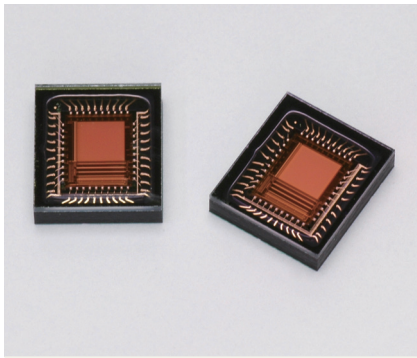


Distance area image sensor



S11962-01CR

Measures the distance to an object by TOF (Time-Of-Flight) method

The distance image sensors are designed to measure the distance to an object by TOF method. When used in combination with a pulse modulated light source, this sensor outputs phase difference information on the timing that the light is emitted and received. The sensor output signals are arithmetically processed by an external signal processing circuit or a PC to obtain distance data.

Features

- High-speed charge transfer structure
- Operates with minimal detection errors even under fluctuating (charge drain function)
- Real-time distance measurement

Applications

- Obstacle detection (self-driving, robots, etc.)
- Security (intrusion detection, etc.)
- Shape recognition (logistics, robots, etc.)
- Motion capture

Structure

Parameter	Specification	Unit
Image size	2.56 × 2.56	mm
Pixel size	40 × 40	μm
Pixel pitch	40	μm
Number of pixels	72 × 72	pixels
Number of effective pixels	64 × 64	pixels
Package	48-pin PWB	-
Window material	AR-coated glass	-

Note: This product is not hermetically sealed.

Absolute maximum ratings

Parameter	Symbol	Condition	Value	Unit	
Analog supply voltage	Vdd(A)	Ta=25 °C	-0.3 to +6	V	
Digital supply voltage	Vdd(D)	Ta=25 °C	-0.3 to +6	V	
Analog input terminal voltage	Pixel amplifier	Vsf	Ta=25 °C	-0.3 to Vdd(A) + 0.3	V
	Pixel reset	Vr			
	Output offset	Vref			
	Photosensitive area	Vpg			
Digital input terminal voltage	Frame reset pulse	reset	Ta=25 °C	-0.3 to Vdd(D) + 0.3	V
	Frame synchronous trigger pulse	vst			
	Line synchronous trigger pulse	hst			
	Pixel reset pulse	ext_reset			
	Master clock pulse	mclk			
Charge transfer clock pulse voltage	VTX1, VTX2, VTX3	Ta=25 °C	-0.3 to Vdd(A) + 0.3	V	
Operating temperature	Topr	No dew condensation*1	-25 to +85	°C	
Storage temperature	Tstg	No dew condensation*1	-40 to +100	°C	
Soldering temperature*2	Tsol		260 (twice)	°C	

*1: 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: Reflow soldering, IPC/JEDEC J-STD-020 MSL 3, see P.10

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	
Analog supply voltage	Vdd(A)	4.75	5	5.25	V	
Digital supply voltage	Vdd(D)	4.75	5	5.25	V	
Bias voltage	Pixel amplifier	Vsf	4.5	5	Vdd(A)	V
	Pixel reset	Vr	3.7	3.9	4.1	V
	Output offset	Vref	2.3	2.5	2.7	V
	Photosensitive area	Vpg	0.8	1.0	1.2	V
Frame reset pulse voltage	High level	reset	Vdd(D) × 0.8	-	-	V
	Low level		-	-	Vdd(D) × 0.2	
Frame synchronous trigger pulse voltage	High level	vst	Vdd(D) × 0.8	-	-	V
	Low level		-	-	Vdd(D) × 0.2	
Line synchronous trigger pulse voltage	High level	hst	Vdd(D) × 0.8	-	-	V
	Low level		-	-	Vdd(D) × 0.2	
Master clock pulse voltage	High level	mclk	Vdd(D) × 0.8	-	-	V
	Low level		-	-	Vdd(D) × 0.2	
Pixel reset pulse voltage	High level	ext_reset	Vdd(D) × 0.8	-	-	V
	Low level		-	-	Vdd(D) × 0.2	
Output signal effective period pulse voltage	High level	oe	Vdd(D) × 0.8	-	-	V
	Low level		-	-	Vdd(D) × 0.2	
Output signal synchronous pulse voltage	High level	dclk	Vdd(D) × 0.8	-	-	V
	Low level		-	-	Vdd(D) × 0.2	
Non-readout period pulse voltage	High level	dis_read	Vdd(D) × 0.8	-	-	V
	Low level		-	-	Vdd(D) × 0.2	

