

S9226 series

Built-in timing generator and signal processing circuit

The S9226 series is a small CMOS linear image sensor designed for image input applications. The signal processing circuit has a charge amplifier with excellent input/output characteristics. Two package styles are provided: a DIP type and a surface mount type.

Features

- Pixel pitch: 7.8 μm
Pixel height: 125 μm
- 1024 pixels
- 3.3 V single power supply operation available
- High sensitivity, low dark current, low noise
- On-chip charge amplifier with excellent input/output characteristics
- Built-in timing generator allows operation with only start and clock pulse inputs.
- Video data rate: 200 kHz max.
- Spectral response range: 400 to 1000 nm
- Two package styles are provided:
DIP (dual inline package) type: S9226-03
Surface mount type: S9226-04

Applications

- Analytical instruments
- Position detection
- Image reading

Structure

Parameter	S9226-03	S9226-04	Unit
Number of pixels	1024		-
Pixel pitch	7.8		μm
Pixel height	125		μm
Photosensitive area length	7.9872		mm
Package	Ceramic		-
Window material	Borosilicate glass		-

Absolute maximum ratings

Parameter	Symbol	Condition	Value	Unit
Supply voltage	Vdd	Ta=25 °C	-0.3 to +6	V
Gain selection terminal voltage	Vg	Ta=25 °C	-0.3 to +6	V
Clock pulse voltage	V(CLK)	Ta=25 °C	-0.3 to +6	V
Start pulse voltage	V(ST)	Ta=25 °C	-0.3 to +6	V
Operating temperature	Topr	No dew condensation*1	-20 to +60	°C
Storage temperature	Tstg	No dew condensation*1	-20 to +70	°C
Soldering temperature	S9226-03	Tsol	*2 240 (twice)*3	-
	S9226-04			

*1: 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.

*2: See the recommended soldering conditions (P.9).

*3: Reflow soldering, IPC/JEDEC J-STD-020 MSL 5, see P.9

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.

➤ Recommended terminal voltage (Ta=25 °C)

Parameter	Symbol	Min.	Typ.	Max.	Unit
Supply voltage	Vdd	3.3	5	5.25	V
Gain selection terminal voltage	High gain	-	0	-	V
	Low gain	Vdd - 0.25	Vdd	Vdd + 0.25	V
Clock pulse voltage	High level	Vdd - 0.25	Vdd	Vdd + 0.25	V
	Low level	-	0	-	V
Start pulse voltage	High level	Vdd - 0.25	Vdd	Vdd + 0.25	V
	Low level	-	0	-	V

➤ Electrical characteristics [Ta=25 °C, Vdd=5 V, V(CLK)=V(ST)=5 V]

Parameter	Symbol	Min.	Typ.	Max.	Unit
Clock pulse frequency	f(CLK)	10	-	800	kHz
Data rate	DR	-	f(CLK)/4	-	kHz
Current consumption	Ic	4	6	8	mA
Conversion efficiency	High gain	-	3.2	-	μV/e-
	Low gain	-	1.6	-	
Output impedance	Zo	-	185	-	Ω

➤ Electrical and optical characteristics [Ta=25 °C, Vdd=5 V, V(CLK)=V(ST)=5 V]

Parameter	Symbol	Min.	Typ.	Max.	Unit
Spectral response range	λ	400 to 1000			nm
Peak sensitivity wavelength	λp	-	650	-	nm
Dark current	ID	-	5	50	fA
Dark output voltage*4	High gain	-	0.8	8	mV
	Low gain	-	0.4	4	
Saturation output voltage*5	Vsat	2.2	3.2	-	V
Readout noise	High gain	-	1.4	2.2	mV rms
	Low gain	-	0.7	1.1	
Offset output voltage	Voffset	0.2	0.35	0.6	V
Photoresponse nonuniformity*6 *7	PRNU		-	±5	%

