

Image sensors for scientific
measurements and industrial
equipment

CCD/CMOS image sensors

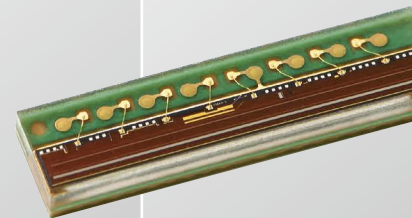
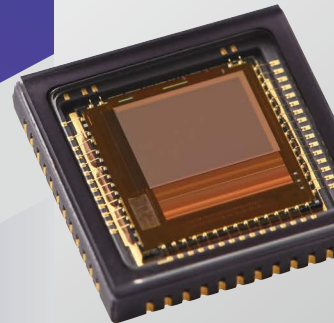
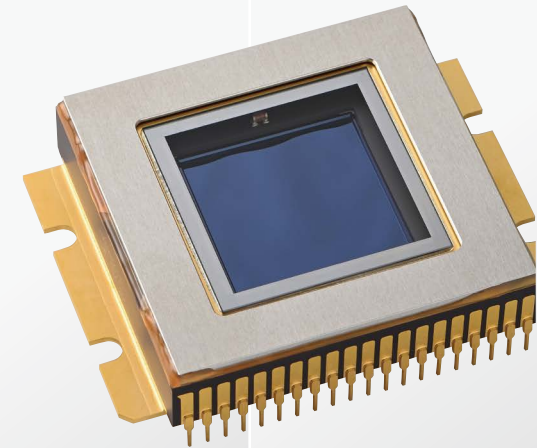
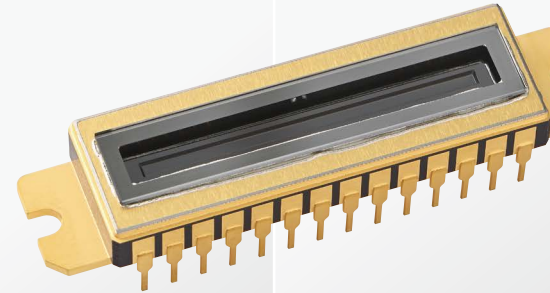
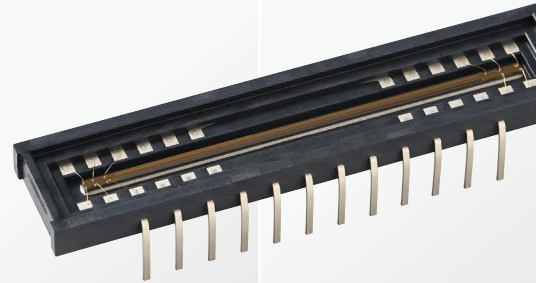




Image sensors for scientific measurements and industrial equipment

Hamamatsu Photonics offers a wide lineup of image sensors for different wavelengths and applications. The CCD image sensors realize high quantum efficiency in the ultraviolet, visible, and near infrared regions. The CMOS image sensors realize low price, low power consumption, and compact size.

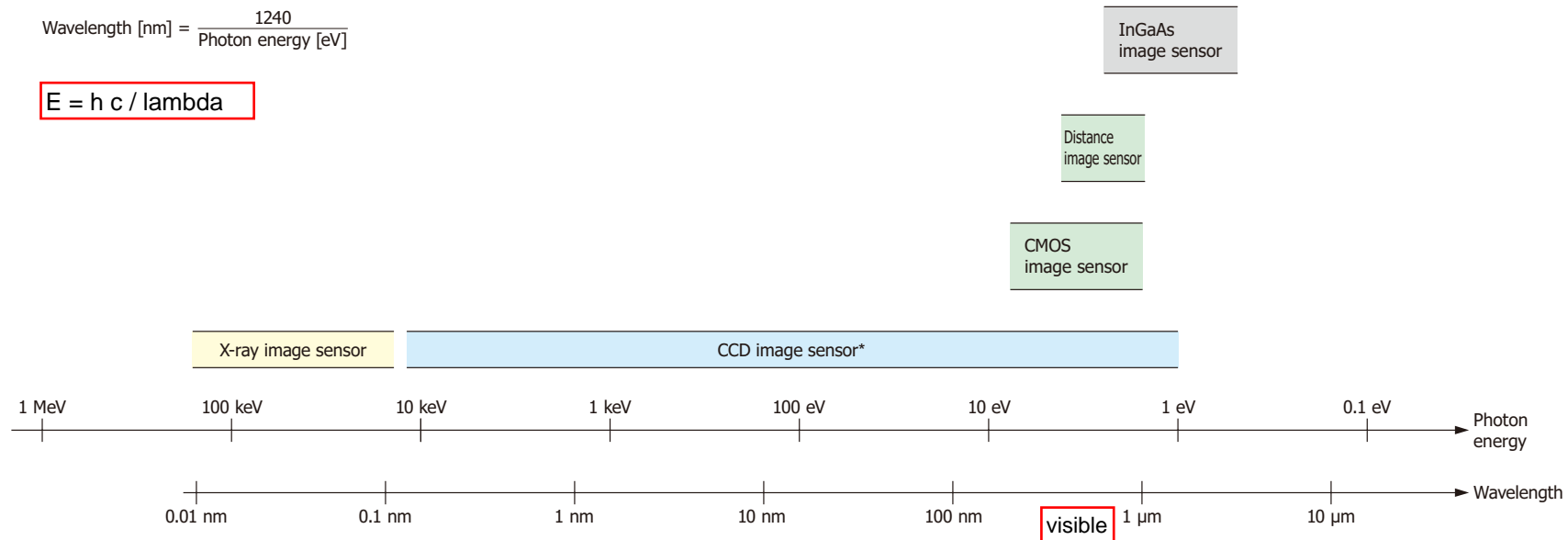
Hamamatsu image sensors

Hamamatsu Photonics develops and manufactures image sensors compatible with various spectral ranges such as near infrared, visible light, ultraviolet, vacuum ultraviolet (VUV), soft X-rays, and hard X-rays.

• Detectable energy and spectral response range

$$\text{Wavelength [nm]} = \frac{1240}{\text{Photon energy [eV]}}$$

$$E = h c / \lambda$$

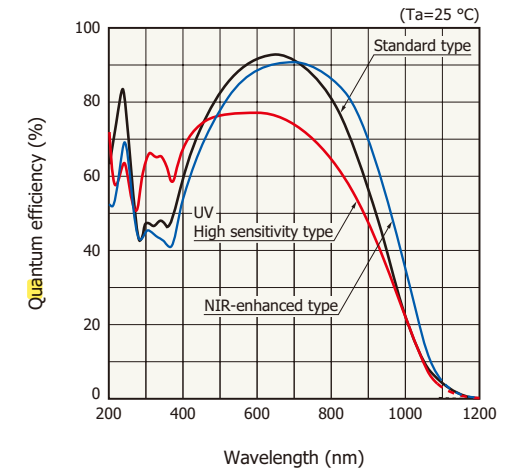


* No window for soft X-ray and hard X-ray

KMPDC1014EA

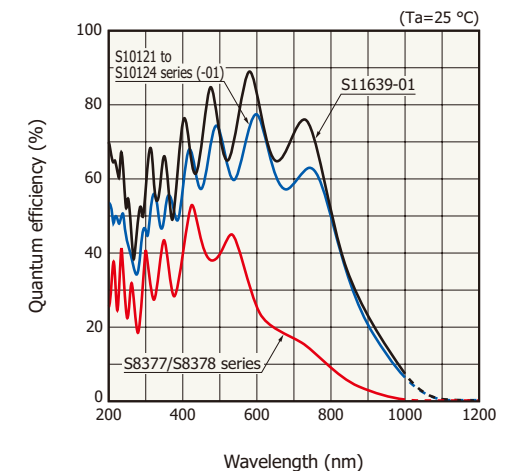
• Spectral response (typical example, without window)

[CCD image sensors]



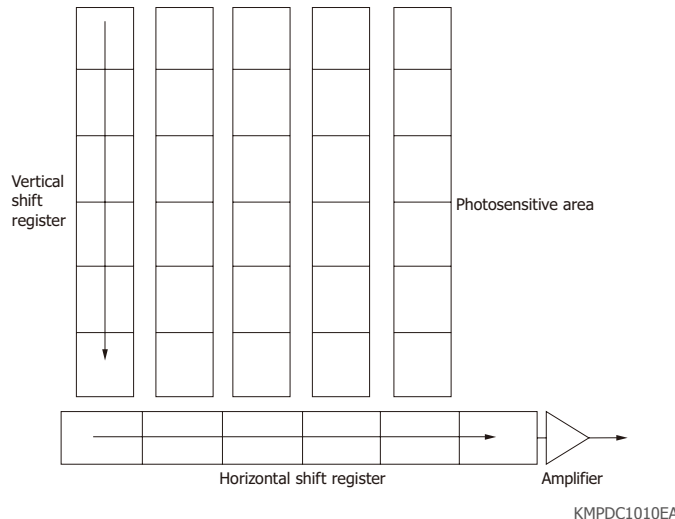
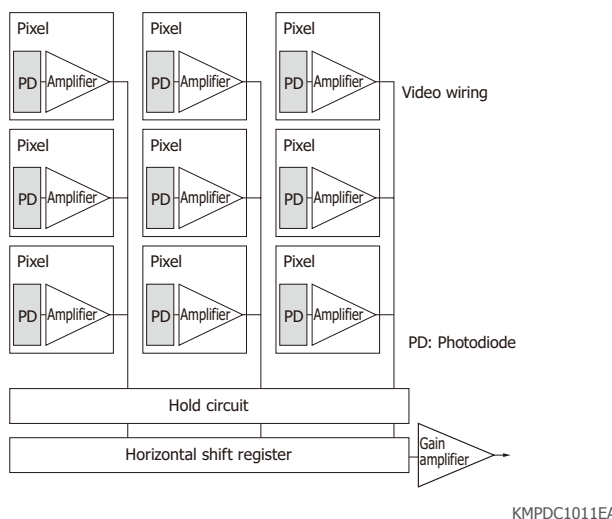
KMPDB0671EA

[CMOS image sensors]



KMPDB0681EA

Features of CCD/CMOS image sensors

| | CCD image sensors | CMOS image sensors |
|--------------------------------|--|---|
| Structure (typical example) |  |  |
| Amplifier | One amplifier for all pixels (in case of one-port readout) | One amplifier per pixel |
| Output | Analog | Digital or analog |
| Drive voltage | Multiple, High | Low |
| On-chip signal processing | Not possible | Possible |
| External circuit | Complex | Simple |
| Readout noise | Small | Small |
| Binning operation | Possible | Possible |
| Partial readout | Impossible | Possible |
| Dynamic range | Large | Small |

Back-thinned type

CCD image sensors

These realize high quantum efficiency in a wide spectral range.

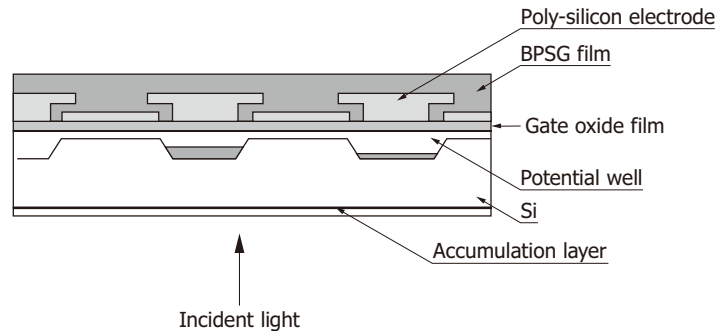
Boro-Phospho-Silicate
Glass (dielectric cover)

The light incident surface of the front-illuminated CCD is formed on the surface of the silicon substrate on which the BPSG film, poly-silicon electrodes, gate oxide film, etc. are deposited, so incident light is mostly reflected or absorbed by that part. The quantum efficiency is therefore limited to approx. 40% at the highest in the visible region, and there is no sensitivity in the ultraviolet region.

The back-thinned CCD also has BPSG film, poly-silicon electrodes, gate oxide film, etc. deposited on the surface of the silicon substrate. It achieves high quantum efficiency over a wide spectral range thanks to its structure, in which light is incident from the backside of the silicon substrate. Besides having high sensitivity and low noise which are the intrinsic features of CCDs, back-thinned CCDs are also sensitive to electron beams, soft X-rays, ultraviolet, visible, and near infrared region.

