

# 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  
C13365-1350SA

# 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.

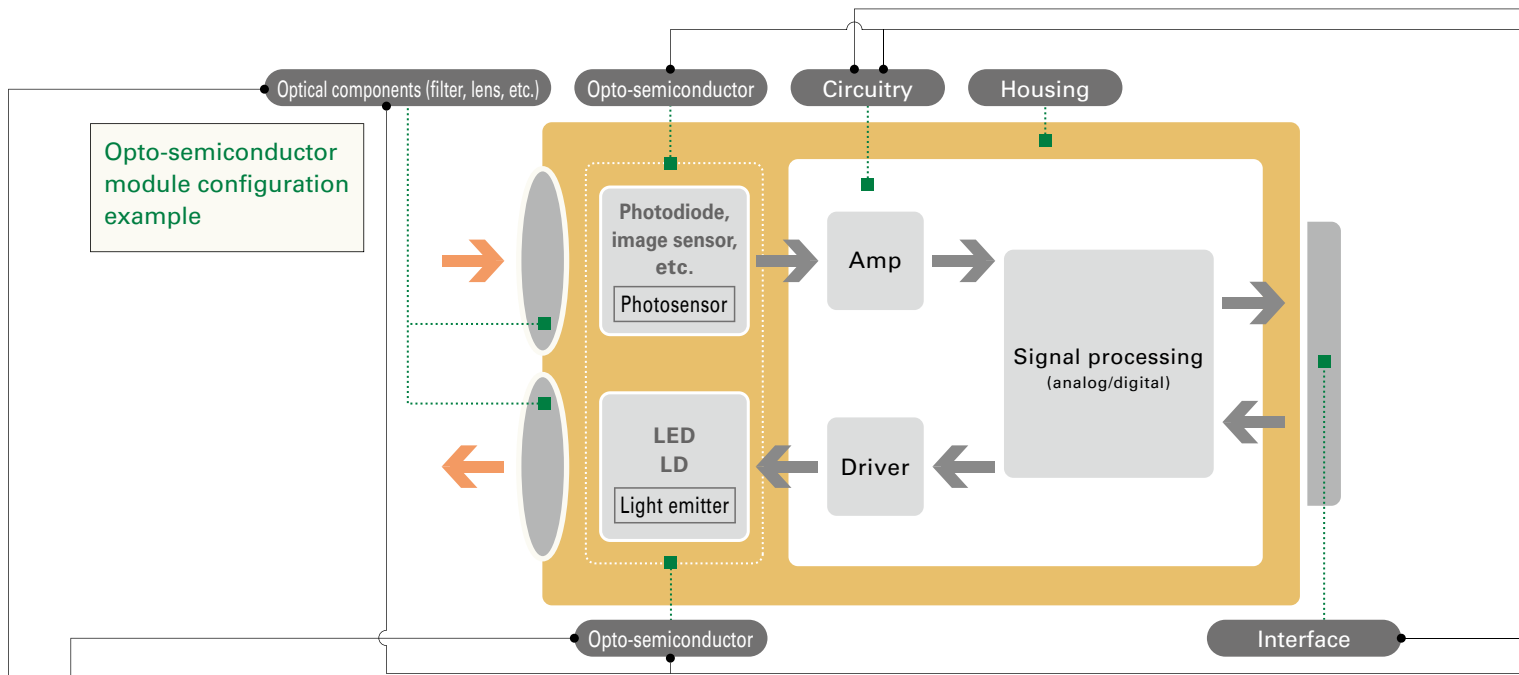


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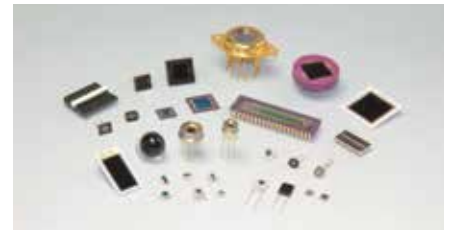


# Technologies that create opto-semiconductor modules

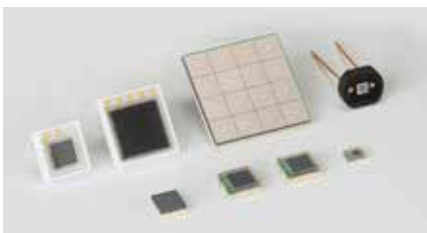


## 01 Opto-semiconductor technology

- 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



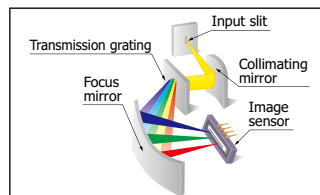
▲ LED

## 02 Optical technology

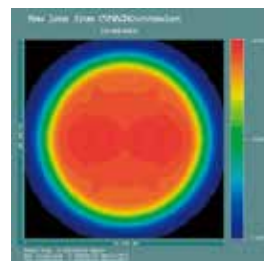
- Optimal optical design leads to high-performance modules.
- Use of simulations  
We perform optics simulations in-house to create optical designs quickly and flexibly.



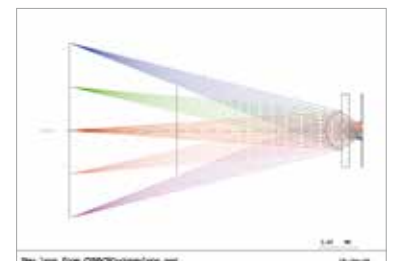
▲ Inside of a mini-spectrometer



▲ Optical system layout example of a mini-spectrometer

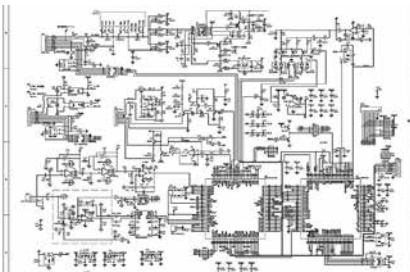


▲ Optical simulation example



## 03 Circuit technology

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



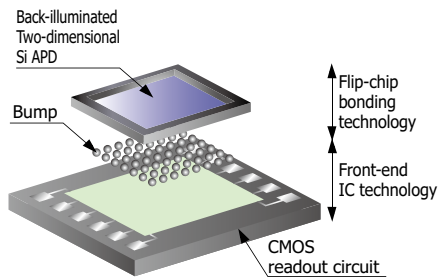
▲ Circuit example



▲ Circuit mounting example

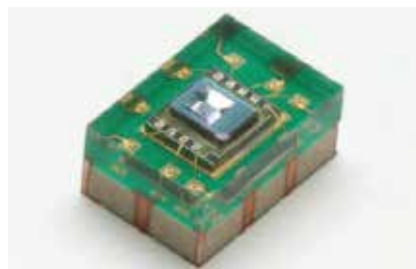
## 04 Mounting technology

- 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.

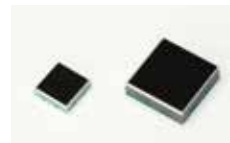


▲ Example of our mounting technology applied

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▲ Hybrid device (using front-end IC technology)



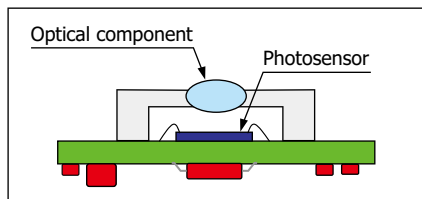
◀ Chip-size packages (Flip-chip bonding technology is used.)



◀ COB



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



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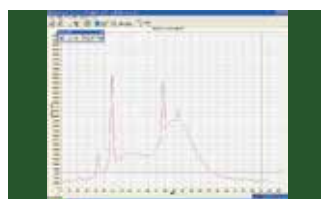


