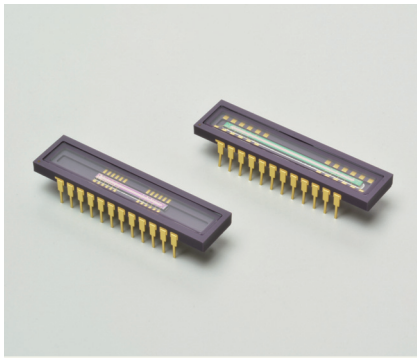


# CCD linear image sensors



S12551 series

**Pixel size: 14 × 14 μm, front-illuminated type, high-speed response and high sensitivity**

The S12551 series is a front-illuminated type CCD linear image sensor with high-speed line rate designed for applications such as sorting machine.

## Features

- Pixel size: 14 × 14 μm
- High CCD node sensitivity: 13 μV/e<sup>-</sup> typ.
- Readout speed: 40 MHz max.
- Anti-blooming function
- Built-in electronic shutter

## Applications

- Foreign object screening
- High-speed imaging

## Structure

Parameter	S12551-1024	S12551-2048
Pixel size (H × V)	14 × 14 μm	
Number of pixels	1044	2068
Number of effective pixels	1024	2048
Image size (H × V)	14.336 × 0.014 mm	28.672 × 0.014 mm
Horizontal clock phase	Two-phase	
Output circuit	Three-stage MOSFET source follower	
Package	24-pin ceramic DIP (refer to dimensional outline)	
Window material	Quartz glass*1	

\*1: Resin sealing

## Absolute maximum ratings (Ta=25 °C, unless otherwise noted)

Parameter	Symbol	Condition	Value	Unit
Operating temperature	Topr	Package temperature No dew condensation*2	-50 to +60	°C
Storage temperature	Tstg	No dew condensation*2	-50 to +70	°C
Output transistor drain voltage	VOD		-0.5 to +20	V
Reset drain voltage	VRD		-0.5 to +18	V
Anti-blooming drain voltage	VABD		-0.5 to +18	V
Horizontal input source voltage	VISH		-0.5 to +18	V
Anti-blooming gate voltage	VABG		-10 to +15	V
Horizontal input gate voltage	VIGH		-10 to +15	V
Summing gate voltage	VSG		-10 to +15	V
Output gate voltage	VOG		-10 to +15	V
Reset gate voltage	VRG		-10 to +15	V
Transfer gate voltage	VTG		-10 to +15	V
Horizontal shift register clock voltage	VP1H, VP2H		-10 to +15	V

\*2: When there is a temperature difference between a product and the surrounding area in high humidity environment, dew condensation may occur on the product surface. Dew condensation on the product may cause deterioration in characteristics and reliability.

Note: During high-speed operation, the temperature of the sensor increases. Take heat dissipation measures as required to prevent exceeding the absolute maximum ratings.

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

▣ Operating conditions (Ta=25 °C)

Parameter		Symbol	Min.	Typ.	Max.	Unit
Output transistor drain voltage		VOD	14	15	16	V
Reset drain voltage		VRD	13	14	15	V
Anti-blooming drain voltage		VABD	13	14	15	V
Test point	Horizontal input source voltage	VISH	-	VRD	-	V
	Horizontal input gate voltage	VIGH	-5	-4	-	
Anti-blooming gate voltage	High	VABGH	2	5	8	V
	Low	VABGL	-4	-2	0	
Summing gate voltage	High	VSGH	2	5	8	V
	Low	VSGL	-5	-4	-3	
Output gate voltage		VOG	3	5	7	V
Substrate voltage		VSS	-	0	-	V
Reset gate voltage	High	VRGH	8	9	10	V
	Low	VRGL	-1	0	1	
Transfer gate voltage	High	VTGH	7	8	9	V
	Low	VTGL	-5	-4	-3	
Horizontal shift register clock voltage	High	VP1HH, VP2HH	2	5	8	V
	Low	VP1HL, VP2HL	-5	-4	-3	
External load resistance		RL	2.0	2.2	2.4	kΩ

▣ Electrical characteristics (Ta=25 °C, operating conditions: Typ.)