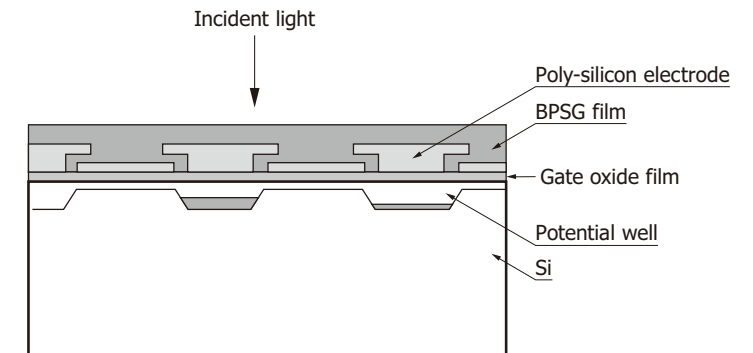
● Cross section of CCD

[Back-thinned type]



KMPDB0180EB

[Front-illuminated type]



KMPDB0179EB

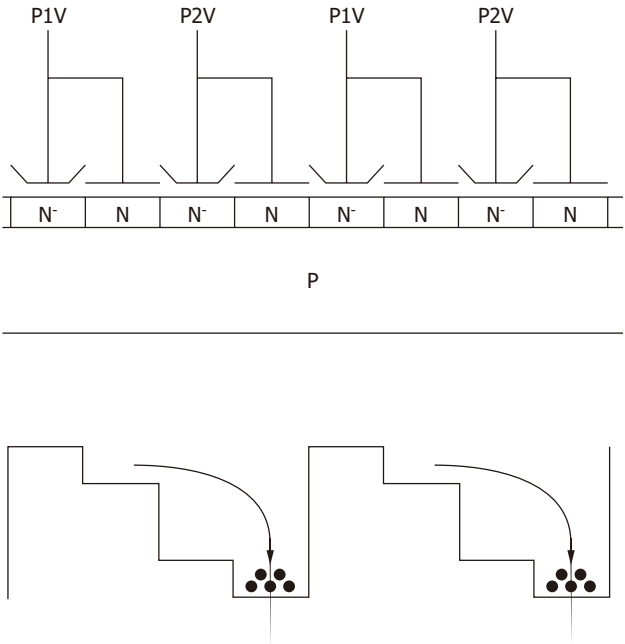
Resistive gate structure

CCD image sensors (built-in electronic shutter type)

Ordinary two-phase drive CCD

- One pixel contains multiple electrodes and a signal charge is transferred by applying different clock pulses to those electrodes
- No limit on pixel height and little image lag

● Schematic diagram and potential

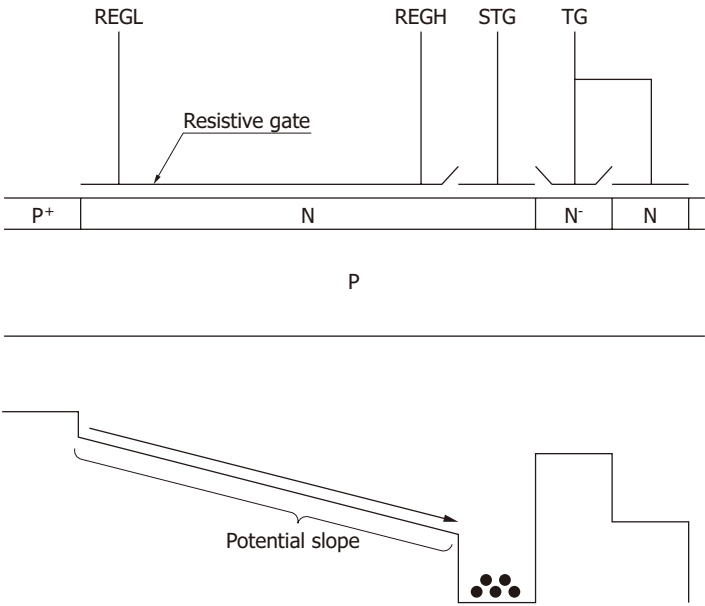


KMPDC0320EA

Resistive gate CCD

- Transfers signal charges by applying different voltages across the photosensitive area and forming a potential slope
- Faster transfer is possible when pixel height is a few millimeters, compared to the case where a two-phase drive CCD undergoes line binning to be used as a 1-D sensor.

● Schematic diagram and potential



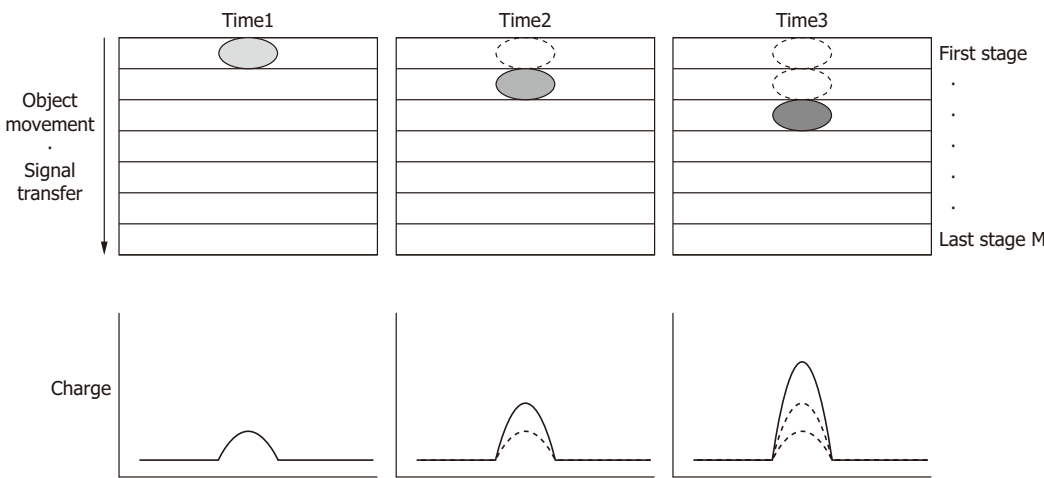
KMPDC0321EB

TDI operation

TDI-CCD image sensors

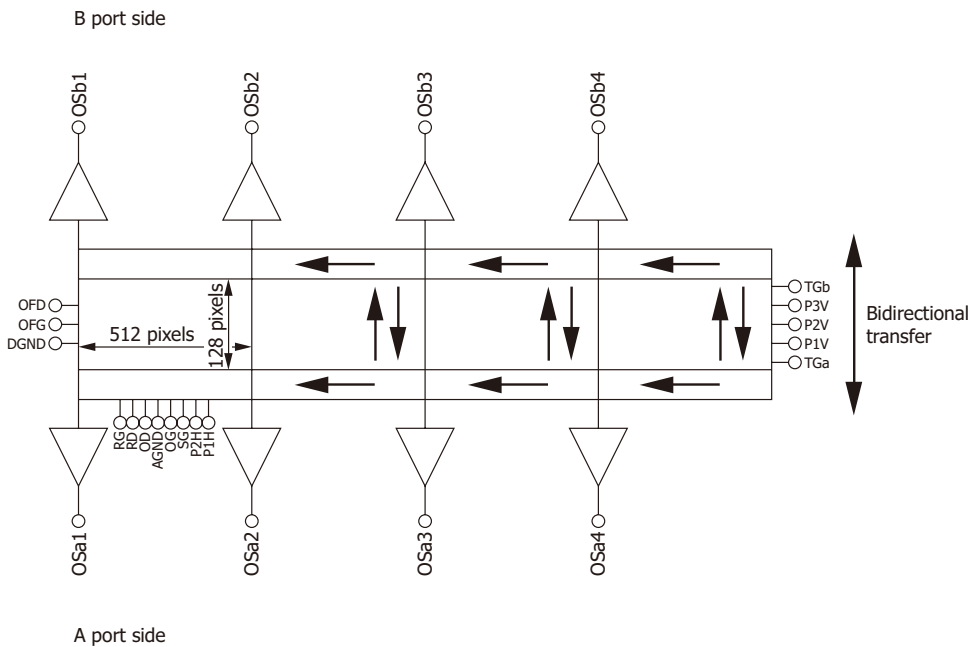
- Schematic diagram of integrated exposure in TDI operation

In FFT-CCD, signal charges in each column are vertically transferred during charge readout. TDI operation is a method that synchronizes the vertical transfer timing with the movement timing of the object incident on the CCD, so that signal charges are integrated a number of times equal to the number of vertical stages of the CCD pixels.



- Sensor structure diagram (S10201-04-01)

By arranging multiple amplifiers and using multi-port output, we have made it capable of parallel image readout and achieved a high-speed line rate.



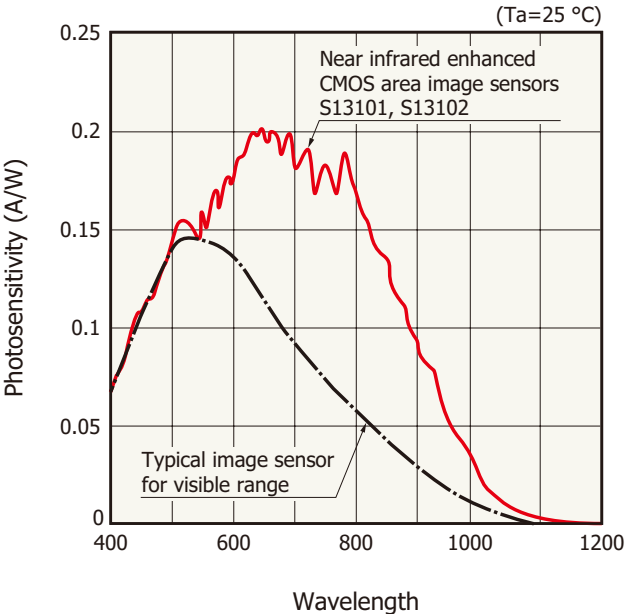
High near infrared sensitivity

CMOS image sensors

These CMOS image sensors have achieved high sensitivity in the near infrared region, using our unique photosensitive area technology.

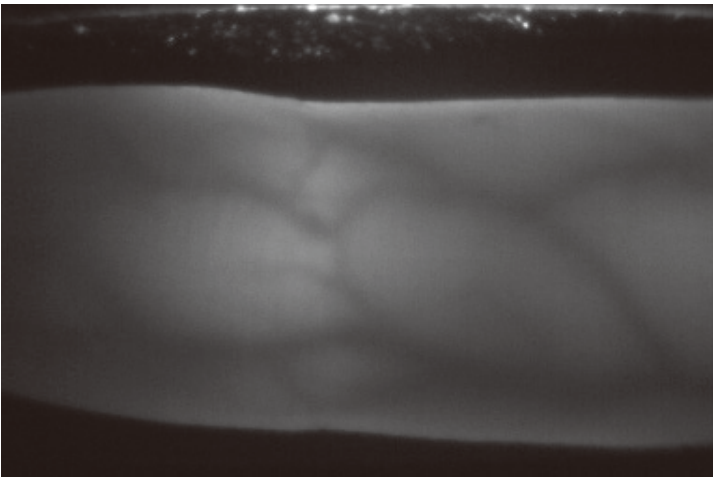


● Spectral response (typical example)



KMPDB0489EA

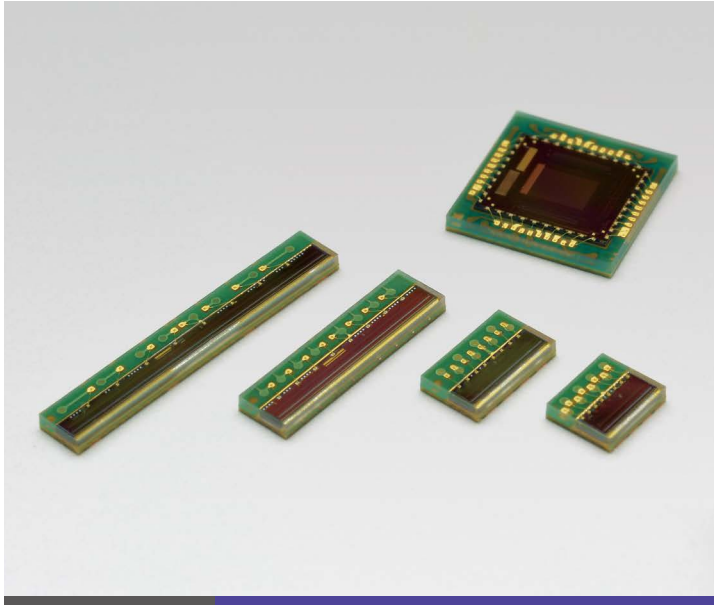
● Imaging example of finger veins using near infrared enhanced CMOS area image sensor



Compact, thin COB package

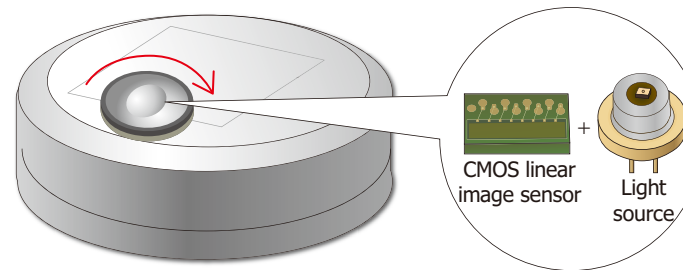
CMOS image sensors

The CMOS image sensors in a compact, thin COB (chip on board) package contributes making equipment compact and low cost. They can be used in a wide range of applications, including barcode readers and encoders.



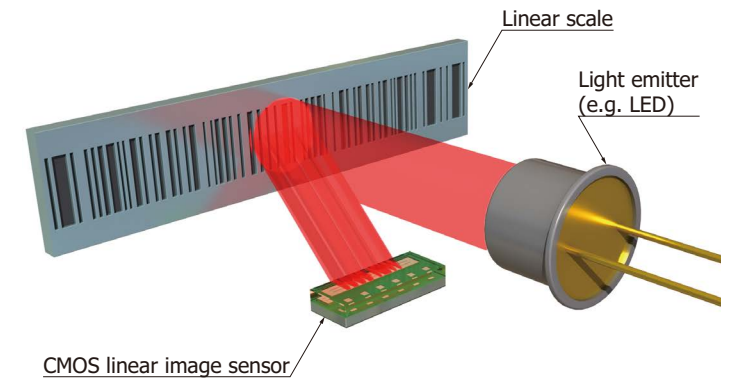
- Application examples of CMOS linear image sensors

[Rangefinder (robot cleaner)]



KMPDC0914EB

[Encoder]

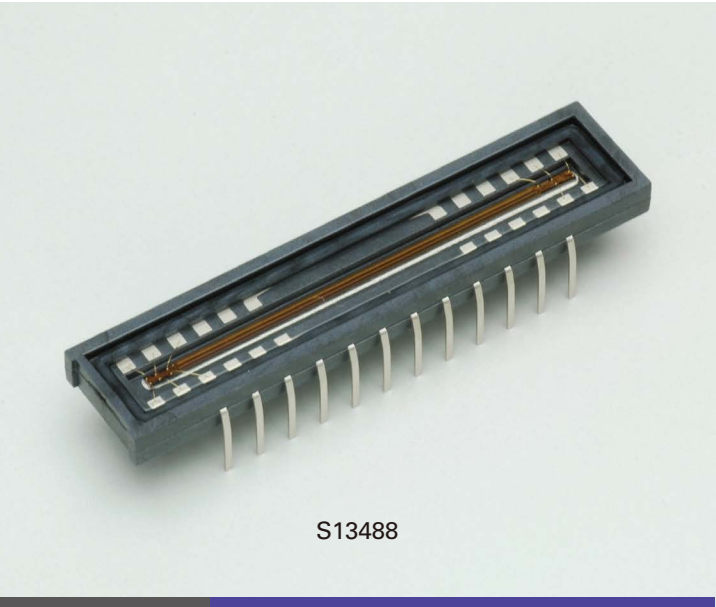


KMPDC0913EA

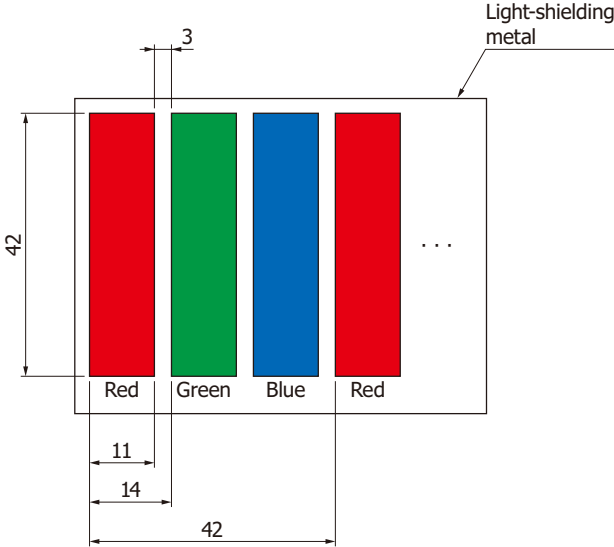
With color filters

CMOS linear image sensor

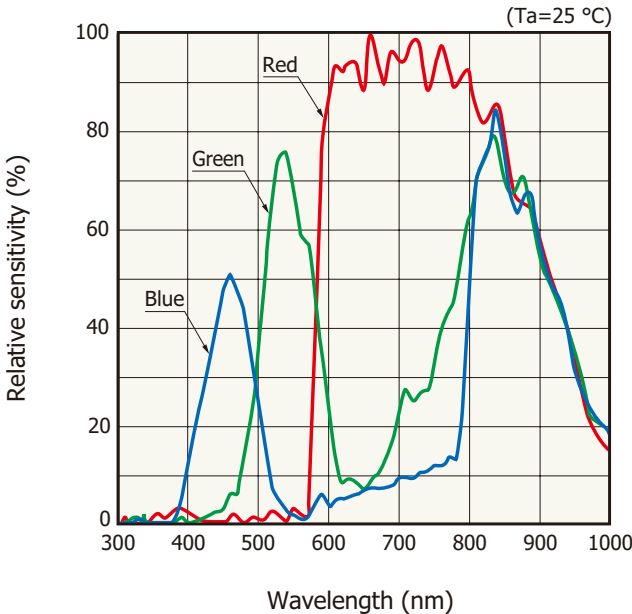
This type has color filters that transmit only light of a specific wavelength on the photodiode of the CMOS linear image sensor. It can acquire color information of the measurement target.



