HAMAMATSU

PHOTON IS OUR BUSINESS

CMOS linear image sensors

S13014 S13014-10

High sensitivity, photosensitive area with vertically long pixels

The S13014 and S13014-10 are high sensitivity CMOS linear image sensors employing a photosensitive area consisting of vertically long pixels (14 × 200 μm). High sensitivity and high durability have been achieved even in the ultraviolet region. Handling is easy because it operates on a single 5 V power supply. In addition, a surface mount type (S13014-10) is available. It can be used in various applications including encoders, position detection, and spectrometers.

Features

- **Pixel size: 14 × 200 μm**
- **512 pixels**
- **Effective photosensitive area length: 7.168 mm**
- **High sensitivity: 1300 V/(lx·s)**
- **High sensitivity in UV to NIR region (spectral response range: 200 to 1000 nm)**
- **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.**
- **Two types of package available**
  DIP type: S13014
  Surface mount type: S13014-10

Applications

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

Structure

Parameter	Specification	Unit
Number of pixels	512	-
Pixel size	14 × 200	μm
Photosensitive area length	7.168	mm
Package	Ceramic	-
Window material	Quartz	-

Absolute maximum ratings

Parameter	Symbol	Condition	S13014	S13014-10	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		*2	260 (3 times)*3	°C

*1: When there is a temperature difference between a product and the surrounding area in high humidity environments, 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 MSL2a, 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	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*4 *5	Ic	10	20	40	mA

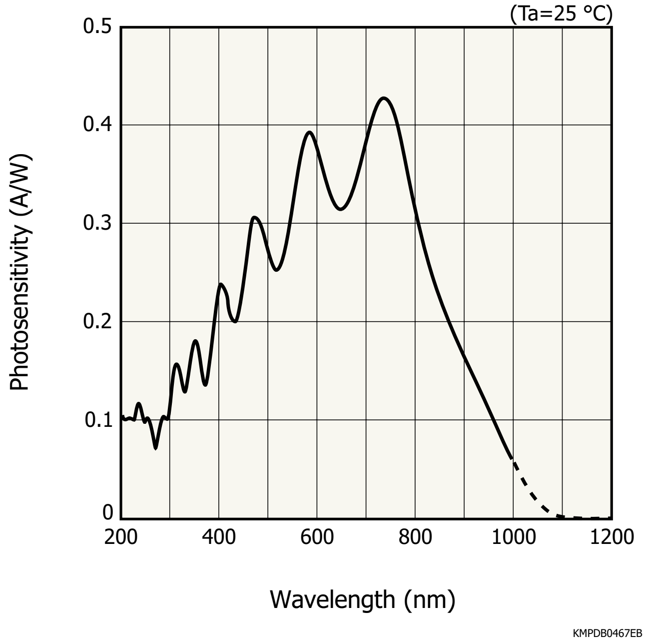
*4: f(CLK)=10 MHz
*5: Current consumption increases as the clock pulse frequency increases. The current consumption is 10 mA typ. at f(CLK)=200 kHz.

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

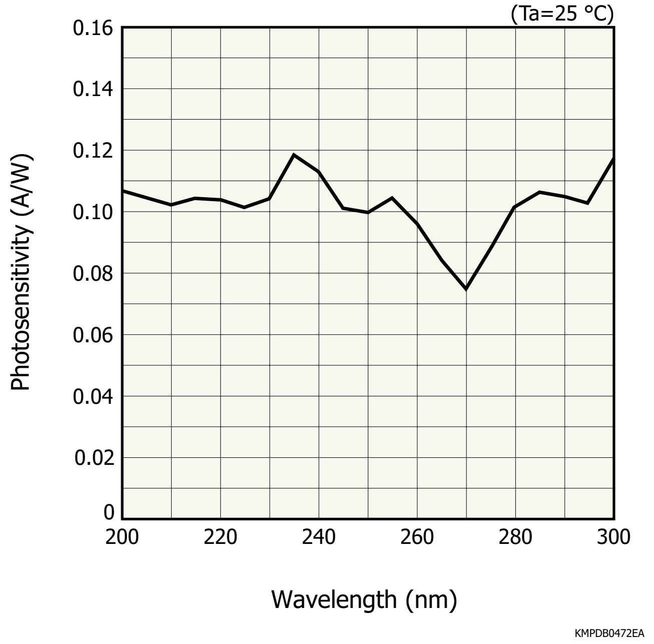
Parameter	Symbol	Min.	Typ.	Max.	Unit
Spectral response range	λ		200 to 1000		nm
Peak sensitivity wavelength	λp	-	700	-	nm
Photosensitivity*6	Sw	-	1300	-	V/(lx·s)
Conversion efficiency*7	CE	-	20	-	μV/e-
Dark output voltage*8	VD	0	0.2	2.0	mV
Saturation output voltage*9 *10	Vsat	1.5	2.0	2.5	V
Readout noise	Nread	0.1	0.4	1.2	mV rms
Dynamic range 1*11	Drange1	-	5000	-	times
Dynamic range 2*12	Drange2	-	10000	-	times
Output offset voltage	Voffset	0.3	0.6	0.9	V
Photoresponse nonuniformity*6 *13	PRNU	-	±2	±10	%
Image lag*14	Lag	-	-	0.1	%

