

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 ($\lambda=250$ 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 | | λ_p | - | 750 | - | nm |
| Dark current | | Id | - | 0.03 | 0.3 | pA |
| Saturation output charge | S15908-512Q | Qsat | 150 | 200 | - | pC |
| | S15909-1024Q | | 75 | 100 | - | |
| Saturation exposure*6 | | Esat | - | 700 | - | m/x · s |
| Photo response non-uniformity*6 *7 *8 | | PRNU | - | - | ±3 | % |

*6: Measured with a tungsten lamp of 2856 K

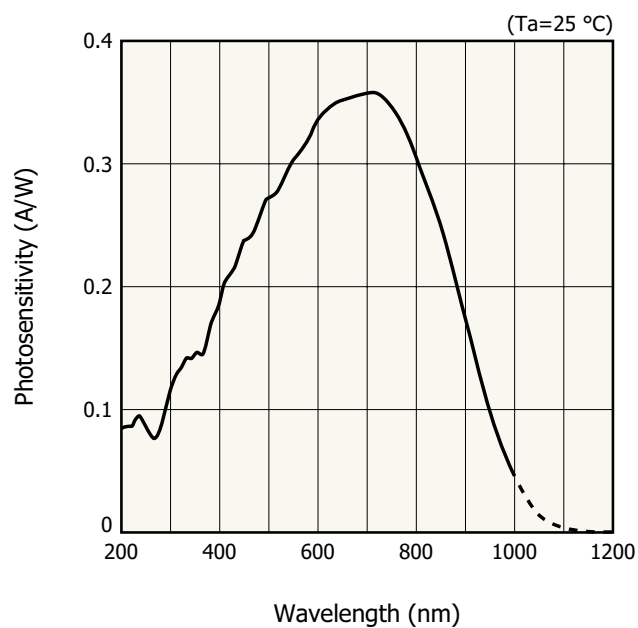
*7: Photo response non-uniformity is defined under the condition that the device is uniformly illuminated by light which is 50 % of the saturation exposure level as follows:

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

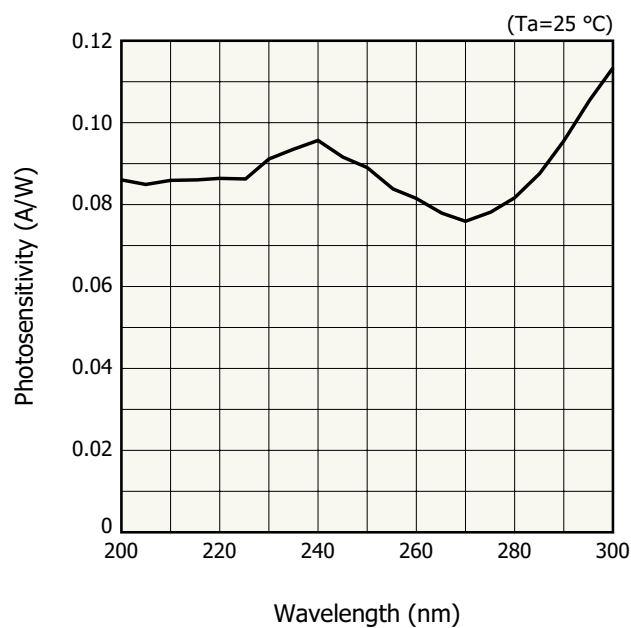
X: the average output of all pixels, ΔX : difference between X and maximum or minimum output.

*8: Except for the first and last pixels

Spectral response (typical example)

