

S11639-01

S11639-21

## High sensitivity, photosensitive area with vertically long pixels

The S11639 series is a high sensitivity CMOS linear image sensor using a photosensitive area with vertically long pixels (14 × 200 μm). Other features include high sensitivity and high resistance in the UV region. The S11639 series operates from a single 5 V supply making it suitable for use in low cost spectrometers. The S11639-21 is provided in a surface mount type package.

### Features

- Pixel size: 14 × 200 μm
- 2048 pixels
- Effective photosensitive area length: 28.672 mm
- High sensitivity: 1300 V/(lx·s)
- High sensitivity in the 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.

### Applications

- Spectrophotometry
- Position detection
- Image reading
- Encoders

### Structure

Parameter	S11639-01	S11639-21	Unit
Number of pixels	2048		-
Pixel size	14 × 200		μm
Photosensitive area length	28.672		mm
Package	LCP (liquid crystal polymer)	Surface mount type ceramic	-
Window material*1	Quartz		-

\*1: Window-less type (S11639N-01, S11639N-21) is available upon request.

### Absolute maximum ratings

Parameter	Symbol	Condition	S11639-01	S11639-21	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*2	-40 to +65		°C
Storage temperature	Tstg	No dew condensation*2	-40 to +65		°C
Soldering temperature	Tsol		*3	260 (twice)*4	°C

\*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.

\*3: See the recommended soldering conditions (P.9).

\*4: 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	3	Vdd	Vdd + 0.25	V
	Low level	0	-	0.3	
Start pulse voltage	High level	3	Vdd	Vdd + 0.25	V
	Low level	0	-	0.3	

➤ 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	-	10 M	Hz
Data rate	DR	-	f(CLK)	-	Hz
Output impedance	Zo	70	-	260	Ω
Current consumption*5 *6	Ic	20	30	50	mA

\*5: f(CLK)=10 MHz

\*6: 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*7	Sw	-	1300	-	V/(lx·s)
Conversion efficiency*8	CE	-	20	-	μV/e <sup>-</sup>
Dark output voltage*9	Vd	0	0.2	2.0	mV
Saturation output voltage*10 *11	Vsat	1.7	2.0	2.5	V
Readout noise	Nread	0.1	0.4	1.2	mV rms
Dynamic range 1*12	Drange1	-	5000	-	times
Dynamic range 2*13	Drange2	-	10000	-	times
Output offset voltage	Voffset	0.3	0.6	0.9	V
Photoresponse nonuniformity*7 *10 *14	PRNU	-	±2	±10	%
Image lag*15	Lag	-	-	0.1	%

\*7: Measured with a tungsten lamp of 2856 K

\*8: Output voltage generated per electron

\*9: Integration time=10 ms

\*10: Voltage difference from Voffset

\*11: 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.

\*12: Drange1 = Vsat/Nread

\*13: 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.

\*14: 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 2042 pixels excluding 3 pixels each at both ends, and is defined as follows:

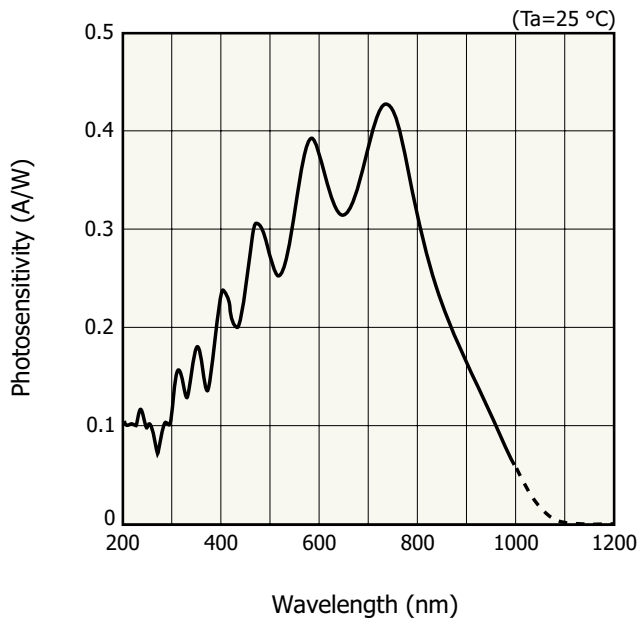
$$PRNU = \Delta X / X \times 100 (\%)$$

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

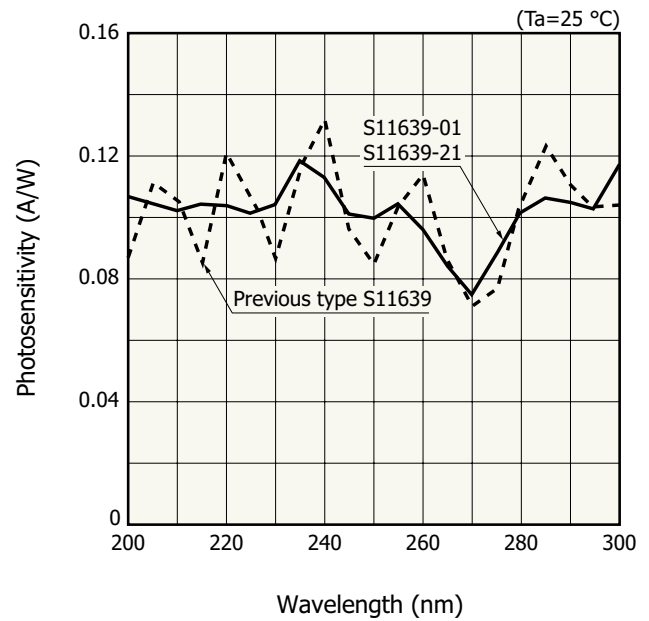
\*15: Signal components of the preceding line data that still remain even after