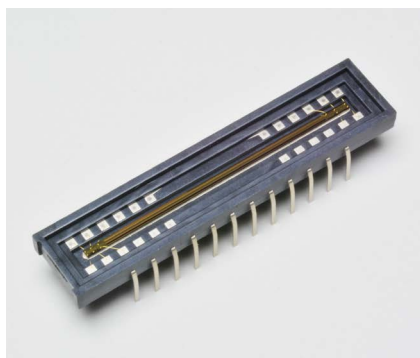


# CMOS linear image sensor

S13496N-02



## High sensitivity in vacuum UV region

The S13496N-02 is a high sensitivity CMOS linear image sensor using a photosensitive area with minute pixels ( $7 \times 200 \mu\text{m}$ ). Other features include higher sensitivity in the VUV (vacuum UV) region compared with the previous product (S13496).

### Features

- Pixel size:  $7 \times 200 \mu\text{m}$
- 4096 pixels
- Effective photosensitive area length: 28.672 mm
- High sensitivity:  $650 \text{ V}/(\text{lx}\cdot\text{s})$
- High sensitivity in UV to NIR region (spectral response range: 140 to 1000 nm)
- Low noise:  $20 \text{ e}^- \text{ rms}$
- 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

- Spectrometers

### Structure

Parameter	Specification	Unit
Number of pixels	4096	-
Pixel size	$7 \times 200$	$\mu\text{m}$
Photosensitive area length	28.672	mm
Package	LCP (liquid crystal polymer)	-
Window material	None <sup>*1</sup>	-

\*1: Temporary window

The glass is fixed with tape at the time of delivery to protect the photosensitive area and wires.

### 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	Topr	No dew condensation <sup>*2</sup>	-40 to +65	°C
Storage temperature	Tstg	No dew condensation <sup>*2</sup>	-40 to +65	°C

\*2: 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.

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	V(CLK)	3	Vdd	Vdd + 0.25	V
		0	-	0.3	V
Start pulse voltage	V(ST)	3	Vdd	Vdd + 0.25	V
		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*3 *4	Ic	20	40	60	mA

\*3: f(CLK)=10 MHz

\*4: 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	140 to 1000			nm
Peak sensitivity wavelength	λp	-	700	-	nm
Photosensitivity*5	Sw	-	650	-	V/(lx·s)
Conversion efficiency*6	CE	-	20	-	μV/e <sup>-</sup>
Dark output voltage*7	Vd	0	0.1	2	mV
Saturation output voltage*8 *9	Vsat	1.5	2.0	2.5	V
Readout noise	Nread	0.1	0.4	1.2	mV rms
Dynamic range 1*10	Drange1	-	5000	-	times
Dynamic range 2*11	Drange2	-	20000	-	times
Output offset voltage	Voffset	0.3	0.6	0.9	V
Photoresponse nonuniformity*4 *12	PRNU	-	±2	±10	%
Image lag*13	Lag	-	-	0.1	%

\*5: Measured with a tungsten lamp of 2856 K

\*6: Output voltage generated per one electron

\*7: Integration time=10 ms

\*8: Difference from Voffset

\*9: 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.

\*10: Drange1 = Vsat/Nread

\*11: 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.

\*12: 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 4090 pixels excluding 3 pixels each at both ends, and is defined as follows:

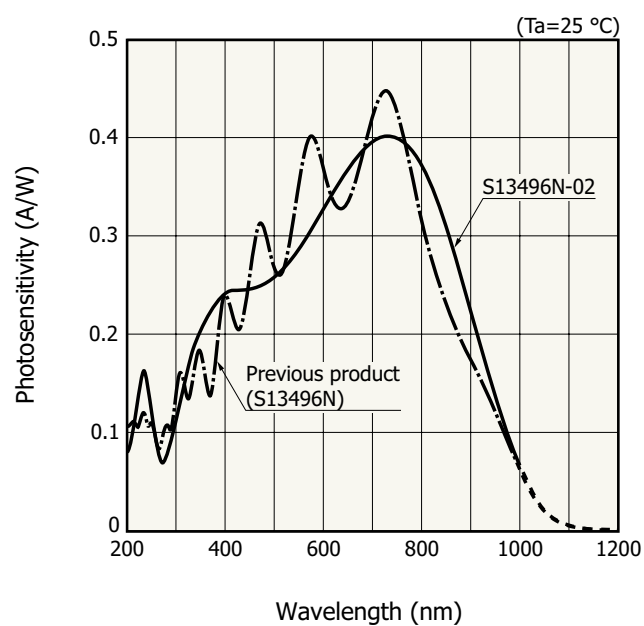
$$PRNU = \Delta X / X \times 100 (\%)$$

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

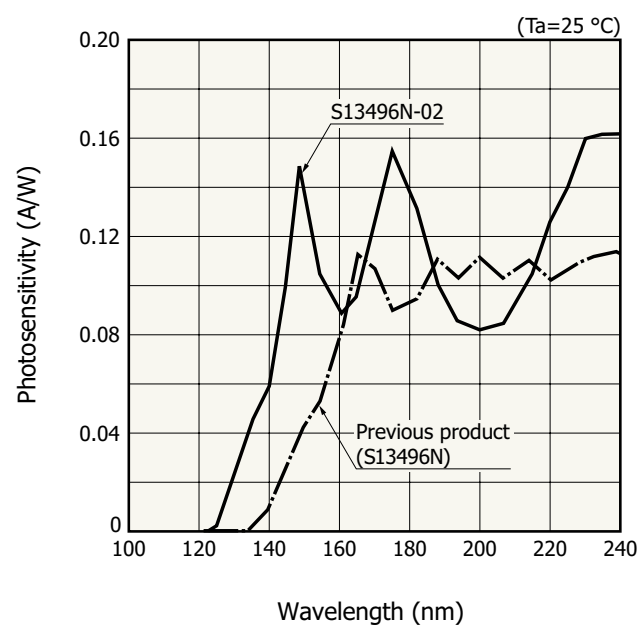
\*13: Signal components of the preceding line data that still remain even after the data is read out in a saturation output state.

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

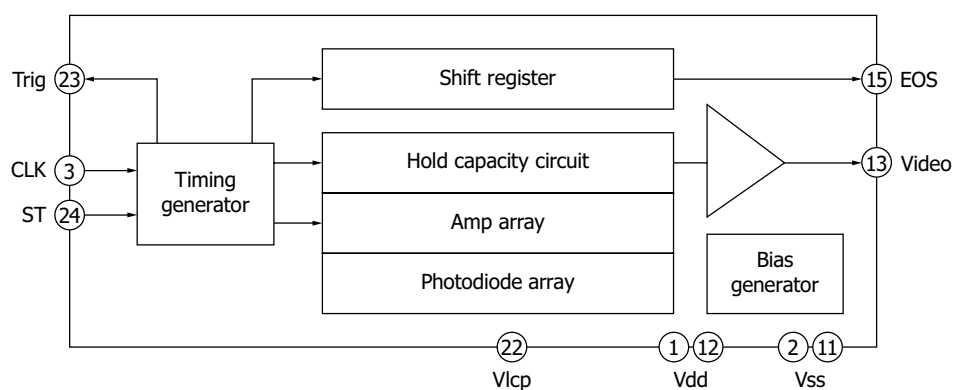
### Spectral response (typical example)



