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CMOS linear image sensors

S15908-512Q   S15909-1024Q

Smooth spectral sensitivity in UV to NIR regions, With variable integration time function for each pixel

The S15908-512Q and S15909-1024Q are self-scanning photodiode arrays designed specifically as detectors for spectroscopy. The scanning circuit operates at low power consumption and is easy to handle. Each photodiode has a large photosensitive area and smoothly varying spectral response characteristics in UV to near IR region.

Features

→ **Suppress fringe of spectral response curve from UV to IR region**

→ **High UV sensitivity: 0.09 A/W (λ=250 nm)**

→ **Low dark current: 0.03 pA**

→ **Large saturation output charge: 200 pC (S15908-512Q)**
100 pC (S15909-1024Q)

→ **Variable integration time for each pixel**

Applications

→ **Spectrophotometry**

Structure

Type no.	Number of pixels	Pixel pitch (µm)	Pixel height (mm)	Package	Window material [*1] [*2]	Weight (g)
S15908-512Q	512	50	2.5	Ceramic	Quartz	3.5
S15909-1024Q	1024	25				

*1: Resin sealing
*2: Refractive index=1.46

Absolute maximum ratings

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
Supply voltage	Vdd	Ta=25 °C	-0.3	-	+6	V
Clock pulse voltage	V(CLK)	Ta=25 °C	-0.3	-	+6	V
Start pulse voltage	V(ST)	Ta=25 °C	-0.3	-	+6	V
Integration time control pulse	V(INT)	Ta=25 °C	-0.3	-	+6	V
Overflow gate voltage	Vofg	Ta=25 °C	-0.3	-	+6	V
Overflow drain voltage	Vofd	Ta=25 °C	-0.3	-	+6	V
Operating temperature	Topr	No dew condensation[*3]	-5	-	+65	°C
Storage temperature	Tstg	No dew condensation[*3]	-10	-	+85	°C

*3: 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.

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)	Vdd - 0.25	Vdd	Vdd + 0.25	V
	Low level		0	-	0.4	
Start pulse voltage	High level	V(ST)	Vdd - 0.25	Vdd	Vdd + 0.25	V
	Low level		0	-	0.4	
Integration time control pulse voltage	High level	V(INT)	Vdd - 0.25	Vdd	Vdd + 0.25	V
	Low level		0	-	0.4	
Overflow drain voltage		Vofd	0.5	2	2.5	V
Overflow gate voltage		Vofg	0.17	0.2	0.23	V

❏ Electrical characteristics [Ta=25 °C, Vdd=5 V, Vb=Vofd=2 V, Vofg=0.2 V]

Parameter		Symbol	Min.	Typ.	Max.	Unit
Clock pulse frequency		f(CLK)	10 k	-	250 k	Hz
Data rate		DR	-	f(CLK)	-	Hz
Power consumption[4]	S15908-512Q	P	-	4.25	-	mW
	S15909-1024Q		-	8.25	-	
Video line capacitance (Vb=2 V)[5]	S15908-512Q	Cv	-	22	-	pF
	S15909-1024Q		-	32	-	

[4]: f(CLK)=250 kHz

[5]: Vb is the voltage at the non-inverting input terminal of the charge amplifier in the current-integration readout circuit. [See the readout circuit example (p.8).]

❏ Electrical and optical characteristics [Ta=25 °C, Vdd=5 V, Vb=Vofd=2 V, Vofg=0.2 V, f(CLK)=200 kHz]

| Parameter		Symbol	Min.	Typ.	Max.	Unit
Spectral response range		λ		200 to 1000		nm
Peak sensitivity wavelength		λp	-	750	-	nm
Dark current		I_D	-	0.03	0.3	pA
Saturation output charge	S15908-512Q	Qsat	150	200	-	pC
	S15909-1024Q		75	100	-	
Saturation exposure[6]		Esat	-	700	-	m$lx \cdot$ s
Photo response non-uniformity[6][7][8]		PRNU	-	-	±3	%

[6]: Measured with a tungsten lamp of 2856 K

[7]: Photo response non-uniformity is defined under the condition that the device is uniformly illuminated by light which is 50 % of the saturation exposure level as follows:
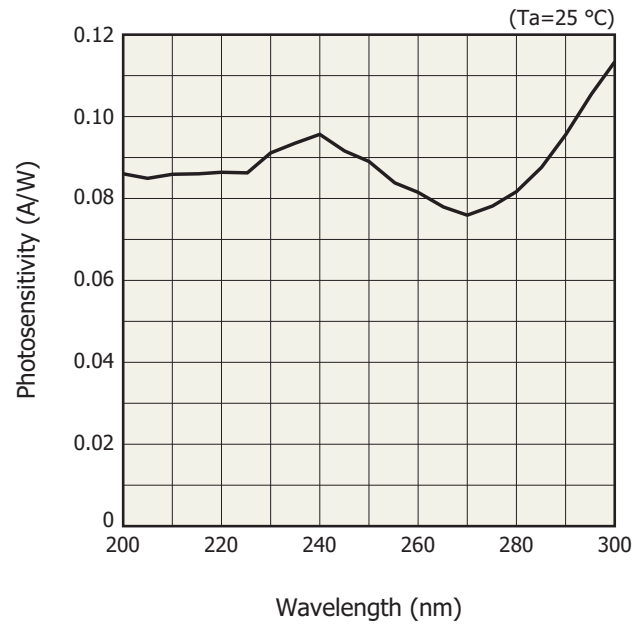
PRNU= $\Delta X/X \times 100$ (%)