● Enlarged view of color filters (unit: μm)



● Spectral response (typical example)



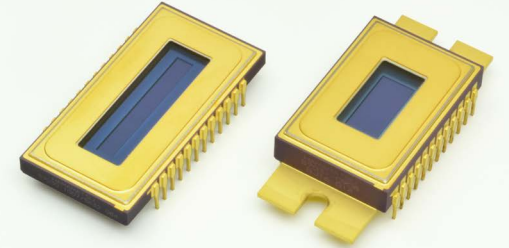
KMPDC0911EA

KMPDB0483EB

CCD image sensors

Standard type

These products offer low noise, low dark current, and wide dynamic range, so they can detect very low-level light by lengthening the integration time.



High performance

▶ [UV enhanced type](#)

These CCDs exhibit high sensitivity in the UV region.

▶ [Large full well type](#)

The products realize a wide dynamic range.

▶ [High-speed readout type](#)

The products are capable of high-speed readout with built-in high-speed amplifier.

▶ [NIR enhanced type](#)

High sensitivity in the near infrared region of 800 nm or longer has been realized.

▶ [High resolution type](#)

The products are low noise CCDs with a small pixel size (12 × 12 μm).

Highly functional

▶ [Built-in electronic shutter type](#)






Any integration timing can be set.

▶ [TDI operation type](#)

During high-speed imaging, the products can obtain high S/N images even under low-light-level conditions.

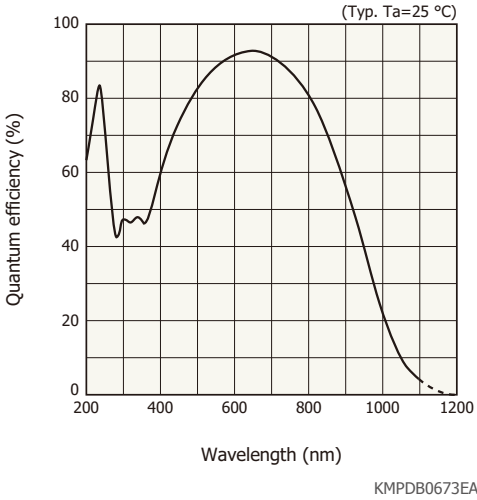
Standard type

These offer low noise and low dark current, so they can detect very low-level light by lengthening the integration time. By doing binning operation (an operation which adds signals of pixels in the vertical direction), they can be used as a linear image sensor that is long in the vertical register direction, so they are suitable for detectors of spectrophotometers.

| Type no. | Pixel size [μm (H) × μm (V)] | Number of effective pixels | Line rate* ¹ Frame rate* ² | Cooling* ³ | Photo | Dedicated driver circuit (sold separately) |
|---------------------------------------|---------------------------------|--|---|------------------------|---|---|
| S7170-0909 | 24 × 24 | 512 × 512 | 0.9 frames/s | Non-cooled |  | C7180 |
| S7030-0906 | | 512 × 58 | 418 lines/s | |  | C7040 |
| S7030-0907 | | 512 × 122 | 316 lines/s | | | |
| S7030-1006 | | 1024 × 58 | 213 lines/s | | | |
| S7030-1007 | | 1024 × 122 | 160 lines/s | | | |
| S7171-0909-01 | | 512 × 512 | 0.9 frames/s | One-stage TE-cooled |  | C7181 |
| S7031-0906S | | 512 × 58 | 418 lines/s | |  | C7041 |
| S7031-0907S | | 512 × 122 | 316 lines/s | | | |
| S7031-1006S | | 1024 × 58 | 213 lines/s | | | |
| S7031-1007S | | 1024 × 122 | 160 lines/s | | | |
| S12071 * ⁴ | 1024 × 1024 | Tap A: 0.1 frames/s Tap B: 1.5 frames/s |  | — | | |












*1: Full line binning (typ.) *2: Area scanning (typ.)
*3: Two-stage TE-cooled type (S7032-1006/-1007) is available upon request (made-to-order products). *4: With anti-blooming function
Note: Windowless types are also available.

● Spectral response
(without window)



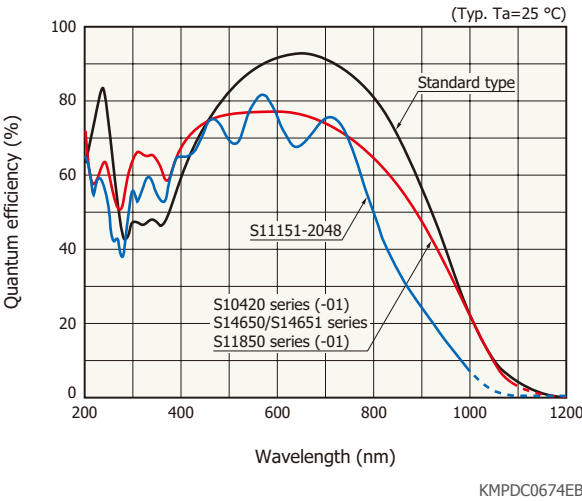
UV enhanced type

These CCDs exhibit high quantum efficiency in the UV region.

| Type no. | Pixel size [μm (H) × μm (V)] | Number of effective pixels | Line rate* (lines/s) | Cooling | Photo | Dedicated driver circuit (sold separately) |
|--------------------------------|---------------------------------|-------------------------------|-------------------------|------------------------|---|---|
| S10420-1004-01 | 14 × 14 | 1024 × 16 | 221 | Non-cooled |  | C11287-01 |
| S10420-1006-01 | | 1024 × 64 | 189 | |  | |
| S10420-1104-01 | | 2048 × 16 | 116 | |  | |
| S10420-1106-01 | | 2048 × 64 | 106 | |  | |
| S14650-1024 | | 1024 × 192 | 95 | |  | |
| S14650-2048 | | 2048 × 192 | 68 | |  | |
| S11850-1006-01 | 14 × 14 | 1024 × 64 | 189 | One-stage TE-cooled |  | C11860 |
| S11850-1106-01 | | 2048 × 64 | 106 | |  | |
| S14651-1024 | | 1024 × 192 | 95 | |  | |
| S14651-2048 | | 2048 × 192 | 68 | |  | |
| S11151-2048 | 14 × 200 | 2048 × 1 | 484 | Non-cooled |  | C11160 |







* Full line binning (typ.)
Note: Windowless types are also available.

● Spectral response (without window)



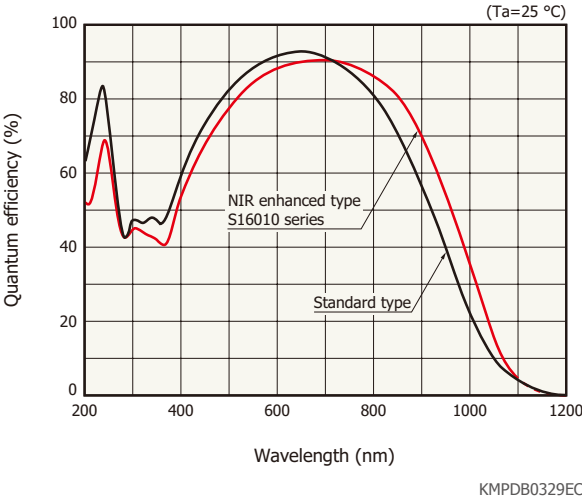
NIR enhanced type

These back-thinned CCDs exhibit high sensitivity in the near infrared region. They are used for Raman spectroscopy.

| Type no. | Pixel size [μm (H) × μm (V)] | Number of effective pixels | Line rate* (lines/s) | Cooling | Photo | Dedicated driver circuit (sold separately) |
|---|---------------------------------|-------------------------------|-------------------------|------------------------|---|---|
| S16000-1007 <small>NEW</small> | 24 × 24 | 1024 × 122 | 160 | Non-cooled |  | C7040 |
| S16001-1007S <small>NEW</small> | | | | One-stage TE-cooled |  | C7041 |
| S16010-1006 | 14 × 14 | 1024 × 64 | 189 | Non-cooled |  | C11287-01 |
| S16010-1106 | | 2048 × 64 | 106 | Non-cooled |  | |
| S16011-1006 | | 1024 × 64 | 189 | One-stage TE-cooled |  | C11860 |
| S16011-1106 | | 2048 × 64 | 106 | |  | |





* Full line binning (typ.)
Note: Windowless types are also available.

● Spectral response
(without window, typical example)



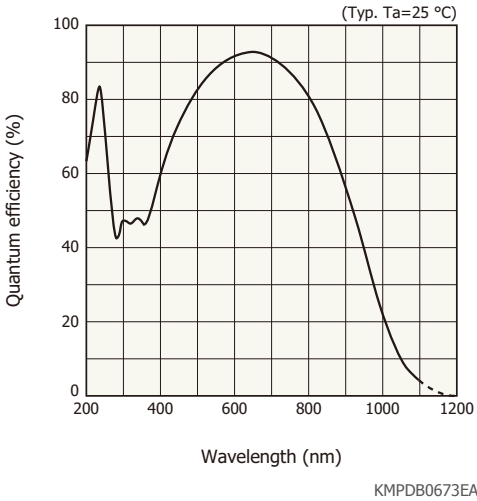
Large full well type

These have a wide dynamic range and are widely used for spectroscopic measurement.

| Type no. | Pixel size [μm (H) × μm (V)] | Number of effective pixels | Line rate*1 (lines/s) | Full well capacity (ke ⁻) | | Cooling | Photo | Dedicated driver circuit (sold separately) |
|-----------------------------|---------------------------------|-------------------------------|--------------------------|--|--------------|------------------------|---|---|
| | | | | Vertical | Horizontal*2 | | | |
| S7033-0907 | 24 × 24 | 512 × 122 | 316 | 320 | 3400 | Non-cooled |  | C7043 |
| S7033-1007 | | 1024 × 122 | 160 | | | |  | |
| S7034-0907S | | 512 × 122 | 316 | | | One-stage TE-cooled |  | C7044 |
| S7034-1007S | | 1024 × 122 | 160 | | | |  | |




*1: Full line binning (typ.)
*2: Linearity=±1.5%
Note: Two-stage TE-cooled type (S7035 series), windowless type are also available.

● Spectral response
(without window)



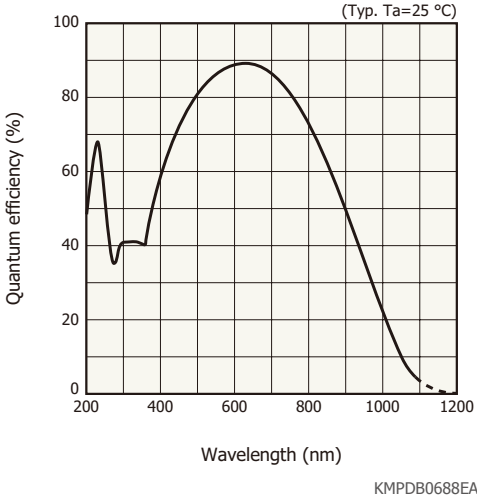
High resolution type

These are low noise CCDs with a small pixel size (12 × 12 μm).

| Type no. | Pixel size [μm (H) × μm (V)] | Number of effective pixels | Line rate*1 (lines/s) | Cooling*2 | Photo | Dedicated driver circuit (sold separately) |
|---------------------------------|---------------------------------|-------------------------------|---|------------------------|--|---|
| S10140-1107-01 | 12 × 12 | 2048 × 122 | 107 | Non-cooled |  | C10150-01 |
| S10140-1108-01 | | 2048 × 250 | 80 | | | |
| S10140-1109-01 | | 2048 × 506 | 40 | | | |
| S10141-1107S-01 | | 2048 × 122 | 107 | One-stage TE-cooled |  | C10151-01 |
| S10141-1108S-01 | | 2048 × 250 | 80 | | | |
| S10141-1109S-01 | | 2048 × 506 | 40 | | | |
| S12101 *3 | | 2048 × 2048 | Tap A: 0.02 frames/s Tap B: 2.4 frames/s | |  | — |








*1: Full line binning (typ.)
*2: Note: Two-stage TE-cooled type [S10142 series (-01)] is available upon request (made-to-order products).
*3: With anti-blooming function
Note: Windowless types are also available.

