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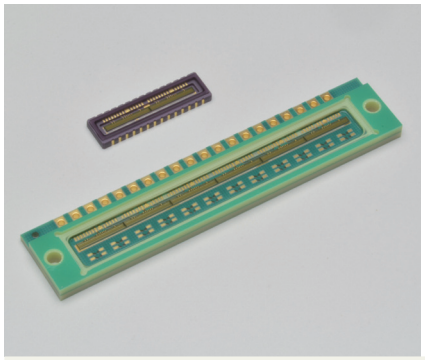
NEW

CMOS linear image sensors



S14416 series

Wide dynamic range and 400 dpi

The S14416 series are low current consumption CMOS linear image sensors with a 10 MHz video data rate. The pixel size is 63.5 × 63.5 µm.

Features

- **Pixel size: 63.5 × 63.5 µm**
  S14416-02: 256 pixels
  S14416-06: 768 pixels
- **High speed data rate: 10 MHz max.**
- **Single 3 V or 5 V supply voltage operation**
- **Built-in timing generator; requires only a start pulse and clock pulse for operation**
- **Low current consumption**
- **Simultaneous integration capable**

Applications

- **Position detection**
- **Object measurement**
- **Various types of image readout**

Structure

Parameter	S14416-02	S14416-06	Unit
Number of pixels	256	768	-
Pixel pitch	63.5		µm
Pixel height	63.5		µm
Effective photosensitive area length	16.256	48.768	mm
Package	Ceramic	Glass epoxy	-
Window material	Borosilicate glass (Tempax)		-

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*1	Topr		-40 to +85	°C
Storage temperature*1	Tstg		-40 to +85	°C
Reflow soldering conditions*2 *3	Tsol		Peak temperature: 260 °C, three times (see P.12)	-

*1: No dew condensation
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: JEDEC MSL 5
*3: S14416-02 only
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

Parameter		Symbol	Min.	Typ.	Max.	Unit
Supply voltage		Vdd	3.0	5	5.25	V
Clock pulse voltage	High level	V(CLK)	3.0	Vdd	Vdd + 0.25	V
	Low level		0	-	0.4	
Start pulse voltage	High level	V(ST)	3.0	Vdd	Vdd + 0.25	V
	Low level		0	-	0.4	

Electrical characteristics (Ta=25 °C)

Parameter		Symbol	S14416-02			S14416-06			Unit
			Min.	Typ.	Max.	Min.	Typ.	Max.	
Clock pulse frequency		f(CLK)	5 k	-	10 M	5 k	-	10 M	Hz
Data rate		DR	-	f(CLK)	-	-	f(CLK)	-	Hz
Output impedance		Zo	60	-	140	60	-	140	Ω
Current consumption*3	Vdd=3 V	Ic	8	12	16	24	36	48	mA
	Vdd=5 V		14	18	22	42	54	66	

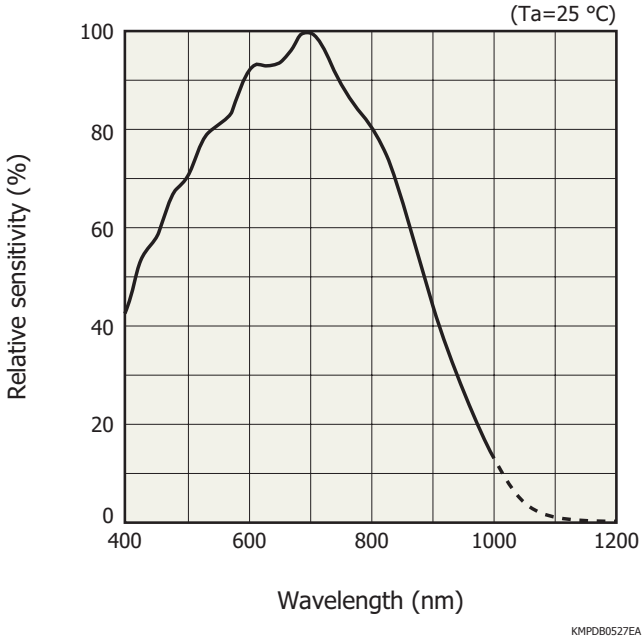
*3: f(CLK)=10 MHz, dark state, V(CLK)=V(ST)=Vdd

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

Parameter		Symbol	Min.	Typ.	Max.	Unit
Spectral response range		λ		400 to 1000		nm
Peak sensitivity wavelength		λp	-	700		nm
Photosensitivity*4		S	-	80	-	V/(lx·s)
Conversion efficiency*5		CE	-	0.75	-	μV/e⁻
Output offset voltage		Voffset	0.5	0.8	1.1	V
Dark output voltage*6		VD	-	0.02	0.2	mV
Saturation output voltage*7	Vdd=3 V	Vsat	1.8	2.0	2.2	V
	Vdd=5 V		3.7	4.0	4.3	
Readout noise*8	Vdd=3 V	Nread	-	1.0	1.5	mV rms
	Vdd=5 V		-	0.7	1.2	
Dynamic range 1*9	Vdd=3 V	Drange1	-	2000	-	times
	Vdd=5 V		-	5700	-	
Dynamic range 2*10	Vdd=3 V	Drange2	-	100000	-	times
	Vdd=5 V		-	200000	-	
Photoresponse nonuniformity*4 *11		PRNU	-	±2	±10	%