*6: Measured with a tungsten lamp of 2856 K
*7: Output voltage generated per one electron
*8: Integration time=10 ms
*9: Difference from Voffset
*10: 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.
*11: Drange1= Vsat/Nread
*12: 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.
*13: 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 506 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
*14: 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.

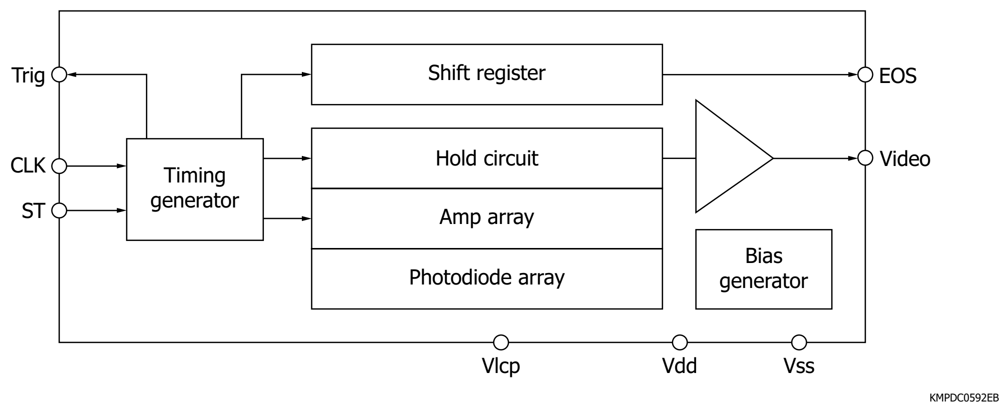
Spectral response (typical example)



Spectral response in UV region (typical example)



