: Emission wavenumber (cm^{-1})*5					Condition: Top(qcl)=20 °C	

*1: This specifies the temperature range within which the target emission wavenumber (K) can be realized.
*2: Full-width half maximum
*3: This specifies the continuous tunable range (without mode hopping). The center wavenumber of the tuning range is the emission wavenumber (K).
*4: The figures are limited by the resolution and signal/noise ratio of the measuring instruments used.
*5: Refer to the lineup table

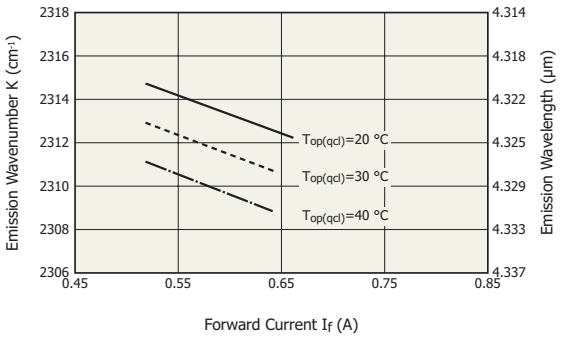
Lineup

Type No.	Wavelength	Wavenumber	Target gas
L12004-2310H-C	4.33 µm	2310 cm^{-1}	CO_2, CO_2 isotope
L12004-2209H-C	4.53 µm	2209 cm^{-1}	N_2O
L12004-2190H-C	4.57 µm	2190 cm^{-1}	N_2O, CO
L12005-1900H-C	5.26 µm	1900 cm^{-1}	NO
L12006-1631H-C	6.13 µm	1631 cm^{-1}	NO_2
L12007-1392H-C	7.18 µm	1392 cm^{-1}	SO_3
L12007-1354H-C	7.39 µm	1354 cm^{-1}	SO_2
L12007-1294H-C	7.73 µm	1294 cm^{-1}	CH_4

* Please make contact with the Hamamatsu sales office about QCLs with emission wavelengths not listed above.

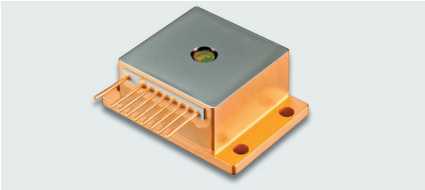
Characteristics examples

●L12004-2310H-C



Parameter	Symbol	Condition	Typical value
Temperature coefficient of wavenumber	δKT	If=fixed	-0.18 cm^{-1}/°C
Current coefficient of wavenumber	δKC	Top(qcl)=fixed	-0.017 cm^{-1}/mA

CW Quantum Cascade Laser (built-in lens)



HHL package

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.

Common specifications

Operating*1 temperature (QCL)		Line width*2	Tunable*3 range	Output power	Threshold current	Side-mode suppression ratio (SMSR)	*4 *5 Beam spread angle	*4 *6 Beam waist location		*4 *7 Width of beam at waist
Min.	Max.	Max.	Min.	Min.	Max.	Min.	Typ.	Min.	Max.	Typ.
+10 °C	+50 °C	0.2 cm^{-1} *8	±1.0 cm^{-1}	20 mW	1.0 A	25 dB	3 mrad	50 mm	1000 mm	1.5 mm
Condition: Emission wavenumber (cm^{-1})*9					Condition: Top(qcl)=20 °C					

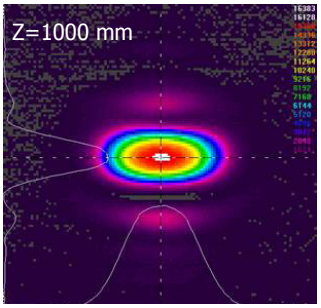
*1: This specifies the temperature range within which the target emission wavenumber (K) can be realized.
*2: Full-width half maximum
*3: This specifies the continuous tunable range (without mode hopping). The center wavenumber of the tuning range is the emission wavenumber (K).
*4: This product has individual difference. Confirm date sheet attached to a product.
*5: Half angle beam spread from the perpendicular (Fast) direction (perpendicular to pins) or horizontal (Slow) direction (parallel to pins), whichever is wider.
*6: From package top surface
*7: $1/e^2$ beam radius
*8: The figures are limited by the resolution and signal/noise ratio of the measuring instruments used.
*9: Refer to the lineup table

Lineup

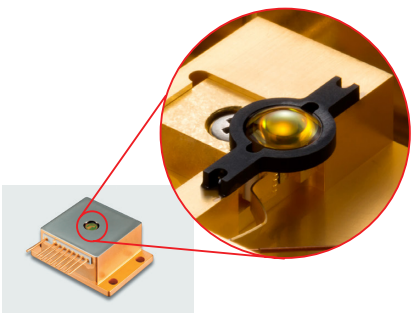
Type No.	Wavelength	Wavenumber	Target gas
L12004-2310H-E	4.33 µm	2310 cm^{-1}	CO_2, CO_2 isotope
L12004-2190H-E	4.57 µm	2190 cm^{-1}	N_2O, CO
L12005-1900H-E	5.26 µm	1900 cm^{-1}	NO
L12006-1631H-E	6.13 µm	1631 cm^{-1}	N_2O

* Please contact a Hamamatsu sales office about QCLs with emission wavelengths not listed above.

