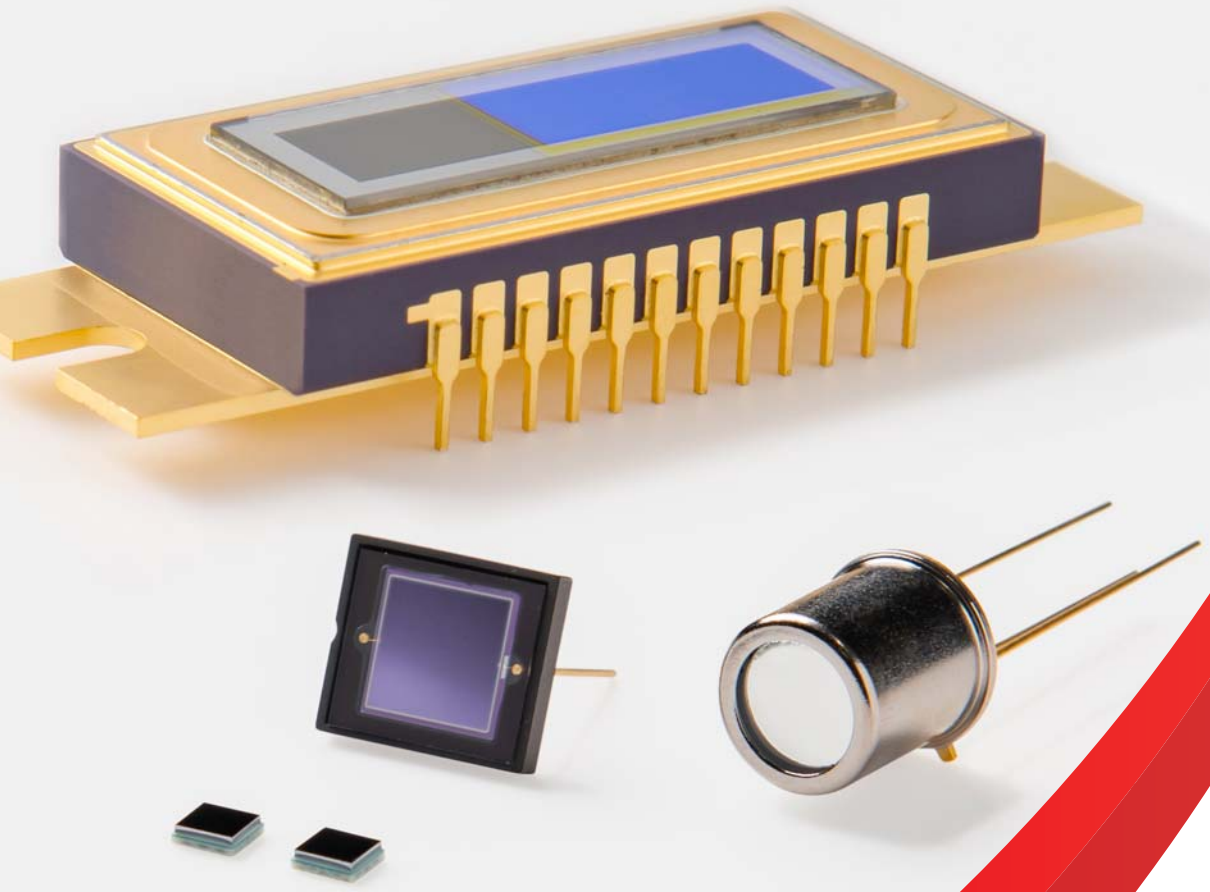
HAMAMATSU

PHOTON IS OUR BUSINESS



Devices for UV Detection

CONTENTS

Feb. 2021

What is ultraviolet light?

Visible light, meaning light visible to the human eye, has a spectral range of approximately 400 to 700 nm. Light with shorter wavelengths is called ultraviolet light (UV). Ultraviolet light is used in a wide range of applications as light sources and detection sensors, from industries fields such as semiconductor manufacturing/inspection and food processing, to familiar places such as fire alarms and skin care against UV. In recent years, ultraviolet light has attracted attention as a key technology for sterilization and inactivation of the novel coronavirus. It is expected that UV technologies will become increasingly popular in the future.
Hamamatsu provides a wide range of detectors with features such as UV high sensitivity and high UV resistance by opto-semiconductor technology amassed over many years.

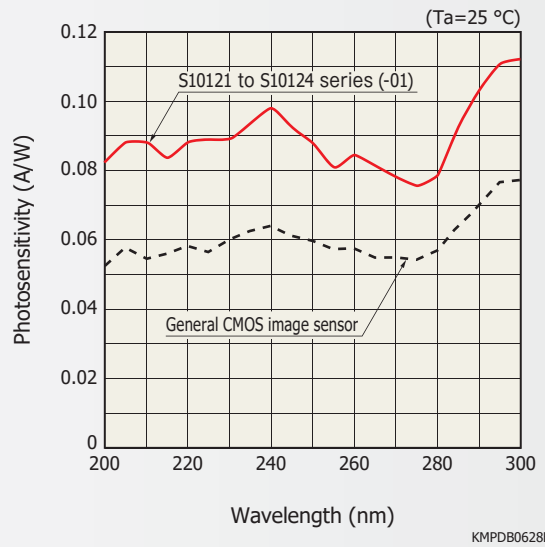
Features of our devices for UV detection

Feature 1 High sensitivity in UV region

Normal silicon sensors can detect ultraviolet light, but some ultraviolet light is absorbed as it passes through window material and packages. Hamamatsu has improved conversion efficiency by adopting a chip structure suitable for ultraviolet light detection. By adopting a window material that easily transmits ultraviolet light and a package without window material, we have realized a high sensitivity in the ultraviolet region.

■ Spectral response in UV region (typical example)

[CMOS linear image sensors S10121 to S10124 series (-01)]