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

[8]: Except for the first and last pixels
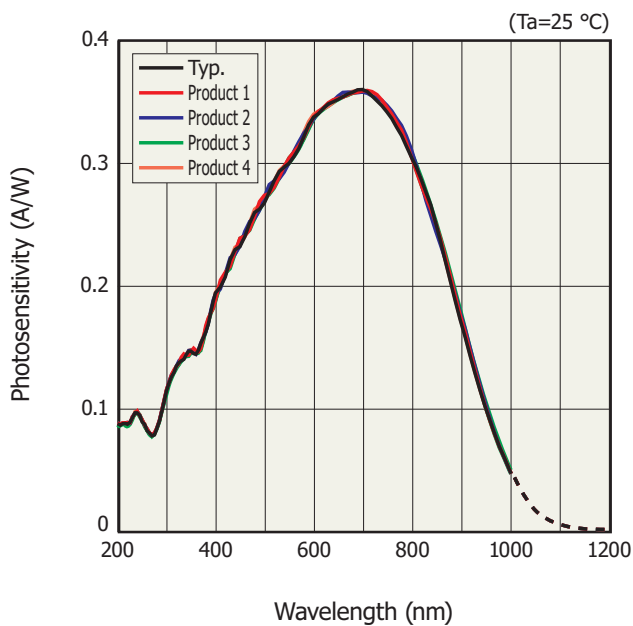
Spectral response (typical example)

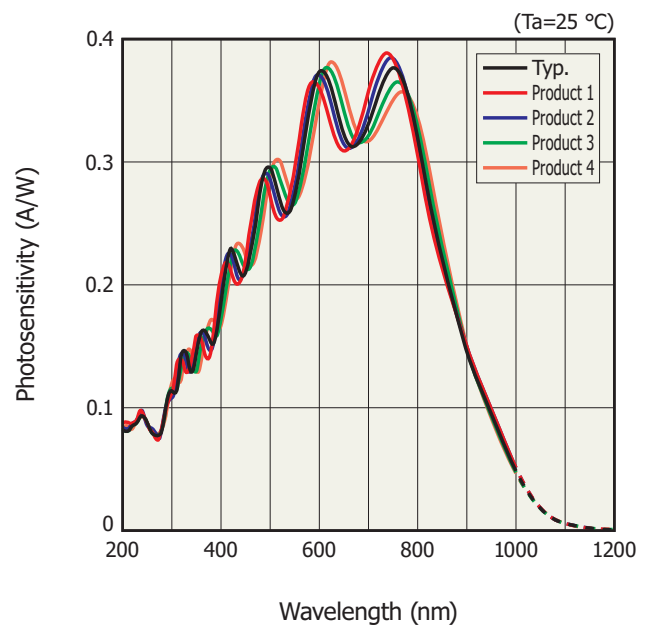KMPDB0623EA
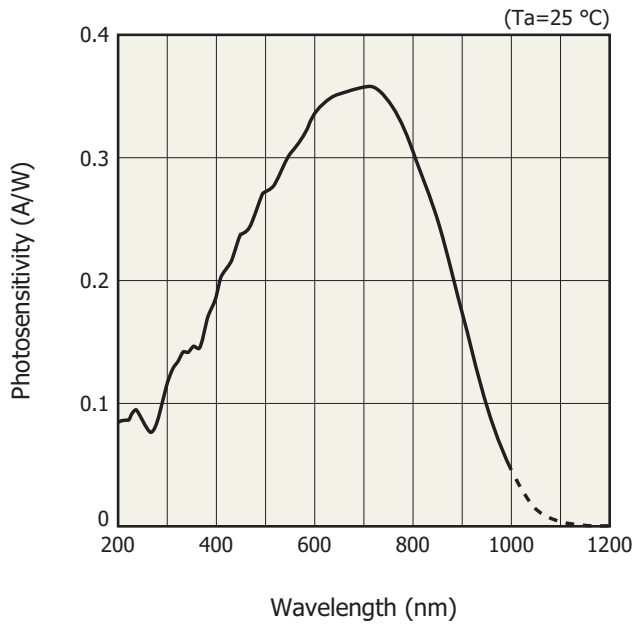
Spectral response in UV region (typical example)

