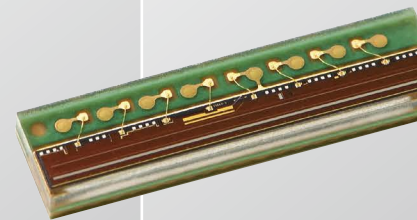
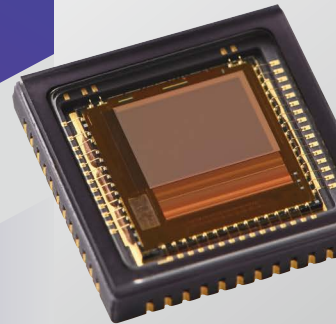
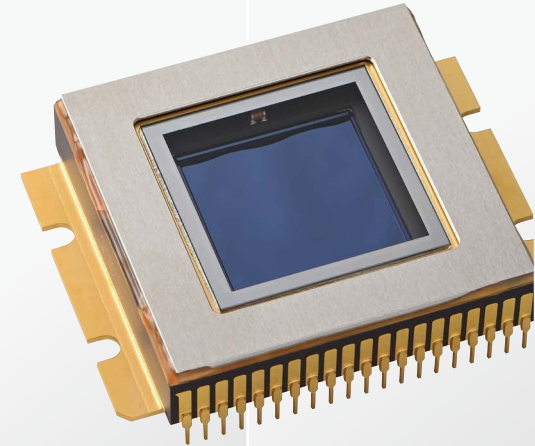
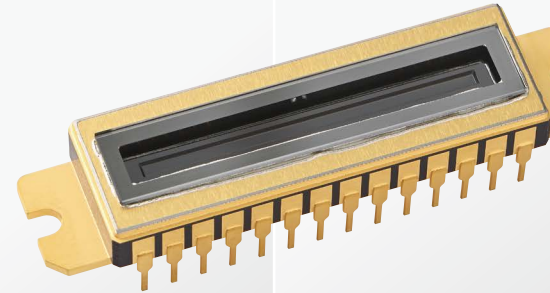
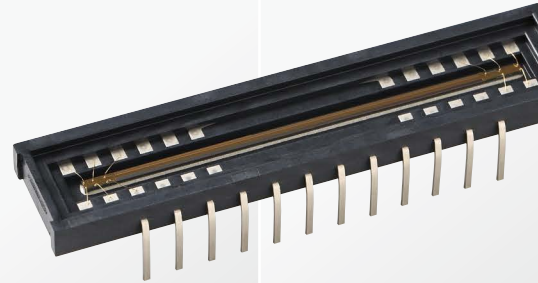


Image sensors for scientific  
measurements and industrial  
equipment

# CCD/CMOS image sensors





## Image sensors for scientific measurements and industrial equipment

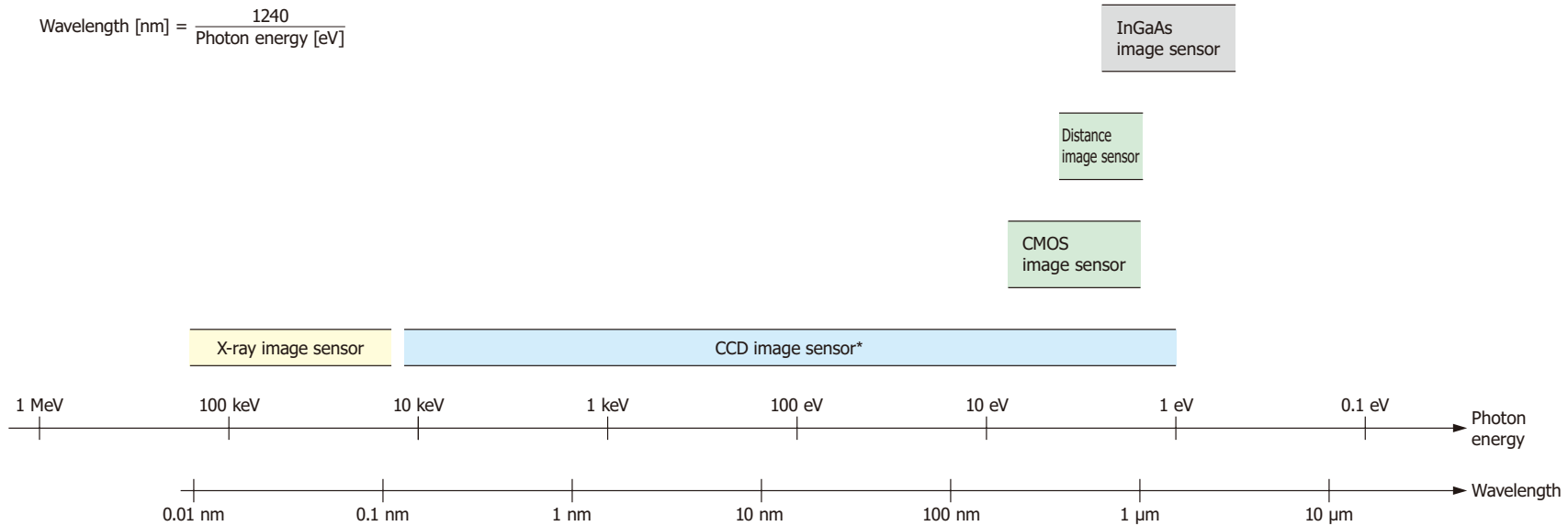
Hamamatsu Photonics offers a wide lineup of image sensors for different wavelengths and applications. The CCD image sensors realize high quantum efficiency in the ultraviolet, visible, and near infrared regions. The CMOS image sensors realize low price, low power consumption, and compact size.

# 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

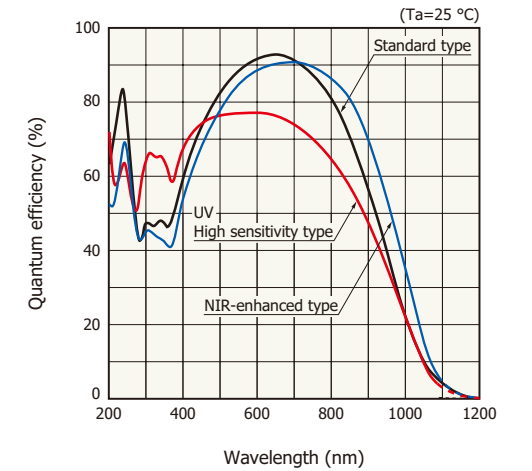
$$\text{Wavelength [nm]} = \frac{1240}{\text{Photon energy [eV]}}$$



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

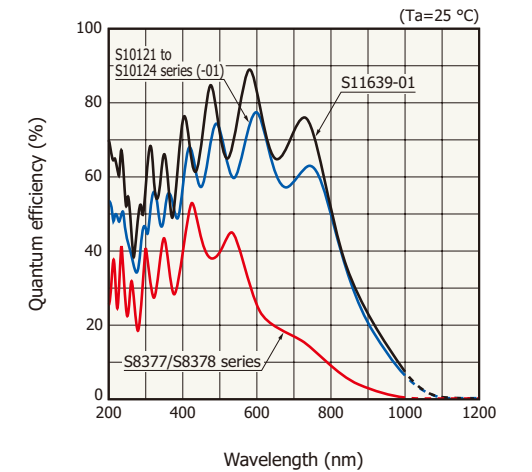
KMPDC1014EA

- 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)	<p>Vertical shift register</p> <p>Photodiode array</p> <p>Horizontal shift register</p> <p>Amplifier</p> <p>KMPDC1010EA</p>	<p>Pixel</p> <p>PD-Amplifier</p> <p>Video wiring</p> <p>PD: Photodiode</p> <p>Hold circuit</p> <p>Horizontal shift register</p> <p>Gain amplifier</p> <p>KMPDC1011EA</p>
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

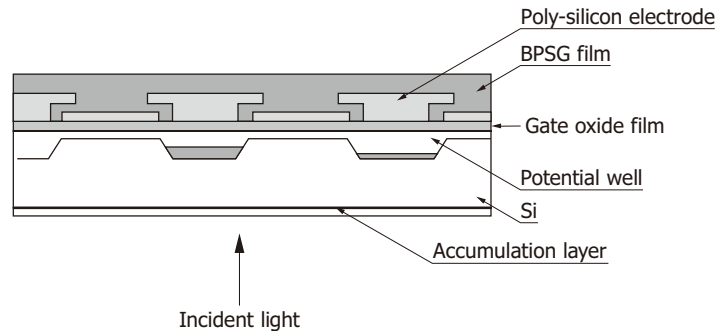
These realize high quantum efficiency in a wide spectral range.

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.

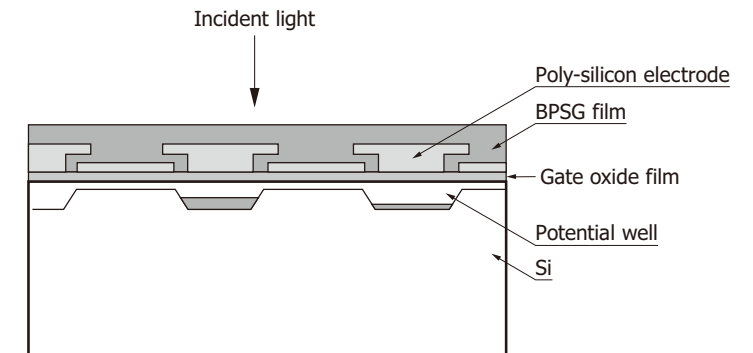
- Cross section of CCD

[ Back-thinned type ]



KMPDB0180EB

[ Front-illuminated type ]