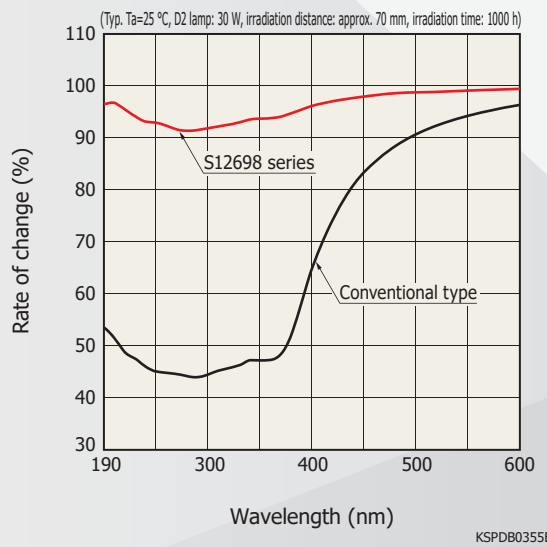


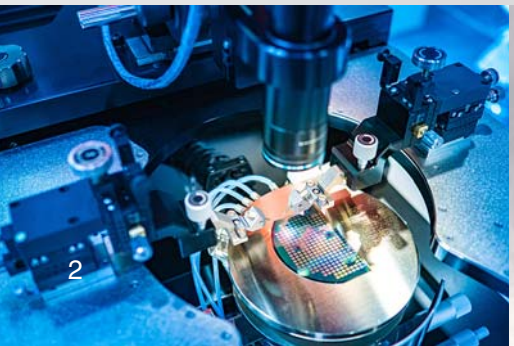
Feature 2 High UV resistance

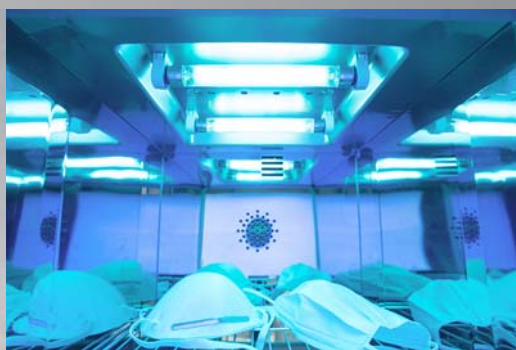
Generally, resin that generates outgas, deteriorating sensitivity of the chip, is used for adhesives such as window materials and chips, in a silicon sensor. Hamamatsu uses a resin-free package to reduce generation of outgas and realize high resistance to ultraviolet light exposure.

■ Changes to spectral sensitivity due to UV light irradiation

[Si photodiode S12698 series]

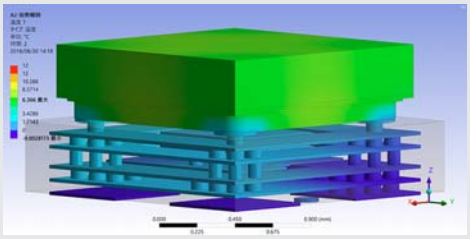






Feature 3 "Flexibility" that can be achieved by consistent in-house production

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.

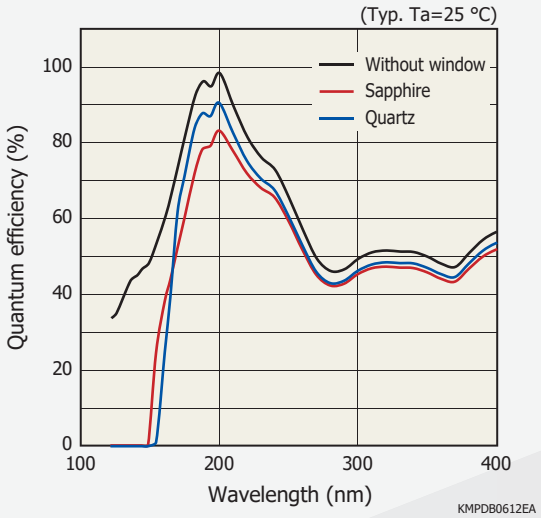


Customization examples

Window material

Choose from quartz, sapphire, no windows, and more. We can also form filters on the window material.

Spectral response of image sensor for each window material



Product example with filter

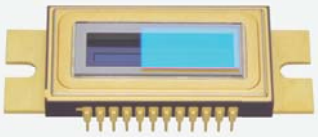
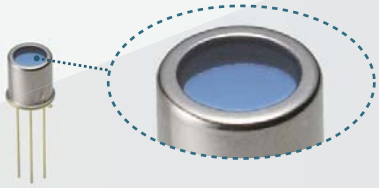


Image sensor with filter on window material

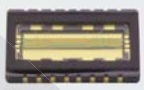


Photodiode with band-pass filter

Package

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.

DIP type (built-in TE-cooler)



Surface mount type

Photosensitive area

In image sensors, 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: 14 × 14 µm
Number of pixels: 1024 × 16

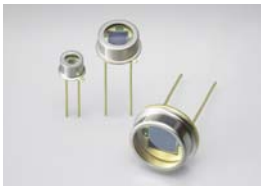
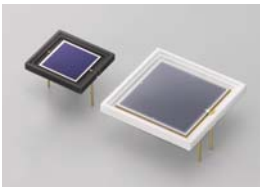
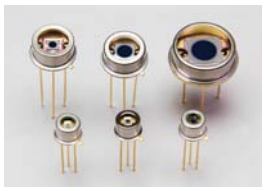
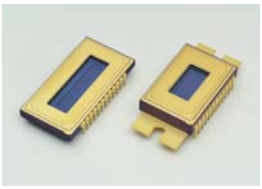
CCD image sensor S10420-1004-01

Pixel size: 12 × 12 µm
Number of pixels: 2048 × 2048

CCD area image sensor S12101

Lineup

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

Product name	Type no.	Photo	Page
Si photodiode	S1226/S1227 series S1336/S1337 series S12742 series S15289-33 S12698 series S10043 S8552, S8553	 	P. 6 to 11
Si APD	S14124-20 S12053 series S9075 / S5344 / S5345		P. 12, 13
CCD image sensor	S10420-01 series S7030/S7031 series	 	P. 14, 15
CMOS image sensor	S11639-01 S10121 to S10124 series		P. 16, 17
Mini-spectrometer	C9404CA C9404CAH		P. 18

Product information

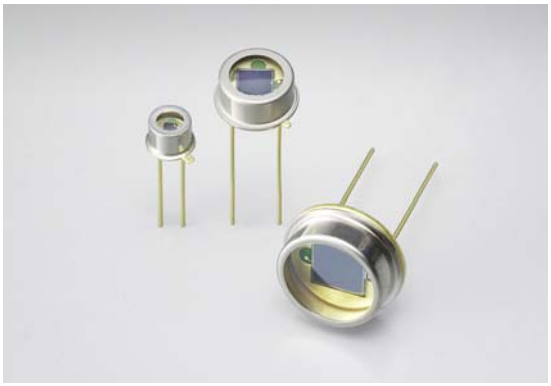
Si photodiodes

S12698 series

High UV Resistance

FEATURES

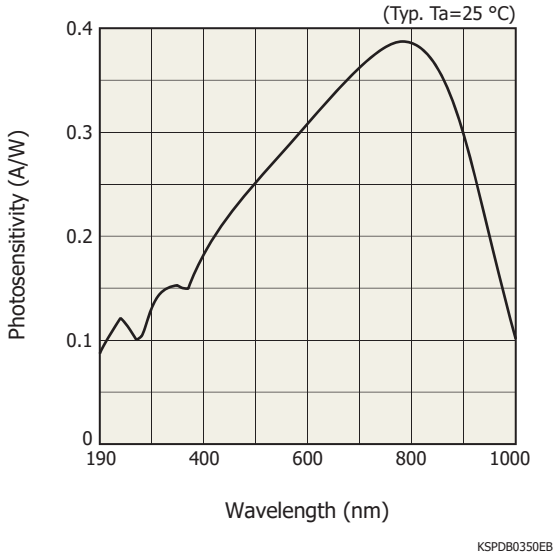
- With UV glass window (hermetically sealed)
- High reliability for monitoring UV light irradiation
- No resin that causes outgassing