KMPDB0624EA

Photosensitivity variations (typical example)
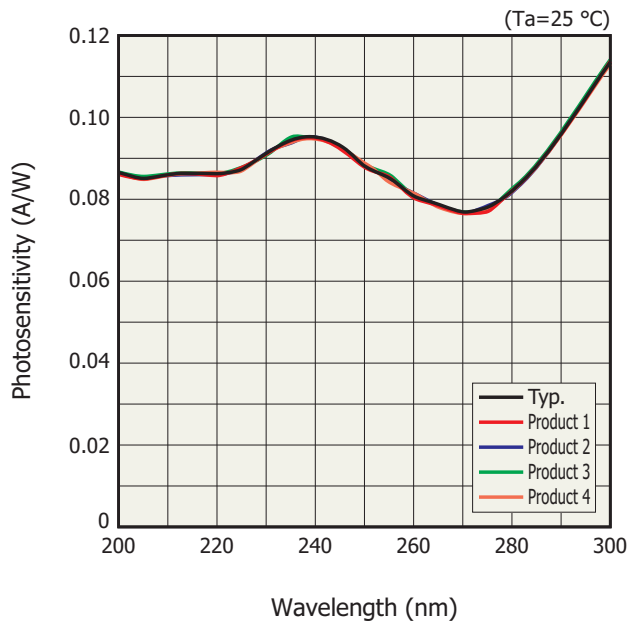
S15908-512Q, S15909-1024Q

KMPDB0630EA

Previous type [S10121 to S10124 series (-01)]

KMPDB0543EB

Compared to previous products, smooth spectral sensitivity from UV to near IR region is realized and photosensitivity variations is suppressed.
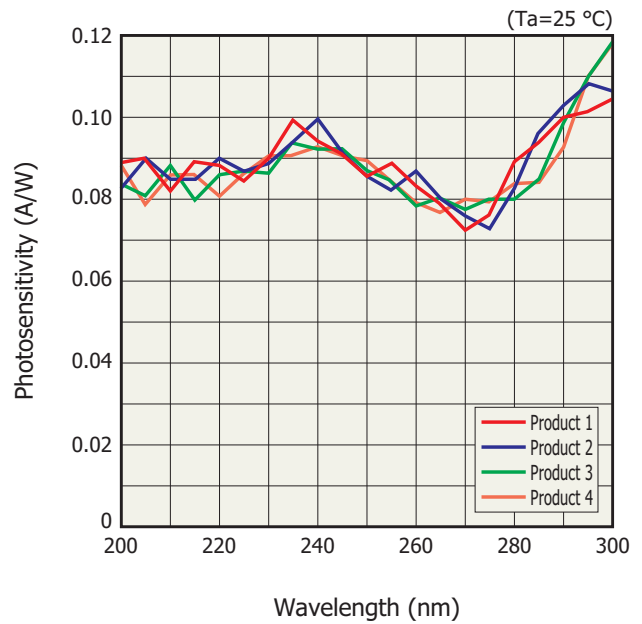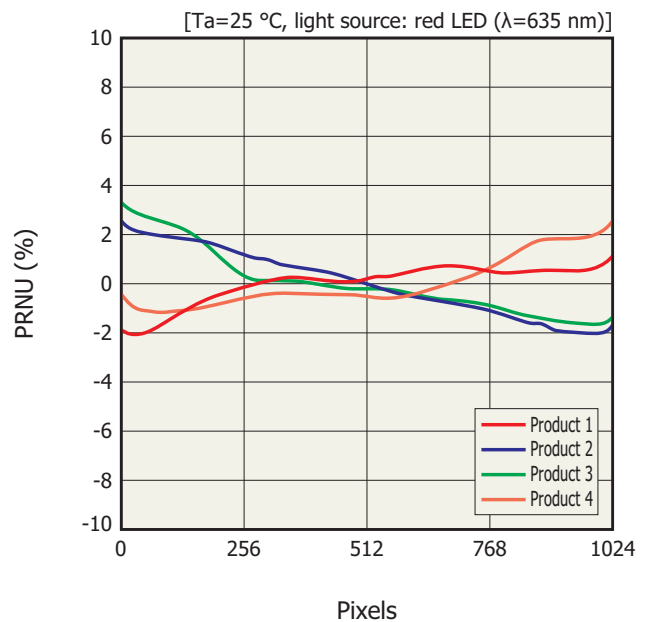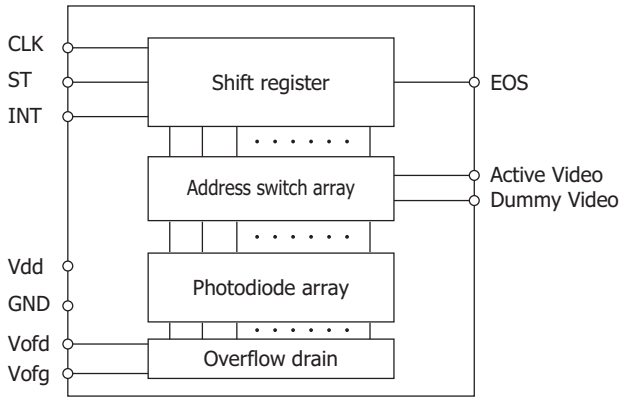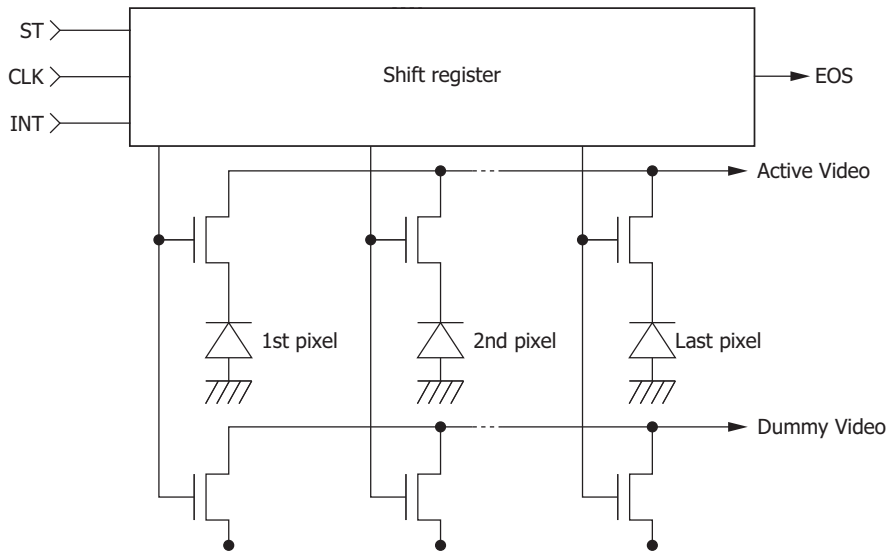
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3

