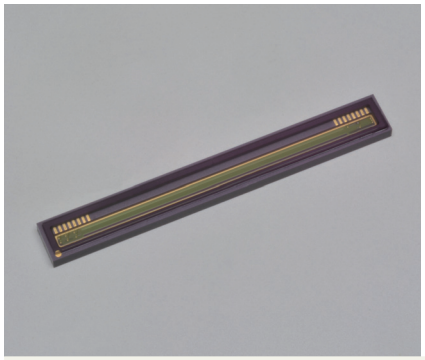
HAMAMATSU
PHOTON IS OUR BUSINESS

CMOS linear image sensor



S13496-20

High sensitivity, photosensitive area with minute pixels, surface mount type

The S13496-20 is a high sensitivity CMOS linear image sensor using a photosensitive area with minute pixels. It has a long photosensitive area (effective photosensitive length: 28.672 mm) consisting of 4096 pixels, each with a pixel size of 7 × 200 µm. DIP type (S13496) is also available.

Features

- **Pixel size: 7 × 200 µm**
- **4096 pixels**
- **Effective photosensitive area length: 28.672 mm**
- **High sensitivity: 650 V/(*lx*·s)**
- **Simultaneous charge integration for all pixels**
- **Variable integration time function (electronic shutter function)**
- **5 V single power supply operation**
- **Built-in timing generator allows operation with only start and clock pulse inputs.**
- **Video data rate: 10 MHz max.**
- **Surface mount type**

Applications

- **Position detection**
- **Image reading**
- **Encoders**
- **Spectrometers**

Structure

Parameter	Specification	Unit
Number of pixels	4096	-
Pixel size	7 × 200	µm
Photosensitive area length	28.672	mm
Package	Ceramic	-
Window material	Quartz	-

Absolute maximum ratings

Parameter	Symbol	Condition	Value	Unit
Supply voltage	Vdd	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	-40 to +65	°C
Storage temperature	Tstg	No dew condensation*1	-40 to +65	°C
Soldering temperature	Tsol		260 (three times)*2	°C

*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: Reflow soldering, IPC/JEDEC J-STD-020 MSL 2a, see P.7
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	4.75	5	5.25	V
Clock pulse voltage	High level	V(CLK)	3	Vdd	Vdd + 0.25	V
	Low level		0	-	0.3	V
Start pulse voltage	High level	V(ST)	3	Vdd	Vdd + 0.25	V
	Low level		0	-	0.3	V

Input terminal capacitance (Ta=25 °C, Vdd=5 V)

Parameter	Symbol	Min.	Typ.	Max.	Unit
Clock pulse input terminal capacitance	C(CLK)	-	5	-	pF
Start pulse input terminal capacitance	C(ST)	-	5	-	pF

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)	200 k	5 M	10 M	Hz
Data rate	DR	-	f(CLK)	-	Hz
Output impedance	Zo	70	-	260	Ω
Current consumption*2 *3	Ic	20	40	60	mA

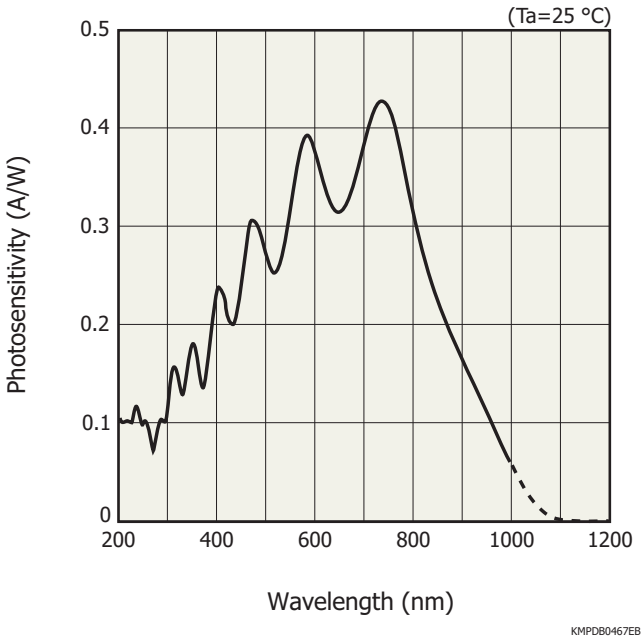
*2: f(CLK)=10 MHz
*3: Current consumption increases as the clock pulse frequency increases. The current consumption is 10 mA typ. at f(CLK)=200 kHz.

