

Opto-semiconductor Modules

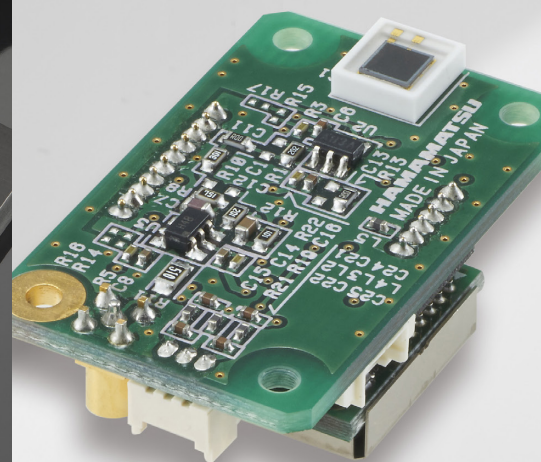
Related products and circuits that enable semiconductor elements to operate at peak performance. A broad range of customization is available.



■ Optics module
C13398-01



■ Mini-spectrometer
C14214MA



■ MPPC module
C13365-3050SA

Opto-semiconductor Modules

Related products and circuits that enable opto-semiconductor devices to operate at peak performance

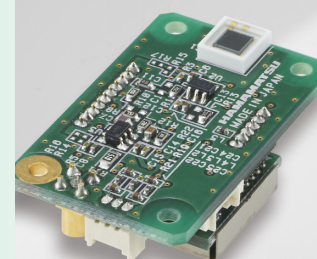
Here at Hamamatsu Photonics, we use the unique opto-semiconductor technology that we have accumulated over the years to develop and manufacture photodiodes, APDs, MPPCs, image sensors, LEDs, and other opto-semiconductors. To make these opto-semiconductors easier to use and more widely used, we have developed opto-semiconductor modules that combine Hamamatsu opto-semiconductor, optic, circuit, mounting, software, and MEMS technologies.

We can also provide customized products. Feel free to contact us with your request.

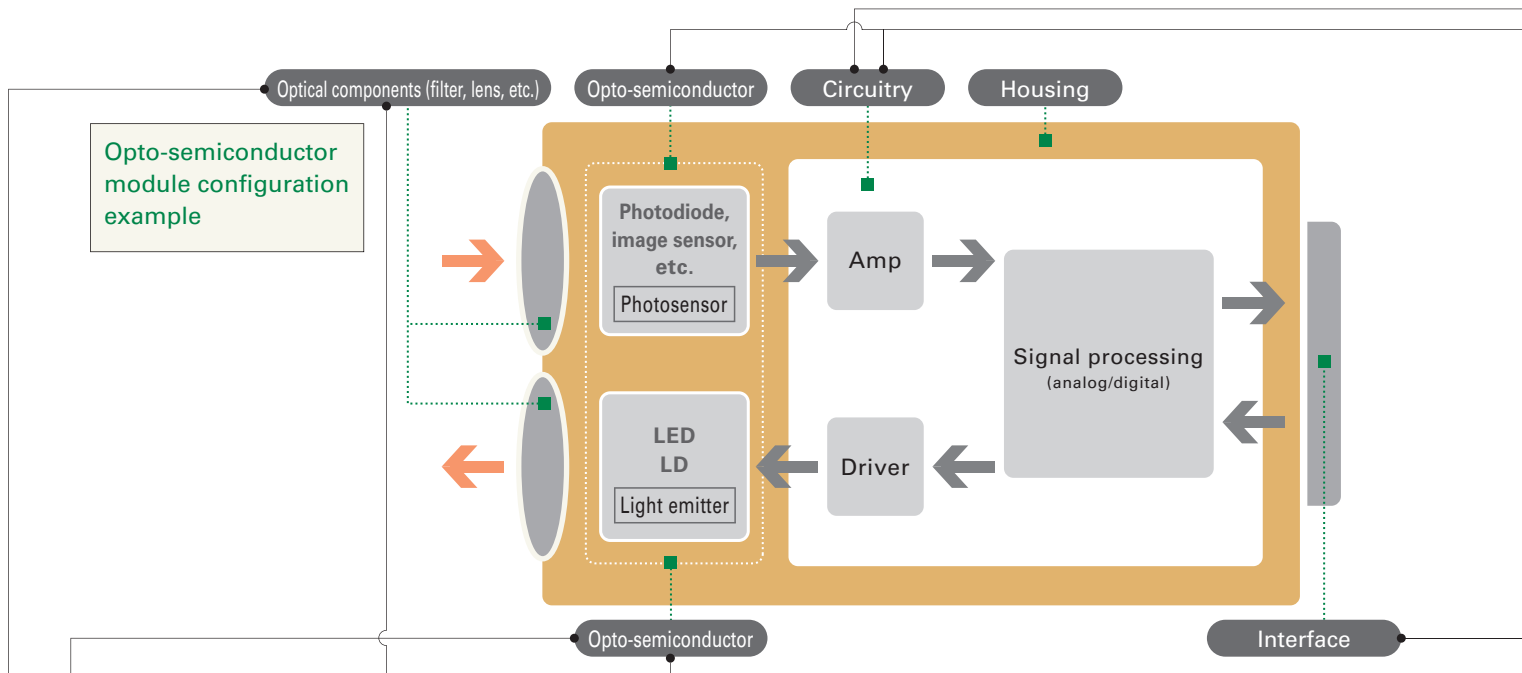


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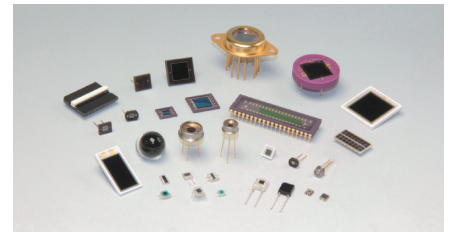


Technologies that create opto-semiconductor modules

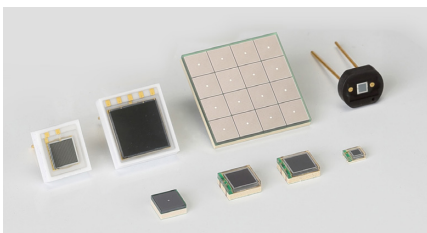


01 Opto-semiconductor technology

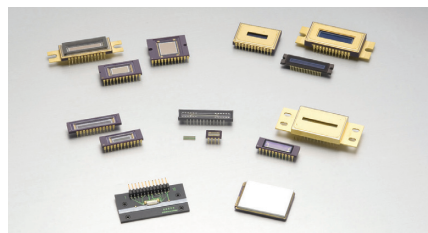
- The detector, which is the heart of the module, uses Hamamatsu opto-semiconductors, which have a long track record for many years in the fields of analysis, measurement, automotive, and consumer products.
- Not only can you select photosensors and light sources from the wide lineup of opto-semiconductors that Hamamatsu has developed, you can also have them custom designed to achieve the features that you want.



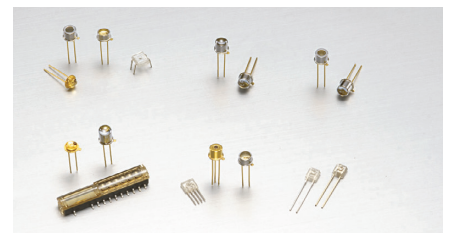
▲ Si photodiode and APD



▲ MPPC



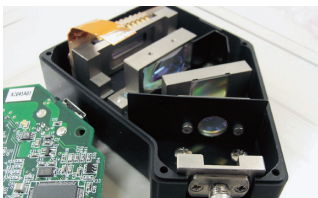
▲ Image sensor



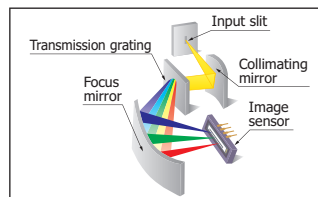
▲ LED

02 Optical technology

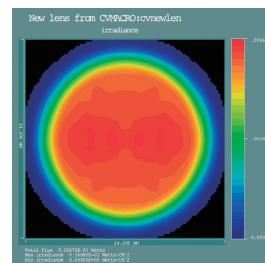
- Optimal optical design leads to high-performance modules.
- Use of simulations
We perform optics simulations in-house to create optical designs quickly and flexibly.



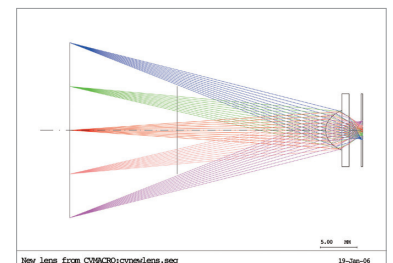
▲ Inside of a mini-spectrometer



▲ Optical system layout example of a mini-spectrometer

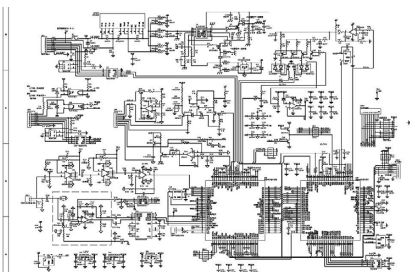


▲ Optical simulation example

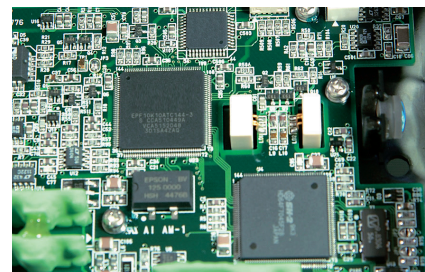


03 Circuit technology

- Optimized for optical devices and applications
- Supports high sensitivity, low noise, high speed, and multiple channels



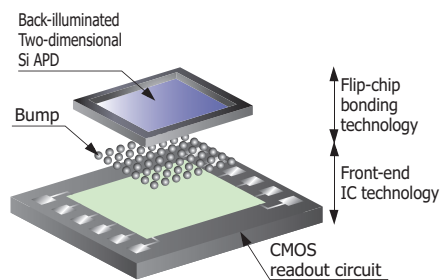
▲ Circuit example



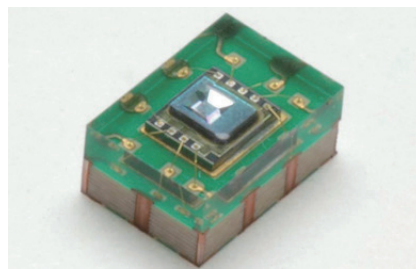
▲ Circuit mounting example

04 Mounting technology

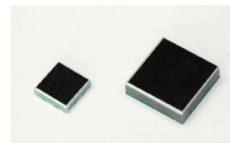
- Our mounting technology combines compactness, high functionality, and low cost.
Flip-chip bonding technology: A flip chip is directly bonded to a board through the use of solder bumps.
Front-end IC technology: A custom first-stage analog signal processing circuit and a photosensitive area are bonded together.
- COB (chip on board): A chip is directly mounted onto a board, and this results in a smaller mounting area, a thinner module, and a lower cost.
- A photosensor and optical component, etc. are bonded to a board, and this results in a smaller size and a lower cost.



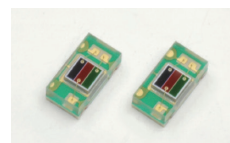
▲ Example of our mounting technology applied



▲ Hybrid device (using front-end IC technology)



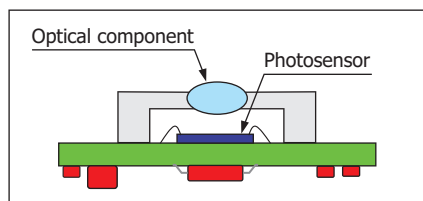
◀ Chip-size packages (Flip-chip bonding technology is used.)



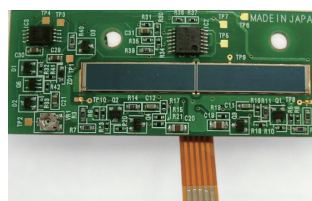
◀ COB



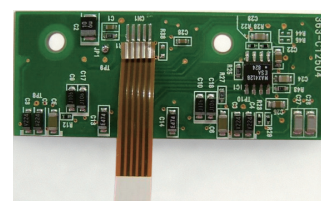
▲ Example in which a photosensor and an optical component are combined (optics module)



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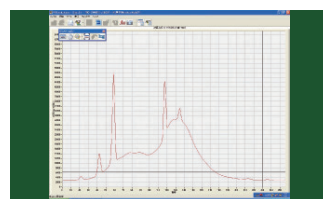


▲ Dual-sided mounting

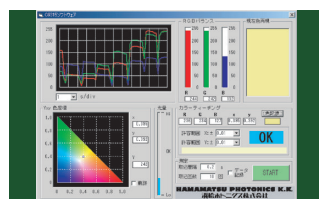


05 Software technology

- The sample software makes swift evaluation possible.
- Support for USB, RS-232C, and other types of interfaces is available.