*4: Integration time=10 ms

*5: Voltage difference with respect to Voffset

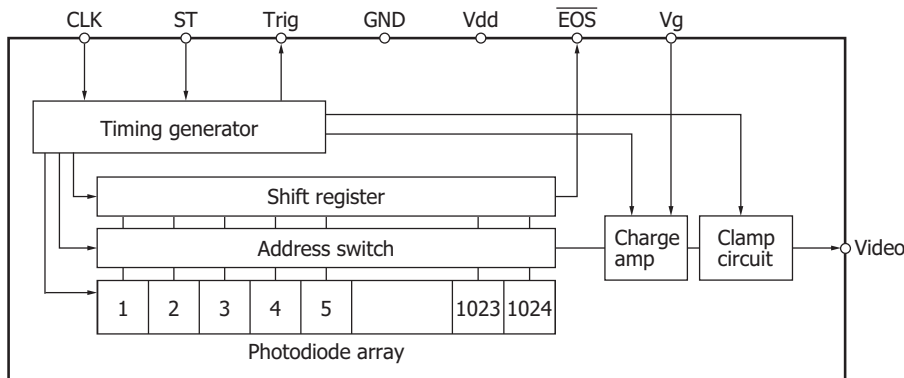
*6: Photoresponse nonuniformity (PRNU) is the output nonuniformity that occurs when the entire photosensitive area is uniformly illuminated by light which is 50% of the saturation exposure level. PRNU is measured using 1022 pixels excluding the pixels at both ends, and is defined as follows:

$$PRNU = \Delta X / X \times 100 (\%)$$

X: average output of all pixels, ΔX: difference between X and maximum or minimum output

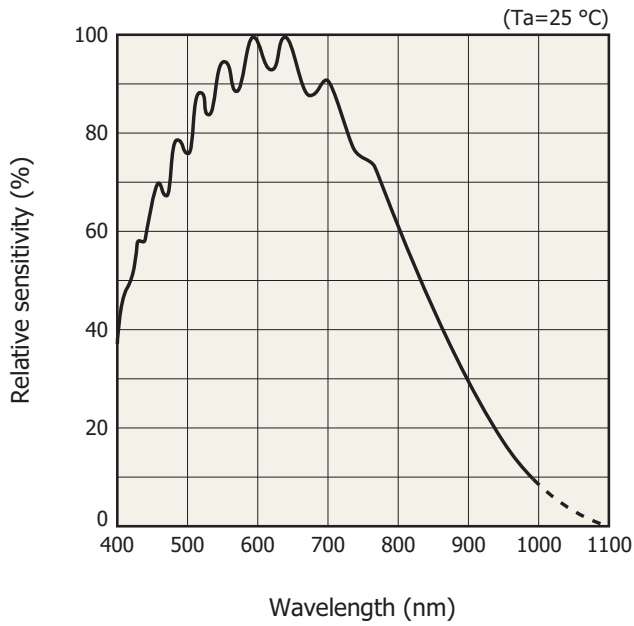
*7: Measured with a tungsten lamp of 2856 K

➤ Block diagram



KMPDC0165EC

Spectral response (typical example)