*4: 2856 K, tungsten lamp
*5: Output voltage generated per electron
*6: Integration time=10 ms
*7: Voltage difference from Voffset
*8: Dark state
*9: DR1 = Vsat/Nread
*10: DR2 = Vsat/VD
*11: Photoresponse nonuniformity is the output non-uniformity when a uniform light with a light exposure that is 50% of saturation output is incident on the entire photosensitive area. It is defined as follows for the 250 pixels excluding the three pixels at each end of the sensor (S14416-02) and for the 762 pixels excluding the three pixels at each end of the sensor (S14416-06).
PRNU = ΔX/X × 100 [%]
X: Average of the output of all pixels, ΔX: difference between the maximum or minimum output and X

Spectral response (typical example)



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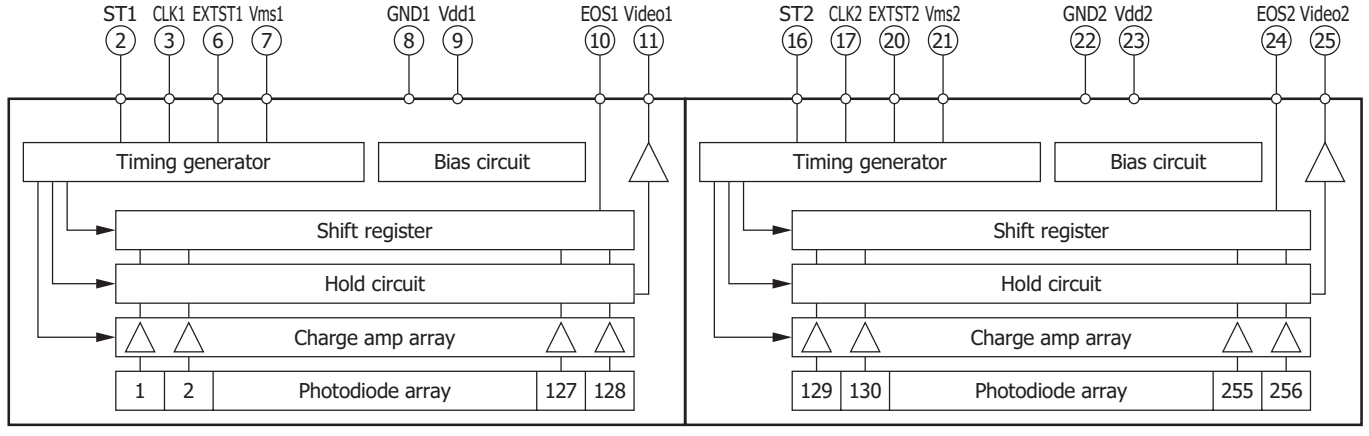
Block diagram

S14416-02



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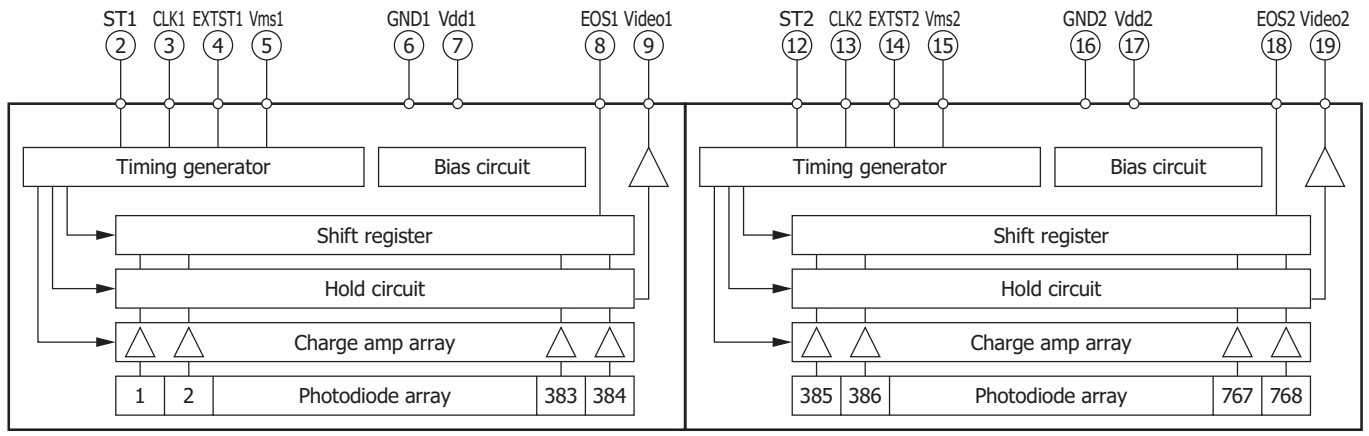
S14416-06