the data is read out in a saturation output state.

Image lag increases when the output exceeds the saturation output voltage.

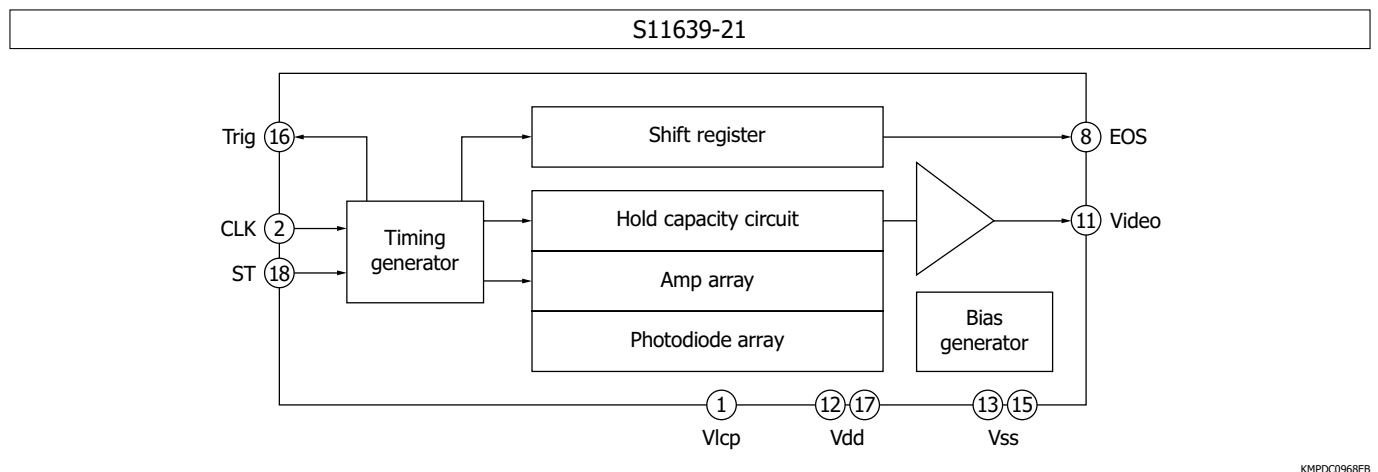
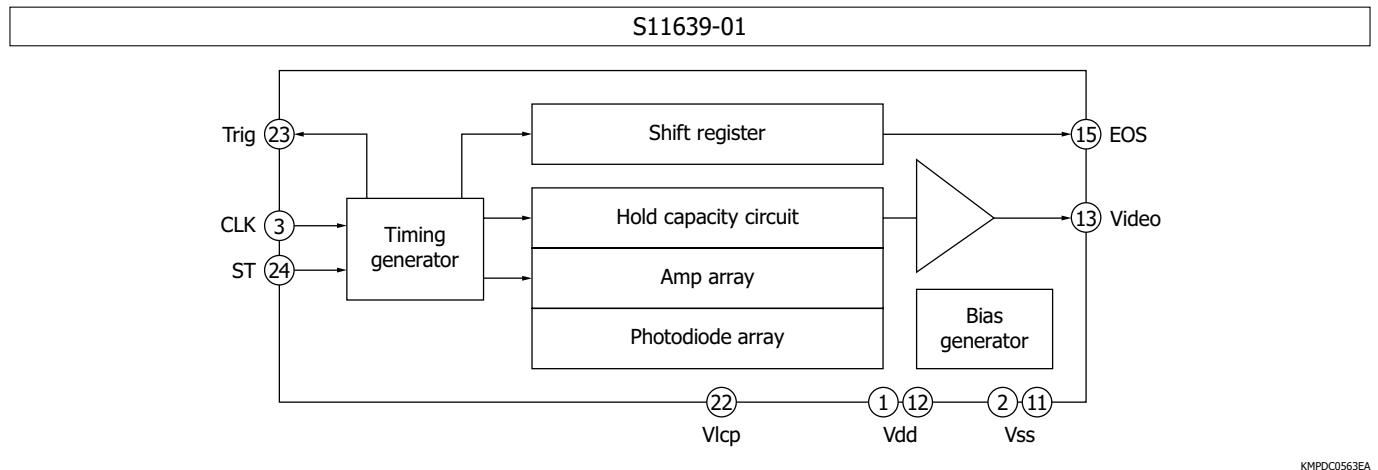
**Spectral response (typical example)**