KMPDB0179EB

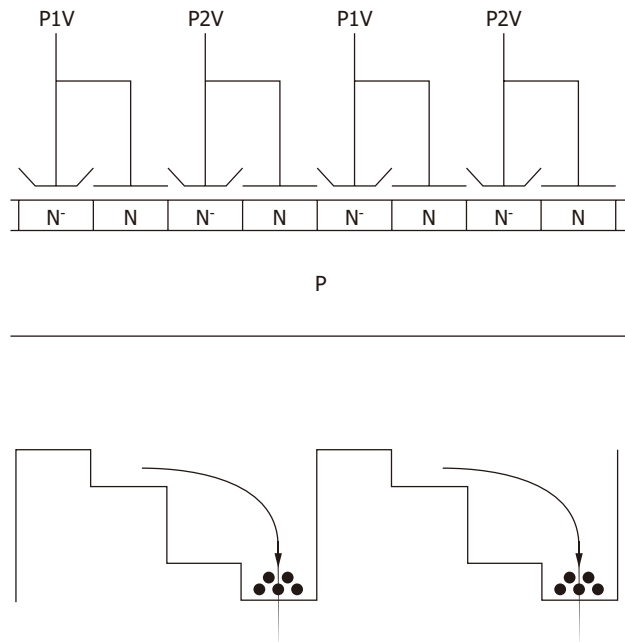
# Resistive gate structure

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

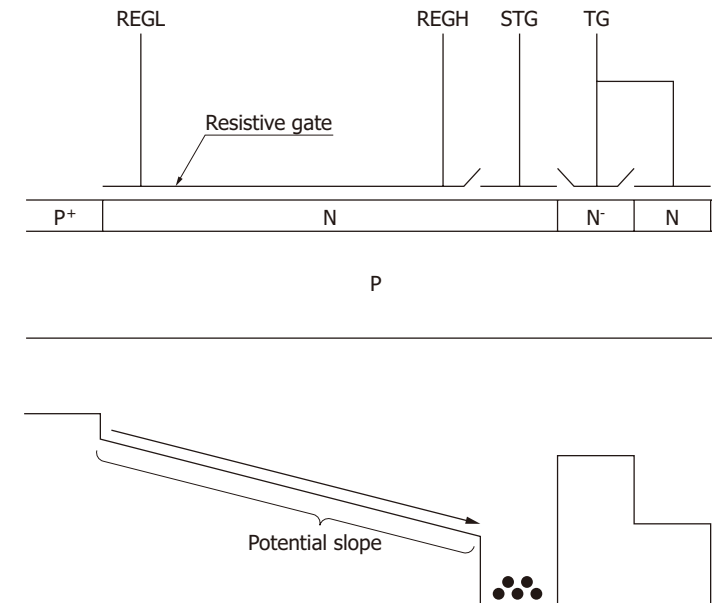


KMPDC0320EA

## 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

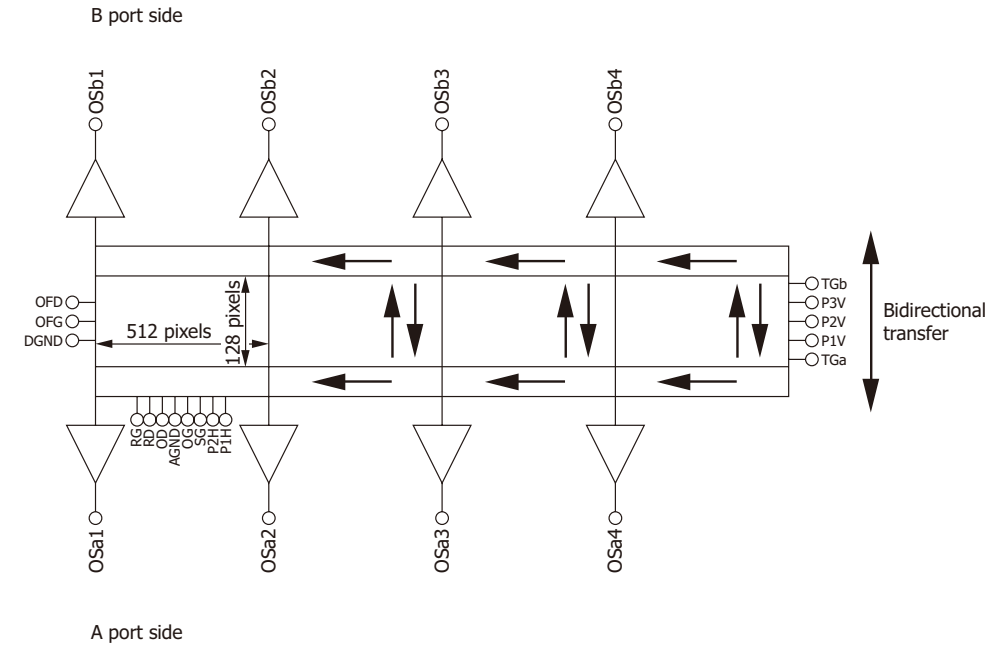
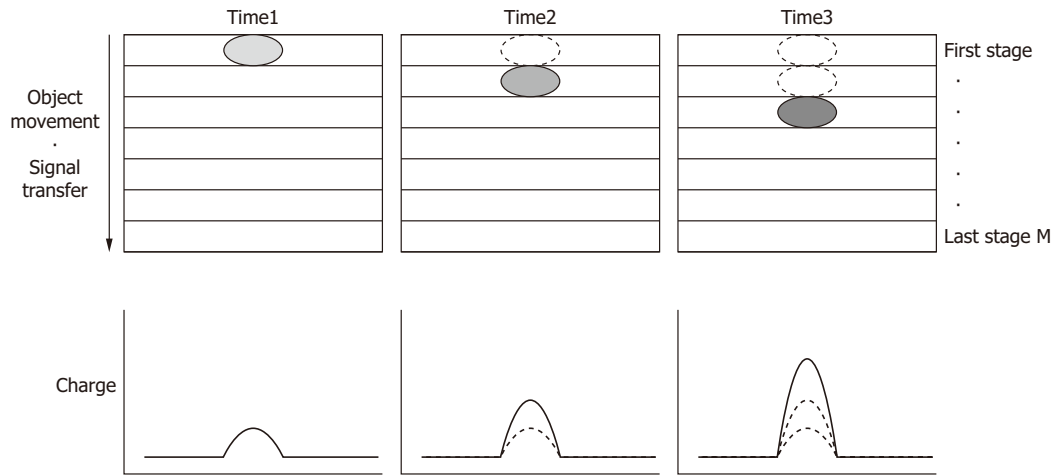
## TDI-CCD image sensors

- 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.





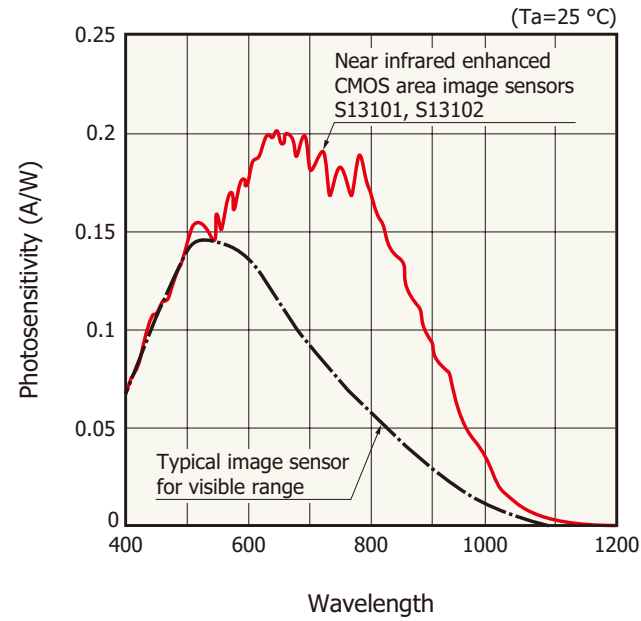
# High near infrared sensitivity

CMOS image sensors

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

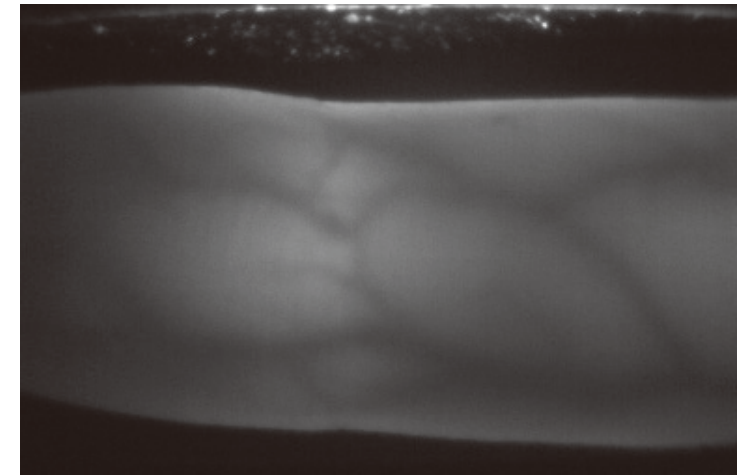


- Spectral response (typical example)



KMPDB0489EA

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

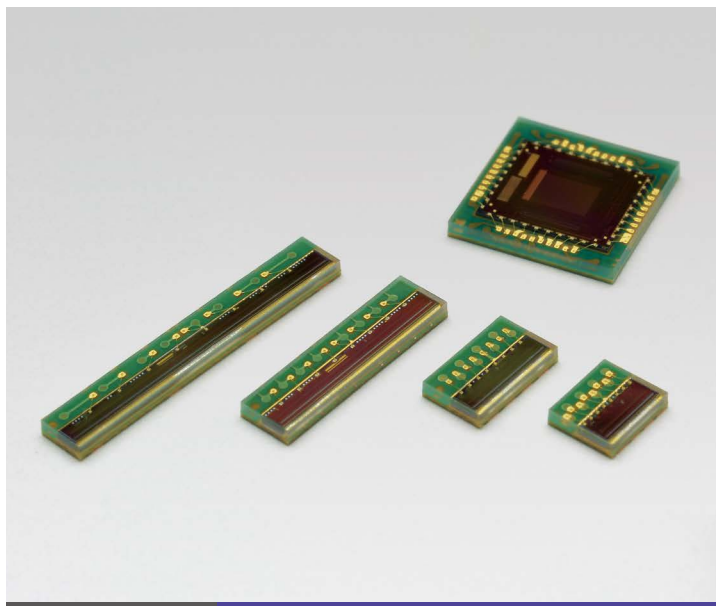




# Compact, thin COB package

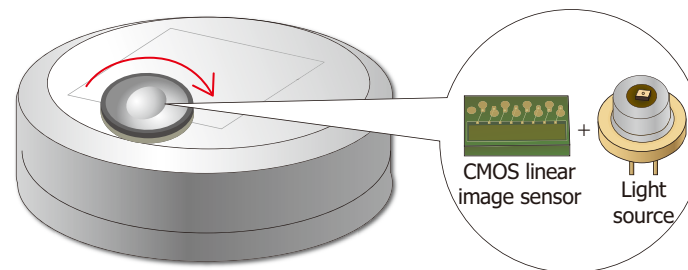
CMOS image sensors

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.



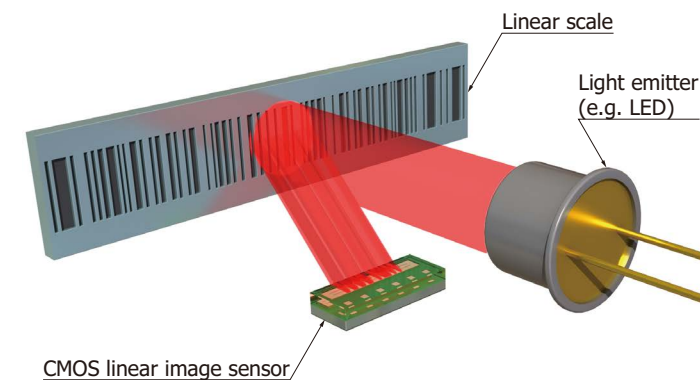
- Application examples of CMOS linear image sensors

[ Rangefinder (robot cleaner) ]



KMPDC0914EB

[ Encoder ]

