HAMAMATSU

PHOTON IS OUR BUSINESS

Si devices for NIR light detection

NIR

CONTENTS

Dec.2020

What is near infrared light?

Infrared light is divided into near infrared light (0.7 to 2.5 μm), mid infrared light (2.5 to 4 μm), and far infrared light (4 to 1000 μm) depending on the length of the wavelength.Of these, near infrared light is used in various applications, including industrial fields such as semiconductor manufacturing, processing, and inspection, as well as analysis fields such as fluorescence, blood, and gas.Also, the sensing technology "LiDAR", which is a function as the "eyes" of self-driving car uses detector / emitter devices of near infrared range.
Hamamatsu uses optical semiconductor technology cultivated over the years to offer a wide range of "high sensitivity in near infrared region " Si devices, which are key to technologies and instruments that use near infrared light.

Hamamatsu

Features of Si devices for NIR light detection

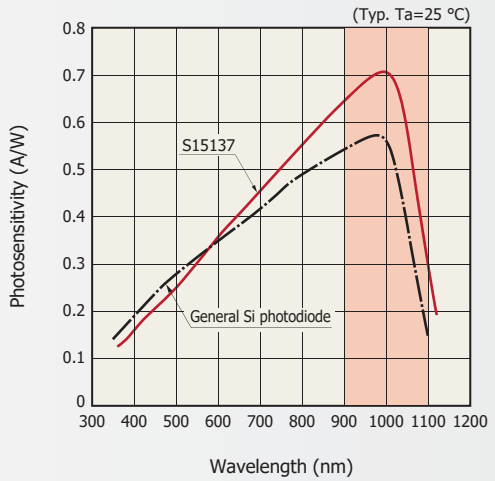
Feature 1

High sensitivity in near infrared region

UV light or visible light can be detected adequately even using a general Si devices. But near infrared light is an extremely small light absorption coefficient and the ratio of light that passes through silicon increases, and therefore sensitivity is lowered.
Hamamatsu uses unique silicon process technology to achieve high sensitivity in the near infrared region (especially in the 900 to 1100 nm), even for Si devices.

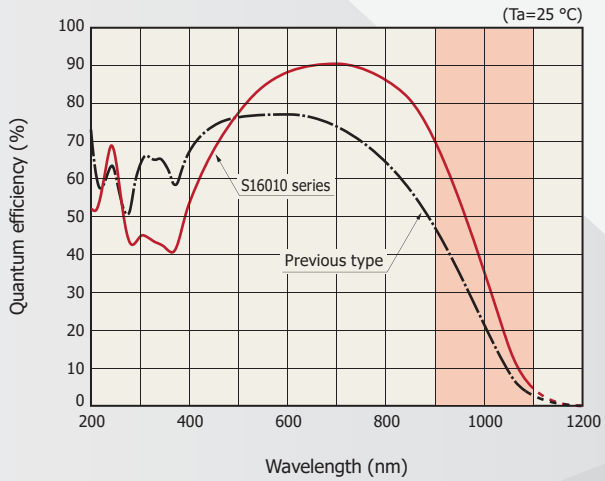
■ Spectral response

[Si photodiode S15137]



KPINB0445EA

[CCD image sensor S16010 series]



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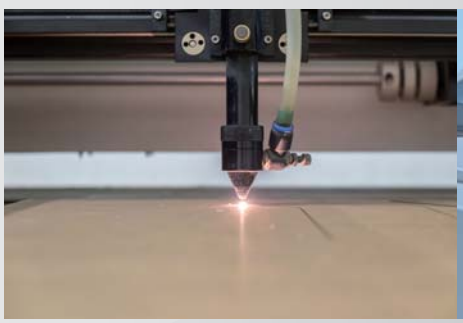
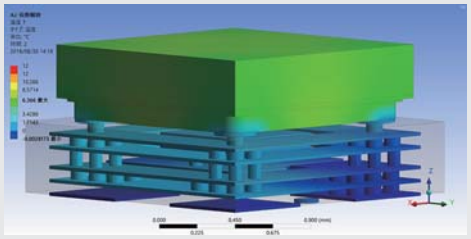


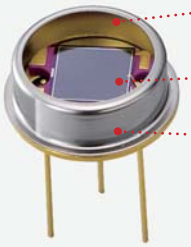
Feature 2

"Flexibility" that can be achieved by consistent in-house production

Hamamatsu has established an integrated production system in our own factory, from the design to the assembly and inspection of optical semiconductor devices.This is why we are flexible and offer products customized according to customers' requests.Customization examples include adding filters on window materials, tiling chips into 1D or 2D arrays, segmenting a detector's photosensitive area, changing the package shape, and adding an electronic cooling element.