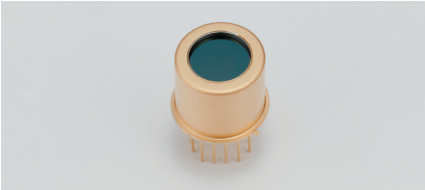
Typical beam profile



Built-in lens



Pulsed Quantum Cascade Lasers



TO-8 package

Quantum Cascade Lasers, which emit single mode mid-IR laser beam under the room temperature by employting Single Phonon Resonance-Continuum Depopulation (SPC) and Distributed Feedback (DFB) structures.
By controlling the chip's operating temperature through the Peltier element installed in the TO-8 package, it is possible to tune the emission wavelength without mode hopping while keeping longitudinal single mode operation.

Common specifications

Operating temperature (QCL)*1		Line width*2	Tunable range*3	Pulsed output power	Threshold current	Side-mode suppression ratio (SMSR)
Min.	Max.	Max.	Min.	Min.	Max.	Min.
-10 °C	+50 °C	0.2 cm^{-1} *4	±1.0 cm^{-1}	50 mW	1.5 A	25 dB
Condition: Emission wavenumber (cm^{-1})*5						

Standard driving conditions: t_w=50 ns, f_r=200 kHz, $T_{op(qcl)}$=20 °C
*1: This specifies the temperature range within which the target emission wavenumber (K) can be realized.
*2: Full-width half maximum
*3: This specifies the continuous tunable range (without mode hopping). The center wavenumber of the tuning range is the emission wavenumber (K).
*4: The figures are limited by the resolution and signal/noise ratio of the measuring instruments used.
*5: Refer to the lineup table

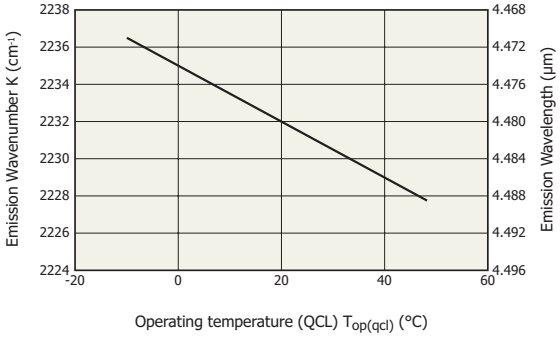
Lineup

Type No.	Wavelength	Wavenumber	Target gas
L12014-2231T-C	4.48 µm	2231 cm^{-1}	N_2O, CO, CO_2
L12015-1901T-C	5.26 µm	1901 cm^{-1}	NO
L12016-1630T-C	6.13 µm	1630 cm^{-1}	NO_2
L12017-1278T-C	7.82 µm	1278 cm^{-1}	CH_4, N_2O
L12020-0993T-C	10.07 µm	993 cm^{-1}	NH_3

* Please contact a Hamamatsu sales office about QCLs with emission wavelengths not listed above.

Characteristics examples

●L12014-2231T-C



Parameter	Symbol	Condition	Typical value
Temperature coefficient of wavenumber	δKT	Ifp=fixed	-0.15 cm^{-1}/°C

Xenon flash lamp (IR-XEF)

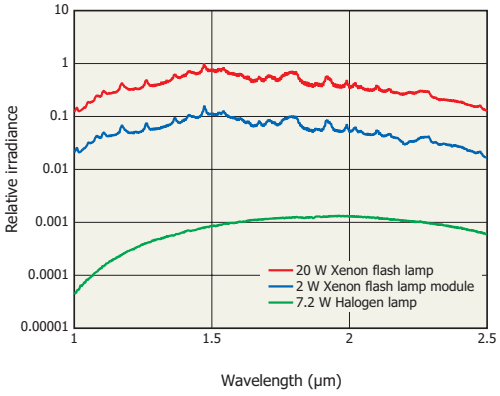
L13651 series, L12745 series

Xenon flash lamp modules allow to choose the most suitable radiation wavelength from various window material including the MgF_2 window material type practicable for measurement of the mid-infrared area. Use of a new electrode ensures highly stable operation and minimal wear even at high energy input, achieving 1.2 times higher light output intensity, 1.5 times light output stability, and 2 times longer lifetime than other manufacturers' lamps.
We can also provide xenon flash lamps separately. Running a standalone lamp requires a dedicated trigger socket and power supply. (See P.18.)

Parameter	2 W type (L13651 series)				20 W type (L12745 series)			Unit
Suffix	-01-3	-02-3	-03-3	-04-3	-01-3	-02-3	-03-3	-
Arc size	1.0				1.5			mm
Window material	MgF_2				MgF_2			-
Spectral distribution	0.16 to 7.5				0.16 to 7.5			μm
Recommended main discharge voltage	400 to 600				400 to 1000			V
Main discharge capacitance	0.141	0.094	0.047	0.02	0.64	0.32	0.1	μF
Maximum lamp energy (1 flash) *1	25.4	16.9	8.5	3.6	320.0	160.0	50.0	mJ
Maximum average lamp input (continuous) *2	2				20			W
Light output stability (Typ.)*3	0.5				0.5			% CV
Guaranteed life*4	1×10^9				1×10^9			flashes
Cooling method	Not required				Not required			-

*1: $E=1/2\ CV^2$ E: Maximum lamp energy (J) C: Main discharge capacitance (F) V: Main discharge voltage (V)
*2: $W=E \times f$ W: Maximum average lamp input (continuous) (W) f: Lamp light emission repetition frequency
*3: Light output stability is given by: Light output stability (% CV) = light output standard deviation / average light output × 100 (when repetition rate is 10 Hz or more)
*4: The service life is defined for 2 W operation for the 2 W type and 20 W operation for the 20 W type. It is defined as when the light output at 0.19 μm to 1.1 μm is reduced to 50% of the initial value or when the light output stability exceeds 2.0%CV.