▲ Dual-sided mounting

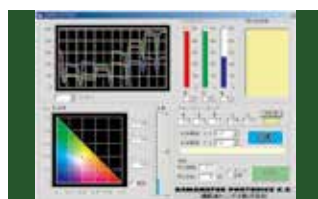


## 05 Software technology

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



▲ Mini-spectrometer measurement example

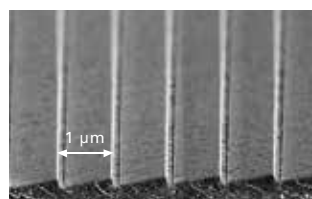


▲ Color sensor module measurement example

## 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.

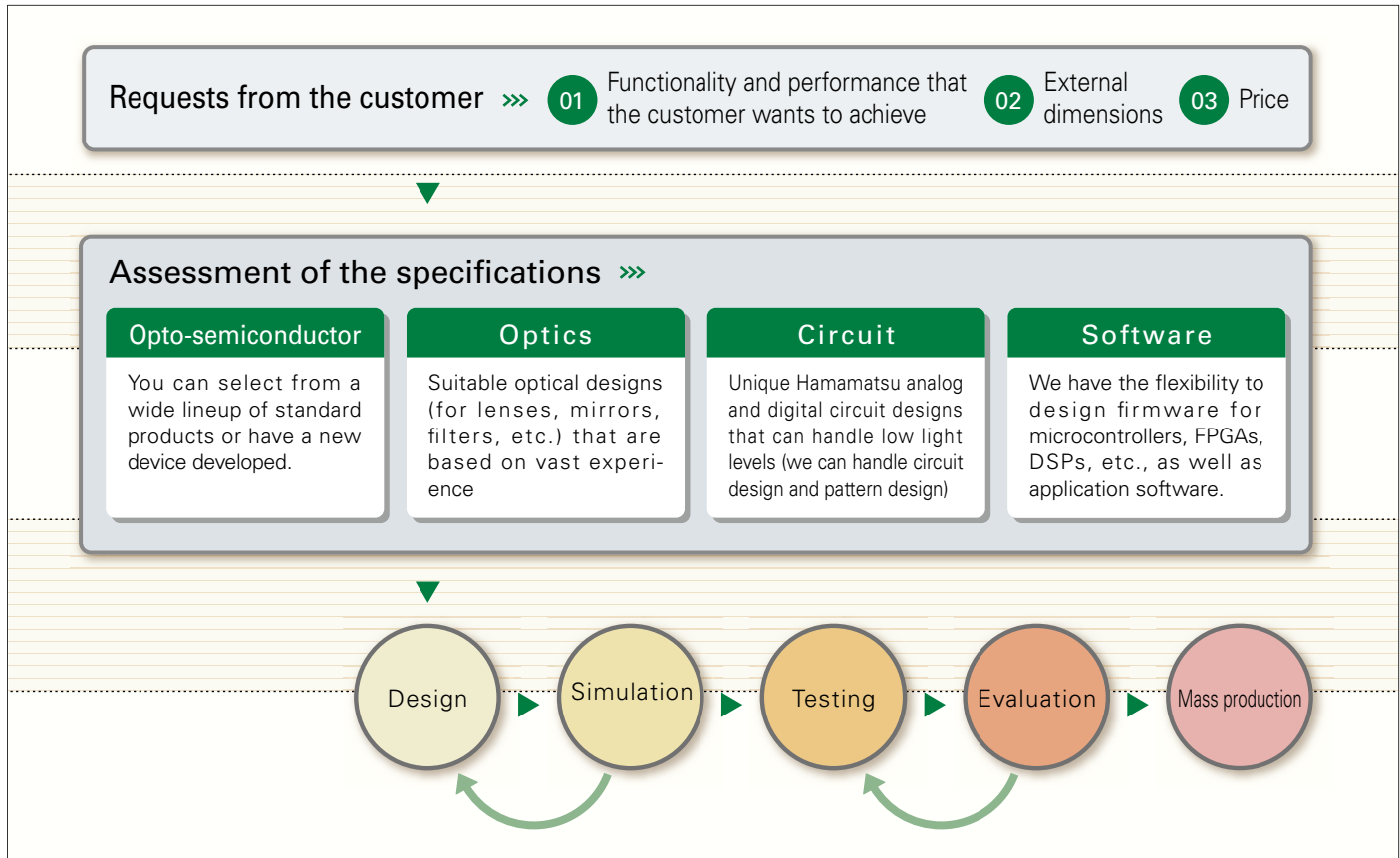
▼ If you have the following requests regarding opto-semiconductor modules, contact your local Hamamatsu office.

- 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



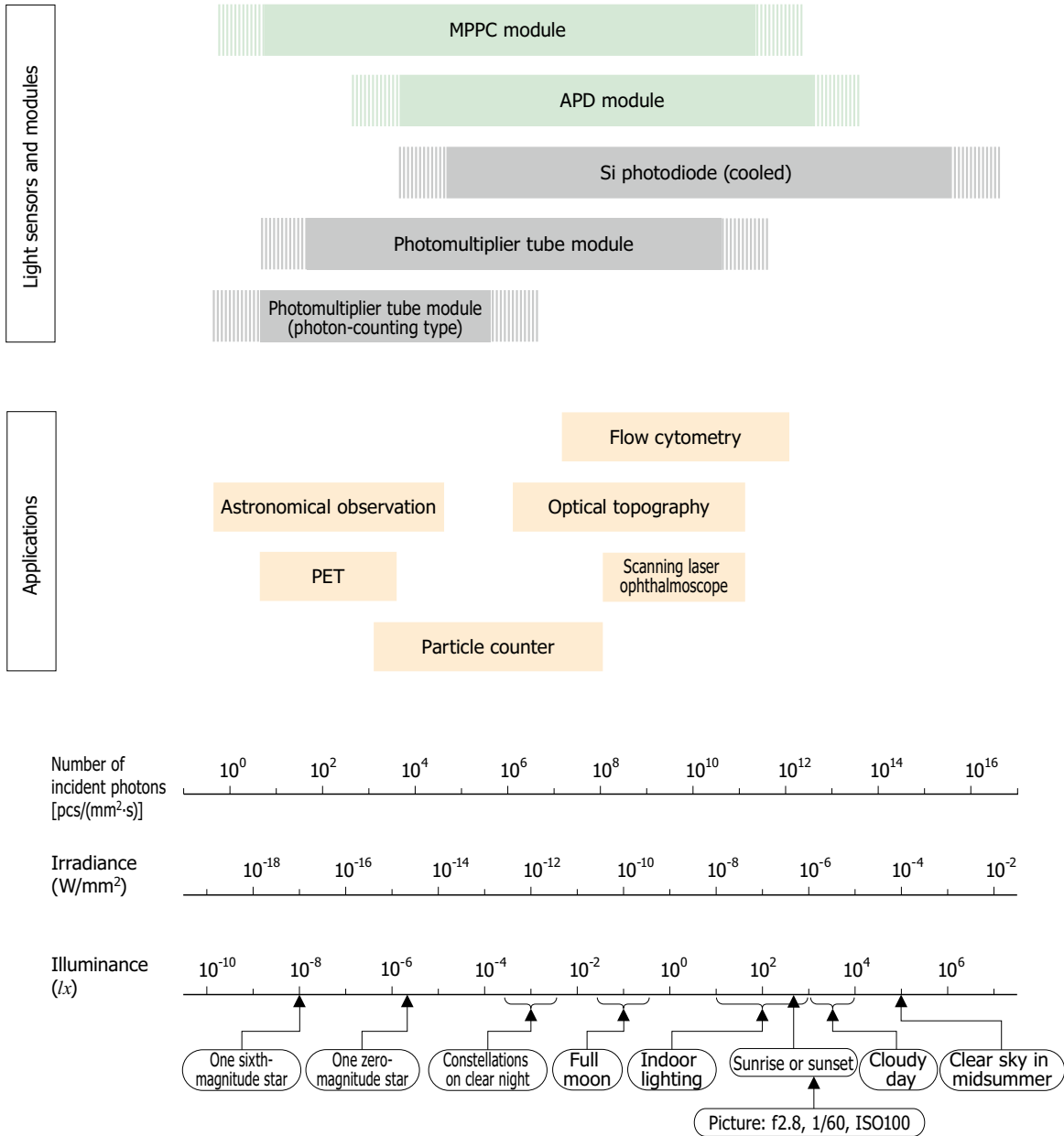
## Process for developing a custom product

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



# 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  $\lambda=555$  nm.

KACCC0616EB




## 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<br>W × D × H<br>(mm)  | Built-in MPPC                                    | Effective<br>photosensitive<br>area<br>(mm) | Pixel<br>pitch<br>(μm) | Photoelectric<br>sensitivity<br>(V/W) | Noise<br>equivalent<br>power<br>(fW/Hz <sup>1/2</sup> ) | Temperature<br>control                      | Supply<br>voltage<br>(V) |
|---------------|---|--|---|------------------------|---------------------------------------|---|---|--------------------------|
| C13365-1350SA |  | S13360-1350CS                                    | 1.3 × 1.3                                   | 50                     | 1 × 10 <sup>9</sup>                   | 0.5   | Temperature<br>compensation<br>(non-cooled) | ±5                       |
| C13365-3050SA |   | S13360-3050CS                                    | 3.0 × 3.0                                   |                        |                                       | 1.2   |   |                          |
| C13366-1350GA |  | TE-cooled type<br>(for precision<br>measurement) | 1.3 × 1.3                                   |                        |                                       | 0.1   | TE-cooled<br>(-20 °C)                       |                          |
| C13366-3050GA |   |  | 3.0 × 3.0                                   |                        |                                       |   |   |                          |
| C11209-110    |  | S12571-010C                                      | 1.0 × 1.0                                   | 10                     | 2.6 × 10 <sup>6</sup>                 | 3   | Temperature<br>compensation<br>(non-cooled) | +5                       |


### Digital output type

(Typ.)

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

### Starter kit

(Typ.)