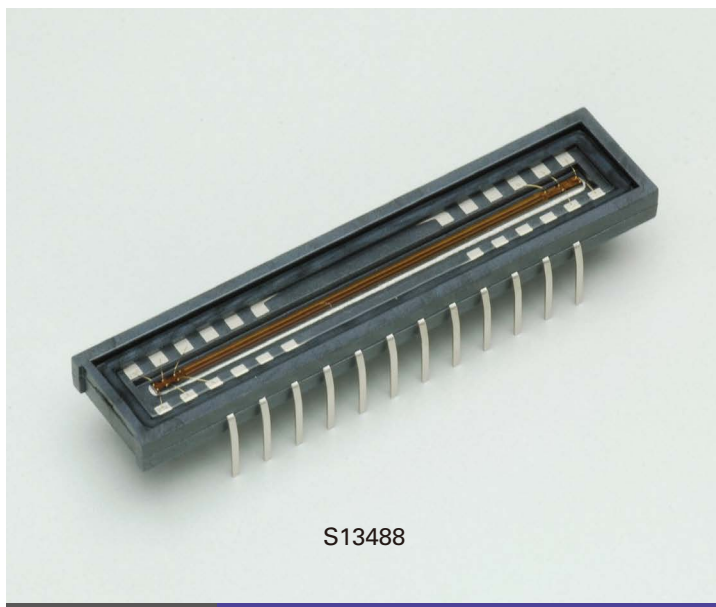


KMPDC0913EA

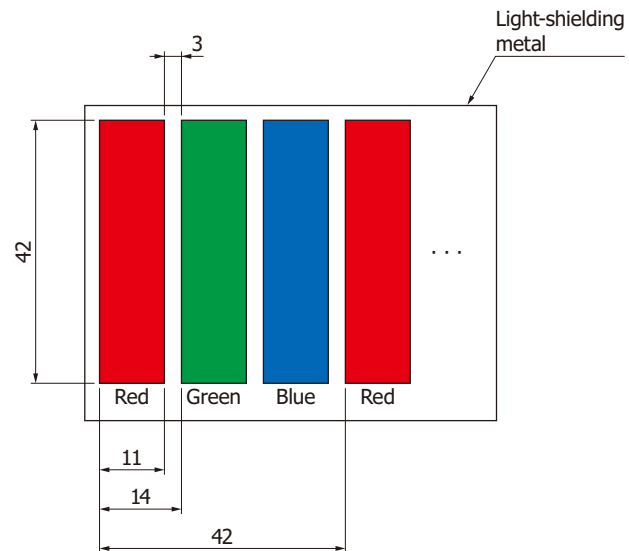
# With color filters

## CMOS linear image sensor

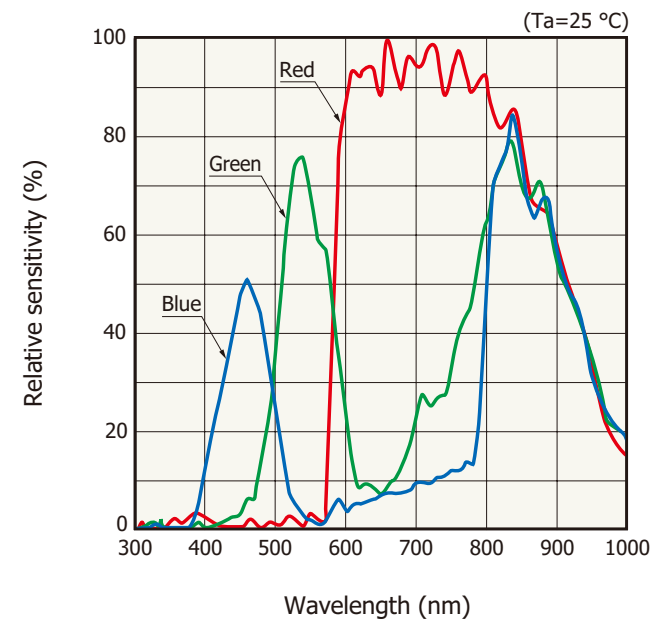
This type has color filters that transmit only light of a specific wavelength on the photodiode of the CMOS linear image sensor. It can acquire color information of the measurement target.



- Enlarged view of color filters (unit:  $\mu\text{m}$ )



- 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.

## Highly functional

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

Any integration timing can be set.

### ▶ [NIR enhanced type](#)

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

### ▶ [High resolution type](#)



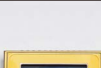

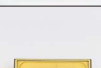
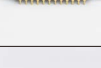


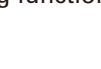

The products are low noise CCDs with a small pixel size (12 × 12 μm).

### ▶ [TDI operation type](#)

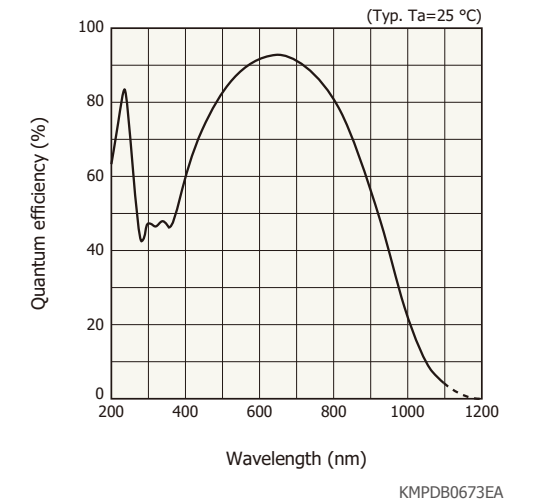
During high-speed imaging, the products can obtain high S/N images even under low-light-level conditions.

# 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	<a href="#">Dedicated driver circuit</a> (sold separately)
<a href="#">S7170-0909</a>	24 × 24	512 × 512	0.9 frames/s	Non-cooled		<a href="#">C7180</a>
<a href="#">S7030-0906</a>		512 × 58	418 lines/s			<a href="#">C7040</a>
<a href="#">S7030-0907</a>		512 × 122	316 lines/s			
<a href="#">S7030-1006</a>		1024 × 58	213 lines/s			
<a href="#">S7030-1007</a>		1024 × 122	160 lines/s			
<a href="#">S7171-0909-01</a>		512 × 512	0.9 frames/s	One-stage TE-cooled		<a href="#">C7181</a>
<a href="#">S7031-0906S</a>		512 × 58	418 lines/s			<a href="#">C7041</a>
<a href="#">S7031-0907S</a>		512 × 122	316 lines/s			
<a href="#">S7031-1006S</a>		1024 × 58	213 lines/s			
<a href="#">S7031-1007S</a>		1024 × 122	160 lines/s			
<a href="#">S12071</a> *4	1024 × 1024	Tap A: 0.1 frames/s Tap B: 1.5 frames/s			—	

## ● Spectral response (without window)












\*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.

# UV enhanced type

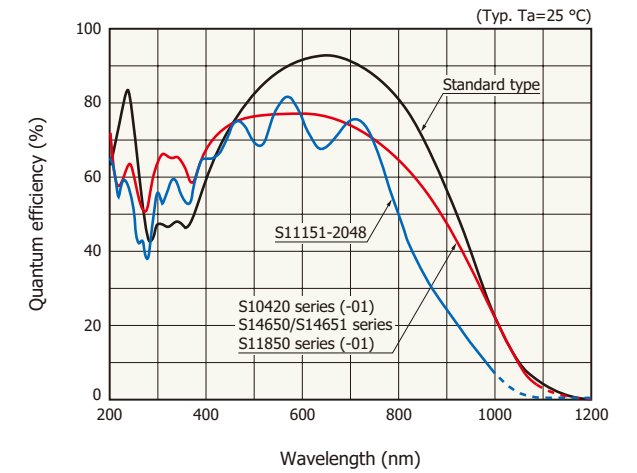
These CCDs exhibit high quantum efficiency in the UV region.

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

\* Full line binning (typ.)

Note: Windowless types are also available.







## ● Spectral response (without window)



KMPDC0674EB

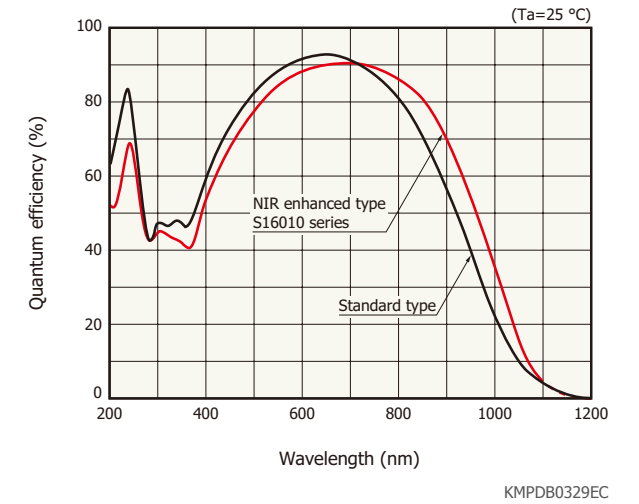
# NIR enhanced type

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	<a href="#">Dedicated driver circuit</a> (sold separately)
<a href="#">S16000-1007</a> <b>NEW</b>	24 × 24	1024 × 122	160	Non-cooled		<a href="#">C7040</a>
<a href="#">S16001-1007S</a> <b>NEW</b>				One-stage TE-cooled		<a href="#">C7041</a>
<a href="#">S16010-1006</a>	14 × 14	1024 × 64	189	Non-cooled		<a href="#">C11287-01</a>
<a href="#">S16010-1106</a>		2048 × 64	106	Non-cooled		
<a href="#">S16011-1006</a>		1024 × 64	189	One-stage TE-cooled		<a href="#">C11860</a>
<a href="#">S16011-1106</a>		2048 × 64	106			

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





## ● Spectral response (without window, typical example)



KMPDB0329EC

# Large full well type

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

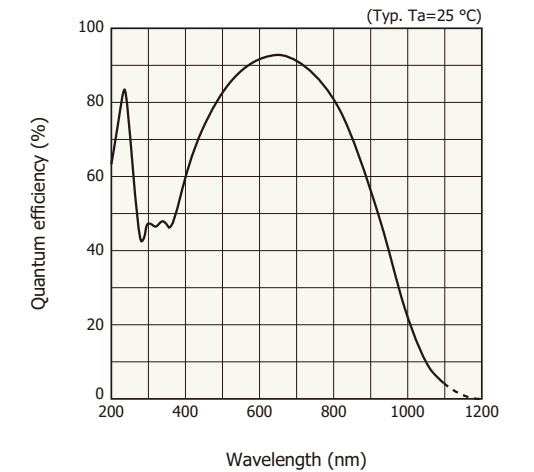
Type no.	Pixel size [μm (H) × μm (V)]	Number of effective pixels	Line rate*1 (lines/s)	Full well capacity (ke <sup>-</sup> )		Cooling	Photo	<a href="#">Dedicated driver circuit</a> (sold separately)
				Vertical	Horizontal*2			
<a href="#">S7033-0907</a>	24 × 24	512 × 122	316	320	3400	Non-cooled		<a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





KMPDB0673EA



# 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	<a href="#">Dedicated driver circuit</a> (sold separately)
<a href="#">S10140-1107-01</a>	12 × 12	2048 × 122	107	Non-cooled		<a href="#">C10150-01</a>
<a href="#">S10140-1108-01</a>		2048 × 250	80			
<a href="#">S10140-1109-01</a>		2048 × 506	40			
<a href="#">S10141-1107S-01</a>		2048 × 122	107	One-stage TE-cooled		<a href="#">C10151-01</a>
<a href="#">S10141-1108S-01</a>		2048 × 250	80			
<a href="#">S10141-1109S-01</a>		2048 × 506	40			
<a href="#">S12101</a> *3		2048 × 2048	Tap A: 0.02 frames/s Tap B: 2.4 frames/s			

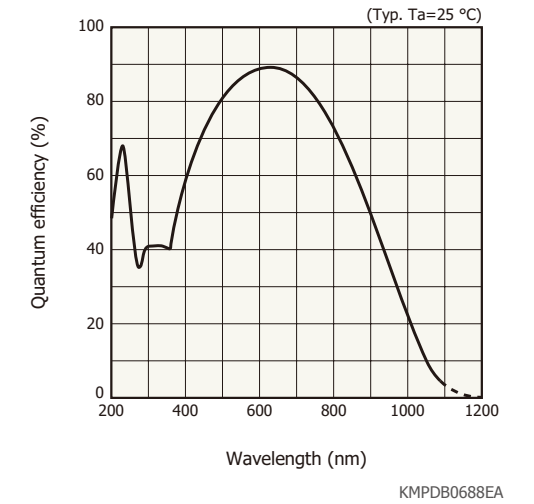
\*1: Full line binning (typ.)

\*2: Note: Two-stage TE-cooled type [S10142 series (-01)] is available upon request (made-to-order products).

\*3: With anti-blooming function





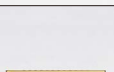
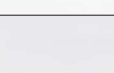
Note: Windowless types are also available.