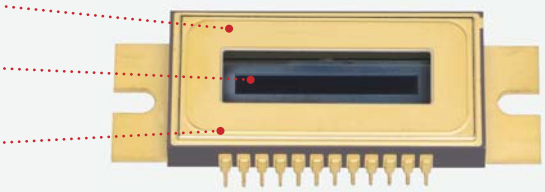
Customization examples



Window material

photosensitive area

Package



We offer customized products
to meet customer demands.

Si photodiodes

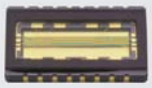
Image sensor

■ Package and window material

Choose from DIP (Dual Inline Package) type, surface mount type, etc. We can also change the package shape and incorporate TE-coolers inside the package. Also, we offer the product without window.

[Package example]

DIP type (built-in TE-cooler)

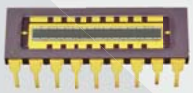


Surface mount type

■ Photosensitive area size

[Si photodiodes]

We can customize the photosensitive area size and shape, as well as the number of elements.
We can also arrange the elements in one dimension to make the photosensitive area larger, or to divide the photosensitive area into two dimensions.



[Photosensitive area: 1.45 × 0.9 mm/ch,
number of elements:16]

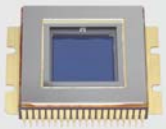
Si photodiode arrays
S4111-16R

[Photosensitive area:
□ 3 mm / Quadrant]

Si photodiode
S4349

[Image sensor]

We can customize the pixel size and number of pixels. We offer pixel sizes as small as 7 µm. We can also change pixel size and number of pixels to configurations other than square.



[Pixel size: □ 12 µm,
number of pixels: 2048 × 2048]

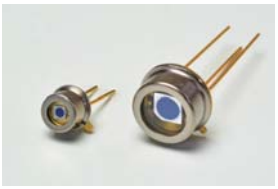
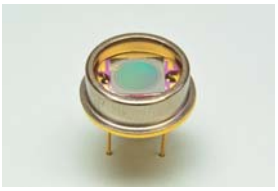
CCD area image sensor
S12101

[Pixel size: □ 14 µm,
number of pixels: 1024 × 16]

CCD image sensor
S10420-1004-01

Lineup

Hamamatsu offers a wide range of detectors, including Si photodiodes and CCD image sensors, as well as modules equipped with these detectors.

Product name	Type no.	Photo	Page
Si photodiode	S15474-01/02		P. 6
Si PIN photodiode	S15137		P. 7
CCD image sensor	S16010/S16011 series S16000 series	 	P. 8 to 10
Mini-spectrometer	C9405CC C14384MA-01	 	P. 11, 12

Product information

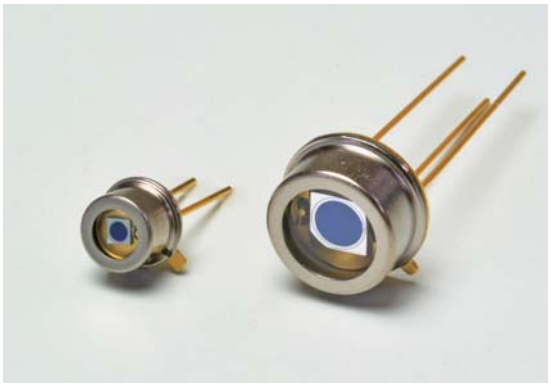
Si photodiode NEW

S15474 series

FEATURES

- High sensitivity in near infrared region: 0.54 A/W (λ =1060 nm)*1
- Low noise
- Sensitivity stability in temperature of near infrared region