Parameter		Symbol	S12551-1024			S12551-2048			Unit
			Min.	Typ.	Max.	Min.	Typ.	Max.	
Output signal frequency*3		fop	-	20	40	-	20	40	MHz
Line rate	Without electronic shutter	LRnes	-	18.9	37.9	-	9.6	19.2	kHz
	With electronic shutter	LRes	-	18.4	36.0	-	9.5	18.7	
Horizontal shift register capacitance		CP1H, CP2H	-	90	-	-	220	-	pF
Anti-blooming gate capacitance		CABG	-	40	-	-	80	-	pF
Summing gate capacitance		CSG	-	10	-	-	10	-	pF
Reset gate capacitance		CRG	-	10	-	-	10	-	pF
Transfer gate capacitance		CTG	-	50	-	-	120	-	pF
Charge transfer efficiency*4		CTE	0.99995	0.99999	-	0.99995	0.99999	-	-
DC output level*3		Vo	8	9	10	8	9	10	V
Output impedance*3		Zo	-	160	-	-	160	-	Ω
Power consumption*3 *5		P	-	100	140	-	100	140	mW

\*3: The value depends on the load resistance.

\*4: Charge transfer efficiency per pixel of CCD shift register, measured at half of the full well capacity

\*5: Power consumption of the on-chip amplifier plus load resistance

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

Parameter	Symbol	Min.	Typ.	Max.	Unit
Saturation output voltage	Vsat	-	Fw × CE	-	V
Full well capacity	Fw	70	100	-	ke <sup>-</sup>
Conversion efficiency	CE	11	13	15	μV/e <sup>-</sup>
Dark current (maximum of all effective pixels)	Id max	-	15	75	e <sup>-</sup> /pixel/ms
Readout noise*7	Nread	-	40	60	e <sup>-</sup> rms
Dynamic range*8	Drange	1167	2500	-	-
Spectral response range	λ	-	200 to 1000	-	nm
Photoresponse nonuniformity*9 *10	PRNU	-	±3	±10	%
Image lag*9	Lag	-	0.1	1	%

\*6: Dark current is reduced to half for every 5 to 7 °C decrease in temperature.

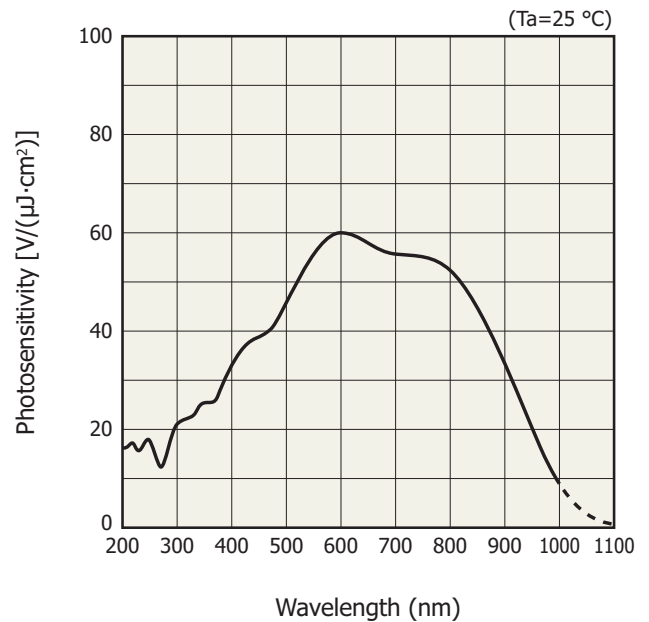
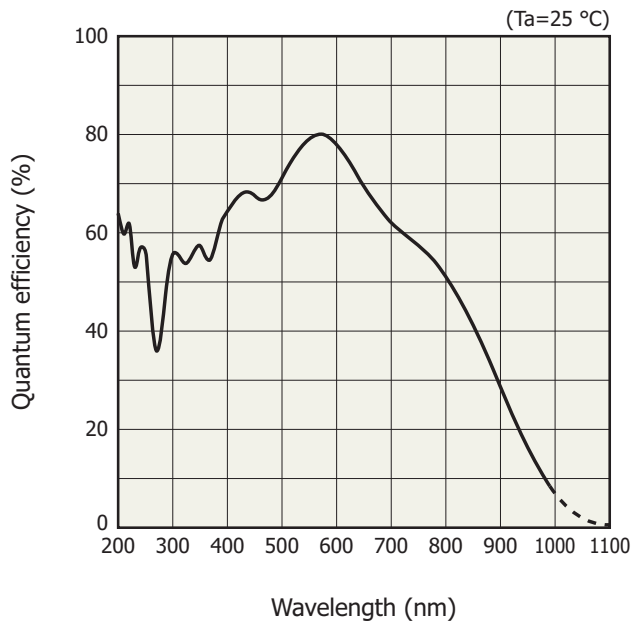
\*7: Readout frequency 40 MHz