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

### 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



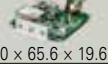
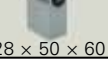


# APD modules

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

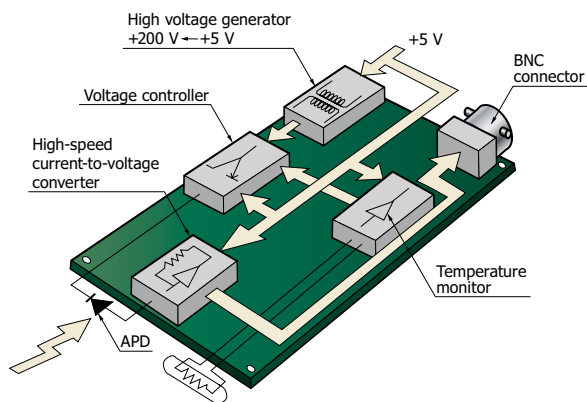


(Typ. unless otherwise noted)

| Type                | Type no.                   | Photo<br>W × D × H<br>(mm)  | Effective<br>photosensitive<br>area*<br>(mm)                                      | Built-in<br>APD | Cutoff frequency |               | Photoelectric<br>conversion sensitivity<br>M=30<br>λ=800 nm<br>(V/W) | Minimum<br>detection limit<br>M=30<br>λ=800 nm<br>(nW rms) | Temperature<br>stability of gain<br>25 ± 10 °C<br>(%) | Supply<br>voltage<br>(V) |    |
|---------------------|----------------------------|---|---|-----------------|------------------|---------------|--|--|---|--------------------------|----|
|                     |                            |   |   |                 | Low<br>speed     | High<br>speed |  |  |   |                          |    |
| Standard            | For near<br>infrared light | C12702-03   |  | φ1.0            | S12023-10        | 4 kHz         | 100 MHz  | -6.8 × 10 <sup>4</sup>                                     | 3   | ±2.5                     | +5 |
|                     |                            | C12702-04   |   | φ3.0            | S2384            |               | 80 MHz   | -2.3 × 10 <sup>4</sup>                                     | 3.6   |                          |    |
|                     | For short<br>wavelengths   | C12702-11   |   | φ1.0            | S12053-10        | 4 kHz         | 100 MHz  | -2.5 × 10 <sup>4</sup>                                     | 5   | ±2.5                     | +5 |
|                     |                            | C12702-12   |   | φ3.0            | S5344            |               | 40 MHz   | -1.9 × 10 <sup>4</sup>                                     | 6.3   |                          |    |
| High<br>sensitivity | C12703                     |                        | φ1.5  | S3884           | DC               | 10 MHz        | 1.5 × 10 <sup>6</sup>  | 0.63   | ±2.5  | ±12                      |    |
|                     | C12703-01                  |   | φ3.0  | S2384           |                  | 100 kHz       | -1.5 × 10 <sup>8</sup>   | 0.0063   |   |                          |    |
| High<br>stability   | C10508-01                  | <br>60 × 65.6 × 19.6 | φ1.0  | S12023-10A      | DC               | 10 MHz        | 1.25 × 10 <sup>7</sup>   | 0.063  | ±5.0 max.   | ±5                       |    |
| High<br>speed       | C5658                      | <br>28 × 50 × 60     | φ0.5  | S12023-05       | 50 kHz           | 1 GHz         | 2.5 × 10 <sup>5</sup>  | 16   | ±5.0  | +12                      |    |

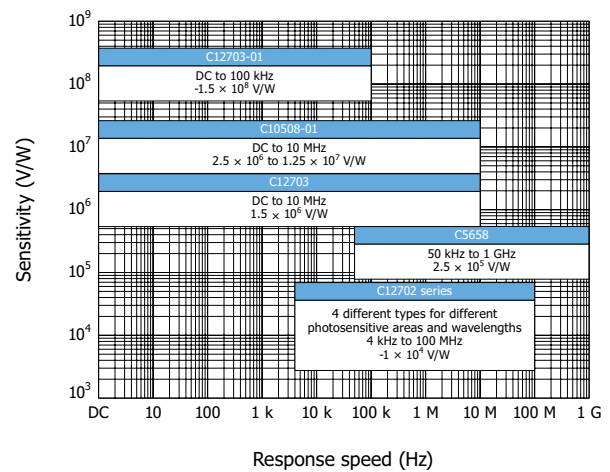
\* Area in which a typical gain can be obtained

## Block diagram (C12702 series)



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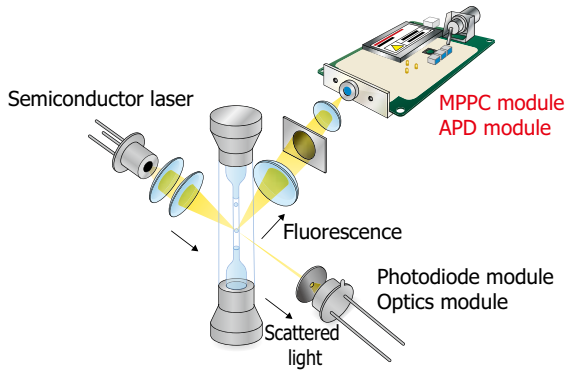
## Sensitivity and response speed



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## Application examples

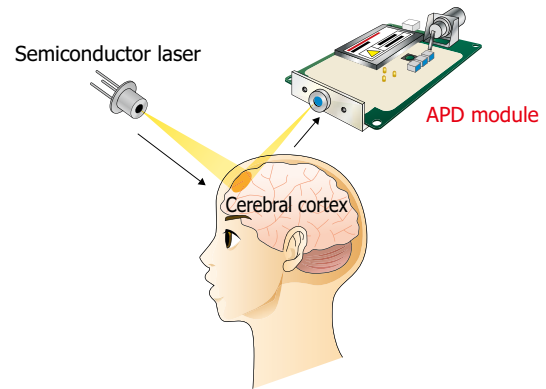
### [ Flow cytometry ]



KACCC0593EA

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.

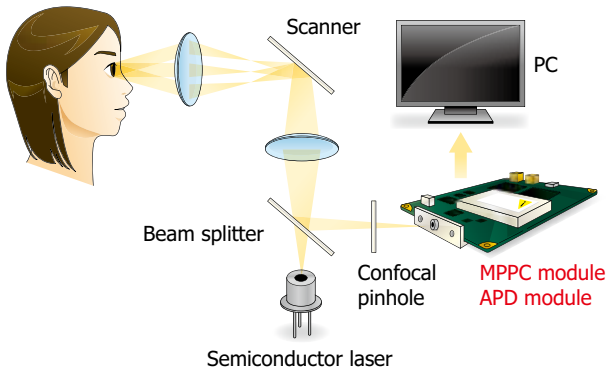
### [ Optical topography ]



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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.

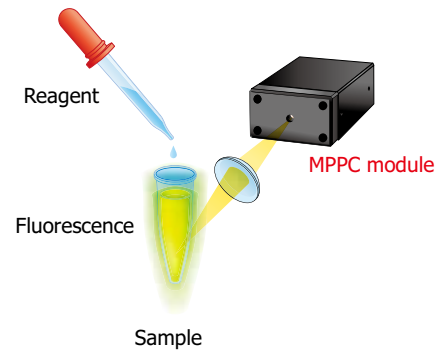
### [ Scanning laser ophthalmoscope (SLO) ]



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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.

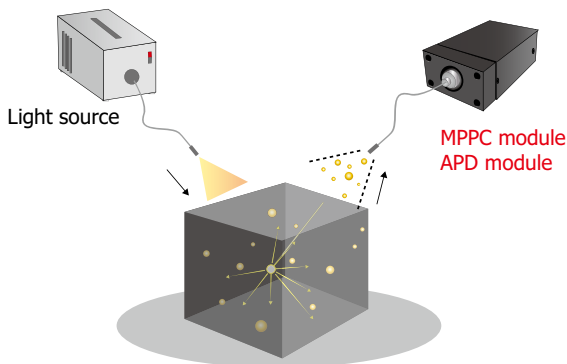
### [ Fluorescence measurement ]



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The MPPC module can detect minute fluorescence emission of reagents.

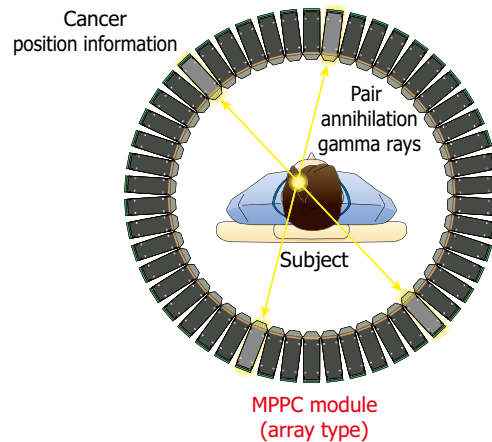
### [ Particle counter ]



KACCC0764EA

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) ]



KACCC0598EA

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  $^{137}\text{Cs}$  (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)* <sup>1</sup>                   | 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.* <sup>2</sup>                 | 40                                       | 400            | 2000            |                  | cpm   |
| Energy range   | 0.03 to 2                                |                | 0.06 to 2       |                  | MeV   |
| Energy resolution* <sup>3</sup>                        | 8  | 8.5            | 9               | 10               | %     |
| Measurement range (dose equivalent rate)* <sup>4</sup> | 0.01 to 100                              | 0.001 to 10    | * <sup>5</sup>  |                  | μSv/h |
| Measurement error* <sup>6</sup>                        | ±20                                      |                | * <sup>5</sup>  |                  | %     |
| 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)* <sup>1</sup>                   | 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.* <sup>2</sup>                 | 40                              | 400            | 2000            |                  | cpm   |
| Energy range   | 0.03 to 2                       |                | 0.06 to 2       |                  | MeV   |
| Energy resolution* <sup>3</sup>                        | 8                               | 8.5            | 9               | 10               | %     |
| Measurement range (dose equivalent rate)* <sup>4</sup> | 0.01 to 100                     | 0.001 to 10    | * <sup>5</sup>  |                  | μSv/h |
| Measurement error* <sup>6</sup>                        | ±20                             |                | * <sup>5</sup>  |                  | %     |
| 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:  $^{137}\text{Cs}$ , 0.01 μSv/h

\*3:  $^{137}\text{Cs}$ , 662 keV

\*4:  $^{137}\text{Cs}$ , 662 keV\*<sup>7</sup>. The lower limit depends on the environmental radiation.