● Spectral response
(without window)



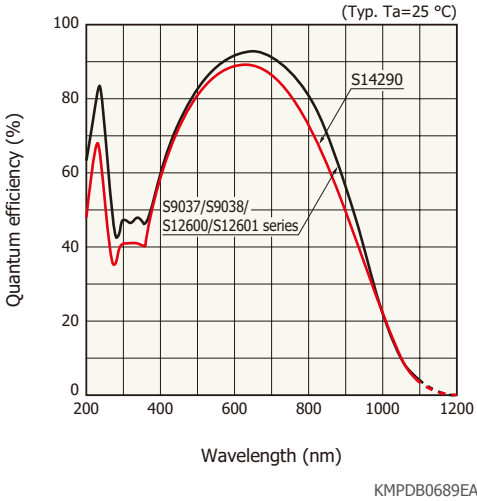
High-speed readout type

This type has a built-in high-speed readout amplifier.

| Type no. | Pixel size [μm (H) × μm (V)] | Number of effective pixels | Data rate (MHz) | Line rate* (lines/s) | Cooling | Photo |
|------------------------------|---------------------------------|-------------------------------|--------------------|-------------------------|------------------------|---|
| S9037-0902 | 24 × 24 | 512 × 4 | 10 | 16300 | Non-cooled |  |
| S9037-1002 | | 1024 × 4 | | 8100 | |  |
| S9038-0902S | | 512 × 4 | | 16300 | One-stage TE-cooled |  |
| S9038-1002S | | 1024 × 4 | | 8100 | |  |
| S12600-1006 | | 1024 × 58 | 5 | 2097 | Non-cooled |  |
| S12600-1007 | | 1024 × 122 | | 1162 | | |
| S12601-1006S | | 1024 × 58 | | 2097 | One-stage TE-cooled |  |
| S12601-1007S | | 1024 × 122 | | 1162 | | |
| S14290 | 24 × 500 | 1024 × 1 | | 10000 | Non-cooled |  |

* Full line binning (typ.)
Note: Windowless types are also available.









● Spectral response
(without window)



High resolution

High-speed readout type

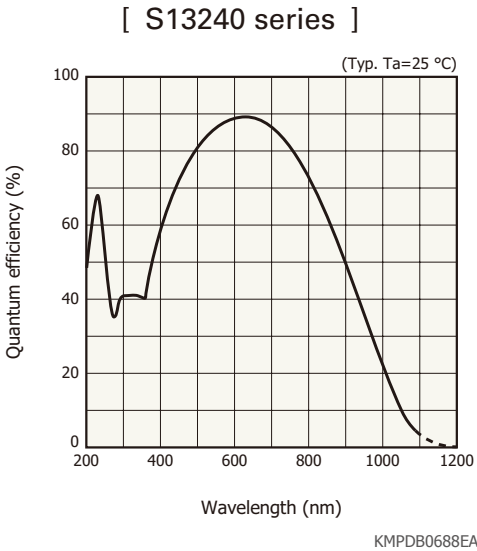
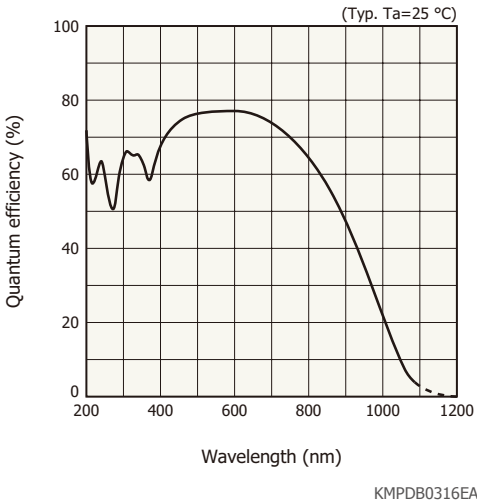
These CCDs have a small pixel size and a data rate of 10 MHz.

| Type no. | Pixel size [μm (H) × μm (V)] | Number of effective pixels | Data rate (MHz) | Line rate* (lines/s) | Number of ports | Cooling | Photo | Dedicated driver circuit (sold separately) |
|--------------------------------|---------------------------------|-------------------------------|--------------------|-------------------------|-----------------|------------------------|---|---|
| S11071-1004 | 14 × 14 | 1024 × 16 | 10 | 1777 | 1 | Non-cooled |  | C11288-01 |
| S11071-1006 | | 1024 × 64 | | 751 | | | | |
| S11071-1104 | | 2048 × 16 | | 1303 | | |  | |
| S11071-1106 | | 2048 × 64 | | 651 | | | | |
| S11851-1106-01 | | 2048 × 64 | | 651 | | One-stage TE-cooled |  | — |
| S14660-1024 | | 1024 × 192 | | 296 | | Non-cooled |  | C11288-01 |
| S14660-2048 | | 2048 × 192 | | 148 | | |  | |
| S14661-1024 | | 1024 × 192 | | 296 | | One-stage TE-cooled |  | — |
| S14661-2048 | | 2048 × 192 | | 148 | | One-stage TE-cooled |  | — |
| S13240-1107 | 12 × 12 | 2048 × 122 | 10 | 921 | 1 | Non-cooled |  | — |
| S13240-1108 | | 2048 × 250 | | 539 | | | | |
| S13240-1109 | | 2048 × 506 | | 203 | | | | |

* Full line binning (typ.)
Note: Windowless types are also available.

Spectral response
(without window)


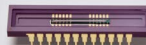



[S11071/S11851/S14660/S14661 series]



High resolution

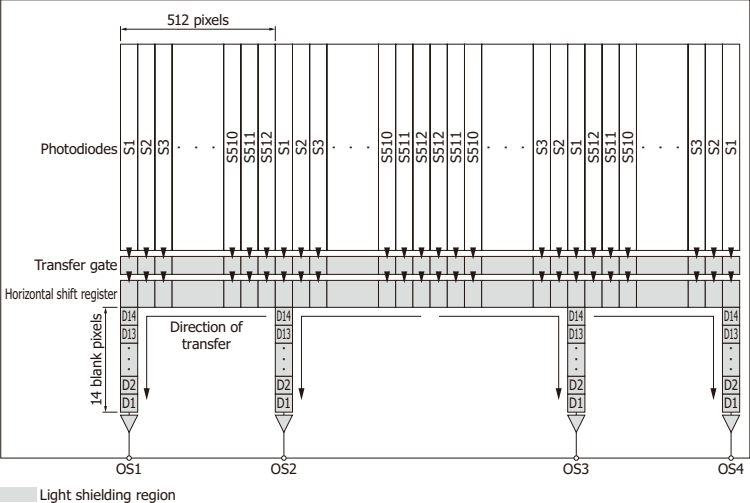
High-speed readout type

These CCDs have a small pixel pitch. The S12379 and S15729-01 realize high-speed line rate with multi-port readout.

| Type no. | Pixel size [μm (H) × μm (V)] | Number of effective pixels | Data rate (MHz) | Line rate (lines/s) | Number of ports | Cooling | Photo | Dedicated driver circuit (sold separately) |
|------------------------------|---------------------------------|----------------------------|--------------------|------------------------|-----------------|---------------------|--|---|
| S13241-1107S | 12 × 12 | 2048 × 122 | 10 | 921*1 | 1 | One-stage TE-cooled |  | — |
| S13241-1108S | | 2048 × 250 | | 539*1 | | | | |
| S13241-1109S | | 2048 × 506 | | 203*1 | | | | |
| S12551-1024 | 14 × 14 | 1024 × 1 | 40 | 37900*2 | 1 | Non-cooled |  | — |
| S12551-2048 | | 2048 × 1 | | 19200*2 | | |  | — |
| S12379 | 8 × 8 | 2048 × 1 | | 72000 | 4 | |  | — |
| S15729-01 | 10 × 180 | 2048 × 1 | | 70000 | | |  | C15821-2351 |

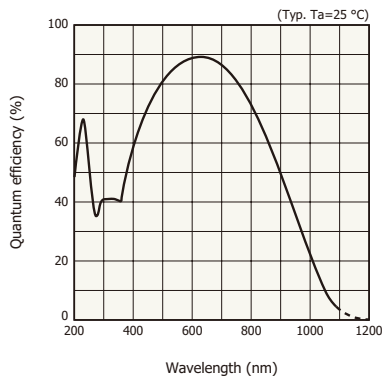
*1: Full line binning (typ.)
*2: With electronic shutter (line rate when electronic shutter is not used)
Note: Windowless types are also available.

- Device structure
(schematic of CCD chip as viewed from top of dimensional outline)
[S15729-01 (4 ports)]

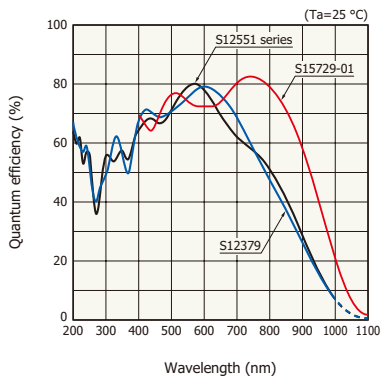


KMPDC0862EA

- Spectral response (without window)
[S13241 series] [S12551 series, S12379, S15729-01]








KMPDB0688EA



KMPDB0679EA

Built-in electronic shutter type

These are CCD linear image sensors for spectrophotometry with a built-in electronic shutter function. High-speed transfer is enabled by adopting a resistive gate structure (except for S15351-2048).

| Type no. | Pixel size [μm (H) × μm (V)] | Number of effective pixels | Line rate (lines/s) | Cooling | Photo | Dedicated driver circuit (sold separately) |
|--------------------------------|---------------------------------|-------------------------------|------------------------|------------------------|--|---|
| S11155-2048-02 | 14 × 500 | 2048 × 1 | 2327 | Non-cooled |  | C11165-02 |
| S11156-2048-02 | 14 × 1000 | | | | | |
| S13255-2048-02 | 14 × 500 | | 2327 | One-stage TE-cooled |  | — |
| S13256-2048-02 | 14 × 1000 | | | | | |
| S15254-2048 | 14 × 200 | | 2356 | Non-cooled |  | C15361-2105 |
| S15257-2048 | 14 × 2500 | | 2294 | |  | |
| S15351-2048 | 14 × 200 | | 1180 | |  | C15361-1105 |

Note: Windowless types are also available.

Related products

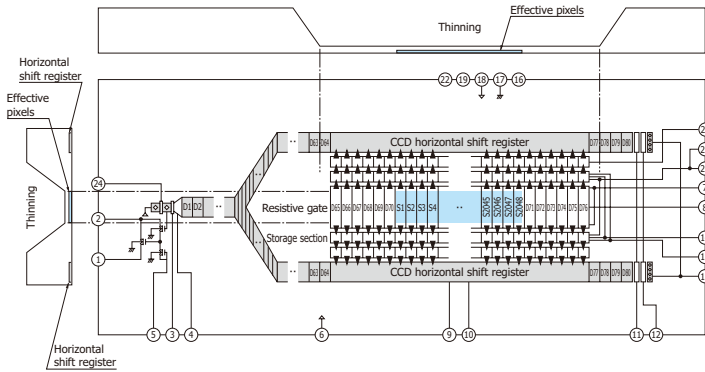


CMOS linear image sensors
for spectrophotometry
High sensitivity type



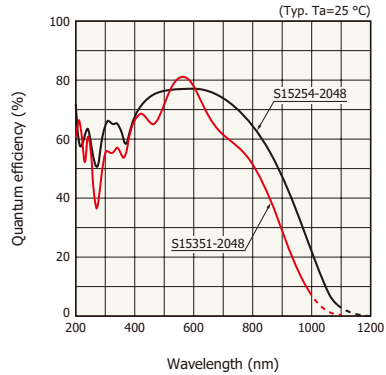
CMOS linear image sensors
for industrial equipment
High sensitivity type

- Device structure
(schematic of CCD chip as viewed from top of dimensional outline)
[S11155/S11156/S13255/S13256-2048-02, S15254/S15257-2048]



KMPDC0543EB



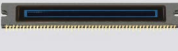


- Spectral response (without window)
[S15254-2048, S15351-2048]



KMPDB0680EA

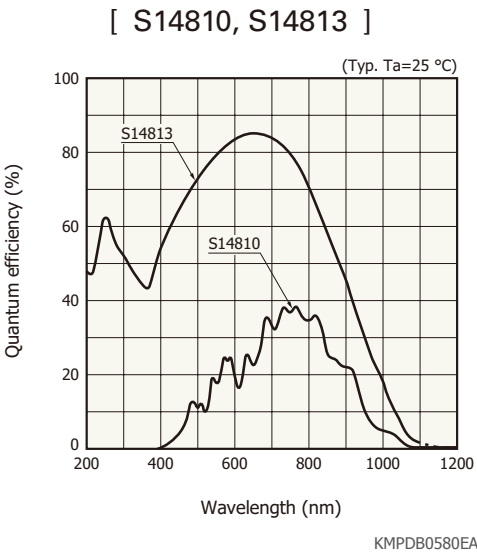
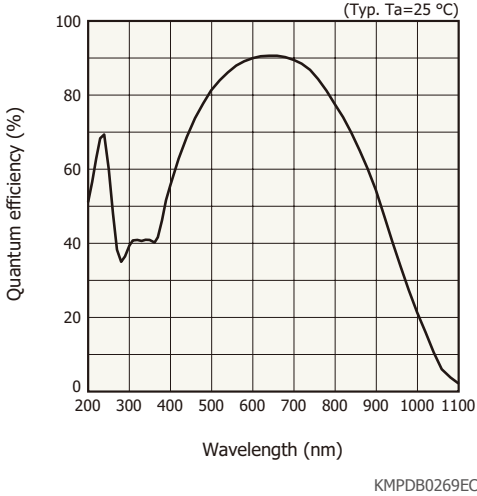
TDI-CCD image sensors

High S/N images can be obtained when moving objects are subjected to integration while being exposed to light during high-speed imaging. The S14810 and S14813 have a hybrid structure combining TDI-CCD and CMOS readout circuit. With the photosensitive area technology that Hamamatsu has cultivated over many years, the S14813 realizes the highest level of UV sensitivity and UV resistance in the world.

| Type no. | Pixel size [μm (H) × μm (V)] | Number of effective pixels | Number of ports | Pixel rate (MHz/port) | Line rate (lines/s) | Vertical transfer | Photo | Applicable camera (sold separately) |
|------------------------------|---------------------------------|-------------------------------|-----------------|--------------------------|------------------------|-------------------|---|--|
| S10200-02-01 | 12 × 12 | 1024 × 128 | 2 | 30 | 50000 | Bidirectional |  | — |
| S10201-04-01 | | 2048 × 128 | 4 | | | |  | C10000-801* C10000-A01* |
| S10202-08-01 | | 4096 × 128 | 8 | | | |  | — |
| S10202-16-01 | | 4096 × 128 | 16 | | 100000 | | | — |
| S14810 | | 1024 × 128 | 1024 | 0.1 | 100000 | |  | — |
| S14813 | | | | | | |  | |

*The C10000 series camera is a product of Hamamatsu’s System Division.
Note: TDI: time delay integration

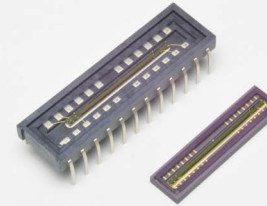
● Spectral response
[S10200/S10201/S10202 series]



CMOS image sensors

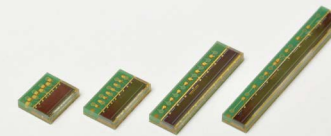
CMOS linear image sensors for spectrophotometry

These have vertically long pixels, realizing high quantum efficiency in the ultraviolet to visible regions.