▲ Mini-spectrometer measurement example

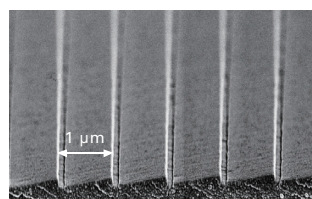


▲ Color sensor module measurement example

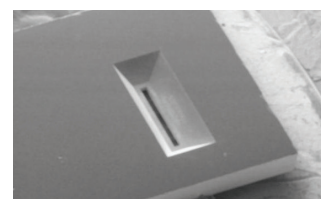
06 MEMS* technology

- High-precision micromachining
- Helps make modular components smaller and modules more functional

* Micro-electro-mechanical systems



▲ Magnified photograph of micro-grating



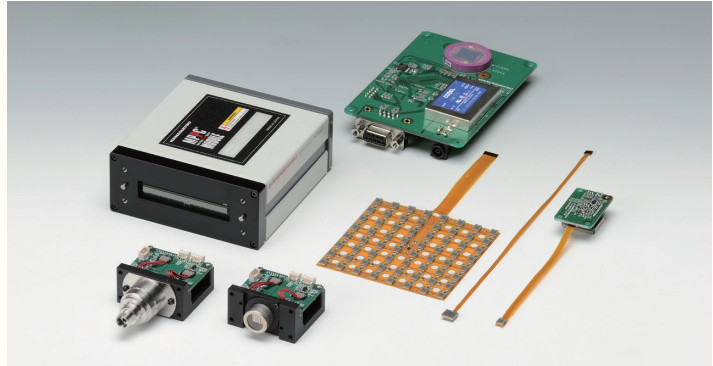
▲ Enlarged photo of slit

Customization example

In addition to offering standard opto-semiconductor modules, Hamamatsu can also provide opto-semiconductor modules that are customized in accordance with the specifications that our customers request.

▼ If you have the following requests regarding opto-semiconductor modules, contact your local Hamamatsu office.

- Want to detect light with this wavelength
- Want to detect very low-level light
- Want to detect light at high speeds
- Want to output this type of signal
- Want to miniaturize the detector
- Want to achieve low cost
- Want to use in this type of location



Process for developing a custom product

Not only do we modify the specifications of our standard opto-semiconductor modules, we can also design new custom products.

Requests from the customer >>> 01 Functionality and performance that the customer wants to achieve 02 External dimensions 03 Price

Assessment of the specifications >>>

Opto-semiconductor

You can select from a wide lineup of standard products or have a new device developed.

Optics

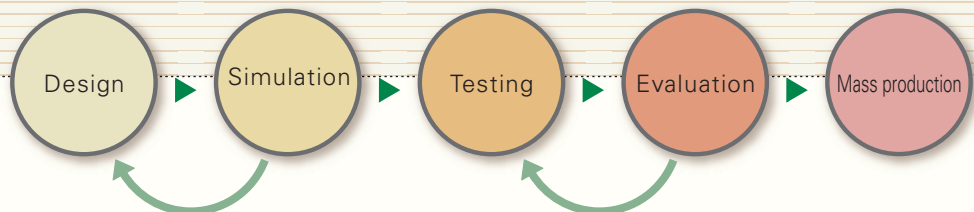
Suitable optical designs (for lenses, mirrors, filters, etc.) that are based on vast experience

Circuit

Unique Hamamatsu analog and digital circuit designs that can handle low light levels (we can handle circuit design and pattern design)

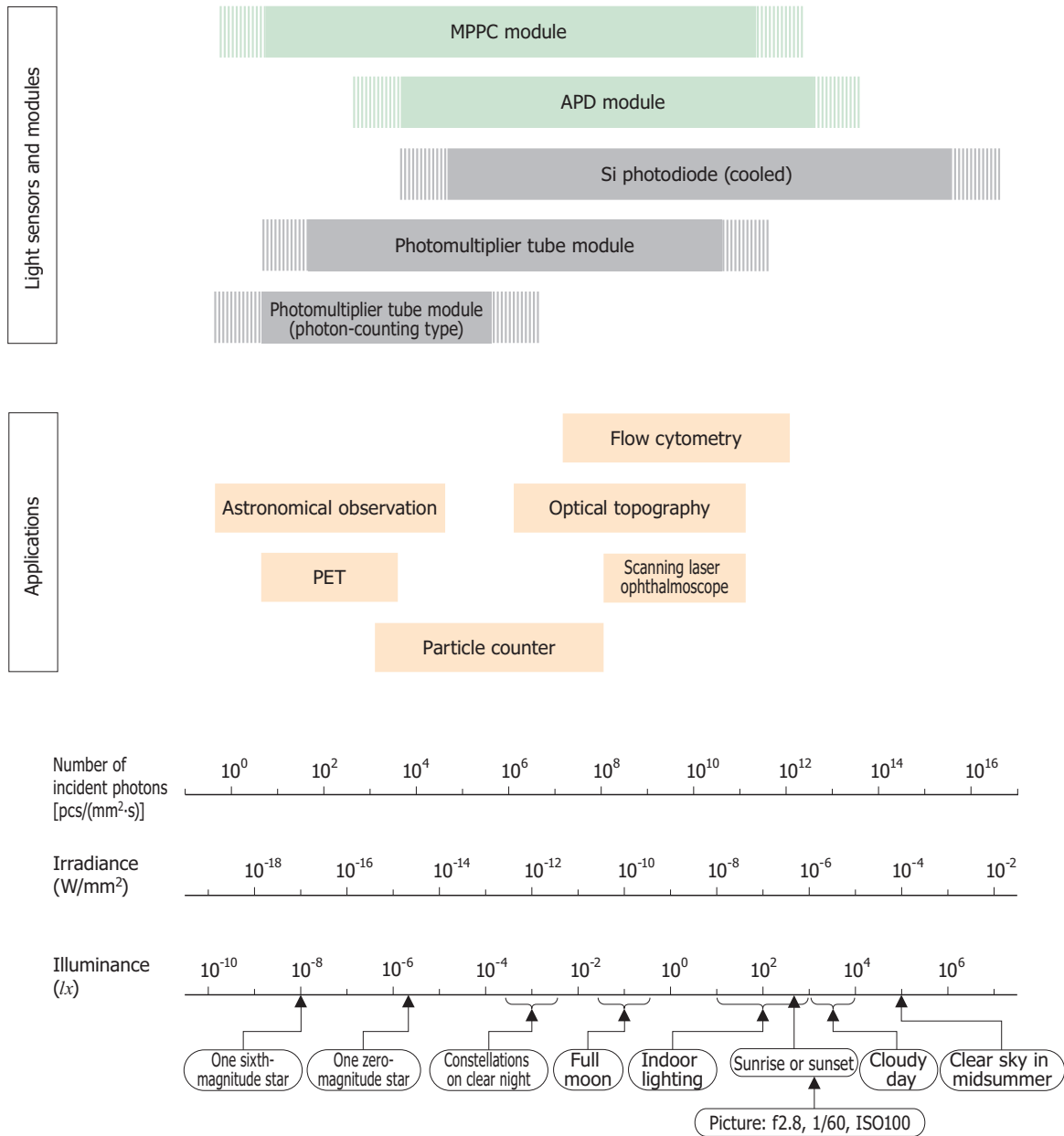
Software

We have the flexibility to design firmware for microcontrollers, FPGAs, DSPs, etc., as well as application software.



Low-light-level detection modules

Examples of optical sensors and modules that correspond to different light levels and applications



Note: Reference data

Correlation between the number of incident photons, irradiance, and illuminance is shown for light at $\lambda=555 \text{ nm}$.

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MPPC® modules

MPPC modules are photon counting modules with built-in MPPCs. These modules consist of an MPPC, current-to-voltage converter, high-speed comparator circuit, high-voltage power supply circuit, temperature-compensation circuit, counter circuit, and microcontroller. Excellent photon counting characteristics are achieved by exploiting the full potential of the MPPC.





Analog output type

(Typ.)

Type no.	Photo W × D × H (mm)	Built-in MPPC	Effective photosensitive area (mm)	Pixel pitch (μm)	Photoelectric sensitivity (V/W)	Noise equivalent power (fW/Hz ^{1/2})	Temperature control	Supply voltage (V)
C13365-1350SA	 36 × 22 × 12.9	S13360-1350CS	1.3 × 1.3	50	1 × 10 ⁹	0.5	Temperature compensation (non-cooled)	±5
C13365-3050SA		S13360-3050CS	3.0 × 3.0			1.2		
C13366-1350GA	 98 × 60 × 35	TE-cooled type (for precision measurement)	1.3 × 1.3			0.1	TE-cooled (-20 °C)	
C13366-3050GA			3.0 × 3.0			0.15		
C11209-110	 38 × 45 × 13	S12571-010C	1.0 × 1.0	10	2.6 × 10 ⁶	3	Temperature compensation (non-cooled)	+5

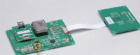
Digital output type

(Typ.)

Type no.	Photo W × D × H (mm)	Built-in MPPC	Effective photosensitive area (mm)	Pixel pitch (μm)	Photon detection efficiency (%)	Dark count (cps)	Temperature control	Supply voltage (V)
C13366-1350GD	 98 × 60 × 35	TE-cooled type (for precision measurement)	1.3 × 1.3	50	40	2.5 k	TE-cooled (-20 °C)	±5
C13366-3050GD			3.0 × 3.0			12 k		
C13001-01	 98 × 60 × 35	Single pixel φ50 μm (fiber coupling type)			45	7		

Starter kit

(Typ.)

Type no.	Photo	Temperature control	Supply voltage (V)	Features
C12332-01		Temperature compensation (non-cooled)	±5	<ul style="list-style-type: none"> Enables the evaluation of non-cooled MPPCs (sold separately) Includes C11204-01 power supply for MPPC Measurable just by setting MPPC operating voltage from PC

MPPC array modules

Array modules are available in various types. Contact us for detailed information.

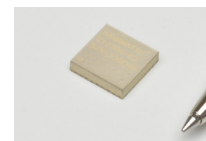
■ C13368 series: One-dimensional type MPPC array module

■ C13369 series: Two-dimensional type MPPC array module

Each series has three circuit types (analog, counting, multichannel analyzer).

C11204-01/-02 power supply for MPPC

These are high voltage power supplies that are optimized for driving MPPCs. Since they have a temperature compensation function, MPPCs can be driven stably even in environments subject to temperature changes.



C11204-02

Features





- Wide output voltage range: 50 to 90 V (C11204-01)
40 to 90 V (C11204-02)
- Low ripple noise: 0.1 mVp-p typ.
- Superb temperature stability: ±10 ppm/°C typ.
- High resolution settings (1.8 mV resolution)
- Serial interface
- Surface mount type

APD modules

These modules combine an APD, low-noise amplifier, and bias power supply in a compact form.