## ● Spectral response (without window)



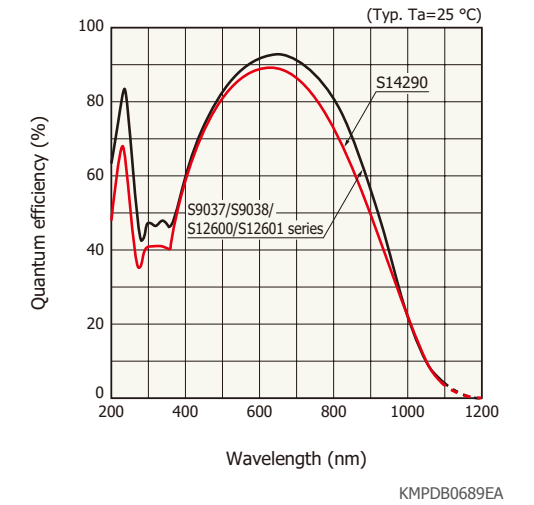
# High-speed readout type

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
<a href="#">S9037-0902</a>	24 × 24	512 × 4	10	16300	Non-cooled	
<a href="#">S9037-1002</a>		1024 × 4		8100		
<a href="#">S9038-0902S</a>		512 × 4		16300	One-stage TE-cooled	
<a href="#">S9038-1002S</a>		1024 × 4		8100		
<a href="#">S12600-1006</a>		1024 × 58	5	Non-cooled	2097	
<a href="#">S12600-1007</a>		1024 × 122				
<a href="#">S12601-1006S</a>		1024 × 58		2097	One-stage TE-cooled	
<a href="#">S12601-1007S</a>		1024 × 122		1162		
<a href="#">S14290</a>	24 × 500	1024 × 1	10000	Non-cooled		

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

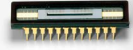
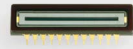





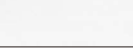

## ● Spectral response (without window)



High resolution

# High-speed readout type

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

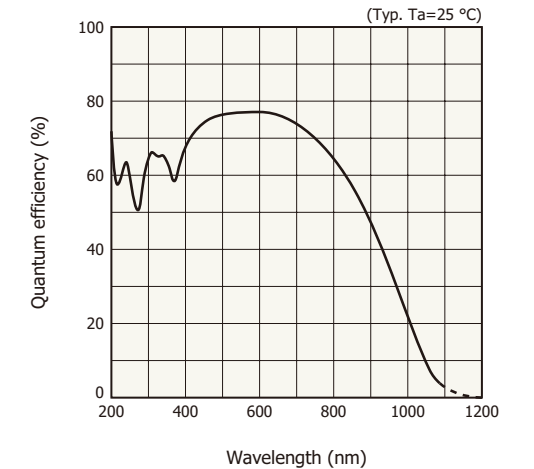
Type no.	Pixel size [μm (H) × μm (V)]	Number of effective pixels	Data rate (MHz)	Line rate* (lines/s)	Number of ports	Cooling	Photo	Dedicated driver circuit (sold separately)		
<a href="#">S11071-1004</a>	14 × 14	1024 × 16	10	1777	1	Non-cooled		<a href="#">C11288-01</a>		
<a href="#">S11071-1006</a>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

\* Full line binning (typ.)

Note: Windowless types are also available.

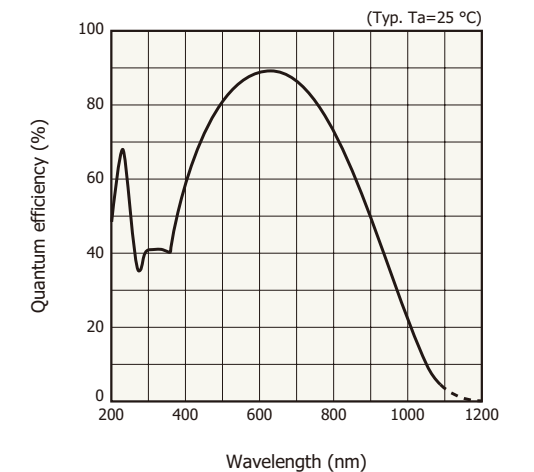
## ● Spectral response (without window)

[ S11071/S11851/S14660/S14661 series ]



KMPDB0316EA

## [ S13240 series ]


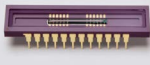



KMPDB0688EA

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	<a href="#">Dedicated driver circuit</a> (sold separately)
<a href="#">S13241-1107S</a>	12 × 12	2048 × 122	10	921*1	1	One-stage TE-cooled		—
<a href="#">S13241-1108S</a>		2048 × 250		539*1				
<a href="#">S13241-1109S</a>		2048 × 506		203*1				
<a href="#">S12551-1024</a>	14 × 14	1024 × 1	40	37900*2	1	Non-cooled		—
<a href="#">S12551-2048</a>		2048 × 1		19200*2				
<a href="#">S12379</a>	8 × 8	2048 × 1	40	72000	4	Non-cooled		—
<a href="#">S15729-01</a>	10 × 180	2048 × 1		70000				

\*1: Full line binning (typ.)

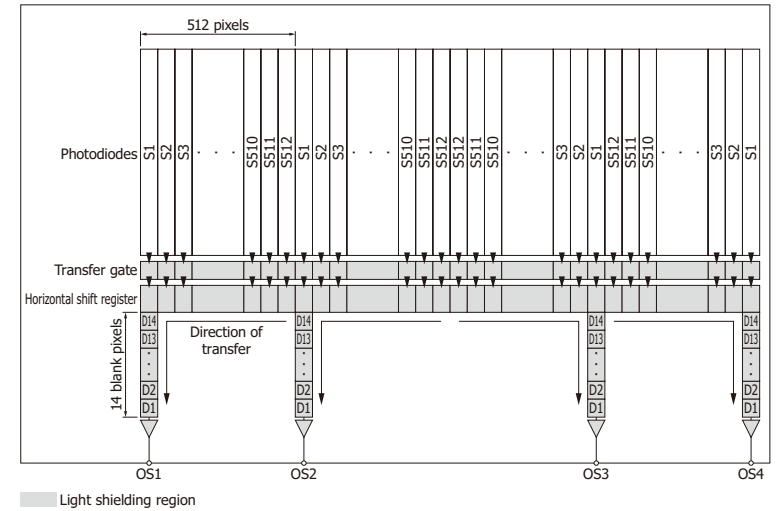
\*2: With electronic shutter (line rate when electronic shutter is not used)

Note: Windowless types are also available.

## Device structure

(schematic of CCD chip as viewed from top of dimensional outline)

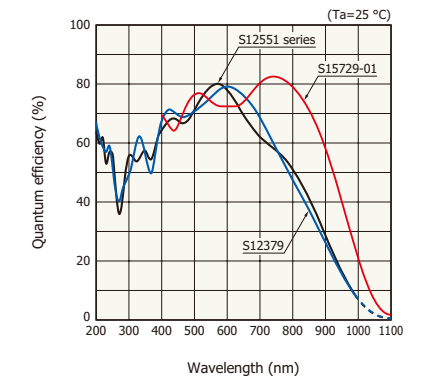
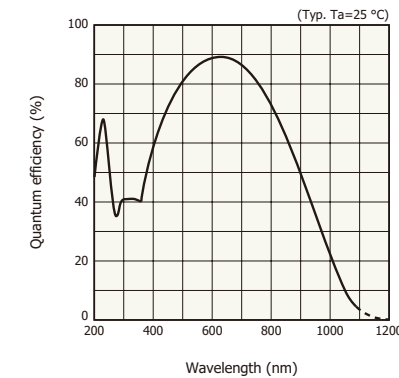
[ S15729-01 (4 ports) ]



## Spectral response (without window)




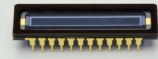
[ S13241 series ]

[ S12551 series, S12379, S15729-01 ]




# 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	<a href="#">Dedicated driver circuit</a> (sold separately)		
<a href="#">S11155-2048-02</a>	14 × 500	2048 × 1	2327	Non-cooled		<a href="#">C11165-02</a>		
<a href="#">S11156-2048-02</a>	14 × 1000							
<a href="#">S13255-2048-02</a>	14 × 500			One-stage TE-cooled		-	-	
<a href="#">S13256-2048-02</a>	14 × 1000							
<a href="#">S15254-2048</a>	14 × 200							
<a href="#">S15257-2048</a>	14 × 2500			Non-cooled	2356			<a href="#">C15361-2105</a>
<a href="#">S15351-2048</a>	14 × 200							
			1180					

Note: Windowless types are also available.

### Related products



CMOS linear image sensors for spectrophotometry  
High sensitivity type

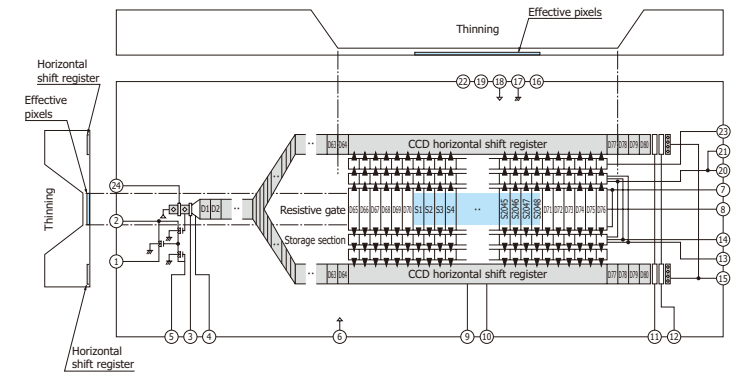


CMOS linear image sensors for industrial equipment  
High sensitivity type

### Device structure

(schematic of CCD chip as viewed from top of dimensional outline)

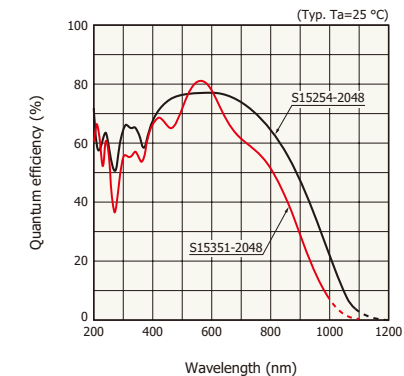
[ S11155/S11156/S13255/S13256-2048-02, S15254/S15257-2048 ]



KMPDC0543EB

### Spectral response (without window)




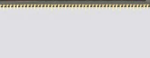
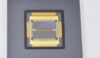

[ S15254-2048, S15351-2048 ]



KMPDB0680EA

# TDI-CCD image sensors

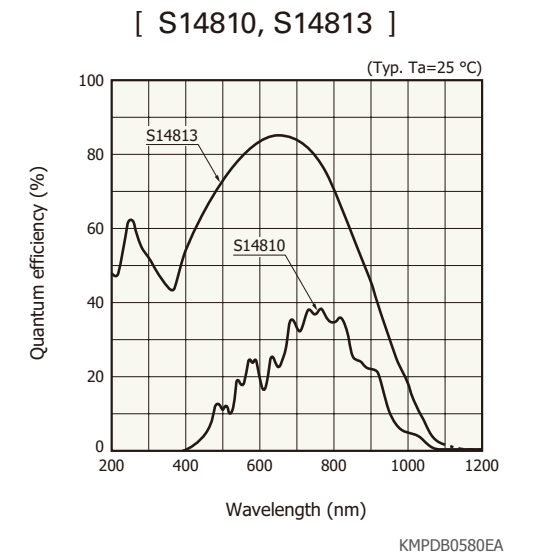
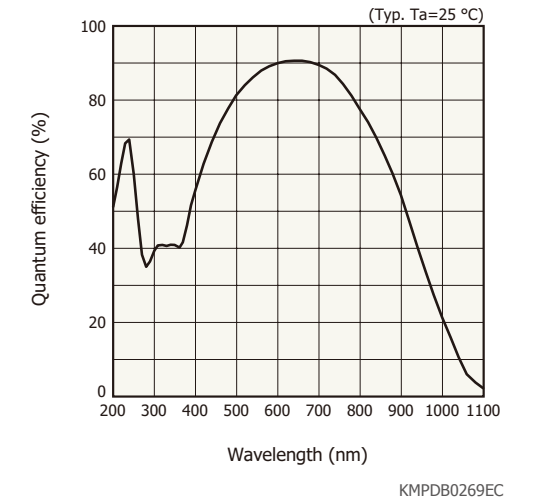
High S/N images can be obtained when moving objects are subjected to integration while being exposed to light during high-speed imaging. The S14810 and S14813 have a hybrid structure combining TDI-CCD and CMOS readout circuit. With the photosensitive area technology that Hamamatsu has cultivated over 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)		
<a href="#">S10200-02-01</a>	12 × 12	1024 × 128	2	30	50000	Bidirectional		—		
<a href="#">S10201-04-01</a>		2048 × 128	4					<a href="#">C10000-801*</a> <a href="#">C10000-A01*</a>		
<a href="#">S10202-08-01</a>		4096 × 128	8					—		
<a href="#">S10202-16-01</a>		4096 × 128	16					—		
<a href="#">S14810</a>		1024 × 128	1024				0.1	100000		—
<a href="#">S14813</a>			—				—	—	—	—

\*The C10000 series camera is a product of Hamamatsu's System Division.

