

# CCD image sensors



S11071/S10420-01 series

## Improved etaloning characteristics, High-speed type and low noise type available

The S11071/S10420-01 series are back-thinned CCD image sensors designed for spectrometers. Two types consisting of a high-speed type (S11071 series) and low noise type (S10420-01 series) are available with improved etaloning characteristics. The S11071/S10420-01 series offer nearly flat spectral response characteristics with high quantum efficiency from the UV to near infrared region.

### Features

- Improved etaloning characteristics
- High sensitivity over a wide spectral range and nearly flat spectral response characteristics
- High CCD node sensitivity: 8  $\mu\text{V}/\text{e}^-$  (S11071 series)  
6.5  $\mu\text{V}/\text{e}^-$  (S10420-01 series)
- High full well capacity and wide dynamic range (with anti-blooming function)
- Pixel size: 14  $\times$  14  $\mu\text{m}$
- High UV resistance: S10420-1106NU-01/-1106NW-01

### Applications

- Spectrometers, etc.

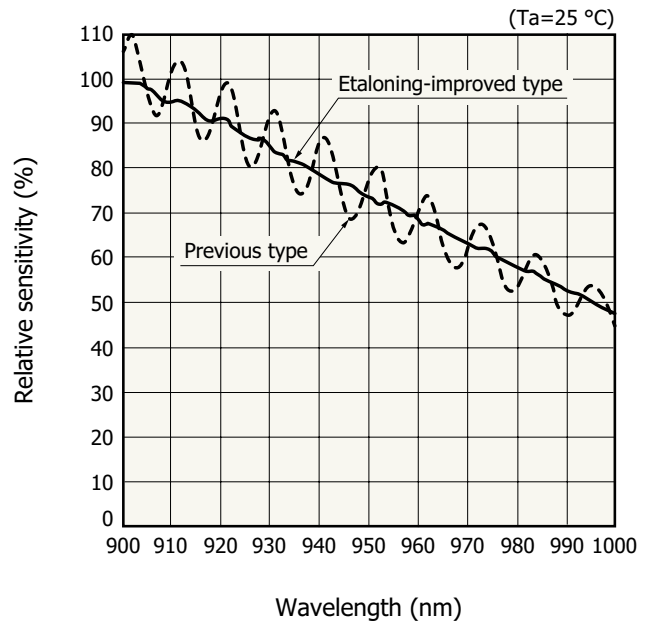
### Selection guide

Type no.	Number of total pixels	Number of effective pixels	Image size [mm (H) $\times$ mm (V)]	Readout speed max. (MHz)	Suitable driver circuit
S11071-1004	1044 $\times$ 22	1024 $\times$ 16	14.336 $\times$ 0.224	10	C11288-01
S11071-1006	1044 $\times$ 70	1024 $\times$ 64	14.336 $\times$ 0.896		
S11071-1104	2068 $\times$ 22	2048 $\times$ 16	28.672 $\times$ 0.224		
S11071-1106	2068 $\times$ 70	2048 $\times$ 64	28.672 $\times$ 0.896		
S10420-1004-01	1044 $\times$ 22	1024 $\times$ 16	14.336 $\times$ 0.224	0.5	C11287-01
S10420-1006-01	1044 $\times$ 70	1024 $\times$ 64	14.336 $\times$ 0.896		
S10420-1104-01	2068 $\times$ 22	2048 $\times$ 16	28.672 $\times$ 0.224		
S10420-1106-01	2068 $\times$ 70	2048 $\times$ 64	28.672 $\times$ 0.896		
S10420-1106NU-01					
S10420-1106NW-01					

**Improved etaloning characteristics**

Etaloning is an interference phenomenon that occurs when the light incident on a CCD repeatedly reflects between the front and back surfaces of the CCD while being attenuated, and causes alternately high and low sensitivity. When long-wavelength light enters a back-thinned CCD, etaloning occurs due to the relationship between the silicon substrate thickness and the absorption length. The S11071/S10420-01 series back-thinned CCDs have achieved a significant improvement in etaloning by using a unique structure that is unlikely to cause interference.

▣ **Etaloning characteristics (typical example)**



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▣ **Structure**

Parameter	S11071 series	S10420 series	
		-1004-01/-1006-01 -1104-01/-1106-01	-1106NU-01 -1106NW-01
Pixel size (H × V)	14 × 14 μm		
Vertical clock phase	2-phase		
Horizontal clock phase	4-phase		
Output circuit	Two-stage MOSFET source follower	One-stage MOSFET source follower	
Package	24-pin ceramic DIP (refer to dimensional outline)		
Window material	Quartz glass (resin sealing)*1		None*2
Cooling	Non-cooled		

\*1: Temporary window type (ex: S11071-1106N, S10420-1106N-01) is available upon request.