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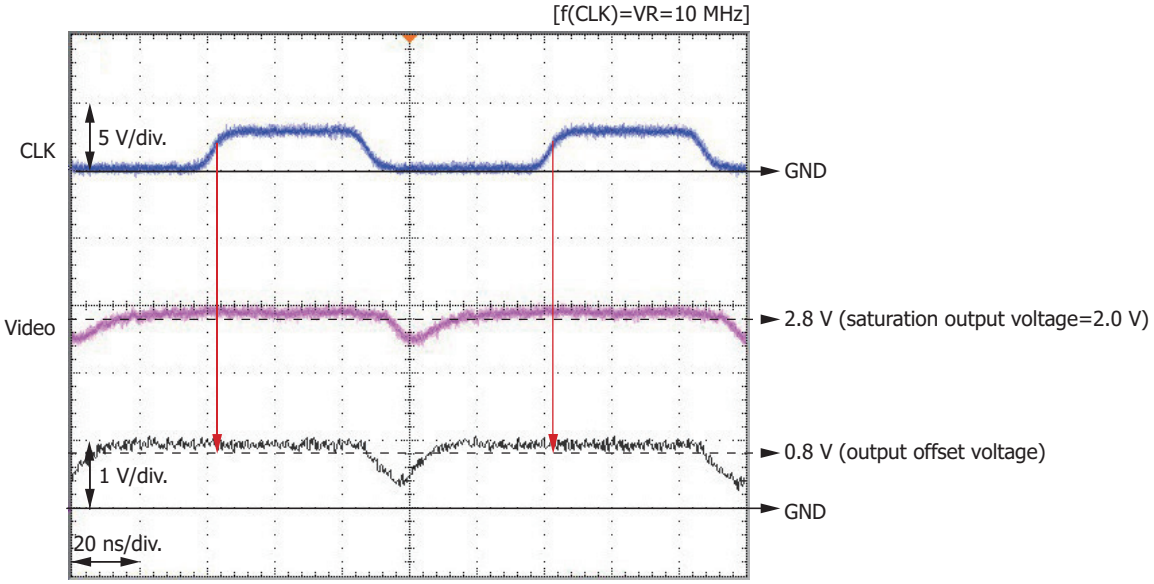
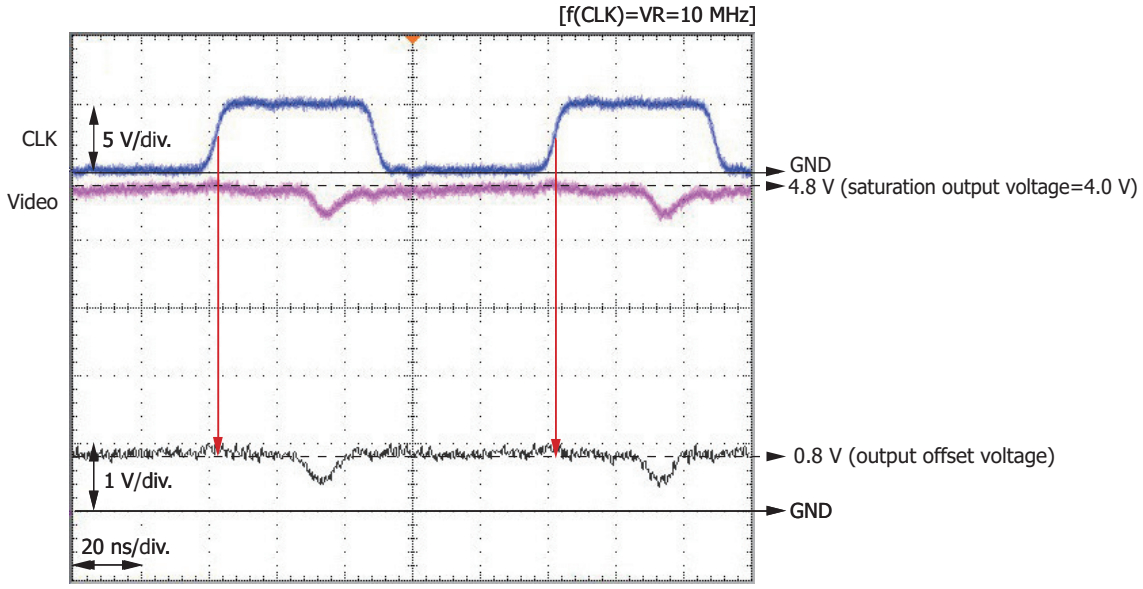
Output waveform of a pixel

The video signal is captured at the rising edge of the CLK signal (see the red arrow).