Electrical and optical characteristics [Ta=25 °C, Vdd=5 V, V(CLK)=V(ST)=5 V, f(CLK)=10 MHz]

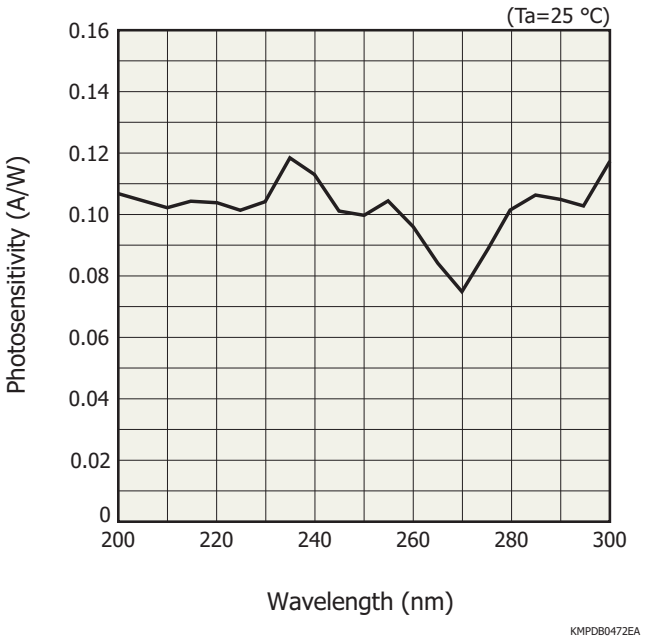
Parameter	Symbol	Min.	Typ.	Max.	Unit
Spectral response range	λ		200 to 1000		nm
Peak sensitivity wavelength	λp	-	700	-	nm
Photosensitivity*4	Sw	-	650	-	V/(*lx*·s)
Conversion efficiency*5	CE	-	25	-	μV/e⁻
Dark output voltage*6	VD	0	0.1	2	mV
Saturation output voltage*7*8	Vsat	1.5	2.0	2.5	V
Readout noise	Nread	0.1	0.4	1.2	mV rms
Dynamic range 1*9	Drange1	-	5000	-	times
Dynamic range 2*10	Drange2	-	20000	-	times
Output offset voltage	Voffset	0.3	0.6	0.9	V
Photoresponse nonuniformity*4 *11	PRNU	-	±2	±10	%
Image lag*12	Lag	-	-	0.1	%

*4: Measured with a tungsten lamp of 2856 K
*5: Output voltage generated per one electron
*6: Integration time=10 ms
*7: Diference from Voffset
*8: CDS (correlated double sampling) is done inside the image sensor in order to reduce noise. The final output is the difference between the output when the photosensitive area is put in the reset state, and the light output integrated in the photosensitive area. If used in an over-saturated state, the light output component may get mixed into the output when the photosensitive area is put in the reset state, causing the final output to decrease.
*9: Drange1 = Vsat/Nread
*10: Drange2 = Vsat/VD
Integration time=10 ms
Dark output voltage is proportional to the integration time and so the shorter the integration time, the wider the dynamic range.
*11: 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 4090 pixels excluding 3 pixels each 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 output or minimum output
*12: Signal components of the preceding line data that still remain even after the data is read out in a saturation output state. Image lag increases when the output exceeds the saturation output voltage.