\*2: Temporary window (borosilicate glass)

➤ Absolute maximum ratings (Ta=25 °C)

Parameter	Symbol	Min.	Typ.	Max.	Unit
Operating temperature*3	Topr	-50	-	+50	°C
Storage temperature	Tstg	-50	-	+70	°C
Output transistor drain voltage	S11071 series	-0.5	-	+25	V
	S10420-01 series	-0.5	-	+30	
Reset drain voltage	VRD	-0.5	-	+18	V
Output amplifier return voltage	Vret	-0.5	-	+18	V
Overflow drain voltage	VOFD	-0.5	-	+18	V
Vertical input source voltage	VISV	-0.5	-	+18	V
Horizontal input source voltage	VISH	-0.5	-	+18	V
Overflow gate voltage	VOFG	-10	-	+15	V
Vertical input gate voltage	VIG1V, VIG2V	-10	-	+15	V
Horizontal input gate voltage	VIG1H, VIG2H	-10	-	+15	V
Summing gate voltage	VSG	-10	-	+15	V
Output gate voltage	VOG	-10	-	+15	V
Reset gate voltage	VRG	-10	-	+15	V
Transfer gate voltage	VTG	-10	-	+15	V
Vertical shift register clock voltage	VP1V, VP2V	-10	-	+15	V
Horizontal shift register clock voltage	VP1H, VP2H VP3H, VP4H	-10	-	+15	V

\*3: Package temperature

Note: Exceeding the absolute maximum ratings even momentarily may cause a drop in product quality. Always be sure to use the product within the absolute maximum ratings.

➤ Operating conditions (MPP mode, Ta=25 °C)

Parameter	Symbol	S11071 series			S10420-01 series			Unit	
		Min.	Typ.	Max.	Min.	Typ.	Max.		
Output transistor drain voltage	VOD	12	15	18	23	24	25	V	
Reset drain voltage	VRD	14	15	16	11	12	13	V	
Overflow drain voltage	VOFD	11	12	13	11	12	13	V	
Overflow gate voltage	VOFG	0	13	14	0	12	13	V	
Output gate voltage	VOG	4	5	6	4	5	6	V	
Substrate voltage	VSS	-	0	-	-	0	-	V	
Output amplifier return voltage*4	Vret	-	1	2	-	-	-	V	
Test point	Input source	VISV, VISH	-	VRD	-	-	-	V	
	Vertical input gate	VIG1V, VIG2V	-9	-8	-	-9	-8	-	V
	Horizontal input gate	VIG1H, VIG2H	-9	-8	-	-9	-8	-	V
Vertical shift register clock voltage	High	VP1VH, VP2VH	4	6	8	4	6	8	V
	Low	VP1VL, VP2VL	-9	-8	-7	-9	-8	-7	
Horizontal shift register clock voltage	High	VP1HH, VP2HH VP3HH, VP4HH	4	6	8	4	6	8	V
	Low	VP1HL, VP2HL VP3HL, VP4HL	-6	-5	-4	-6	-5	-4	
Summing gate voltage	High	VSGH	4	6	8	4	6	8	V
	Low	VSGL	-6	-5	-4	-6	-5	-4	
Reset gate voltage	High	VRGH	4	6	8	4	6	8	V
	Low	VRGL	-6	-5	-4	-6	-5	-4	
Transfer gate voltage	High	VTGH	4	6	8	4	6	8	V
	Low	VTGL	-9	-8	-7	-9	-8	-7	
External load resistance	RL	2.0	2.2	2.4	90	100	110	kΩ	

\*4: Output amplifier return voltage is a positive voltage with respect to Substrate voltage, but the current flows in the direction of flow out of the sensor.