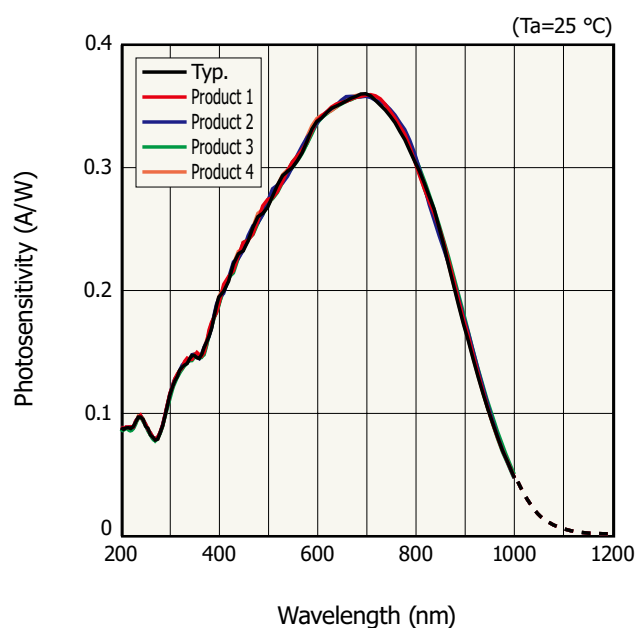


Spectral response in UV region (typical example)

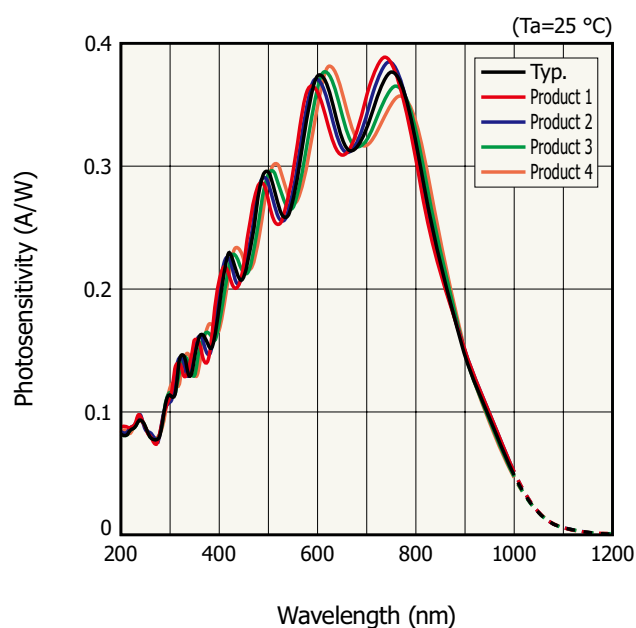


Photosensitivity variations (typical example)

S15908-512Q, S15909-1024Q



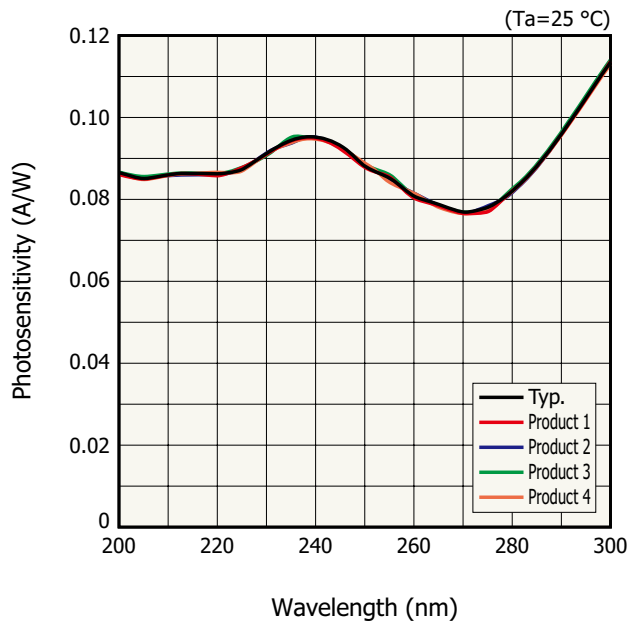
Previous type [S10121 to S10124 series (-01)]



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

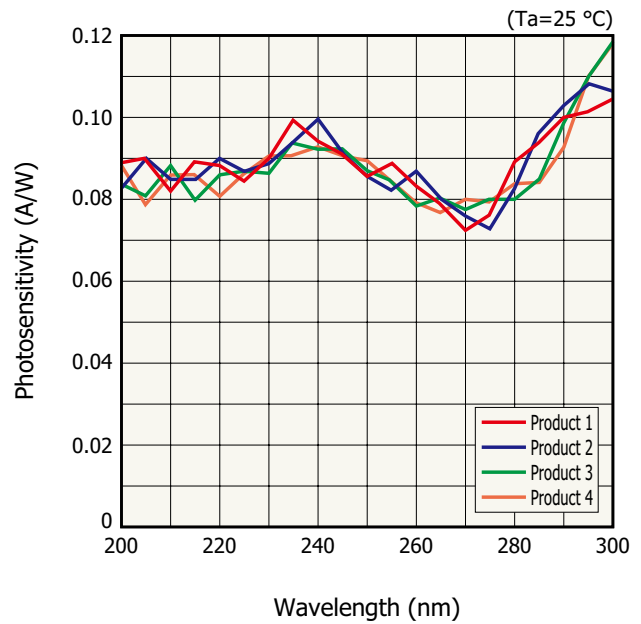
Photosensitivity variation in UV region (typical example)