KMPDB0229EC

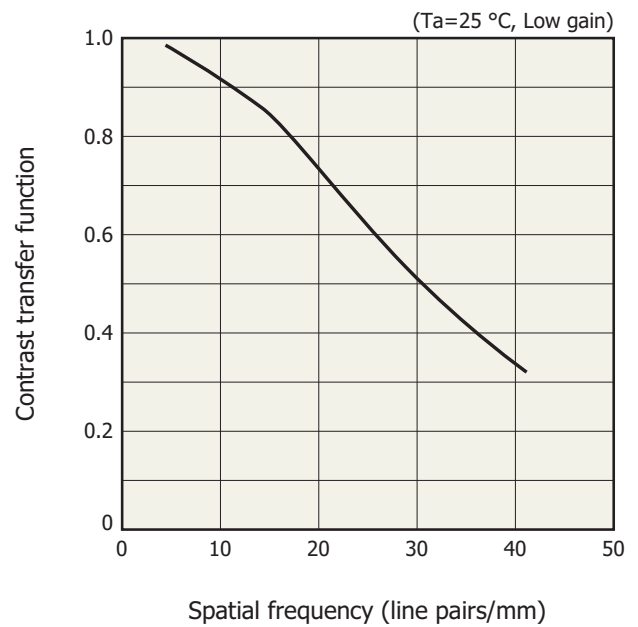
Resolution

CTF: contrast transfer function

$$CTF = \frac{V_{WO} - V_{BO}}{V_W - V_B}$$

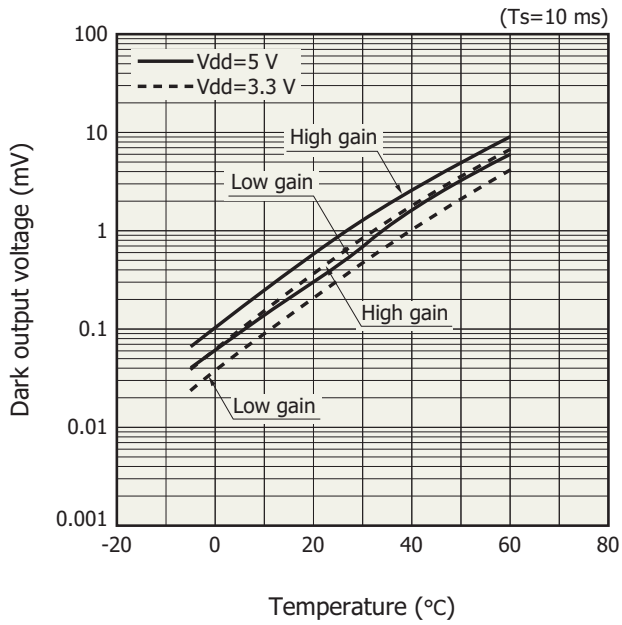
- V_{WO} : output white level
- V_{BO} : output black level
- V_W : output white level (when input pattern pulse width is wide)
- V_B : output black level (when input pattern pulse width is wide)

Contrast transfer function vs. spatial frequency (typical example)



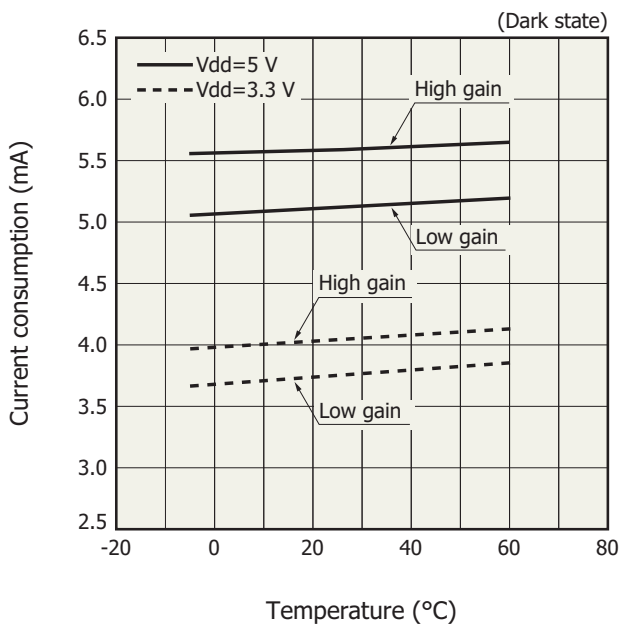
KMPDB0318EC

Dark output voltage vs. temperature (typical example)



KMPDB0319EB

Current consumption vs. temperature (typical example)