Photosensitivity variation in UV region (typical example)

S15908-512Q, S15909-1024Q	Previous type [S10121 to S10124 series (-01)]

KMPDB0631EA

KMPDB0627EB

Photoresponse nonuniformity (typical example)
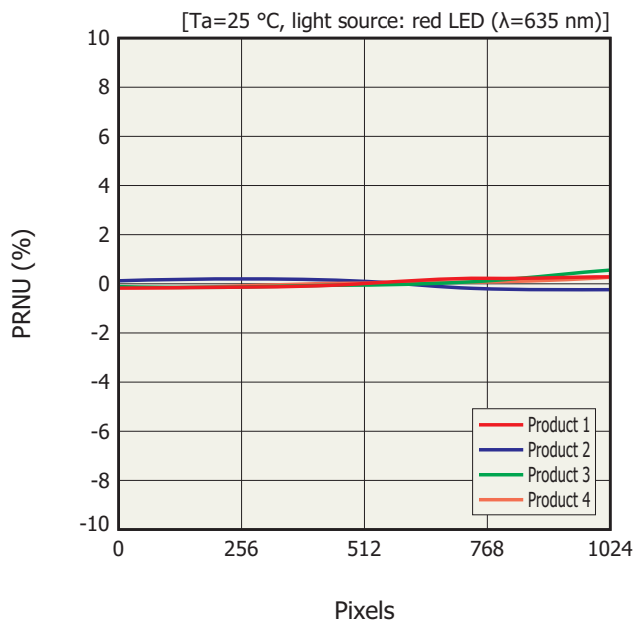
S15909-1024Q	Previous type (S10124-1024-01)

KMPDB0644EA

KMPDB0645EA

Compared to previous types, PRNU has been reduced.

Photo response non-uniformity is defined under the condition that the device is uniformly illuminated by light which is 50 % of the saturation exposure level as follows:

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

X: the average output of all pixels,

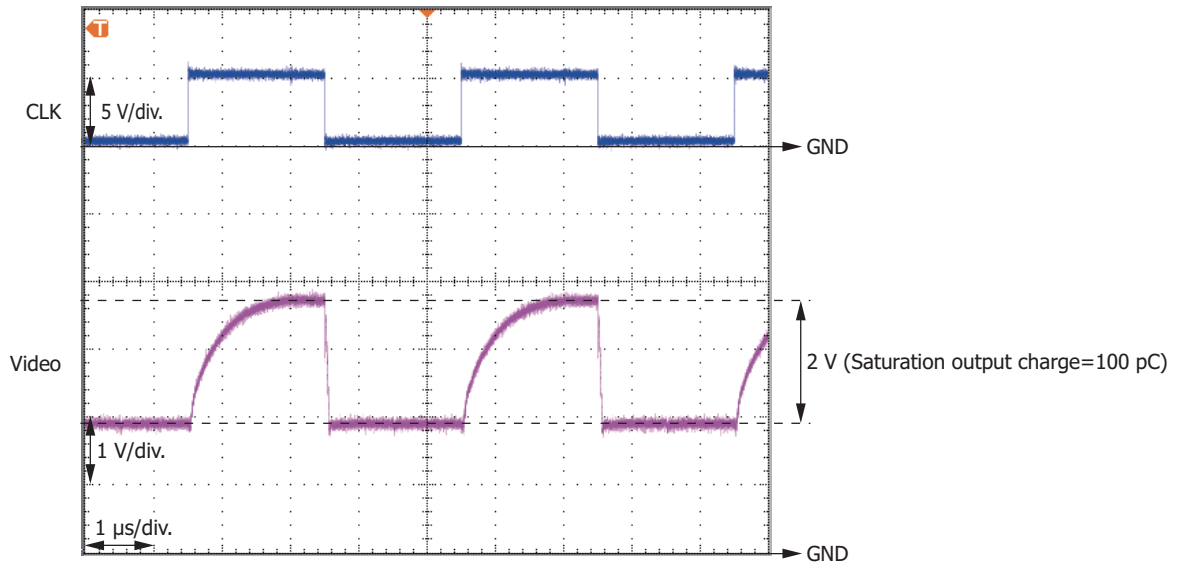ΔX: difference between X and maximum or minimum output.
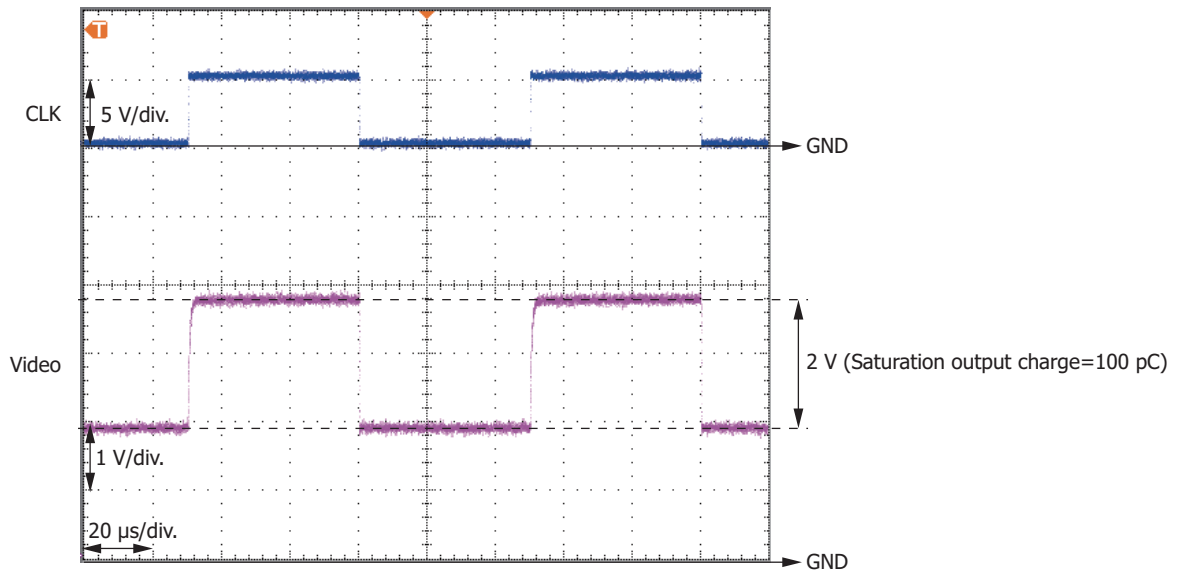
Block diagram

CLK
ST
INT

Shift register — EOS

Address switch array — Active Video
— Dummy Video

Vdd
GND

Photodiode array

Vofd
Vofg

Overflow drain

KMPDC0232EC

Equivalent circuit

ST
CLK
INT

Shift register — EOS

Active Video

1st pixel   2nd pixel   Last pixel

Dummy Video

KMPDC0279EC

Output waveform of one pixel (S15909-1024Q)