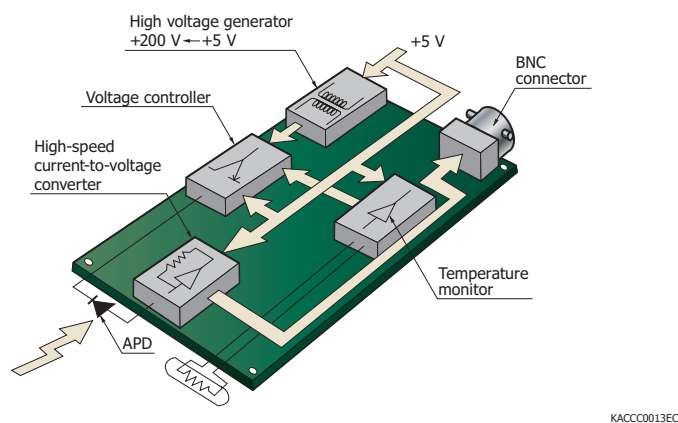


(Typ. unless otherwise noted)

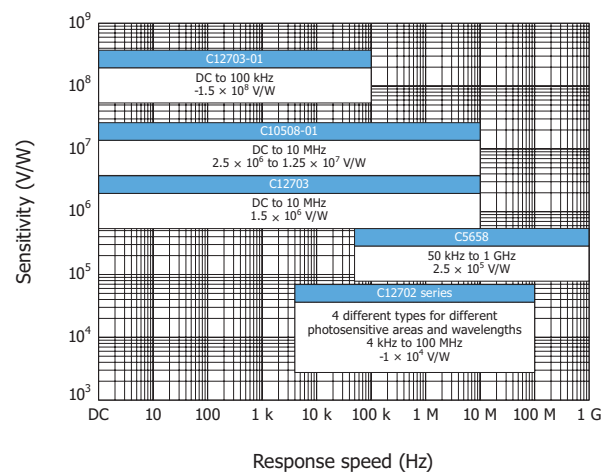
Type	Type no.	Photo W × D × H (mm)	Effective photosensitive area* (mm)	Built-in APD	Cutoff frequency		Photoelectric conversion sensitivity M=30 λ=800 nm (V/W)	Minimum detection limit M=30 λ=800 nm (nW rms)	Temperature stability of gain 25 ± 10 °C (%)	Supply voltage (V)
					Low speed	High speed				
Standard	C12702-03		φ1.0	S12023-10	4 kHz	100 MHz	-6.8×10^4	3	±2.5	+5
	C12702-04		φ3.0	S2384		80 MHz	-2.3×10^4	3.6		
	C12702-11		φ1.0	S12053-10	4 kHz	100 MHz	-2.5×10^4	5	±2.5	+5
	C12702-12		φ3.0	S5344		40 MHz	-1.9×10^4	6.3		
High sensitivity	C12703		φ1.5	S3884	DC	10 MHz	1.5×10^6	0.63	±2.5	±12
	C12703-01		φ3.0	S2384		100 kHz	-1.5×10^8	0.0063		
High stability	C10508-01		φ1.0	S12023-10A	DC	10 MHz	1.25×10^7	0.063	±5.0 max.	±5
High speed	C5658		φ0.5	S12023-05	50 kHz	1 GHz	2.5×10^5	16	±5.0	+12

* Area in which a typical gain can be obtained

Block diagram (C12702 series)



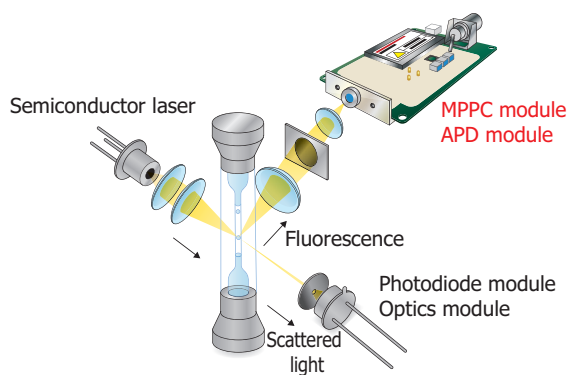
Sensitivity and response speed



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Application examples

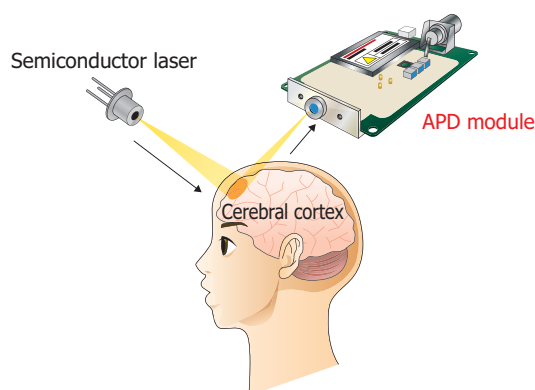
[Flow cytometry]



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So that the type, number, and nucleic acids (DNA and RNA) of cells can be detected, a liquid that contains cells is made to flow at high speeds and is irradiated with a laser. The resulting faint fluorescence is detected.

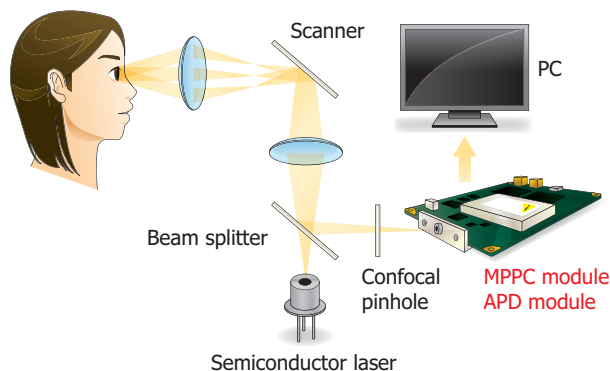
[Optical topography]



KACCC0594EA

So that changes in the amount of blood flow in the cerebral cortex can be detected, near infrared light is irradiated from above the head, an APD module detects scattered light, and changes in the hemoglobin density of the blood are thereby detected.

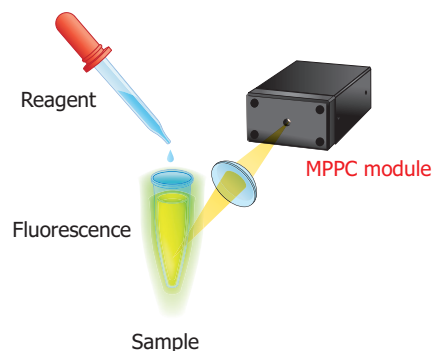
[Scanning laser ophthalmoscope (SLO)]



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In ophthalmoscopy, for safety reasons, the laser light that is irradiated into the eyeball must have a low intensity. MPPC and APD modules can be used to detect faint reflected light from the eye-ball with superior resolution and contrast.

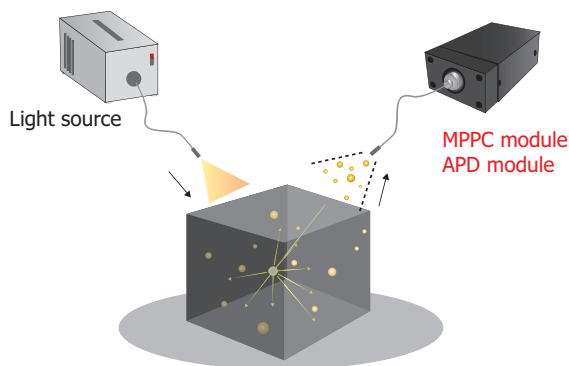
[Fluorescence measurement]



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The MPPC module can detect minute fluorescence emission of reagents.

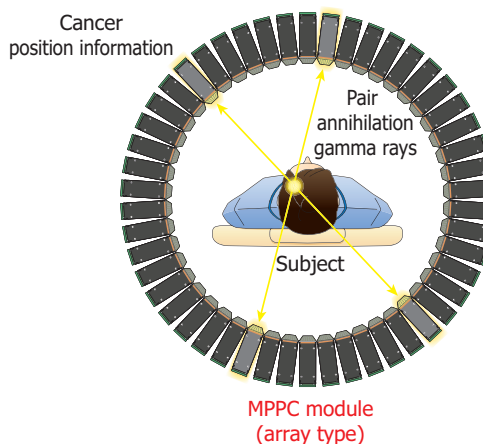
[Particle counter]



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When a laser is made to pass through a chamber that contains a gas or liquid with particles, the quantity and size distributions of the particles in the chamber can be determined through the detection of the light that is scattered by the particles.

[PET (positron emission tomography)]

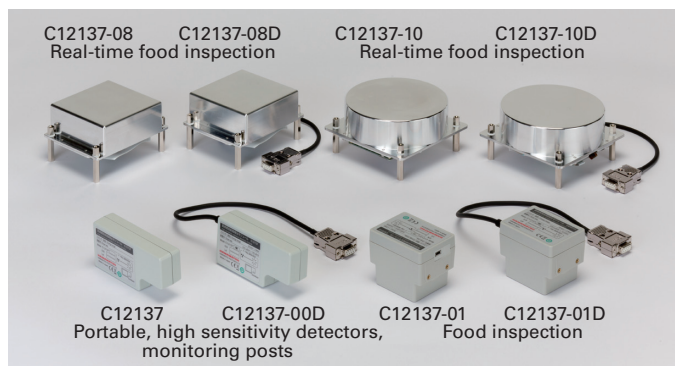


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MPPCs that are arranged 360° around a subject detect pair annihilation gamma rays, and the location of a target, such as cancer, can be determined on the basis of the detected intersections.

Radiation detector modules

The C12137 series is a radiation detector module containing a scintillator and MPPC (multi-pixel photon counter) designed to detect gamma rays such as ^{137}Cs (Cesium-137). The scintillator converts incident gamma rays into a visible light which is detectable by the MPPC even at very low light levels to ensure highly accurate measurement of low energy gamma rays. The signal processing circuit and A/D converter come housed in a compact case with a USB interface.



USB type

Parameter	C12137	C12137-01	C12137-08	C12137-10	Unit
Dimensions (W × D × H)* ¹	110 × 55 × 27	71 × 55 × 60.5	112 × 94 × 53.3	122 × 122 × 53.3	mm
Weight	120	320	1130	1570	g
Detector	MPPC				-
Scintillator	CsI(Tl)				-
Scintillator size (W × D × H)	13 × 13 × 20	38 × 38 × 25	80 × 80 × 25	φ110 × 25	mm
Counting efficiency min.* ²	40	400	2000		cpm
Energy range	0.03 to 2		0.06 to 2		MeV
Energy resolution* ³	8	8.5	9	10	%
Measurement range (dose equivalent rate)* ⁴	0.01 to 100	0.001 to 10	* ⁵		μSv/h
Measurement error* ⁶	±20		* ⁵		%
Sampling time	10 to 60 s, adjustable				-
Interface	USB 2.0 (Full Speed)				-
Compatible OS	Windows 7 SP1 (32-bit, 64-bit)				-
Power supply	USB bus power (150 mA typ., 500 mA max.)				-

RS-232C type

Parameter	C12137-00D	C12137-01D	C12137-08D	C12137-10D	Unit
Dimensions (W × D × H)* ¹	110 × 55 × 27	71 × 55 × 60.5	112 × 94 × 55.6	122 × 122 × 55.6	mm
Weight	160	360	1170	1610	g
Detector	MPPC				-
Scintillator	CsI(Tl)				-
Scintillator size (W × D × H)	13 × 13 × 20	38 × 38 × 25	80 × 80 × 25	φ110 × 25	mm
Counting efficiency min.* ²	40	400	2000		cpm
Energy range	0.03 to 2		0.06 to 2		MeV
Energy resolution* ³	8	8.5	9	10	%
Measurement range (dose equivalent rate)* ⁴	0.01 to 100	0.001 to 10	* ⁵		μSv/h
Measurement error* ⁶	±20		* ⁵		%
Sampling time	10 to 60 s, adjustable				-
Interface	RS-232C (EIA-232-E)				-
Bit rate	115200				bps
Power supply	+5 V (200 mA typ., 500 mA max.)				-

*1: Excluding the cable and connector

*2: ^{137}Cs , 0.01 μSv/h

*3: ^{137}Cs , 662 keV

*4: ^{137}Cs , 662 keV*⁷. The lower limit depends on the environmental radiation.

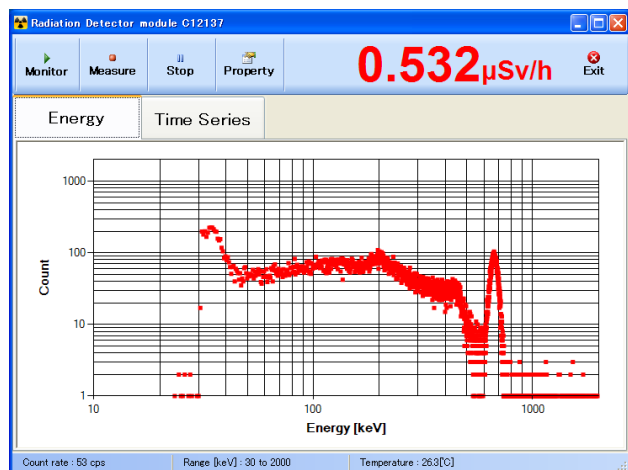
*5: The C12137-08/-08D/-10/-10D do not perform conversion into dose equivalent rate using the G(E) function.