### Spectral response in UV (typical example)



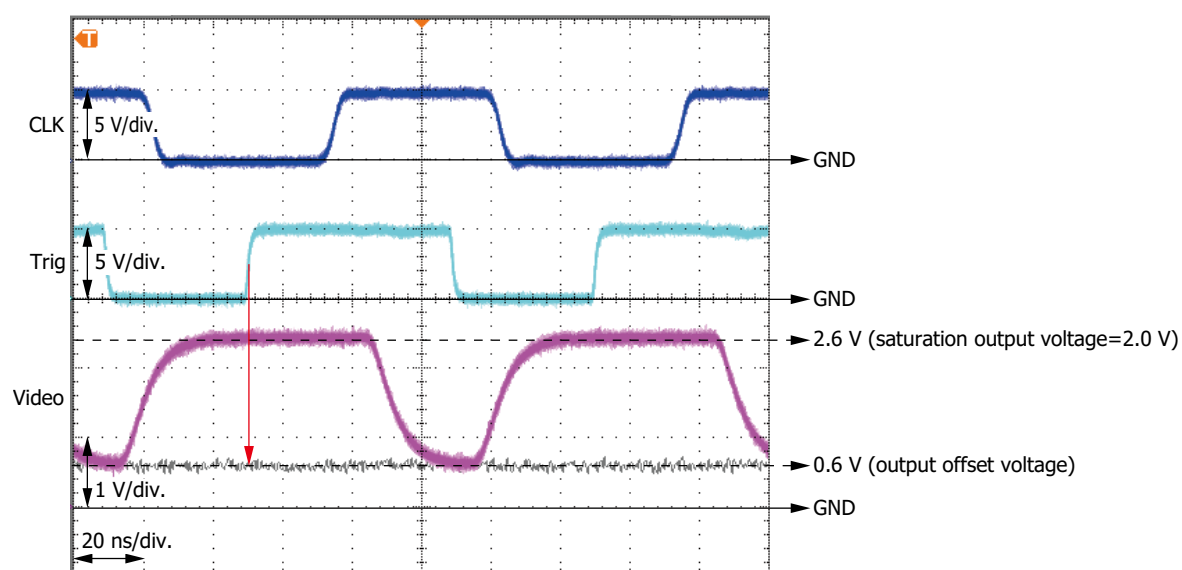
### Block diagram



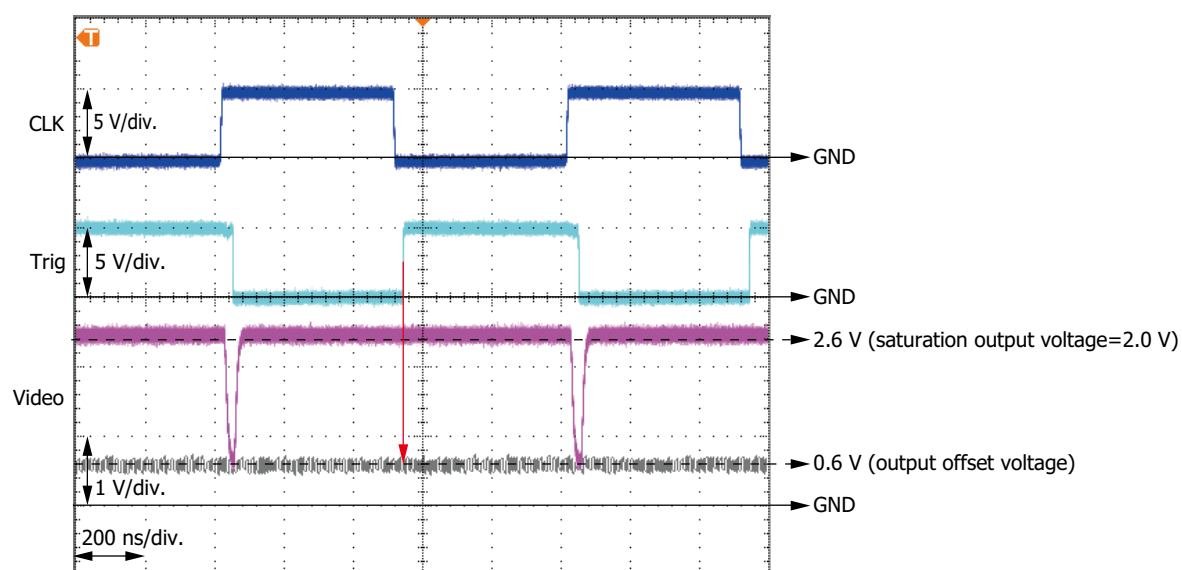
### Output waveforms of one pixel

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

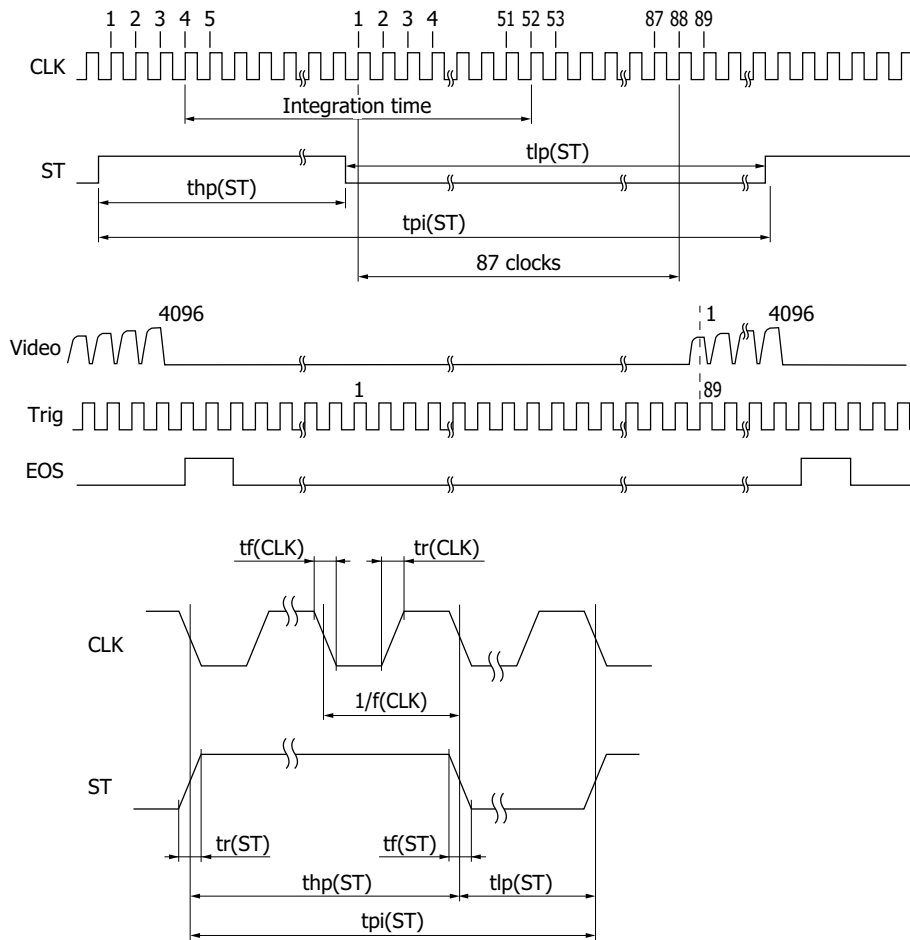
$f(\text{CLK}) = \text{DR} = 10 \text{ MHz}$



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



## Timing chart



KMPDC0480EA

Parameter	Symbol	Min.	Typ.	Max.	Unit
Start pulse cycle	t <sub>pi</sub> (ST)	106/f(CLK)	-	-	s
Start pulse high period <sup>*14</sup>	t <sub>hp</sub> (ST)	6/f(CLK)	-	-	s