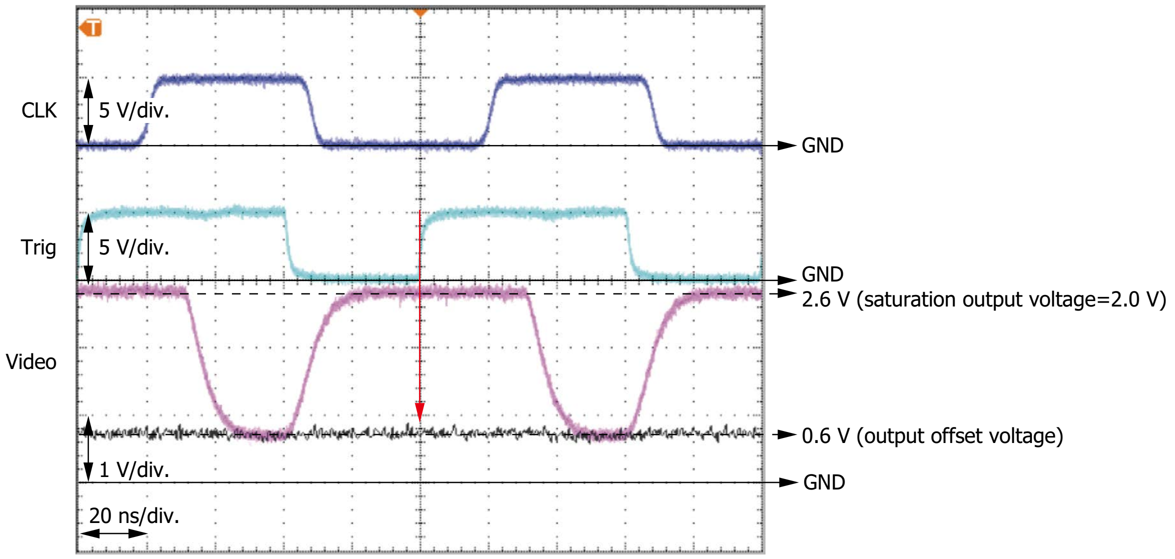
Block diagram



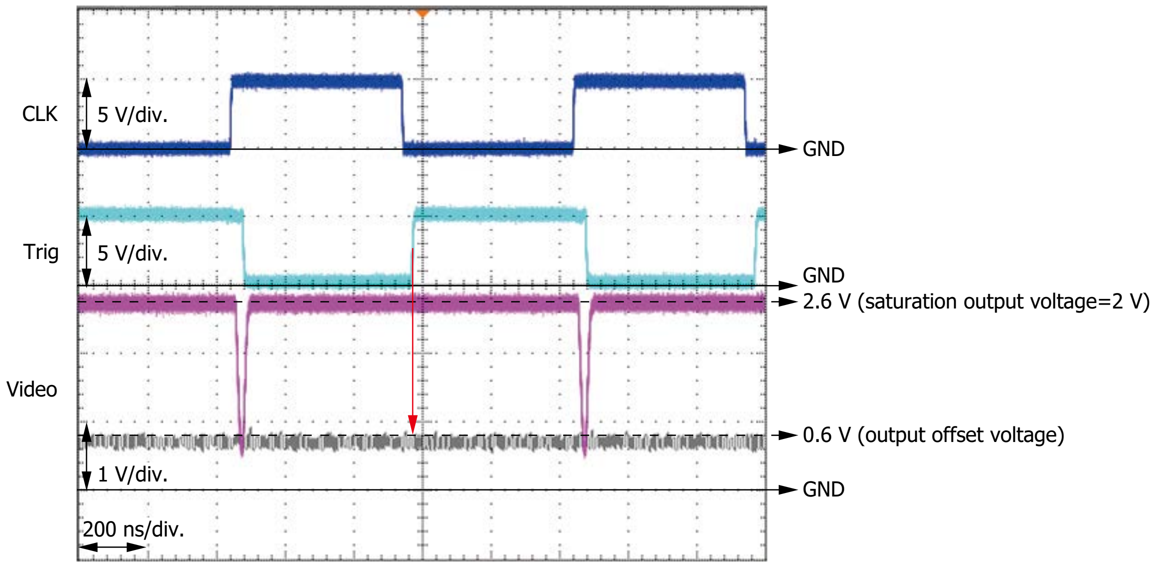
Output waveform of one pixel

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

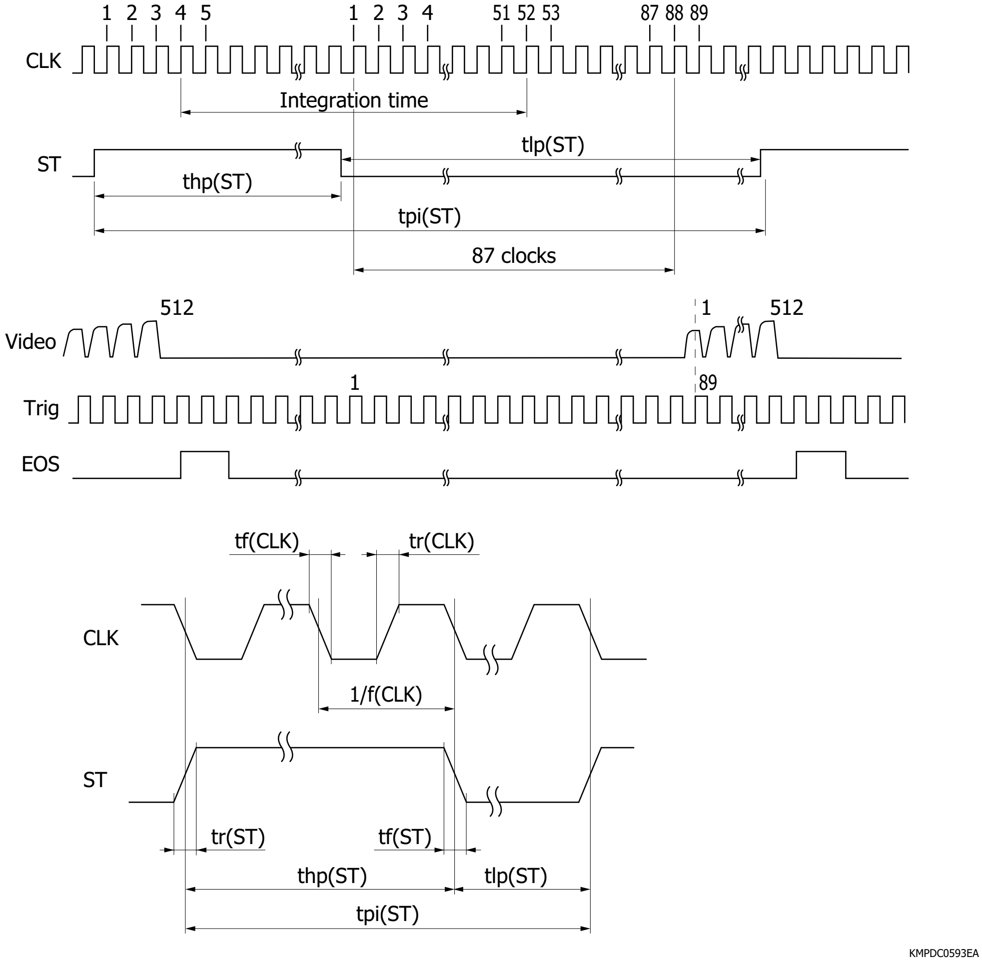
f(CLK)=DR=10 MHz



f(CLK)=DR=1 MHz



Timing chart



Parameter	Symbol	Min.	Typ.	Max.	Unit
Start pulse width interval*15	tpi(ST)	106/f(CLK)	-	-	s
Start pulse high period*15 *16	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	-	45	50	55	%
Clock pulse rise and fall times	tr(CLK), tf(CLK)	0	10	30	ns

*15: Dark output increases if the start pulse period or the start pulse high period is lengthened.

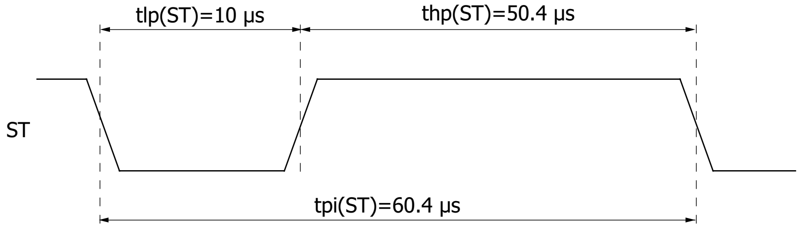
*16 The integration time equals the high period of ST plus 48 CLK cycles.
The shift register starts operation at the rising edge of CLK immediately after ST goes low.
The integration time can be changed by changing the ratio of the high and low periods of ST.
If the first Trig pulse after ST goes low is counted as the first pulse, the Video signal is acquired at the rising edge of the 89th Trig pulse.

Note: After power-on, do not float the ST and CLK input terminals. Instead, set them to high level or low level. Immediately after power-on, the signal in the sensor becomes undefined. Do not use invalid data from the first scan. Instead, use valid data from the second scan onwards.

Operation example

■ When outputting from all 512 pixels

When the clock pulse frequency is maximized (data rate is also maximized), the time of one scan is minimized, and the integration time is maximized (for outputting signals from all 512 channels)
Clock pulse frequency = Data rate = 10 MHz
Start pulse cycle = 604/f(CLK) = 604/10 MHz = 60.4 µs
High period of start pulse = Start pulse cycle - Start pulse's low period min.
= 604/f(CLK) - 100/f(CLK) = 604/10 MHz - 100/10 MHz = 50.4 µs
Integration time is equal to the high period of start pulse + 48 cycles of clock pulses, so it will be 50.4 + 4.8 = 55.2 µs.