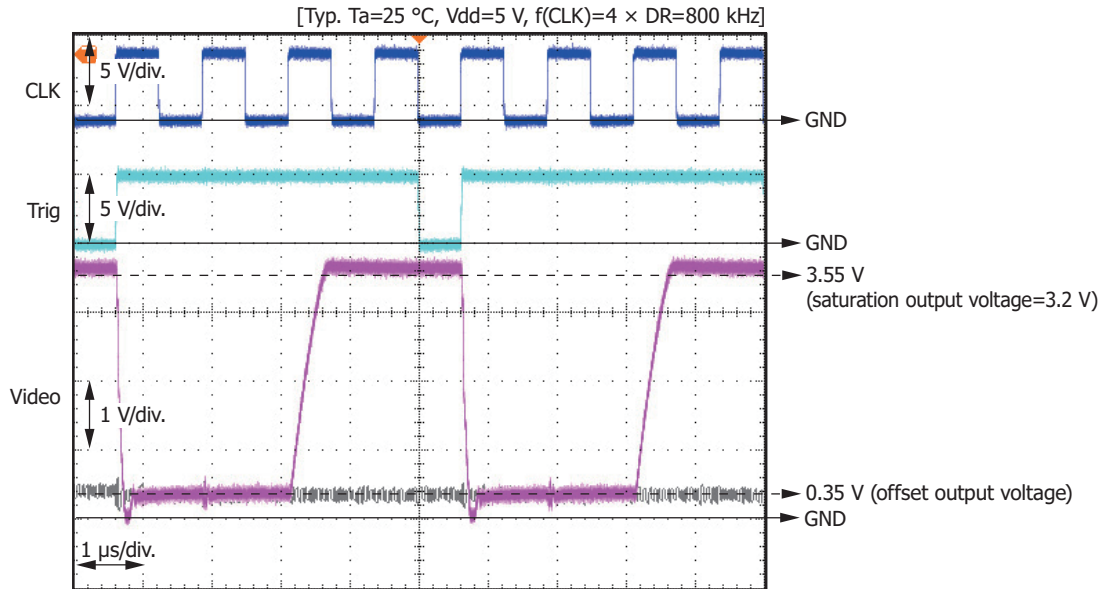


KMPDB0320EB

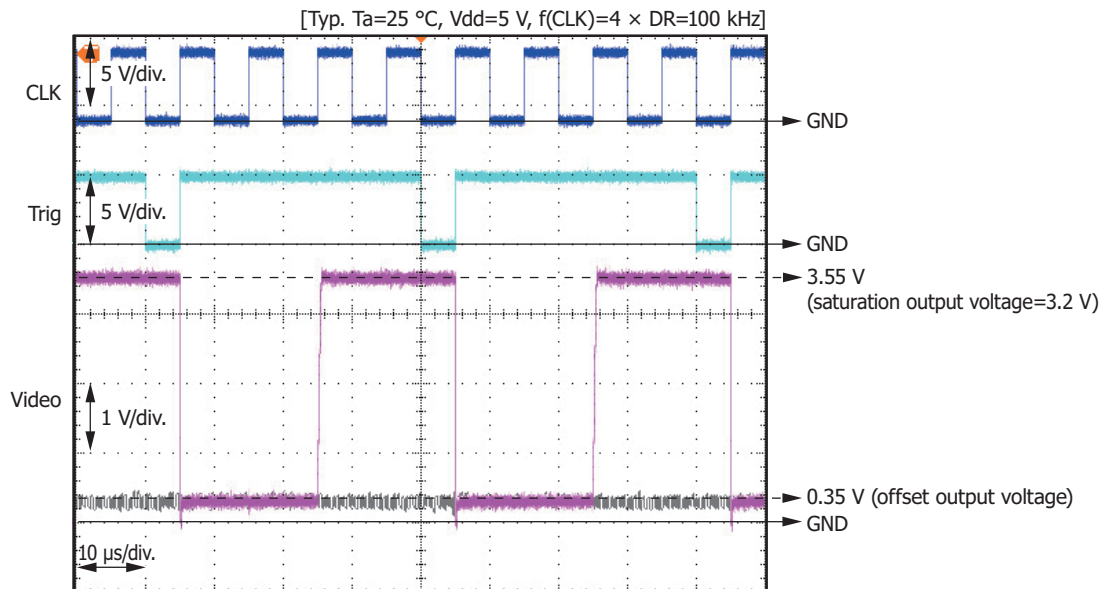
Output waveform of one element

High gain

■ $f(\text{CLK})=4 \times \text{DR}=800 \text{ kHz}$

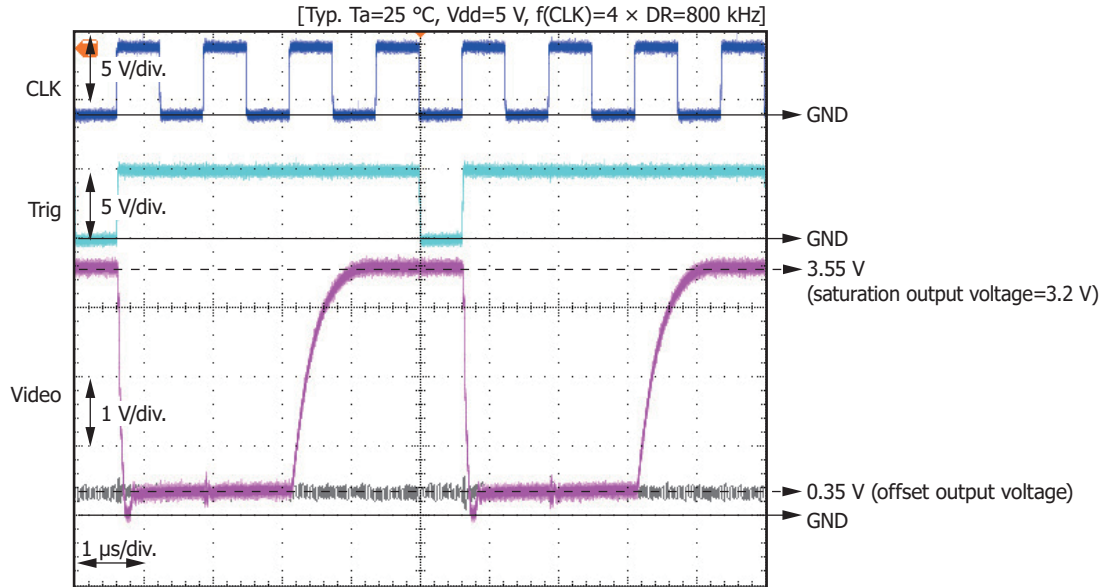


■ $f(\text{CLK})=4 \times \text{DR}=100 \text{ kHz}$

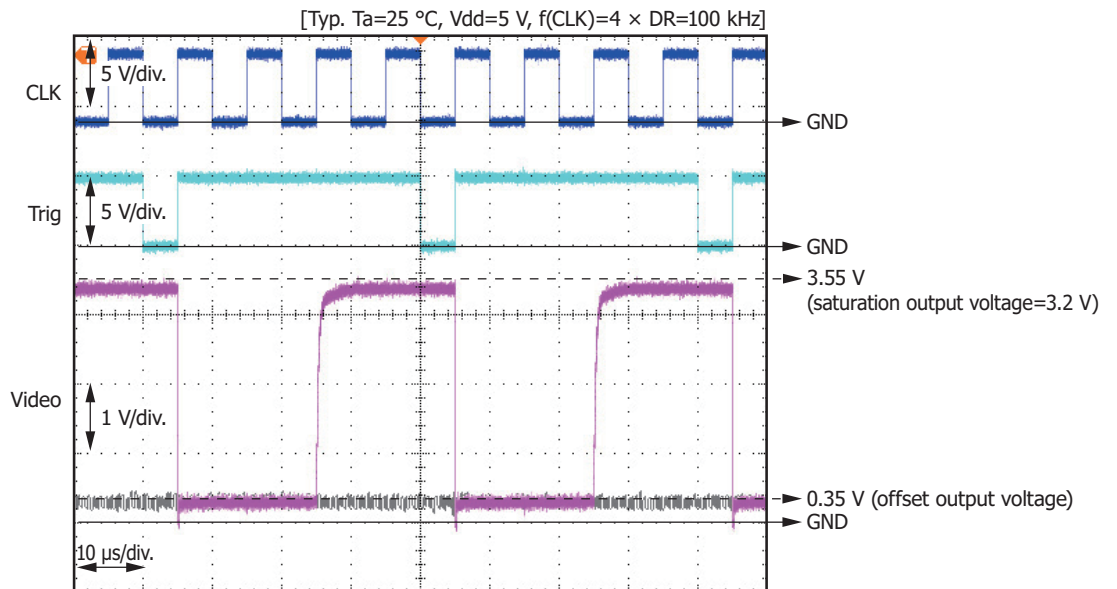


Low gain

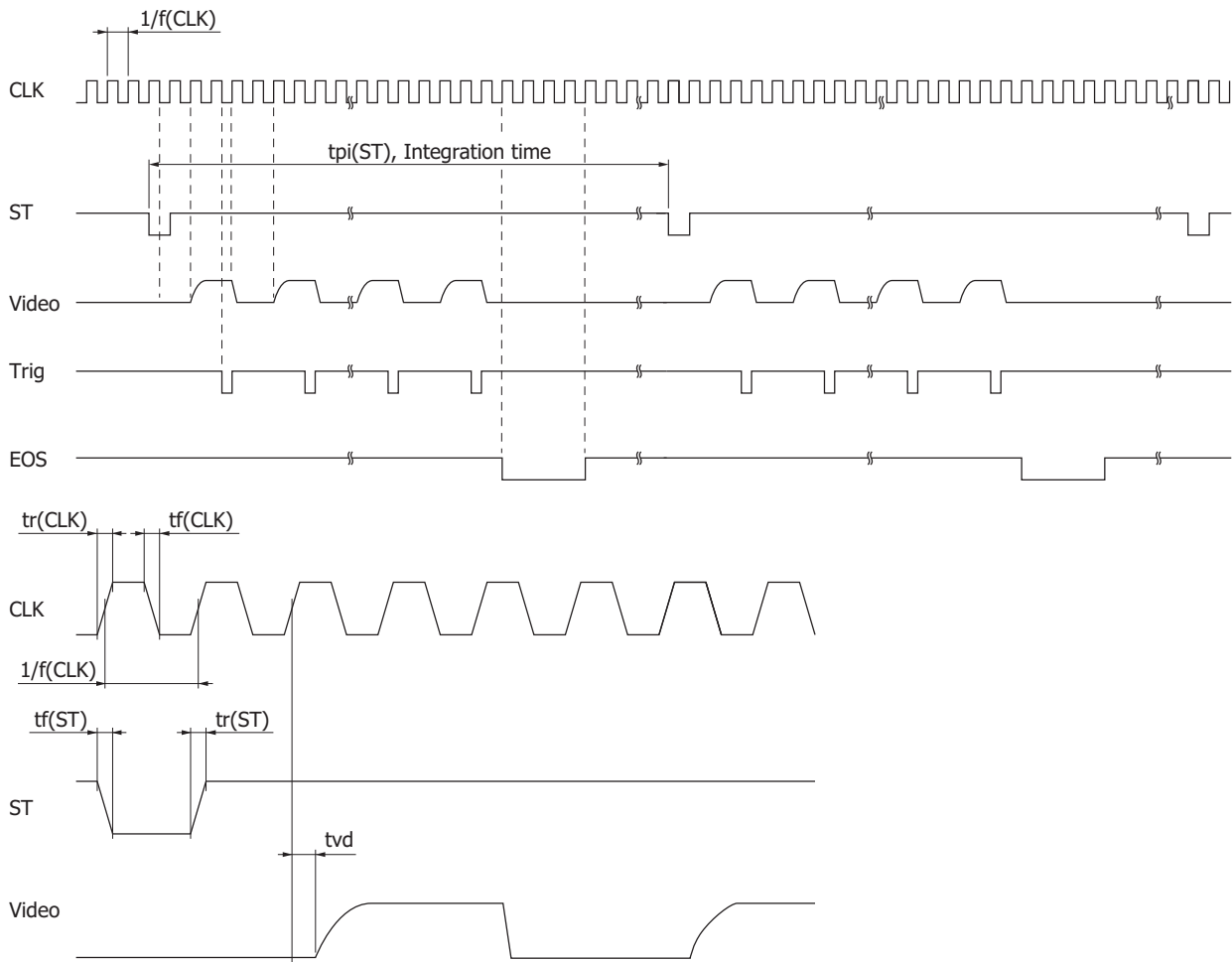
■ $f(\text{CLK})=4 \times \text{DR}=800 \text{ kHz}$



■ $f(\text{CLK})=4 \times \text{DR}=100 \text{ kHz}$



Timing chart