*1: Value of S15474-02

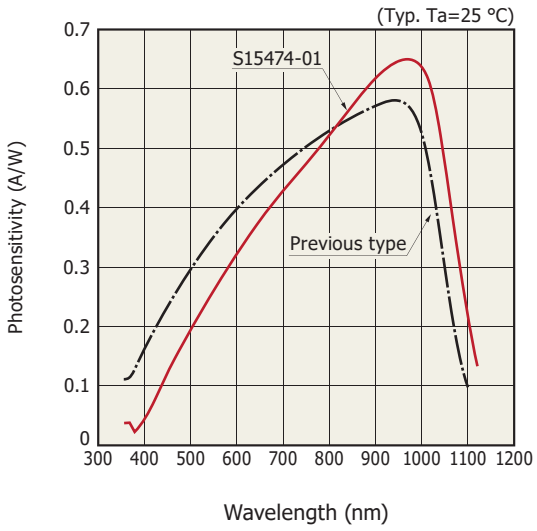


APPLICATIONS

- YAG laser monitor
- Fiber laser monitor

Spectral response

S15474-01



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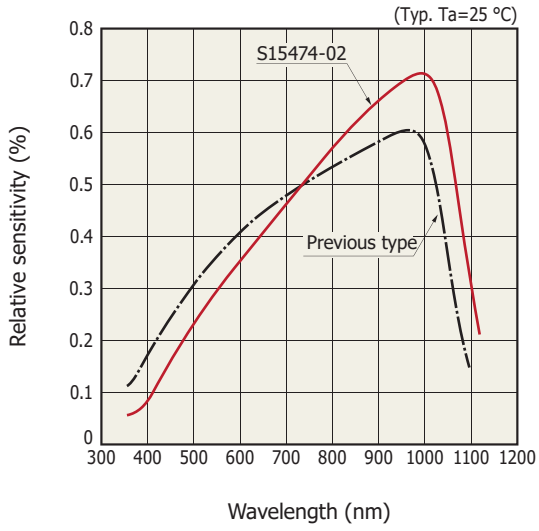
S15474-02



KSPDB0406EA

Structure

Parameter	S15474-01	S15474-02	Unit
Photosensitive area	ϕ1.2	ϕ3.0	mm
Package	TO-18	TO-5	-
Window material	Borosilicate glass		-

Electrical and optical characteristics (Typ. Ta=25 ℃, unless otherwise noted)

Parameter	S15474-01	S15474-02	Unit
Spectral response range	360 to 1120		mm
Peak sensitivity wavelength	980	1000	nm
Photosensitivity*2	0.46	0.54	A/W
Dark current	0.05 (V_R=10 V)	0.05 (V_R=20 V)	nA
Terminal capacitance	4 (V_R=10 V)	13 (V_R=20 V)	pF

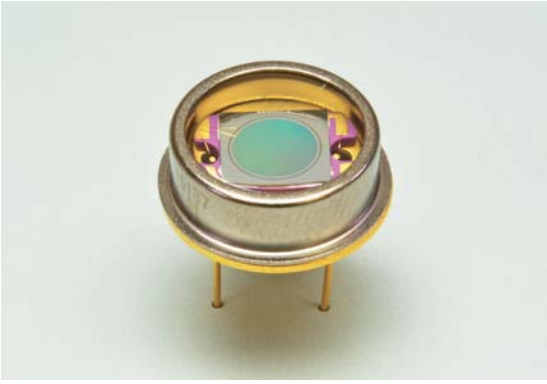
*2: λ =1060 nm

Si PIN photodiode NEW

S15137

FEATURES

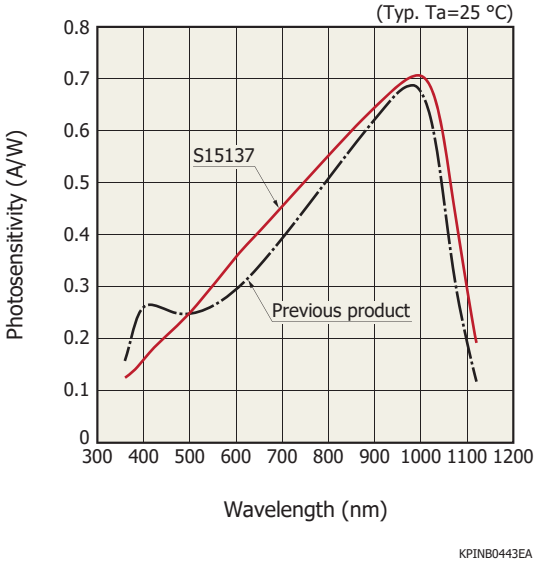
- High sensitivity in infrared region: 0.52 A/W (λ=1060 nm)
- High-speed response: 12.5 ns (V_R=100 V)
- Low capacitance: 10 pF (V_R=100 V)