\*8: Dynamic range = Full well capacity / Readout noise

\*9: Measured at one-half of the saturation output (full well capacity) using LED light (peak emission wavelength: 470 nm)

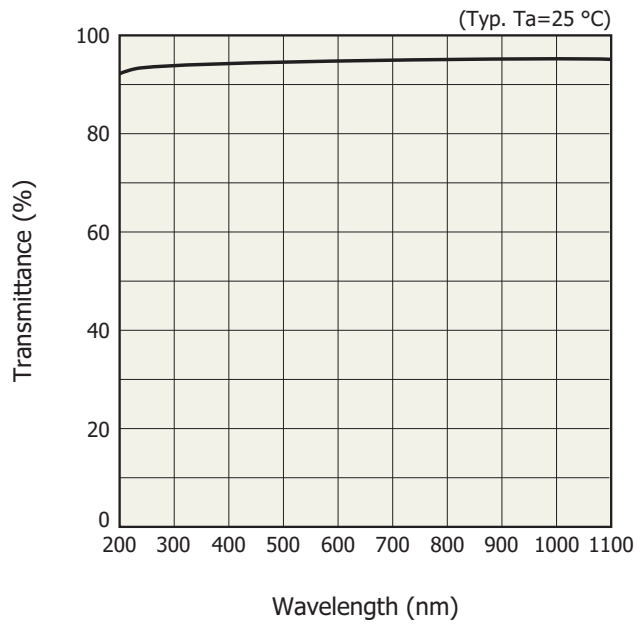
\*10: Photoresponse nonuniformity =  $\frac{\text{Fixed pattern noise (peak to peak)}}{\text{Signal}} \times 100$  [%]

**Spectral response (without window, typical example)\*11**



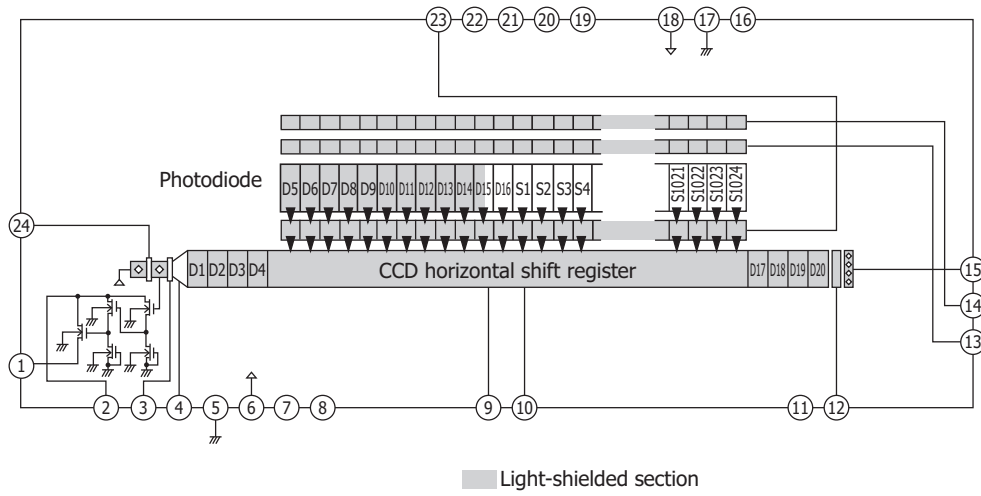
\*11: Spectral response with quartz glass is decreased according to the spectral transmittance characteristics of window material.