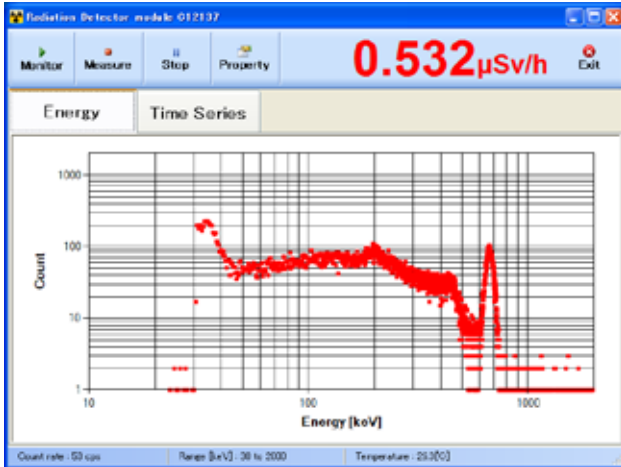
\*5: The C12137-08/-08D/-10/-10D do not perform conversion into dose equivalent rate using the G(E) function.

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

\*7: Measurement range of these products is defined by  $^{137}\text{Cs}$ . 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

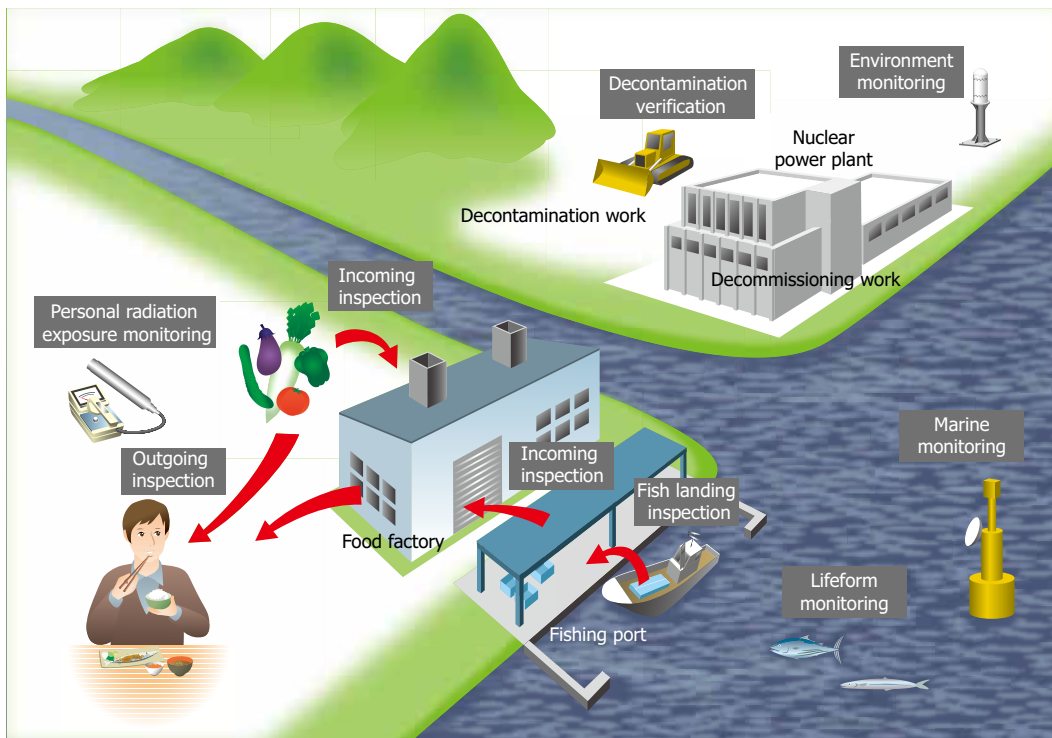
[ Cesium-137 radiation source (energy spectrum) ]



[ Environmental radiation (time variation) ]



## Application examples



### Related product

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



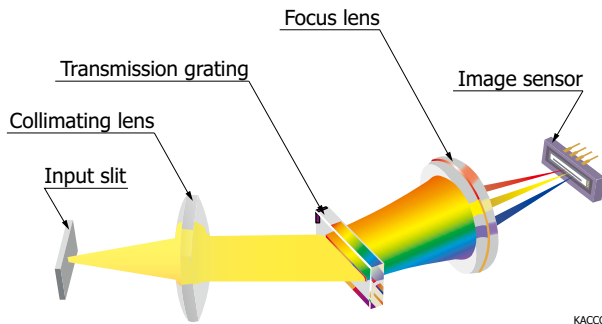
# Mini-spectrometers

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.



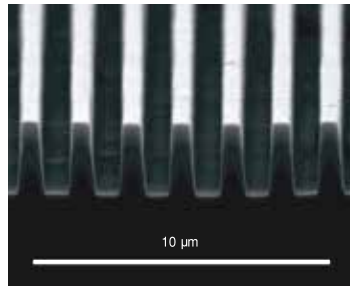
## Elemental technologies that go into making mini-spectrometers

### Optical system layouts (typical example: TG series)



KACCC0256EA

### SEM photo of a grating



### Image sensors that are built into the mini-spectrometers



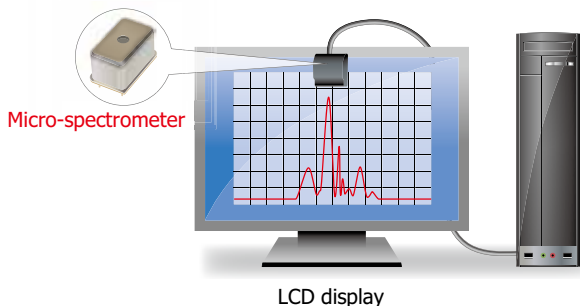
The wavelength dispersive elements of the mini-spectrometers (TM and TG series) use a transmission grating (quartz) fabricated by a holographic process. The holographic process is a technique suited for mass production, and a grating can be formed directly onto the matrix, instead of replicating the 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

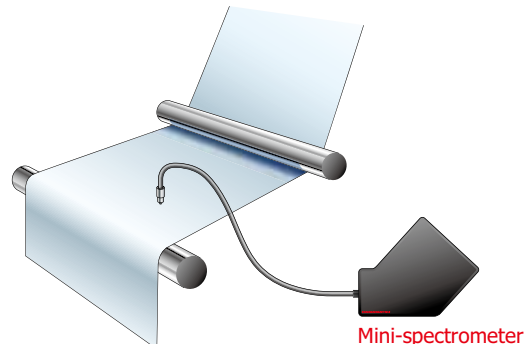
### [ Display color measurement ]



KACCC0599EB

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

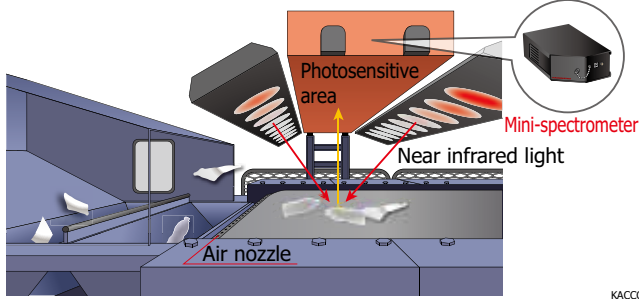
### [ Film thickness measurement ]



KACCC0600EA

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.

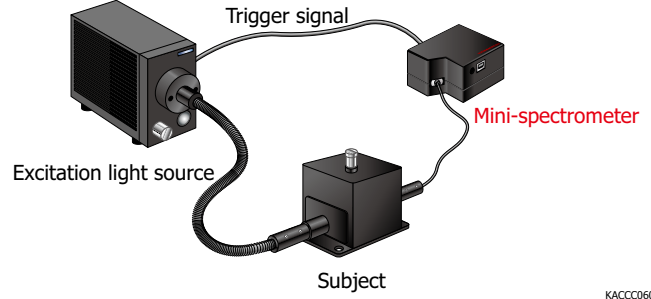
[ Plastic selection ]



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

KACCC0601EA

[ Fluorescence measurement ]



The emission spectra of fluorescent lights, organic EL devices, and other luminescent materials are measured.