Electrical characteristics (Ta=25 °C)

Parameter	Symbol	S11071 series			S10420-01 series			Unit	
		Min.	Typ.	Max.	Min.	Typ.	Max.		
Signal output frequency*5	fc	-	5	10	-	0.25	0.5	MHz	
Vertical shift register capacitance	-1004(-01)	CP1V, CP2V	-	200	-	-	200	-	pF
	-1006(-01)		-	600	-	-	600	-	
	-1104(-01)		-	400	-	-	400	-	
	-1106(-01)		-	1200	-	-	1200	-	
Horizontal shift register capacitance	-1004(-01)/-1006(-01)	CP1H, CP2H	-	80	-	-	80	-	pF
	-1104(-01)/-1106(-01)	CP3H, CP4H	-	160	-	-	160	-	
Summing gate capacitance	CSG	-	10	-	-	10	-	pF	
Reset gate capacitance	CRG	-	10	-	-	10	-	pF	
Transfer gate capacitance	-1004(-01)/-1006(-01)	CTG	-	30	-	-	30	-	pF
	-1104(-01)/-1106(-01)		-	60	-	-	60	-	
Charge transfer efficiency*6	CTE	0.99995	0.99999	-	0.99995	0.99999	-	-	
DC output level*5	Vout	7	8	9	16	17	18	V	
Output impedance*5	Zo	-	0.3	-	-	10	-	kΩ	
Power consumption*5 *7	P	-	75	-	-	4	-	mW	

\*5: The values depend on the load resistance. (S11071 series: VOD=15 V, RL=2.2 kΩ, S10420-01 series: VOD=24 V, RL=100 kΩ)

\*6: Charge transfer efficiency per pixel, measured at half of the full well capacity

\*7: Power consumption of the on-chip amplifier plus load resistance

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

Parameter	Symbol	S11071 series			S10420-01 series			Unit	
		Min.	Typ.	Max.	Min.	Typ.	Max.		
Saturation output voltage	Vsat	-	Fw × CE	-	-	Fw × CE	-	V	
Full well capacity	Vertical	Fw	50	60	-	50	60	-	ke <sup>-</sup>
	Horizontal		150	200	-	250	300	-	
Conversion efficiency*8	CE	7	8	9	5.5	6.5	7.5	μV/e <sup>-</sup>	
Dark current*9	DS	-	50	500	-	50	500	e <sup>-</sup> /pixel/s	
Readout noise*10	Nread	-	23	28	-	6	15	e <sup>-</sup> rms	
Dynamic range*11	Drange	5350	8700	-	16600	50000	-	-	
Spectral response range	λ	200 to 1100			200 to 1100 120 to 1100 (S10420-1106NW-01)			nm	
Photoresponse nonuniformity*12	PRNU	-	±3	±10	-	±3	±10	%	

\*8: The values depend on the load resistance. (S11071 series: VOD=15 V, RL=2.2 kΩ, S10420-01 series: VOD=24 V, RL=100 kΩ)

\*9: Dark current is reduced to half for every 5 to 7 °C decrease in temperature.

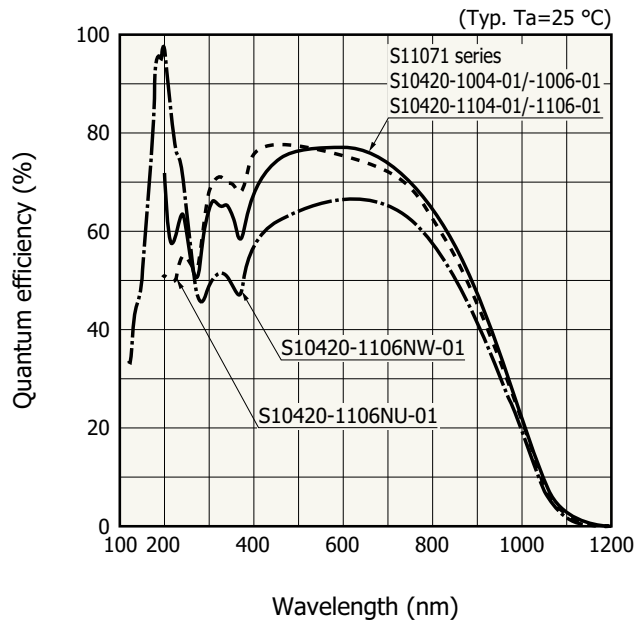
\*10: S11071 series (temperature: 25 °C): fc=2 MHz, S10420-01 series (temperature: -40 °C): fc=20 kHz