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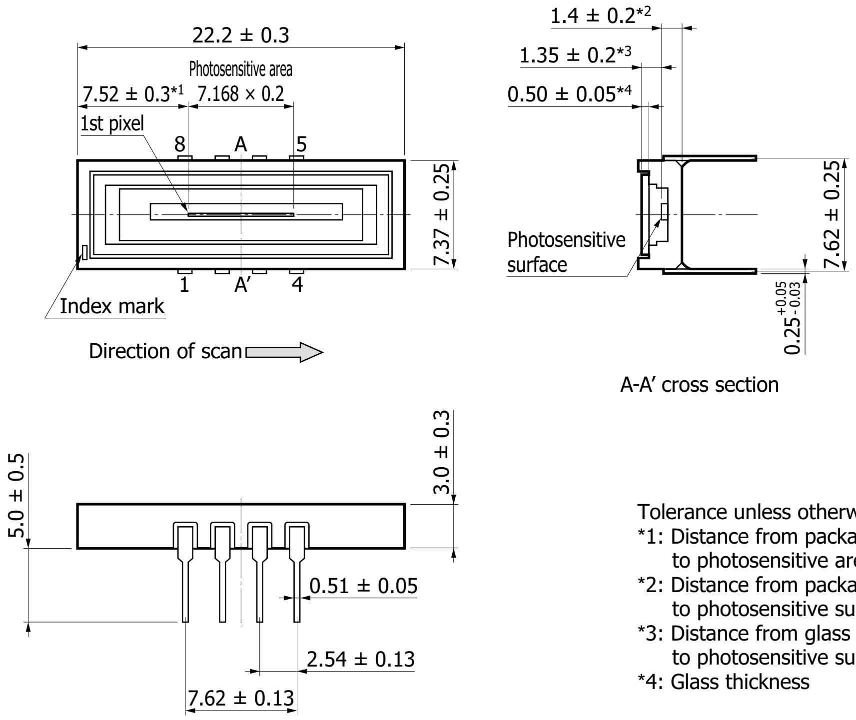
Dimensional outline (unit: mm)

S13014



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

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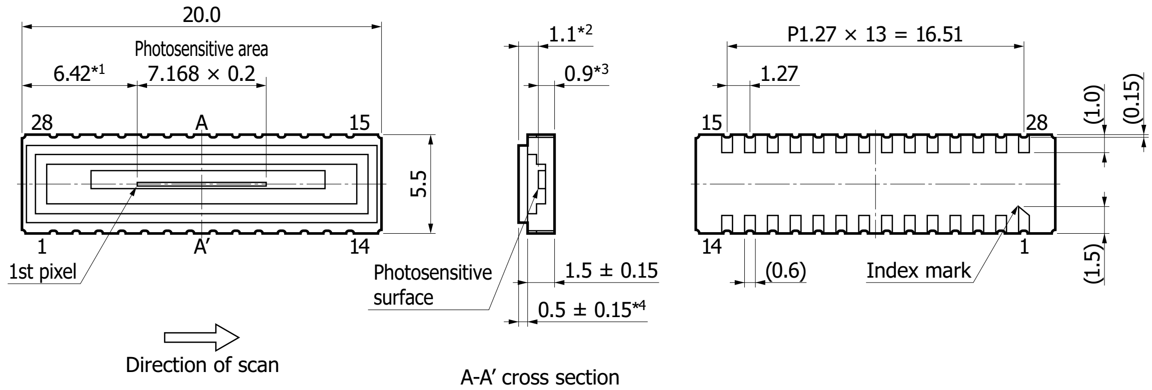
S13014-10



Tolerance unless otherwise noted: ±0.2
*1: Distance from package edge to photosensitive area edge
*2: Distance from glass surface to photosensitive surface
*3: Distance from spackage bottom to photosensitive surface
*4: Glass thickness

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Pin connections

S13014

Pin no.	Symbol	I/O	Description
1	Vlcp	-	Bias voltage for negative voltage circuit*17
2	CLK	I	Clock pulse
3	Vdd	I	Supply voltage
4	Vss	-	GND
5	Video	O	Video signal*18
6	EOS	O	End of scan
7	Trig	O	Trigger pulse for video signal acquisition*19
8	ST	I	Start pulse

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Pin no.	Symbol	I/O	Description	Pin no.	Symbol	I/O	Description
1	NC	-	No connection	15	NC	-	No connection
2	Vdd	I	Supply voltage	16	NC	-	No connection
3	ST	I	Start pulse	17	NC	-	No connection
4	Vss	-	GND	18	NC	-	No connection
5	Trig	O	Trigger pulse for video signal acquisition*19	19	NC	-	No connection
6	CLK	I	Clock pulse	20	Vss	-	GND
7	Vlcp	-	Bias voltage for negative voltage circuit*17	21	NC	-	No connection
8	Vss	-	GND	22	Vss	-	GND
9	NC	-	No connection	23	EOS	O	End of scan
10	NC	-	No connection	24	Vss	-	GND
11	NC	-	No connection	25	Vdd	I	Supply voltage
12	NC	-	No connection	26	Video	O	Video signal*18
13	NC	-	No connection	27	NC	-	No connection
14	NC	-	No connection	28	NC	-	No connection

*17: 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.
*18: 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.
*19: We recommend capturing video signal using the trigger pulse output from Trig.
Note: Leave NC pins open; do not connect to GND.