APPLICATIONS

- YAG laser monitor
- Fiber laser monitor

Spectral response



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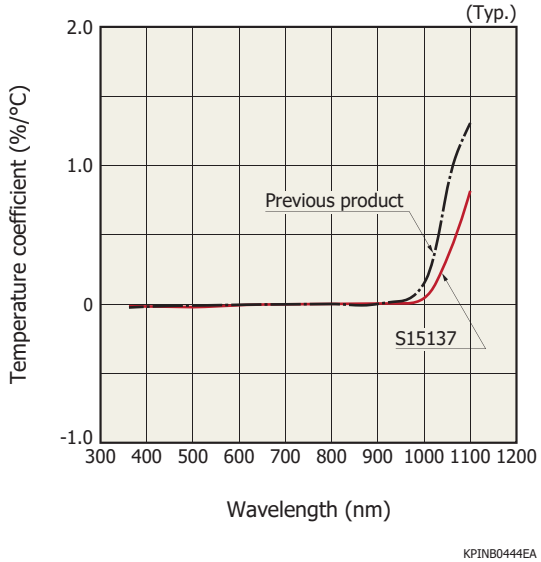
Sensitivity temperature characteristics



KPINB0444EA

Structure

Parameter	Specification	Unit
Photosensitive area	ϕ5.0	mm
Package	TO-8	-
Window material	Borosilicate glass	-

Electrical and optical characteristics (Typ. Ta=25 ℃, unless otherwise noted)

Parameter	Specification	Unit
Spectral response range	360 to 1120	nm
Peak sensitivity wavelength	1000	nm
Photosensitivity*1	0.52	A/W
Short curcuit current*2	21	μA
Dark current*3	1	nA
Temperature coefficient of ID	1.15	Times/℃
Rise time*4	12.5	ns
Terminal capacitance*5	10	pF

*1: λ=1060 nm *2: 2856 K, 1000 lx *3: V_R=100 V *4: V_R=100 V, R_L=50 Ω, λ=1060 nm, 10 ～ 90% *5: V_R=100 V, f=10 kHz

CCD image sensor NEW

S16010 series

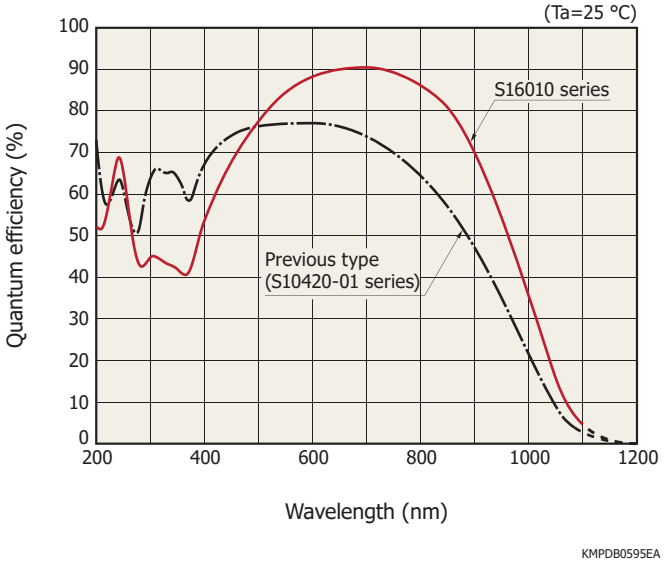
FEATURES

- High sensitivity in near infrared region: QE=36% (λ =1000 nm)
- With anti-blooming function
- MPP operation

APPLICATIONS

- Raman spectrometer, etc.