S15908-512Q, S15909-1024Q



KMPDB0631EA

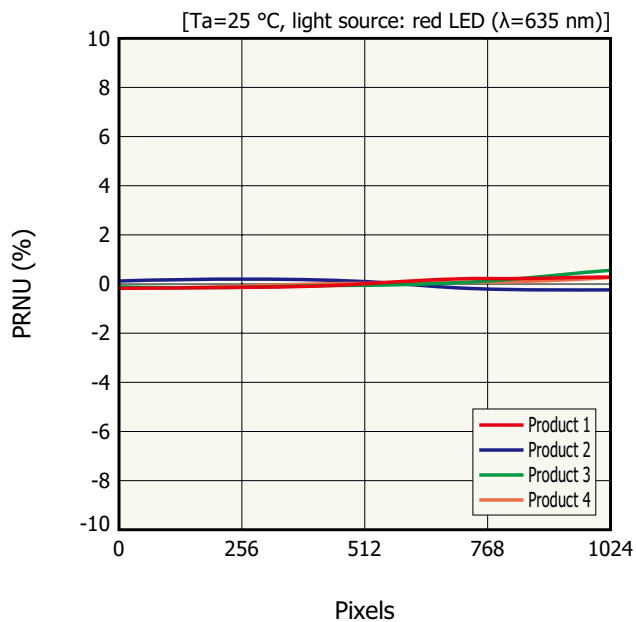
Previous type [S10121 to S10124 series (-01)]



KMPDB0627EB

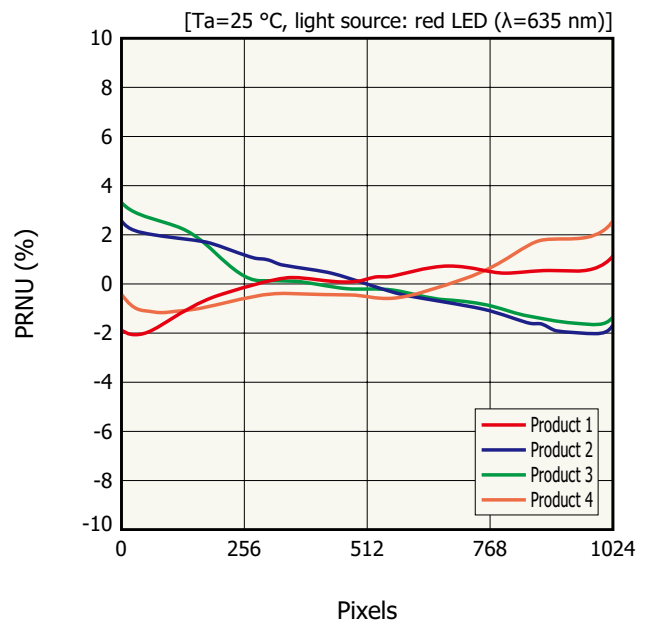
Photoresponse nonuniformity (typical example)

S15909-1024Q



KMPDB0644EA

Previous type (S10124-1024-01)



KMPDB0645EA

Compared to previous types, PRNU has been reduced.