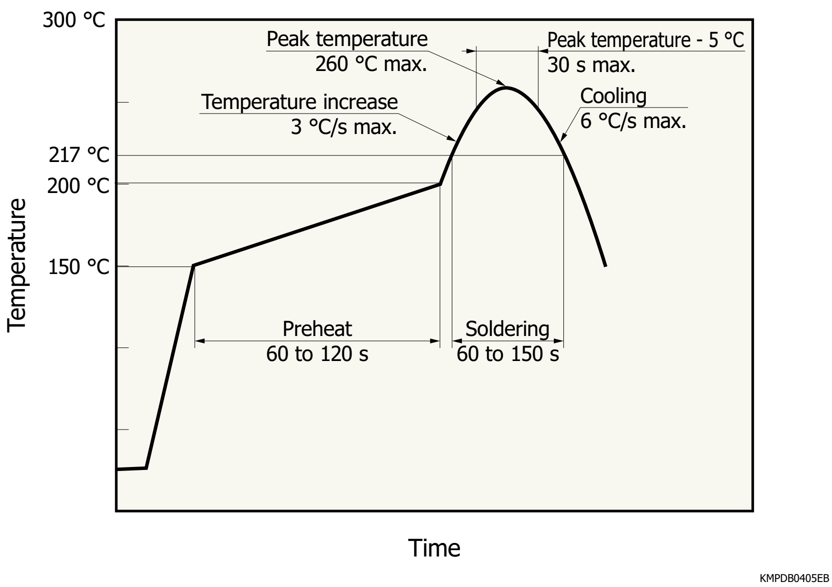
Recommended soldering conditions

S13014

Parameter	Specification	Note
Soldering temperature	260 °C max. (5 seconds or less)	

Note: When you set soldering conditions, check that problems do not occur in the product by testing out the conditions in advance.

S13014-10



Note:

· 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. 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.

Baking (S13014-10)

When applying reflow soldering after the storage period has passed after opening the package, you need to perform baking to remove moisture.

When you perform baking, be careful of the following points.

· Perform baking according to the recommended baking conditions using a clean drying machine.

· The product package tray is typically not heat tolerant. When baking, transfer the product into a heat tolerant container (metal tray or the like).

· Bake in a dry machine filled with nitrogen gas to prevent the soldering terminal from oxidation.

■ Recommended baking conditions

· Temperature: 120 °C, 3 hours, up to 2 times

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

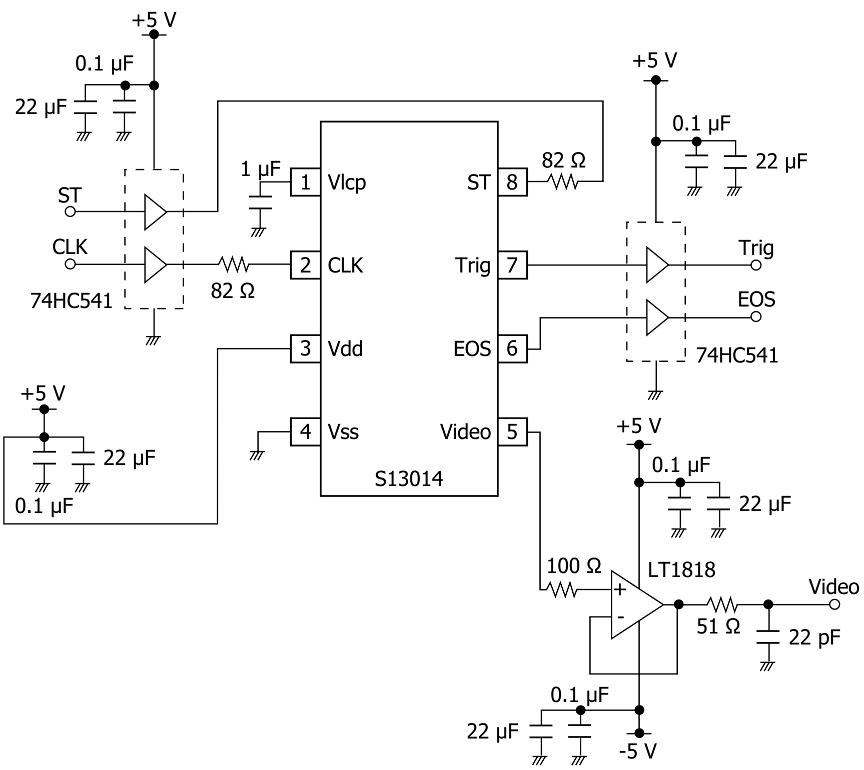
If dust or dirt gets on the light input window, it will show up as black blemishes on the image. When cleaning, avoid rubbing the window surface with dry cloth or dry cotton swab, since doing so may generate static electricity. Use soft cloth, paper or a cotton swab moistened with alcohol to wipe dust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