▣ Spectral transmittance characteristics of window material



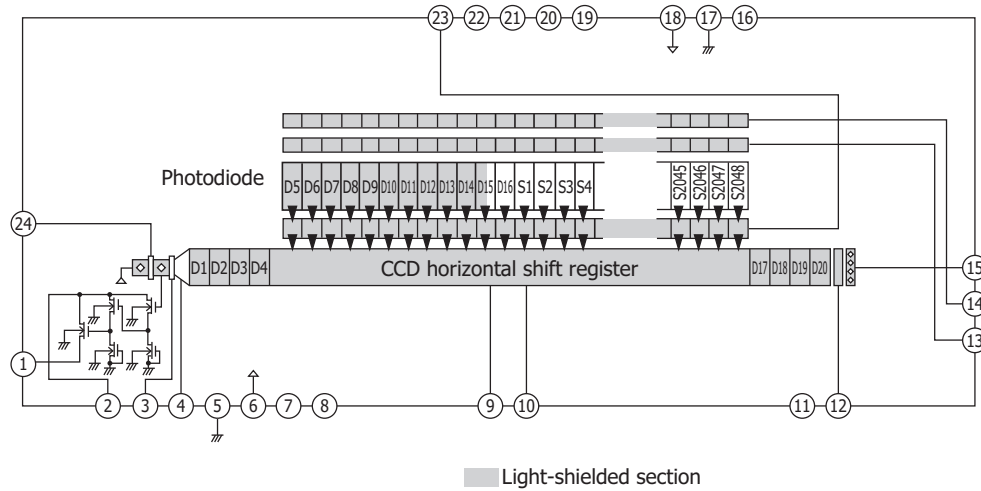
Device structure (conceptual drawing of top view in dimensional outline)