Spectral distribution (Typ.)



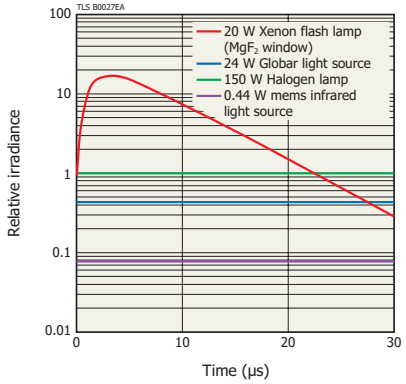
Measurement conditions
Detector: Spectrometer NIRQuest512-2.5 made by Ocean Optics
(Slit width: 25 μm, integration time: 1 ms)
Optical fiber: MF11L1 made by Thorlabs
(Core diameter: 100 μm,
InF_3 transmission wavelength range: 0.3 μm to 5.5 μm)

* Light output depends on detector sensitivity.
Use this data as a reference for comparison with other infrared light sources.
* Light output of halogen lamp is corrected to peak irradiance of xenon flash lamp (flash duration: Approx. 6 μs)

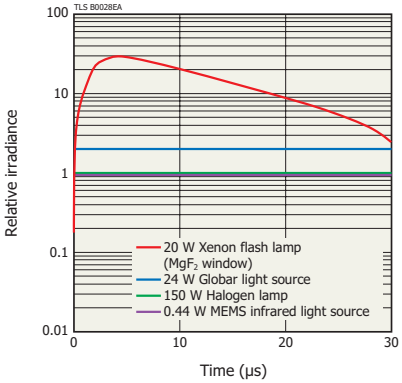
Emission pulse waveform (Typ.)

* The waveform measurement setup is carried in P.18.

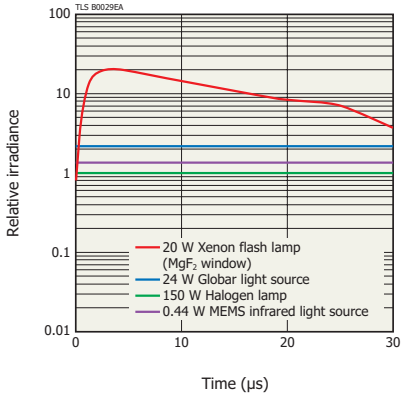
● **Wavelength at 3 μm**



● **Wavelength at 5 μm**



● **Wavelength at 7 μm**



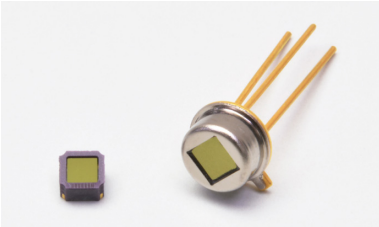
Detector

InAsSb Photovoltaic Detector (3 to 5 µm)

P13243 series

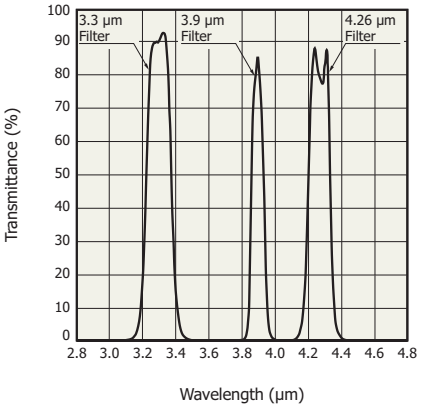
These photovoltaic type infrared detectors have achieved high sensitivity in the spectral band up to 5 µm using Hamamatsu unique crystal growth technology and process technology.

■ P13243-033MF/-039MF/-043MF (TO-46 package) -033CF/-039CF/-043CF (Ceramic package) NEW



These types have a 3.3 µm (for CH_4), 3.9 µm (for reference light), or 4.26 µm (for CO_2) band-pass filter.

Spectral transmittance of window material (typical example)



Electrical and optical characteristics (Typ. Tchip=25 °C, unless otherwise noted)

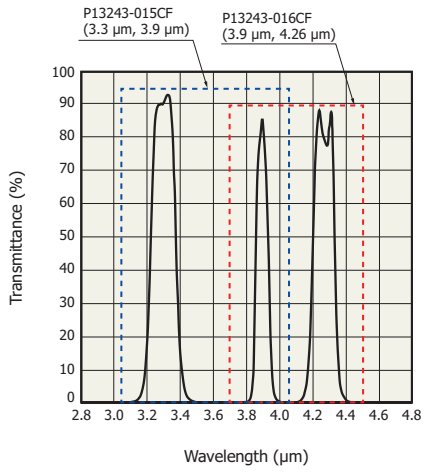
Parameter	Symbol	Condition	P13243 -033MF/CF	P13243 -039MF/CF	P13243 -043MF/CF	Unit
Center wavelength	CWL		3.3	3.9	4.26	µm
Photosensitivity	S	λ=CWL	2.3	3.0	3.1	mA/W
Shunt resistance	Rsh	V_R=10 mV	300			kΩ
Detectivity	D*	(CWL, 1200, 1)	5.1×10^{8} *1	6.5×10^{8} *2	6.9×10^{8} *3	cm·$Hz^{1/2}$/W
Noise equivalent power	NEP	λ=CWL	1.4×10^{-10} *1	1.1×10^{-10} *2	1.0×10^{-10} *3	W/$Hz^{1/2}$
Rise time	tr	10 to 90 %	15			ns