*6: Excludes attenuation (caused by the shield) and counting fluctuations

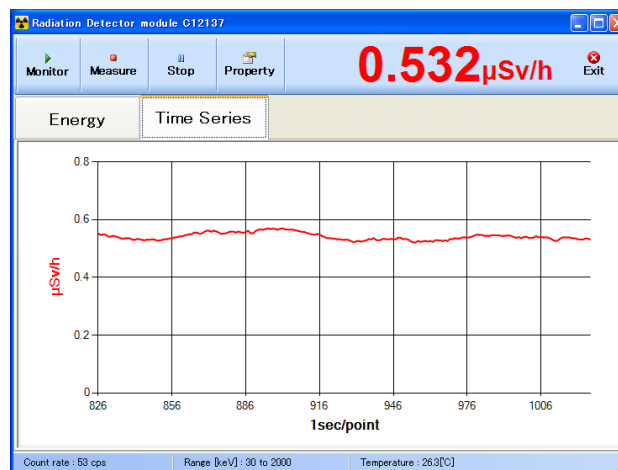
*7: Measurement range of these products is defined by ^{137}Cs . When detecting environmental radiation that mainly consists of low energy radiation, the maximum measurement value will be approx. 1/3 to 1/2 of this figure.

Measurement examples

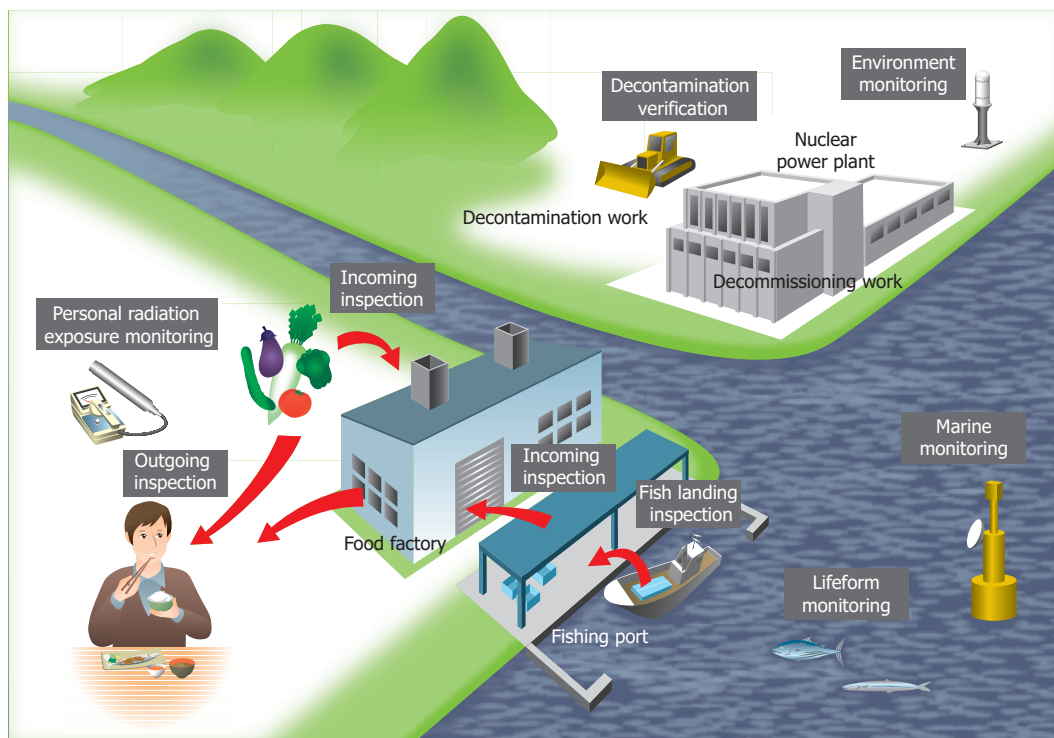
[Cesium-137 radiation source (energy spectrum)]



[Environmental radiation (time variation)]

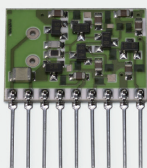


Application examples



Related product

Charge amplifier H4083
(Low noise amplifier for detecting X-rays, radiation, and high energy particles)



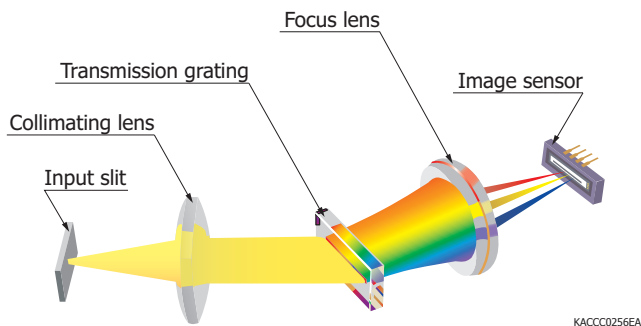
Mini-spectrometers

Mini-spectrometers are compact devices that include a grating and other optical elements and an image sensor. There are modular types that have a built-in driver circuit and head types that do not have a built-in driver circuit.



Elemental technologies that go into making mini-spectrometers

Optical system layouts (typical example: TG series)



SEM photo of a grating

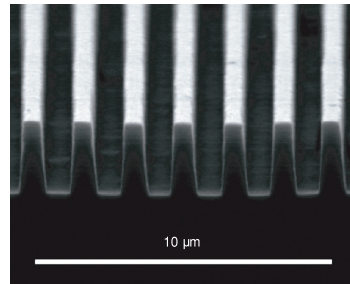
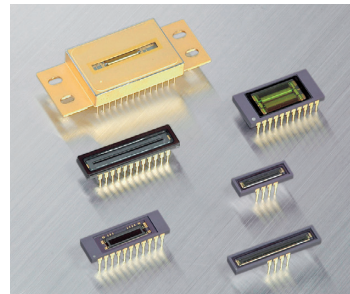


Image sensors that are built into the mini-spectrometers



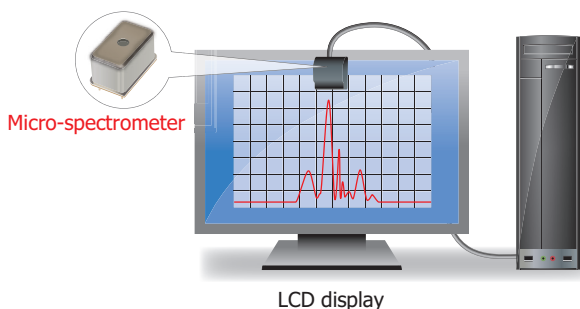
The wavelength dispersive elements of the mini-spectrometers (TM and TG series) use a transmission grating (quartz) fabricated by a holographic process. The holographic process is a technique suited for mass production, and a grating can be formed directly onto the matrix, instead of replicating the grating. This grating can separate light into a spectrum precisely and improve measurement throughput. It also reduces stray light levels.

Also, the detector, which is the heart of the mini-spectrometer, uses Hamamatsu image sensors, which have performed exceptionally for many years in the fields of analysis and measurement.

The mini-spectrometer was developed and produced from these elemental technologies.

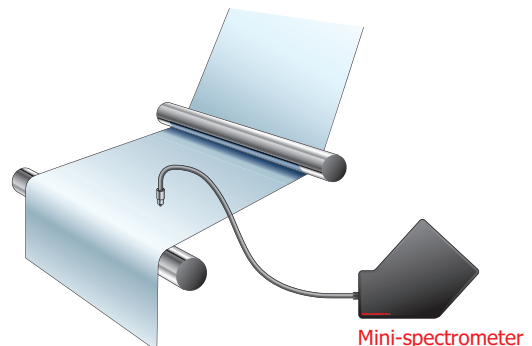
Application examples

[Display color measurement]



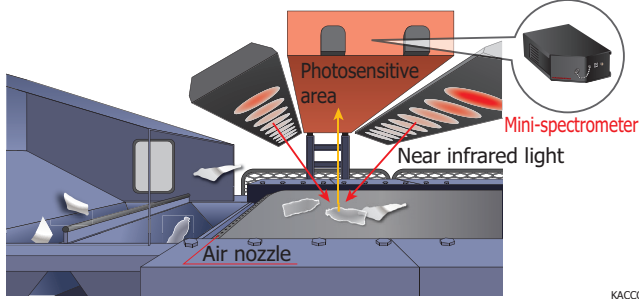
The emission spectrum of an LCD display is monitored through the use of a micro-spectrometer.

[Film thickness measurement]



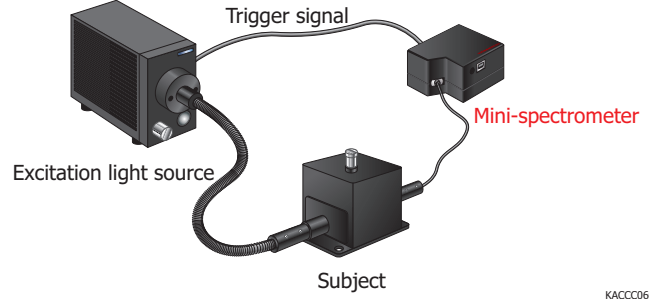
White light interferometry can be used to determine the thickness of a film on the basis of the number of reflected light's spectral peaks, refractive index, and incident light angle.

[Plastic selection]










Near-infrared light is emitted onto plastics. Different types of plastics absorb different wavelengths, and this fact is used to separate the plastics.

[Fluorescence measurement]



The emission spectra of fluorescent lights, organic EL devices, and other luminescent materials are measured.
(Typ. unless otherwise noted)

Type no.	Photo W × D × H (mm)	Type	Spectral response range (nm)	Wavelength resolution (nm)	Built-in image sensor	Features		
C10082CA	 95 × 92 × 76	TM series	[High sensitivity] TM-UV/VIS-CCD	200 to 800	6 max.	Back-thinned CCD image sensor	• Suitable for spectroscopic measurement (fluorescence measurement, etc.) of low light levels	
C10082CAH			[High resolution] TM-UV/VIS-CCD		1 typ.			
C10082MD	[Wide dynamic range] TM-UV/VIS-MOS		6 max.	CMOS linear image sensor	• Suitable for use in environments with high light levels (light source spectrometry, absorbance measurement, etc.)			
C10083CA	 95 × 92 × 76		[High sensitivity] TM-VIS/NIR-CCD	320 to 1000	8 max. (320 to 900 nm)	Back-thinned CCD image sensor	• Suitable for spectroscopic measurement (fluorescence measurement, etc.) of low light levels	
C10083CAH			[High resolution] TM-VIS/NIR-CCD		1 typ. (320 to 900 nm)			
C10083MD	[Wide dynamic range] TM-VIS/NIR-MOS		8 max.		CMOS linear image sensor	• Suitable for use in environments with high light levels (light source spectrometry, absorbance measurement, etc.)		
C11697MB	[Triggering] TM-VIS/NIR-MOS-II			High sensitivity CMOS linear image sensor			• Triggering • Suitable for spectroscopic measurement using pulsed light	
C9404CA	 125.7 × 115.7 × 75	TG series	[High sensitivity] TG-UV-CCD	200 to 400	3 max.	Back-thinned CCD image sensor	• Suitable for spectroscopic measurement (fluorescence measurement, etc.) of low light levels	
C9404CAH			[High resolution] TG-UV-CCD		1 typ.			
C11713CA	[High resolution] TG-RAMAN-I		500 to 600	0.3 typ.	Back-thinned CCD image sensor	• Suitable for Raman spectrometry		
C11482GA	[No cooling] TG2-NIR		900 to 1700	7 max.	InGaAs linear image sensor	• For near infrared range • A low-noise, cooled type is available.		
C9913GC	[Low noise (cooled type)] TG-cooled-NIR-I							
C9914GB	[Low noise (cooled type)] TG-cooled-NIR-II		1100 to 2200	8 max.				
C11118GA	[Low noise (cooled type)] TG2-cooled-NIR-III		900 to 2550	20 max.				
C13053MA	 80 × 60 × 12*	TF series	[Compact, thin] TF-SWNIR	500 to 1100	3.5 max.	High-sensitivity CMOS linear image sensor	• Thin type • Triggering	
C13054MA			[Compact, thin] TF-RAMAN	790 to 920	0.4 typ.			
C14214MA			[Compact, thin] TF-RAMAN	790 to 1050	0.6 max.			
C13555MA			[Compact, thin] TF-VIS	340 to 830	3 max.	InGaAs linear image sensor		
C14486GA			[Compact, thin] TF-NIR	950 to 1700	7 max.			
C11007MA	 55 × 48 × 100	RC series	[Spectrometer module] RC-VIS-MOS	340 to 780	9 max.	CMOS linear image sensor	• Compact • Inexpensive	
C11008MA			[Spectrometer module] RC-SWNIR-MOS	640 to 1050	8 max.	High infrared sensitivity CMOS linear image sensor		
C11009MA	[Spectrometer head] RC-VIS-MOS		340 to 780	9 max.	CMOS linear image sensor	• For incorporating into devices		
C11010MA	[Spectrometer head] RC-SWNIR-MOS		640 to 1050	8 max.	High infrared sensitivity CMOS linear image sensor			
C11708MA	 27.6 × 13 × 16.8	MS series	[Spectrometer head] MS-SWNIR-MOS	640 to 1050	20 max.	CMOS linear image sensor	• For near infrared range	
C12666MA	 20.1 × 12.5 × 10.1	Micro-spectrometer	[Spectrometer head]	340 to 780	15 max.	CMOS linear image sensor	• Wide dynamic range	
C12880MA			[Spectrometer head]	340 to 850		High-sensitivity CMOS linear image sensor	• High sensitivity • Simultaneous integration	