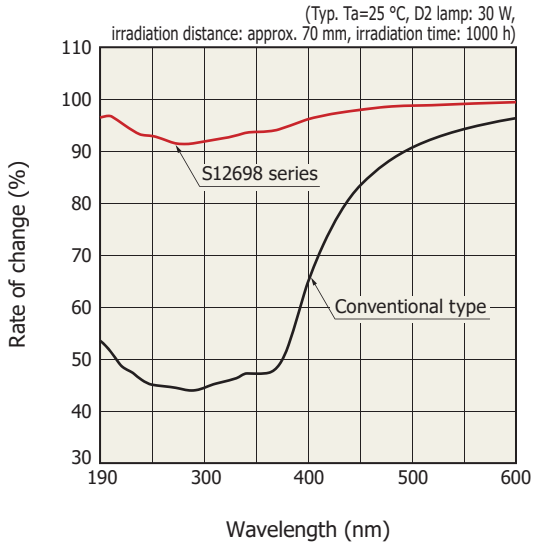
APPLICATIONS

- Power monitor for UV light sources
- Analytical instrument

Spectral response



Changes in spectral response after irradiated with UV light



Structure

Parameter	S12698	S12698-01	S12698-04	S12698-02	Unit
Photosensitive area size	1.1 × 1.1	2.4 × 2.4	3.6 × 3.6	5.8 × 5.8	mm
Package	TO-18	TO-5		TO-8	-
Window material	UV glass				-

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

Parameter	S12698	S12698-01	S12698-04	S12698-02	Unit
Spectral response range	190 to 1000				nm
Peak sensitivity wavelength	800				nm
Photosensitivity*1	0.38				A/W
Dark current*2	10	30	50	100	pA
Temp. coefficient of dark current	1.12				times/°C
Rise time*3	0.1	0.5	0.6	1.5	μs
Terminal capacitance*4	25	230	240	700	pF

*1: λ=λp *2: V_R=10 mV *3: V_R=0 V, R_L=1 kΩ, λ=655 nm *4: V_R=0 V, f=10 kHz

Si photodiode

S10043

for VUV Detection

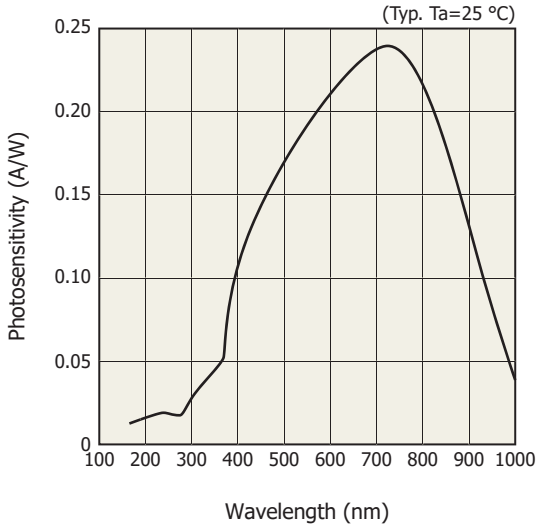
FEATURES

- Greatly improved sensitivity stability even after exposure to ArF (λ=193 nm) excimer laser
- Windowless package

APPLICATIONS

- ArF excimer laser detection
- Various UV detection

Spectral response



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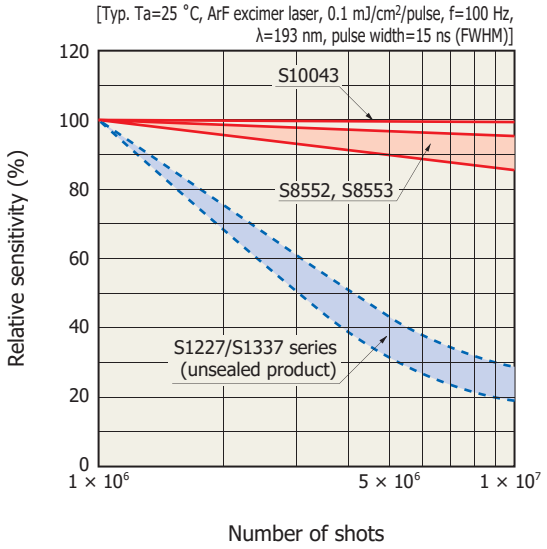
Variation in sensitivity due to VUV exposure



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Structure

Parameter	Specification	Unit
Photosensitive area size	10 × 10	mm
Package	Ceramic	-
Window material	None	-

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

Parameter	Specification	Unit
Spectral response range	190 to 1100	nm
Peak sensitivity wavelength	720	nm
Photosensitivity*1	15	mA/W
Dark current*2	0.1	nA
Rise time*3	9	μs
Terminal capacitance*4	4	pF

*1: λ=193 nm *2: V_R=10 mV *3: V_R=0 V, R_L=1 kΩ, 10 to 90% *4: V_R=0 V, f=10 kHz

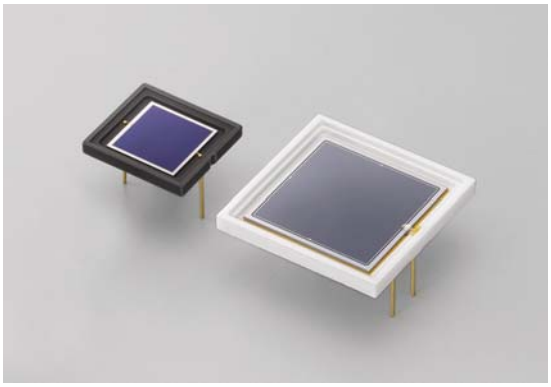
Si photodiodes

for VUV Detection

S8552, S8553

FEATURES

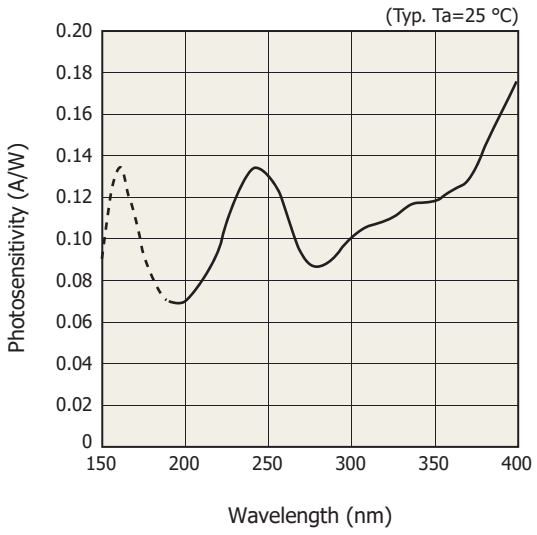
- Greatly improved sensitivity stability even after exposure to ArF (λ=193 nm) excimer laser
- Windowless package