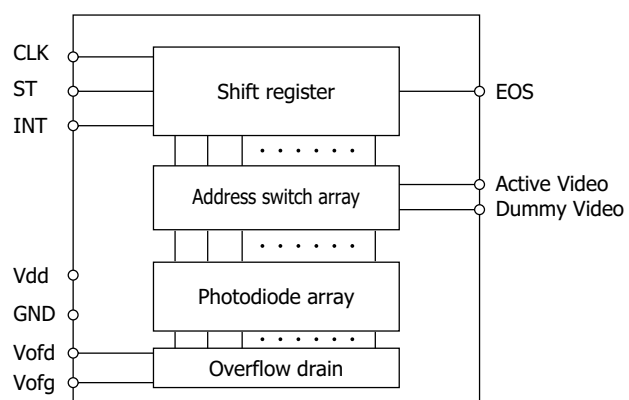
Photo response non-uniformity is defined under the condition that the device is uniformly illuminated by light which is 50 % of the saturation exposure level as follows:

$$\text{PRNU} = \frac{\Delta X}{X} \times 100 (\%)$$

X: the average output of all pixels,

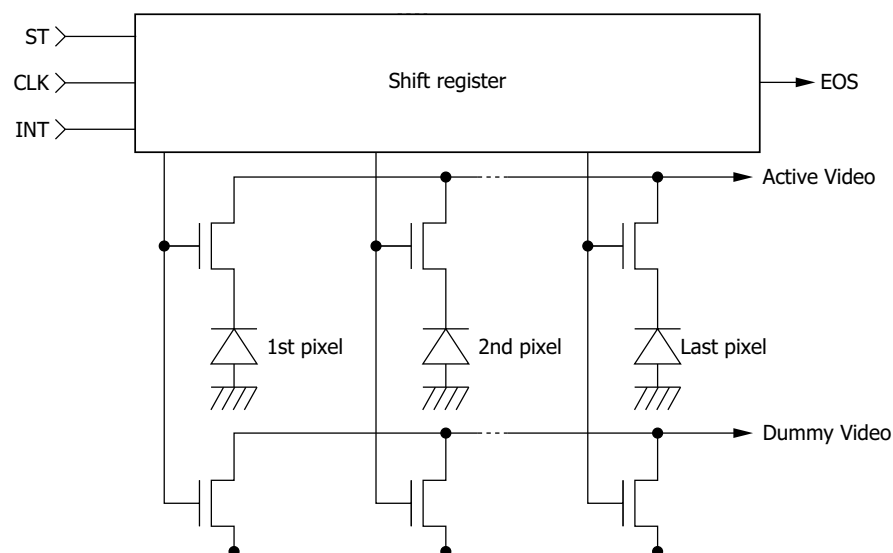
ΔX: difference between X and maximum or minimum output.