\*11: Dynamic range = Full well capacity / Readout noise

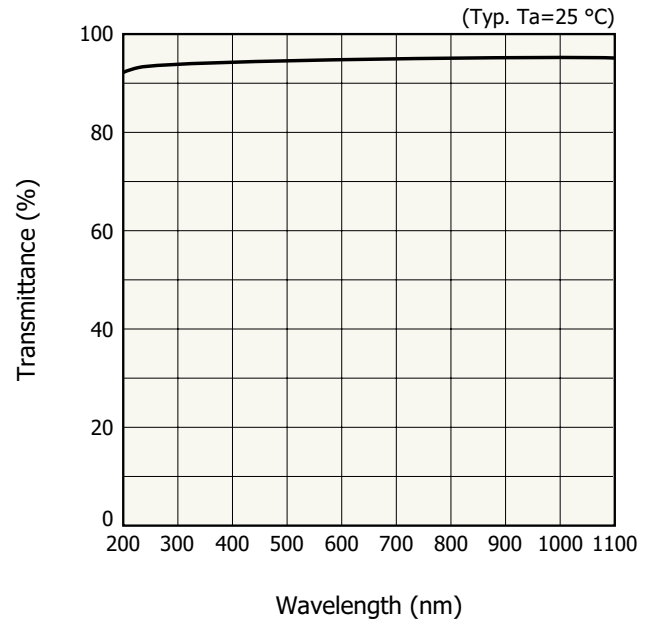
\*12: Measured at one-half of the saturation output (full well capacity) using LED light (peak emission wavelength: 660 nm)

$$\text{Photoresponse nonuniformity} = \frac{\text{Fixed pattern noise (peak to peak)}}{\text{Signal}} \times 100 \text{ [%]}$$

▣ Spectral response (typical example, without window)<sup>\*13</sup>

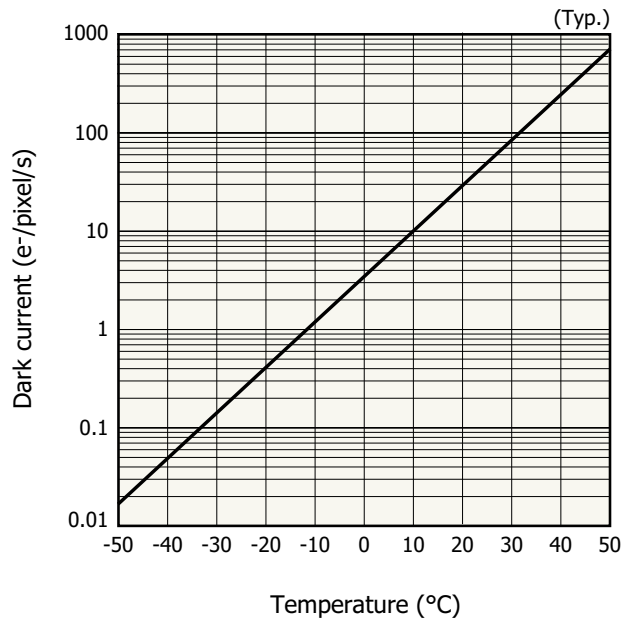


▣ Spectral transmittance characteristic of window material



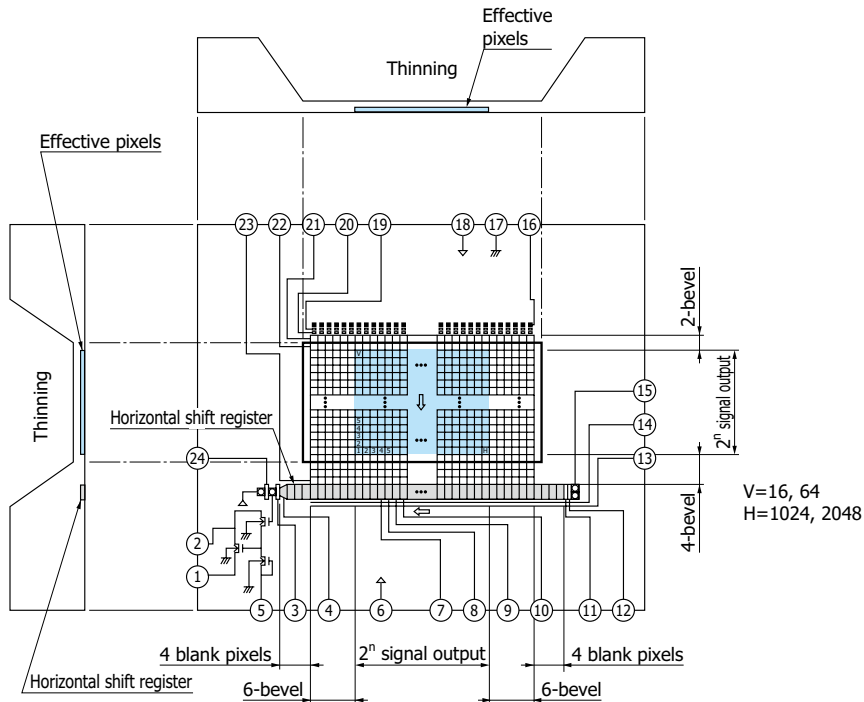
\*13: Spectral response with quartz glass is decreased according to the spectral transmittance characteristic of window material.