f(CLK)=250 kHz, Cf=50 pF, gain=1

CLK
5 V/div.
GND

Video
2 V (Saturation output charge=100 pC)
1 V/div.
1 µs/div.
GND

f(CLK)=10 kHz, Cf=50 pF, gain=1

CLK
5 V/div.
GND

Video
2 V (Saturation output charge=100 pC)
1 V/div.
20 µs/div.
GND

Timing chart
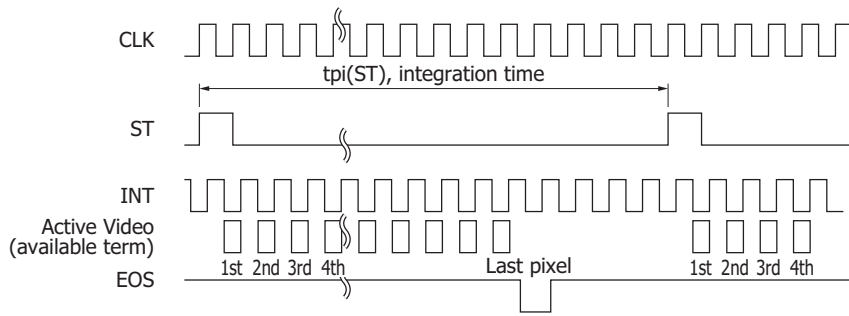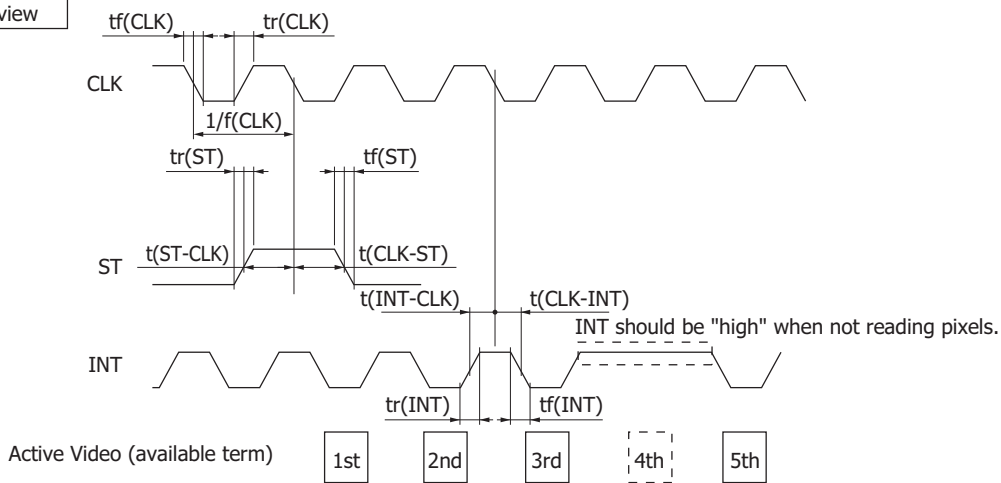
Note: · Allow CLK pulse transition from "high" to "low" only one time while ST pulse is "high".
· Integration time is determined by the interval between start pulses.
· Only the switching noise component is output from the Dummy Video.
· Do not use the Dummy Video output during current-integration readout.
· The INT signal is not needed between EOS and the rising edge of the next ST signal.

KMPDC0249ED

Parameter		Symbol	Min.	Typ.	Max.	Unit
Start pulse (ST)	S15908-512Q	tpi(ST)	514/f(CLK)	-	-	s
cycle	S15909-1024Q		1026/f(CLK)	-	-	
INT pulse rise and fall times		tr(INT), tf(INT)	0	20	30	ns
INT pulse - clock pulse timing		t(INT-CLK)	30	-	1 / [2 × f(CLK)]	ns
Clock pulse - INT pulse timing		t(CLK-INT)	30	-	1 / [2 × f(CLK)]	ns
Start pulse rise and fall times		tr(ST), tf(ST)	0	20	30	ns
Clock pulse duty ratio		-	40	50	60	%
Clock pulse rise and fall times		tr(CLK), tf(CLK)	0	20	30	ns
Clock pulse - start pulse timing		t(CLK-ST)	20	-	-	ns
Start pulse - clock pulse timing		T(ST-CLK)	20	-	-	ns

▶ Current-integration readout circuit example and timing chart example
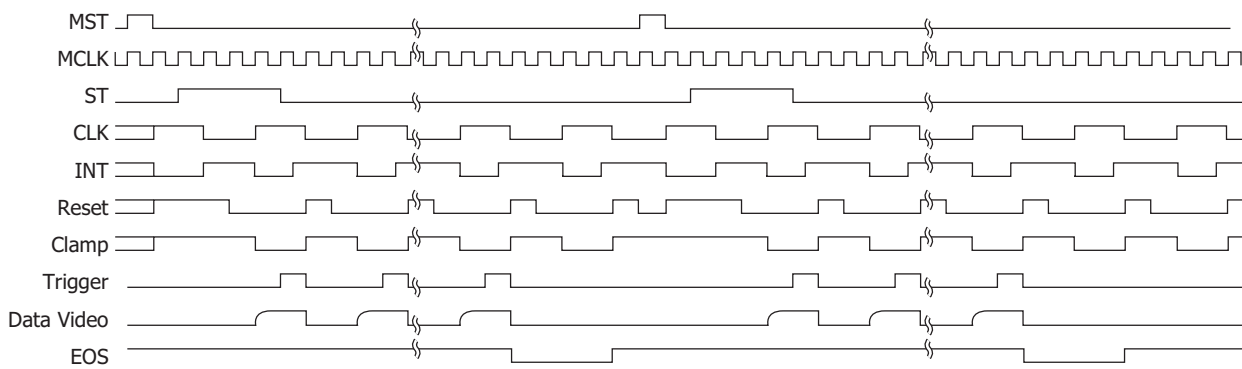
■ Readout circuit example
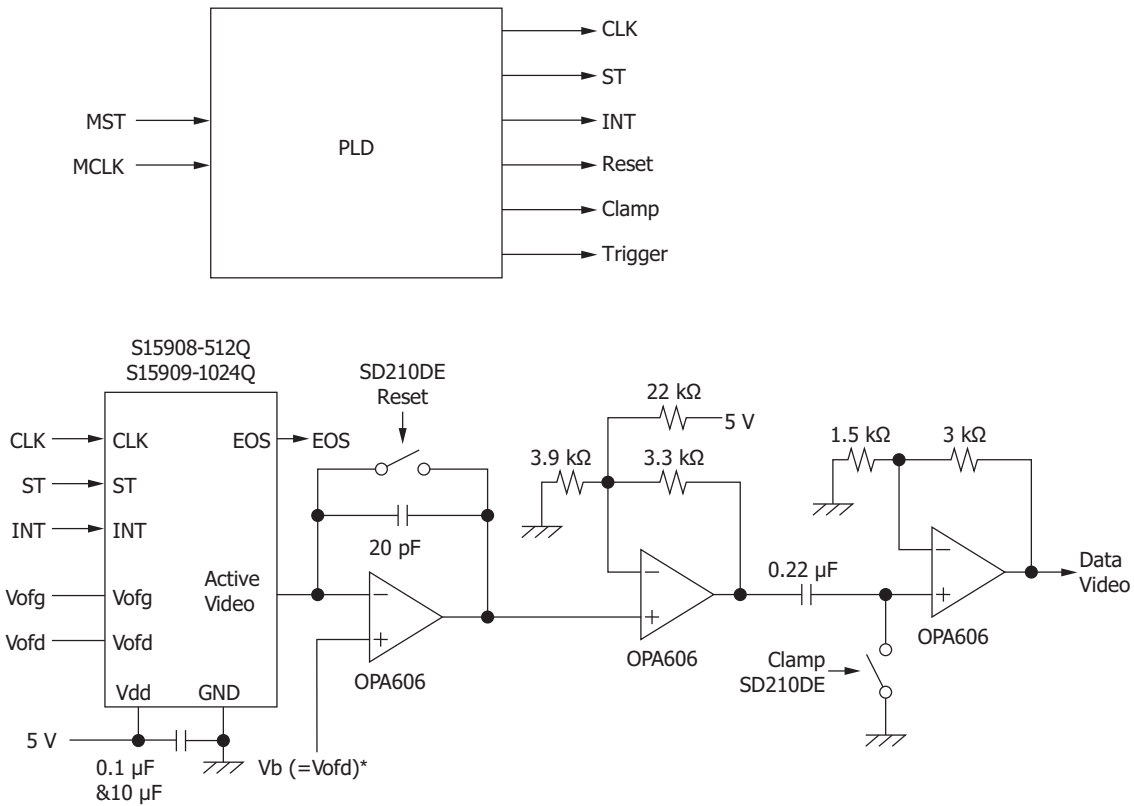
* Supply the Vb terminal with the same voltage as Vofd.