■ Vdd=3 V

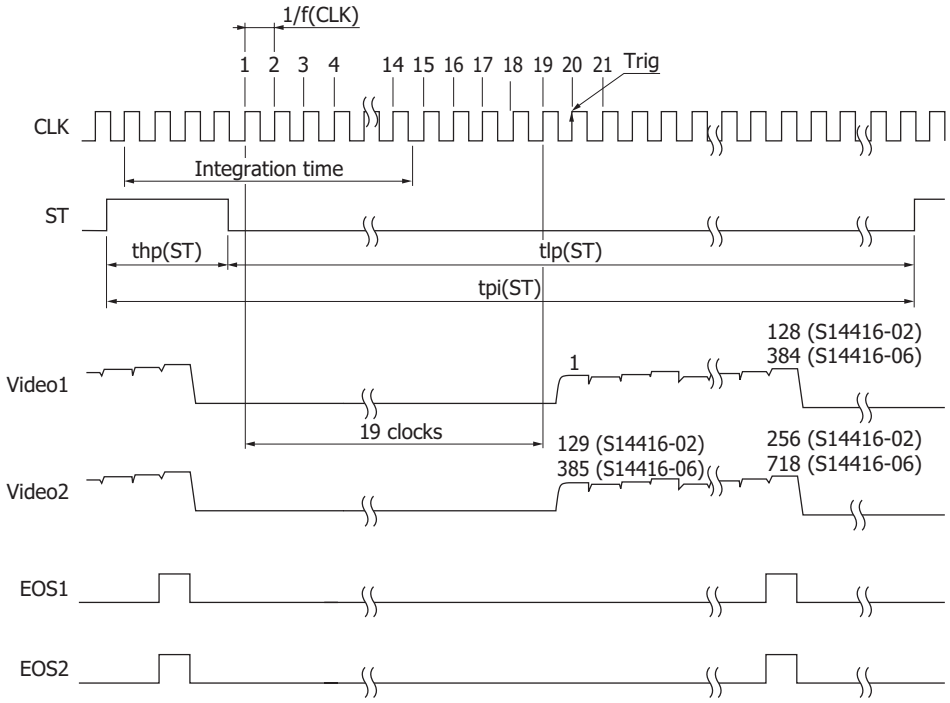


■ Vdd=5 V



Timing chart

Parallel readout



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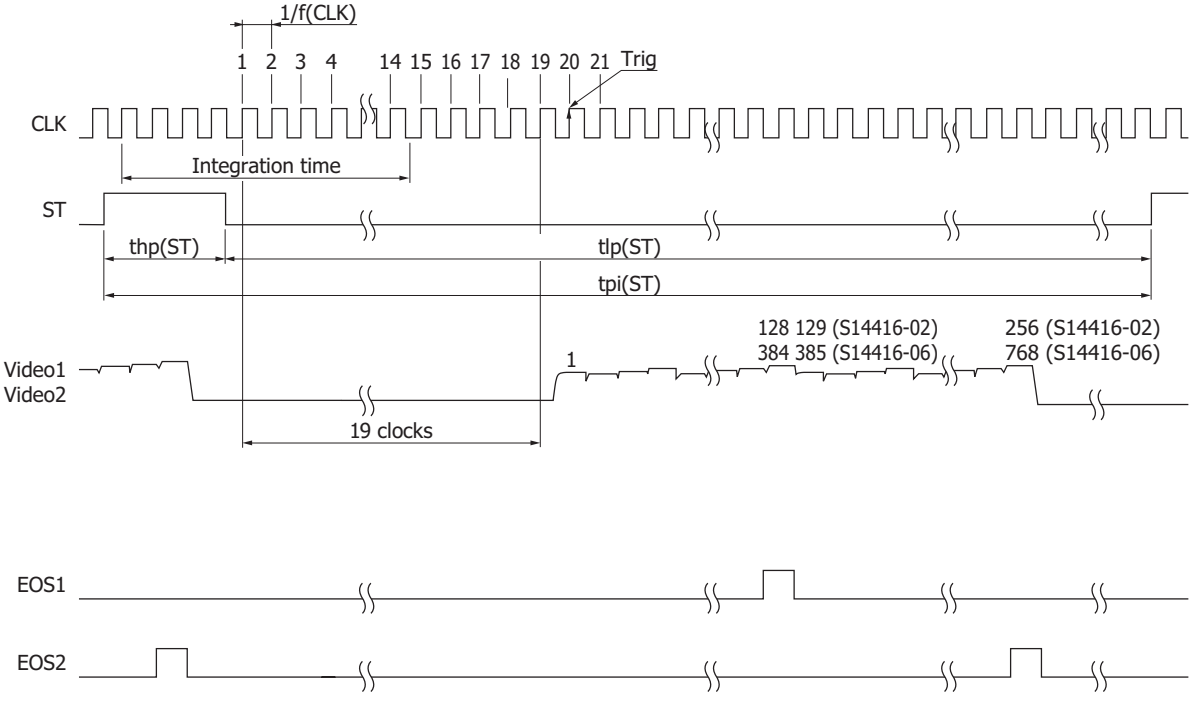
Serial readout



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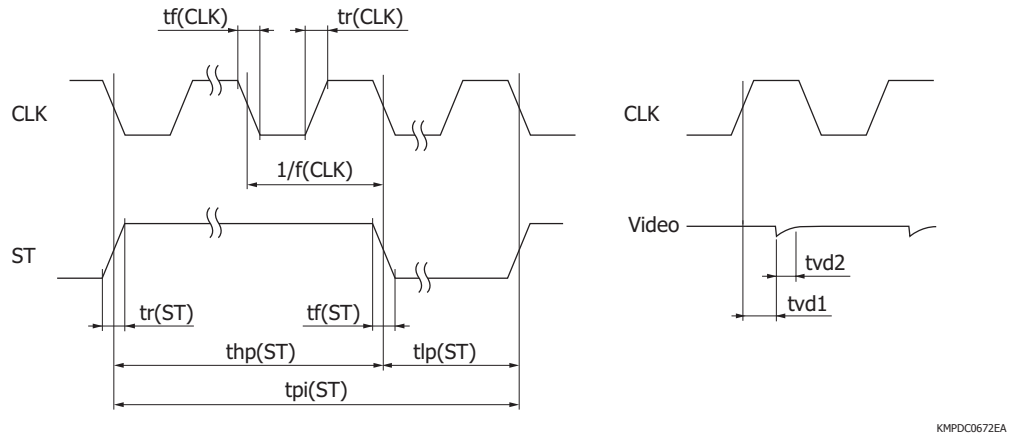