▣ Dark current vs. temperature



Device structure (conceptual drawing of top view in dimensional outline)

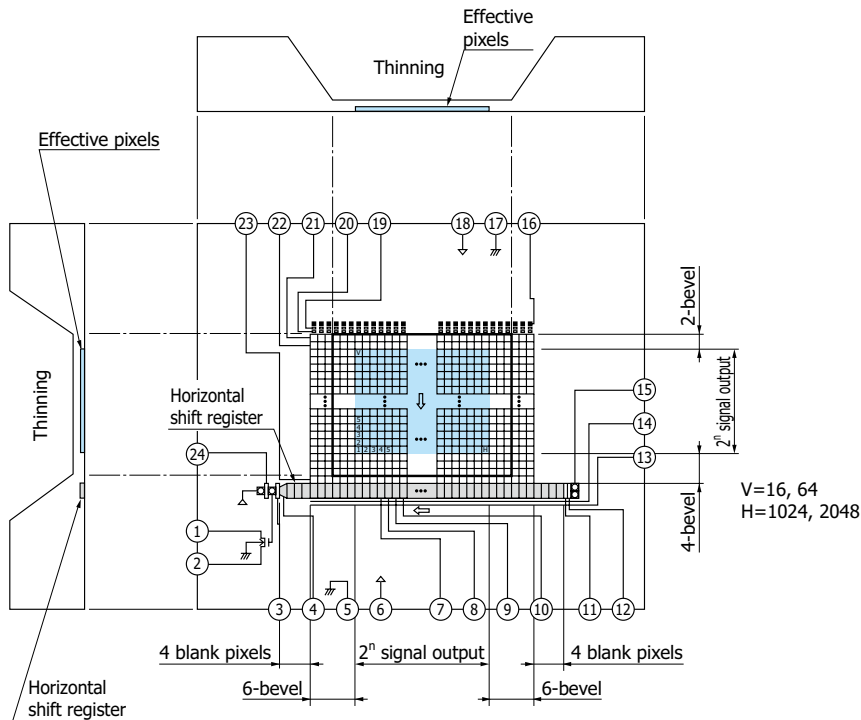
S11071 series



Note: When viewed from the light input side, the horizontal shift register is covered by the thick area of the silicon (insensitive area), but long-wavelength light may pass through the insensitive silicon area. This light may be received by the horizontal shift register. Take measures such as shielding the light.

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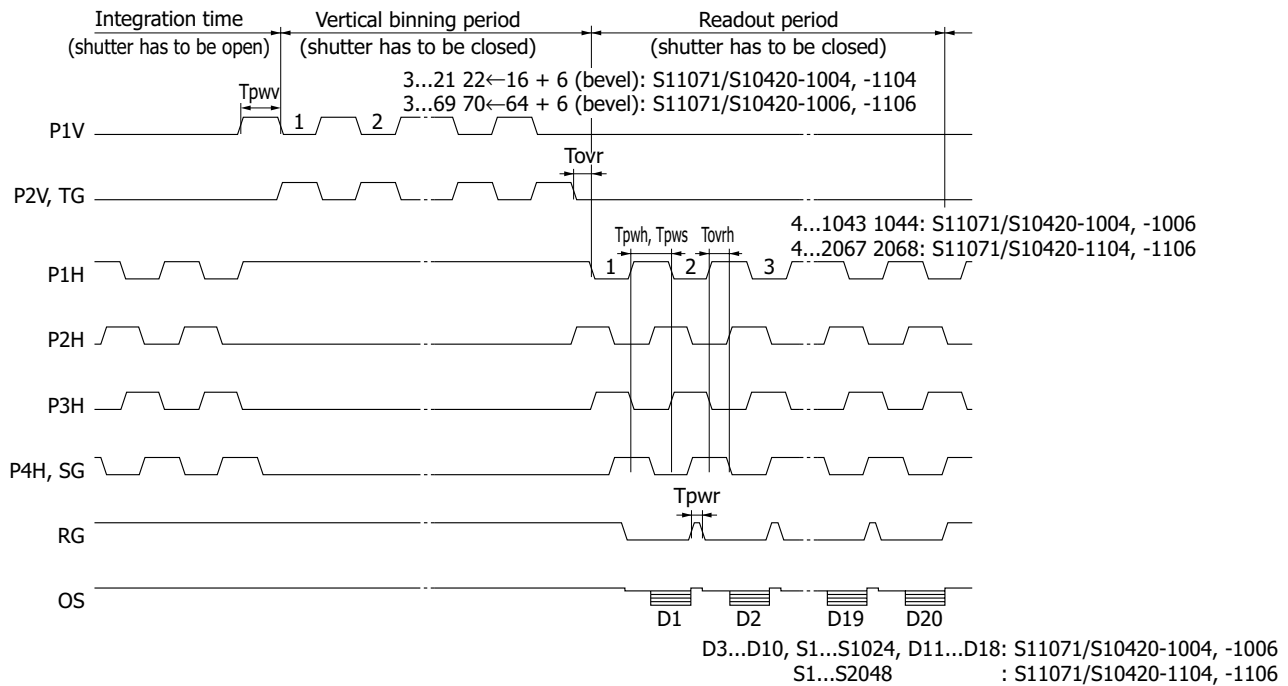
S10420-01 series