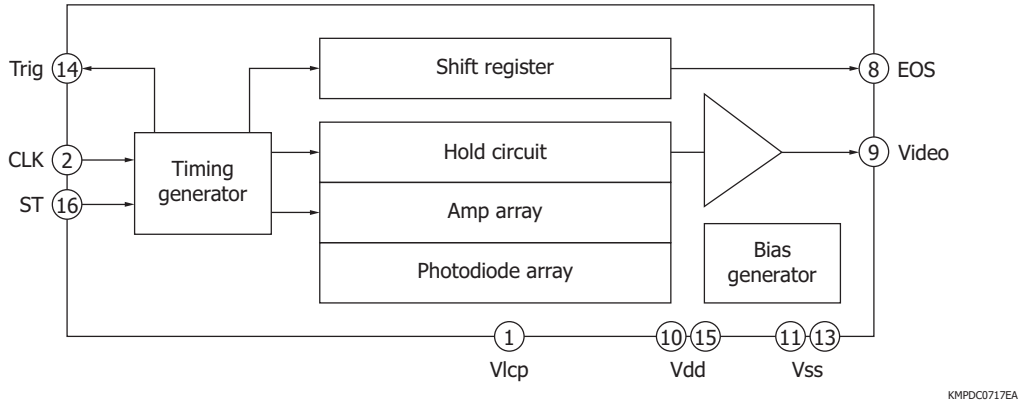
Spectral response (typical example)



Spectral response in UV (typical example)