Note: TDI: time delay integration

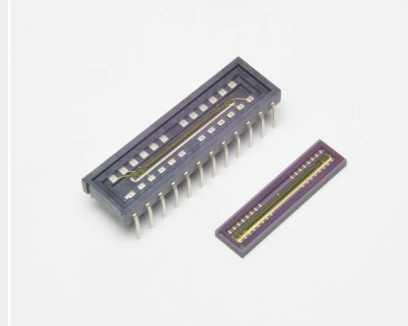
## ● Spectral response [ S10200/S10201/S10202 series ]



# CMOS image sensors

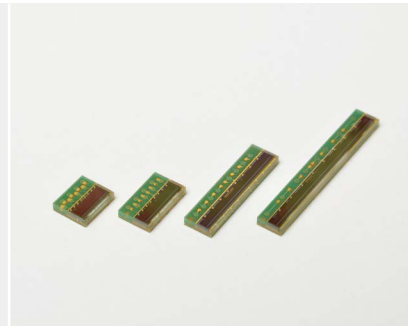
## CMOS linear image sensors for spectrophotometry

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



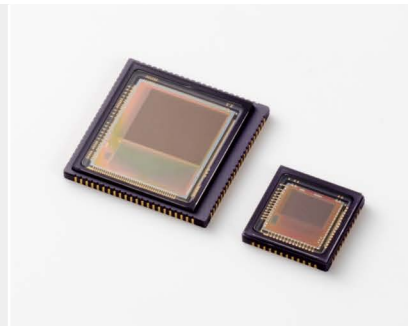
## CMOS linear image sensors for industrial equipment

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

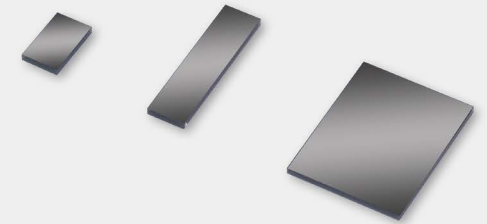
We offer a type that has high sensitivity in the UV and near IR region.



## Highly functional CMOS image sensors

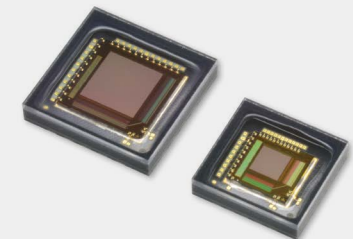
### ▶ [Distance image sensors](#)

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.



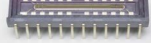









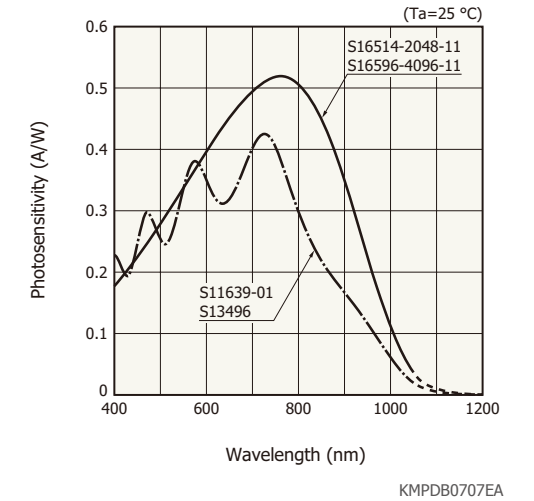
For spectrophotometry

# 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)
<a href="#">S16528-1024-11</a>	200	28	1024	8960		<a href="#">C13015-01</a>
<a href="#">S11639-01</a> *1			2048	4672		<a href="#">C13015-01</a>
<a href="#">S15739-1024</a> *2		14	1024	8960		<a href="#">C13015-01</a>
<a href="#">S13014</a> *2			512	16556		<a href="#">C13015-01</a> *3
<a href="#">S14739-20</a>			256	28735		
<a href="#">S13496</a> *1			7	4096	2387	
<a href="#">S15796-2048</a> *2		2048		4672		<a href="#">C13015-01</a>
<a href="#">S15796-1024</a> *2		1024		8960		<a href="#">C13015-01</a> *3
<a href="#">S16514-2048-11</a>		14		2048	4672	
<a href="#">S16596-4096-11</a>		7	4096	2387		

## ● Spectral response (typical example)



\*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


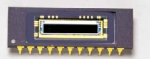

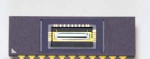

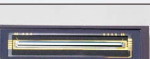
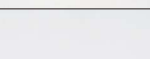


CCD image sensors  
Built-in electronic shutter type

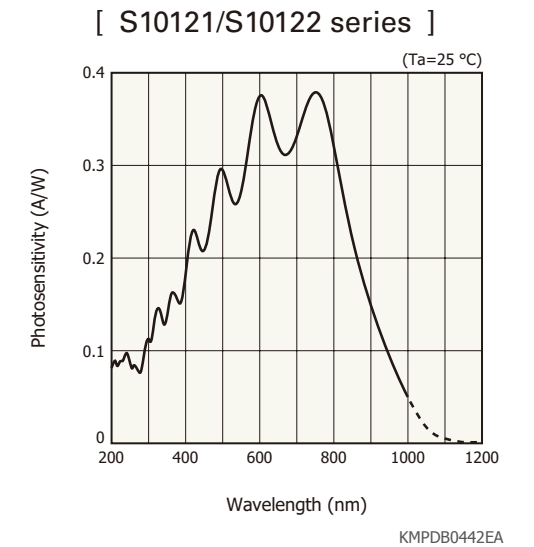
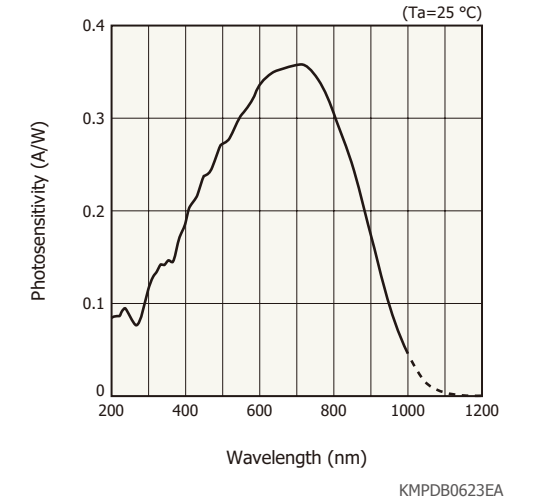
For spectrophotometry

# 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	<a href="#">Dedicated driver circuit</a> (sold separately)
<a href="#">S10121-128Q-01</a>	2.5	50	128	1923		<a href="#">C10808 series</a>
<a href="#">S10121-256Q-01</a>			256	969		
<a href="#">S10121-512Q-01</a>			512	486		
<a href="#">S10122-128Q-01</a>	0.5		128	3846		
<a href="#">S10122-256Q-01</a>			256	1938		
<a href="#">S10122-512Q-01</a>			512	972		
<a href="#">S15908-512Q</a>	2.5	50	512	486		<a href="#">C10808 series</a>
<a href="#">S15909-1024Q</a>		25	1024	243		

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



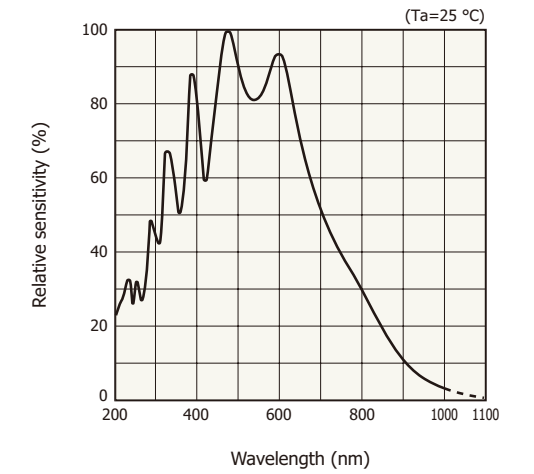
# For spectrophotometry

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
<a href="#">S8377-128Q</a>	500	50	128	3846	
<a href="#">S8377-256Q</a>			256	1938	
<a href="#">S8377-512Q</a>			512	972	
<a href="#">S8378-256Q</a>		25	256	1938	
<a href="#">S8378-512Q</a>			512	972	
<a href="#">S8378-1024Q</a>			1024	487	
<a href="#">S9226-03</a>	125	7.8	1024	194	
<a href="#">S9226-04</a>					

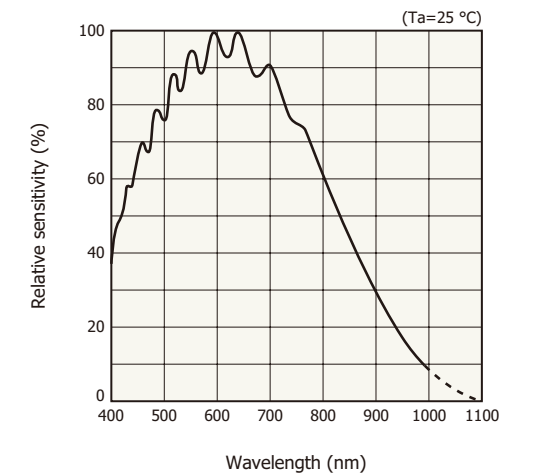
## ● Spectral response (typical example, without window)

[ S8377/S8378 series ]



KMPDB0213EC

[ S9226 series ]


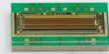








KMPDB0229EC

For industrial equipment

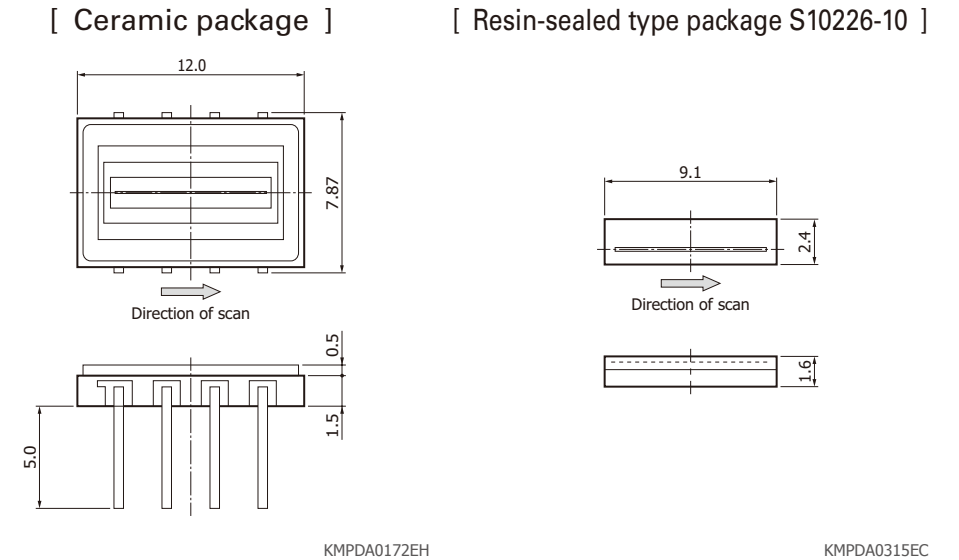
# Resin-sealed type package

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
<a href="#">S10226-10</a>	125	7.8	1024	194	
<a href="#">S10227-10</a>	250	12.5	512	9434	
<a href="#">S11106-10</a>	63.5	63.5	128	67568	
<a href="#">S11107-10</a>	127	127	64	119048	
<a href="#">S12443</a>	125	7	2496	3924	
<a href="#">S13131-512</a>	63.5	5.5	512	3787	
<a href="#">S13131-736</a>			736	2659	
<a href="#">S13131-1536</a>			1536	1288	
<a href="#">S13434-2496</a>		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.