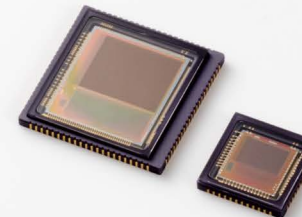
CMOS linear image sensors for industrial equipment

We offer sensors suitable for position detection, encoders, line scan cameras, and more. These are equipped with a timing generator and signal processing amplifier, and are driven by a simple input pulse and a single power supply.



CMOS area image sensors

We offer a type that has high sensitivity in the UV and near IR region.



Highly functional CMOS image sensors

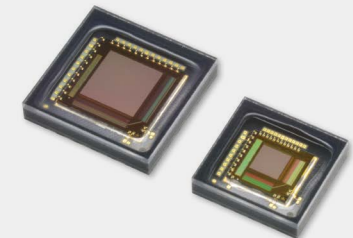
► Distance image sensors

These sensors measure the distance to an object by TOF (time-of-flight) method. When used in combination with a pulse modulated light source, these sensors output phase difference information on the timing that the light is emitted and received.



► Profile sensors



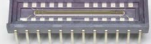

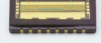



These high-performance sensors are specialized for acquiring 2D projection data.



For spectrophotometry

High sensitivity type

These are high sensitivity CMOS linear image sensors employing a photosensitive area with vertically long pixels. High sensitivity and high durability have been achieved even in the ultraviolet region. The S16514-2048-11 and S16596-4096-11 realize high sensitivity in near IR region and smooth spectral response.

| Type no. | Pixel height (μm) | Pixel pitch (μm) | Number of pixels | Line rate max. (lines/s) | Photo | Dedicated driver circuit (sold separately) |
|--------------------------------|----------------------|---------------------|------------------|--------------------------------|--|--|
| S16528-1024-11 | 200 | 28 | 1024 | 8960 |  | C13015-01 |
| S11639-01 *1 | | 14 | 2048 | 4672 |  | C13015-01 |
| S15739-1024 *2 | | | 1024 | 8960 |  | |
| S13014 *2 | | | 512 | 16556 |  | C13015-01 *3 |
| S14739-20 | | | 256 | 28735 |  | |
| S13496 *1 | | 7 | 4096 | 2387 |  | C13015-01 |
| S15796-2048 *2 | | | 2048 | 4672 |  | C13015-01 |
| S15796-1024 *2 | | | 1024 | 8960 | | C13015-01 *3 |
| S16514-2048-11 | | 14 | 2048 | 4672 |  | C13015-01 |
| S16596-4096-11 | | 7 | 4096 | 2387 | | |

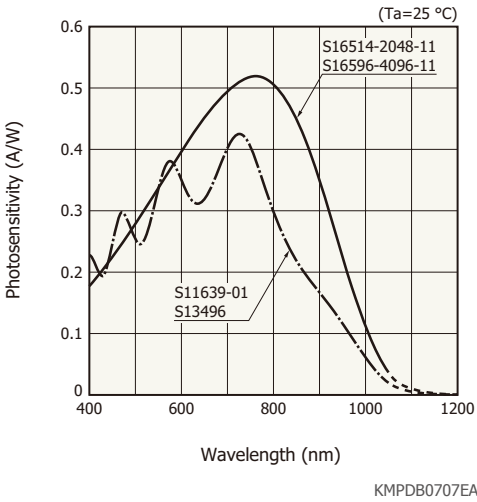
*1: We also offer types with light-shielding pixels (S11639-11, S13496-11). *2: Surface mount type is also available. *3: A conversion board is required during use.

Related products



CCD image sensors
Built-in electronic shutter type

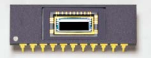




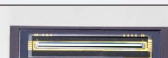
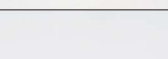
Spectral response (typical example)



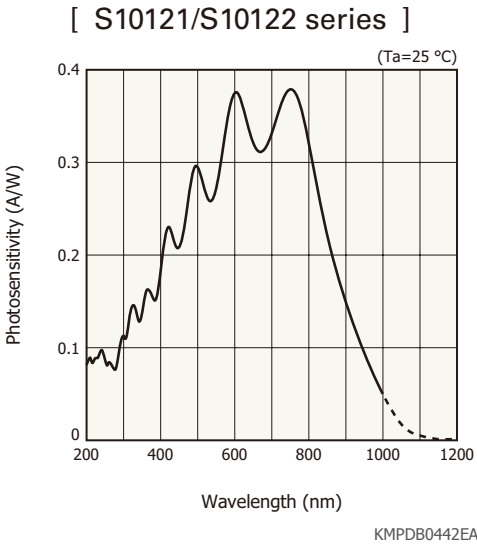
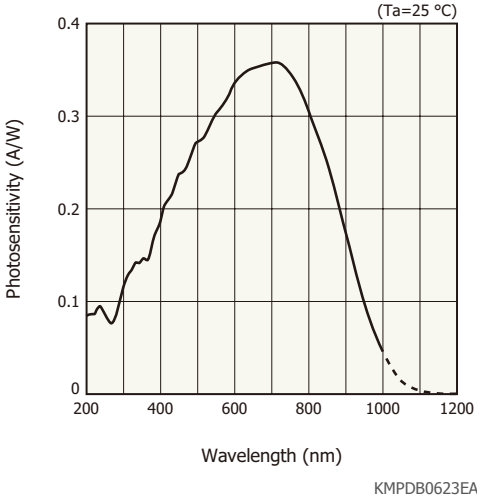
For spectrophotometry

Large saturation charge type

This current output type features high UV sensitivity and smooth spectral response. It has a large saturation charge and integration time is variable for each pixel, so it can efficiently detect the dispersed very low-level light.








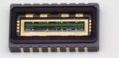
| Type no. | Pixel height (mm) | Pixel pitch (μm) | Number of pixels | Line rate max. (lines/s) | Photo | Dedicated driver circuit (sold separately) |
|--------------------------------|----------------------|---------------------|------------------|--------------------------------|---|---|
| S10121-128Q-01 | 2.5 | 50 | 128 | 1923 |  | C10808 series |
| S10121-256Q-01 | | | 256 | 969 |  | |
| S10121-512Q-01 | | | 512 | 486 |  | |
| S10122-128Q-01 | 0.5 | | 128 | 3846 |  | |
| S10122-256Q-01 | | | 256 | 1938 |  | |
| S10122-512Q-01 | | | 512 | 972 |  | |
| S15908-512Q | 2.5 | 50 | 512 | 486 |  | C10808 series |
| S15909-1024Q | | 25 | 1024 | 243 | | |

Spectral response (typical example)
[S15908-512Q, S15909-1024Q]

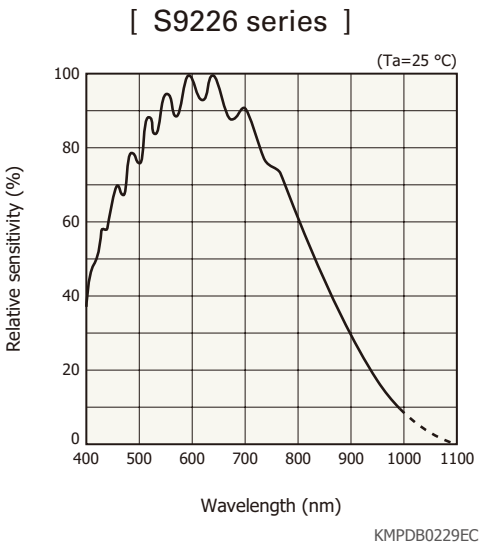
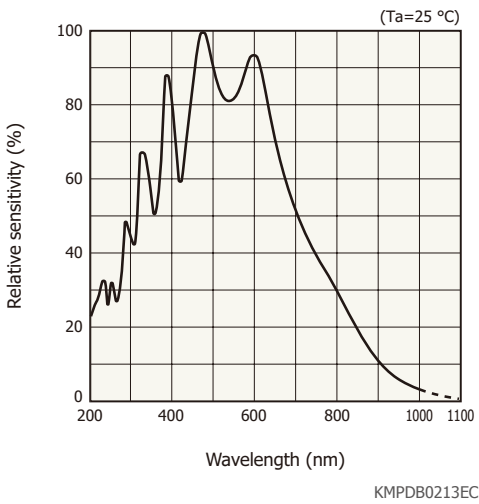


For spectrophotometry

These linear image sensors have a built-in readout circuit.

| Type no. | Pixel height (μm) | Pixel pitch (μm) | Number of pixels | Line rate max. (lines/s) | Photo |
|-----------------------------|----------------------|---------------------|------------------|--------------------------------|---|
| S8377-128Q | 500 | 50 | 128 | 3846 |  |
| S8377-256Q | | | 256 | 1938 |  |
| S8377-512Q | | | 512 | 972 |  |
| S8378-256Q | | 25 | 256 | 1938 |  |
| S8378-512Q | | | 512 | 972 |  |
| S8378-1024Q | | | 1024 | 487 |  |
| S9226-03 | 125 | 7.8 | 1024 | 194 |  |
| S9226-04 | | | | |  |


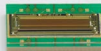
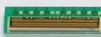





● Spectral response
(typical example, without window)
[S8377/S8378 series]



For industrial equipment

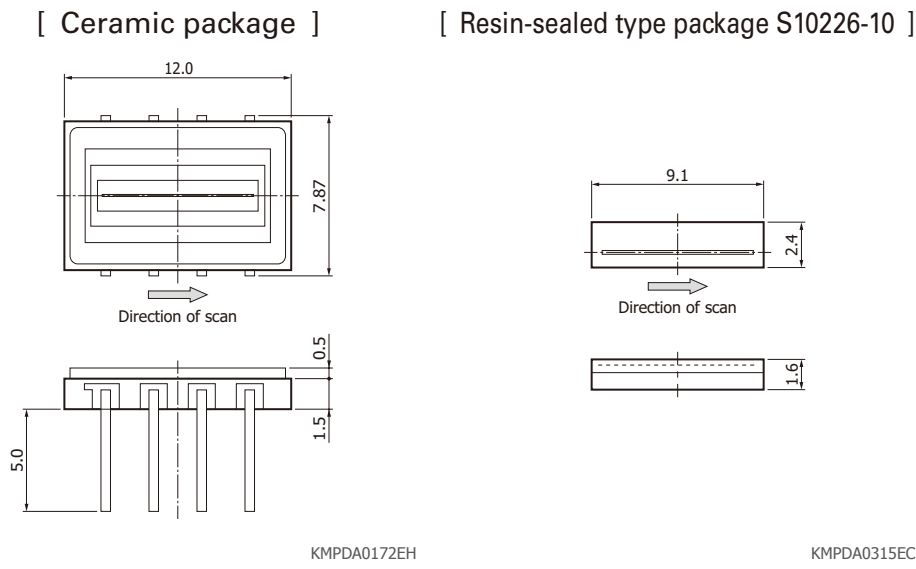
Resin-sealed type package

These are a compact and surface mounted high-volume production type.

| Type no. | Pixel height (μm) | Pixel pitch (μm) | Number of pixels | Line rate max. (lines/s) | Photo |
|-----------------------------|----------------------|---------------------|------------------|--------------------------------|---|
| S10226-10 | 125 | 7.8 | 1024 | 194 |  |
| S10227-10 | 250 | 12.5 | 512 | 9434 |  |
| S11106-10 | 63.5 | 63.5 | 128 | 67568 |  |
| S11107-10 | 127 | 127 | 64 | 119048 | |
| S12443 | 125 | 7 | 2496 | 3924 |  |
| S13131-512 | 63.5 | 5.5 | 512 | 3787 |  |
| S13131-736 | | | 736 | 2659 |  |
| S13131-1536 | | | 1536 | 1288 |  |
| S13434-2496 | | 5.25 | 2496 | 796 |  |

● Size of ceramic package and resin-sealed type package









The following products have the same photosensitive area size (7.9872 × 0.125 mm), but the resin-sealed type package is more compact and thin.