**Spectral response in UV region (typical example)**



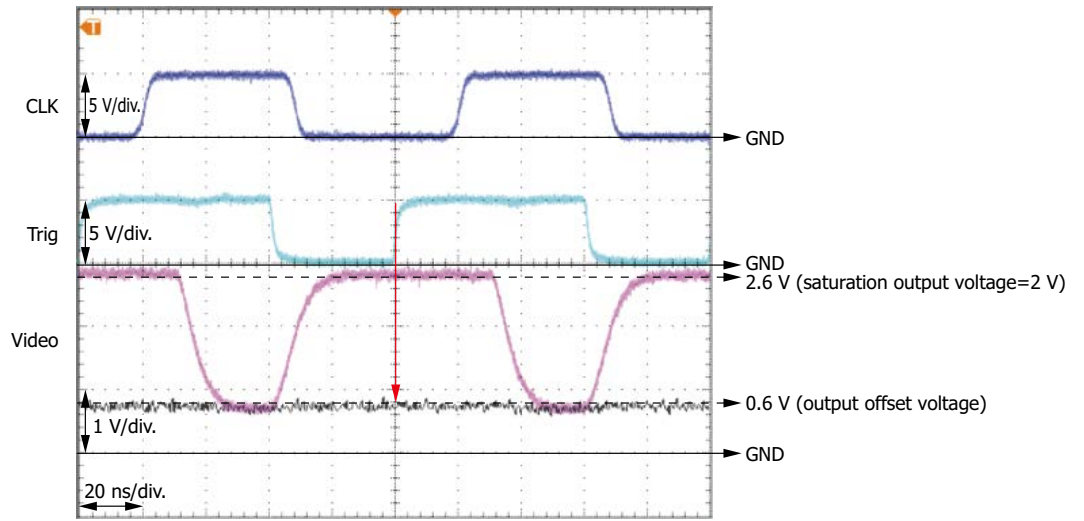
**Block diagram**



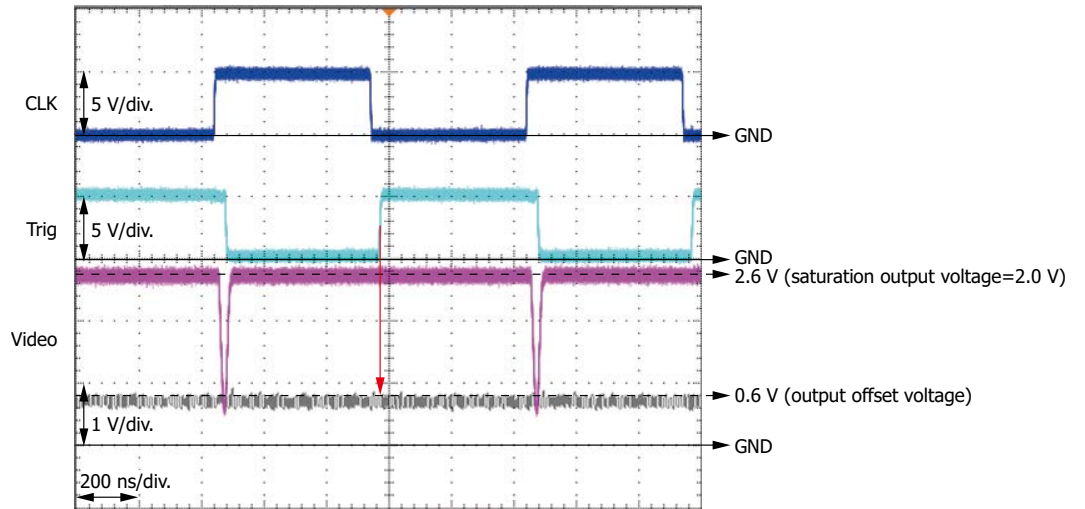
**Output waveform of a pixel**

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

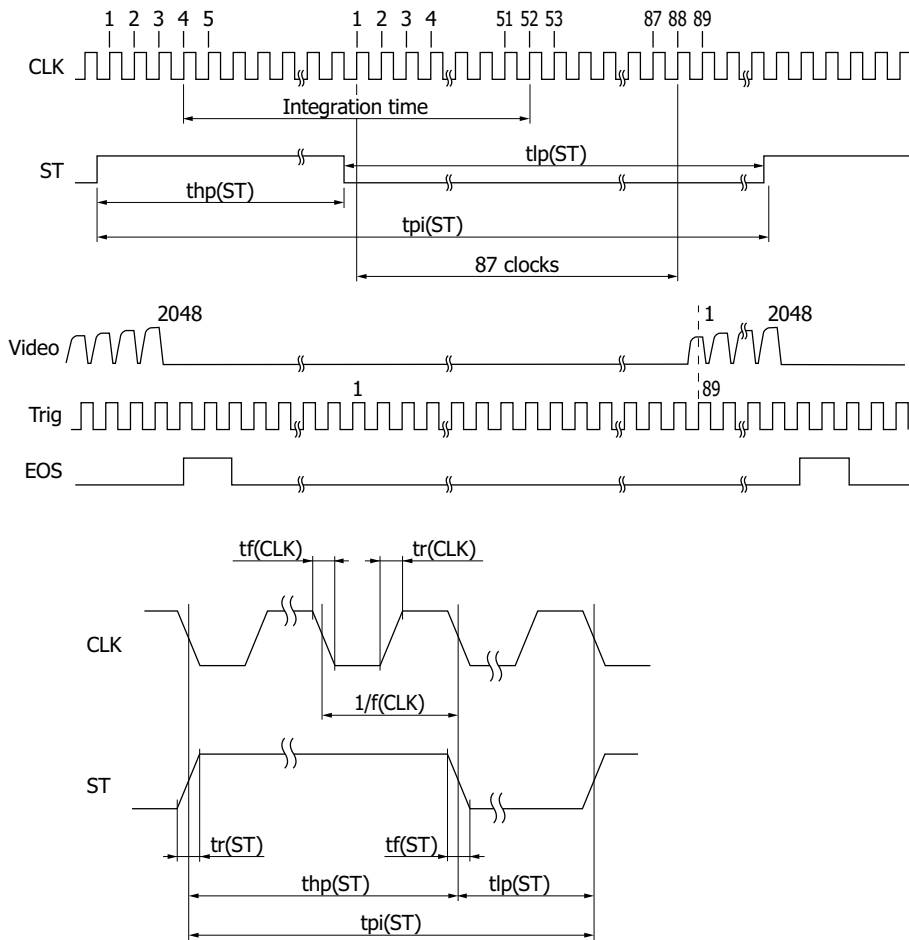
$f(\text{CLK})=\text{DR}=10\text{ MHz}$



$f(\text{CLK})=\text{DR}=1\text{ MHz}$



**Timing chart**



KMPDC0969EA

Parameter	Symbol	Min.	Typ.	Max.	Unit
Start pulse period*16	tpi(ST)	106/f(CLK)	-	-	s
Start pulse high period*16 *17	thp(ST)	6/f(CLK)	-	-	s
Start pulse low period	tlp(ST)	100/f(CLK)	-	-	s
Start pulse rise/fall times	tr(ST), tf(ST)	0	10	30	ns
Clock pulse duty	-	45	50	55	%
Clock pulse rise/fall times	tr(CLK), tf(CLK)	0	10	30	ns