Block diagram

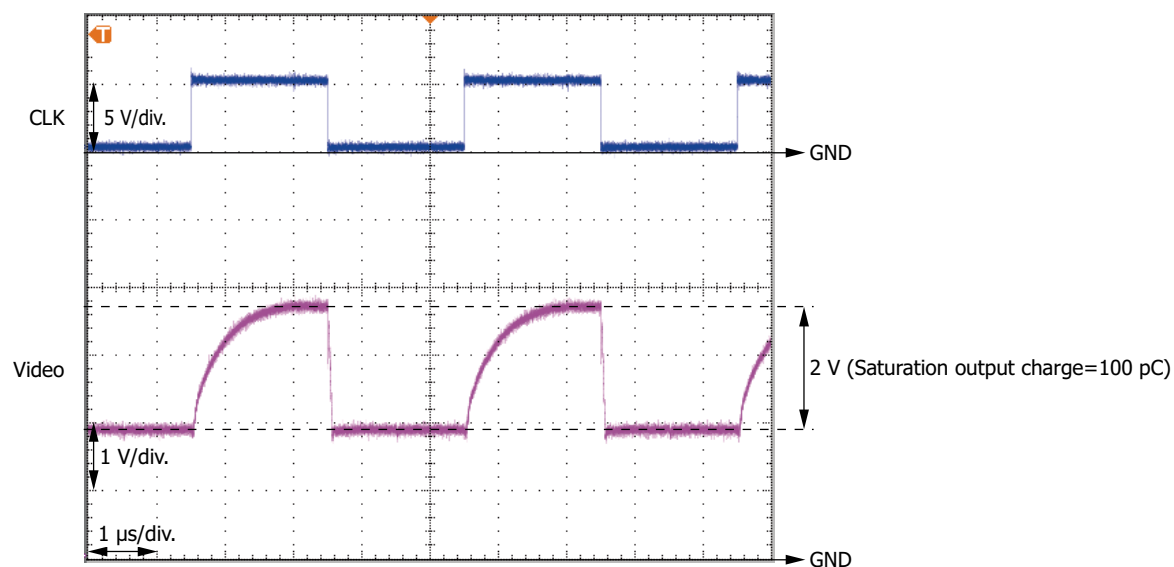
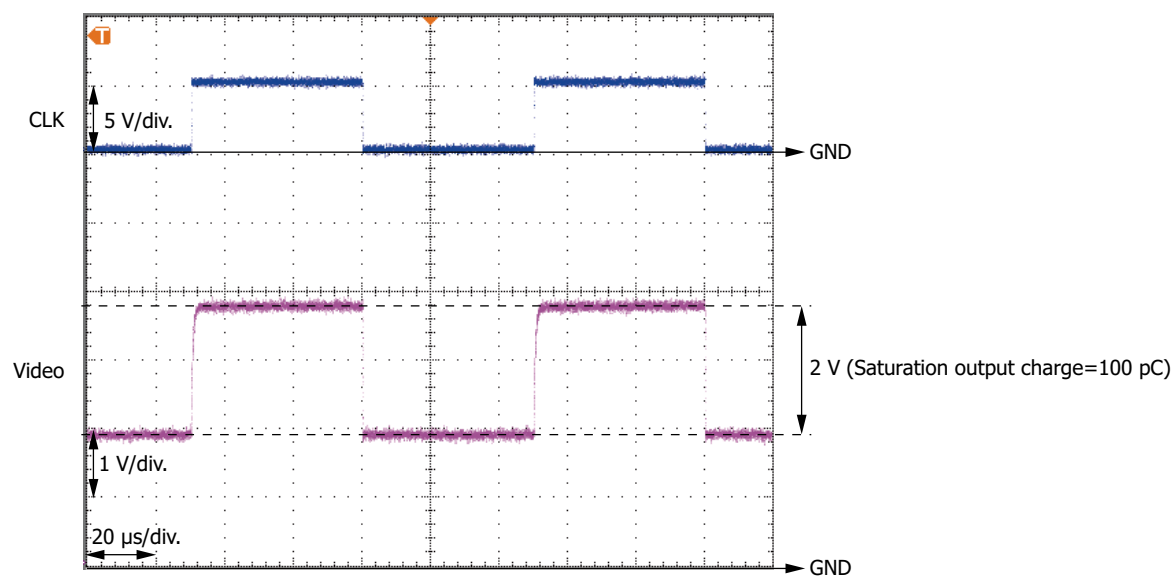