APPLICATIONS

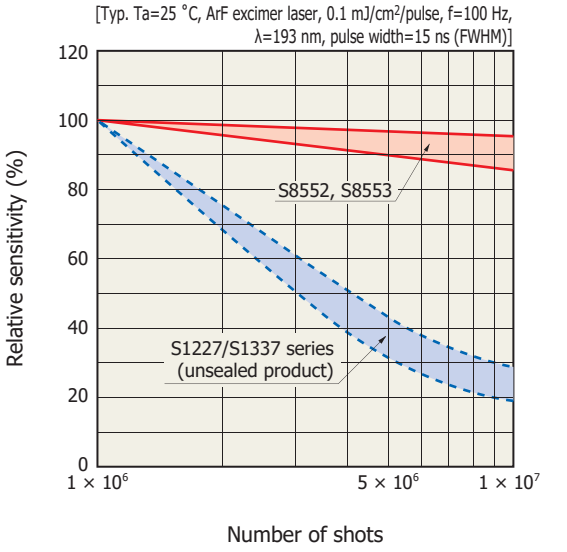
- Vacuum UV monitor
- Excimer laser monitor

Spectral response



KSPDB0358EA

Variation in sensitivity due to VUV exposure



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Structure

Parameter	S8552	S8553	Unit
Photosensitive area size	10 × 10	18 × 18	mm
Package	Ceramic		-
Window material	None		-

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

Parameter	S8552	S8553	Unit
Spectral response range	190 to 1100		nm
Peak sensitivity wavelength	780		nm
Photosensitivity*1	60		mA/W
Dark current*2	0.05	0.1	nA
Rise time*3	9	18	μs
Terminal capacitance*4	4	8	pF

*1: λ=193 nm *2: V_R=10 mV *3: V_R=0 V, R_L=1 kΩ, 10 to 90% *4: V_R=0 V, f=10 kHz

Si photodiode

S15289-33

High UV Resistance

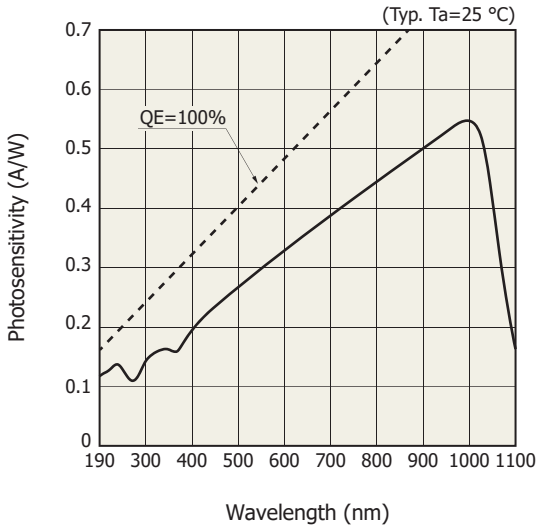
FEATURES

- High sensitivity in UV region: QE=75% (λ =200 nm)
- High reliability in UV light irradiation
- Compatible with lead-free solder reflow

APPLICATIONS

- Light level monitor for UV light source
- Analytical instruments

Spectral response



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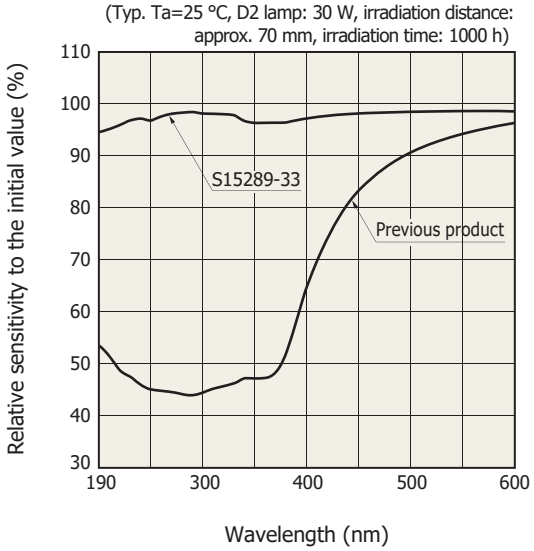
Changes in spectral response after irradiated with UV light



KSPDB0395EA

Structure

Parameter	Specification	Unit
Package size	3 × 3	mm
Photosensitive area size	2.5 × 2.5	mm
Package	Glass epoxy	-
Window material	None	-

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

Parameter		Specification	Unit
Spectral response range		190 to 1100	nm
Peak sensitivity wavelength		1000	nm
Photosensitivity	λ=200 nm	0.12	A/W
	λ=1060 nm	0.54	
Dark current*1		10	pA
Temp. coefficient of dark current		1.15	times/°C
Rise time*2		50	μs
Terminal capacitance*3		70	pF

*1: V_R=10 mV *2: V_R=0 V, R_L=1 kΩ, λ=650 nm, 10 to 90% *3: V_R=0 V, f=10 kHz

Si photodiodes

for Monochromatic Light

S12742 series

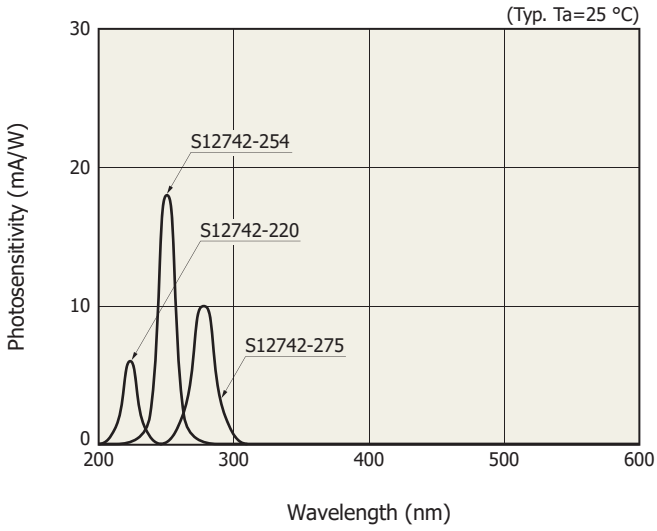
FEATURES

- With monochromatic light filter
- arrow spectral response half width (FWHM): 10 nm typ.

APPLICATIONS

- Water quality and atmosphere analysis
- UV monitors (mercury lamp, etc.)

Spectral response



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The S12742 series can be customized to support other peak sensitivity wavelengths such as 340 nm and 560 nm.

Structure

Parameter	Specification	Unit
Photosensitive area size	3.6 × 3.6	mm
Package	TO-5	-
Window material	With monochromatic light filter	-

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

Parameter	S12742-220	S12742-254	S12742-275	Unit
Center wavelength	220	254	275	mm
Spectral response half width	10			nm
Photosensitivity*1	6	18	10	mA/W
Dark current*2	25			pA
Temp. coefficient of dark current	1.12			times/°C
Rise time*3	1			μs
Terminal capacitance*4	500			pF

*1: λ=Center wavelength *2: V_R=10 mV *3: V_R=0 V, R_L=1 kΩ *4: V_R=0 V, f=10 kHz

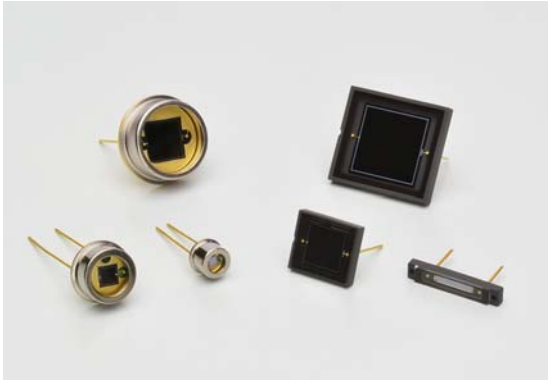
Si photodiodes

High UV Sensitivity

S1226 / S1227 / S1336 / S1337 series

FEATURES

- High UV sensitivity
- IR sensitivity suppressed type (S1226/S1227 series)
- High sensitivity in UV to near IR range (S1336/S1337 series)