(3) UV exposure

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 examples

S13014



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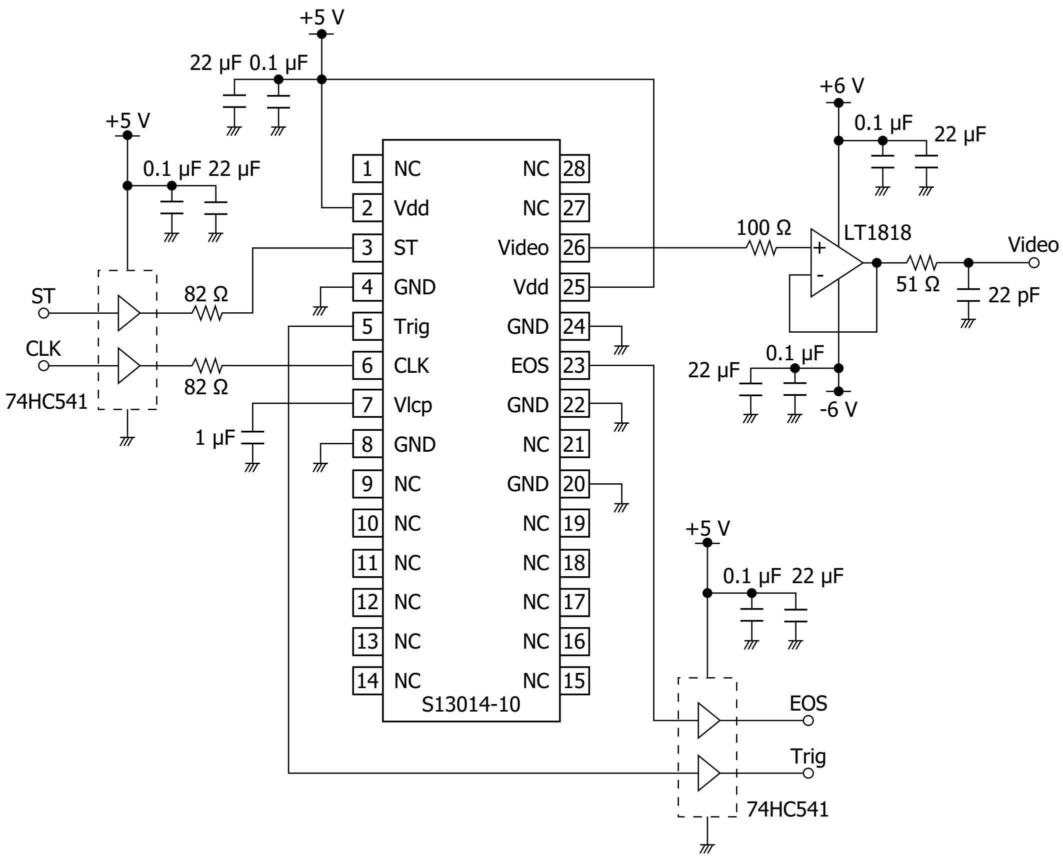
S13014-10



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Related information

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

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

■ Technical note
· CMOS linear image sensors

Driver circuit for CMOS linear image sensors C16605 [sold separately]

The driver circuit for the CMOS linear image sensors S13014 and S13014-10 is available (sold separately). It can be used for spectrometers, etc. combining with the CMOS linear image sensor. A conversion board is needed when using in combination with the S13014 and S13014-10. Contact us for detailed information.

Features

- **Built-in 16-bit A/D converter**
- **Interface to PC: USB 2.0**
- **Power supply: USB bus power operation**

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