*1: λ=3.3 µm
*2: λ=3.9 µm
*3: λ=4.26 µm

■ P13243-015CF (CH_4, reference light) -016CF (CO_2, reference light) NEW

These dual element detectors have two types of band-pass filters with different target wavelengths.

Spectral transmittance of window material (typical example)

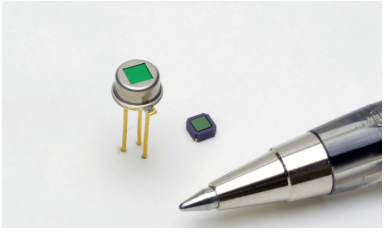


Electrical and optical characteristics (Typ. Tchip=25 °C, unless otherwise noted)

Parameter	Symbol	Condition	P13243-015CF	P13243-016CF	Unit
Center wavelength	CWL		3.3, 3.9	3.9, 4.26	µm
Photosensitivity	S	λ=CWL	2.3*1, 3.0*2	3.0*2, 3.1*3	mA/W
Shunt resistance	Rsh	V_R=10 mV	300		kΩ
Detectivity	D*	(CWL, 1200, 1)	5.1×10^{8} *1 6.5×10^{8} *2	6.5×10^{8} *2 6.9×10^{8} *3	cm·$Hz^{1/2}$/W
Noise equivalent power	NEP	λ=CWL	1.4×10^{-10} *1 1.1×10^{-10} *2	1.1×10^{-10} *2 1.0×10^{-10} *3	W/$Hz^{1/2}$
Rise time	tr	10 to 90 %	15		ns

*1: λ=3.3 µm
*2: λ=3.9 µm
*3: λ=4.26 µm

■ P13243-011MA/-013CA

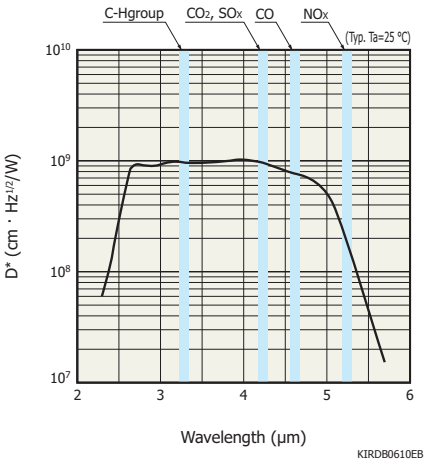


The P13243-011MA/-013CA are compact and easy to handle since they are non-cooled.

Electrical and optical characteristics (Ta=25 °C)

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
Peak sensitivity wavelength	λp		-	4.1	-	μm
Cutoff wavelength	λc		5.0	5.3	-	μm
Photosensitivity	S	λ=λp	4.0	4.5	-	mA/W
Shunt resistance	Rsh	V_R=10 mV	120	300	-	kΩ
Detectivity	D*	(λp, 1200, 1)	8.0×10^8	1.0×10^9	-	cm·$Hz^{1/2}$/W
Noise equivalent power	NEP	λ=λp	-	7.0×10^{-11}	8.8×10^{-11}	W/$Hz^{1/2}$
Rise time	tr	10 to 90%	-	15	25	ns

Spectral response (D*)



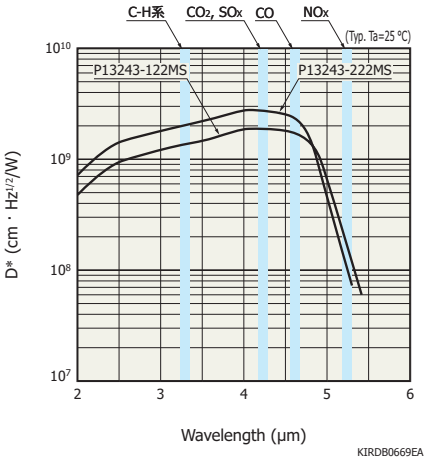
■ P13243-122MS/-222MS

The TE-cooled type P13243-122MS/-222MS deliver stable high S/N measurement through their large photosensitive area.