Electrical characteristics [Ta=25 °C, Vdd(A)=Vdd(D)=5 V]

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
Clock pulse frequency	f(mclk)		1 M	-	10 M	Hz
Video data rate	VR		-	f(mclk)	-	Hz
Current consumption	Ic	Dark state	-	10	20	mA

Electrical and optical characteristics [Ta=25 °C, Vdd(A)=Vdd(D)=5 V, Vref=2.5 V, Vsf=5 V, Vr=3.9 V, MCLK=10 MHz]

Parameter	Symbol	Min.	Typ.	Max.	Unit
Spectral response range	λ	400 to 1100			nm
Peak sensitivity wavelength	λ_p	-	800	-	nm
Photosensitivity*3	S	1.15×10^{12}	2.3×10^{12}	4.6×10^{12}	V/W·s
Dark output	Vd	-	0.5	10	V/s
Random noise	RN	-	0.8	1.6	mV rms
Dark output voltage*4	Vor	Vref + 1.0	-	Vref + 2.1	V
Saturation output voltage	Vsat	Vref - 1.1	-	Vref + 0.3	V
Sensitivity ratio*5	SR	0.7	-	1.43	-
Photoresponse nonuniformity*6	PRNU	-	-	±10	%

*3: Monochromatic wavelength source ($\lambda=805$ nm)

*4: Output voltage right after reset in dark state

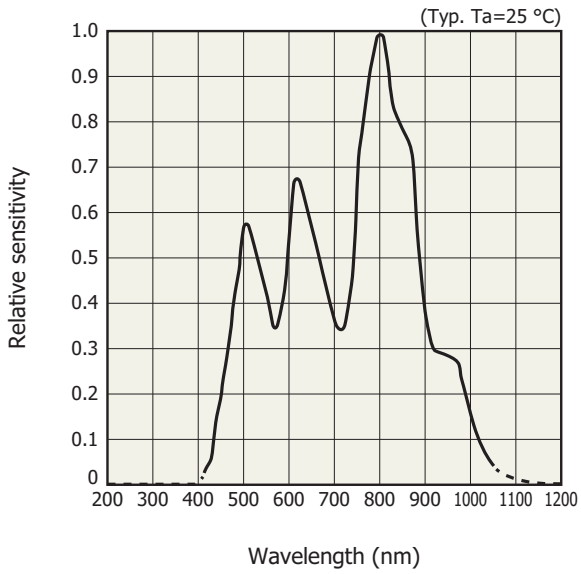
*5: Sensitivity ratio of Vout1 (VTX1=3 V, VTX2=VTX3=0 V) to Vout2 (VTX2=3 V, VTX1=VTX3=0 V)

*6: Photoresponse nonuniformity (PRNU) is the output nonuniformity that occurs when the entire photosensitive area is uniformly illuminated by white light which is approx. 50% of the saturation level. PRNU is measured using the pixels excluding the pixels of the 4 outermost lines and defective pixels, and is defined as follows:

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

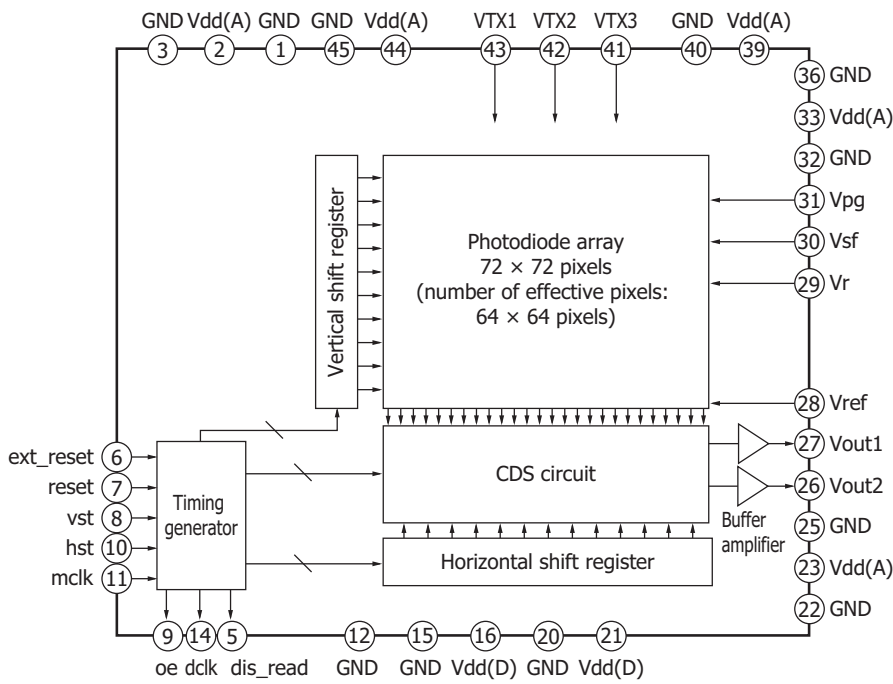
X: average output of all pixels, ΔX : standard deviation of pixel output

Spectral response



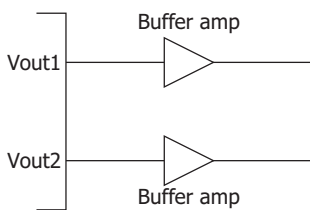
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Block diagram