KACCC0602EA

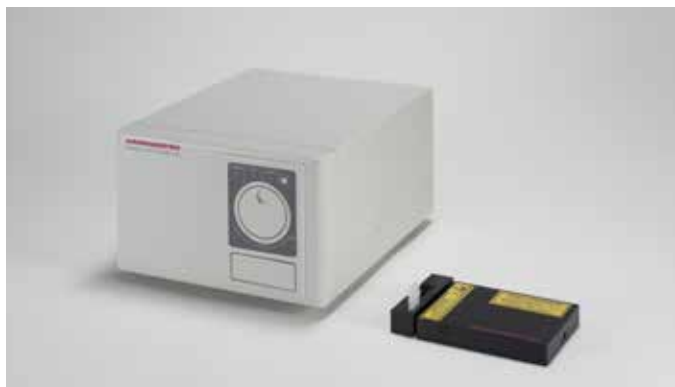
(Typ. unless otherwise noted)

| Type no.            | Photo W × D × H (mm)                          | Type  | Spectral response range (nm) | Wavelength resolution (nm) | Built-in image sensor                                   | Features  |
|---------------------|---|---|------------------------------|----------------------------|---|---|
| C10082CA            | 95 × 92 × 76                                  | [High sensitivity]<br>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]<br>TM-UV/VIS-CCD              |                              | 1 typ.                     |   |   |
| C10082MD            |   | [Wide dynamic range]<br>TM-UV/VIS-MOS           |                              | 6 max.                     | CMOS linear image sensor                                |   |
| C10083CA            | 95 × 92 × 76                                  | [High sensitivity]<br>TM-VIS/NIR-CCD            | 320 to 1000                  | 8 max.<br>(320 to 900 nm)  | Back-thinned CCD image sensor                           | • Suitable for spectroscopic measurement (fluorescence measurement, etc.) of low light levels                                     |
| C10083CAH           |   | [High resolution]<br>TM-VIS/NIR-CCD             |                              | 1 typ.<br>(320 to 900 nm)  |   |   |
| C10083MD            |   | [Wide dynamic range]<br>TM-VIS/NIR-MOS          |                              | 8 max.                     | CMOS linear image sensor                                |   |
| C11697MB            | 94 × 90 × 55                                  | [Triggering]<br>TM-VIS/NIR-MOS-II               |                              |                            | High sensitivity CMOS linear image sensor               | • Triggering<br>• Suitable for spectroscopic measurement using pulsed light   |
| C9404CA             | 125.7 × 115.7 × 75                            | [High sensitivity]<br>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]<br>TG-UV-CCD                  |                              | 1 typ.                     |   |   |
| C9405CB             | 125.7 × 115.7 × 75                            | [High sensitivity]<br>TG-SWNIR-CCD-II           | 500 to 1100                  | 5 max.<br>(550 to 900 nm)  | High infrared sensitivity back-thinned CCD image sensor | • High near-infrared sensitivity<br>• Suitable for spectroscopic measurement (fluorescence measurement, etc.) of low light levels |
| C11713CA            | 120 × 70 × 60                                 | [High resolution]<br>TG-RAMAN-I                 | 500 to 600                   | 0.3 typ.                   | Back-thinned CCD image sensor                           | • Suitable for Raman spectrometry   |
| C11714CB            |   | [High resolution]<br>TG-RAMAN-II                | 790 to 920                   |                            | High infrared sensitivity back-thinned CCD image sensor |   |
| C11482GA            | 38.5 × 106 × 86                               | [No cooling]<br>TG2-NIR                         | 900 to 1700                  | 7 max.                     | InGaAs linear image sensor                              | • For near infrared range<br>• A low-noise, cooled type is available.   |
| C9913GC             | [Low noise (cooled type)]<br>TG-cooled-NIR-I  | 1100 to 2200                                    | 8 max.                       |                            |   |   |
| C9914GB             | [Low noise (cooled type)]<br>TG-cooled-NIR-II |   |                              |                            |   |   |
| C11118GA            | 142 × 218 × 80                                | [Low noise (cooled type)]<br>TG2-cooled-NIR-III | 900 to 2550                  | 20 max.                    |   |   |
| C13053MA            | 80 × 60 × 12*                                 | [Compact, thin]<br>TF-SWNIR                     | 500 to 1100                  | 3.5 max.                   | High-sensitivity CMOS linear image sensor               | • Thin type<br>• Triggering   |
| C13054MA            |   | [Compact, thin]<br>TF-RAMAN                     | 790 to 920                   | 0.4 typ.                   |   |   |
| <b>NEW</b> C14214MA |   | [Compact, thin]<br>TF-RAMAN                     | 790 to 1050                  | 0.6 max.                   |   |   |
| C13555MA            |   | [Compact, thin]<br>TF-VIS                       | 340 to 830                   | 3 max.                     |   |   |
| <b>NEW</b> C14486GA |   | [Compact, thin]<br>TF-NIR                       | 950 to 1700                  | 7 max.                     | InGaAs linear image sensor                              |   |
| C11007MA            | 55 × 48 × 100                                 | [Spectrometer module]<br>RC-VIS-MOS             | 340 to 780                   | 9 max.                     | CMOS linear image sensor                                | • Compact<br>• Inexpensive  |
| C11008MA            |   | [Spectrometer module]<br>RC-SWNIR-MOS           | 640 to 1050                  | 8 max.                     | High infrared sensitivity CMOS linear image sensor      |   |
| C11009MA            | 28 × 28 × 28                                  | [Spectrometer head]<br>RC-VIS-MOS               | 340 to 780                   | 9 max.                     | CMOS linear image sensor                                | • For incorporating into devices  |
| C11010MA            | 35 × 20 × 28                                  | [Spectrometer head]<br>RC-SWNIR-MOS             | 640 to 1050                  | 8 max.                     | High infrared sensitivity CMOS linear image sensor      |   |
| C11708MA            | 276 × 13 × 16.8                               | [Spectrometer head]<br>MS-SWNIR-MOS             | 640 to 1050                  | 20 max.                    | CMOS linear image sensor                                | • For near infrared range   |
| C12666MA            | 20.1 × 12.5 × 10.1                            | [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<br>• Simultaneous integration  |



\* C14214MA: 100 × 60 × 12

# Spectroscopic modules

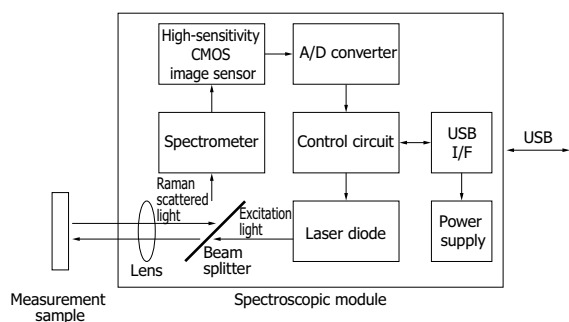
These are compact, lightweight Raman spectroscopy analysis modules. A compact spectrometer, excitation light source, wavelength filter, and other optical elements are integrated into a single unit. The modules can be used for onsite screening tests and other applications that use Raman spectroscopy. In addition, using the surface-enhanced Raman spectroscopy (SERS) substrate makes high-sensitivity Raman spectroscopic analysis possible. The C12710, a high-resolution portable type, and the C13560, a palm-sized lightweight type, are available.



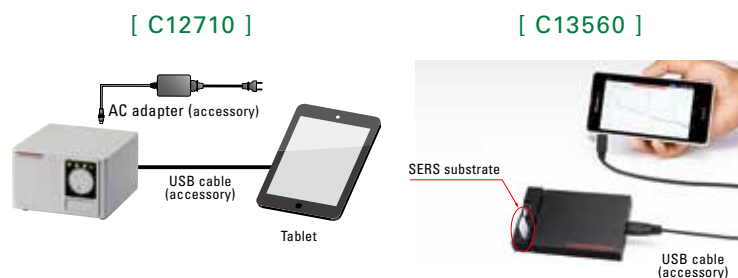
(Typ. unless otherwise noted)

| Type no. | Photo<br>W × D × H<br>(mm)  | Excitation<br>wavelength<br>(nm) | Excitation power<br>(mW) | Spectral range<br>(cm <sup>-1</sup> ) | Resolution<br>(cm <sup>-1</sup> ) | Internal image sensor                     | Features   |
|----------|---|----------------------------------|--------------------------|---------------------------------------|-----------------------------------|---|--|
| C12710   | <br>150 × 182 × 95 | 785                              | 3, 50                    | 400 to 1850                           | 5                                 | IR-enhanced back-thinned CCD image sensor | <ul style="list-style-type: none"> <li>• High resolution</li> <li>• Portable size</li> </ul>                       |
| C13560   | <br>96 × 14.5 × 60 |                                  | 5, 10, 15                |                                       | 10                                | High-sensitivity CMOS linear image sensor | <ul style="list-style-type: none"> <li>• Low power consumption</li> <li>• Palm size</li> <li>• Low cost</li> </ul> |

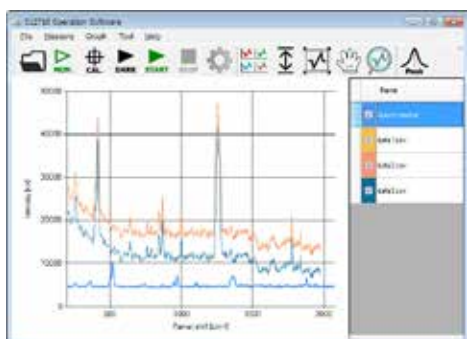
## Block diagram



## Connection example



## Measurement example (C12710)



## SERS substrate (sold separately)

[ J12853 (for C12710) ]



[ J13856 (for C13560) ]



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"> <li>These modules have built-in photodiodes.</li> <li>Suitable for light level monitors, color-difference meters, and flow meters</li> </ul> | Si               | 2.4 × 2.4                | H: 10 <sup>9</sup><br>L: 10 <sup>7</sup> | H: 10<br>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                |  |                             |                                |         |   |
| C10439-08 |                      |   |                  | 5.8 × 5.8                |  |                             |                                |         |   |
| C10439-09 |                      |   |                  | 10 × 10                  |  |                             |                                |         |   |
| C10439-10 | 19 × 50 × 52         |   | InGaAs           | φ1                       | H: 10 <sup>6</sup><br>L: 10 <sup>4</sup> | H: 1 k<br>L: 100 k*2        |                                |         |   |
| C10439-11 |                      |   | InGaAs           | φ3                       |  |                             |                                |         |   |
| C10439-14 | 19 × 50 × 52         |   | InAsSb           | 0.7 × 0.7                | H: 10 <sup>7</sup><br>L: 10 <sup>6</sup> | H: 100<br>L: 1 k            |                                |         |   |
| C10475    | 110 × 100 × 30       | <ul style="list-style-type: none"> <li>Signal processing unit for the C10439 series</li> </ul>  | -                | -                        | -  | -                           | -                              | RS-232C | AC adapter (+12 V) or battery (one 9 V battery) |