KMPDC0896EA

■ Timing chart example

KMPDC0386EC

## Variable integration time function for each pixel

By controlling the clock pulse to the INT terminal, the integration time for each pixel can be changed to any length that is an integer multiple of one readout period. When the clock pulse at the INT terminal is set to "high" at certain pixels signal readout timing, no signal is output from that pixel (see below). This allows the signal charge to continuously accumulate in that pixel as long as no signal is output. For example, when the integration time of one readout period is 100 ms and this function is used to output a signal from a pixel once every 3 readout periods, then the integration time of that pixel will be 300 ms. Using this function to lengthen the integration time of certain pixels makes it possible to effectively detect spectral signals of weak wavelength components.
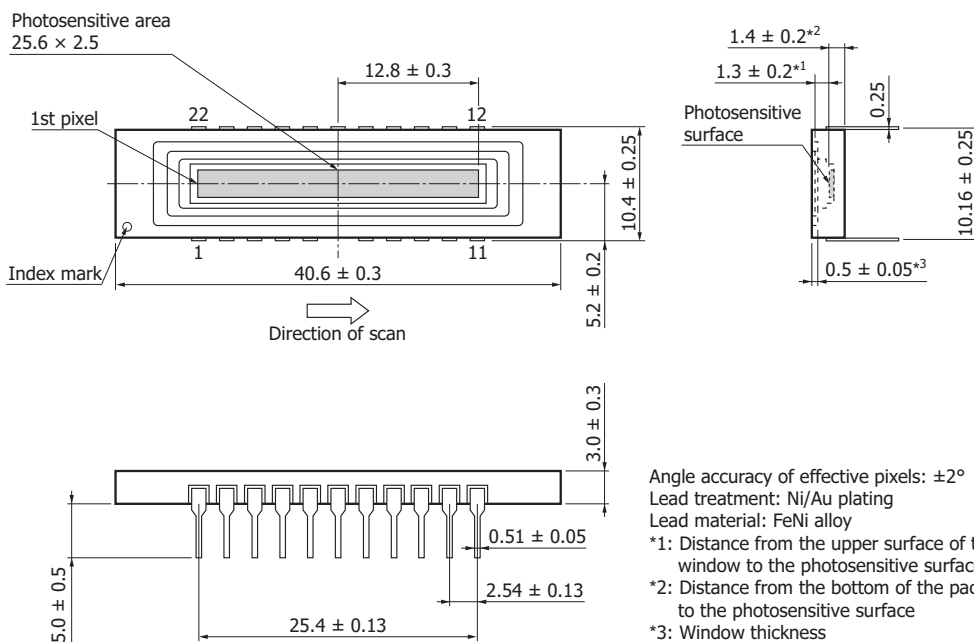
■ Timing chart