Start pulse low period	t <sub>lp</sub> (ST)	100/f(CLK)	-	-	s
Start pulse rise and fall times	t <sub>r</sub> (ST), t <sub>f</sub> (ST)	0	10	30	ns
Clock pulse duty ratio	-	45	50	55	%
Clock pulse rise and fall times	t <sub>r</sub> (CLK), t <sub>f</sub> (CLK)	0	10	30	ns

<sup>\*14</sup>: 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 4096 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

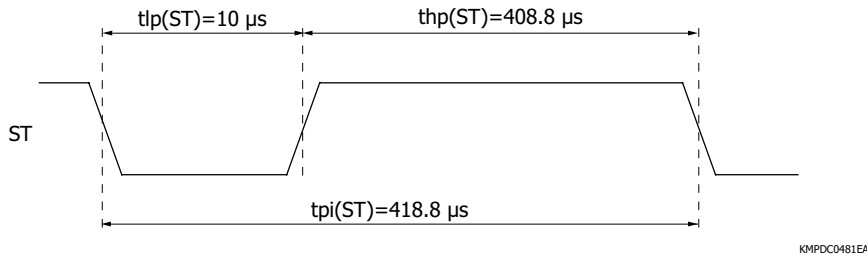
Clock pulse frequency = Data rate = 10 MHz

Start pulse cycle =  $4188/f(\text{CLK}) = 4188/10 \text{ MHz} = 418.8 \mu\text{s}$