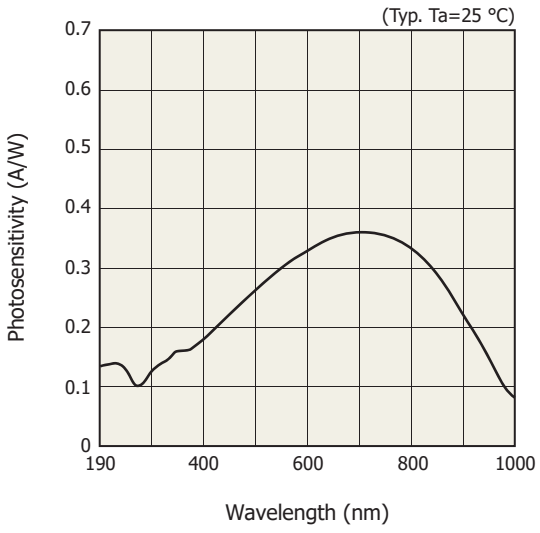


APPLICATIONS

- Analytical equipment
- Optical measurement equipment

Spectral response

S1226/S1227-BQ series



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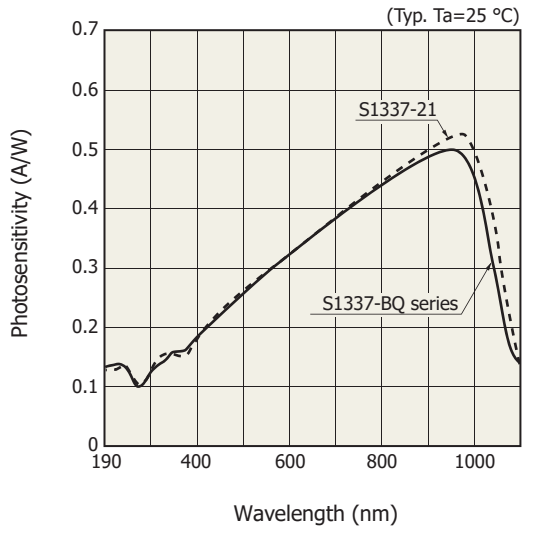
S1336/S1337-BQ series



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Structure

Parameter	S1226 series	S1227 series	S1336 series	S1337 series	Unit
Photosensitive area size	1.1 × 1.1 to 5.8 × 5.8	1.1 × 5.9 to 10 × 10	1.1 × 1.1 to 5.8 × 5.8	1.1 × 5.9 to 18 × 18	mm
Package	Metal	Ceramic	Metal	Ceramic	-
Window material	Quartz glass				-

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

Parameter	S1226/S1227 series	S1336/S1337 series	Unit
Spectral response range	190 to 1000	190 to 1100	nm
Peak sensitivity wavelength	720	960	nm
Photosensitivity*1	0.12		A/W

*1: λ=200 nm

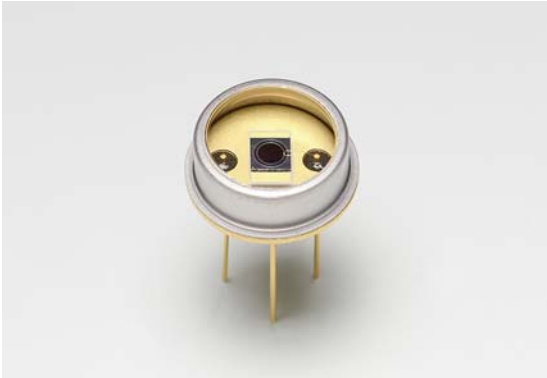
Si APD

S14124-20

High UV Sensitivity

FEATURES

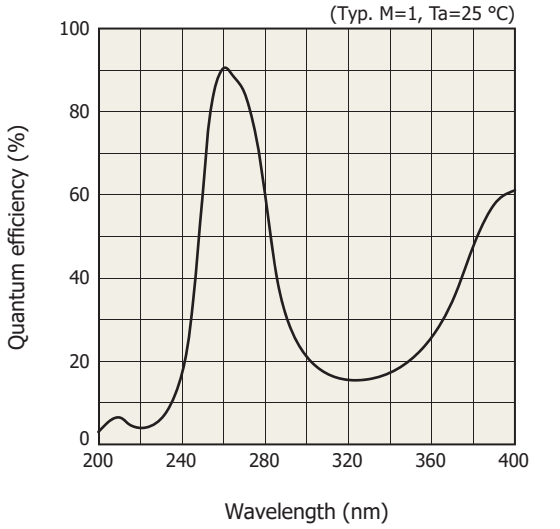
- High sensitivity: QE=87% (λ=266 nm)
- Low capacitance
- Low noise



APPLICATIONS

- Semiconductor inspection system
- Laser processing equipment

Spectral response



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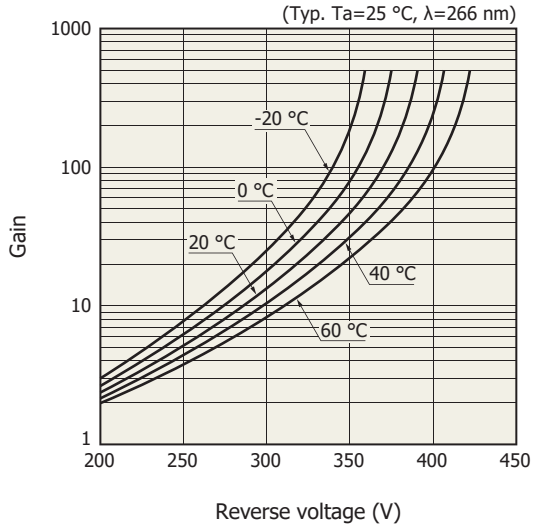
Gain vs. reverse voltage



KAPDB0570EA

Structure

Parameter	Specification	Unit
Photosensitive area size	ϕ2.0	mm
Package	TO-8	-
Window material	AR-coated quartz	-

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

Parameter	Specification	Unit
Peak sensitivity wavelength*1	600	nm
Breakdown voltage*2	400	V
Temp. coefficient of breakdown voltage	0.78	V/°C
Dark current (max.)*1	3	nA
Terminal capacitance*3	11	pF
Cutoff frequency*4	250	MHz
Gain*5	50 to 400	-

*1: M=50 *2: I_D=10 μA *3: M=50, f=1 MHz *4: M=50, λ=266 nm, R_L=50 Ω, -3dB *4: V_R=0 V, f=10 kHz