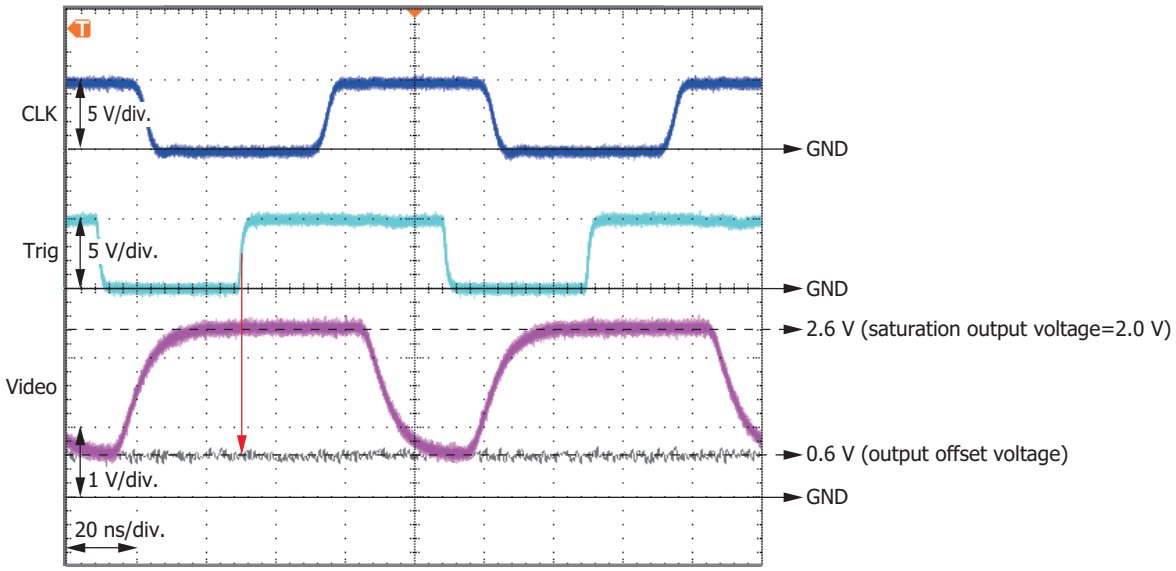
Block diagram



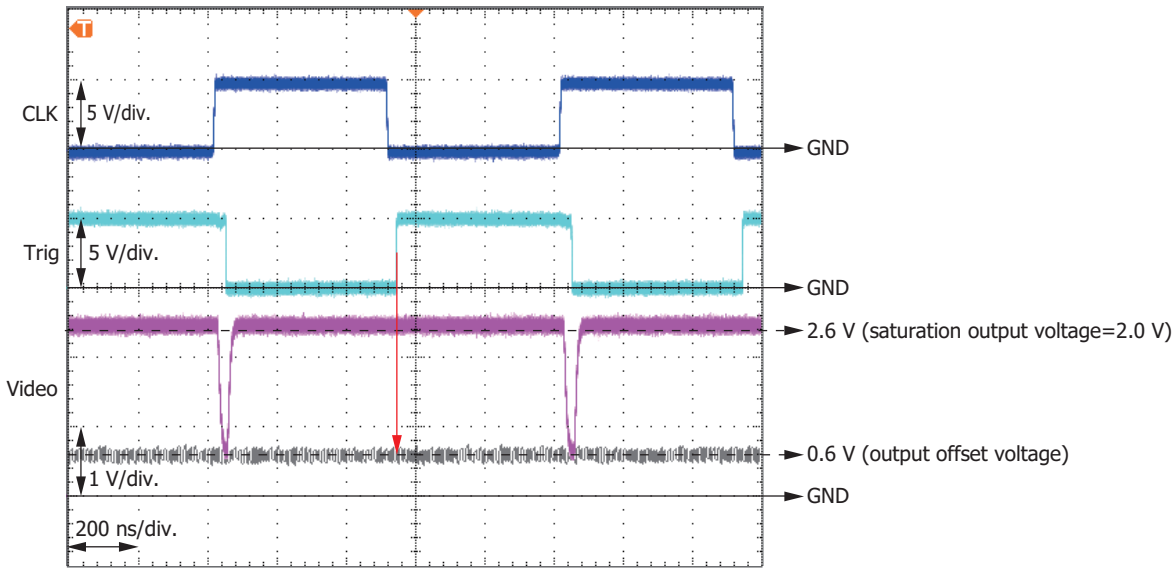
Output waveforms of one pixel

The timing for acquiring the Video signal is synchronized with the rising edge of Trig pulse (See red arrow below.).