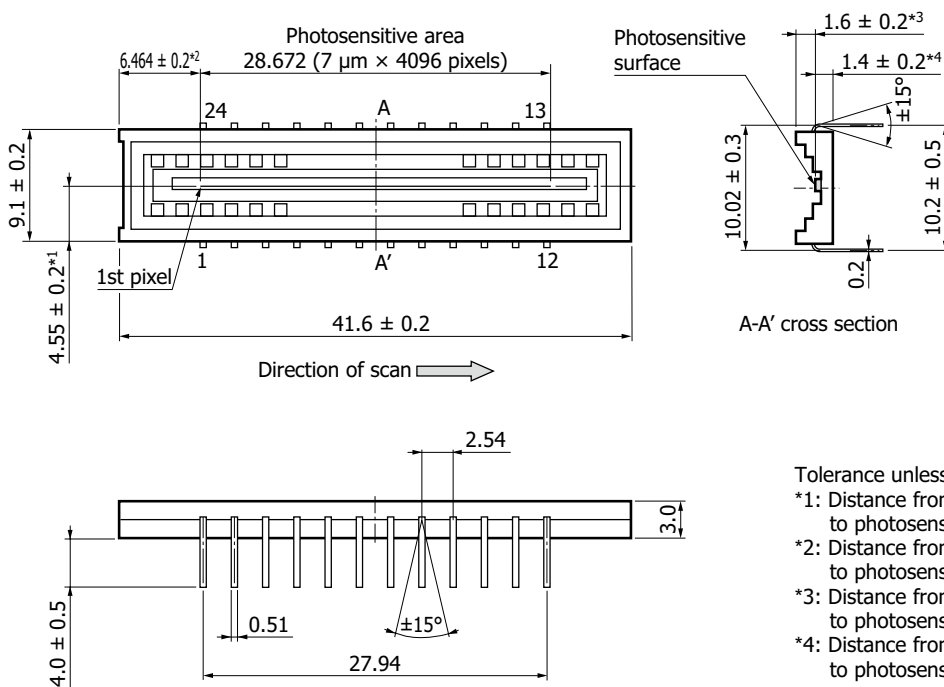
High period of start pulse = Start pulse cycle - Start pulse's low period min.

$= 4188/f(\text{CLK}) - 100/f(\text{CLK}) = 4188/10 \text{ MHz} - 100/10 \text{ MHz} = 408.8 \mu\text{s}$

Integration time is equal to the high period of start pulse + 48 cycles of clock pulses, so it will be  $408.8 + 4.8 = 413.6 \mu\text{s}$ .



## Dimensional outline (unit: mm)



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 package surface to photosensitive surface

\*4: Distance from package bottom to photosensitive surface

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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 <sup>*15</sup>
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 <sup>*16</sup>
11	Vss	-	GND	23	Trig	O	Trigger pulse for video signal acquisition <sup>*17</sup>
12	Vdd	I	Supply voltage	24	ST	I	Start pulse

<sup>\*15</sup>: 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.

<sup>\*16</sup>: 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.

<sup>\*17</sup>: 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

Parameter	Specification	Remarks
Solder temperature	260 °C max. (less than 5 s)	

Note: When setting the soldering conditions, check for any problems by testing out the soldering methods in advance.

## 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) Operating and storage environments

Use the device within the rated temperature range. Operating or storing the device at an excessively high temperature and humidity may cause variations in performance characteristics and must be avoided. This product is packed in a conductive moisture-proof bag prior to shipping. If the product is stored in a high humidity environment for a long period of time, characteristic degradation such as a decrease in sensitivity and an increase in dark current will become noticeable when exposed to UV light. So do not open the bag until just before using this product. After unpacking, storing in a low-humidity desiccator is recommended.

### (3) UV exposure

When UV light irradiation is applied, the product characteristics may degrade. Such examples include degradation of the product's UV sensitivity and increase in dark current. This phenomenon varies depending on the irradiation level, irradiation intensity, usage time, and ambient environment. Before employing the product, we recommend that you check the tolerance under the ultraviolet light environment that the product will be used in. Even so, avoid unnecessary UV exposure to the device.

KMPDC0564E

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