\*16: Dark output increases if the start pulse period or the start pulse high period is lengthened.

\*17: 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 2048 pixels

This example assumes that the clock pulse frequency is maximized (data rate is also maximized), the time of one scan is minimized, and the integration time is maximized.

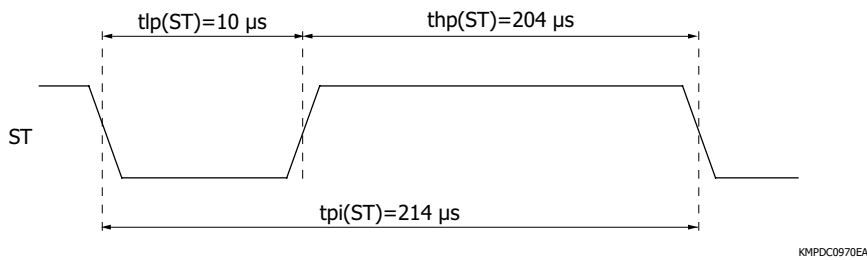
Clock pulse frequency=Data rate=10 MHz

Start pulse cycle= $2140/f(\text{CLK})=2140/10 \text{ MHz}=214 \mu\text{s}$

High period of start pulse =Start pulse cycle - Start pulse's low period min.

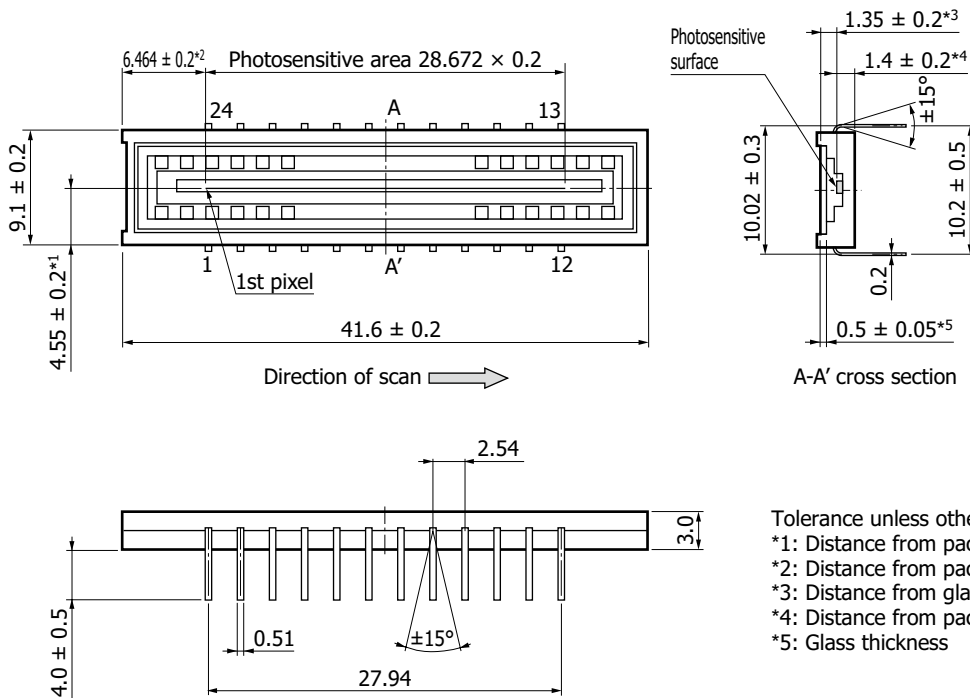
$$=2140/f(\text{CLK}) - 100/f(\text{CLK})=2140/10 \text{ MHz} - 100/10 \text{ MHz}=204 \mu\text{s}$$