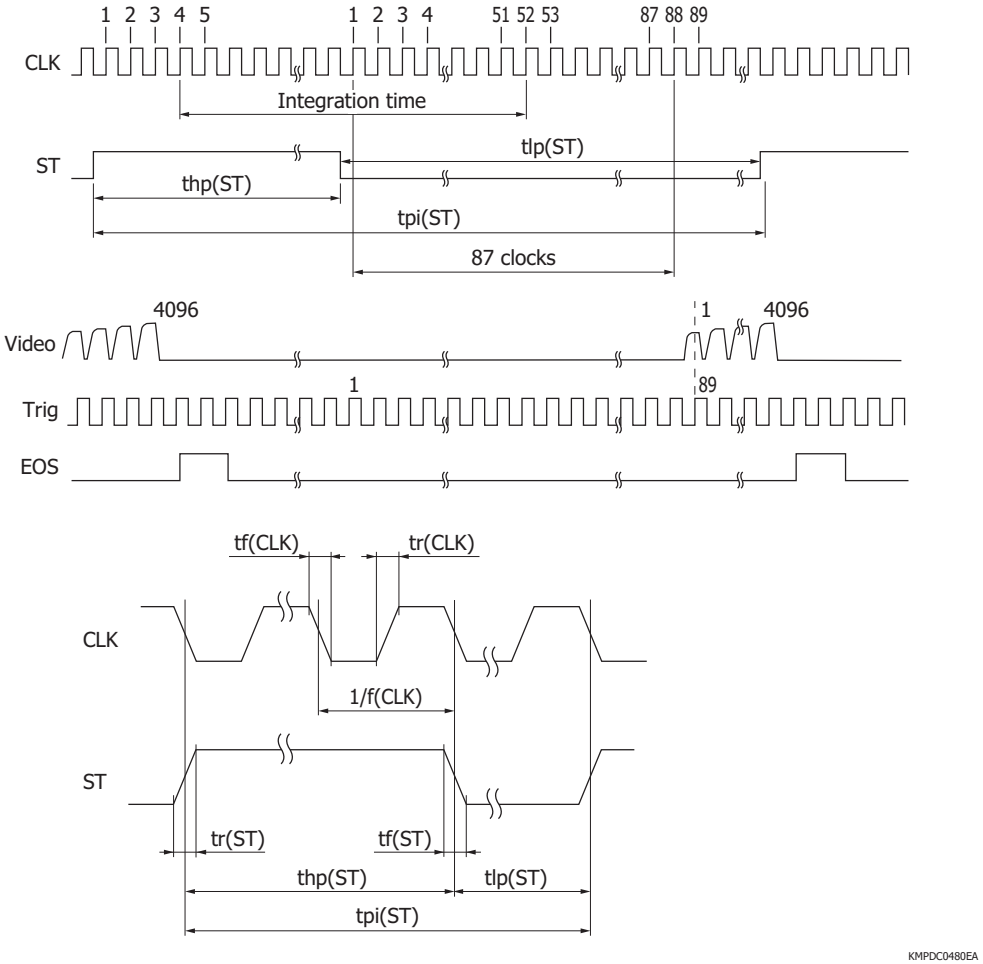
f(CLK)=DR=10 MHz



f(CLK)=DR=1 MHz



Timing chart



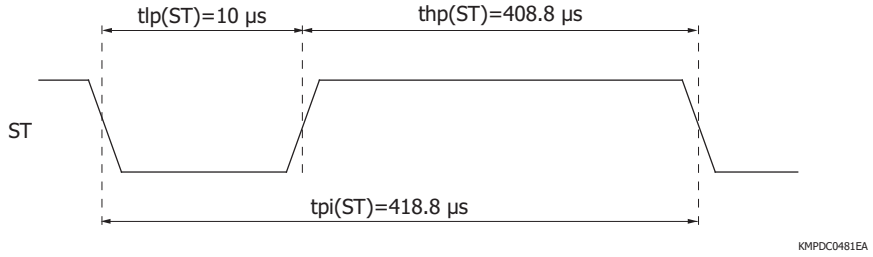
KMPDC0480EA

Parameter	Symbol	Min.	Typ.	Max.	Unit
Start pulse cycle*13	tpi(ST)	106/f(CLK)	-	-	s
Start pulse high period*13 *14	thp(ST)	6/f(CLK)	-	-	s
Start pulse low period	tlp(ST)	100/f(CLK)	-	-	s
Start pulse rise and fall times	tr(ST), tf(ST)	0	10	30	ns
Clock pulse duty ratio	-	45	50	55	%
Clock pulse rise and fall times	tr(CLK), tf(CLK)	0	10	30	ns

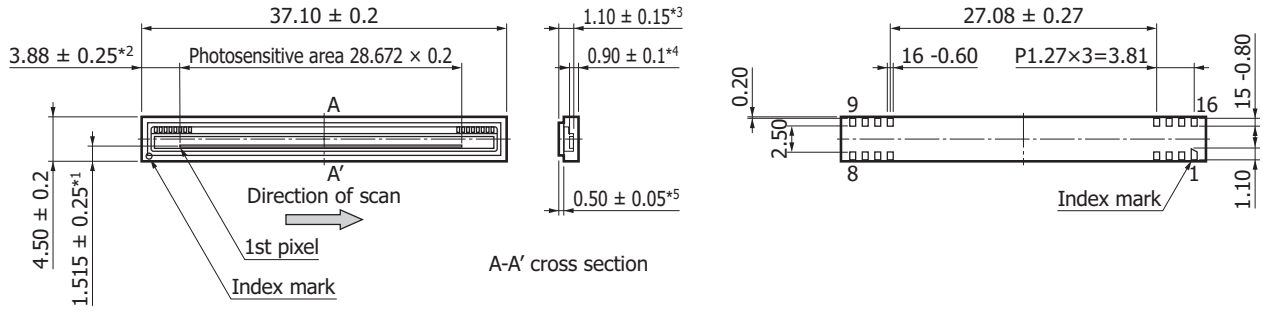
*13: Dark output increases if the start pulse cycle or the start pulse high period is lengthened.
*14: The integration time equals the high period of ST plus 48 CLK cycles.
The shift register starts operation at the rising edge of CLK immediately after ST goes low.
The integration time can be changed by changing the ratio of the high and low periods of ST.
If the first Trig pulse after ST goes low is counted as the first pulse, the Video signal is acquired at the rising edge of the 89th Trig pulse.