Note: When viewed from the light input side, the horizontal shift register is covered by the thick area of the silicon (insensitive area), but long-wavelength light may pass through the insensitive silicon area. This light may be received by the horizontal shift register. Take measures such as shielding the light.

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Timing chart (line binning)



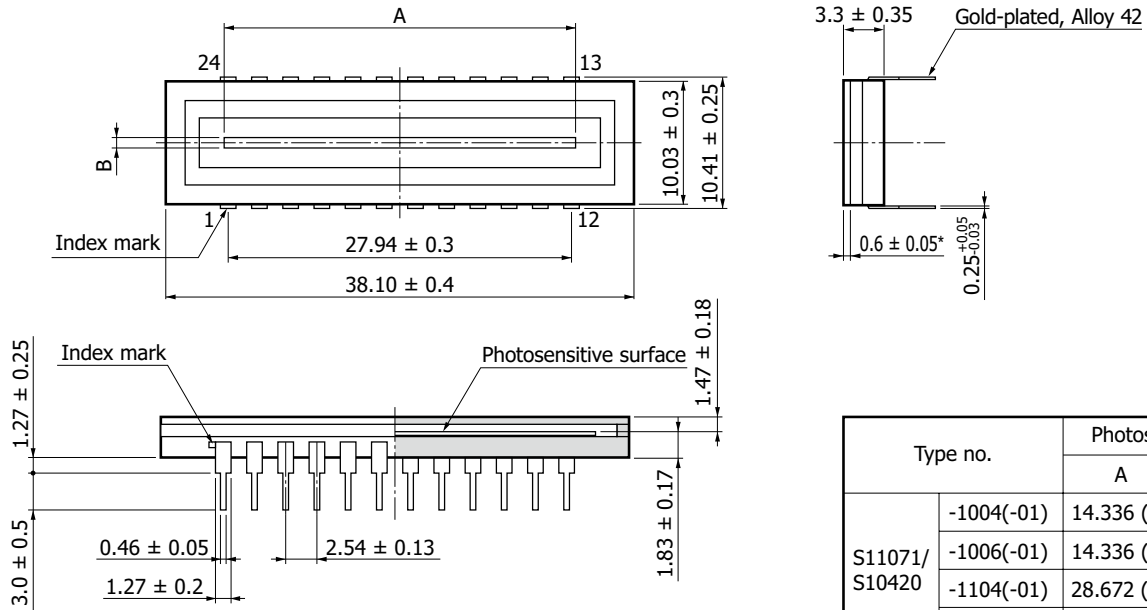
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Parameter		Symbol	S11071 series			S10420-01 series			Unit
			Min.	Typ.	Max.	Min.	Typ.	Max.	
P1V, P2V, TG	Pulse width <sup>*14</sup>	$T_{pww}$	1	8	-	6	8	-	$\mu s$
	Rise and fall times <sup>*14</sup>	$T_{prv}, T_{pfv}$	20	-	-	20	-	-	ns
P1H, P2H, P3H, P4H	Pulse width <sup>*14</sup>	$T_{pwh}$	50	100	-	1000	2000	-	ns
	Rise and fall times <sup>*14</sup>	$T_{prh}, T_{pvh}$	10	-	-	10	-	-	ns
	Pulse overlap time	$T_{ovrh}$	25	50	-	500	1000	-	ns
	Duty ratio <sup>*14</sup>	-	40	50	60	40	50	60	%
SG	Pulse width <sup>*14</sup>	$T_{pws}$	50	100	-	1000	2000	-	ns
	Rise and fall times <sup>*14</sup>	$T_{prs}, T_{pfs}$	10	-	-	10	-	-	ns
	Pulse overlap time	$T_{ovrh}$	25	50	-	500	1000	-	ns
	Duty ratio <sup>*14</sup>	-	40	50	60	40	50	60	%
RG	Pulse width	$T_{pwr}$	5	50	-	100	1000	-	ns
	Rise and fall times	$T_{pr}, T_{pr}$	5	-	-	5	-	-	ns
TG-P1H	Overlap time	$T_{ovr}$	1	2	-	1	2	-	$\mu s$