Integration time is equal to the high period of start pulse + 48 cycles of clock pulses, so it will be  $204 + 4.8 = 208.8 \mu\text{s}$ .



**Dimensional outlines (unit: mm)**

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Tolerance unless otherwise noted:  $\pm 0.1$   
 \*1: Distance from package edge to photosensitive area center  
 \*2: Distance from package edge to photosensitive area edge  
 \*3: Distance from glass surface to photosensitive surface  
 \*4: Distance from package bottom to photosensitive surface  
 \*5: Glass thickness

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**Pin connections**

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

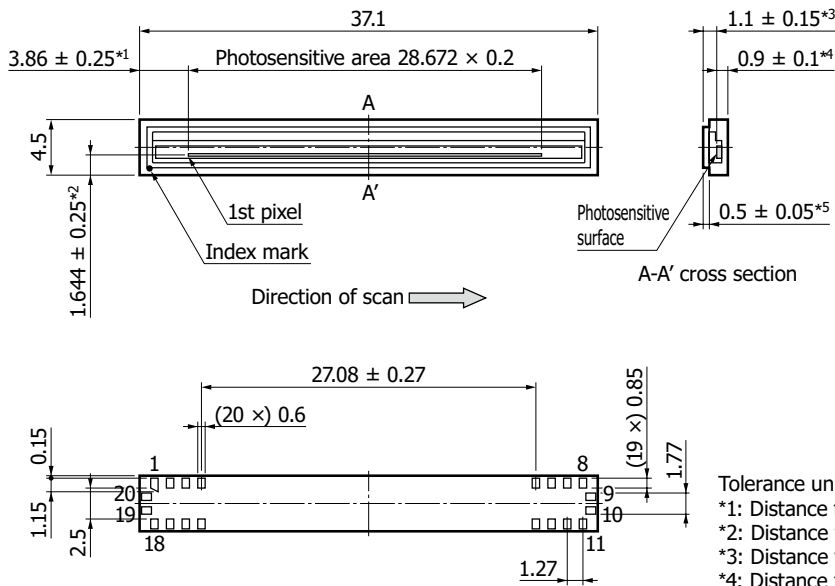
\*18: Connect a buffer amplifier for impedance conversion to the video output terminal so as to minimize the current flow. As the buffer amplifier, use a high input impedance op-amp with JFET or CMOS input.

\*19: 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  $\mu$ F between Vlcp and GND.

\*20: We recommend capturing video signal using the trigger pulse output from Trig.

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

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Tolerance unless otherwise noted:  $\pm 0.2$   
 \*1: Distance from package edge to photosensitive area edge  
 \*2: Distance from package edge to photosensitive area center  
 \*3: Distance from glass surface to photosensitive surface  
 \*4: Distance from package bottom to photosensitive surface  
 \*5: Glass thickness

KMPDA0371EB

**Pin connections**

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

\*21: 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  $\mu$ F between Vlcp and GND.  
 \*22: 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.  
 \*23: We recommend capturing video signal using the trigger pulse output from Trig.  
 Note: Leave the "NC" terminals open and do not connect them to GND.