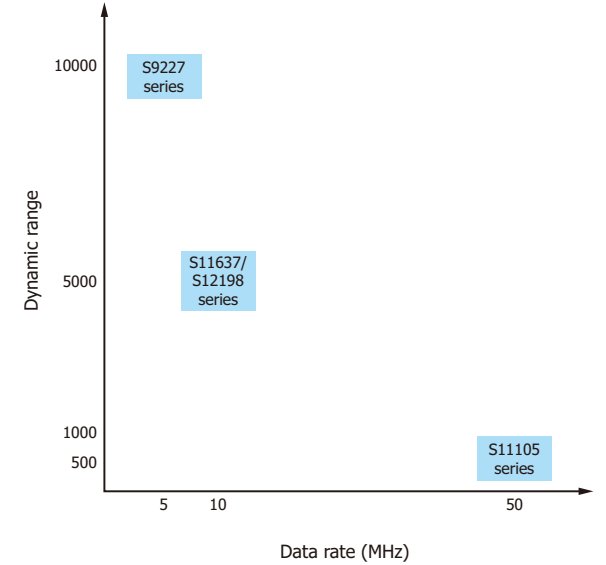
For industrial equipment

# 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
<a href="#">S9227-03</a>	250	12.5	512	9434	
<a href="#">S9227-04</a>					
<a href="#">S11105</a>	250	12.5	512	88652	
<a href="#">S11105-01</a>				88495	
<a href="#">S11637-1024Q</a>	500	12.5	1024	9487	
<a href="#">S11637-2048Q</a>			2048	4812	
<a href="#">S12198-512Q-01</a>	500	25	512	18450	
<a href="#">S12198-1024Q-01</a>			1024	9487	






● Dynamic range vs. data rate



KMPDB0678EA

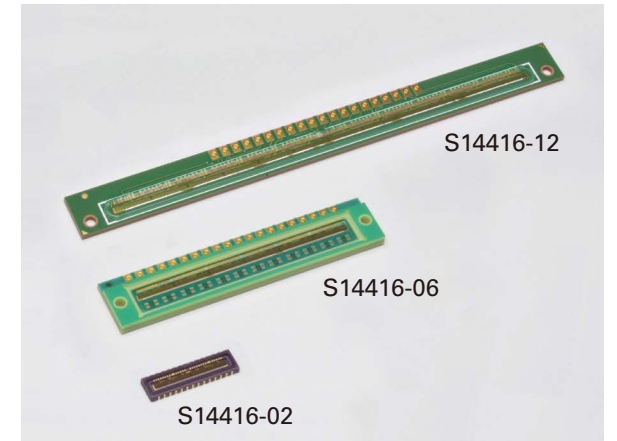
For industrial equipment  
**High-speed readout type**

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
<a href="#">S14416-02</a>	63.5	63.5	256	36231	
<a href="#">S14416-06</a>			768	12690	
<a href="#">S14416-12</a>			1536	6426	
<a href="#">S14417-02</a>	127	127	128	67567	
<a href="#">S14417-06</a>			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.

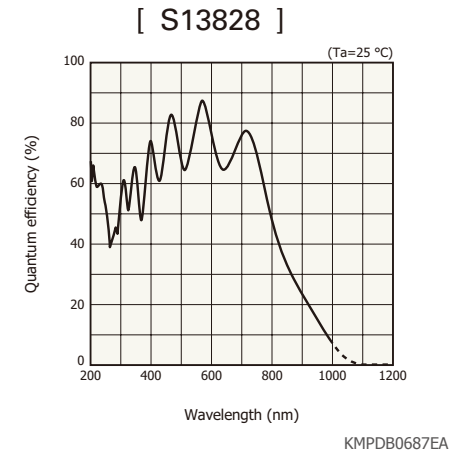
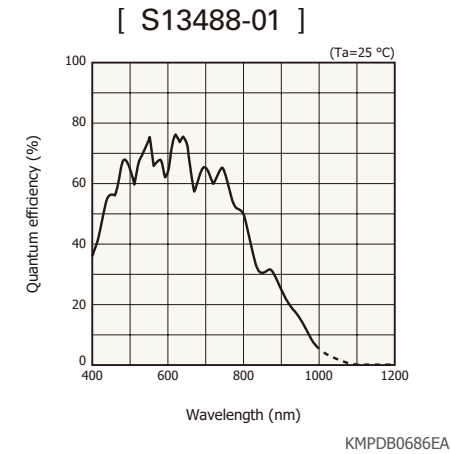
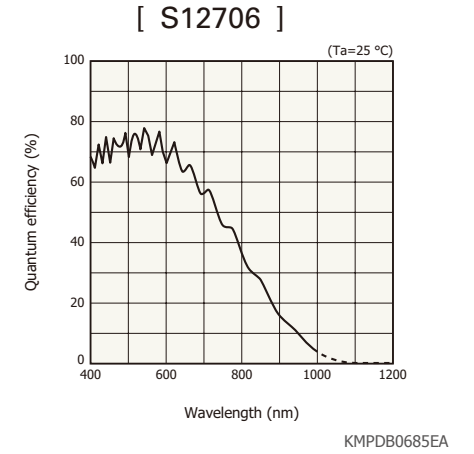
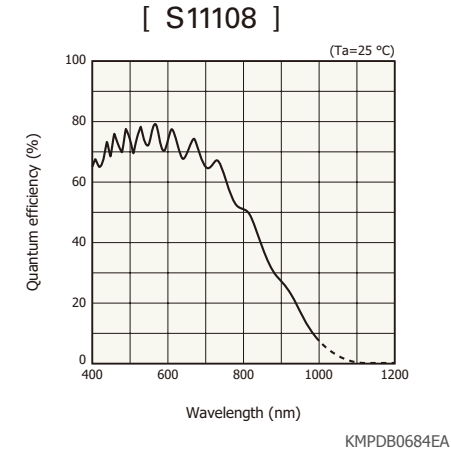


For industrial equipment  
**High sensitivity type**


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	<a href="#">Dedicated driver circuit</a> (sold separately)
<a href="#">S11108</a>	14	14	2048	4672		—
<a href="#">S12706</a>	7	7	4096	2387		<a href="#">C13015-01</a>
<a href="#">S13488-01</a>	42	14	2048	4672		—
<a href="#">S13828</a>	84	28	1024	8960		<a href="#">C13015-01</a>

● Spectral response (typical example, without window)



**Related product**






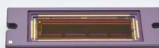





CCD image sensors  
 Built-in electronic shutter type



For industrial equipment

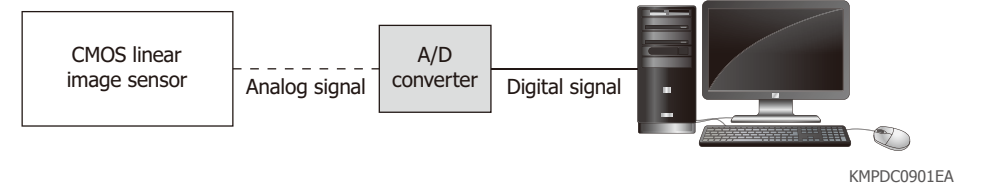
# Digital output type

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

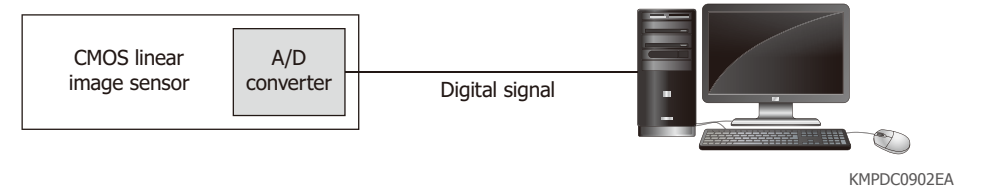
Type no.	Pixel height (μm)	Pixel pitch (μm)	Number of pixels	Line rate max. (lines/s)	Photo
<a href="#">S10077</a>	50	14	1024	972	
<a href="#">S11720-20</a>	127	127	1536	45400	
<a href="#">S11720-40</a>			3072		
<a href="#">S13774</a>	7	7	4096	100000 (high-speed mode)	
<a href="#">S14772</a>	14	14	2048	125000 (high-speed mode)	
<a href="#">S15611</a>	200	7	1024	34000	
<a href="#">S15611-10</a> <span style="color:red">NEW</span>					
<a href="#">S15778</a>	7	7	8192	100000 (high-speed mode)	
<a href="#">S16074</a> * <span style="color:red">NEW</span>	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.

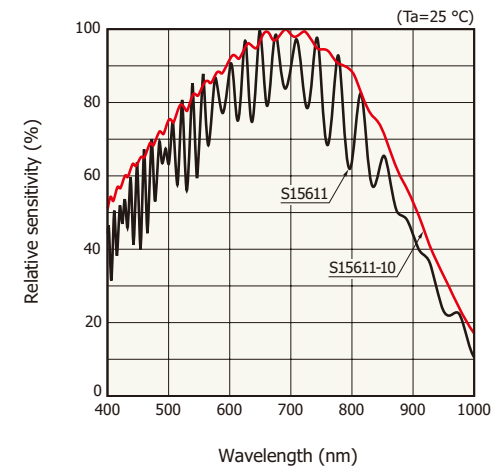
## ● A/D conversion of CMOS linear image sensors [ Analog output type ]



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



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




KMPDB0712EA

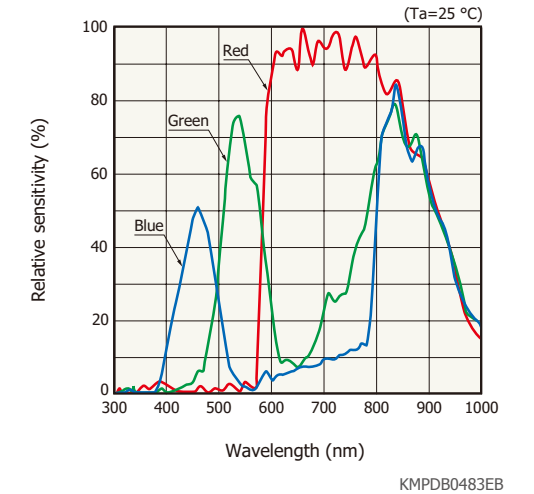
For industrial equipment

# 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
<a href="#">S13488</a>	42	14	2048	4672	







## ● Spectral response (typical example)



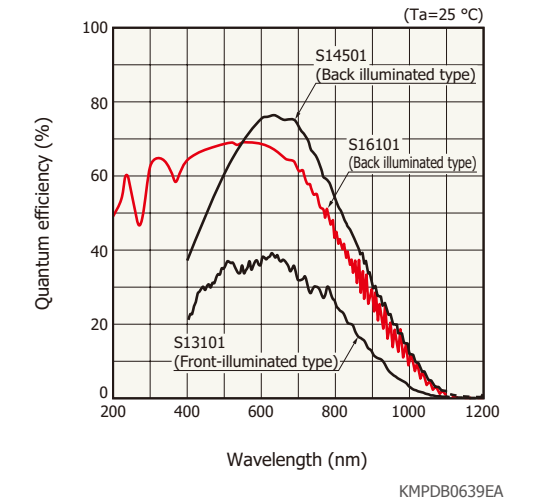
Note: This sensor also has sensitivity in the infrared region, so cut off incident infrared light as needed.