\*14: Symmetrical clock pulses should be overlapped at 50% of maximum pulse amplitude.

Dimensional outline (unit: mm)

S11071 series, S10420-1004-01/-1006-01/-1104-01/-1106-01

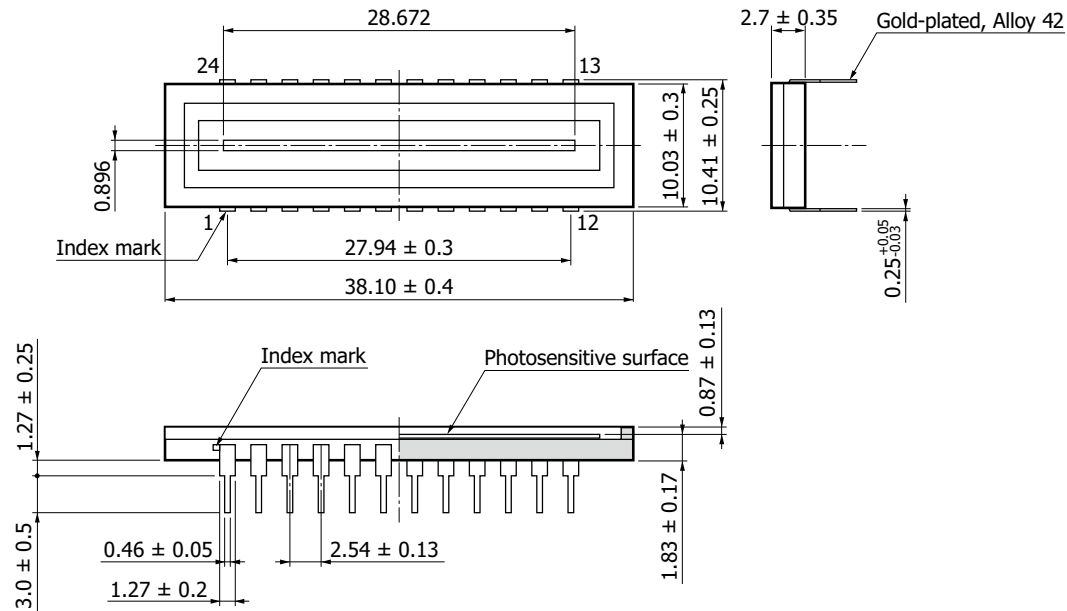


Type no.	Photosensitive area	
	A	B
S11071/ S10420	-1004(-01)	14.336 (H) 0.224 (V)
	-1006(-01)	14.336 (H) 0.896 (V)
	-1104(-01)	28.672 (H) 0.224 (V)
	-1106(-01)	28.672 (H) 0.896 (V)

\* Glass thickness (refractive index≈1.5)