Electrical and optical characteristics (Ta=25 °C)

Parameter	Symbol	Condition	P13243-122MS			P13243-222MS			Unit
			Min.	Typ.	Max.	Min.	Typ.	Max.	
Peak sensitivity wavelength	λp		-	4.1	-	-	4.1	-	μm
Cutoff wavelength	λc		-	5.2	-	-	5.1	-	μm
Photosensitivity	S	λ=λp	-	8.6	-	-	8.8	-	mA/W
Shunt resistance	Rsh	V_R=10 mV	9.5	19	-	16.5	33	-	kΩ
Detectivity	D*	(λp, 1200, 1)	1.0×10^9	1.9×10^9	-	1.6×10^9	2.8×10^9	-	cm·$Hz^{1/2}$/W
Noise equivalent power	NEP	λ=λp	-	1.0×10^{-10}	2.0×10^{-10}	-	0.7×10^{-10}	1.3×10^{-10}	W/$Hz^{1/2}$
Rise time	tr	V_R=0 V R_L=50 Ω 10 to 90% λ=1.55 μm	-	100	-	-	100	-	ns

Spectral response (D*)



InAsSb Photovoltaic Detector (up to 5 µm)

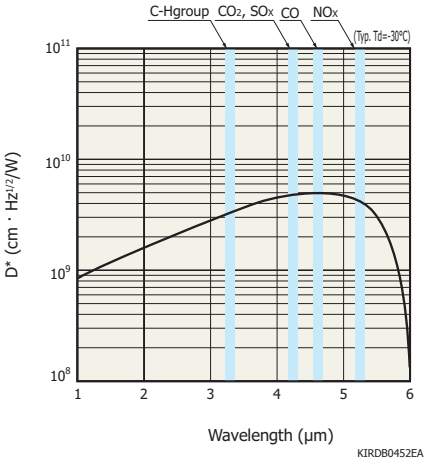
P11120-201

The P11120-201 is a cooled type infrared detector that provides high sensitivity in the 5 µm spectral band by employing our unique crystal growth technology. It has a PN junction that ensures high-speed response and high reliability. D* is improved as a result of cooling, enabling higher-accuracy gas detection. Handling is easy because it is a TE-cooled type that uses a TO-8 package.

Electrical and optical characteristics (Td=-30 °C)

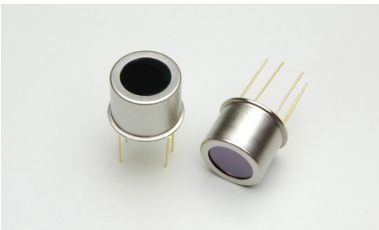
Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
Peak sensitivity wavelength	λp		4.0	4.9	-	µm
Cutoff wavelength	λc		5.6	5.9	-	µm
Photosensitivity	S	λ=λp	0.8	1.6	-	A/W
Shunt resistance	Rsh	V_R=10 mV	10	13	-	Ω
Detectivity	D*	(λp, 1200, 1)	3.5×10^9	5.0×10^9	-	cm·$Hz^{1/2}$/W
Noise equivalent power	NEP	λ=λp	-	1.8×10^{-11}	2.5×10^{-11}	W/$Hz^{1/2}$
Rise time	tr	V_R=0 V, R_L=50 Ω 0 to 63%	-	0.4	-	µs

Spectral response (D*)



InAsSb Photovoltaic Detector (4 to 8 µm)

P12691-201G

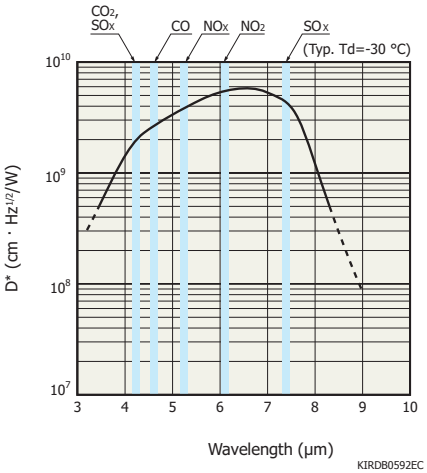


The P12691-201G is an infrared detector that provides high sensitivity in the 8 µm spectral band by employing our unique crystal growth technology and back-illuminated structure and by integrating a lens. It has a PN junction that ensures high-speed response and high reliability. Handling is easy because it is a TE-cooled type that uses a TO-8 package. Typical applications include gas analysis such as NOx, SOx, and H_2S.

Electrical and optical characteristics (Td=-30 °C)

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
Peak sensitivity wavelength	λp		-	6.7	-	µm
Cutoff wavelength	λc		8.2	8.3	-	µm
Photosensitivity	S	λ=λp	0.8	1.2	-	A/W
Shunt resistance	Rsh	V_R=10 mV	13	40	-	Ω
Detectivity	D*	(λp, 1200, 1)	4.0×10^9	6.0×10^9	-	cm·$Hz^{1/2}$/W
Noise equivalent power	NEP	λ=λp	-	1.5×10^{-11}	2.3×10^{-11}	W/$Hz^{1/2}$
Rise time	tr	V_R=0 V, R_L=50 Ω 0 to 63%	-	-	10	ns

Spectral response (D*)

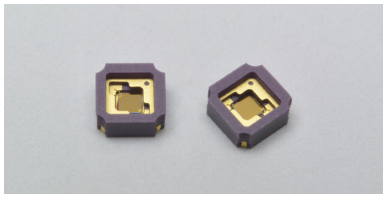


InAsSb Photovoltaic Detector (3 to 11 µm)

P13894 series

These photovoltaic type infrared detectors have achieved high sensitivity in the spectral band up to 11 µm using Hamamatsu unique crystal growth technology and process technology.