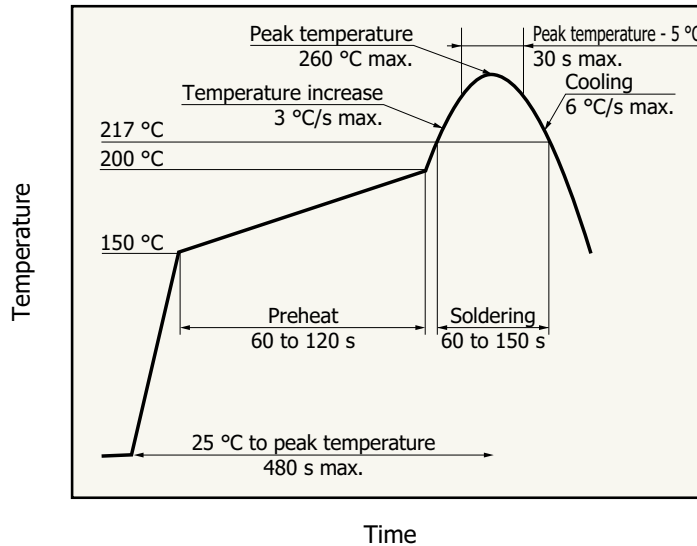
**Recommended soldering conditions**

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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.

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KSPDB0419EA

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 receives 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.

**Precautions**

(1) Electrostatic countermeasures

These devices has a built-in protection circuit against static electrical charges. However, to prevent destroying the devices with electrostatic charges, take countermeasures such as grounding yourself, the workbench and tools to prevent static discharges. Also protect these devices from surge voltages which might be caused by peripheral equipment.

(2) Light input window

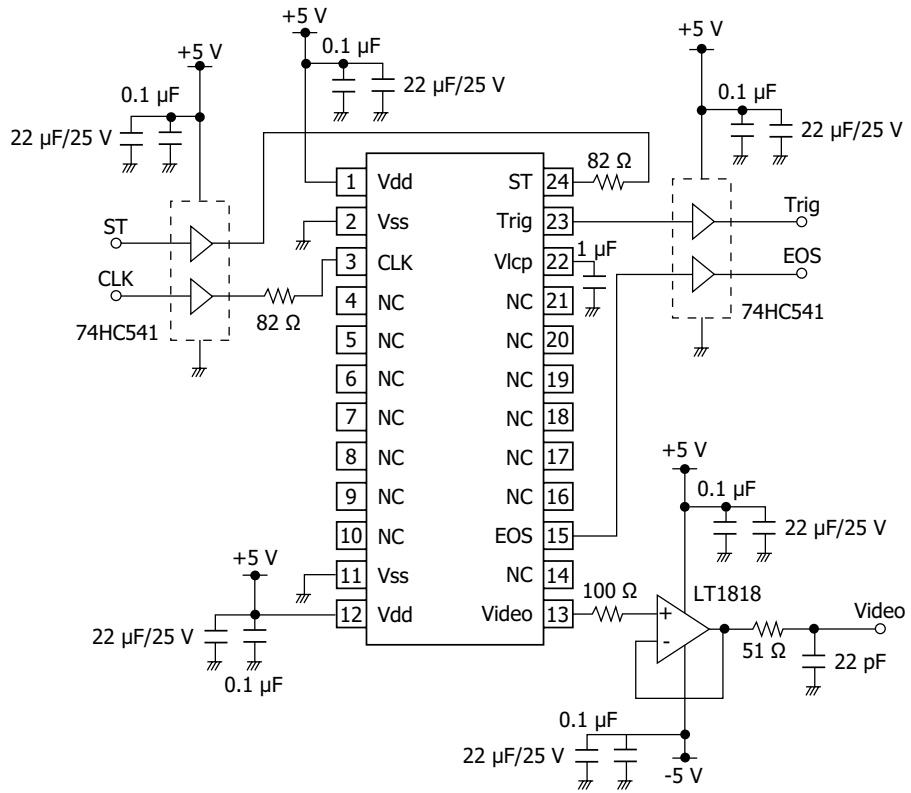
If dust or stain adheres to the surface of the input window glass, it will appear as black spots on the image. When cleaning, avoid rubbing the window surface with dry cloth, dry cotton swab or the like, since doing so may generate static electricity. Use soft cloth, paper, a cotton swab, or the like moistened with alcohol to wipe off dust and stain. Then blow compressed air so that no stain remains.