KMPDC0232EC

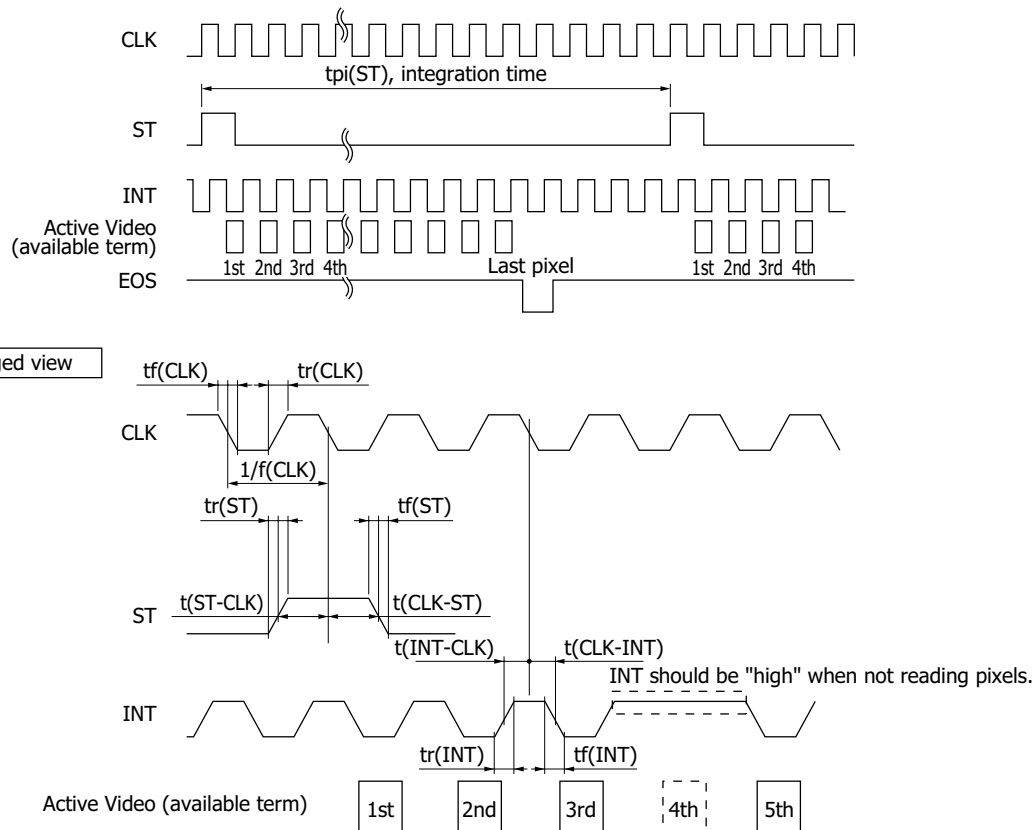
Equivalent circuit



KMPDC0279EC

Output waveform of one pixel (S15909-1024Q) $f(\text{CLK})=250 \text{ kHz}$, $C_f=50 \text{ pF}$, $\text{gain}=1$  $f(\text{CLK})=10 \text{ kHz}$, $C_f=50 \text{ pF}$, $\text{gain}=1$ 

Timing chart



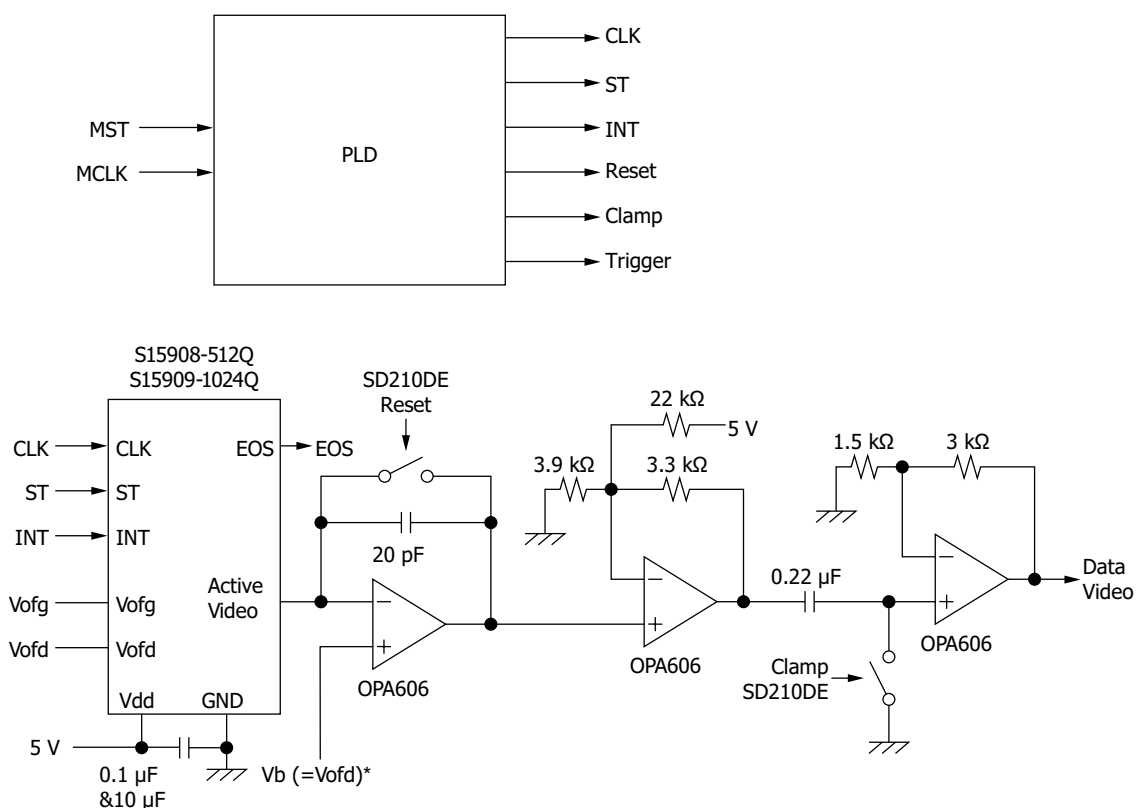
- Note:
- Allow CLK pulse transition from "high" to "low" only one time while ST pulse is "high".
 - Integration time is determined by the interval between start pulses.
 - Only the switching noise component is output from the Dummy Video.
 - Do not use the Dummy Video output during current-integration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