■ P13894-011CN



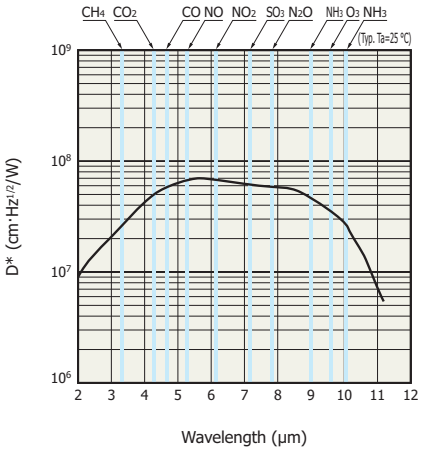
A ceramic package type has been added to the lineup.

Electrical and optical characteristics (Ta=25 °C)

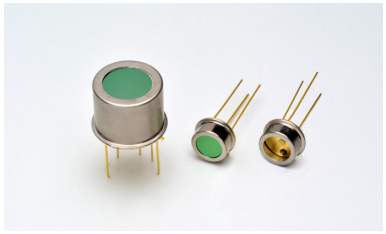
Parameter	Symbol	Condition	Specifications	Unit
Peak sensitivity wavelength	λp		5.6	µm
Cutoff wavelength	λc		11.0	µm
Photosensitivity	S	λ=λp	2.0	mA/W
Shunt resistance	Rsh	V_R=10 mV	2.0	kΩ
Detectivity	D*	(λp, 1200, 1)	7.0×10^7	cm·Hz$^{1/2}$/W
Noise equivalent power	NEP	λ=λp	1.4×10^{-9}	W/Hz$^{1/2}$
Rise time	tr	10 to 90 % λ=1.55 µm*	3	ns

* Without light input window

Spectral response (D*)



■ P13894-011NA /-011MA/-211MA



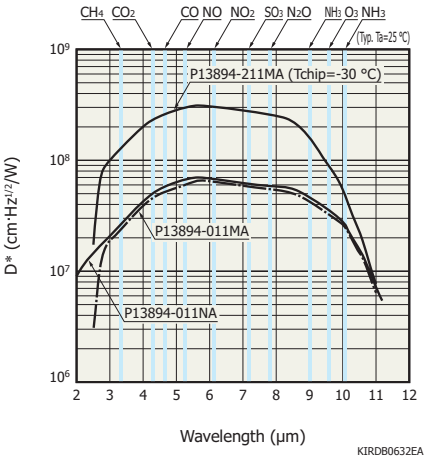
Right: P13894-011NA (non-cooled, no window)
Center: P13894-011MA (non-cooled, Ge with AR coating)
Left: P13894-211MA (two-stage TE-cooled, Ge with AR coating)

Electrical and optical characteristics (Typ. Tchip=25 °C, unless otherwise noted)

Parameter	Symbol	Condition	P13894 -011NA	P13894 -011MA	P13894 -211MA	Unit
Peak sensitivity wavelength	λp		5.6			µm
Cutoff wavelength	λc		11.0	11.0	10.2	µm
Photosensitivity	S	λ=λp	2.0	1.9	3.8	mA/W
Shunt resistance	Rsh	V_R=10 mV	2.0	2.0	10.0	kΩ
Detectivity	D*	(λp, 1200, 1)	7.0×10^7	6.5×10^7	3.2×10^8	cm·Hz$^{1/2}$/W
Noise equivalent power	NEP	λ=λp	1.4×10^{-9}	1.5×10^{-9}	3.1×10^{-10}	W/Hz$^{1/2}$
Rise time	tr	10 to 90% λ=1.55 µm*	3			ns

* Without light input window

Spectral response (D*)



Type II superlattice infrared detector (1 to 14 µm) P15409-901

NEW

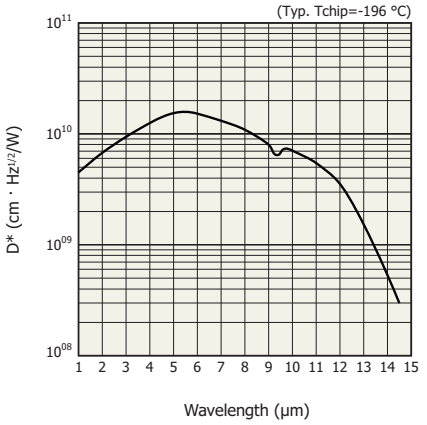
This is a Type II InAs/GaSb superlattice infrared detector with the spectral response range expanded to the 14 µm band. The spectral response range has been expanded using Hamamatsu unique crystal growth technology. This product is an environmentally friendly infrared detector and does not use mercury or cadmium, which are substances restricted by the RoHS Directive. This is a replacement for previous products that contain these substances.

Electrical and optical characteristics

Parameter	Specifications	Unit
Cooling	Liquid nitrogen	-
Photosensitive area	Φ 0.1	mm
Cutoff wavelength *1	14.5	µm
Peak sensitivity wavelength	5.4	µm
Photosensitivity *2	2.6	A/W
Shunt resistance *3	2.5	kΩ
Detectivity *4	1.6×10^{10}	$cm \cdot Hz^{1/2}/W$
Rise time *5	150	ns

*1: Wavelength at which signal/noise=1
*2: λ=λp
*3: V_R=10 mV
*4: λ=λp, fc=1200 Hz, Δf=1 Hz
*5: 0 to 63 %

Spectral response (D*)



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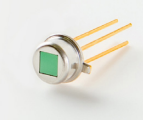
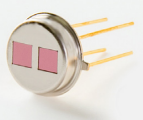
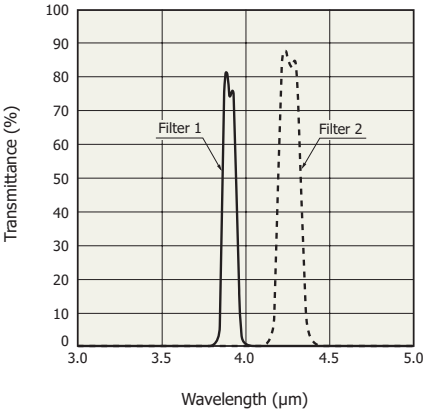
Thermopile

Hamamatsu Photonics applies the MEMS technology that it has accumulated over the years to thermopiles. We offer a lineup of single element and dual elements types. This enables the customers to select the appropriate type for their needs.