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S10420-1106NU-01/-1106NW-01



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Pin connections

S11071 series			
Pin no.	Symbol	Function	Remark (standard operation)
1	OS	Output transistor source	RL=2.2 kΩ
2	OD	Output transistor drain	+15 V
3	OG	Output gate	+5 V
4	SG	Summing gate	Same pulse as P4H
5	Vret	Output amplifier return	+1 V
6	RD	Reset drain	+15 V
7	P4H	CCD horizontal register clock-4	
8	P3H	CCD horizontal register clock-3	
9	P2H	CCD horizontal register clock-2	
10	P1H	CCD horizontal register clock-1	
11	IG2H	Test point (horizontal input gate-2)	-8 V
12	IG1H	Test point (horizontal input gate-1)	-8 V
13	OFG	Over flow gate	+13 V
14	OFD	Over flow drain	+12 V
15	ISH	Test point (horizontal input source)	Connect to RD
16	ISV	Test point (vertical input source)	Connect to RD
17	SS	Substrate	GND
18	RD	Reset drain	+15 V
19	IG2V	Test point (vertical input gate-2)	-8 V
20	IG1V	Test point (vertical input gate-1)	-8 V
21	P2V	CCD vertical register clock-2	
22	P1V	CCD vertical register clock-1	
23	TG	Transfer gate	Same pulse as P2V
24	RG	Reset gate	

S10420-01 series			
Pin no.	Symbol	Function	Remark (standard operation)
1	OS	Output transistor source	RL=100 kΩ
2	OD	Output transistor drain	+24 V
3	OG	Output gate	+5 V
4	SG	Summing gate	Same pulse as P4H
5	SS	Substrate	GND
6	RD	Reset drain	+12 V
7	P4H	CCD horizontal register clock-4	
8	P3H	CCD horizontal register clock-3	
9	P2H	CCD horizontal register clock-2	
10	P1H	CCD horizontal register clock-1	
11	IG2H	Test point (horizontal input gate-2)	-8 V
12	IG1H	Test point (horizontal input gate-1)	-8 V
13	OFG	Over flow gate	+12 V
14	OFD	Over flow drain	+12 V
15	ISH	Test point (horizontal input source)	Connect to RD
16	ISV	Test point (vertical input source)	Connect to RD
17	SS	Substrate	GND
18	RD	Reset drain	+12 V
19	IG2V	Test point (vertical input gate-2)	-8 V
20	IG1V	Test point (vertical input gate-1)	-8 V
21	P2V	CCD vertical register clock-2	
22	P1V	CCD vertical register clock-1	
23	TG	Transfer gate	Same pulse as P2V
24	RG	Reset gate	

### ⚠ Precautions (electrostatic countermeasures)

#### ■ Electrostatic countermeasures

- Handle these sensors with bare hands or wearing cotton gloves. In addition, wear anti-static clothing or use a wrist band with an earth ring, in order to prevent electrostatic damage due to electrical charges from friction.
- Avoid directly placing these sensors on a work-desk or work-bench that may carry an electrostatic charge.
- Provide ground lines or ground connection with the work-floor, work-desk and work-bench to allow static electricity to discharge.
- Ground the tools used to handle these sensors, such as tweezers and soldering irons.

It is not always necessary to provide all the electrostatic measures stated above. Implement these measures according to the amount of damage that occurs.

#### ■ Handling the temporary window type (S10420-1106NU-01/-1106NW-01)

- Never touch or wipe the photosensitive surface. It will adversely affect the characteristics.

### ⚠ Related information

[www.hamamatsu.com/sp/ssd/doc\\_en.html](http://www.hamamatsu.com/sp/ssd/doc_en.html)

#### ■ Precautions

- Disclaimer
- Image sensors
- Unsealed products

#### ■ Technical information

- FFT-CCD area image sensor

### Driver circuits for CCD image sensor C11287-01/C11288-01 [sold separately]

The C11287-01, C11288-01 are driver circuits designed for HAMAMATSU CCD image sensors. The C11287-01 is for S10420-01 series, S16010 series and S14650 series. The C11288-01 is for S11071 series and S14660 series. The C11287-01, C11288-01 can be used in spectrometers, etc. when combined with the CCD image sensor.

### ⚠ Features

- **Built-in 16-bit A/D converter**
- **Interface to computer: USB 2.0**
- **Power supply: USB bus power operation (C11287-01)  
DC+5 V operation (C11288-01)**



C11287-01/C11288-01

Information described in this material is current as of February 2023.

Product specifications are subject to change without prior notice due to improvements or other reasons. This document has been carefully prepared and the information contained is believed to be accurate. In rare cases, however, there may be inaccuracies such as text errors. Before using these products, always contact us for the delivery specification sheet to check the latest specifications.

The product warranty is valid for one year after delivery and is limited to product repair or replacement for defects discovered and reported to us within that one year period. However, even if within the warranty period we accept absolutely no liability for any loss caused by natural disasters or improper product use. Copying or reprinting the contents described in this material in whole or in part is prohibited without our prior permission.

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