S12551-1024



KMPDC0825EA

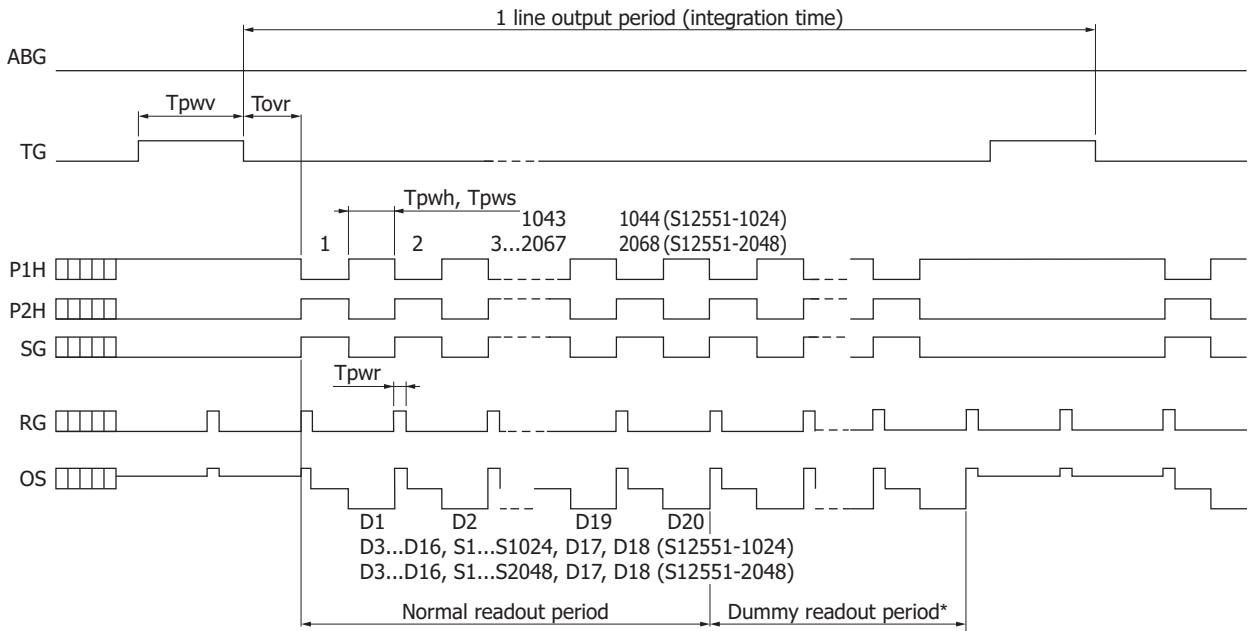
S12551-2048



KMPDC0483EA

**Timing chart**

When not using electronic shutter

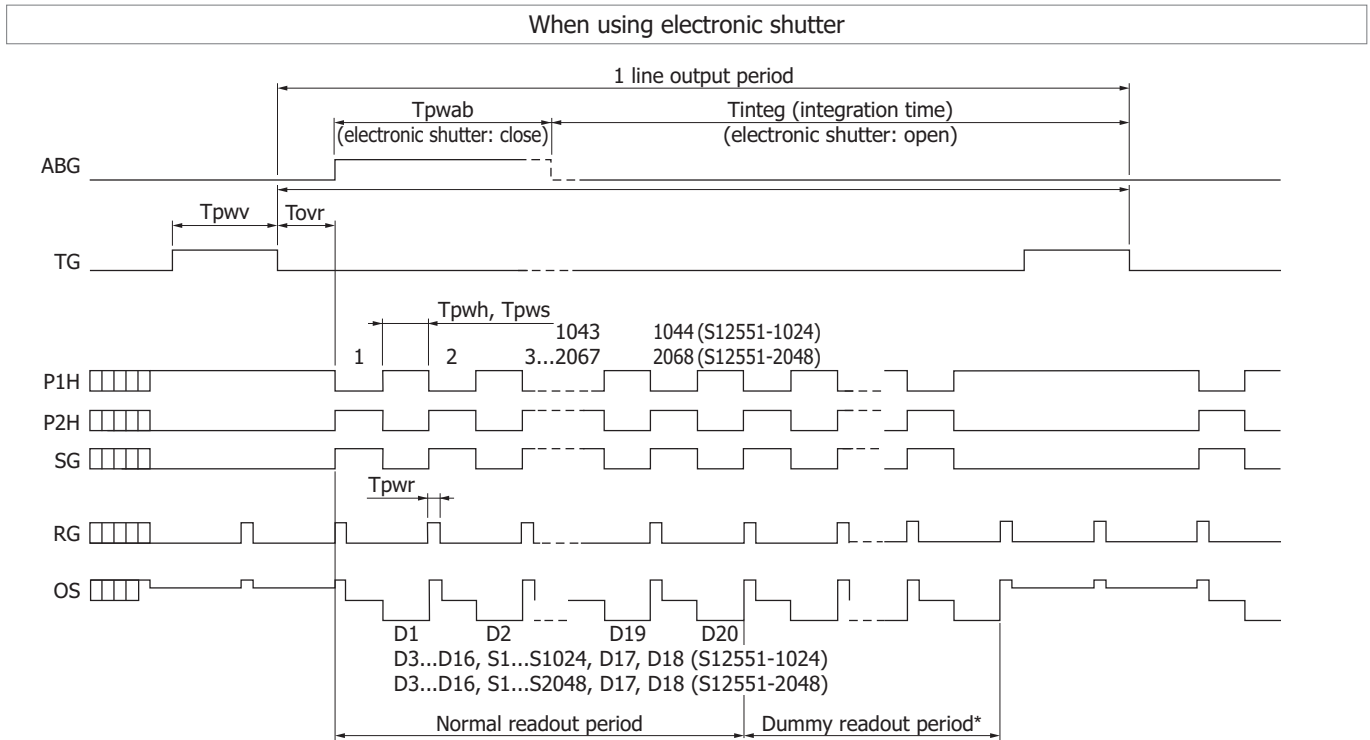


\* When making the integration time longer than the normal readout period, to carry away the dark current generated in the CCD horizontal shift register, perform dummy readout after completion of the normal readout until right before rising transfer gate pulse.

KMPDC0484EC

Parameter		Symbol	Min.	Typ.	Max.	Unit
TG	Pulse width	Tpww	0.2	0.4	-	μs
	Rise and fall times	Tprv, Tpfv	10	-	-	ns
P1H, P2H*12	Pulse width	Tpwh	12.5	25	-	ns
	Rise and fall times	Tprh, Tpfh	2	-	-	ns
	Duty ratio	-	40	50	60	%
SG	Pulse width	Tpws	12.5	25	-	ns
	Rise and fall times	Tprs, Tpfs	2	-	-	ns
	Duty ratio	-	40	50	60	%
RG	Pulse width	Tpwr	6	12	-	ns
	Rise and fall times	Tpr, Tprf	1	-	-	ns
TG - P1H	Overlap time	Tovr	0.1	0.2	-	μs

\*12: Symmetrical clock pulses should be overlapped at 50% of maximum pulse amplitude.



\* When making the integration time longer than the normal readout period, to carry away the dark current generated in the CCD horizontal shift register, perform dummy readout after completion of the normal readout until right before rising transfer gate pulse.