Spectral response (without window, typical example)



Structure

Parameter	S16060-1006	S16060-1106	Unit
Pixel size (H × V)	14 × 14		μm
Number of effectiev pixels (H × V)	1024 × 64	2048 × 64	-
Package	24-pin ceramic DIP		-
Window material	Quartz glass (Resion sealing)		-

Electrical and optical characteristics (Typ. Ta=25 ℃, unless otherwise noted)

Parameter		Specification	Unit
Spectral response range		200 to 1100	nm
Full well capacity	Vertical	60	ke^-
	Horizontal	300	
CCD node sensitivity		6.5	$\mu V/e^-$
Dark current		50	e^-/pixel/s
Readout noise*1		6	e^- rms
Dynamic range*2	Line binning	50,000	-
Photoresponse nonuniformity*3		±3	%

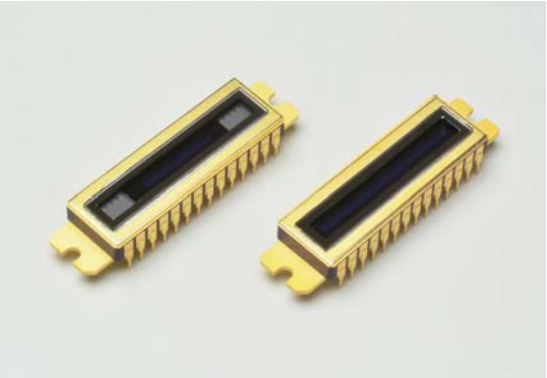
*1: Ta=-40 °C, readout frequency=20 kHz *2: Dynamic range = Full well capacity／Readout noise
*3: Measured at one-half of the saturation output (full well capacity) using LED light (peak emission wavelength: 450 nm)

CCD image sensor NEW

S16011 series

FEATURES

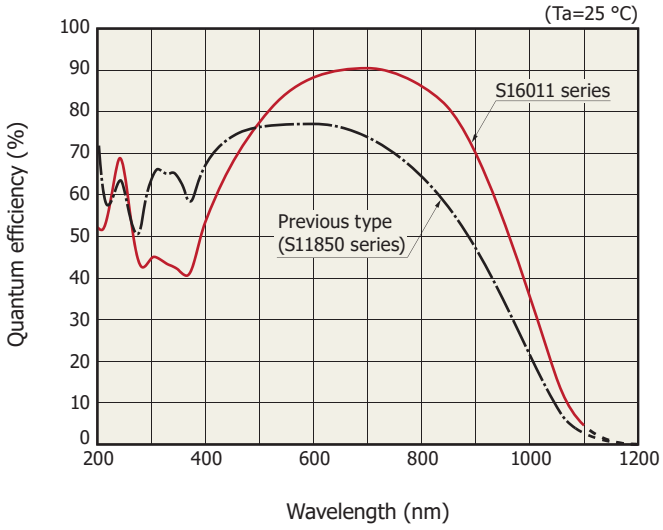
- High sensitivity in near infrared region: QE=36% (λ=1000 nm)
- With anti-blooming function
- MPP operation
- One-stage TE-cooled type (element temperature: approx. 5 ℃)



APPLICATIONS

- Raman spectrometer, etc.

■ Spectral response (without window, typical example)



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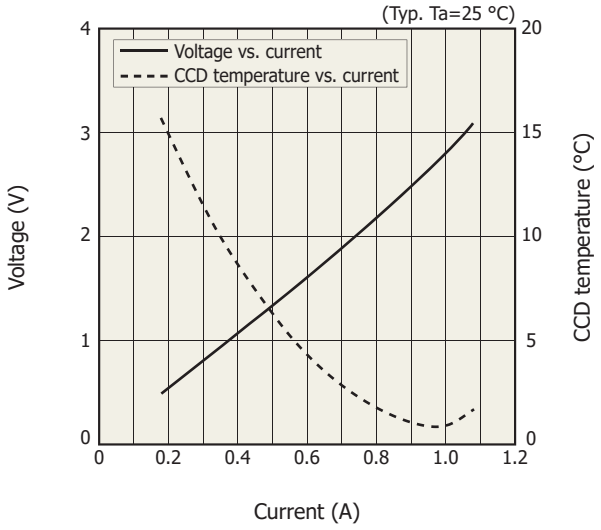
■ Specification of built-in TE-cooler