# CMOS area image sensors

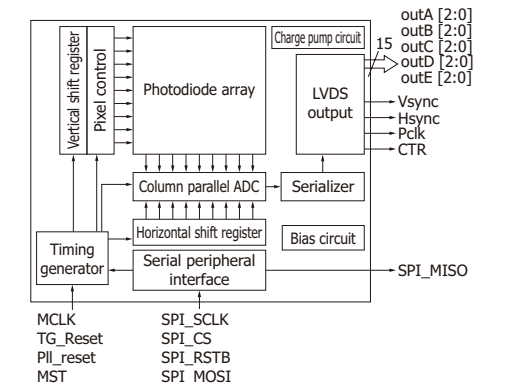
These APS (active pixel sensor) type CMOS area image sensors have high sensitivity in the UV and near infrared light. They integrate a timing generator, bias generator, amplifier, A/D converter, and are easy to handle because of all-digital I/O.

Type no.	Pixel size [μm (H) × μm (V)]	Number of effective pixels	Spectral response range (nm)	Frame rate max. (frames/s)	Type	Photo
<a href="#">S16101</a> <span style="color: red; font-weight: bold;">NEW</span>	7.4 × 7.4	1280 × 1024	200 to 1100	146	Back-illuminated type	
<a href="#">S14501</a>			400 to 1100			
<a href="#">S13101</a>	7.4 × 7.4	1280 × 1024	400 to 1100	146	Front-illuminated type	
<a href="#">S13102</a>		640 × 480		78		
<a href="#">S13499</a>		659 × 494		75		
<a href="#">S14250</a>		30 × 30		344		

## ● Spectral response (S16101, S14501, S13101, typical example)





## ● Block diagram (S16101, S14501, S13101)



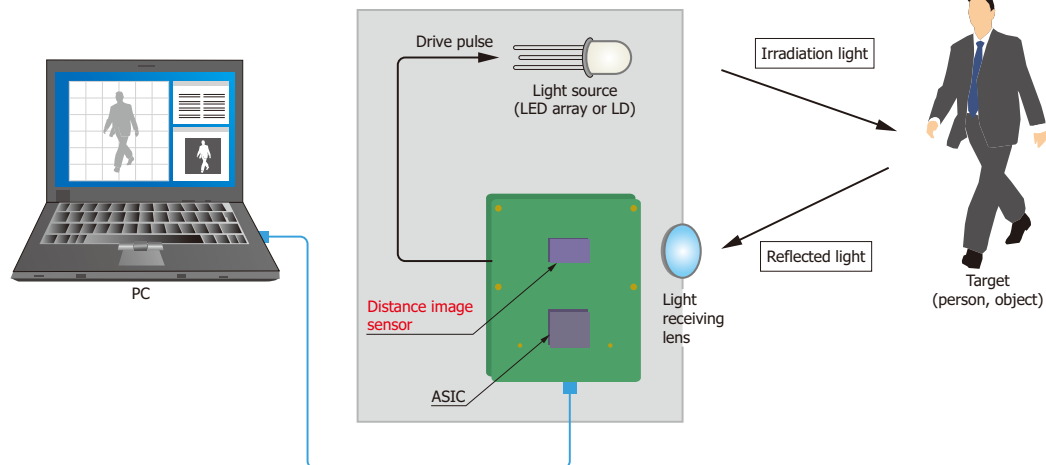
## Distance linear image sensors

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 ( $\mu\text{m}$ )	Pixel pitch ( $\mu\text{m}$ )	Number of effective pixels	Video data rate max. (MHz)	Photo
<a href="#">S15452-01WT</a>	50	20	64	5	
<a href="#">S15453-01WT</a>			256		

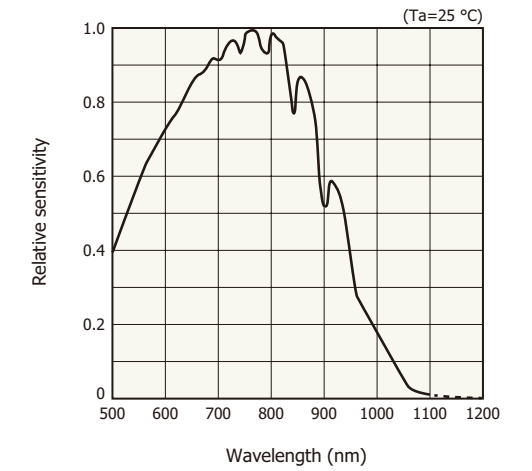
Note: An evaluation kit is available. Contact us for detailed information.

### Configuration example of distance measurement



KMPDC0417EE




### Spectral response



KMPDB0564EA

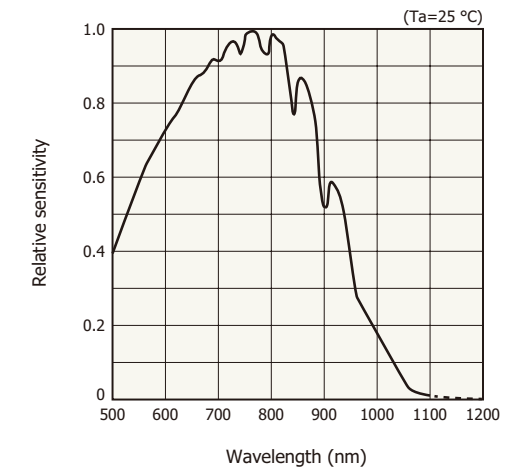
## Distance area image sensors

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 [ $\mu\text{m}$ (H) $\times$ $\mu\text{m}$ (V)]	Pixel pitch ( $\mu\text{m}$ )	Number of effective pixels	Video data rate max. (MHz)	Photo
<a href="#">S15454-01WT</a>	50 $\times$ 50	50	96 $\times$ 72	10	
<a href="#">S16443-01WT</a>	20 $\times$ 50	20 (H) $\times$ 201.5 (V)	128 $\times$ 8	10	
<a href="#">S16444-01WT</a>	20 $\times$ 50	20 (H) $\times$ 201.5 (V)	320 $\times$ 20	10	

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

### ● Spectral response



KMPDB0564EA

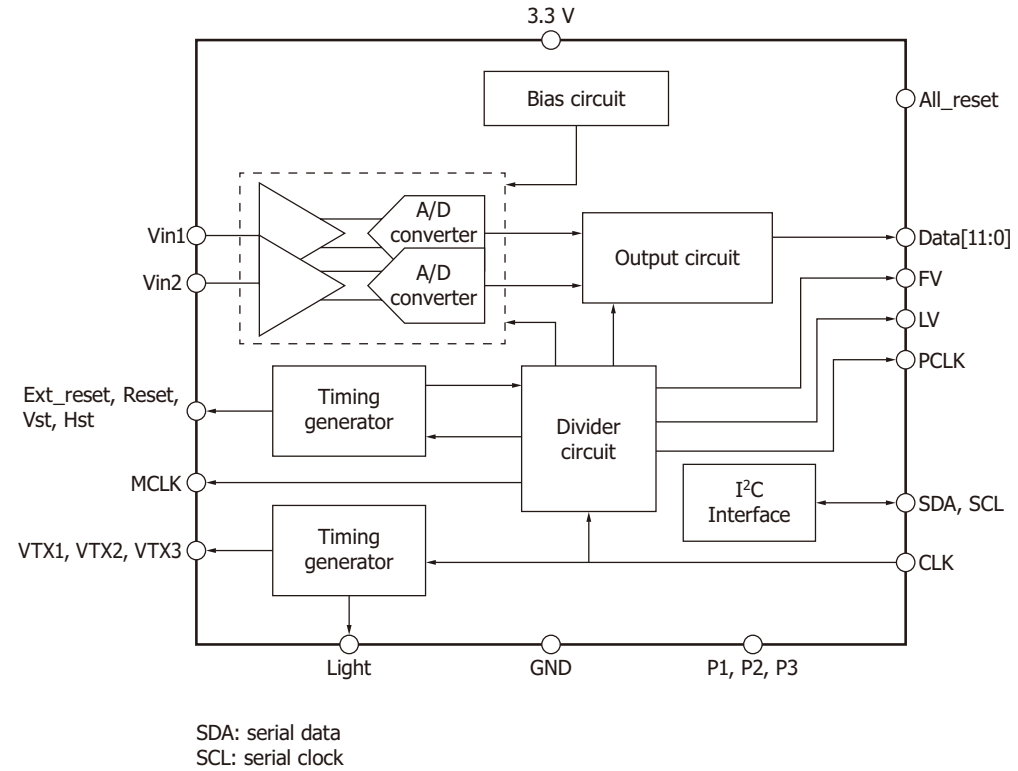
# ASIC

for distance image sensor

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






● Block diagram



KACCC1053EA

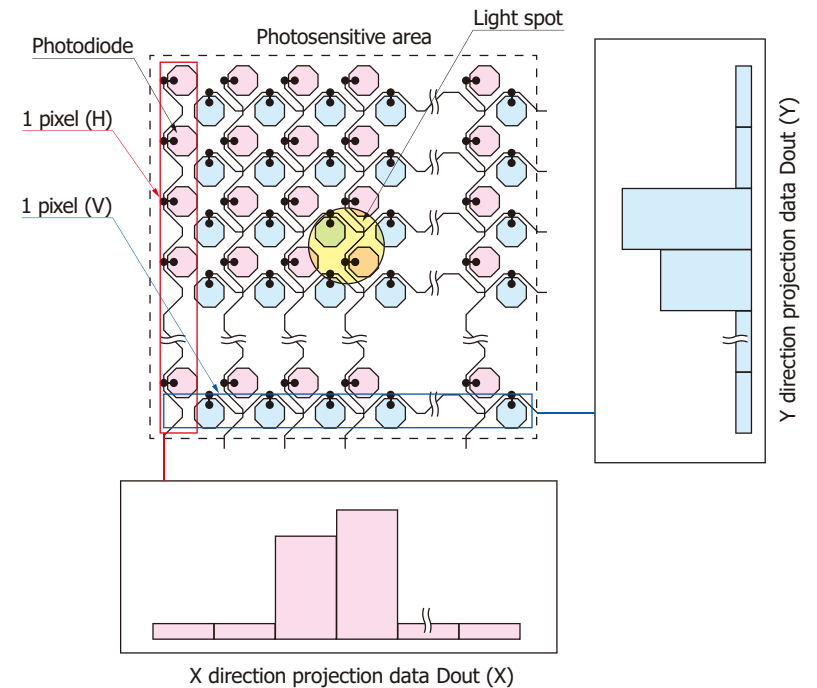
# Profile sensors

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) × mm (V)]	Photo
<a href="#">S9132</a>	256	7.8	3200	1.9968 × 1.9968	
<a href="#">S15366-256</a>			3156		
<a href="#">S15366-512</a>	512		1602	3.9936 × 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

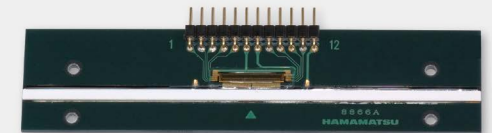
### ▶ [CMOS area image sensors](#)

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.

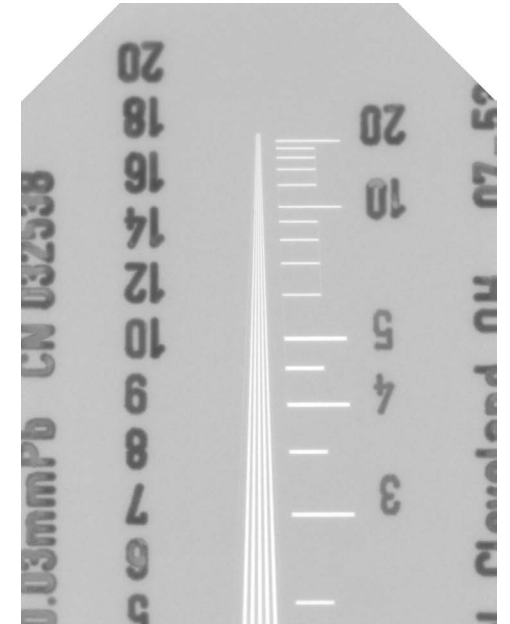
They use FOP (fiber optic plate) input window. They also have a built-in 14-bit A/D converter and use LVDS digital output. An OEM type with a cable to be used for simple X-ray imaging is also available. Contact us for detailed information.