* C14214MA: 100 × 60 × 12

Spectroscopic module

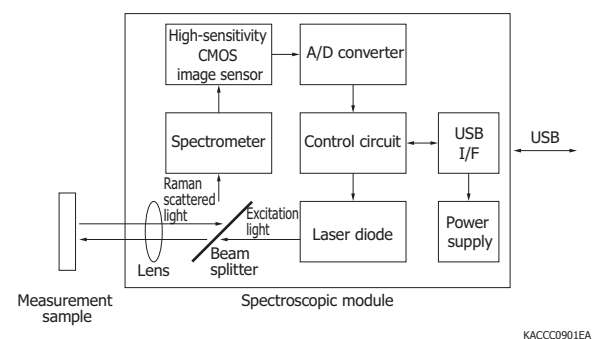
This is a compact, lightweight Raman spectroscopy analysis module. A compact spectrometer, excitation light source, wavelength filter, and other optical elements are integrated into a single unit. The module can be used for onsite screening tests and other applications that use Raman spectroscopy. In addition, using the surface-enhanced Raman spectroscopy (SERS) substrate makes high-sensitivity Raman spectroscopic analysis possible. The C13560 is a palm-sized lightweight type.



(Typ. unless otherwise noted)

Type no.	Photo W × D × H (mm)	Excitation wavelength (nm)	Excitation power (mW)	Spectral range (cm ⁻¹)	Resolution (cm ⁻¹)	Internal image sensor	Features
C13560	 96 × 14.5 × 60	785	5, 10, 15	400 to 1850	10	High-sensitivity CMOS linear image sensor	<ul style="list-style-type: none"> • Low power consumption • Palm size • Low cost

Block diagram



Connection example



SERS substrate J13856 (for C13560, sold separately)



Note: The J13856 is a product for customers that have purchased the C13560.

Light position, light-level, and color detection modules




Photodiode modules Photosensor amplifiers

Photodiode modules are high precision photodetectors that have built-in photodiode and a current-to-voltage converter. Because the output from these photodiode modules is an analog voltage signal, it can be easily measured with a voltmeter, etc. Photosensor amplifiers are current-to-voltage conversion amplifiers that can amplify the weak photocurrent of a photodiode with low noise levels.



Photodiode modules, Signal processing unit

(Typ. Ta=25 °C)

Type no.	Photo W × D × H (mm)	Features	Photo- diode type	Photosensitive area (mm)	Conversion impedance (V/A)	Cutoff frequency -3 dB (Hz)	Output noise voltage*1 (mVp-p)	Output	Power supply
C10439-01	 19 × 46 × 52	<ul style="list-style-type: none">• These modules have built-in photodiodes.• Suitable for light level monitors, color-difference meters, and flow meters	Si	2.4 × 2.4	H: 10 ⁹ L: 10 ⁷	H: 10 L: 1 k	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: 10 ⁶ L: 10 ⁴	H: 1 k L: 100 k*2				
C10439-08			5.8 × 5.8						
C10439-09			10 × 10						
C10439-10	 19 × 50 × 52		InGaAs	φ1	H: 10 ⁷ L: 10 ⁶	H: 100 L: 1 k			
C10439-11				φ3					
C10439-14			InAsSb	0.7 × 0.7					
C10475	 110 × 100 × 30	• Signal processing unit for the C10439 series	-	-	-	-	-	RS-232C	AC adapter (+12 V) or battery (one 9 V battery)

*1: Dark state *2: Output amplitude=2 Vp-p

Photosensor amplifiers

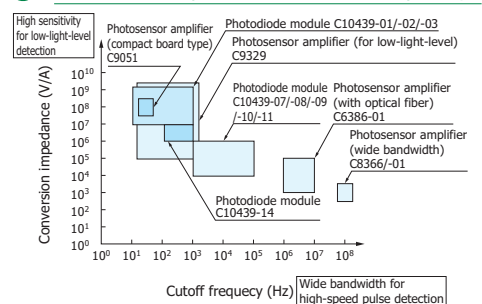
(Typ. Ta=25 °C, unless otherwise noted)

Type no.	Photo W × D × H (mm)	Features	Photodiode	Conversion impedance (V/A)	Cutoff frequency -3 dB (Hz)	Output noise voltage (mVp-p)	Output	Power supply
C6386-01	115 × 90 × 40	<ul style="list-style-type: none"> Optical fiber included Suitable for plasma monitors and for detecting scratches and defects in metal and glass 	Built-in (optical fiber diameter φ2 mm, NA 0.56)	H: 10 ⁵ M: 10 ⁴ L: 10 ³	H: 1 M M: 3 M L: 10 M	10 max.*3	Analog	External power supply (±15 V) or batteries (two 9 V batteries)
C8366	19 × 52 × 46	<ul style="list-style-type: none"> Fast and compact Suitable for high-speed light measurement (laser power monitoring, etc.) 	Sold separately (high-speed Si PIN PD; photosensitive area φ0.4 to φ5 mm)	10 ³	100 M	3	Analog	External power supply (±15 V)
C8366-01			Sold separately (high-speed InGaAs PIN PD; photosensitive area φ0.3 to φ0.5 mm)					
C9051	50 × 50 × 19	<ul style="list-style-type: none"> Compact board type Suitable for optical power meters and illuminometers 	Sold separately (terminal capacitance of 5 nF or less)	10 ⁸	16	0.5 max.	Analog	AC adapter (+12 V)
C9329	115 × 90 × 40	<ul style="list-style-type: none"> Ultra-low noise and high gain Suitable for low-light-level detection and precise photometry 	Sold separately (terminal capacitance of 5 nF or less)	H: 10 ⁹ M: 10 ⁷ L: 10 ⁵	H: 16 M: 1.6 k L: 1.6 k	0.5 max.	Analog RS-232C	AC adapter (+12 V) or battery (one 9 V battery)

*3: Dark state

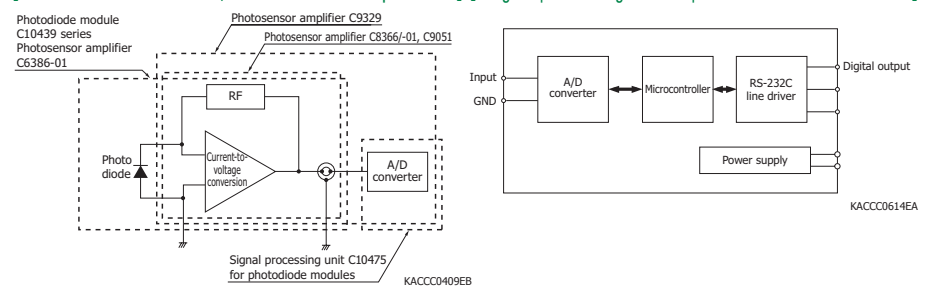
Note: Please refer to the datasheet for more information. We can also provide customized products. Please contact the sales office for more information.

Conversion impedance vs. cutoff frequency











Block diagram

[Photodiode modules, Photosensor amplifiers] [Signal processing unit for photodiode module C10475]

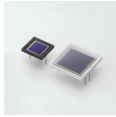

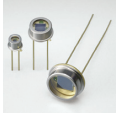






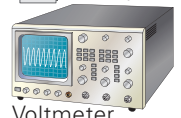








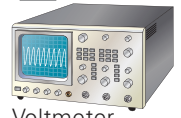

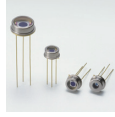











Connection example of photodiode modules

Photodiode module	Signal processing unit	Power supply and PC
 <p>C10439 series (with built-in photodiode)</p>  <p>Photodiode module connection cable (for power supply)*4</p>  <p>BNC-BNC cable (for signal)*4</p>	 <p>C10475</p>	 <p>AC adapter*4</p>  <p>RS-232C cable</p>  <p>AC 100 to 240 V 50/60 Hz</p>  <p>PC</p>

*4: Accessory for C10475 signal processing unit

Connection examples of photosensor amplifiers

Si photodiode	Photosensor amplifier	Power supply, measuring instrument, and PC
<p>For ArF excimer laser</p>  <p>S8552, S8553*5</p>  <p>BNC cable</p> <p>For high-precision photometry</p>  <p>S2281 series</p>  <p>BNC cable</p>	<p>Ultra-low noise and high gain</p>  <p>C9329*6</p>	 <p>AC adapter*7</p>  <p>BNC-BNC cable</p>  <p>RS-232C cable</p>  <p>AC 100 to 240 V 50/60 Hz</p>  <p>Voltmeter, oscilloscope, etc.</p>  <p>PC</p>
<p>Infrared high sensitivity S2386/S2387 series*5</p> <p>For UV to infrared range S1336/S1337 series</p> <p>Infrared sensitivity suppressed type S1226/S1227 series</p> <p>BNC connector included</p>  <p>S2281 series</p>  <p>BNC-BNC cable</p>	<p>Small board type</p>  <p>C9051</p>	 <p>AC adapter*7</p>  <p>BNC-BNC cable</p>  <p>BNC cable</p>  <p>AC 100 to 240 V 50/60 Hz</p>  <p>Voltmeter, oscilloscope, etc.</p>  <p>PC (with A/D conversion board)</p>
<p>High-speed Si PIN photodiode</p>  <p>S3071, S3072, S3399, S3883, S5821 S5971, S5972, S5973 series</p> <p>Insert the leads into the socket of the C8366</p>	<p>High-speed type C8366</p>  <p>C8366-01</p>	 <p>Power cable*7</p>  <p>Power supply (±15 V)</p>
<p>High-speed InGaAs PIN photodiode</p>  <p>G8376-03/-05 G10899-003K/-005K G12180-003A/-005A</p> <p>Insert the leads into the socket of the C8366-01</p>	<p>Optical fiber included (with built-in photodiode)</p>  <p>C6386-01*6</p>	 <p>BNC-BNC cable</p>  <p>BNC cable</p>  <p>Voltmeter, oscilloscope, etc.</p>  <p>PC (with A/D conversion board)</p>

*5: The S8553 and S2387-1010BQ cannot be used on the C9329.

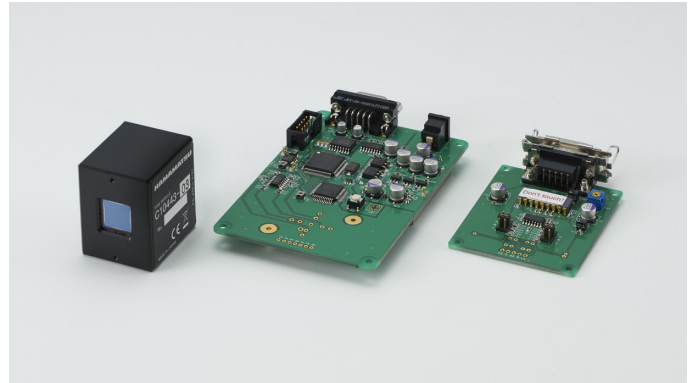
*6: Can also be driven by a rectangular battery (0006P, 9 V)

*7: Accessory for photosensor amplifiers

PSD modules

PSD signal processing circuits

The PSD modules are position detection modules that combine a PSD (position sensitive detector) and a current-to-voltage conversion circuit in a compact case. By using a PSD module with a signal processing unit for PSD modules (sold separately), you can acquire analog and digital position signals. PSD signal processing circuits use a current-to-voltage conversion circuit to convert the photocurrent from a PSD to voltage. Some types of signal processing circuits process the resulting voltage signal and output an analog voltage, while others process the signal, convert it to digital data using an A/D converter, and then output the resulting signal.