KMPDB0469EA

■ Structure

Parameter	S16060-1006	S16060-1106	Unit
Pixel size (H × V)	14 × 14		μm
Number of effectiev pixels (H × V)	1024 × 64	2048 × 64	-
Package	28-pin ceramic DIP		-
Window material	Quartz glass (Resion sealing)		-

■ Electrical and optical characteristics (Typ. Ta=25 ℃, unless otherwise noted)

Parameter		Specification	
Spectral response range		200 to 1100	nm
Full well capacity	Vertical	60	ke⁻
	Horizontal	300	
CCD node sensitivity		6.5	μV/e⁻
Dark current		50	e⁻/pixel/s
Readout noise*1		6	e⁻ rms
Dynamic range*2	Line binning	50,000	-
Photoresponse nonuniformity*3		±3	%

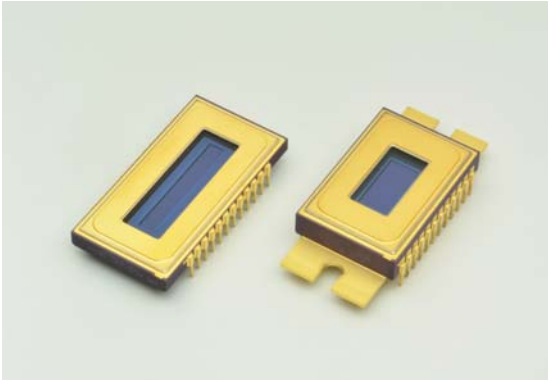
*1: Ta=-40 °C, readout frequency=20 kHz *2: Dynamic range = Full well capacity／Readout noise
*3: Measured at one-half of the saturation output (full well capacity) using LED light (peak emission wavelength: 450 nm)

CCD image sensor NEW

S16000-1007, S16001-1007S

FEATURES

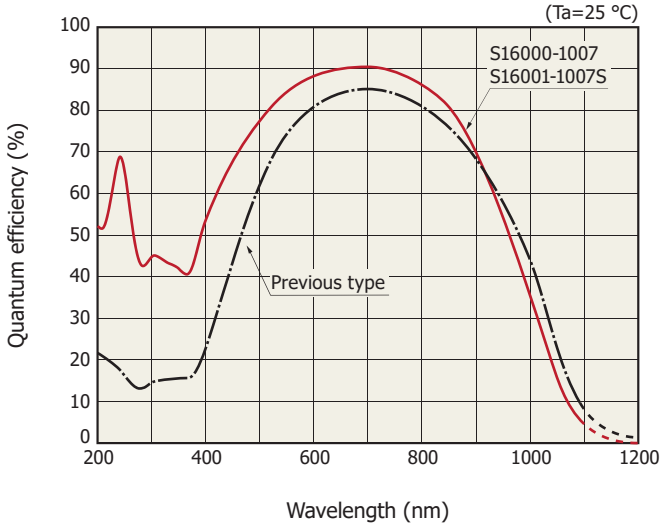
- High sensitivity in near infrared region: QE=36% (λ =1010 nm)
- MPP operation
- One-stage TE-cooled type (S16001-1007S)



APPLICATIONS

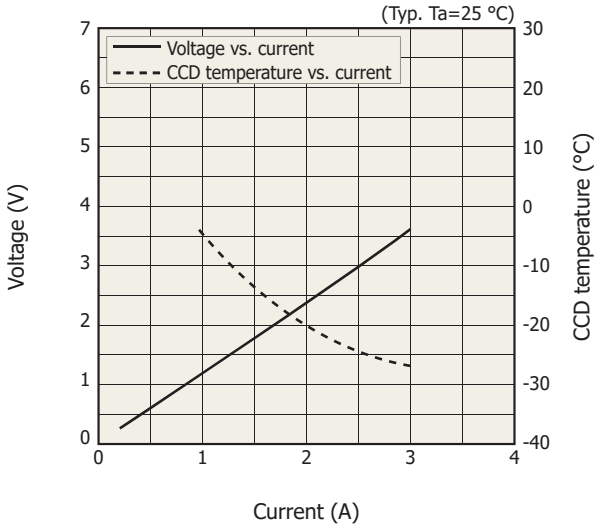
- Raman spectrometer, etc.