(3) UV light irradiation

These products are designed to reduce characteristic deterioration under UV light irradiation, but unnecessary irradiation should be avoided. Also avoid exposing the bonding sections of the glass to UV light.

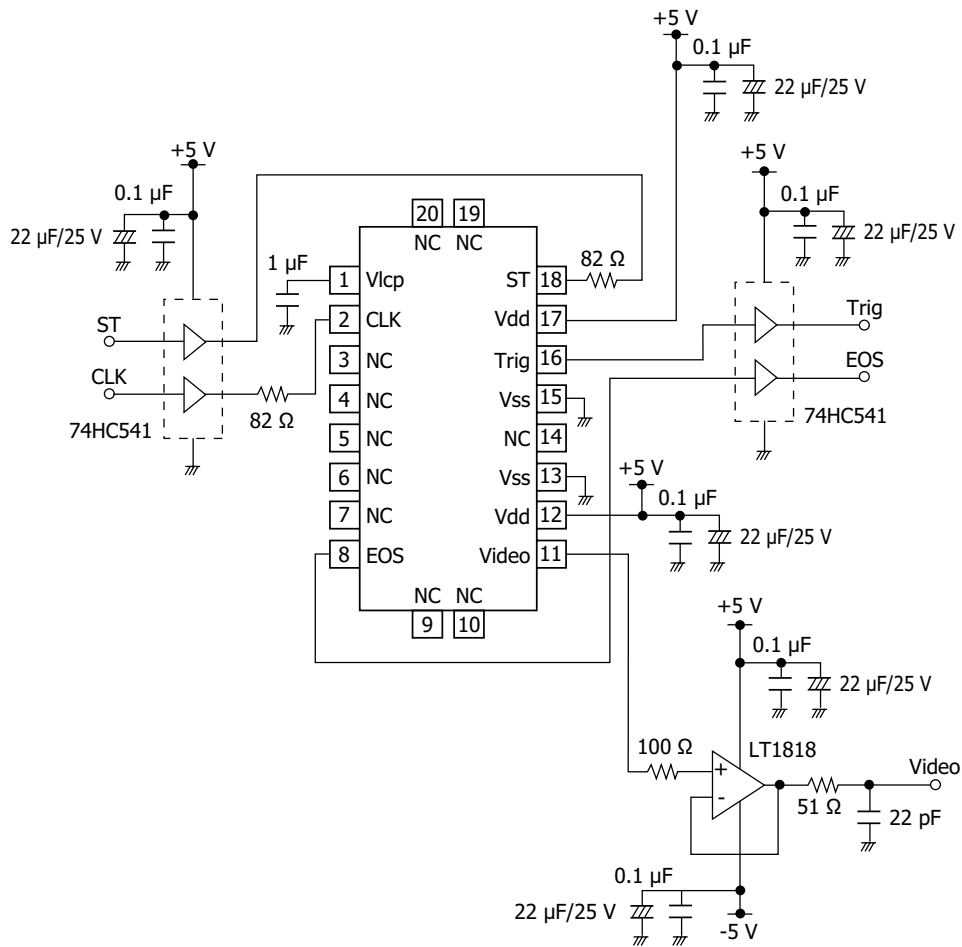
Application circuit examples

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KMPDC0564EA

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KMPDC0718EB

■ Related information

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

- Precautions
  - Disclaimer
  - Image sensors
  - Surface mount type products
- Technical information
  - CMOS linear image sensors

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

The driver circuit for CMOS linear image sensors S11639-01/-21 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 S11639-21. Contact us for detailed information.



## Features

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

Information described in this material is current as of October 2024.

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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