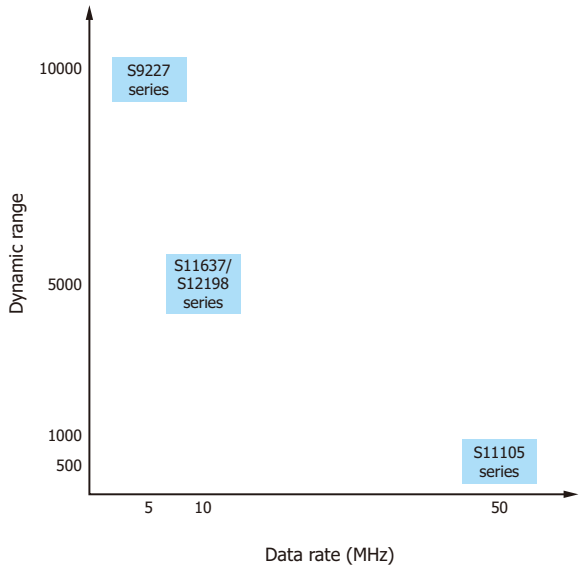
For industrial equipment

High-speed readout type

These CMOS image sensors are capable of high-speed readout.

| Type no. | Pixel height (μm) | Pixel pitch (μm) | Number of pixels | Line rate max. (lines/s) | Photo |
|---------------------------------|----------------------|---------------------|------------------|--------------------------------|---|
| S9227-03 | 250 | 12.5 | 512 | 9434 |  |
| S9227-04 | | | | |  |
| S11105 | 250 | 12.5 | 512 | 88652 |  |
| S11105-01 | | | | 88495 |  |
| S11637-1024Q | 500 | 12.5 | 1024 | 9487 |  |
| S11637-2048Q | | | 2048 | 4812 |  |
| S12198-512Q-01 | 500 | 25 | 512 | 18450 |  |
| S12198-1024Q-01 | | | 1024 | 9487 |  |

● Dynamic range vs. data rate








KMPDB0678EA

For industrial equipment

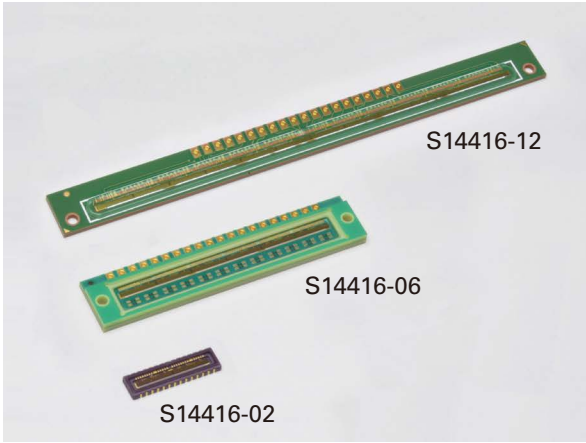
High-speed readout type

These CMOS image sensors are capable of high-speed readout.

| Type no. | Pixel height (μm) | Pixel pitch (μm) | Number of pixels | Line rate max. (lines/s) | Photo |
|---------------------------|----------------------|---------------------|------------------|--------------------------------|---|
| S14416-02 | 63.5 | 63.5 | 256 | 36231 |  |
| S14416-06 | | | 768 | 12690 |  |
| S14416-12 | | | 1536 | 6426 |  |
| S14417-02 | 127 | 127 | 128 | 67567 |  |
| S14417-06 | | | 384 | 24752 |  |

● S14416 series


The S14416-02/-06/-12 are products with 128-element photodiode arrays arranged in 2/6/12 parts respectively. Select a product of the size that matches your detection target.



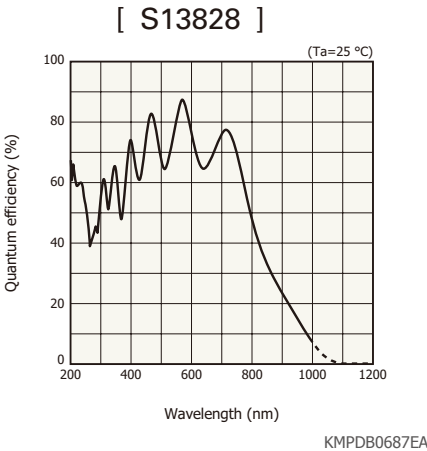
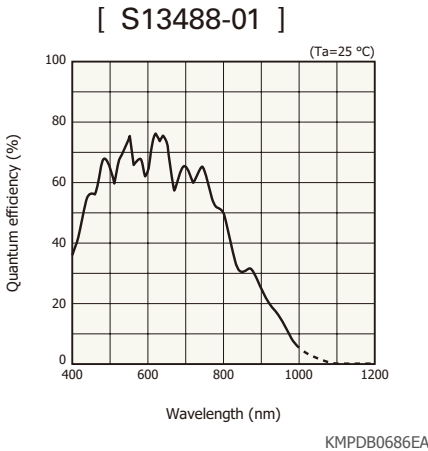
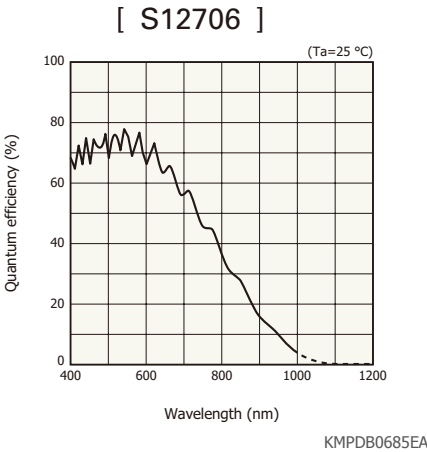
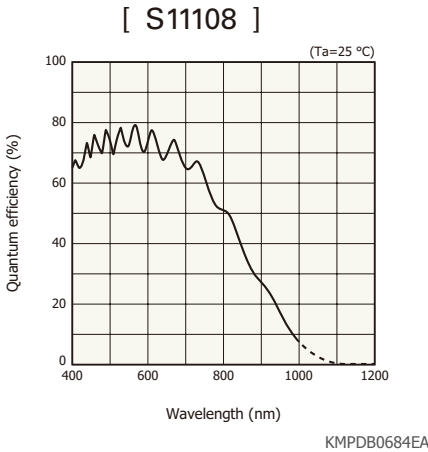
For industrial equipment

High sensitivity type

We have realized high sensitivity by incorporating an amplifier for each pixel.

| Type no. | Pixel height (μm) | Pixel pitch (μm) | Number of pixels | Line rate max. (lines/s) | Photo | Dedicated driver circuit (sold separately) |
|---------------------------|----------------------|---------------------|---------------------|--------------------------------|--|---|
| S11108 | 14 | 14 | 2048 | 4672 |  | — |
| S12706 | 7 | 7 | 4096 | 2387 | | C13015-01 |
| S13488-01 | 42 | 14 | 2048 | 4672 | | — |
| S13828 | 84 | 28 | 1024 | 8960 | | C13015-01 |

Spectral response (typical example, without window)



Related product







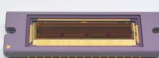



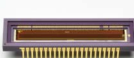
CCD image sensors

Built-in electronic shutter type

For industrial equipment

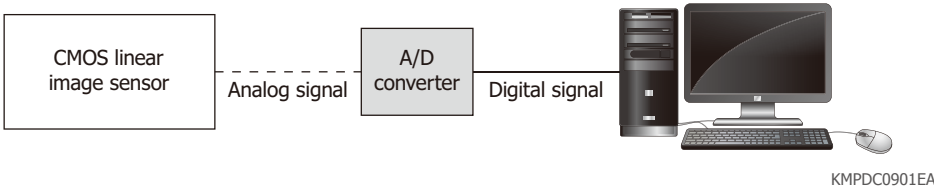
Digital output type

These are linear image sensors with a built-in A/D converter. The S15611-10 realizes smooth spectral response.

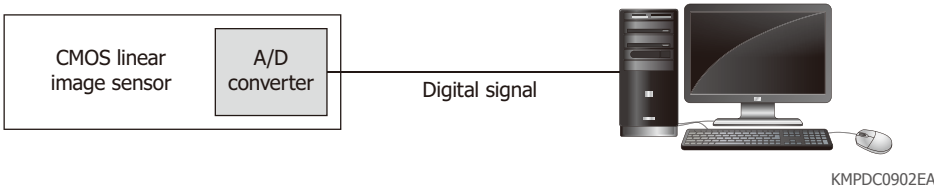
| Type no. | Pixel height (μm) | Pixel pitch (μm) | Number of pixels | Line rate max. (lines/s) | Photo |
|--|----------------------|---------------------|----------------------|--------------------------------|---|
| S10077 | 50 | 14 | 1024 | 972 |  |
| S11720-20 | 127 | 127 | 1536 | 45400 |  |
| S11720-40 | | | 3072 | |  |
| S13774 | 7 | 7 | 4096 | 100000 (high-speed mode) |  |
| S14772 | 14 | 14 | 2048 | 125000 (high-speed mode) |  |
| S15611 | 200 | 7 | 1024 | 34000 |  |
| S15611-10 NEW | | | | |  |
| S15778 | 7 | 7 | 8192 | 100000 (high-speed mode) |  |
| S16074 * NEW | 7 9.3 14 | 7 9.3 14 | 4160 3120 2080 | 35000 46000 65000 |  |

* 3 lines of pixel sizes (7 × 7 μm, 9.3 × 9.3 μm, 14 × 14 μm) are arranged in parallel in the photosensitive area and can be switched with SPI settings.

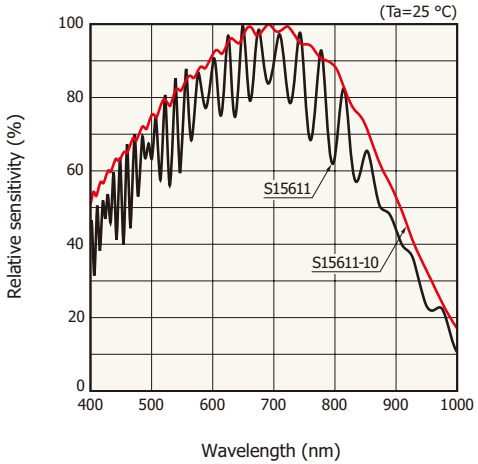
A/D conversion of CMOS linear image sensors [Analog output type]



[With A/D converter (digital output type)]



Spectral response (typical example) [S15611, S15611-10]




KMPDB0712EA

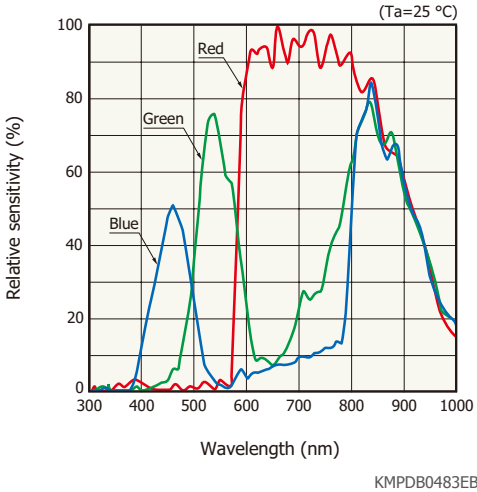
For industrial equipment

With RGB color filters

This CMOS linear image sensor has sensitivity to red (630 nm), green (540 nm), and blue (460 nm) light. Each pixel has a filter in the order RGB, so it can obtain the color information of the measurement target.

| Type no. | Pixel height (μm) | Pixel pitch (μm) | Number of pixels | Line rate max. (lines/s) | Photo |
|------------------------|----------------------|---------------------|------------------|--------------------------------|---|
| S13488 | 42 | 14 | 2048 | 4672 |  |







Spectral response
(typical example)



Note: This sensor also has sensitivity in the infrared region, so cut off incident infrared light as needed.

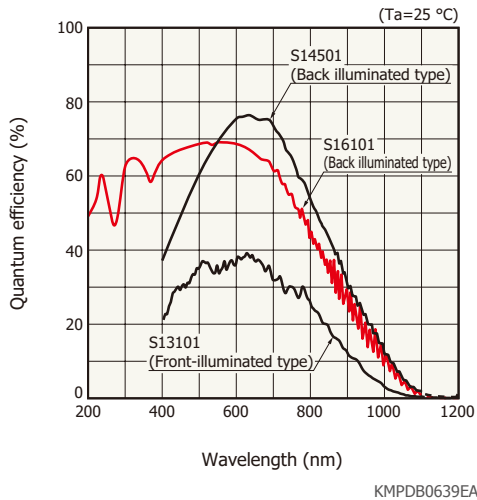
CMOS area image sensors

These APS (active pixel sensor) type CMOS area image sensors have high sensitivity in the UV and near infrared light. They integrate a timing generator, bias generator, amplifier, A/D converter, and are easy to handle because of all-digital I/O.

| Type no. | Pixel size [μm (H) × μm (V)] | Number of effective pixels | Spectral response range (nm) | Frame rate max. (frames/s) | Type | Photo |
|---|---------------------------------|-------------------------------|------------------------------------|----------------------------------|------------------------|---|
| S16101 NEW | 7.4 × 7.4 | 1280 × 1024 | 200 to 1100 | 146 | Back-illuminated type |  |
| S14501 | | | 400 to 1100 | | |  |
| S13101 | 7.4 × 7.4 | 1280 × 1024 | 400 to 1100 | 146 | Front-illuminated type |  |
| S13102 | | 640 × 480 | | 78 | |  |
| S13499 | | 659 × 494 | | 75 | |  |
| S14250 | 50 × 50 | 30 × 30 | | 344 | |  |

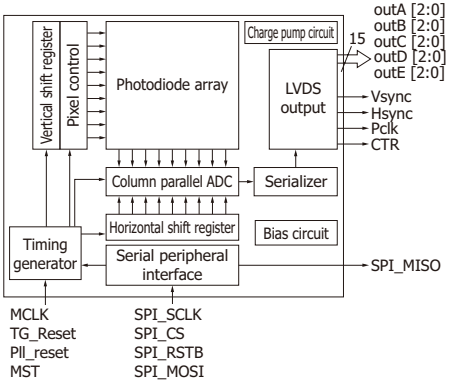
Spectral response

(S16101, S14501, S13101, typical example)





Block diagram

(S16101, S14501, S13101)



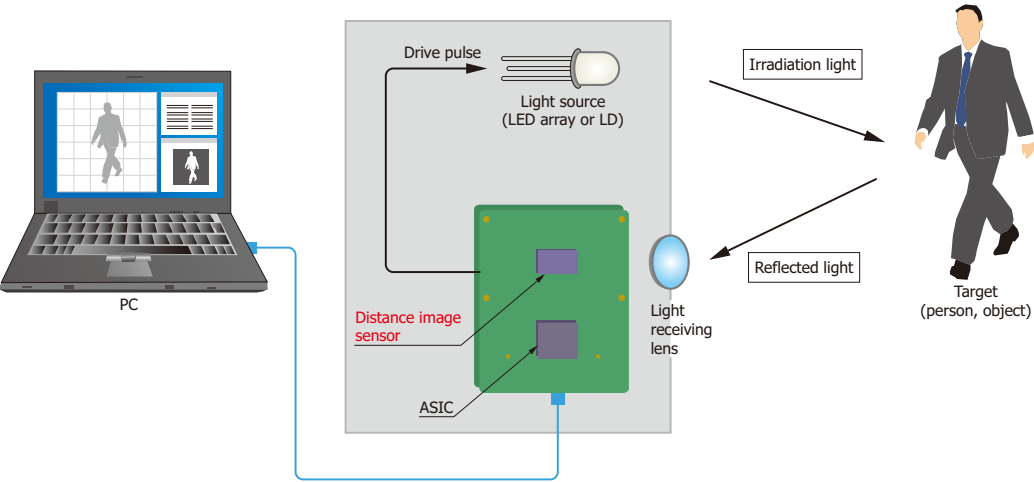
Distance linear image sensors

The distance image sensors are designed to measure the distance to an object by **TOF method**. When used in combination with a pulse modulated light source, these sensors output phase difference information on the timing that the light is emitted and received. Distance data can be obtained by performing calculation on the signals with an external signal processing circuit or a PC.

| Type no. | Pixel height (μm) | Pixel pitch (μm) | Number of effective pixels | Video data rate max. (MHz) | Photo |
|-----------------------------|----------------------|---------------------|----------------------------|----------------------------------|---|
| S15452-01WT | 50 | 20 | 64 | 5 |  |
| S15453-01WT | | | 256 | |  |

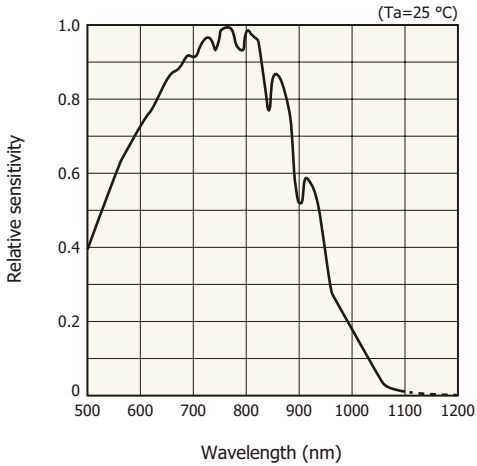
Note: An evaluation kit is available. Contact us for detailed information.