Type no.	Scintillator	Pixel size [ $\mu\text{m}$ (H) $\times$ $\mu\text{m}$ (V)]	Number of effective pixels	Frame rate* (frames/s)	Photo
S10830-12	CsI (+ FOP)	20 $\times$ 20	1000 $\times$ 1500	0.9	
S10831	CsI (+ FOP)	20 $\times$ 20	1300 $\times$ 1700	0.6	

\* Global clock=20 MHz

Note: Please prepare a circuit for driving the sensor.


### • X-ray imaging example (S10831)



For non-destructive inspection

# CMOS area image sensors

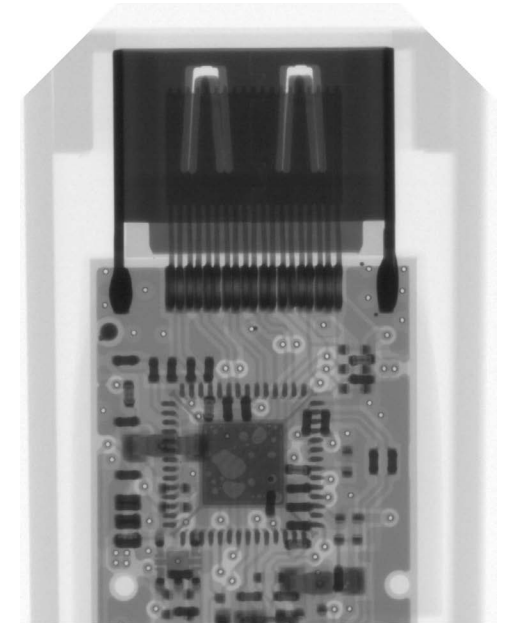
This product has an APS type CMOS area image sensor and USB interface, built into a compact housing. The fiber optic plate (FOP) protects the X-ray image sensor to realize 1 million Gy\* of radiation resistance.

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

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

This product is an X-ray area image sensor for non-destructive inspection applications. It is not for medical applications. Even if it is used for medical diagnosis, customers are required to obtain approval for it as a medical device.





- X-ray imaging example  
[ Electronic part ]



For non-destructive inspection

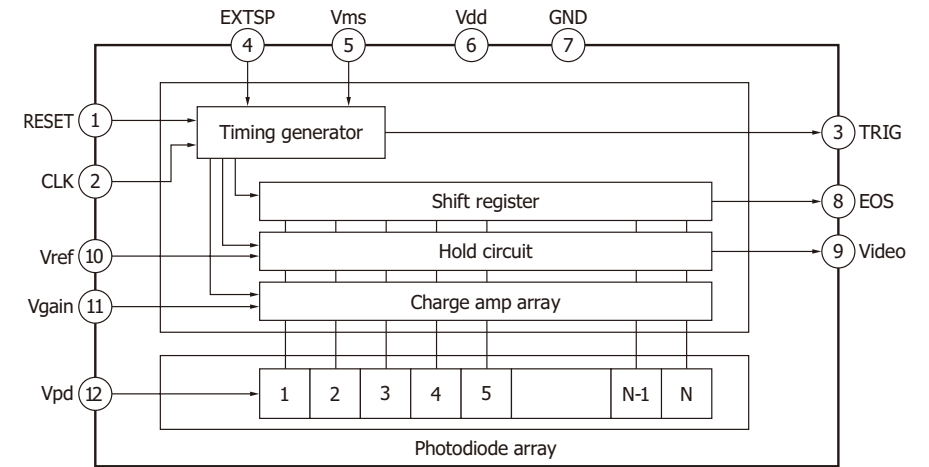
# Photodiode arrays with amplifier

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)
<a href="#">S11865-64G</a>	0.8	0.8	64	5	14678	0.5		<a href="#">C9118-01</a>
<a href="#">S11865-128G</a>	0.6	0.4	128	5	7568	0.5		
<a href="#">S13885-128G</a>	0.6	0.4	128	3.3	7568	0.125		
<a href="#">S11865-256G</a>	0.3	0.2	256	5	3844	0.5		—
<a href="#">S13885-256G</a>	0.3	0.2	256	3.3	3844	0.125		
<a href="#">S11866-64G-02</a>	1.6	1.6	64	5	14678	0.5		<a href="#">C9118-01</a>
<a href="#">S11866-128G-02</a>	0.8	0.8	128	5	7568	0.5		
<a href="#">S13886-128G</a>	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.

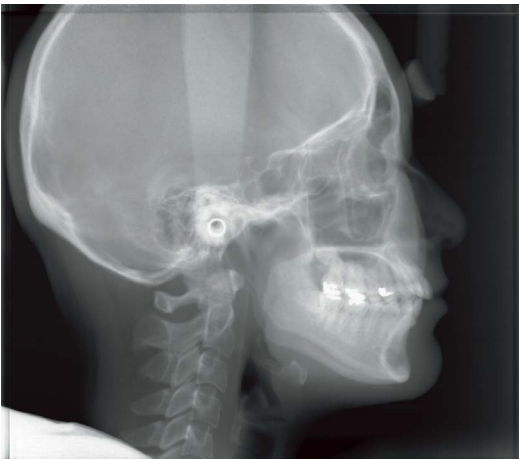
Type no.	Scintillator	Pixel size [ $\mu\text{m}$ (H) $\times$ $\mu\text{m}$ (V)]	Number of effective pixels	Line rate*1 max. (lines/s)	Photo
<a href="#">S7199-01</a> *2	CsI (+ FOP)	48 $\times$ 48	1536 $\times$ 128 ( $\times$ 2-chip buttable)	2100	
<a href="#">S8658-01</a> *2			1536 $\times$ 128 ( $\times$ 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

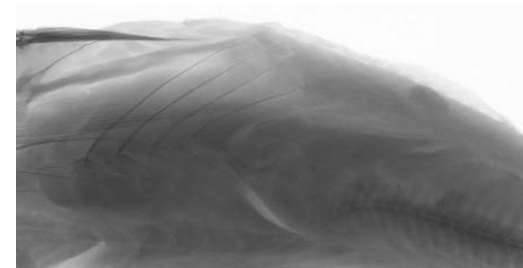
[ Cephalo ]



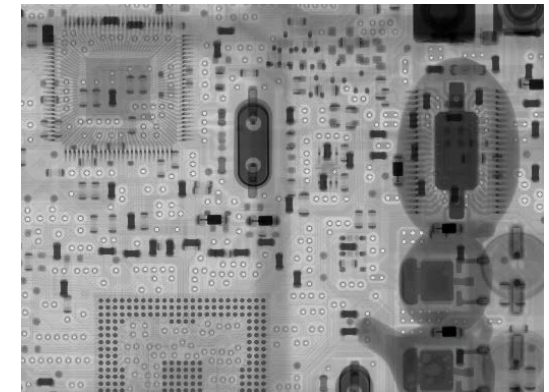
[ Panorama ]



[ 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)
<a href="#">C7040</a>	Analog	Non-cooled	S7030 series, S16000-1007
<a href="#">C7041</a>		One-stage TE-cooled	S7031 series, S16001-1007S
<a href="#">C7043</a>		Non-cooled	S7033 series
<a href="#">C7044</a>		One-stage TE-cooled	S7034 series
<a href="#">C7180</a>		Non-cooled	S7170-0909
<a href="#">C7181</a>		One-stage TE-cooled	S7171-0909-01
<a href="#">C10150-01</a>		Non-cooled	S10140 series (-01)
<a href="#">C10151-01</a>		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.

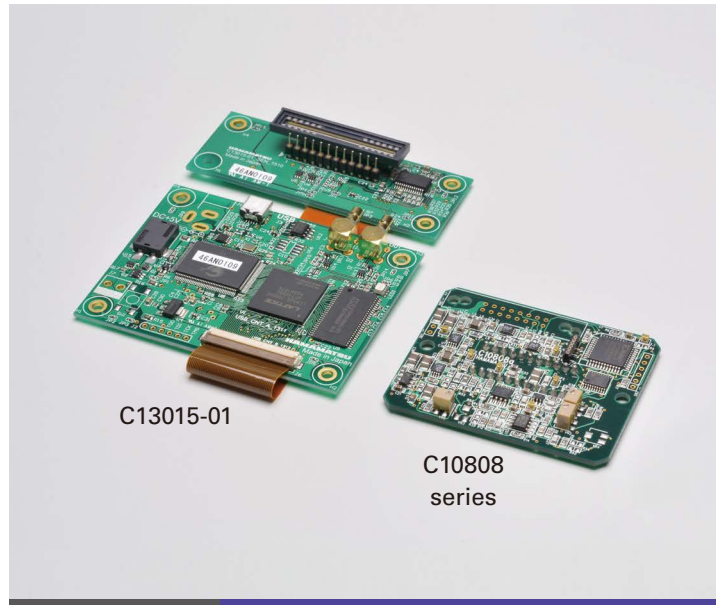


Type no.	Interface	Line rate max. (lines/s)	Applicable sensors (sold separately)
<a href="#">C11160</a>	USB 2.0	483	S11151-2048
<a href="#">C11287-01</a>		210	S10420-1004-01
		180	S10420-1006-01, S16010-1006
		110	S10420-1104-01
		100	S10420-1106-01, S16010-1106
		90	S14650-1024
<a href="#">C11288-01</a>		70	S14650-2048
		1420	S11071-1004
		1040	S11071-1104
		600	S11071-1006
		520	S11071-1106
		290	S14660-1024
<a href="#">C11165-02</a>		150	S14660-2048
<a href="#">C11860</a>		2780	S11155-2048-02, S11156-2048-02
		126	S11850-1006-01, S16011-1106
	100	S14651-1024	
	83	S11850-1106-01, S16011-1106	
<a href="#">C15361-1105</a>	71	S14651-2048	
<a href="#">C15361-2105</a>	2340	S15351-2048	
	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)
<a href="#">C10808 series</a>	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
<a href="#">C13015-01</a>	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.

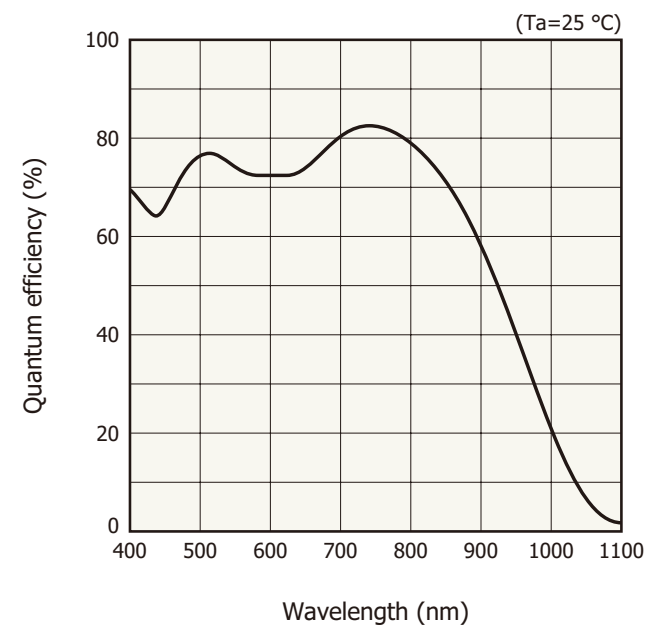


Type no.	Line rate max. (lines/s)	Interface	Built-in sensor
<a href="#">C15821-2351</a>	70000	CameraLink	S15729-01

## 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](http://www.hamamatsu.com)

- Information described in this material is current as of July 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.

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KMPD0002E29 Jul. 2023 DN

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