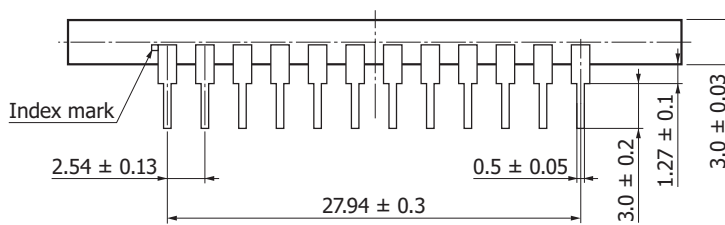
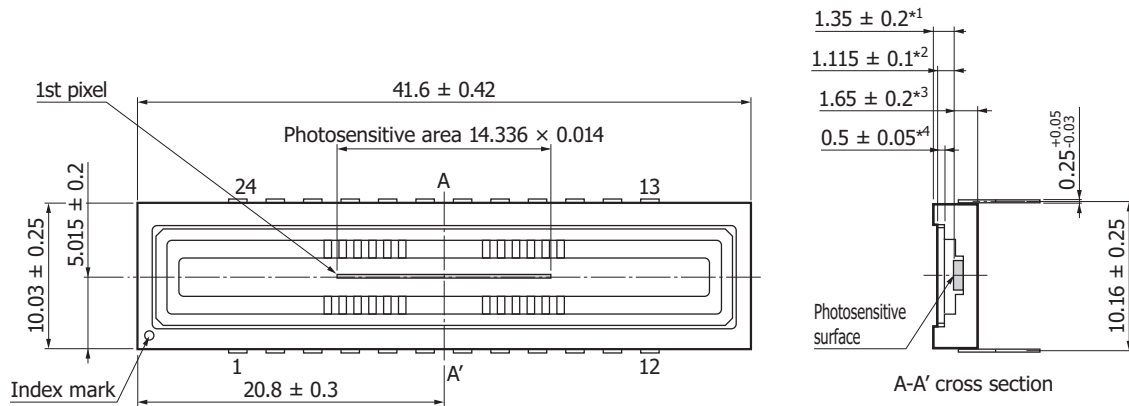
KMPDC0485EC

Parameter		Symbol	Min.	Typ.	Max.	Unit
ABG	Pulse width	$T_{pwb}$	1	-	-	$\mu\text{s}$
	Rise and fall times	$T_{prab}, T_{pfab}$	300	-	-	ns
TG	Pulse width	$T_{pww}$	1.6	2.0	-	$\mu\text{s}$
	Rise and fall times	$T_{prv}, T_{pfv}$	10	-	-	ns
P1H, P2H*13	Pulse width	$T_{pwh}$	12.5	25	-	ns
	Rise and fall times	$T_{prh}, T_{pfh}$	2	-	-	ns
	Duty ratio	-	40	50	60	%
SG	Pulse width	$T_{pws}$	12.5	25	-	ns
	Rise and fall times	$T_{prs}, T_{pfs}$	2	-	-	ns
	Duty ratio	-	40	50	60	%
RG	Pulse width	$T_{pwr}$	6	12	-	ns
	Rise and fall times	$T_{prr}, T_{pfr}$	1	-	-	ns
TG - P1H	Overlap time	$T_{ovr}$	0.1	0.2	-	$\mu\text{s}$
Integration time		$T_{integ}$	2	-	-	$\mu\text{s}$

\*13: Symmetrical clock pulses should be overlapped at 50% of maximum pulse amplitude.

Dimensional outlines (unit: mm)

S12551-1024

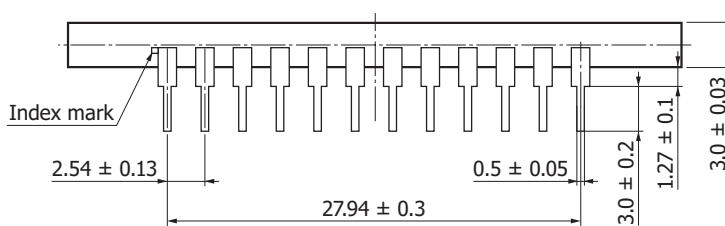
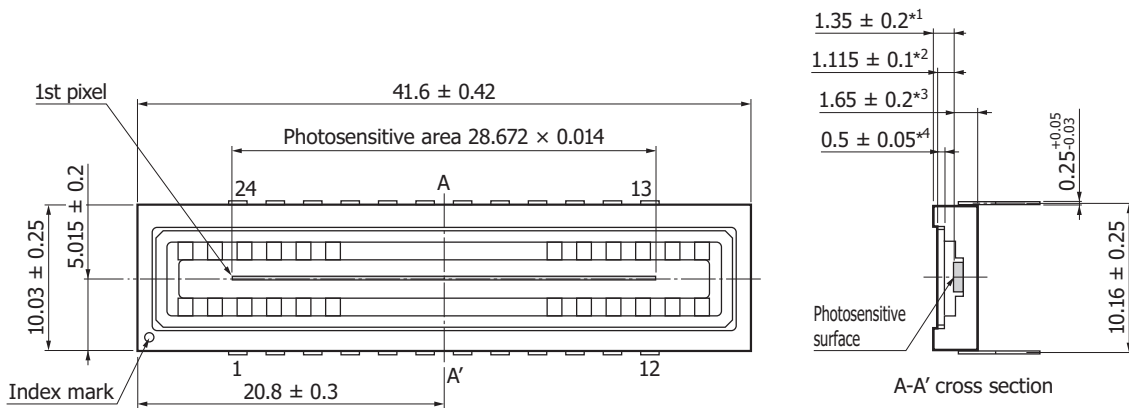