KMPDC0438EC

Basic connection example

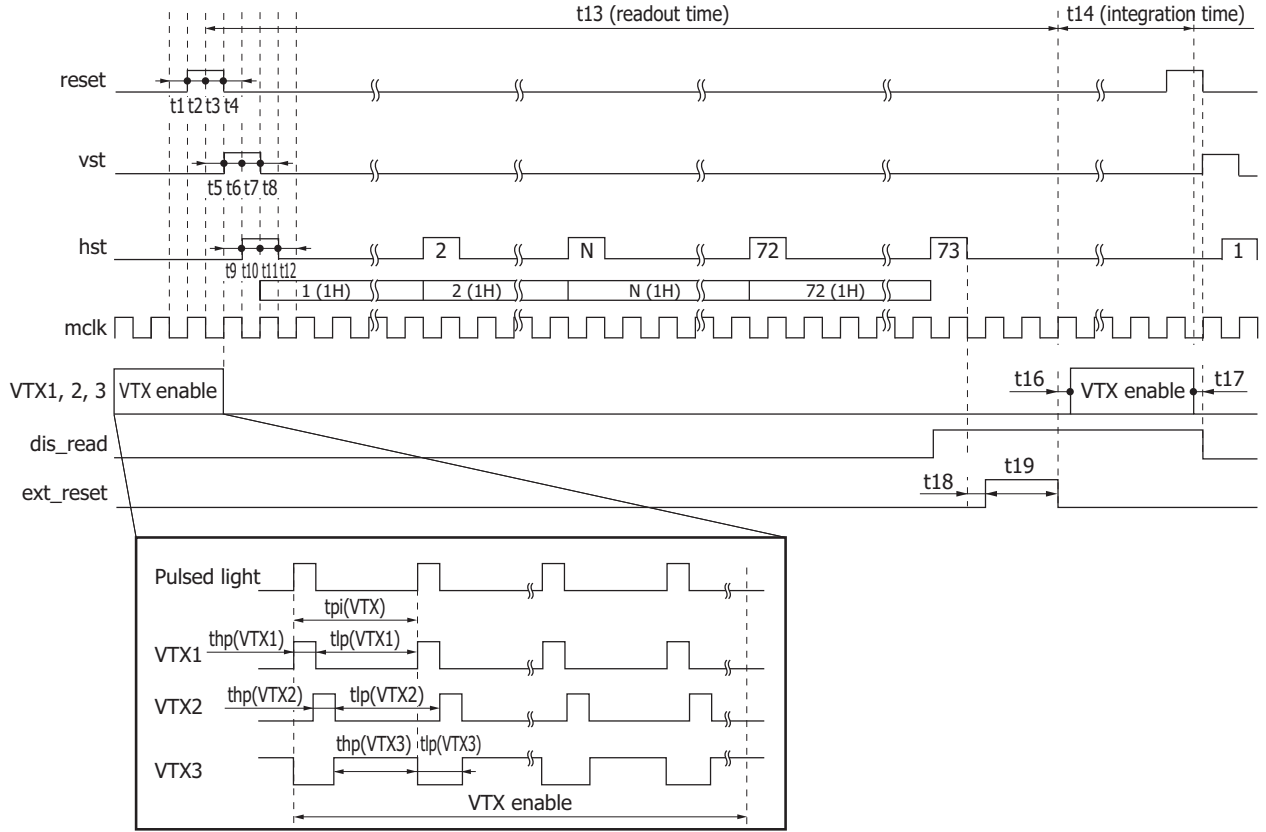


KMPDC0486EA

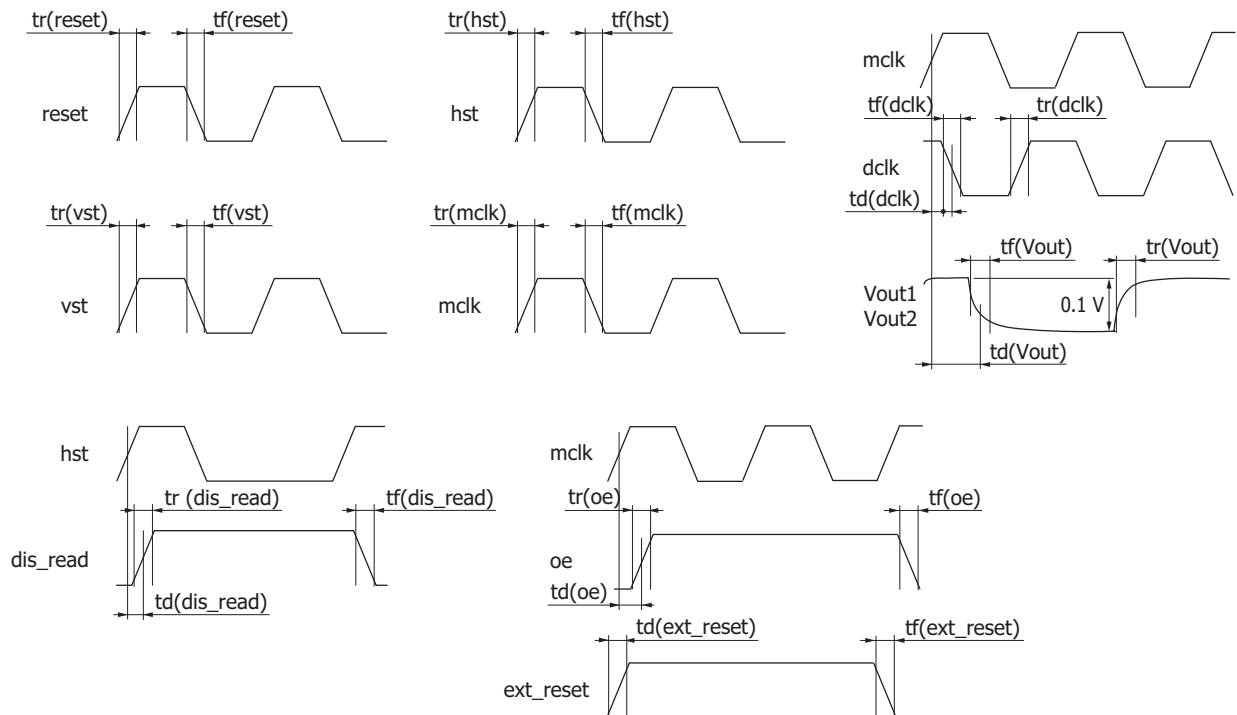
Timing chart

Using VTX3 allows changing the light source duty ratio to increase the light emission power. When thp(VTX3) is set to 0 ns, the light source can be driven with a duty ratio of 50%.

■ Frame timing



KMPDC0439EB



KMPDC0440EB

Calculation method of frame rate

$$\begin{aligned} \text{Frame rate} &= 1/(\text{Time per frame}) \\ &= 1/(\text{Integration time} + \text{Readout time}) \end{aligned}$$

Integration time:

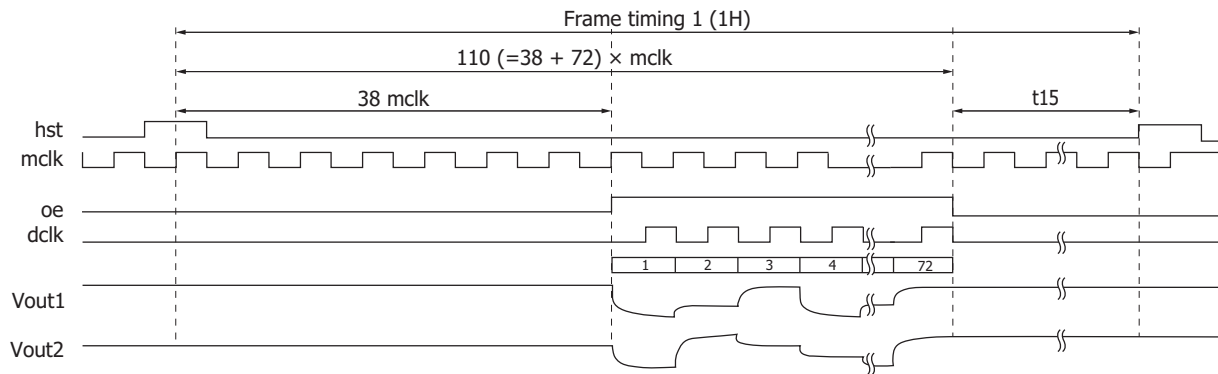
It is necessary to be changed by the required distance accuracy and usage environment factors such as fluctuating background light.

$$\begin{aligned} \text{Readout time} &= \frac{1}{\text{Clock pulse frequency}} \times \text{Horizontal timing clock} \times \text{Number of vertical pixels} \\ &= \text{Time per clock (Readout time per pixel)} \times \text{Horizontal timing clocks} \times \text{Number of vertical pixels} \end{aligned}$$

Calculation example of readout time (clock pulse frequency: 5 MHz, horizontal timing clocks: 110, number of vertical pixels: 72)

$$\begin{aligned} \text{Readout time} &= \frac{1}{5 \times 10^6 [\text{Hz}]} \times 110 \times 72 \\ &= 200 [\text{ns}] \times 110 \times 72 \\ &= 1.584 [\text{ms}] \end{aligned}$$