Parameter	Single element type	Dual element type
Type no.	T11262 series T11361 series	T11722-01
Number of elements	1	2
Package type	TO-18	TO-5
Window material	Si with AR coating	Band-pass filter
Spectral response range	3 to 5 µm	3.9 µm (reference light)/4.3 µm
Main applications	Gas analysis	
Photosensitivity	50 V/W	
Detectivity	1.3×10^8	
Appearance		

Spectral transmittance of window material (typical example)



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HAMAMATSU
PHOTON IS OUR BUSINESS

Ultraviolet and visible light sources and detectors

Light source

Lamps for Gas Measurement

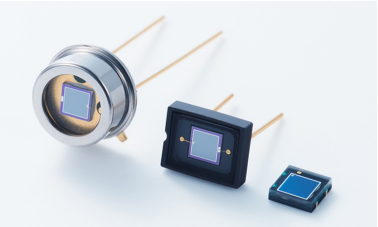
LAMP		Features of lamp	Features of Hamamatsu lamp	Spectral Distribution (nm)	Wattage (W)	Output stability fluctuation (p-p)	Life (hours)
Xenon Flash Lamp		· Pulsed light · Broad spectrum from UV to IR	· Long life · High stability	160 to 7500	2 to 60	Less than 3 %	20000*
Xenon Lamp		· Broad spectrum from UV to IR	· Long life · High stability · No arc point shift	185 to 2500	35 to 300	Less than 1 %	1000 to 4000
Deuterium Lamp		· Broad spectrum in UV range · High stability	· Long life · High stability · Stationary emission point ensures high accuracy	115 to 400	5 to 150	0.005 % Typ.	1000 to 4000

* This value is when repetition rate is set to 10 Hz of operation. Life time is depends on the repetition rate.

Detector

Si Photodiode

S12698 series



The S12698 series are Si photodiodes that have achieved high reliability for detecting ultraviolet light by employing a structure that does not use resin. They exhibit low sensitivity deterioration under UV light irradiation and are suitable for applications such as monitoring intense UV light sources.

Photomultiplier Tube

R955

R955 is Φ28 mm side-on type photomultiplier tube.(multialkali photocathode) effective area is 8×24 mm, spectral response is 160 nm to 900 nm.

Related products

Pulsed QCL Module

L14147 series

The Pulsed QCL Module is a compact module containing a TO-8 can packaged pulsed DFB quantum cascade laser, pulse driver and TEC controller.
The module can be easily and remotely controlled via Ethernet connection.

Standard driving conditions: t_w=500 ns, f_r=100 kHz, $T_{op(qcl)}$=20 °C

Type No.	Wavelength*1	Operating*2 temperature (QCL)		Line width*3	Tunable*4 range	Output power	Side-mode suppression ratio (SMSR)	Colimation lenses	Beam spread angle	Width of*5 beam at waist
	Typ.	Min.	Max.	Min.	Min.	Typ.	Min.		Typ.	Typ.
L14147-1278-01	7.82 µm	+10 °C	+60 °C	1.0 cm^{-1}	1.0 cm^{-1}	100 mW	25 dB	Not included		
		Condition: K=1278 cm^{-1}*6								
L14147-1278-02	7.82 µm	+10 °C	+60 °C	1.0 cm^{-1}	1.0 cm^{-1}	100 mW	25 dB	Included	3 mrad	5 mm
		Condition: K=1278 cm^{-1}*6								

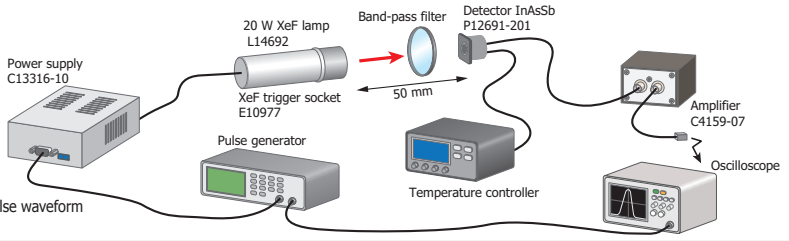
*1: Please contact a Hamamatsu sales office about QCLs with emission wavelengths not listed above.
*2: This specifies the temperature range within which the target emission wavenumber (K) can be realized.
*3: Full-width half maximum
*4: This specifies the continuous tunable range (without mode hopping). The center wavenumber of the tuning range is the emission wavenumber (K).
*5: $1/e^2$ beam radius
*6: K: Emission wavenumber (cm^{-1})

Trigger Socket and Power Supply for 20 W Xenon Flash Lamp

Lamp+power supply+trigger socket

These dedicated peripherals to extract the maximize performance of Xenon Flash Lamp.
Dedicated power supply which enables stable lighting of Xenon Flash Lamp has large output capacitance while keeping compactness. Also, trigger socket is integrated with a high voltage transformer, voltage dividing resistors and capacitors in a same compact case. This frees the user from the troublesome task of designing and assembling the external circuit.