Parameter		Symbol	Min.	Typ.	Max.	Unit
Start pulse period		tpi(ST)	36/f(CLK)	-	-	s
High start pulse period		thp(ST)	4/f(CLK)	-	-	s
Low start pulse period		tlp(ST)	32/f(CLK)	-	-	s
Start pulse rise/fall times		tr(ST), tf(ST)	0	10	15	ns
Clock pulse duty ratio		-	45	50	55	%
Clock pulse rise/fall times		tr(CLK), tf(CLK)	0	10	15	ns
Video delay time 1*12	Vdd=3 V	tvd1	-	60	-	ns
	Vdd=5 V		-	35	-	
Video delay time 2*12	Vdd=3 V	tvd2	-	35	-	ns
	Vdd=5 V		-	30	-	

*12: Ta=25 °C, CLK=10 MHz, V(CLK)=V(ST)=Vdd

Note: If the start pulse period or high start pulse period is increased, the dark output increases.
The internal timing circuit starts operation at the rising edge of CLK immediately after an ST pulse goes low. This rising edge of CLK is considered to be 1.
The integration time corresponds to high ST period + 14 CLK cycles - 100 ns.
If ST is set to low while the shift register is running, the shift register operation is reset and the next operation begins.
The integration time can be changed by changing the ratio of the high and low periods of ST.

Setting for each readout method

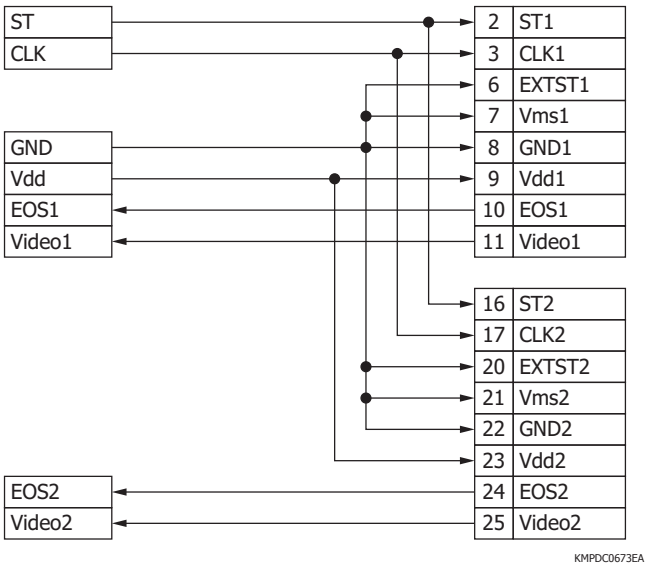
S14416-02

The S14416-02 output terminals are divided into Video1 consisting of 1 ch to 128 ch and Video2 consisting of 129 ch to 256 ch.
To read Video1 and Video2 in parallel mode, use setting A in the following table.
To read Video1 and Video2 in serial mode, use setting B in the following table for the first stage and setting C for the second stage.

Setting	Readout method	Vms	EXTST
A	All stages of parallel readout	GND	GND
B	First stage of serial readout	GND	Vdd
C	Second stage of serial readout	Vdd	Preceding stage EOS is input.

■ Connection examples

· Parallel readout method



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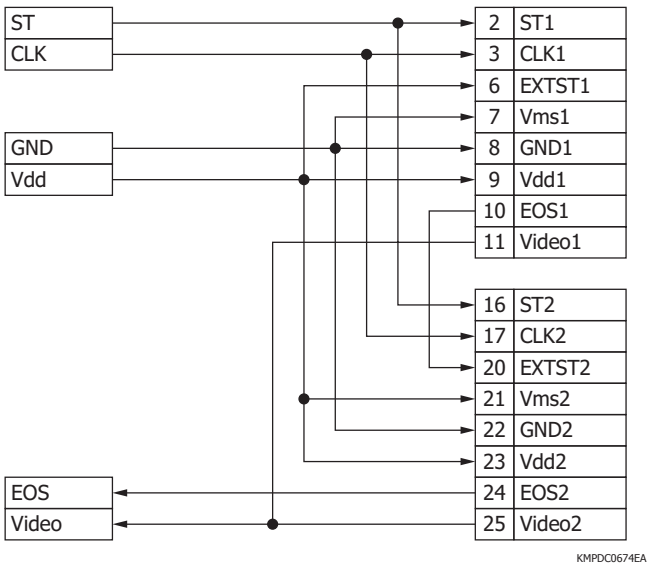
· Serial readout method



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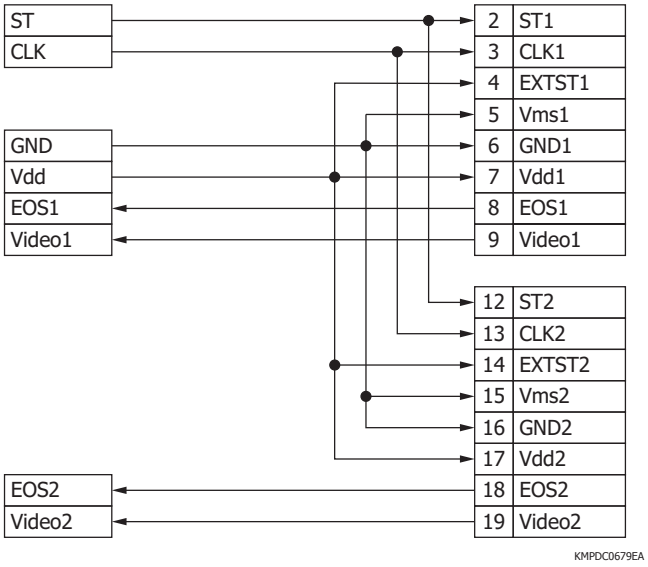
S14416-06

The S14416-06 output terminals are divided into Video1 consisting of 1 ch to 384 ch and Video2 consisting of 385 ch to 768 ch.
To read Video1 and Video2 in parallel mode, use setting A in the following table.
To read Video1 and Video2 in serial mode, use setting A in the following table for the first stage and setting B for the second stage.