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

### Photosensor amplifiers

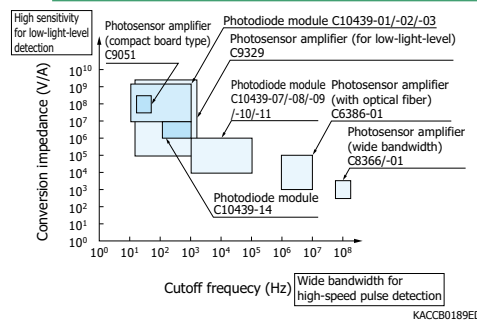
(Typ. Ta=25 °C, unless otherwise noted)

| 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"> <li>Optical fiber included</li> <li>Suitable for plasma monitors and for detecting scratches and defects in metal and glass</li> </ul> | Built-in (optical fiber diameter φ2 mm, NA 0.56)                                | H: 10 <sup>5</sup><br>M: 10 <sup>4</sup><br>L: 10 <sup>3</sup> | H: 1 M<br>M: 3 M<br>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"> <li>Fast and compact</li> <li>Suitable for high-speed light measurement (laser power monitoring, etc.)</li> </ul>                      | Sold separately (high-speed Si PIN PD; photosensitive area φ0.4 to φ5 mm)       | 10 <sup>3</sup>  | 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"> <li>Compact board type</li> <li>Suitable for optical power meters and illuminometers</li> </ul>  | Sold separately (terminal capacitance of 5 nF or less)                          | 10 <sup>8</sup>  | 16                            | 0.5 max.                     | Analog         | AC adapter (+12 V)   |
| C9329    | 115 × 90 × 40        | <ul style="list-style-type: none"> <li>Ultra-low noise and high gain</li> <li>Suitable for low-light-level detection and precise photometry</li> </ul>                    | Sold separately (terminal capacitance of 5 nF or less)                          | H: 10 <sup>9</sup><br>M: 10 <sup>7</sup><br>L: 10 <sup>5</sup> | H: 16<br>M: 1.6 k<br>L: 1.6 k | 0.5 max.                     | Analog RS-232C | AC adapter (+12 V) or battery (one 9 V battery)                |

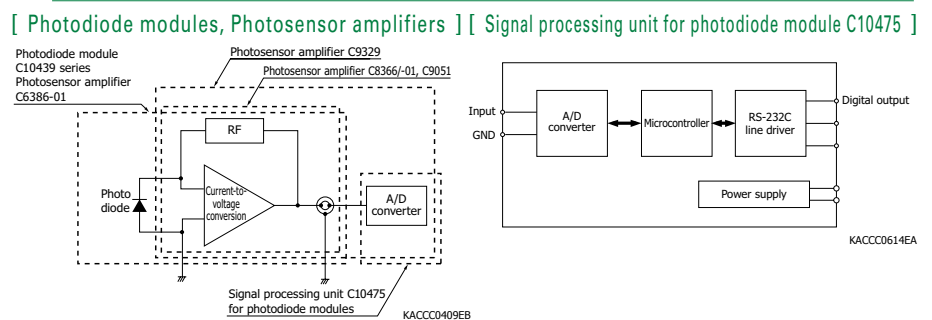
\*3: Dark state

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



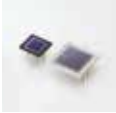




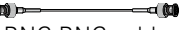


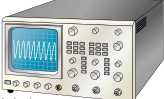








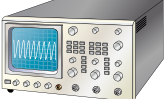








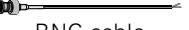
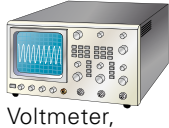



### Connection example of photodiode modules

| Photodiode module  | Signal processing unit  | Power supply and PC  |
|--|---|--|
|  <p>Photodiode module connection cable (for power supply)*4</p>  <p>BNC-BNC cable (for signal)*4</p> <p>C10439 series (with built-in photodiode)</p> |  <p>C10475</p> |  <p>AC adapter*4</p>  <p>RS-232C cable</p>  <p>AC 100 to 240 V<br/>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>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<br/>50/60 Hz</p>  <p>Voltmeter, oscilloscope, etc.</p>  <p>PC</p>                                  |
| <p>Infrared high sensitivity S2386/S2387 series*5<br/>For UV to infrared range S1336/S1337 series<br/>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<br/>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>Insert the leads into the socket of the C8366</p> <p>S3071, S3072, S3399, S3883, S5821<br/>S5971, S5972, S5973 series</p>   | <p>High-speed type C8366</p>  <p>C8366-01</p>                               |  <p>Power cable*7</p>  <p>Power supply (<math>\pm 15</math> V)</p>  |
| <p>High-speed InGaAs PIN photodiode</p>  <p>Insert the leads into the socket of the C8366-01</p> <p>G8376-03/-05<br/>G10899-003K/-005K<br/>G12180-003A/-005A</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


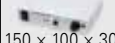
# PSD modules PSD signal processing circuits

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                        |                               | 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                          | -         | -              | -                                   |
| C10460    | <br>150 × 100 × 30 | • Signal processing unit for C10443-01/-02/-03/-04 | -                        | 5                        | *1                            | 13.5                         | 16        | Analog RS-232C | AC Adapter (+12 V)                  |

\*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   | <br>56 × 66 × 15.5 | One-dimensional PSD | H: 10 <sup>6</sup><br>M: 10 <sup>5</sup><br>L: 10 <sup>4</sup> | 22             | -               | Analog  | External power supply (±15 V) |                        |                                |                          |
| C9068      | <br>75 × 110 × 15  |                     |  |                |                 |         |                               | S4581-04               | 2 × 1                          | 0.8                      |
|            |   |                     |  |                |                 |         |                               | S4583-04, S8673        | 3 × 1                          | 1.3                      |
|            |   |                     |  |                |                 |         |                               | S4584 series, S3274-05 | 3.5 × 1                        | 1.5                      |
|            |   |                     |  |                |                 |         |                               | S7105 series           | 4.2 × 1                        | 1.8                      |
|            |   |                     |  |                |                 |         |                               | S5629 series, S3931    | 6 × 1                          | 2.5                      |
|            |   | S3932               | 12 × 1   | 5              |                 |         |                               |                        |                                |                          |
| C4674-01*3 | <br>65 × 90 × 15.5 | Two-dimensional PSD | H: 10 <sup>6</sup><br>M: 10 <sup>5</sup><br>L: 10 <sup>4</sup> | 22             | -               | Analog  | External power supply (±15 V) |                        |                                |                          |
|            |   |                     |  |                |                 |         |                               | S5990-01               | 4 × 4                          | 1.7                      |
|            |   |                     |  |                |                 |         |                               | S5991-01               | 9 × 9                          | 3.8                      |
| C9069*3    | <br>75 × 110 × 15  |                     | H: 10 <sup>6</sup><br>M: 10 <sup>5</sup><br>L: 10 <sup>4</sup> | *2             | 12              | RS-232C | AC adapter (+12 V)            |                        |                                |                          |
|            |   |                     |  |                |                 |         |                               | S2044                  | 4.7 × 4.7                      | 2                        |
|            |   | S1880               | 12 × 12  | 5              | 10 <sup>5</sup> | 12      | RS-232C                       | AC adapter (+12 V)     |                                |                          |

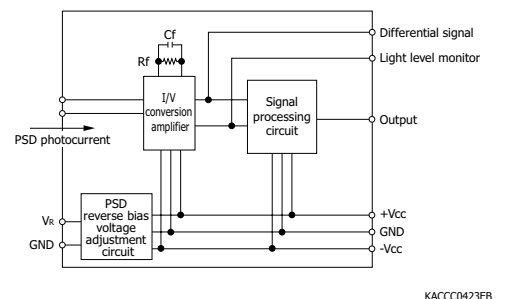
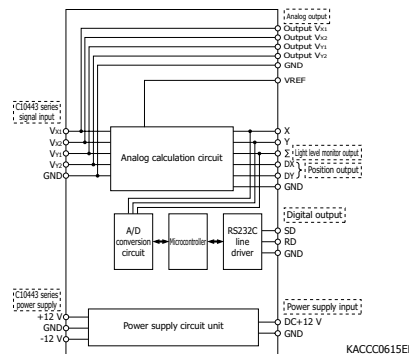
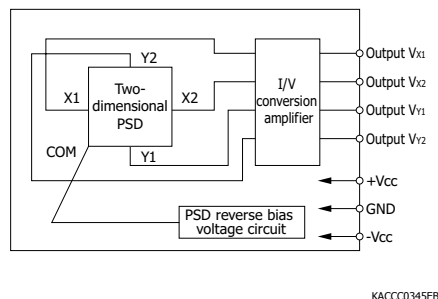
\*2: Signal conversion time=5 ms min.