KMPDC0164EC

Parameter	Symbol	Min.	Typ.	Max.	Unit
Start pulse cycle	$t_{pi}(\text{ST})$	$4104/f(\text{CLK})$	-	-	s
Start pulse rise and fall times	$t_r(\text{ST}), t_f(\text{ST})$	0	20	30	ns
Clock pulse duty ratio	-	40	50	60	%
Clock pulse rise and fall times	$t_r(\text{CLK}), t_f(\text{CLK})$	0	20	30	ns
Video delay time*8	t_{vd}	10	20	30	ns

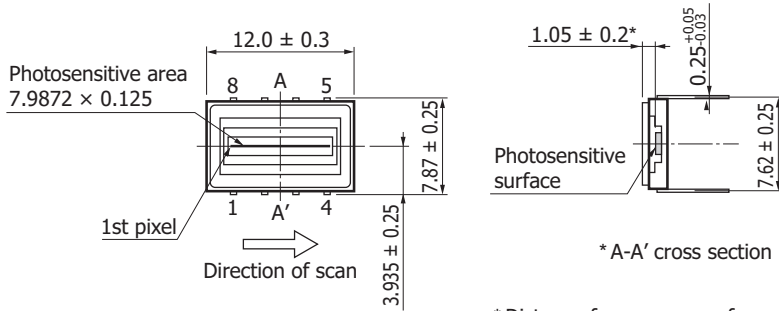
*8: $T_a=25\text{ }^\circ\text{C}$, $V_{dd}=5\text{ V}$, $V(\text{CLK})=V(\text{ST})=5\text{ V}$

Note: The CLK pulse should be set from high to low just once when the st pulse is low. The internal shift register starts operating at this timing.

The integration time is determined by the start pulse cycles. However, since the charge integration of each pixel is carried out between the signal readout of that pixel and the next signal readout of the same pixel, the start time of charge integration differs depending on each pixel. In addition, the next start pulse cannot be input until signal readout from all pixels is completed.