Setting	Readout method	Vms	EXTST
A	All stages of parallel readout, First stage of serial readout	GND	Vdd
B	Second stage of serial readout	Vdd	Preceding stage EOS is input.

■ Connection examples

· Parallel readout method



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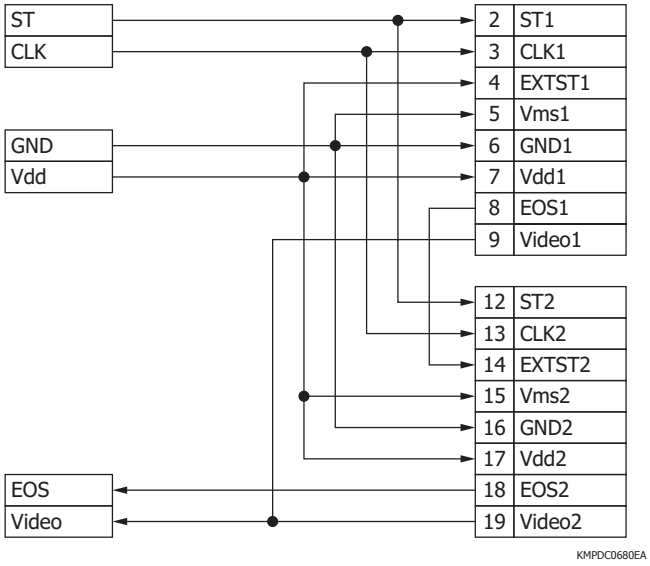
· Serial readout method



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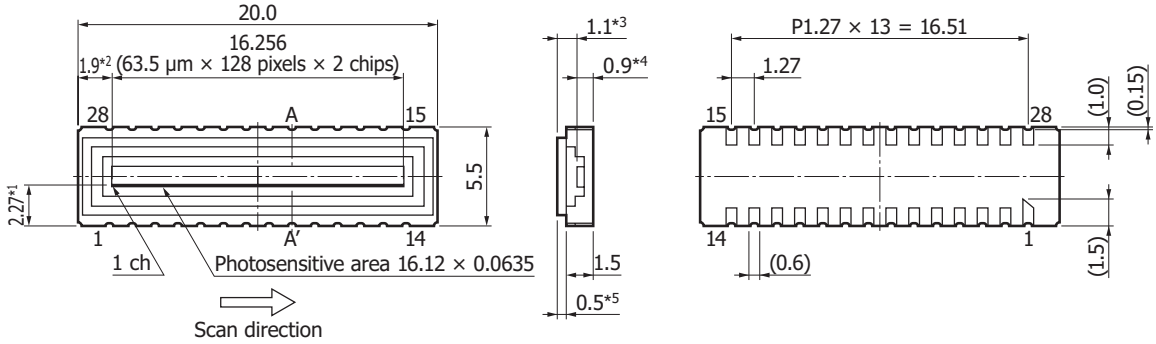
Dimensional outlines (unit: mm)

S14416-02



Tolerance unless otherwise noted: ±0.2
*1: Distance from the end of the package to the center of the photosensitive area
*2: Distance from the end of the package to the end of the photosensitive area
*3: Distance from the glass surface to the photosensitive area
*4: Distance from the bottom of the substrate to the photosensitive area
*5: Glass thickness

A-A' cross section

Pin no.	Symbol	I/O	Pin no.	Symbol	I/O
1	NC		15	NC	
2	ST1	I	16	ST2	I
3	CLK1	I	17	CLK2	I
4	NC		18	NC	
5	NC		19	NC	
6	EXTST1	I	20	EXTST2	I
7	Vms1	I	21	Vms2	I
8	GND1	I	22	GND2	I
9	Vdd1	I	23	Vdd2	I
10	EOS1	O	24	EOS2	O
11	Video1	O	25	Video2	O
12	NC		26	NC	
13	NC		27	NC	
14	NC		28	NC	

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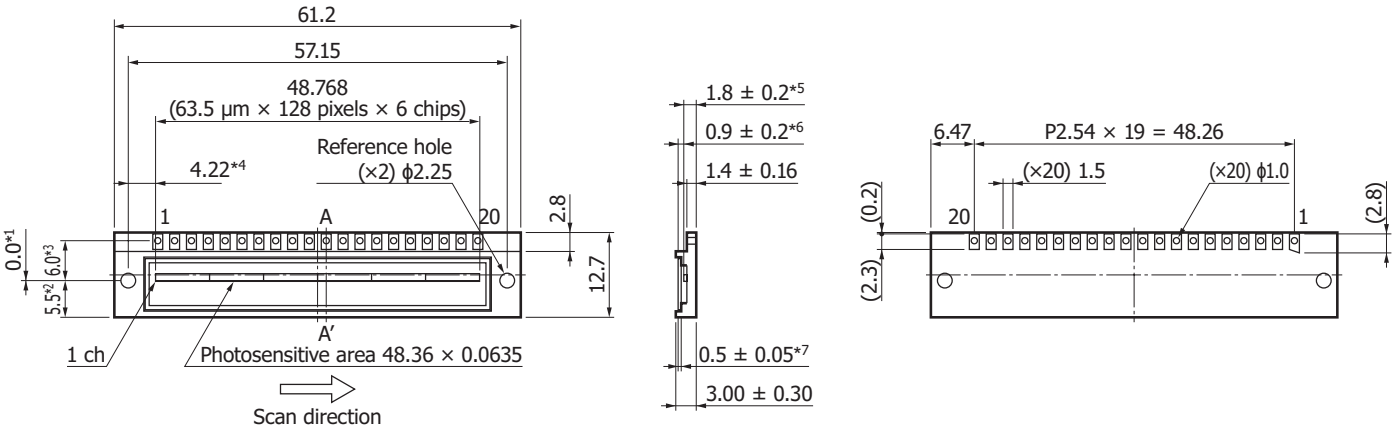
S14416-06