PSD modules, Signal processing unit

(Typ. Ta=25 °C)





Type no.	Photo W × D × H (mm)	Features	Photosensitive area (mm)	Position resolution (μm)	Position detection error (μm)	Cutoff frequency -3 dB (kHz)	A/D (bit)	Output	Power supply
C10443-01		• Built-in two-dimensional PSD	4 × 4	0.5	±70	16	-	Analog	External power supply (±5 to ±12 V)
C10443-02			9 × 9	1	±150	16			
C10443-03			12 × 12	1.4		16			
C10443-04				4.2		160			
C10443-06	34 × 40 × 44	• Built-in quadrant photodiode	10 × 10	-	-	160	16	Analog RS-232C	AC Adapter (+12 V)
C10460	150 × 100 × 30	• Signal processing unit for C10443-01/-02/-03/-04	-	5	*1	13.5			

*1: ±3%

Note: Please refer to the datasheet for more information.

PSD signal processing circuits

(Typ. Ta=25 °C)

Type no.	Photo W × D × H (mm)	Compatible PSDs				Conversion impedance (V/A)	Rise time (μs)	A/D (bit)	Output	Power supply
		Type no.	Photosensitive area X × Y (mm)	Position resolution (μm)						
C3683-02	 56 × 66 × 15.5	One- dimensional PSD	S4581-04	2 × 1	0.8	H: 10 ⁶ M: 10 ⁵ L: 10 ⁴	22	-	Analog	External power supply (±15 V)
C9068	 75 × 110 × 15		S4583-04, S8673	3 × 1	1.3					
			S4584 series, S3274-05	3.5 × 1	1.5					
			S7105 series	4.2 × 1	1.8	10 ⁵	*2	12	RS-232C	AC adapter (+12 V)
			S5629 series, S3931	6 × 1	2.5					
			S3932	12 × 1	5					
			S8543	24 × 0.7	10					
S3270	37 × 1	15.4								
C4674-01*3	 65 × 90 × 15.5	Two- dimensional PSD	S5990-01	4 × 4	1.7	H: 10 ⁶ M: 10 ⁵ L: 10 ⁴	22	-	Analog	External power supply (±15 V)
C9069*3	 75 × 110 × 15		S5991-01	9 × 9	3.8					
			S2044	4.7 × 4.7	2	10 ⁵	*2	12	RS-232C	AC adapter (+12 V)
			S1880	12 × 12	5					

*2: Signal conversion time=5 ms min.

*3: Also supports quadrant photodiodes. Please contact the sales office for more information.

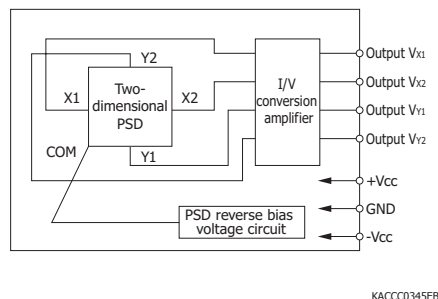
Note: Please refer to the datasheet for more information. We can also provide customized products. Please contact the sales office for more information.

Block diagrams

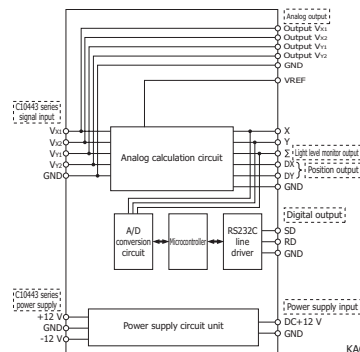
[C10443-01 to -04 PSD module]

[C10460 signal processing unit for PSD module]

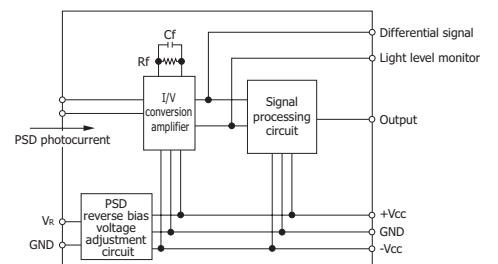
[C3683-02 PSD signal processing circuit]



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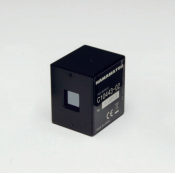









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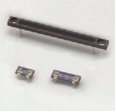
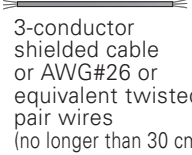
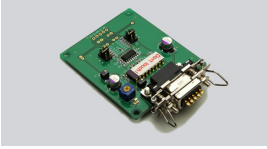
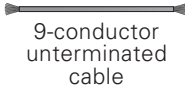
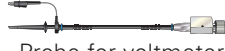

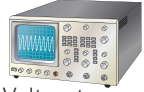






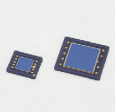


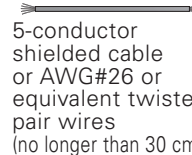

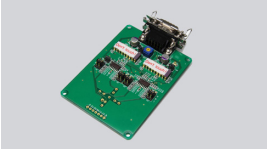
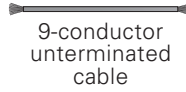
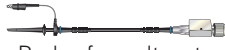



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Connection example of PSD module (C10443-01/-02/-03) and signal processing unit

PSD module	Signal processing unit	Power supply, measuring instrument, and PC
 <p>PSD module connection cable (for signal and power supply)*4</p> <p>C10443-01/-02/-03/-04 (with built-in PSD)</p>	 <p>C10460</p>	 <p>AC adapter*4</p>  <p>Cable for analog output*4</p>  <p>RS-232C cable</p>  <p>AC 100 to 240 V 50/60 Hz</p>  <p>Voltmeter, oscilloscope, etc.</p>  <p>PC</p>

*4: Accessory for C10460 signal processing unit

Connection example of PSD signal processing circuits

PSD	PSD signal processing circuit	Power supply, measuring instrument, and PC
<p>One-dimensional PSDs</p>  <p>Plastic packages S4581-04, S4583-04 S8673 S4584 series S3274-05 S7105 series S5629 series</p>  <p>Ceramic packages S3931*5 S3932*5 S8543 S3270*5</p>  <p>3-conductor shielded cable or AWG#26 or equivalent twisted pair wires (no longer than 30 cm)</p>	<p>Analog voltage output</p>  <p>C3683-02</p>	 <p>9-conductor unterminated cable</p>  <p>Probe for voltmeter or oscilloscope (x 1)</p>  <p>Power supply (±15 V)</p>  <p>Voltmeter, oscilloscope, etc.</p>  <p>PC (with A/D conversion board)</p>
	<p>RS-232C output</p>  <p>C9068</p>	 <p>AC adapter*6</p>  <p>RS-232C cable</p>  <p>AC 100 to 240 V 50/60 Hz</p>  <p>PC</p>
<p>Two-dimensional PSDs</p>  <p>Surface mount type S5990-01, S5991-01</p>  <p>Board for mounting*6 S5990-01, S5991-01</p>  <p>Ceramic/metal packages S1880*5 S2044*5</p>  <p>5-conductor shielded cable or AWG#26 or equivalent twisted pair wires (no longer than 30 cm)</p>	<p>RS-232C output</p>  <p>C9069</p>	
	<p>Analog voltage output</p>  <p>C4674-01</p>	 <p>9-conductor unterminated cable</p>  <p>Probe for voltmeter or oscilloscope (x 2)</p>  <p>Power supply (±15 V)</p>  <p>Voltmeter, oscilloscope, etc.</p>  <p>PC (with A/D conversion board)</p>

*5: Can also be directly mounted on a PSD signal processing circuit

*6: Accessory for PSD signal processing circuit

Optics modules

The C13398 series is an optics module for blood analysis device featuring high blocking performance and low noise. It is composed of Si photodiodes, beam splitters, filters, and current-to-voltage conversion circuit. The C13398-01 can detect 10 wavelengths of light simultaneously. The C13398-02 can detect 9 wavelengths of light and a reference light simultaneously. In combination with the dedicated evaluation circuit C13390 (sold separately), the analog output signals of each channel of the C13398 series can be converted into digital signals, and the results can be acquired into the PC.



Optics modules

(Typ. $T_a=25\text{ }^{\circ}\text{C}$, $V_s=\pm 10\text{ V}$, unless otherwise noted)

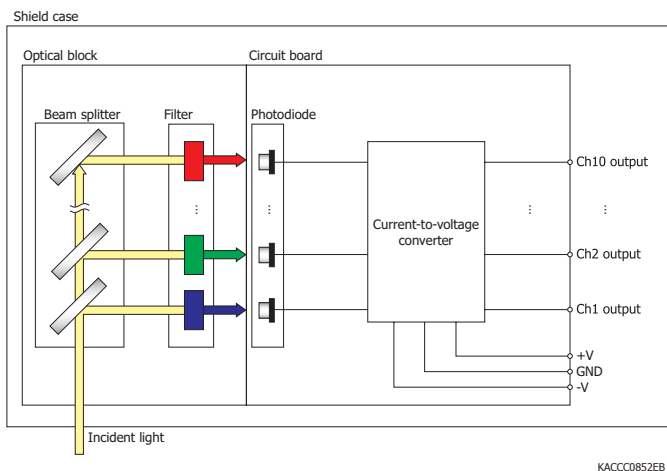
Type no.	Photo W × D × H (mm)	Detection wavelength (nm)	Conversion impedance (V/A)	Cutoff frequency -3 dB (kHz)	Output noise voltage Dark state (mVp-p)	Blocking min.
C13398-01	38 × 89 × 26	10 wavelengths (340, 405, 450, 510, 546, 570, 600, 630, 660, 700)	10^7	1.6	1	4
C13398-02		9 wavelengths (340, 380, 405, 492, 510, 546, 578, 620, 690) + Reference light				

Evaluation circuit for optics module

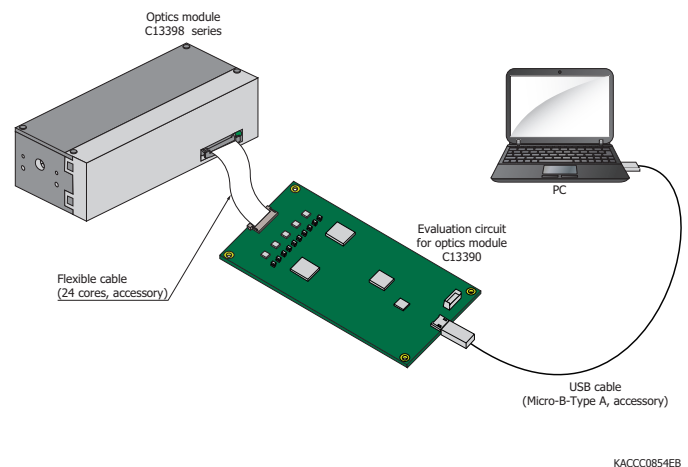
($T_a=25\text{ }^{\circ}\text{C}$)

Type no.	Photo W × D × H (mm)	Features	Full scale error max. (LSB)	Resolution max. (bit)	Output	Sample software
C13390	60 × 100 × 7.8	<ul style="list-style-type: none"> • USB bus powered • Up to 10 channels of output signals can be acquired into a PC. 	±32	16	USB 2.0	○

Block diagram

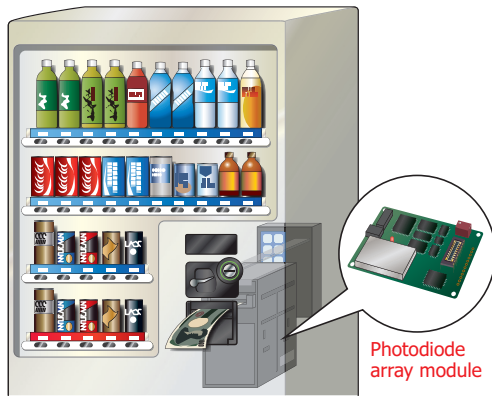


Connection example



Application examples

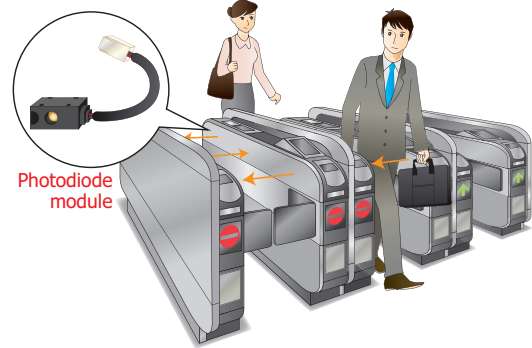
[Vending machine]



KACCC0603EA

Photodiode modules can be used to detect the width and length of paper money and thereby determine its authenticity.