Measurement setup example



* The setup shows flash pulse waveform measurement. (See P.11)

Specifications (Power supply)

Parameter		C13315	C13316 series	Unit
Main power supply	Output voltage (DC)	300 to 1000		V
	Output capacity (Max.)	20		W
	Stability (Max.)	±0.2		%
	Main discharge capacitance	0.1	0.2 to 1.0*1	µF
	Maximum repetition rate*2	1000*2		Hz
Input voltage (DC)		24 ± 2.4		V
Power consumption		26		W
Cooling method		Not required		-
Dimensions (W × H × D)		90 × 43 × 146	102 × 51 × 170	mm
Weight		530	694 to 807*3	g
Compatible lamp*4		L11938, L11948, L11958, L11968, L14691, L14692, L14693, L14694		-

*1: The main discharge capacitance can be selected from 0.2 µF to 1.0 µF in 0.1 µF steps.
*2: Please adjust maximum average lamp input (continuous) to the specification of lower than 20 W.
*3: Depend on the main discharge capacitance.
*4: Sockets depend on lamp. L11938, L11948, L14691, and L14692 are compatible to E10977, and L11958, L11968, L14693, and L14694 are compatible to E10978.

Photodiode Module

Photodiode Modules are high-precision photodetectors with a built-in Si photodiode and an integrated current-to-voltage converter. The output is an analog voltage and can be easily measured with a voltmeter and the like.

Type no.	Dimensions W × D × H (mm)	Characteristics	Photodiode type	Photosensitive area (mm)	Photosensitivity (mV/nW)	Conversion impedance (V/A)	Frequency bandwidth -3 dB (Hz)	Maximum output voltage (V)	Output noise (mVp-p)	Output	Power supply
C10439-01	19 × 46 × 52	· Built-in photodiode · Suitable for light level monitoring, color difference meters, flowmeters, etc.	Si	2.4 × 2.4	H: 500 L: 5	H: 10^9 L: 10^7	H: 10 L: 1 k	Vcc - 0.2	2	Analog	External power supply (±5 to ±12 V)
C10439-02				5.8 × 5.8							
C10439-03				10 × 10							
C10439-07				2.4 × 2.4	H: 0.5 L: 0.005	H: 10^6 L: 10^4	H: 1 k L: 100 k				
C10439-08				5.8 × 5.8							
C10439-09				10 × 10							
C10439-10	19 × 50 × 52		InGaAs	Φ1	H: 1 L: 0.01						
C10439-11				Φ3							
C10439-14			InAsSb	0.7 × 0.7	H: 0.045 L: 0.0045	H: 10^7 L: 10^6	H: 100 L: 1 k				

Infrared Detection Modules with Preamp

These modules integrate a preamp and various infrared detectors. A variety of products is available for different wavelength regions. Infrared light can be detected simply by connecting a DC power supply.

■ C12494-011LH (non-cooled type) NEW

Because 100 MHz is supported, high-speed infrared spectroscopic measurement is possible in combination with a quantum cascade laser (QCL).

Electrical and optical characteristics (Ta=25 °C)

Parameter	Specification	Unit
Detector	InAsSb (P13894-011NA)	-
Photosensitive area	1 × 1	mm
Peak sensitivity wavelength	5.6	µm
Cutoff wavelength	11.0	µm
Photosensitivity *1	40	V/W
Noise equivalent power *2	4.0×10^{-9}	$W/Hz^{1/2}$
Frequency characteristics (FcH) *3	0 to 100	MHz
Supply voltage (max.) *4	±2.5	V

*1: λ=λp
*2: λ=λp, f=1200 Hz
*3: -3 dB
*4: Current consumption (max.)=±35 mA

■ Other lineups (TE-cooled types, metal dewar types)

(Typ.)

Type	Type no.	Photo	Detector (built-in)	Photosensitive area (mm)	Cooling	Measurement conditions: Element temperature (°C)	Cutoff wavelength (µm)	Peak sensitivity wavelength (µm)
TE-cooled type	C12483-250		InGaAs (G12180-250A)	Φ5	TE-cooled	-15	1.66	1.55
	C12485-210		InGaAs (G12182-210K)	Φ1			2.05	1.95
	C12486-210		InGaAs (G12183-210K)				2.56	2.3
	C12492-210		InAs (P10090-21)	Φ1		-28	3.45	3.25
	P4631-03		InSb (P6606-310)	1 × 1		-58	6.1	5.5
	C12494-210S		InAsSb (P11120-201)	Φ1		-28	5.9	4.9
	C12494-210M		InAsSb (P12691-201G)				8.3	6.7
Metal dewar type	G7754-01		InGaAs (G12183-010)*1	Φ1	Liquid nitrogen	-196	2.4	2.0
	G7754-03		InGaAs (G12183-030)*1	Φ3				
	P7751-01*2		InSb (P5968-060)	Φ0.6			5.5	5.3
	P7751-02*2		InSb (P5968-200)	Φ2				

*1: chip
*2: FOV=60°

The content of this document is current as of October 2019.

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