Tolerance unless otherwise noted: ±0.2
*1: Distance from the center of the reference hole to the center of the photosensitive area
*2: Distance from the end of the substrate to the center of the reference hole
*3: Distance from the center of the terminal hole to the center of the reference hole
*4: Distance from the center of the reference hole to the end of the photosensitive area
*5: Distance from the bottom of the substrate to the photosensitive area
*6: Distance from the glass surface to the photosensitive area
*7: Glass thickness

A-A' cross section

Pin no.	Symbol	I/O	Pin no.	Symbol	I/O
1	NC		11	NC	
2	ST1	I	12	ST2	I
3	CLK1	I	13	CLK2	I
4	EXTST1	I	14	EXTST2	I
5	Vms1	I	15	Vms2	I
6	GND1	I	16	GND2	I
7	Vdd1	I	17	Vdd2	I
8	EOS1	O	18	EOS2	O
9	Video1	O	19	Video2	O
10	NC		20	NC	

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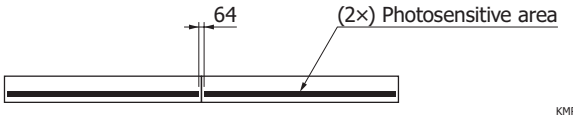
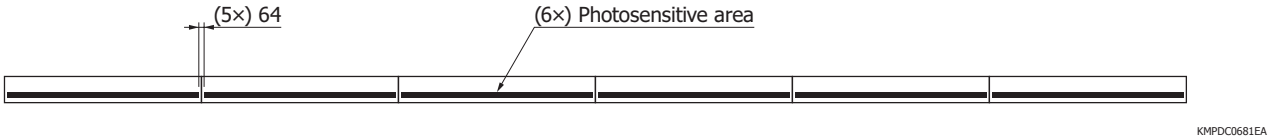
Photosensitive area layout (unit: µm)