Spectral response (without window, typical example)



KMPDB0325EC

Specification of built-in TE-cooler



KMPDB0179EC

Structure

Parameter	S16000-1007	S16001-1007S	Unit
Pixel size (H × V)	24 × 24		μm
Number of effectiev pixels (H × V)	1024 × 122		-
Package	24-pin ceramic DIP		-
Window material	Quartz glass (Resion sealing)	AR-coated sapphire	-
Cooling	Non-cooled	One-stage TE-cooled	-

Electrical and optical characteristics (Typ. Ta=25 ℃, unless otherwise noted)

Parameter		S16000-1007	S16000-1007S	Unit
Spectral response range		200 to 1100		nm
Full well capacity	Vertical	320		ke$^-$
	Horizontal*1	1000		
CCD node sensitivity		2.2		μV/e$^-$
Dark current		100		e$^-$/pixel/s
Readout noise*2		8		e$^-$ rms
Dynamic range*3	Line binning	125,000		-
Photoresponse nonuniformi*4		±3		%

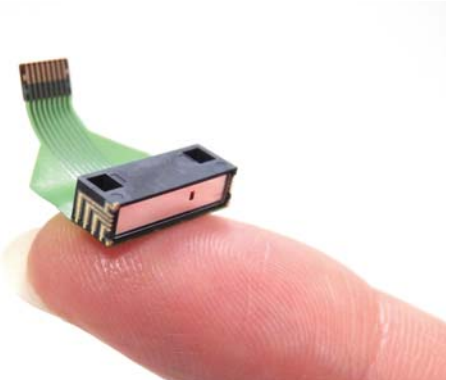
*1: The linearrity=±1.5% *2: Ta=-40 °C, readout frequency=20 kHz *3: Dynamic range = Full well capacity／Readout noise
*4: Measured at one-half of the saturation output (full well capacity) using LED light (peak emission wavelength: 560 nm)

Mini-spectrometer SMD series

C14384MA-01

FEATURES

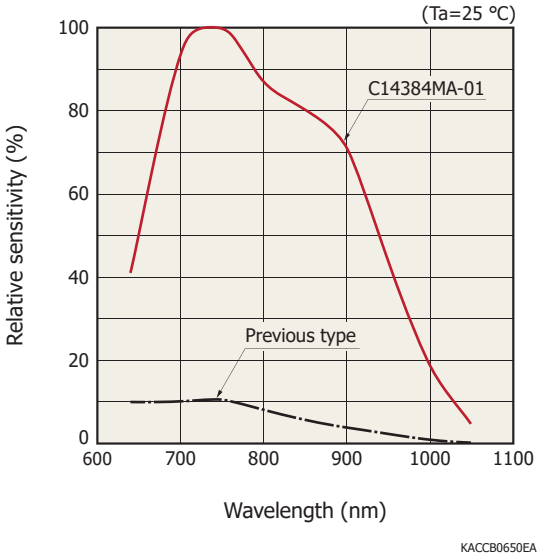
- High sensitivity in near infrared region: 50 times (λ =1000 nm) the previous type
- Spectral response range: 640 to 1050 nm
- Ultra-compact: 11.5 × 4.0 × 3.1 mm



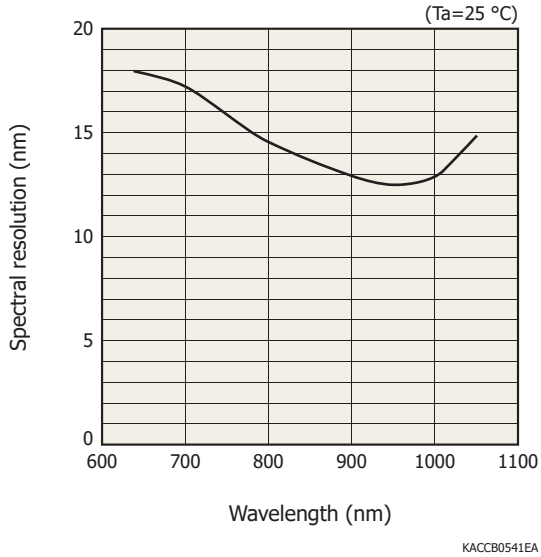
APPLICATIONS

- Food inspection (sugar content, moisture, fat)
- Light level measurement
- Component analysis