[Automatic ticket inspection device]



KACCC0604EA

Photodiode modules can be used to inspect passengers and baggage and to reduce ticket processing mistakes.

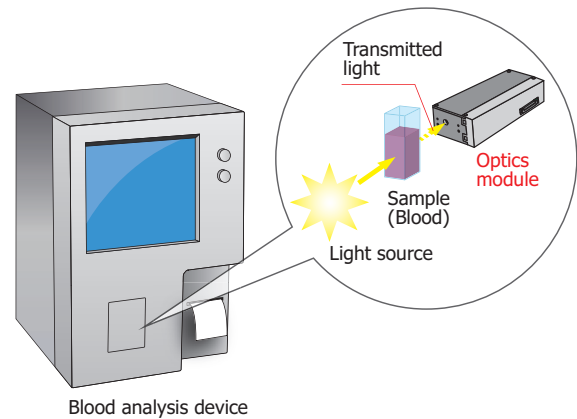
[IH cooking heater]



KACCC0605EA

Photodiode modules can be used to detect the temperature at the bottom of a pan.

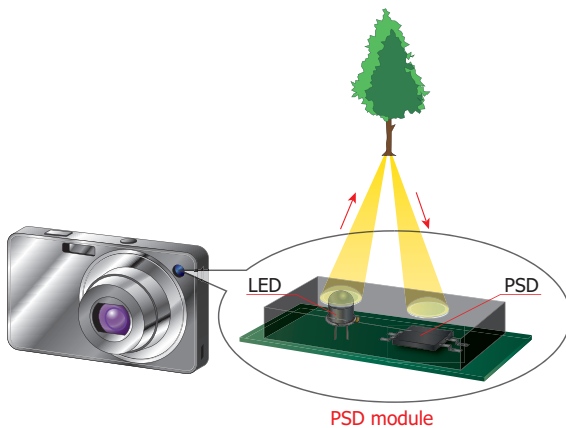
[Blood analysis device]



KACCC0606EB

Optics modules can be used to analyze components contained in blood by directing light on the blood and measure the transmitted light for each wavelength.

[Camera autofocusing]



KACCC0607EA

A PSD module detects how infrared light emitted onto the object is reflected, and this information is used to calculate the distance to the object.

[Solar position detection]



KACCC0608EA

Photodiode modules (or PSD modules) can be used to detect sunlight and open and close shutters or blinds.

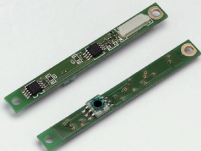

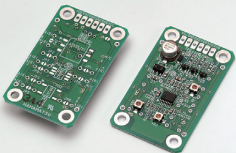
Color sensor modules

In addition to modules with built-in color sensors, we also offer evaluation circuits that you can mount color sensors onto. These products can be used for LCD display color monitoring, simple color detection, etc.



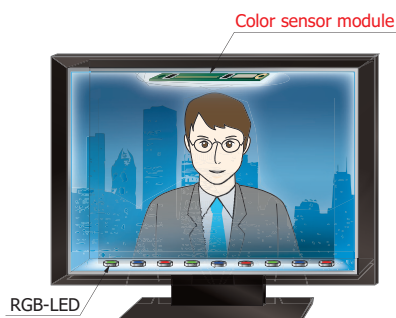
Color sensor modules, Color sensor evaluation circuit

(Typ. Ta=25 °C)

Product name	Color sensor module			Color sensor evaluation circuit
Type no.	C9303-03	C9303-04	C9315	C9331
Photo				
Features	Standard type	High gain type	<ul style="list-style-type: none">• For RGB information measurement of object color• Has an internal white LED as the light source, converts the reflected light into RGB data, and outputs the data to a PC• Measures small areas using an objective optical fiber• 12-bit digital output (RS-232C compatible)	<ul style="list-style-type: none">• Current-to-voltage conversion amplifier allowing a Hamamatsu color sensor (S7505-01, S9032-02) to be mounted
	<ul style="list-style-type: none">• Compact design that enables attachment to the side of the LCD backlight's light-guide plate			
Light source	No		Yes (white LED)	No
Color sensor	Yes		Yes	No
Conversion impedance	R: 91 kΩ G: 91 kΩ B: 100 kΩ	R: 680 kΩ G: 680 kΩ B: 680 kΩ	—	Variable (1×10^5 to $5.1 \times 10^5 \Omega$)
Cutoff frequency -3 dB	16 kHz	2.4 kHz	Digital output period: 200 ms	14 kHz
Light source measurement	Yes		No	Yes
Applications	<ul style="list-style-type: none">• White balance detection of LCD backlight (RGB-LED type)		<ul style="list-style-type: none">• Measurement of object color• Color monitoring of opaque body (molded parts, painting, printing, cosmetics, etc.)• Simple detection of color difference	<ul style="list-style-type: none">• Measurement of light source color• Evaluation of S7505-01 and S9032-02
Accessories	<ul style="list-style-type: none">• Dedicated cable with connector		<ul style="list-style-type: none">• Dedicated AC adapter• Sample software (data acquisition, recording, relative chromaticity Yxy display not conforming to CIE)• White reference card	—

Application examples

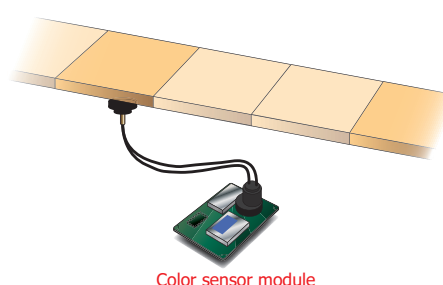
[Color adjustment for LCD backlights]



KACCC0609EA

The white balance of the LCD backlight's light-guide plate is detected, the RGB-LED light level is controlled, and the color of the LCD backlight is made to be consistent.

[Color detection of products]



KACCC0610EA

A color sensor module can be used to detect color differences in an object through the irradiation of light from the built-in LED onto the object and then the conversion of the reflected light into R, G, and B parameters.



Balanced detectors

These are differential amplification type photoelectric conversion modules containing two Hamamatsu photodiodes with balanced characteristics. The photodiodes are connected in a direction that cancels out the photocurrent of each photodiode. This configuration cancels out the common mode noise of the two incident light rays. The minute difference in light levels is treated as a displacement signal, converted into an electrical signal, and output. Moreover, the adoption of our unique structure that suppresses multiple reflections of incident light has made it possible to reduce the noise caused by the reflections. These products can be applied to optical coherence tomography (OCT) used in ophthalmologic examinations and the like. The balanced detector can convert into electrical signals the minute difference in the signal light produced when the back scattering light from the subject is made to interfere with the reference light.

Features

- Employs our unique structure that reduces multiple reflections at the incident light wavelength of 1.0 μm or 1.3 μm
- Input section: FC receptacle (APC polished)
A single-mode fiber with an FC connector can be connected.
- Output section: SMA receptacle
- Compact

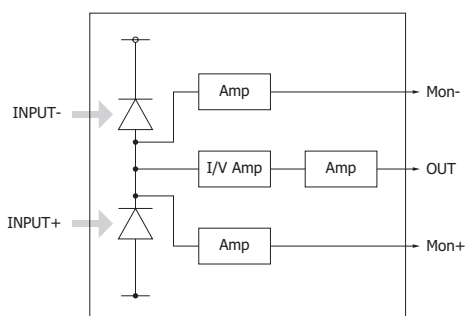
(Typ. $T_a=25^\circ\text{C}$)

Type no.	Photo W × D × H (mm)	Built-in photodiode	Conversion impedance (V/A)	Cutoff frequency -3 dB (MHz)	Common-mode rejection ratio*2 (dB)	Output noise voltage max. (mVp-p)	Input	Output	Supply voltage
		Optimal wavelength band*1 (μm)							
C12668-01	 25 × 54.5 × 65	1.0	3 × 10 ⁴	200	35	40	FC/APC	SMA	External power supply (±12 V)
C12668-02		1.3							
C12668-03	 25 × 78 × 72	1.0	1 × 10 ⁴	400	30				
C12668-04		1.3							

*1: Wavelength band in which multiple reflections can be reduced the most

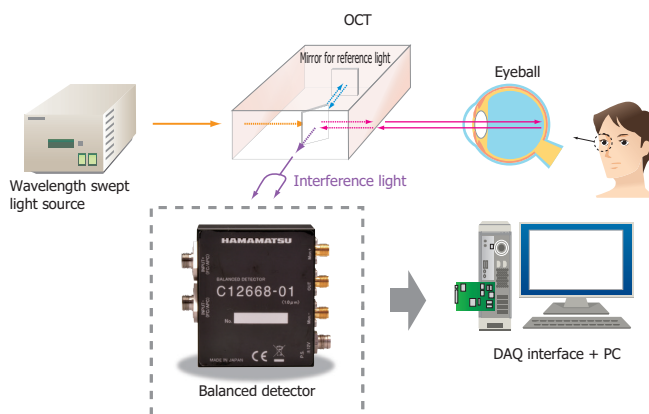
*2: Output difference when an approximately 70 μW light is applied to only the INPUT- terminal and when applied to INPUT+ and INPUT- terminals

Block diagram



KACCC0761EA

Connection example (ophthalmic medical OCT)



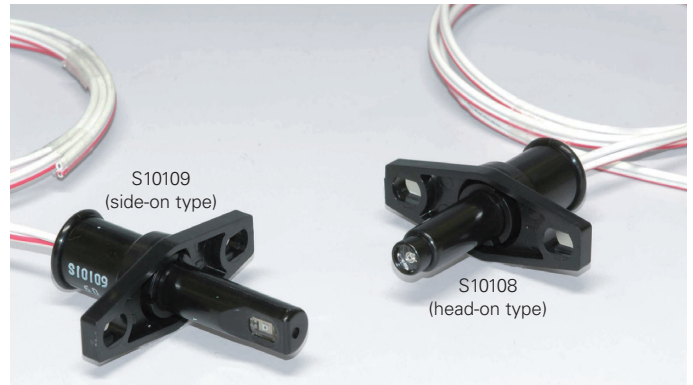
KACCC0762EA

Flame eyes (monitors)

The “flame eye” is a sensor that monitors flames in oil boilers and heating equipment. It detects light emitted from the flame so that the combustion state can be observed. Because this flame eye has a photo IC diode instead of a conventional CdS photoconductive cell, it provides stable detection performance. The flame eye is easy to install because the sensor is integrated into the cable assembly. Two types of flame eyes with different light input directions (a head-on type and a side-on type) are available.

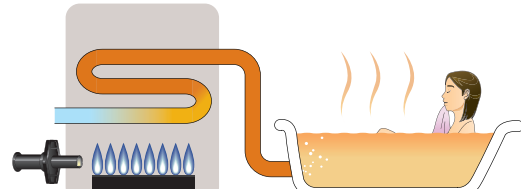
Features

- Internal photo IC diode
The internal photo IC diode boosts the photocurrent generated from the photodiode approx. 13000 times.
The photo IC diode outputs current and can be used the same as a photodiode applied with a reverse voltage.
- Spectral response that is suitable for detecting oil burner flames, etc.
- Cable assembly for easy installation into equipment
- Small output current variations and good output linearity



Application example

(Observation of the combustion condition of a hot-water heater)



KACCC0611EA

Detects light emitted from the flame so that the combustion state can be observed.

Sunlight sensor

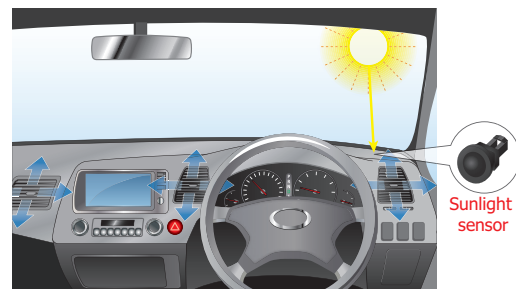
Sunlight sensors detect the light level of sunlight and ambient light. A photodiode with superb linearity relative to the light level is built in a small case with a connector.