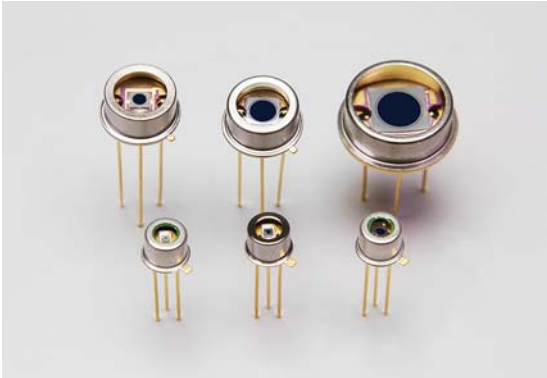
Si APD

S12053 series

High UV Sensitivity

FEATURES

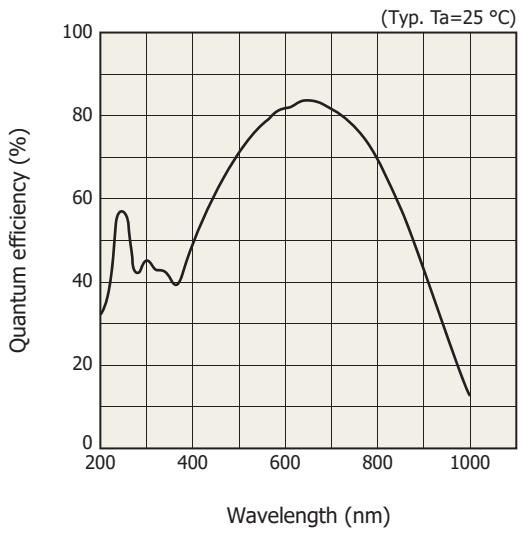
- High sensitivity in UV to visible range
- Low noise



APPLICATIONS

- Low-light-level measurement
- Analytical instrument

Spectral response



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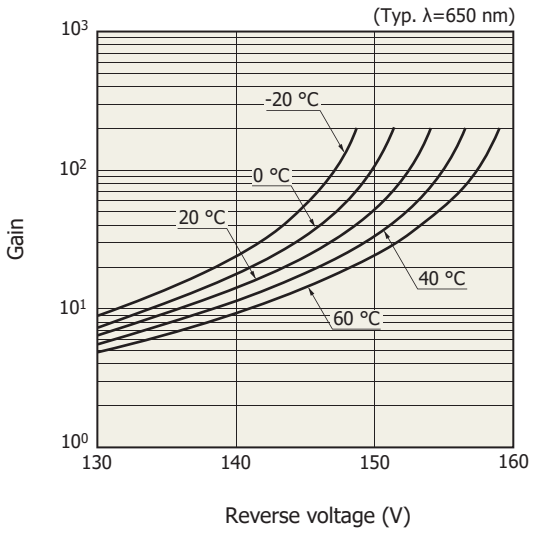
Gain vs. reverse voltage



KAPDB0011EC

Structure

Parameter	S12053-02	S12053-05	S12053-10	Unit
Photosensitive area size	ϕ0.2	ϕ0.5	ϕ1.0	mm
Package	TO-8			-
Window material	UV glass			-

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

Parameter	S12053-02	S12053-05	S12053-10	Unit
Spectral response range	200 to 1000			nm
Peak sensitivity wavelength	620			nm
Breakdown voltage*1	150			V
Temp. coefficient of breakdown voltage	0.14			V/°C
Dark current	0.2			nA
Terminal capacitance	2	5	15	pF
Cutoff frequency*2	900	400	250	MHz
Gain*3	50			-

*1: I_D=100 µA *2: R_L=50 Ω *3: λ=650 nm

CCD area image sensors

High UV Resistance

S10420-1106NU-01, S10420-1106NW-01

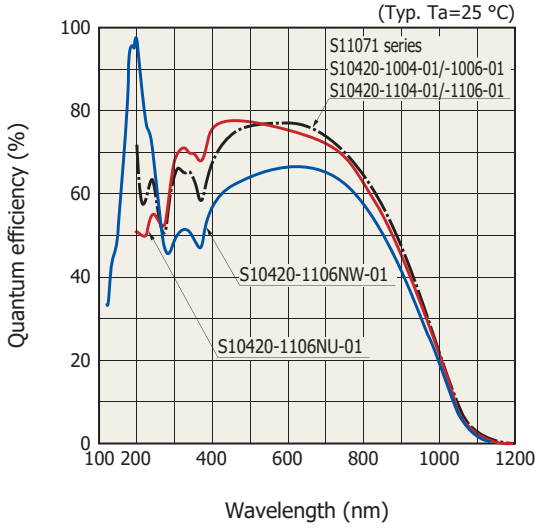
FEATURES

- Improved etaloning characteristics
- High UV resistance
- With anti-blooming function

APPLICATIONS

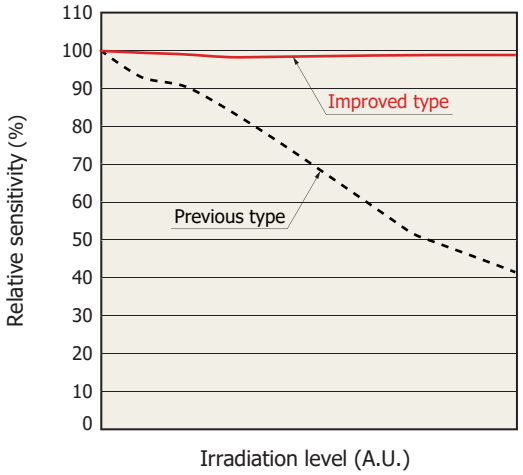
- Spectrometers

Spectral response



KMPDB0578EB

Variation in sensitivity due to UV exposure



* The graph is plotted as 100% at the average spectral response (λ=200 to 400 nm) before irradiation.

KMPDB0610EA

Structure

Parameter	Specification	Unit
Pixel size	14 × 14	mm
Number of eff effective pixels	2048 × 64	-
Package	24-pin ceramic DIP	-
Window material	Quartz glass	-

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

Parameter		S10420-1106NU-01	S10420-1106NW-01	Unit
Spectral response range		200 to 1100	120 to 1100	nm
Full well capacity	Vertical	60		ke⁻
	Horizontal	300		
Conversion efficiency		6.5		μV/e⁻
Dark current		50		e⁻/pixel/s
Readout noise*1		6		e⁻ rms
Dynamic range*2		50000		-
Photoresponse nonuniformity*3		±3		%

*1: Ta=-40 °C, operating 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: 660 nm)