● Configuration example of distance measurement



KMPDC0417EE




● Spectral response



KMPDB0564EA

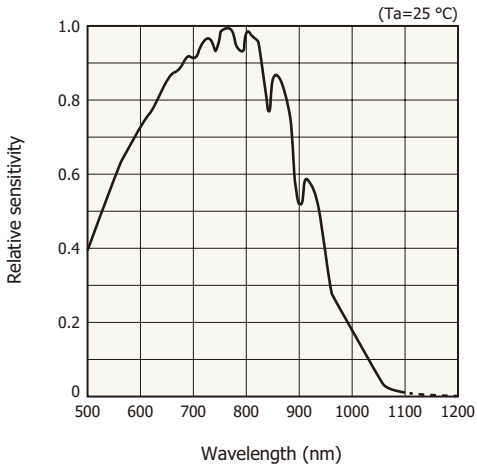
Distance area image sensors

The distance image sensors are designed to measure the distance to an object by TOF method. When used in combination with a pulse modulated light source, these sensors output phase difference information on the timing that the light is emitted and received. Distance data can be obtained by performing calculation on the signals with an external signal processing circuit or a PC.

| Type no. | Pixel size [μm (H) × μm (V)] | Pixel pitch (μm) | Number of effective pixels | Video data rate max. (MHz) | Photo |
|-----------------------------|---------------------------------|---------------------|----------------------------|----------------------------------|---|
| S15454-01WT | 50 × 50 | 50 | 96 × 72 | 10 |  |
| S16443-01WT | 20 × 50 | 20 (H) × 201.5 (V) | 128 × 8 | 10 |  |
| S16444-01WT | 20 × 50 | 20 (H) × 201.5 (V) | 320 × 20 | 10 |  |

Note: An evaluation kit is available. Contact us for detailed information.

Spectral response



KMPDB0564EA

ASIC

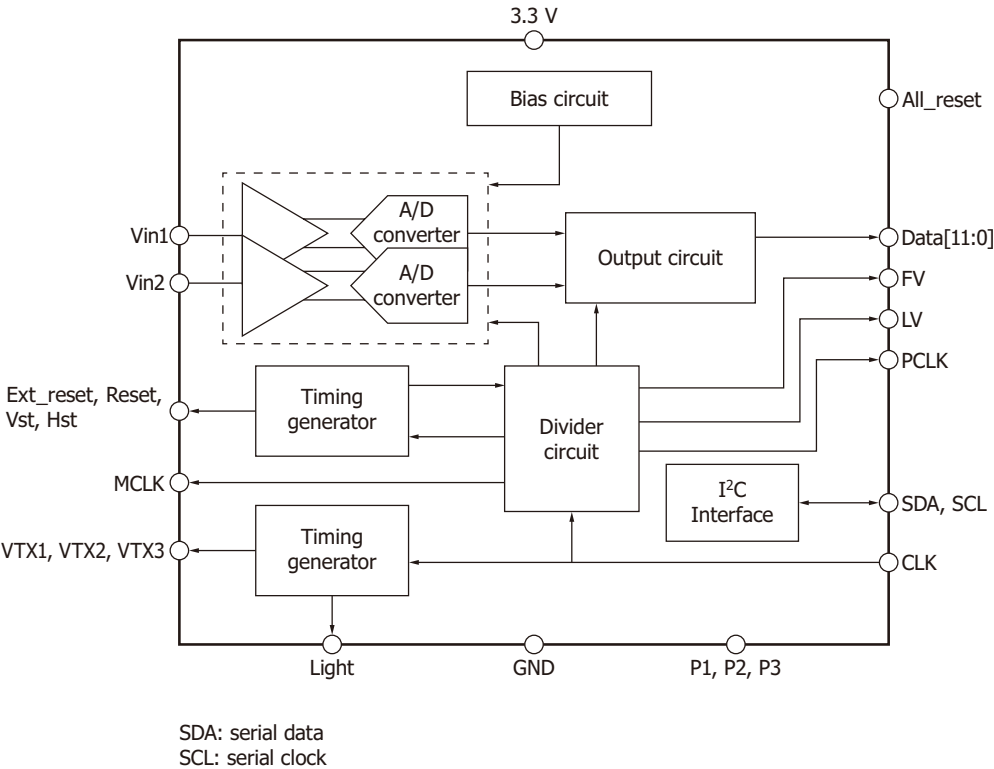
for distance image sensor

The peripheral circuits required for driving and signal processing of the distance image sensors are integrated into the ASIC.



H15472-01




Block diagram



KACCC1053EA

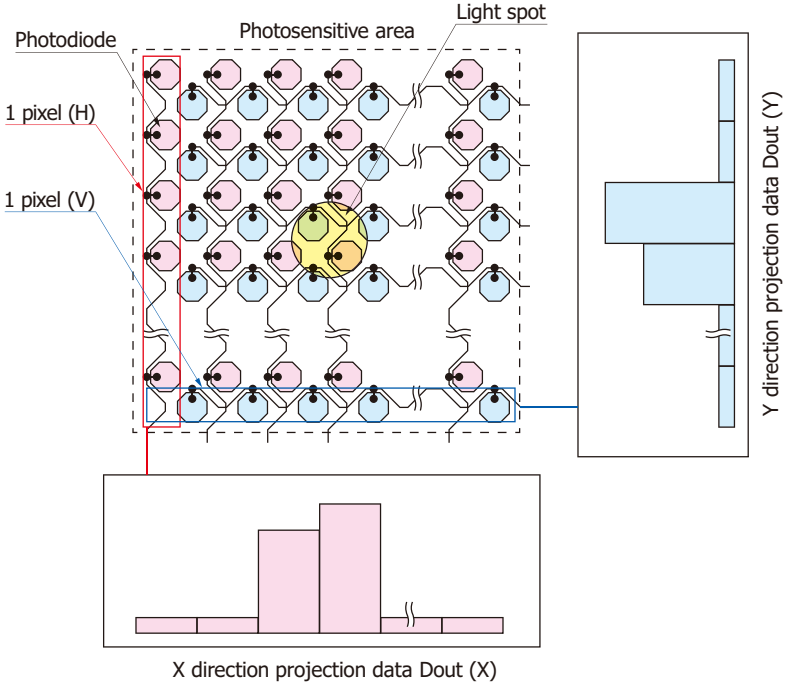
Profile sensors

These high-speed frame rate CMOS image sensors are specialized for acquiring 2-D projection data. It is possible to detect multiple light spots simultaneously. The S15366 series integrate the center-of-gravity calculation circuit and they can directly output the center-of-gravity position coordinates.

| Type no. | Number of lines (X/Y directions) | Pixel pitch (μm) | Frame rate 8-bit max. (frames/s) | Photosensitive area [mm (H) \times mm (V)] | Photo |
|----------------------------|-------------------------------------|----------------------------------|---|--|---|
| S9132 | 256 | 7.8 | 3200 | 1.9968 \times 1.9968 |  |
| S15366-256 | | | 3156 | |  |
| S15366-512 | 512 | | 1602 | 3.9936 \times 3.9936 |  |

● Operating principle

In the photosensitive area arranged two-dimensionally, the photosensitive area for the X-direction projection data is connected in one vertical column, and the photosensitive area for the Y-direction projection data is connected in one horizontal row using metal wiring. Output of the photosensitive area of the same line is read out as added data, making it possible to acquire projection data in the X/Y directions. The amount of data per frame is small, achieving a high frame rate.



X-ray image sensors

For radiography

These large area, high resolution CMOS area image sensors are used in X-ray radiography equipment.



TDI-CCD area image sensors

TDI operation enables X-ray imaging of large subjects. They can be used for X-ray radiography equipment, and for industrial in-line non-destructive inspection.



For non-destructive inspection

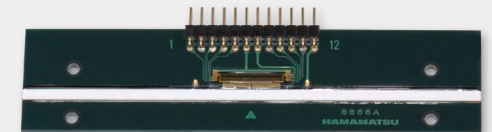
► CMOS area image sensors

These CMOS image sensors can be connected to a PC via USB. They have a thicker FOP, realizing high radiation resistance.



► Photodiode arrays with amplifier





The products can be used for in-line industrial product inspection equipment, foreign matter inspection equipment, etc. for canned and retort foods.



For radiography

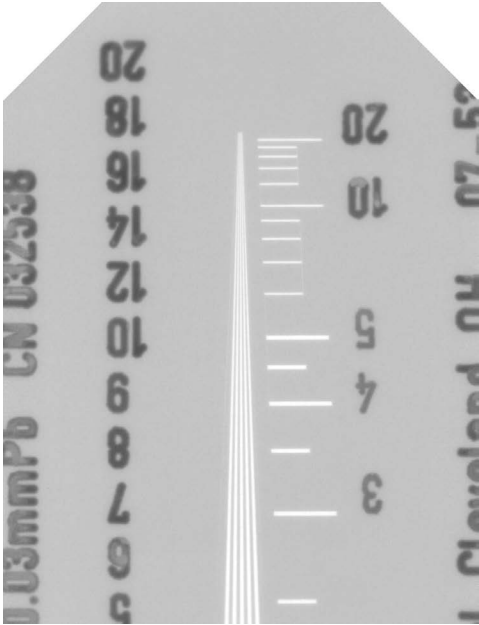
CMOS area image sensors

These are large area, high resolution CMOS area image sensors.
We have a type with FOP (fiber optic plate) input window and a type with a cable to be used for simple X-ray imaging. They have LDVS digital output with a built-in 14-bit A/D converter.

| Type no. | Scintillator | Pixel size [μm (H) × μm (V)] | Number of effective pixels | Frame rate* (frames/s) | Photo |
|---------------------------|----------------|---------------------------------|----------------------------|---------------------------|---|
| S10830-12 | CsI (+ FOP) | 20 × 20 | 1000 × 1500 | 0.9 |  |
| S10834-12 | | | | |  |
| S10831 | CsI (+ FOP) | 20 × 20 | 1300 × 1700 | 0.6 |  |
| S10835-12 | | | | |  |

* Global clock=20 MHz
Note: Please prepare a circuit for driving the sensor.


● X-ray imaging example (S10835-12)



For non-destructive inspection

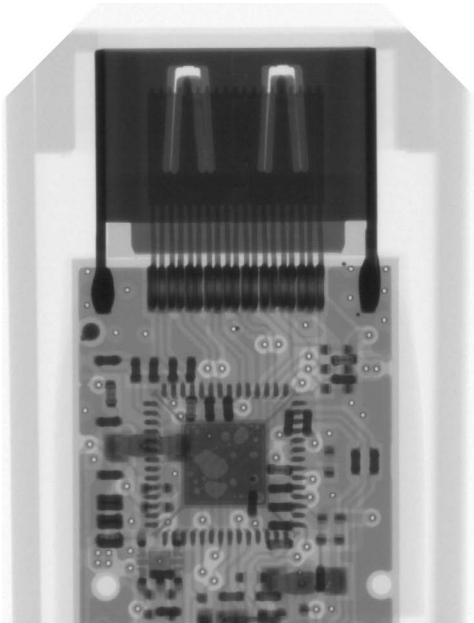
CMOS area image sensors

This product has an APS type CMOS area image sensor and USB interface, built into a compact housing. The fiber optic plate (FOP) protects the X-ray image sensor to realize 1 million Gy* of radiation resistance.

| Type no. | Scintillator | Pixel size [μm (H) × μm (V)] | Number of effective pixels | Frame rate (frames/s) | Photo |
|---------------------------|----------------|---------------------------------|----------------------------|--------------------------|---|
| S15683-13 | CsI (+ FOP) | 20 × 20 | 1300 × 1700 | 0.46 |  |

* X-ray tube voltage=60 kV, without Al filter



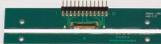

● X-ray imaging example
[Electronic part]



For non-destructive inspection

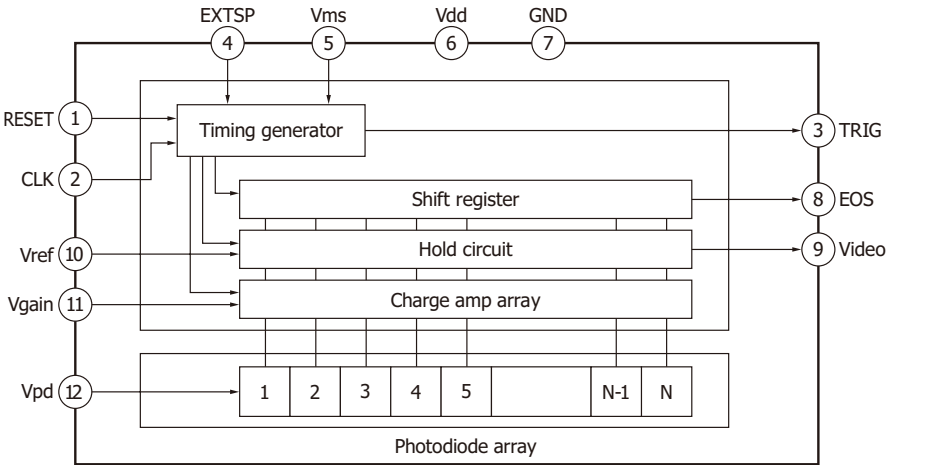
Photodiode arrays with amplifier

The photodiode arrays with an amplifier consist of a Si photodiode array and a CMOS signal processing IC chip. A phosphor sheet is attached to the photosensitive area, making it suitable for non-destructive inspection.

| Type no. | Pixel height (mm) | Pixel pitch (mm) | Number of pixels | Drive voltage (V) | Line rate (lines/s) | Charge amplifier feedback capacitance* (pF) | Photo | Dedicated driver circuit (sold separately) |
|--------------------------------|----------------------|---------------------|------------------|----------------------|------------------------|--|--|---|
| S11865-64G | 0.8 | 0.8 | 64 | 5 | 14678 | 0.5 |  | C9118-01 |
| S11865-128G | 0.6 | 0.4 | 128 | 5 | 7568 | 0.5 | | — |
| S13885-128G | 0.6 | 0.4 | 128 | 3.3 | 7568 | 0.125 | | |
| S11865-256G | 0.3 | 0.2 | 256 | 5 | 3844 | 0.5 |  | — |
| S13885-256G | 0.3 | 0.2 | 256 | 3.3 | 3844 | 0.125 | | |
| S11866-64G-02 | 1.6 | 1.6 | 64 | 5 | 14678 | 0.5 |  | C9118-01 |
| S11866-128G-02 | 0.8 | 0.8 | 128 | 5 | 7568 | 0.5 | | — |
| S13886-128G | 0.8 | 0.8 | 128 | 3.3 | 7568 | 0.125 |  | |

* High gain
Note: We also offer a type without a phosphor sheet.