KMPC00249ED

| Parameter | Symbol | Min. | Typ. | Max. | Unit |
|----------------------------------|-------------------------|------------|------|-------------------------|------|
| Start pulse (ST) cycle | $t_{pi}(ST)$ | 514/f(CLK) | - | - | s |
| INT pulse rise and fall times | $t_r(INT)$, $t_f(INT)$ | 0 | 20 | 30 | ns |
| INT pulse - clock pulse timing | $t(INT-CLK)$ | 30 | - | $1 / [2 \times f(CLK)]$ | ns |
| Clock pulse - INT pulse timing | $t(CLK-INT)$ | 30 | - | $1 / [2 \times f(CLK)]$ | ns |
| Start pulse rise and fall times | $t_r(ST)$, $t_f(ST)$ | 0 | 20 | 30 | ns |
| Clock pulse duty ratio | - | 40 | 50 | 60 | % |
| Clock pulse rise and fall times | $t_r(CLK)$, $t_f(CLK)$ | 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

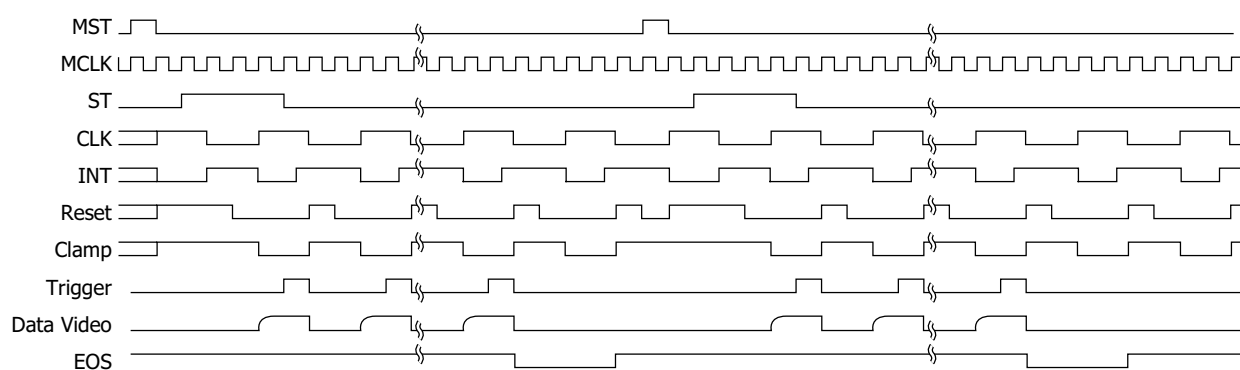
- Readout circuit example



* Supply the Vb terminal with the same voltage as Vofd.