(Concept view showing the settings to double, triple and quadruple the integration times at 2nd, 3rd and 4th pixels, respectively, by using the variable integration time function for each pixel on the basis of the integration time at 1st pixel.)
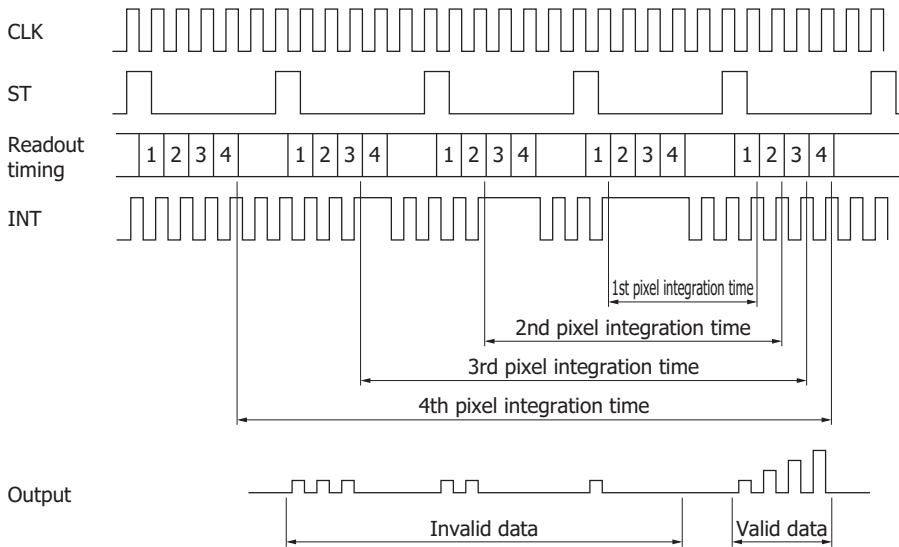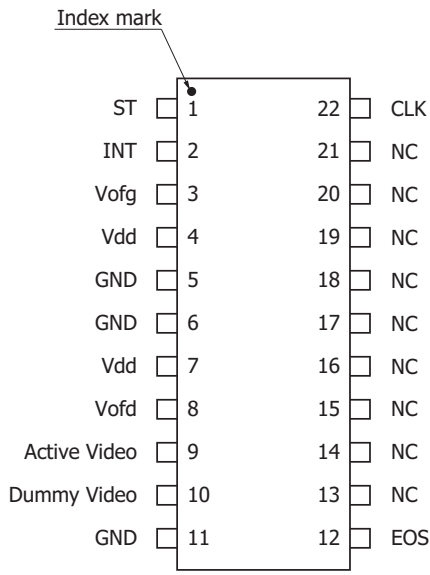

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Dimensional outlines (unit: mm)

Angle accuracy of effective pixels: ±2°
Lead treatment: Ni/Au plating
Lead material: FeNi alloy
*1: Distance from the upper surface of the quartz
    window to the photosensitive surface
*2: Distance from the bottom of the package
    to the photosensitive surface
*3: Window thickness

KMPDA0062EH

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9

Pin connections

Pin no.	Symbol	Name of pin	I/O
1	ST	Start pulse	I
2	INT	Integration time control pulse	I
3	Vofg	Overflow gate voltage	I
4	Vdd	Supply voltage	I
5	GND	Ground	I
6	GND	Ground	I
7	Vdd	Supply voltage	I
8	Vofd	Overflow drain voltage	I
9	Active Video	Video output	O
10	Dummy Video	Dummy video output	O
11	GND	Ground	I
12	EOS	End of scan	O
13	NC		
14	NC		
15	NC		
16	NC		
17	NC	No connection	
18	NC		
19	NC		
20	NC		
21	NC		
22	CLK	Clock pulse	I

KMPDC0230EC

Recommended soldering conditions

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

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

Precautions

(1) Electrostatic countermeasures

These devices have 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 these devices from surge voltages which might be caused by peripheral equipment.

(2) Incident window

If dust or dirt gets on the light incident 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

These devices are 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.

Related information

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

■ Precautions
· Disclaimer
· Image sensors

Driver circuit for CMOS linear image sensors: C10808 series (sold separately)

The C10808 series are driver circuits designed for HAMAMATSU CMOS linear image sensors S15908-512Q and S15909-1024Q. The high-speed readout type (C10808) and low noise type (C10808-01) are available. The C10808 series can be used in spectrometers, etc. when combined with the CMOS linear image sensor.

Features

→ **Excellent output linearity**
→ **Boxcar waveform output**
→ **High-speed readout (C10808)**
→ **Low noise (C10808-01)**
→ **Double power supply (±15 V) operation**
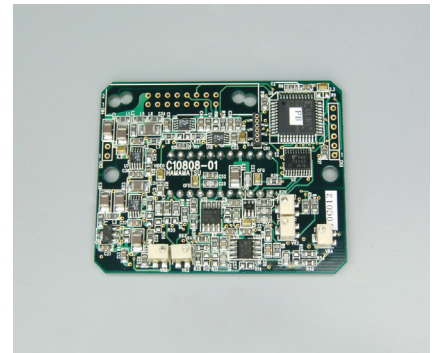
Information described in this material is current as of February 2021.

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