Lead material: FeNi alloy  
 Lead processing: NiAu plating  
 Weight: 3.8 g typ.  
 Tolerance unless otherwise noted: ±0.1  
 \*1: Distance from package surface to photosensitive surface  
 \*2: Distance from window upper surface to photosensitive surface  
 \*3: Distance from package bottom to photosensitive surface  
 \*4: Glass thickness (Refractive ratio≈1.5)

This product is not hermetically sealed and moisture may penetrate inside the package. Avoid using or storing this product in an environment where sudden temperature and humidity changes may occur and cause condensation in the package.

KMPDA0628EA

S12551-2048



Lead material: FeNi alloy  
 Lead processing: NiAu plating  
 Weight: 3.8 g typ.  
 Tolerance unless otherwise noted: ±0.1  
 \*1: Distance from package surface to photosensitive surface  
 \*2: Distance from window upper surface to photosensitive surface  
 \*3: Distance from package bottom to photosensitive surface  
 \*4: Glass thickness (Refractive ratio≈1.5)

This product is not hermetically sealed and moisture may penetrate inside the package. Avoid using or storing this product in an environment where sudden temperature and humidity changes may occur and cause condensation in the package.

KMPDA0310EB



### Pin connections

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 P2H
5	SS	Substrate	GND
6	RD	Reset drain	+14 V
7	-		
8	-		
9	P2H	CCD horizontal resister clock-2	+5/-4 V
10	P1H	CCD horizontal resister clock-1	+5/-4 V
11	-		
12	IGH	Test point (horizontal input gate)	-4 V
13	ABG	Anti-blooming gate	+5/-2 V
14	ABD	Anti-blooming drain	+14 V
15	ISH	Test point (horizontal input source)	Connect it to RD.
16	-		
17	SS	Substrate	GND
18	RD	Reset drain	+14 V
19	-		
20	-		
21	-		
22	-		
23	TG	Transfer gate	+8/-4 V
24	RG	Reset gate	+9/0 V

### Precautions

#### 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.

#### When UV light irradiation is applied

When UV light irradiation is applied, the product characteristics may degrade. Such examples include degradation of the product's UV sensitivity and increase in dark current. This phenomenon varies depending on the irradiation level, irradiation intensity, usage time, and ambient environment and also varies depending on the product model. Before employing the product, we recommend that you check the tolerance under the UV light environment that the product will be used in.

### Related information

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

#### Precautions

- Disclaimer
- Image sensors

Information described in this material is current as of March 2021.

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.

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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](mailto: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](mailto: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](mailto:infos@hamamatsu.fr)

United Kingdom: Hamamatsu Photonics UK Limited: 2 Howard Court, 10 Tewin Road, Welwyn Garden City, Hertfordshire AL7 1BW, UK, Telephone: (44)1707-294888, Fax: (44)1707-325777, E-mail: [info@hamamatsu.co.uk](mailto: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](mailto: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](mailto:info@hamamatsu.it)

China: Hamamatsu Photonics (China) Co., Ltd.: 1201 Tower B, Jiaming Center, 27 Dongsanhuan Beilu, Chaoyang District, 100020 Beijing, P.R.China, Telephone: (86)10-6586-6006, Fax: (86)10-6586-2866, E-mail: [hpc@hamamatsu.com.cn](mailto: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](mailto:info@hamamatsu.com.tw)