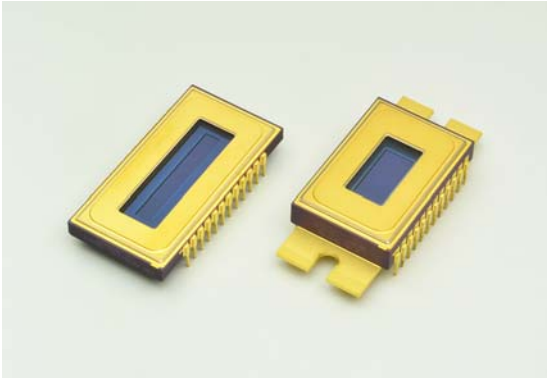
CCD area image sensors

S7030/S7031 series

High UV Resistance

FEATURES

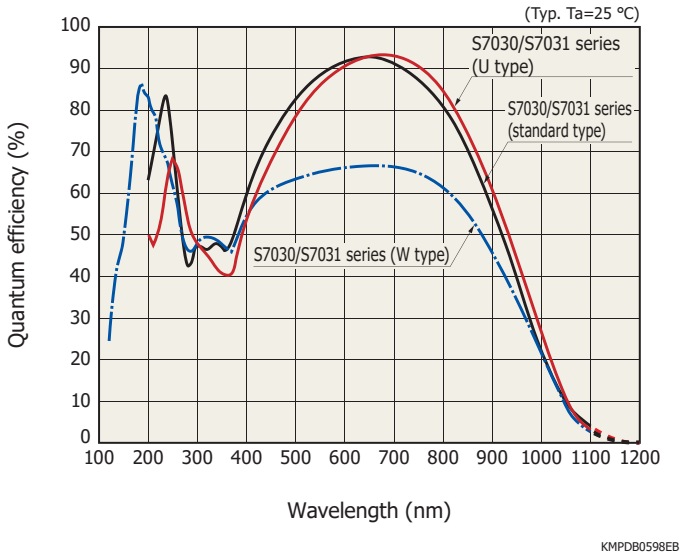
- Non-cooled type (S7030 series), One-stage TE-cooled type (S7031 series)
- Line / PIxel binning
- High UV resistance: U type, W type



APPLICATIONS

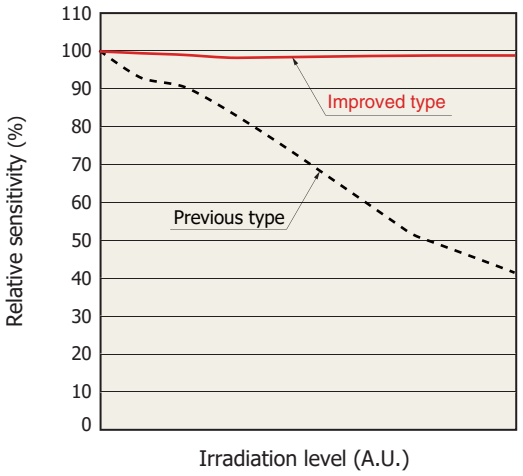
- Fluorescence spectrometer, ICP
- Spectrometers

Spectral response



KMPDB0598EB

Variation in sensitivity due to UV exposure



* The graph is plotted as 100% at the average spectral response (λ=200 to 400 nm) before irradiation.

KMPDB0610EA

Structure

Parameter	S7030-1006U/W	S7030-1007U/W	S7031-1006SU/SW	S7031-1007SU/SW	Unit
Pixel size	24.5 × 1.3	24.5 × 2.9	24.5 × 1.3	24.5 × 2.9	mm
Number of effective pixels	1024 × 58	1024 × 122	1024 × 58	1024 × 122	-
Package	24-pin ceramic DIP				-
Window material	Quartz glass		AR-coated sapphire		-

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

Parameter		U type	W type	Unit
Spectral response range		200 to 1100	120 to 1100	nm
Full well capacity*1	Vertical	320		ke⁻
	Horizontal	1000		
Conversion efficiency		2.2		μV/e⁻
Dark current		50		e⁻/pixel/s
Readout noise*2		8		e⁻ rms
Dynamic range*3	Line binning	125000		-
	Area scanning	4000		
Photoresponse nonuniformity*4		±3		%

*1: The linearity is ±1.5%. *2: Ta=-40 °C, operating frequency: 150 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: 660 nm)

CMOS linear image sensor

High UV Sensitivity

S11639-01

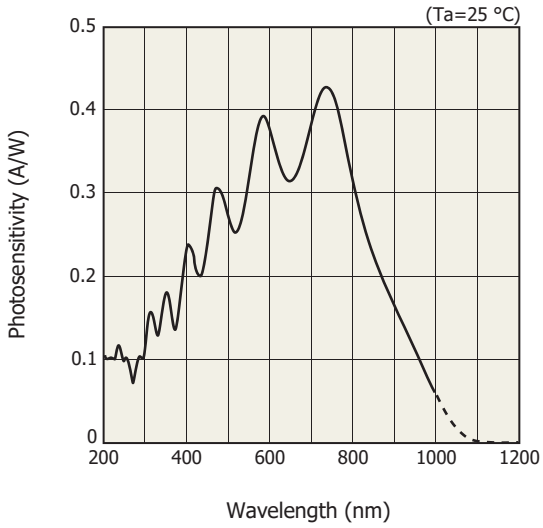
FEATURES

- Simultaneous charge integration for all pixels
- 5 V single power supply operation
- Built-in timing generator allows operation with only start and clock pulse inputs

APPLICATIONS

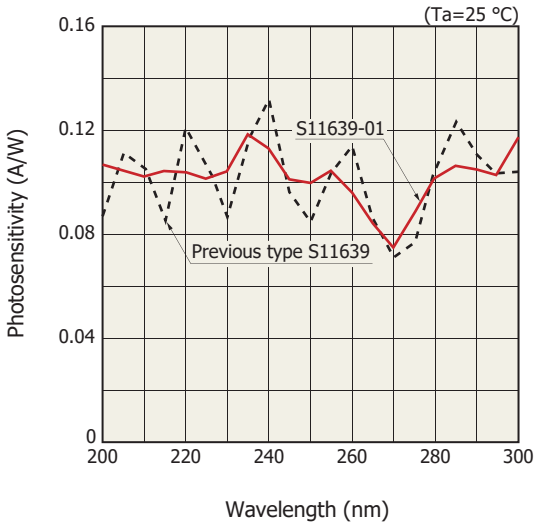
- Spectrometers
- Position detection

Spectral response (typical example)



KMPDB0467EB

Spectral response in UV region (typical example)



KMPDB0449EB

Structure

Parameter	Specification	Unit
Pixel height	200	µm
Pixel pitch	14	µm
Number of effective pixels	2048	-
Package	LCP (liquid crystal polymer)	-
Window material	Quartz glass	-

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

Parameter	Specification	Unit
Spectral response range	200 to 1000	nm
Saturation output voltage*1	2.0	V
Conversion efficiency	25	µV/e⁻
Dark output voltage*2	0.2	mV
Readout noise	0.4	mV rms
Dynamic range*3	5000	-
Photoresponse nonuniformity*4	±2	%

*1: Difference from output offset voltage *2: Integration time=10 ms *3: Dynamic range = Saturation output voltage / Readout noise
*4: Measured at one-half of the saturation output