Dimensional outlines (unit: mm)

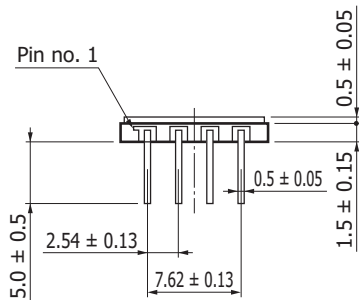
S9226-03



* A-A' cross section

* Distance from upper surface of window to photosensitive surface

KMPDA0172EG

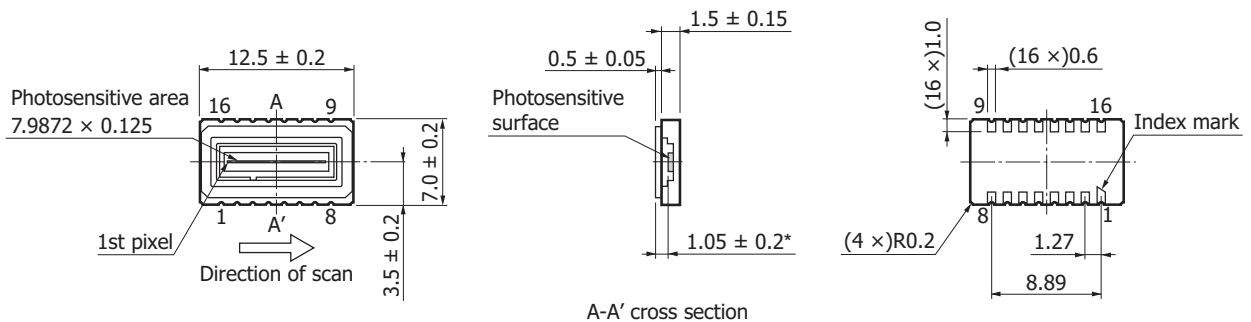


Pin no.	Symbol	Pin name	Input/Output
1	GND	Ground	Input
2	CLK	Clock pulse	Input
3	Trig	Trigger pulse	Output
4	ST	Start pulse	Input
5	Vg	Gain selection voltage	Input
6	Video	Video signal*9	Output
7	EOS	End of scan	Output
8	Vdd	Supply voltage	Input

*9: Connect a buffer amplifier for impedance conversion to the video output terminal so as to minimize the current flow. As the buffer amplifier, use a high input impedance operational amplifier with JFET or CMOS input.

Note: Leave the "NC" terminals open and do not connect them to GND.

S9226-04



A-A' cross section

* Distance from upper surface of window to photosensitive surface

KMPDA0258ED

Pin no.	Symbol	Pin name	Input/Output	Pin no.	Symbol	Pin name	Input/Output
1	NC	No connection		9	NC	No connection	
2	NC	No connection		10	NC	No connection	
3	GND	Ground	Input	11	Vg	Gain selection voltage	Input
4	CLK	Clock pulse	Input	12	Video	Video signal*9	Output
5	Trig	Trigger pulse	Output	13	EOS	End of scan	Output
6	ST	Start pulse	Input	14	Vdd	Supply voltage	Input
7	NC	No connection		15	NC	No connection	
8	NC	No connection		16	NC	No connection	

*9: Connect a buffer amplifier for impedance conversion to the video output terminal so as to minimize the current flow. As the buffer amplifier, use a high input impedance operational amplifier with JFET or CMOS input.

Note: Leave the "NC" terminals open and do not connect them to GND.

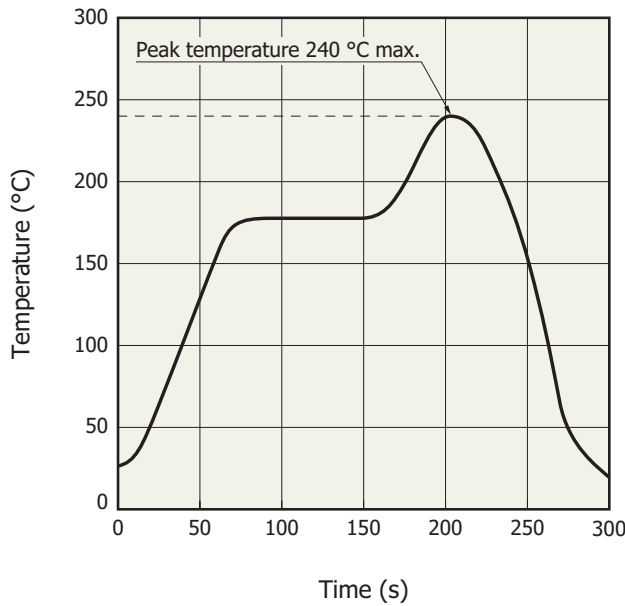
Recommended soldering conditions

S9226-03

Parameter	Specification	Remarks
Solder temperature	260 °C max. (less than 5 s)	-

Note: When setting the soldering conditions, check for any problems by testing out the soldering methods in advance.