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





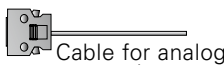
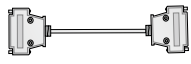



Note: Please refer to the datasheet for more information. We can also provide customized products. Please contact the sales office for more information.

## Block diagrams

[ C10443-01 to -04 PSD module ] [ C10460 signal processing unit for PSD module ] [ C3683-02 PSD signal processing circuit ]





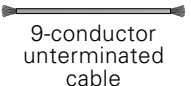








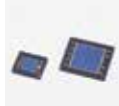







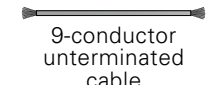


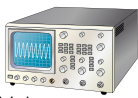



Connection example of PSD module (C10443-01/-02/-03) and signal processing unit

| 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<br/>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<br/>S4581-04, S4583-04<br/>S8673<br/>S4584 series<br/>S3274-05<br/>S7105 series<br/>S5629 series</p>  <p>Ceramic packages<br/>S3931*5<br/>S3932*5<br/>S8543<br/>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 (<math>\pm 15</math> 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>AC 100 to 240 V<br/>50/60 Hz</p>  <p>PC</p>  |
| <p>Two-dimensional PSDs</p>  <p>Surface mount type<br/>S5990-01, S5991-01</p>  <p>Board for mounting*6<br/>S5990-01, S5991-01</p>  <p>Ceramic/metal packages<br/>S1880*5<br/>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>RS-232C cable</p>  <p>PC</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 (<math>\pm 15</math> 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. Ta=25 °C, Vs=±10 V, unless otherwise noted)

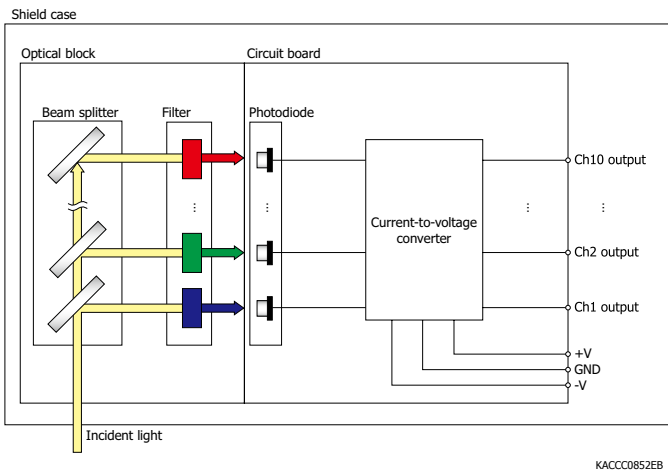
| Type no.  | Photo W × D × H (mm) | Detection wavelength (nm)   | Conversion impedance (V/A) | Cutoff frequency -3 dB (kHz) | Output noise voltage Dark state (mVp-p) | Blocking min. |
|-----------|----------------------|---|----------------------------|------------------------------|---|---------------|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

## Evaluation circuit for optics module

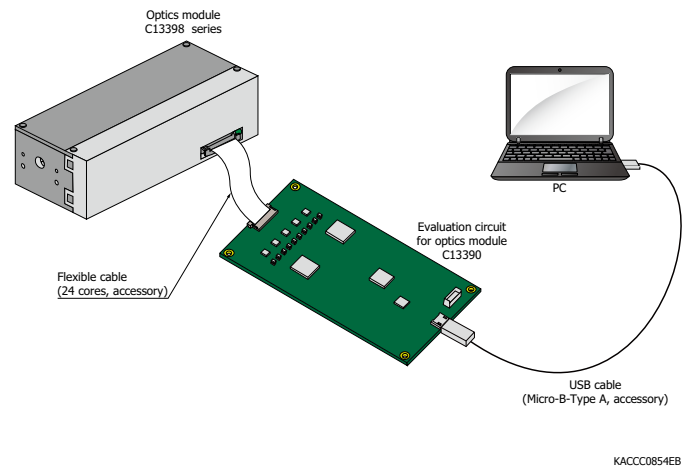
(Ta=25 °C)

| 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"> <li>• USB bus powered</li> <li>• Up to 10 channels of output signals can be acquired into a PC.</li> </ul> | ±32                         | 16                    | USB 2.0 | ○               |

## Block diagram

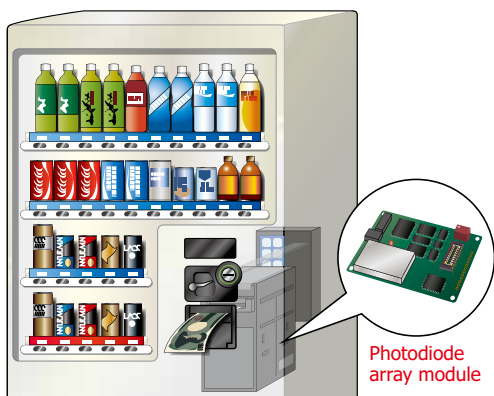


## Connection example



Application examples

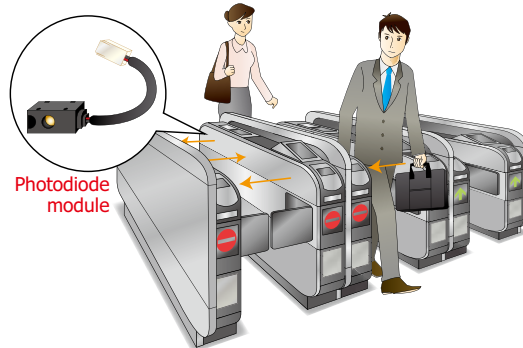
[ Vending machine ]



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.

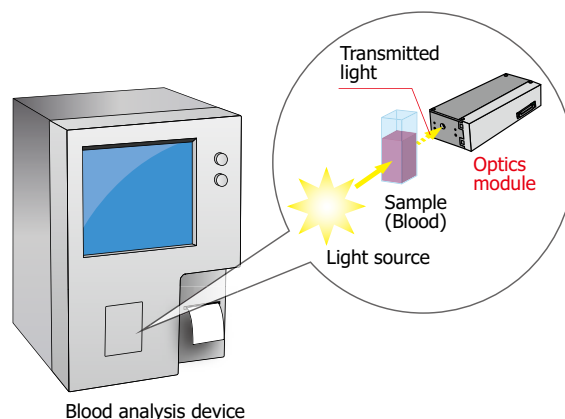
[ IH cooking heater ]



KACCC0605EA

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

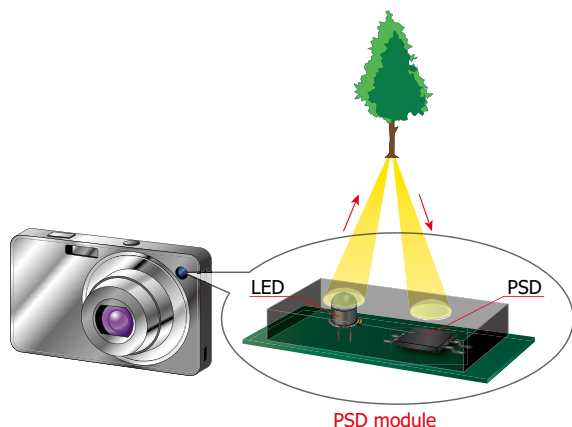
[ Blood analysis device ]



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.

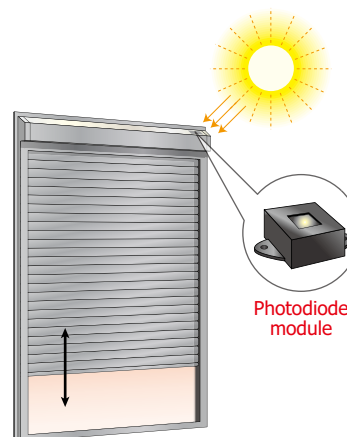
[ Camera autofocusing ]



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.



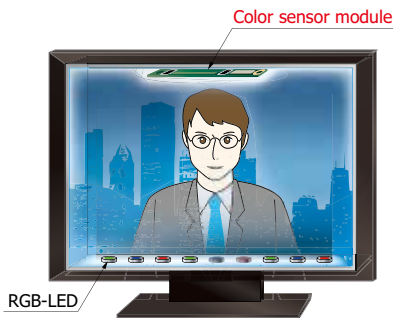
## Color sensor modules, Color sensor evaluation circuit