Operation example

This example assumes that the clock pulse frequency is maximized (video data rate is also maximized), the time of one scan is minimized, and the integration time is maximized
Clock pulse frequency = Video data rate = 10 MHz
Start pulse cycle = 4188/f(CLK) = 4188/10 MHz = 418.8 µs
High period of start pulse = Start pulse cycle - Start pulse's low period min.
= 4188/f(CLK) - 100/f(CLK) = 4188/10 MHz - 100/10 MHz = 408.8 µs
Integration time is equal to the high period of start pulse + 48 cycles of clock pulses, so it will be 408.8 + 4.8 = 413.6 µs.



Dimensional outline (unit: mm)



Tolerance unless otherwise noted: ±0.2
*1: Distance from package edge to photosensitive area center
*2: Distance from package edge to photosensitive area edge
*3: Distance from window upper surface to photosensitive surface
*4: Distance from package bottom to photosensitive surface
*5: Glass thickness

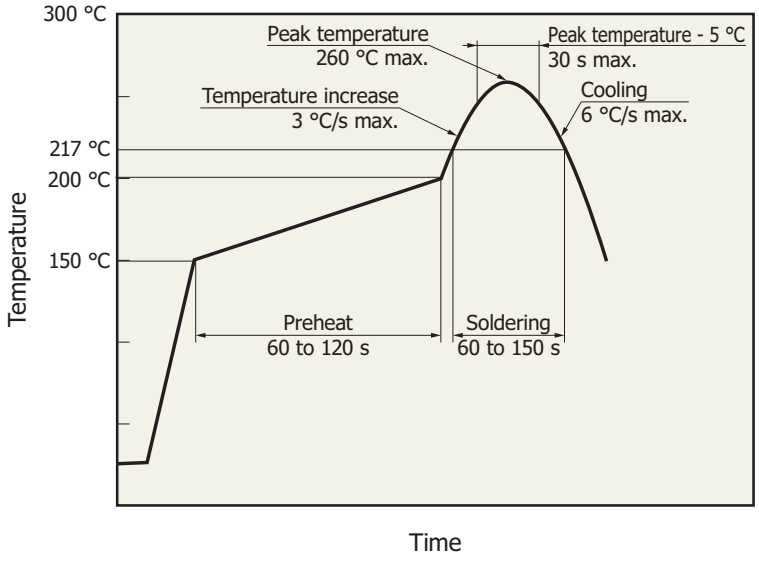
KMPDA0606EA

Pin connections

Pin no.	Symbol	I/O	Description	Pin no.	Symbol	I/O	Description
1	Vclp	O	Bias voltage for negative voltage circuit*15	9	Video	O	Video signal*16
2	CLK	I	Clock pulse	10	Vdd	-	Supply voltage
3	NC	-	No connection	11	Vss	-	GND
4	NC	-	No connection	12	NC	-	No connection
5	NC	-	No connection	13	Vss	-	GND
6	NC	-	No connection	14	Trig	O	Trigger pulse for video signal acqusition
7	NC	-	No connection	15	Vdd	I	Supply voltage
8	EOS	O	End of scan	16	ST	I	Start pulse

*15: Approximately -1.5 V generated by the negative voltage circuit inside the chip is output to the terminal. To maintain the voltage, insert a capacitor around 1 µF between Vlcp and GND.
*16: 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



· This product 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 4 weeks.
· The effect that the product is subject to during reflow soldering varies depending on the circuit board and reflow oven that are used. When you set reflow soldering conditions, check that problems do not occur in the product by testing out the conditions in advance.
· Drastic changes in temperature can cause problems. Keep the temperature change to less than 3 °C/second for heating and to less than 6 °C/second for cooling. Note that 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.

Recommended baking condition

See Precautions of surface mount type products (P3. (1) Baking).

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. Also protect this device from surge voltages which might be caused by peripheral equipment.

(2) Light input window

If dust or dirt gets on the light input window, it will show up as black blemishes on the image. When cleaning, avoid rubbing the window surface with dry cloth or dry cotton swab, since doing so may generate static electricity. Use soft cloth, paper or a cotton swab moistened with alcohol to wipe dust and dirt off the window surface. Then blow compressed air onto the window surface so that no spot or stain remains.