S9226-04



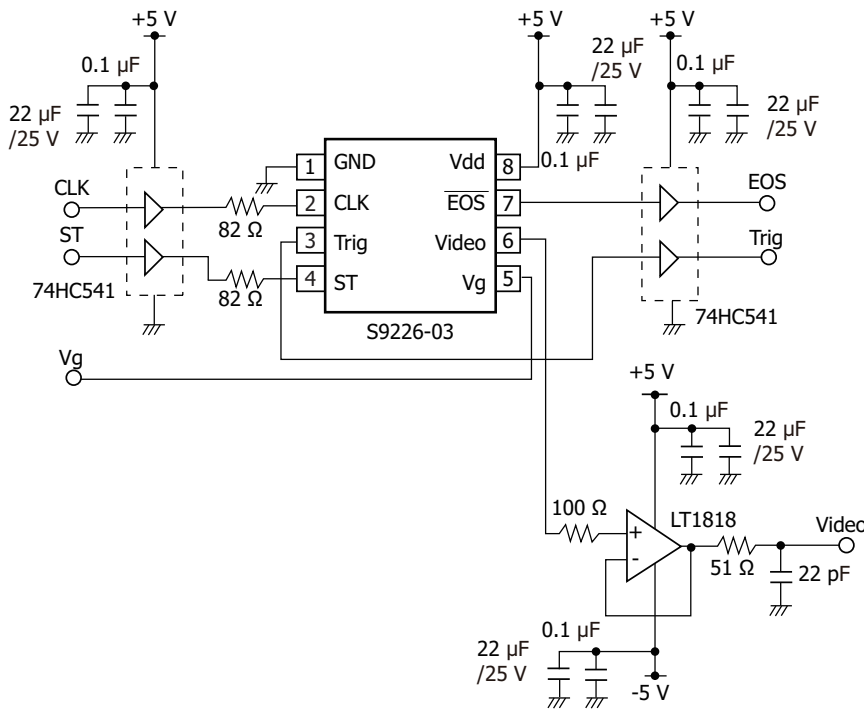
KSPDB0418EA

- This product (S9226-04) supports lead-free soldering. After unpacking, store it in an environment at a temperature of 30 °C or less and a humidity of 60% or less, and perform soldering within 48 hours.
- The effect that the product receives during reflow soldering varies depending on the circuit board and reflow oven that are used. Before actual reflow soldering, check for any problems by testing out the reflow soldering methods in advance.
- A sudden temperature rise and cooling may be the cause of trouble, so make sure that the temperature change is within 4 °C per second.
- The bonding portion between the ceramic base and the glass may discolor after reflow soldering, but this has no adverse effects on the hermetic sealing of the product.

Precautions

- (1) Electrostatic countermeasures
This device has a built-in protection circuit against static electrical charges. However, to prevent destroying the device with electrostatic charges, take countermeasures such as grounding yourself, the workbench and tools to prevent static discharges. Also protect this device from surge voltages which might be caused by peripheral equipment.
- (2) Light input window
If the incident window is contaminated or scratched, the output uniformity will deteriorate considerably, so care should be taken in handling the window. Avoid touching it with bare hands.
The window surface should be cleaned before using the device. If dry cloth or dry cotton swab is used to rub the window surface, static electricity may be generated, and therefore this practice should be avoided. Use soft cloth, cotton swab or soft paper moistened with ethyl alcohol to wipe off dirt and foreign matter on the window surface.
- (3) UV exposure
This product is not designed to prevent deterioration of characteristics caused by UV exposure, so do not expose it to UV light.

Application circuit example (S9226-03)*10



KMPDC0416EB

*10: The S9226-04 has a different pin connections, but uses the same circuit.

Related information

www.hamamatsu.com/sp/ssd/doc_en.html

■ Precautions

- Disclaimer
- Image sensors/Precautions
- Surface mount type products/Precautions

Information described in this material is current as of December 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.

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.

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, 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, UK, 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, 20044 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.: 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

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