(Typ. Ta=25 °C)

| Product name             | Color sensor module   |  |   | Color sensor evaluation circuit  |
|--------------------------|---|--|---|--|
|                          | Type no.  | C9303-03   | C9303-04  | C9315  |
| Photo                    |   |  |   |  |
| Features                 | Standard type   | High gain type   | <ul style="list-style-type: none"> <li>For RGB information measurement of object color</li> <li>Has an internal white LED as the light source, converts the reflected light into RGB data, and outputs the data to a PC</li> <li>Measures small areas using an objective optical fiber</li> <li>12-bit digital output (RS-232C compatible)</li> </ul> | <ul style="list-style-type: none"> <li>Current-to-voltage conversion amplifier allowing a Hamamatsu color sensor (S7505-01, S9032-02) to be mounted</li> </ul> |
| Light source             | No  |  | Yes (white LED)   | No   |
| Color sensor             | Yes   |  | Yes   | No   |
| Conversion impedance     | R: 91 kΩ<br>G: 91 kΩ<br>B: 100 kΩ   | R: 680 kΩ<br>G: 680 kΩ<br>B: 680 kΩ  | —   | Variable (1 × 10 <sup>5</sup> to 5.1 × 10 <sup>5</sup> Ω)  |
| 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"> <li>White balance detection of LCD backlight (RGB-LED type)</li> </ul> | <ul style="list-style-type: none"> <li>Measurement of object color</li> <li>Color monitoring of opaque body (molded parts, painting, printing, cosmetics, etc.)</li> <li>Simple detection of color difference</li> </ul> | <ul style="list-style-type: none"> <li>Measurement of light source color</li> <li>Evaluation of S7505-01 and S9032-02</li> </ul>  |  |
| Accessories              | <ul style="list-style-type: none"> <li>Dedicated cable with connector</li> </ul>                          | <ul style="list-style-type: none"> <li>Dedicated AC adapter</li> <li>Sample software (data acquisition, recording, relative chromaticity Yxy display not conforming to CIE)</li> <li>White reference card</li> </ul>     | —   |  |

## Application examples

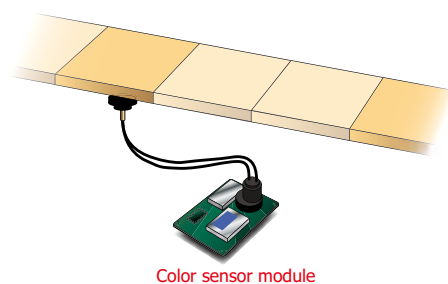
### [ Color adjustment for LCD backlights ]



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

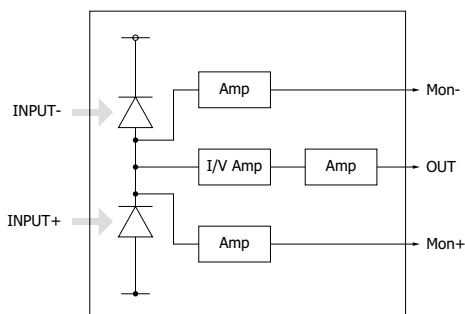
(Typ. Ta=25°C)

| 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 <sup>4</sup>        | 200                          | 35                                 | 40                                | FC/APC | SMA    | External power supply (±12 V) |
| C12668-02 |                      | 1.3                            |                            |                              |                                    |                                   |        |        |                               |
| C12668-03 | 25 × 78 × 72         | 1.0                            | 1 × 10 <sup>4</sup>        | 400                          | 30                                 |                                   |        |        |                               |
| C12668-04 |                      | 1.3                            |                            |                              |                                    |                                   |        |        |                               |

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

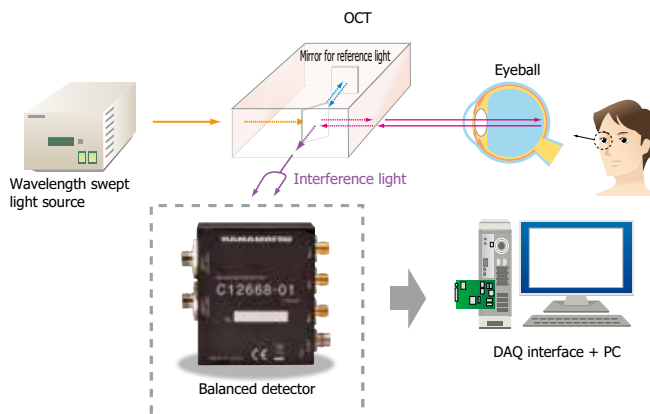
\*2: Output difference when an approximately 70 μW light is applied to only the INPUT- terminal and when applied to INPUT+ and INPUT- terminals

### 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.

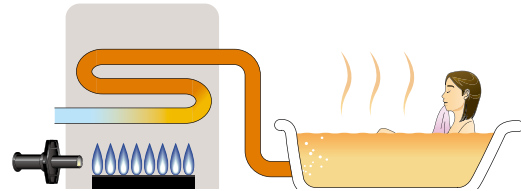
### Features

- 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

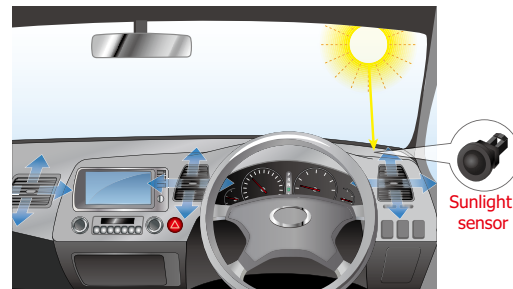
Sunlight sensors detect the light level of sunlight and ambient light. A photodiode with superb linearity relative to the light level is built in a small case with a connector.

### 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.)

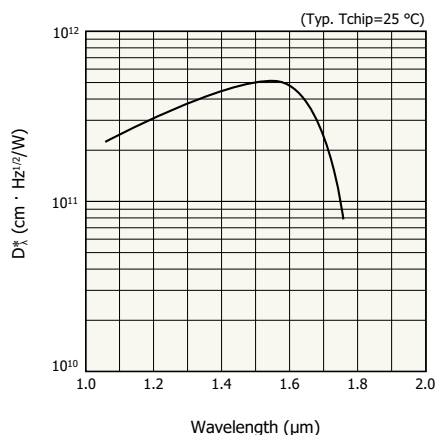
| Type                  | Type no.    | Photo   | Detector (built-in)   | Photosensitive area (mm) | Cooling         | Measurement condition | Cutoff wavelength (μm) | Peak sensitivity wavelength (μm) |
|-----------------------|-------------|---|-----------------------|--------------------------|-----------------|-----------------------|------------------------|----------------------------------|
|                       |             |   |                       |                          |                 | 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°

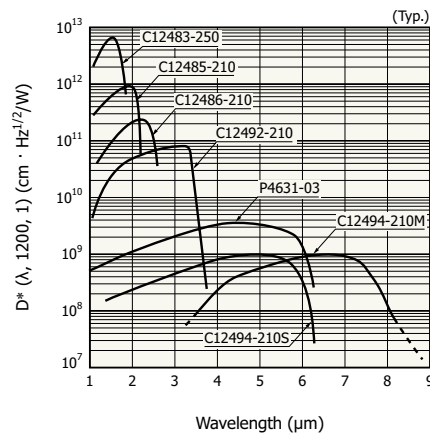
## Spectral response

[ Room-temperature type ]



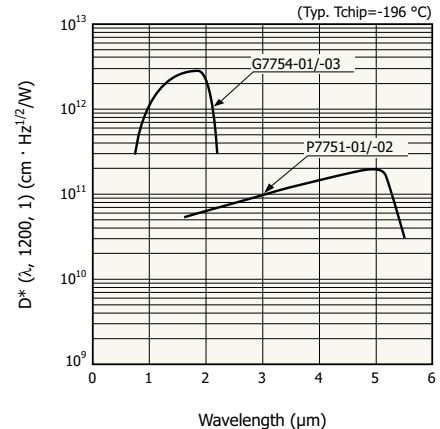
KIRD80532EB

[ TE-cooled type ]



KIRD80188EL

[ Metal dewar type ]



KIRD80612EA

## 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, S11500-1007   | Sold separately |
|  | C7041        |            | S7031 series, S11501-1007S  |                 |
|  | 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<br>G9202/G9204/G9212/G9214-512S              |                 |
|  | C8062-01     |            | G9205/G9206/G9207/G9208-256W<br>G9205/G9206/G9208-512W<br>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/S11510 series  |
|  | 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<br>S8380/S8381 series<br>(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  |

Sold separately







## Disclaimer

- Products manufactured by Hamamatsu Photonics K.K. (hereafter “Hamamatsu”) are intended for use in general-use electronic devices (such as measurement equipment, office equipment, information communications equipment, household appliances, etc.). Unless an exception to the following is stated in the documentation of a specific product, Hamamatsu products are not to be used for special applications which demand extremely high reliability or safety (such as equipment for nuclear power control, aerospace equipment, medical equipment and transportation equipment that directly affect human life, or disaster prevention or safety equipment).
- Hamamatsu products should not be used in excess of their absolute maximum ratings. Attention must be paid to all documented precautions.
- Hamamatsu continually makes efforts to improve the quality and reliability of its products; however these efforts cannot ensure 100% compliance with the manufacturing specifications. Sufficient safety design (such as redundant safety, fire preventative, and malfunction preventative features) are to be implemented in the development of equipment manufactured with the Hamamatsu product so that personal injury, fire, or damage to public property or welfare does not occur in the unlikely event of a malfunction of the Hamamatsu product. A dangerous condition could be created if sufficient consideration is not given to safety design that addresses potential problems, especially in the design of equipment where the failure or malfunction of the Hamamatsu product within the equipment could result in bodily harm, life-threatening injury, or serious property damage during the use of the equipment. With such types of equipment, Hamamatsu shall not be responsible for the use of its products within the equipment in any way for not obtaining our written consent such as specification sheets beforehand.
- Appropriate descriptions of the functions, performance, and methods of operation of the Hamamatsu product and the equipment within which the Hamamatsu product is incorporated are to be provided to end-users of the equipment. All accompanying warnings and cautionary labeling are also to be provided to the end-user.
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# HAMAMATSU

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**Quality, technology, and service are part of every product.**

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