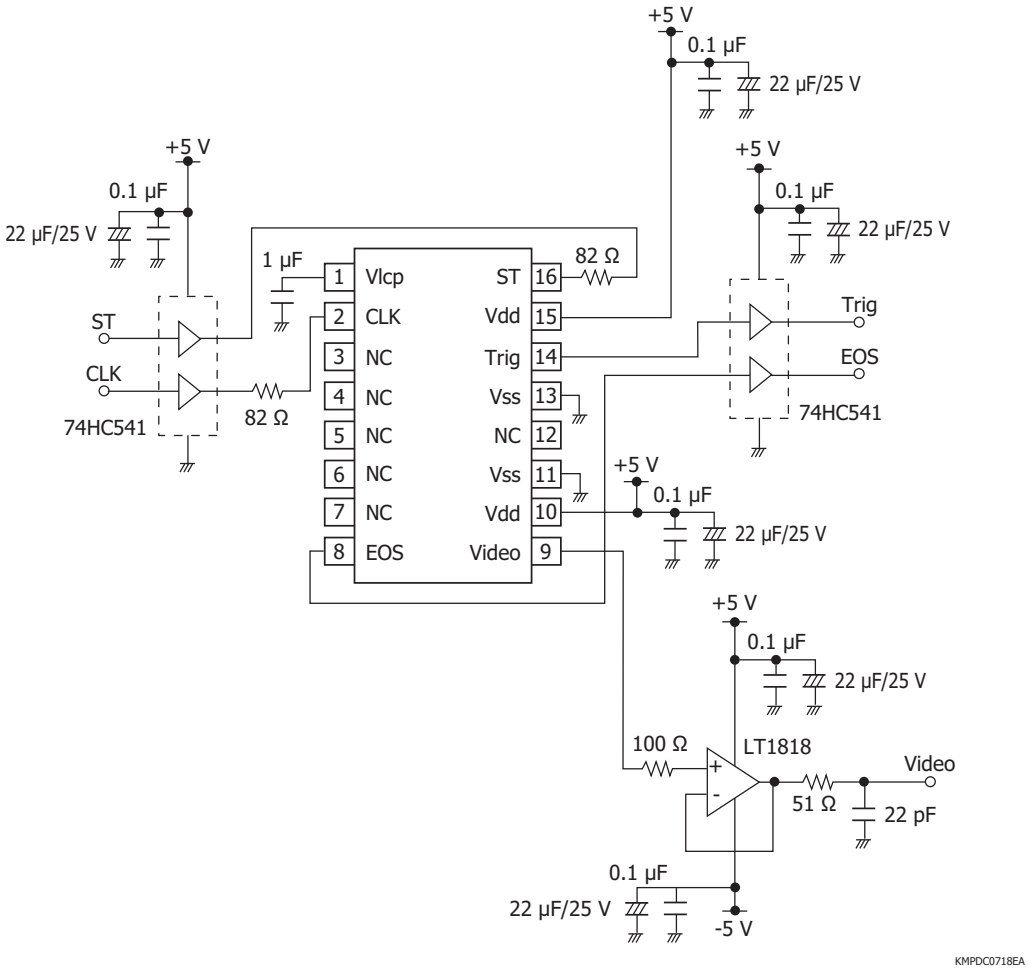
(3) Soldering

To prevent damaging the device during soldering, take precautions to prevent excessive soldering temperatures and times. Soldering should be performed within 5 seconds at a soldering temperature below 260 °C.

(4) UV light irradiation

This device is designed to suppress performance deterioration due to UV exposure. Even so, avoid unnecessary UV exposure to the device. Also, be careful not to allow UV light to strike the cemented portion of the glass.

Application circuit example



Related information

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

■ Precautions
· Disclamer
· Image sensors
· Surface mount type products

■ Technical information
· CCD linear image sensors

Information described in this material is current as of October 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.

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

Cat. No. KMPD1201E02 Oct. 2021 DN