Features

- High reliability (for automotive use)
- The optical design of the cover makes it possible to adjust the directivity for different applications.
- Both visible light and near-infrared light sensors can be selected.



Application examples (Sunlight sensor)



KACCC0612EA

A sunlight sensor can be used to detect the amount of sunshine to control the volume of air flow of an automotive air conditioner.



Related products and circuits for infrared detectors and image sensors

Infrared detector modules with preamp

These modules integrate preamps and various infrared detectors. Modules are available for a variety of different wavelength ranges. You can detect infrared light simply by connecting a DC power supply.



(Typ.)

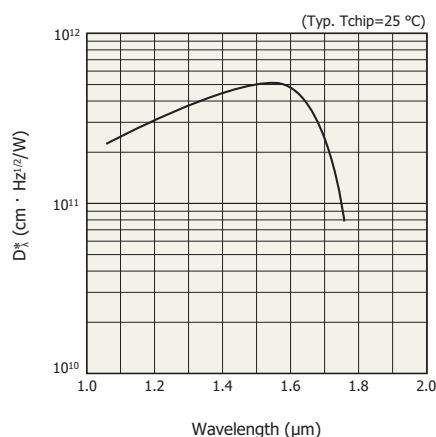
Type	Type no.	Photo	Detector (built-in)	Photosensitive area (mm)	Cooling	Measurement condition	Cutoff wavelength (μm)	Peak sensitivity wavelength (μm)
						Chip temperature (°C)		
Room-temperature type	G6121		InGaAs (G8370-05)	φ5	No cooling	25	1.7	1.55
	C12496-046		Photon drag (B749)	φ4.6			-	10.6
TE-cooled type	C12483-250		InGaAs (G12180-250A)	φ5	TE-cooling	-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
	C12492-210S		InAsSb (P11120-201)	φ1		-28	5.9	4.9
	C12492-210M		InAsSb (P12691-201)				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

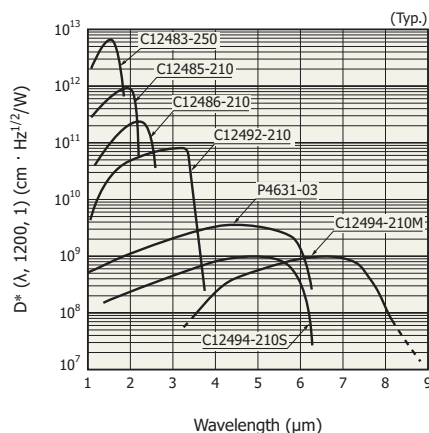
*2: FOV=60°

Spectral response

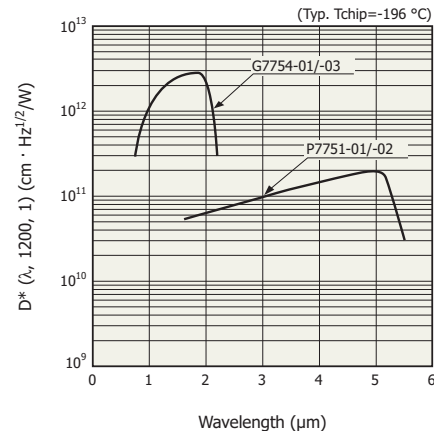
[Room-temperature type]



[TE-cooled type]



[Metal dewar type]



Multichannel detector heads

Because the electronics and signal processing of image sensors are more complicated than those of single-element sensors, we offer multichannel detector heads that can be connected to sensors and used. It's easy to use these detector heads with a controller and software to gather data.



Type	Type no.	Output	Applicable sensors	
For front-illuminated CCD image sensor	C7020	Analog	S9970 series	Sold separately
	C7020-02		S9972 series	
	C7021		S9971-0906/-1006/-1007	
	C7021-02		S9973-1007	
	C7025		S9971-1008	
	C7025-02		S9973-1008	
For back-thinned CCD image sensor	C7040	Analog	S7030 series	Sold separately
	C7041		S7031 series	
	C7043		S7033 series	
	C7044		S7034 series	
	C7180		S7170-0909	
	C7181		S7171-0909-01	
For NMOS linear image sensor	C5964 series	Analog	S5930/S5931/S8382/S8383 series	Built-in
	C8892		S3901 to S3904/S8380/S8381 series (excluding S3901-1024Q and S3904-2048Q)	Sold separately
For InGaAs linear image sensor	C10854	CameraLink	G10768 series	Sold separately
	C8061-01	Analog	G9201/G9203/G9211/G9213-256S G9202/G9204/G9212/G9214-512S	
	C8062-01		G9205/G9206/G9207/G9208-256W G9205/G9206/G9208-512W G9206-02	
For InGaAs area image sensor	C11512	CameraLink	G11097-0606S, G12460-0606S	Sold separately
	C11512-02		G12242-0707W	

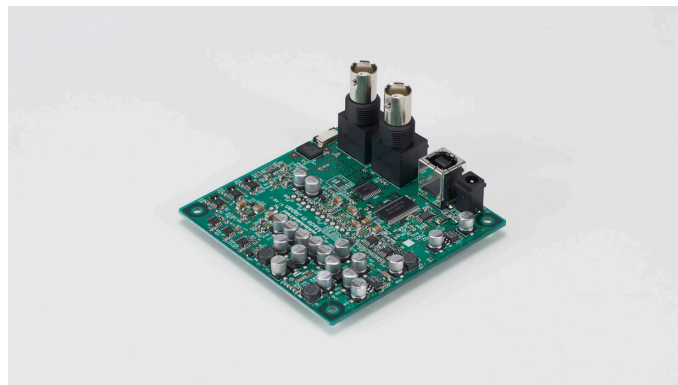
Related products



Controller for multichannel detector head
C7557-01
(Applicable with analog output type CCD/
NMOS/InGaAs multichannel detector heads)

Circuits for image sensors

These are driver circuits for CCD, NMOS, and CMOS image sensors.



Type	Type no.	Output	Features	Applicable sensors	
Driver circuit for CCD image sensor	C11287	Digital	Signal frequency: 250 kHz, USB 2.0, USB bus power	S10420-01 series	Sold separately
	C11288		Signal frequency: 4 MHz, USB 2.0	S11071 series	
	C11165-01		Signal frequency: 6 MHz, USB 2.0	S11155/S11156-2048-01	
	C11165-02		Signal frequency: 6 MHz, USB 2.0	S11155/S11156-2048-02	
	C11860		Single power supply, USB 2.0	S11850-1106	
Driver circuit for NMOS image sensor	C7884	Analog	High-precision, current output type	S3901 to S3904 series S8380/S8381 series (excluding S3901-1024Q and S3904-2048Q)	
	C7884-01		Low noise, current output type		
Driver circuit for CMOS image sensor	C9001	Analog	Single power supply (+5 V) operation	S8377/S8378 series	
	C10808 series		Supports variable integration time	S10111 to S10114/S10121 to S10124 series	
	C13015-01	Digital	USB 2.0, USB bus power	S11639-01, S11638, S12706, S13496	
Driver circuit for InGaAs image sensor	C10820	Analog	High-gain settings for low light levels	G9494 series	
	C11513	Digital	USB 2.0, USB bus power	G11620 series (except cooled type)	
	C11514		CameraLink compatible	G11135 series, G14006-512DE	



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No.



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HAMAMATSU

HAMAMATSU PHOTONICS K.K., Solid State Division

1126-1, Ichino-cho, Higashi-ku, Hamamatsu City, 435-8558, Japan

Telephone: (81)53-434-3311, Fax: (81)53-434-5184

www.hamamatsu.com

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Sales Offices

■ Japan:

HAMAMATSU PHOTONICS K.K.

325-6, Sunayama-cho, Naka-ku,
Hamamatsu City, Shizuoka Pref. 430-8587, Japan
Telephone: (81)53-452-2141, Fax: (81)53-456-7889
E-mail: intl-div@hq.hpk.co.jp

■ China:

HAMAMATSU PHOTONICS (CHINA) Co., Ltd.

Main Office
1201 Tower B, Jiaming 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

Shanghai Branch

4905 Wheelock Square, 1717 Nanjing Road West,
Jingan District, 200040 Shanghai, P.R.China
Telephone: (86)21-6089-7018, Fax: (86)21-6089-7017

■ Taiwan:

HAMAMATSU PHOTONICS TAIWAN Co., Ltd.

Main Office
8F-3, No.158, Section2, 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

■ U.S.A.:

HAMAMATSU CORPORATION

Main Office
360 Foothill Road, Bridgewater, NJ 08807, U.S.A.
Telephone: (1)908-231-0960, Fax: (1)908-231-1218
E-mail: usa@hamamatsu.com

California Office

2875 Moorpark Ave. San Jose, CA 95128, U.S.A.
Telephone: (1)408-261-2022, Fax: (1)408-261-2522
E-mail: usa@hamamatsu.com

Chicago Office

4711 W.Golf Road, Suite 805, Skokie, IL 60076, U.S.A.
Telephone: (1)847-825-6046, Fax: (1)847-825-2189
E-mail: usa@hamamatsu.com

Boston Office

20 Park Plaza, Suite 312, Boston, MA 02116, U.S.A.
Telephone: (1)617-536-9900, Fax: (1)617-536-9901
E-mail: usa@hamamatsu.com

■ United Kingdom:

HAMAMATSU PHOTONICS UK Limited

Main Office
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

South Africa Contact:

9 Beukes Avenue, Highway Gardens, Edenvale
1609 South Africa
Telephone/Fax: (27)11-609-0367

■ France, Portugal, Belgium, Switzerland, Spain:

HAMAMATSU PHOTONICS FRANCE S.A.R.L.

Main Office
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

Swiss Office

Dornacherplatz 7, 4500 Solothurn, Switzerland
Telephone: (41)32-625-60-60, Fax: (41)32-625-60-61
E-mail: swiss@hamamatsu.ch

Belgian Office

Axisparc Technology, rue Andre Dumont 7
1435 Mont-Saint-Guibert, Belgium
Telephone: (32)10 45 63 34, Fax: (32)10 45 63 67
E-mail: info@hamamatsu.be

Spanish Office

C. Argenters, 4 edif 2 Parque Tecnológico del Vallés
08290 Cerdanyola (Barcelona), Spain
Telephone: (34)93 582 44 30, Fax: (34)93 582 44 31
E-mail: infospain@hamamatsu.es

■ Germany, Denmark, The Netherlands, Poland:

HAMAMATSU PHOTONICS DEUTSCHLAND GmbH

Main Office
Arzbergerstr. 10, D-82211 Herrsching am Ammersee,
Germany
Telephone: (49)8152-375-0, Fax: (49)8152-265-8
E-mail: info@hamamatsu.de

Danish Office

Lautruphøj 1-3, DK-2750 Ballerup, Denmark
Telephone: (45)70 20 93 69, Fax: (45)44 20 99 10
Email: info@hamamatsu.dk

Netherlands Office

Transistorstraat 7, NL-1322 CJ Almere, The Netherlands
Telephone: (31)36-5405384, Fax: (31)36-5244948
E-mail: info@hamamatsu.nl

Poland Office

8 St. A. Boboli Str. PL-02-525 Warsaw, Poland
Telephone: (48)22-646-0016, Fax: (48)22-646-0018
E-mail: poland@hamamatsu.de

■ North Europe and CIS:

HAMAMATSU PHOTONICS NORDEN AB

Main Office
Torshamnsgatan 35 16440 Kista, Sweden
Telephone: (46)8-509 031 00, Fax: (46)8-509 031 01
E-mail: info@hamamatsu.se

Russian Office

11, Christoprudny Boulevard, Building 1, Office 114,
101000, Moscow, Russia
Telephone: (7)495 258 85 18, Fax: (7)495 258 85 19
E-mail: info@hamamatsu.ru

■ Italy:

HAMAMATSU PHOTONICS ITALIA S.r.l.

Main Office
Strada della Moia, 1 int. 6, 20020 Arese (Milano), Italy
Telephone: (39)02-93 58 17 33, Fax: (39)02-93 58 17 41
E-mail: info@hamamatsu.it

Rome Office

Viale Cesare Pavese, 435, 00144 Roma, Italy
Telephone: (39)06-50 51 34 54, Fax: (39)02-93 58 17 41
E-mail: inforoma@hamamatsu.it