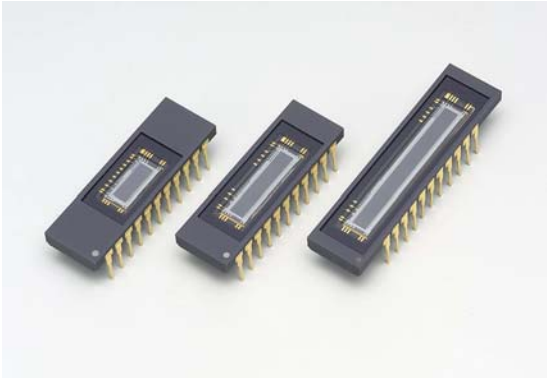
CMOS linear image sensors

High UV Sensitivity

S10121 to S10124 series

FEATURES

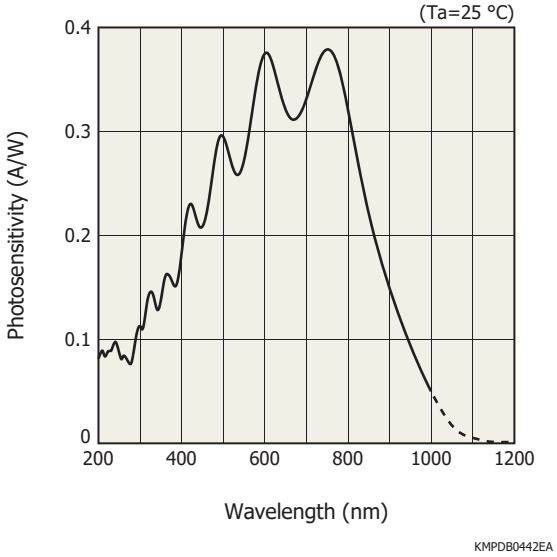
- Smoothly varying spectral response characteristics in UV region
- Variable integration time for each pixel
- Large saturation output charge



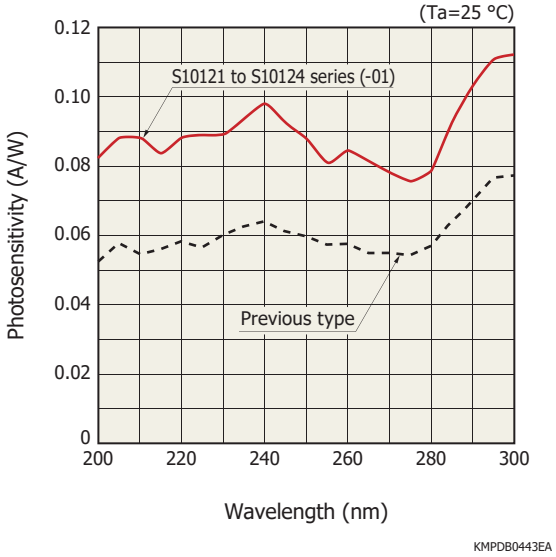
APPLICATIONS

- Spectrophotometry

Spectral response (typical example)



Spectral response in UV region (typical example)



Structure

Parameter	S10121 series	S10122 series	S10123 series	S10124 series	Unit
Pixel height	2.5	0.5	0.5	2.5	mm
Pixel pitch	50	50	25	25	µm
Number of effective pixels	128 / 256 / 512		256 / 512 / 1024		-
Package	Ceramic				-
Window material	Quartz glass				-

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

Parameter	S10121 series	S10122 series	S10123 series	S10124 series	Unit
Spectral response range	200 to 1000				nm
Saturation output charge	165	32	14	75	pC
Dark current	0.1	0.02	0.02	0.1	pA
Photo response non-uniformity (max.)*	±3				%

* Measured at one-half of the saturation output

Mini-spectrometers

C9404CA, C9404CAH

High UV Sensitivity

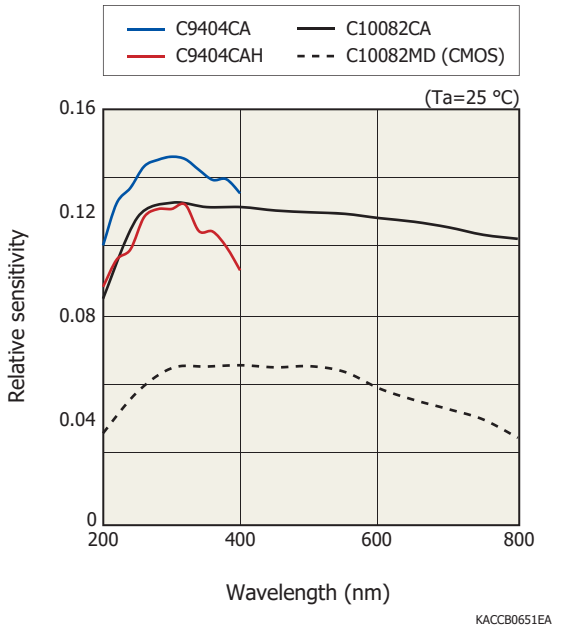
FEATURES

- High resolution 1 nm (C9404CAH)
- Integrated with back-thinned type CCD image sensor:
  Sensitivity is about two orders of magnitude higher than CMOS types.
- High throughput due to transmission grating made of quartz

APPLICATIONS

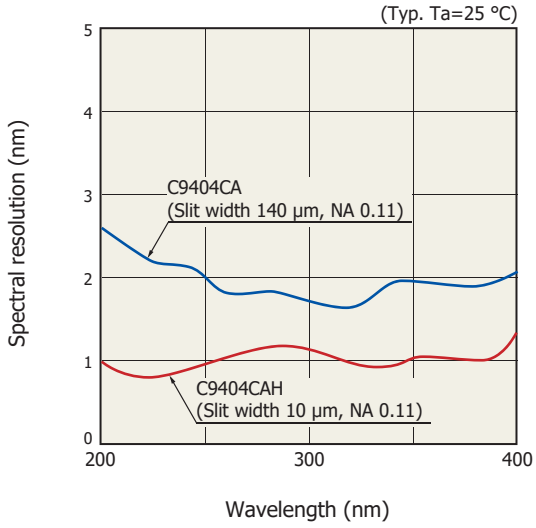
- Low-light-level measurement such as fluorescence measurement
- Moisture measurement
- Liquid chromatography

Spectral response in UV region (typical example)



KACCB0651EA

Spectral resolution vs. wavelength



KACCB0160EC

Structure

Parameter	Specification	Unit
Number of pixels	1024	-
Dimensions (W × D × H)	125.7 × 115.7 × 75	mm
Weight	670	g
Interface	USB 1.1	-
External power supply	5	V
Image sensor	Back-thinned type CCD image sensor (S10420-1006-01)	-

Optical characteristics

Parameter	C9404CA	C9404CAH	Unit
Spectral response range	200 to 400		nm
Spectral resolution (FWHM)	3 max.	1 typ.	nm
Wavelength reproducibility	-0.1 to +0.1		nm
Wavelength temperature dependence	-0.02 to +0.02		nm/°C

HAMAMATSU

www.hamamatsu.com

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, N.J. 08807, U.S.A., Telephone: (1)908-231-0960, Fax: (1)908-231-1218, E-mail: usa@hamamatsu.com
Germany: Hamamatsu Photonics Deutschland GmbH: Arzbergerstr. 10, D-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, United Kingdom, 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, 20020 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.: B1201, Jiaming Center, No.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, Section2, Gongdao 5th Road, East District, Hsinchu, 300, Taiwan R.O.C. Telephone: (886)3-659-0080, Fax: (886)3-659-0081, E-mail: info@hamamatsu.com.tw

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