Spectral response (Typical example)



Spectral resolution vs. wavelength



Structure

Parameter	Specification	Unit
Dimensions (W × D × H)*1	11.5 × 4.0 × 3.1	mm
Image sensor	High-sensitivity CMOS linear image sensor with a slit	-
Number of pixels	256 (including optical black)	pixels
Weight	0.3	g

*1: Flexible cable not included

Electrical and optical characteristics (Typ. Ta=25 ℃, unless otherwise noted)

Parameter		Specification	Unit
Spectral response range		640 to 1050	nm
Spectral resolution (FWHM)	640～800 nm	20	nm
	800～1050 nm	17	
Wavelength reproducibility*2		-0.5 to +0.5	nm

*2: Measured under constant light input conditions

Mini-spectrometer TG series

C9405CC

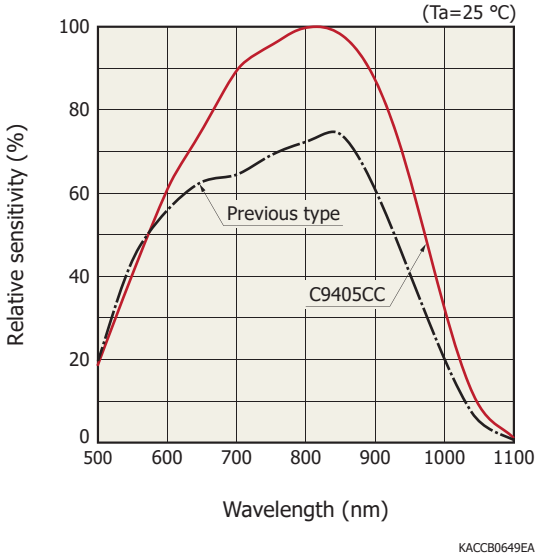
FEATURES

- High sensitivity in near infrared region
- Improved etaloning characteristics
- Easy to install into equipment

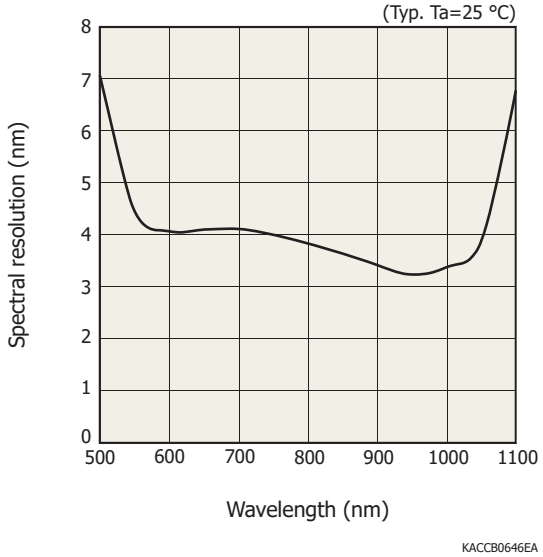
APPLICATIONS

- Detection of saccharic acids in food
- Film thickness meter

Spectral response (Typical example)



Spectral resolution vs. wavelength



Structure

Parameter	Specification	Unit
Dimensions (W × D × H)	125.7 × 115.7 × 75	mm
Image sensor	IR-enhanced back-thinned type CCD image sensor (S16010-1006)	-
Number of pixels	1024	pixels
Weight	670	g

Electrical and optical characteristics (Typ. Ta=25 ℃, unless otherwise noted)

Parameter	Specification	Unit
Spectral response range	500 to 1100	nm
Spectral resolution (FWHM)*	5 max.	nm
Wavelength reproducibility	-0.2 to +0.2	nm
Integration time	10 to 10000	ms
Interface	USB 1.1	-
Consumption current of USB bus power	150 max.	mA
External power supply	5	V

* λ=550 to 900 nm

HAMAMATSU

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