● Block diagram (S11865-64G/-128G, S11866-64G-02/-128G-02)



KMPDC0153EA



Driver circuit C9118-01

This CMOS driver circuit is designed for the photodiode arrays with amplifier S11865/S11866 series. It is possible to configure a long and narrow image sensor by combining this product with a compatible photodiode array with amplifier (sold separately) and arranging multiple combinations in line. It operates with two signal inputs, MCLK and M-RESET, and a single +5 V power supply.



TDI-CCD area image sensors

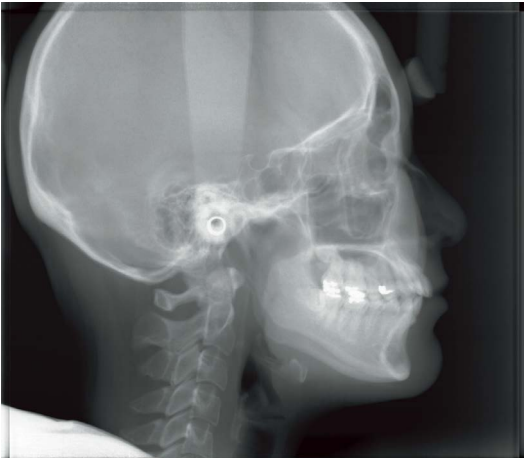
These are long and narrow type CCDs coupled with FOS.
They are used for X-ray radiography and non-destructive X-ray inspection, etc.

| Type no. | Scintillator | Pixel size [μm (H) × μm (V)] | Number of effective pixels | Line rate*1 max. (lines/s) | Photo |
|-----------------------------|----------------|---------------------------------|-----------------------------------|----------------------------------|---|
| S7199-01 *2 | CsI (+ FOP) | 48 × 48 | 1536 × 128 (× 2-chip buttable) | 2100 |  |
| S8658-01 *2 | | | 1536 × 128 (× 3-chip buttable) | |  |

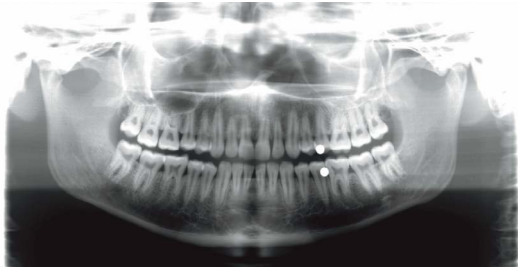
*1: TDI scanning
*2: We also offer types (S7199-01F, S8658-01F) that have no scintillator, with only the FOP coupled.

● X-ray imaging examples

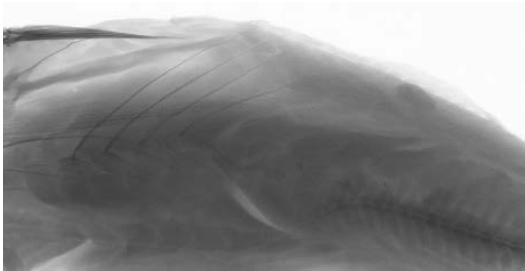
[Cephalo]



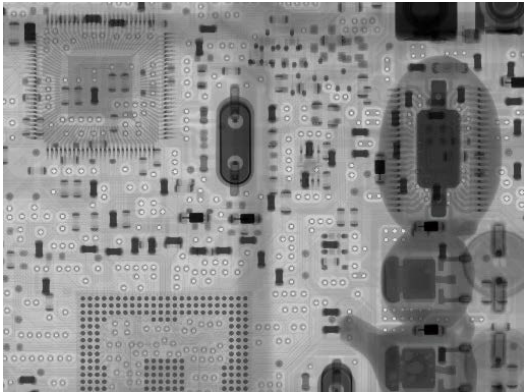
[Panorama]



[Fish bone]



[Printed circuit board]



CCD multichannel detector heads

These products have a housing with a built-in driver circuit for a back-thinned CCD (sold separately) with a care of heat dissipation.



| Type no. | Output | Cooling | Applicable sensors (sold separately) |
|---------------------------|--------|---------------------|--------------------------------------|
| C7040 | Analog | Non-cooled | S7030 series, S16000-1007 |
| C7041 | | One-stage TE-cooled | S7031 series, S16001-1007S |
| C7043 | | Non-cooled | S7033 series |
| C7044 | | One-stage TE-cooled | S7034 series |
| C7180 | | Non-cooled | S7170-0909 |
| C7181 | | One-stage TE-cooled | S7171-0909-01 |
| C10150-01 | | Non-cooled | S10140 series (-01) |
| C10151-01 | | One-stage TE-cooled | S10141 series (-01) |

Note: A multichannel detector head for the two-stage TE-cooled type CCD area image sensors (back-thinned type) S7032 series is also available.

Multichannel detector head controller C7557-01

This controller was developed for basic operation of multichannel photometry. By connecting it to a Hamamatsu multichannel detector head and a PC, it allows easy control of the detector head and data acquisition with the use of dedicated software that comes with the unit.



Driver circuits

for CCD image sensors

CCD image sensors can be evaluated by using these low-price driver circuits.

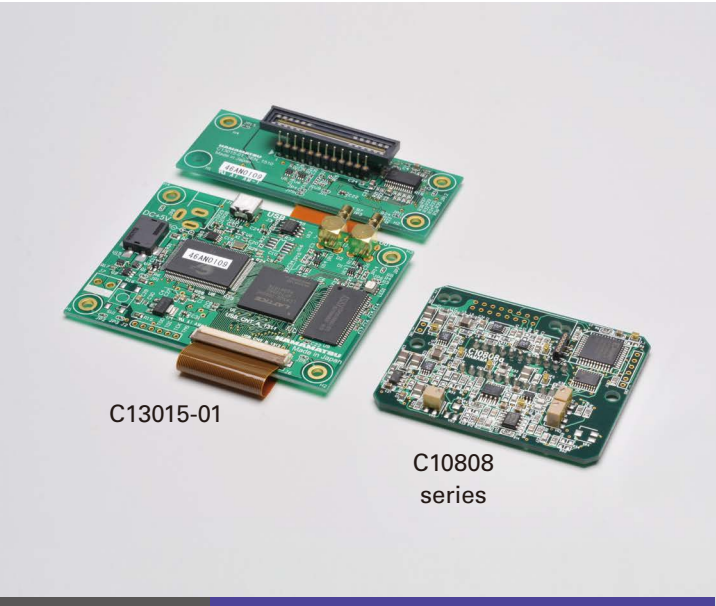


| Type no. | Interface | Line rate max. (lines/s) | Applicable sensors (sold separately) |
|-----------------------------|--------------|--------------------------------|--------------------------------------|
| C11160 | USB 2.0 | 483 | S11151-2048 |
| C11287-01 | | 210 | S10420-1004-01 |
| | | 180 | S10420-1006-01, S16010-1006 |
| | | 110 | S10420-1104-01 |
| | | 100 | S10420-1106-01, S16010-1106 |
| | | 90 | S14650-1024 |
| | | 70 | S14650-2048 |
| C11288-01 | | 1420 | S11071-1004 |
| | | 1040 | S11071-1104 |
| | | 600 | S11071-1006 |
| | | 520 | S11071-1106 |
| | | 290 | S14660-1024 |
| | | 150 | S14660-2048 |
| C11165-02 | | 2780 | S11155-2048-02, S11156-2048-02 |
| C11860 | | 126 | S11850-1006-01, S16011-1106 |
| | | 100 | S14651-1024 |
| | | 83 | S11850-1106-01, S16011-1106 |
| | | 71 | S14651-2048 |
| C15361-1105 | USB 3.1 Gen1 | 2340 | S15351-2048 |
| C15361-2105 | | 2340 | S15254-2048 |
| | | 1870 | S15257-2048 |

Driver circuits

for CMOS image sensors

CMOS image sensors can be evaluated by using these low-price driver circuits.



| Type no. | Features | Applicable sensors (sold separately) |
|-------------------------------|---|--|
| C10808 series | High-speed readout type (C10808) and low-noise type (C10808-01), both equipped with integration time function | S10121 to S10124-01 series, S15908-512Q, S15909-1024Q |
| C13015-01 | Built-in 16-bit A/D converter, interface: USB 2.0, single power supply operation: USB bus powered (+5 V) | S11639-01, S12706, S13496, S16528-1024-11, S16514-2048-11, S16596-4096-11, S15796 series, S15739-1024, S13014, S14739-20, S13828 |

Image sensor module

This module for OCT has a built-in CCD image sensor.

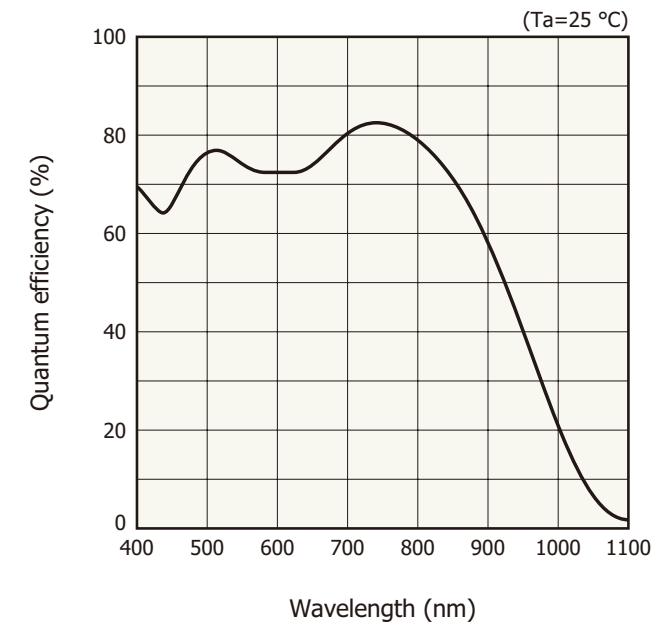


| Type no. | Line rate max. (lines/s) | Interface | Built-in sensor |
|-----------------------------|--------------------------------|------------|-----------------|
| C15821-2351 | 70000 | CameraLink | S15729-01 |

Features

- High-speed line rate: 70000 lines/s
- Number of pixels: 2048 pixels (512 pixels × 4 taps)
- Single 12 V power supply operation
- High near infrared sensitivity (>60%, $\lambda=850$ nm)
- CameraLink interface
- Flat field correction function
- External input synchronization mode
- With evaluation software

● Spectral response (typical example)



KMPDB0611EA

● Technical notes

[CCD image sensors](#)

[CMOS linear image sensors](#)

[Profile sensors S15366 series](#)

● Precautions

[Disclaimer](#)

[Safety consideration](#)

[Image sensors](#)

[Unsealed products](#)

[Surface mount type products](#)

[Resin-sealed CMOS linear image sensors](#)

● [Inquiries from online](#)

www.hamamatsu.com

- Information described in this material is current as of May 2023.
- Product specifications are subject to change without prior notice due to improvements or other reasons. Before using these products, always contact us for the delivery specification sheet to check the latest specifications.

HAMAMATSU PHOTONICS K.K.

KMPD0002E28 May 2023 DN

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

U.S.A.: HAMAMATSU CORPORATION: 360 Foothill Road, Bridgewater, NJ 08807, U.S.A., Telephone: (1)908-231-0960, Fax: (1)908-231-1218

Germany: HAMAMATSU PHOTONICS DEUTSCHLAND GMBH: Arzbergerstr. 10, 82211 Herrsching am Ammersee, Germany, Telephone: (49)8152-375-0, Fax: (49)8152-265-8 E-mail: info@hamamatsu.de

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

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

North Europe: HAMAMATSU PHOTONICS NORDEN AB: Torshamnsgatan 35, 16440 Kista, Sweden, Telephone: (46)8-509-031-00, Fax: (46)8-509-031-01 E-mail: info@hamamatsu.se

Italy: HAMAMATSU PHOTONICS ITALIA S.R.L.: Strada della Moia, 1 int. 6 20044 Arese (Milano), Italy, Telephone: (39)02-93 58 17 33, Fax: (39)02-93 58 17 41 E-mail: info@hamamatsu.it

China: HAMAMATSU PHOTONICS (CHINA) CO., LTD.: 1201, Tower B, 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

Taiwan: HAMAMATSU PHOTONICS TAIWAN CO., LTD.: 8F-3, No.158, Section 2, Gongdao 5th Road, East District, Hsinchu, 300, Taiwan R.O.C. Telephone: (886)3-659-0080, Fax: (886)3-659-0081 E-mail: info@hamamatsu.com.tw