KMPDC0896EA

- Timing chart example



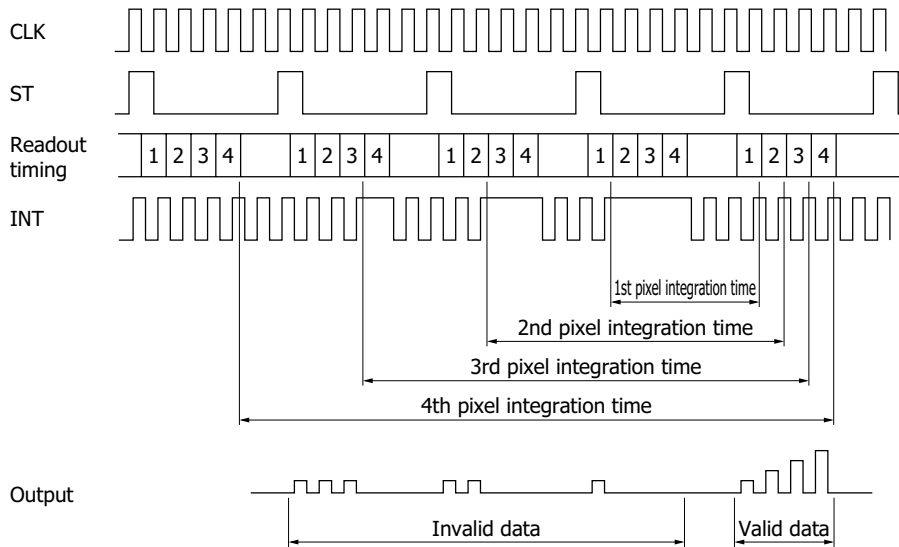
KMPDC0386FC

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.

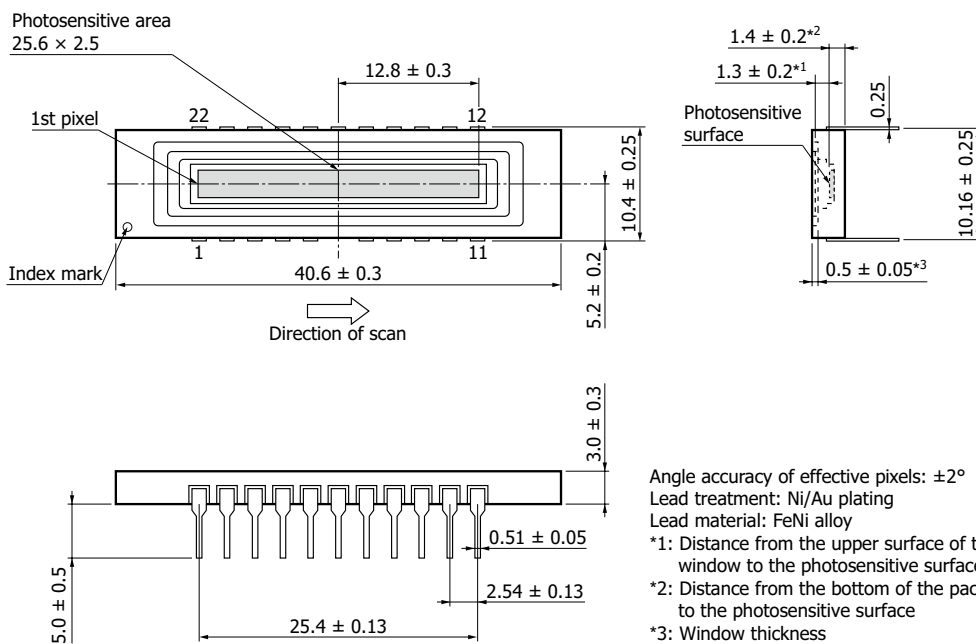
Timing chart

(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.)



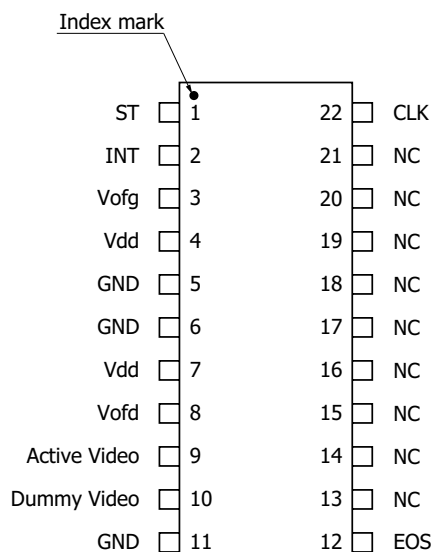
KMPDC0233ED

Dimensional outlines (unit: mm)



KMPDA0062EH

Pin connections



KMPDC0230EC

| 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 | No connection | |
| 14 | NC | | |
| 15 | NC | | |
| 16 | NC | | |
| 17 | NC | | |
| 18 | NC | | |
| 19 | NC | | |
| 20 | NC | | |
| 21 | NC | | |
| 22 | CLK | Clock pulse | I |

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 April 2022.

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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