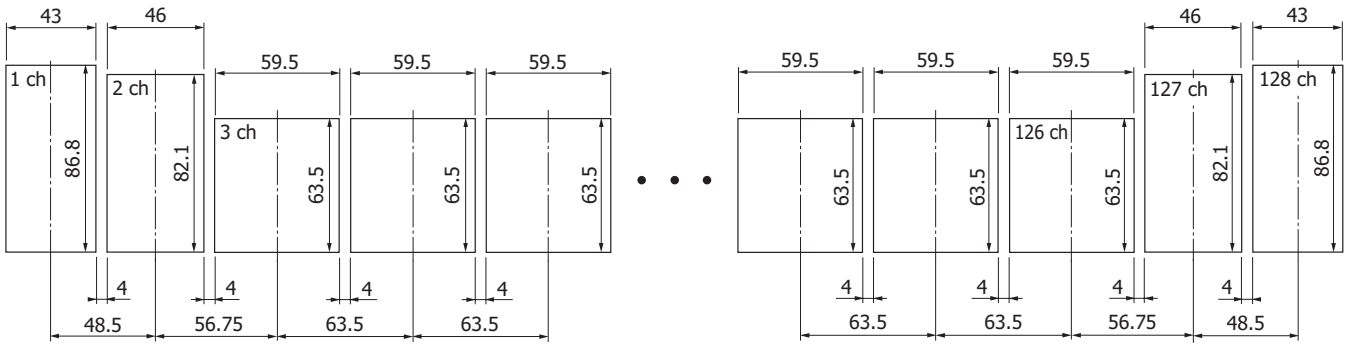
S14416-02



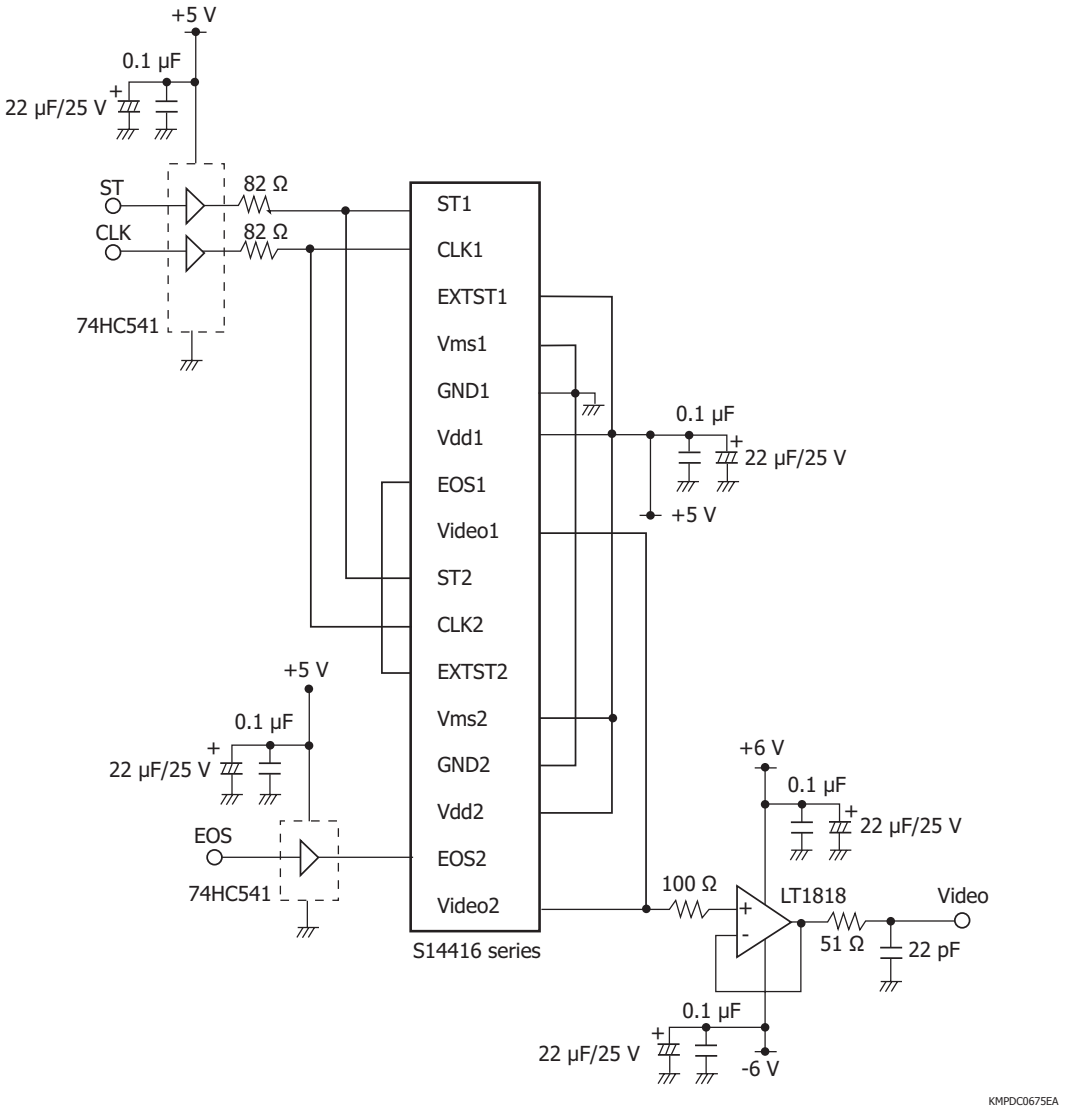
S14416-06



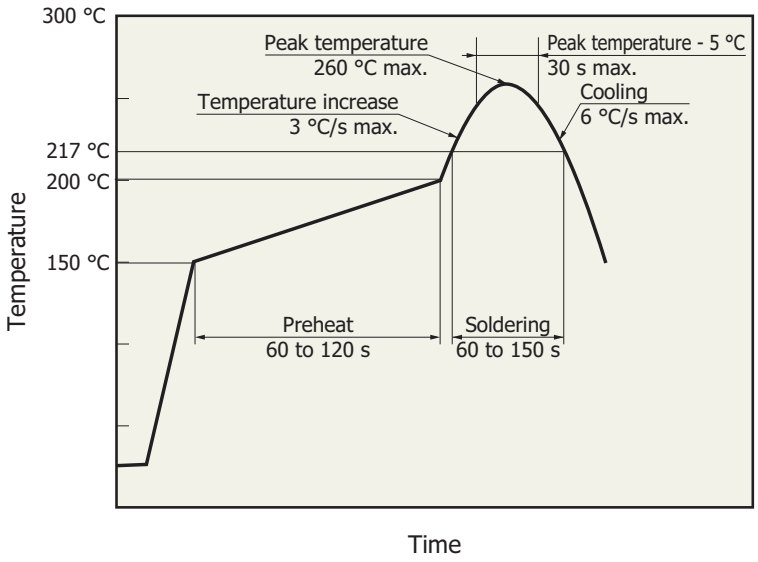
Enlarged view of photosensitive area (×1) (unit: µm)



Application circuit example



Recommended temperature profile for reflow soldering (S14416-02, typical example)



· 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 24 hours.
· 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.

Recommended baking condition

See Precautions of surface mount type products (P13. Related information).

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 stain adheres to the surface of the light 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, a cotton swab, or the like moistened with alcohol to wipe dust and stain off the window surface. Then blow compressed air onto the window surface so that no dust or stain remains.

(3) Operating and storage environments
Handle the device within the temperature range specified in the absolute maximum ratings. Operating or storing the device at an excessively high temperature and humidity may cause variations in performance characteristics and must be avoided.

(4) 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.

(5) Reflow soldering
Soldering conditions vary depending on the size of the circuit board, reflow oven, and the like. Check the conditions advance before soldering. 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.

(6) UV light irradiation
This product is not designed to resist characteristic deterioration under UV light irradiation. Do not apply UV light to it.

Related information

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

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

■ Technical information

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