Horizontal timing



KMPDC0441EB

Parameter	Symbol	Min.	Typ.	Max.	Unit
Master clock pulse duty ratio	-	45	50	55	%
Master clock pulse rise and fall times	tr(mclk), tf(mclk)	0	-	20	ns
Frame reset pulse rise and fall times	tr(reset), tf(reset)	0	-	20	ns
Frame synchronous trigger pulse rise and fall times	tr(vst), tf(vst)	0	-	20	ns
Line synchronous trigger pulse rise and fall times	tr(hst), tf(hst)	0	-	20	ns
Pixel reset pulse rise and fall times	tr(ext_reset), tf(ext_reset)	0	-	20	ns
Time from falling edge of master clock pulse to rising edge of frame reset pulse	t1	$1/4 \times 1/f(\text{mclk})$	-	$1/2 \times 1/f(\text{mclk})$	s
Time from rising edge of frame reset pulse to falling edge of master clock pulse	t2	$1/4 \times 1/f(\text{mclk})$	-	$1/2 \times 1/f(\text{mclk})$	s
Time from falling edge of master clock pulse to falling edge of frame reset pulse	t3	$1/4 \times 1/f(\text{mclk})$	-	$1/2 \times 1/f(\text{mclk})$	s
Time from falling edge of frame reset pulse to falling edge of master clock pulse	t4	$1/4 \times 1/f(\text{mclk})$	-	$1/2 \times 1/f(\text{mclk})$	s
Time from falling edge of master clock pulse to rising edge of frame synchronous trigger pulse	t5	$1/4 \times 1/f(\text{mclk})$	-	$1/2 \times 1/f(\text{mclk})$	s
Time from rising edge of frame synchronous trigger pulse to falling edge of master clock pulse	t6	$1/4 \times 1/f(\text{mclk})$	-	$1/2 \times 1/f(\text{mclk})$	s
Time from falling edge of master clock pulse to falling edge of frame synchronous trigger pulse	t7	$1/4 \times 1/f(\text{mclk})$	-	$1/2 \times 1/f(\text{mclk})$	s
Time from falling edge of frame synchronous trigger pulse to falling edge of master clock pulse	t8	$1/4 \times 1/f(\text{mclk})$	-	$1/2 \times 1/f(\text{mclk})$	s
Time from rising edge of master clock pulse to rising edge of line synchronous trigger pulse	t9	$1/4 \times 1/f(\text{mclk})$	-	$1/2 \times 1/f(\text{mclk})$	s
Time from rising edge of line synchronous trigger pulse to rising edge of master clock pulse	t10	$1/4 \times 1/f(\text{mclk})$	-	$1/2 \times 1/f(\text{mclk})$	s
Time from rising edge of master clock pulse to falling edge of line synchronous trigger pulse	t11	$1/4 \times 1/f(\text{mclk})$	-	$1/2 \times 1/f(\text{mclk})$	s
Time from falling edge of line synchronous trigger pulse to rising edge of master clock pulse	t12	$1/4 \times 1/f(\text{mclk})$	-	$1/2 \times 1/f(\text{mclk})$	s
Readout time	t13	$(110/f(\text{mclk}) + t15) \times 72 + t18 + t19$	-	-	s
Integration time	t14	-	10	-	ms
Time from rising edge of master clock pulse (after reading signals from all pixels) to rising edge of master clock pulse (hst: high period)	t15	$10/f(\text{mclk})$	-	-	s
Time from falling edge of master clock pulse to rising edge of output signal synchronous pulse	td(dclk)	0	25	50	ns
Output signal synchronous pulse output voltage rise time (10 to 90%)*7	tr(dclk)	-	20	40	ns
Output signal synchronous pulse output voltage fall time (10 to 90%)*7	tf(dclk)	-	20	40	ns
Time from rising edge of master clock pulse to rising edge of output signal effective period pulse	td(oe)	0	25	50	ns
Output signal effective period pulse rise time (10 to 90%)*7	tr(oe)	-	20	40	ns
Output signal effective period pulse fall time (10 to 90%)*7	tf(oe)	-	20	40	ns
Settling time of output signal 1, 2 (10 to 90%)*7 *8	tr(Vout), tf(Vout)	-	35	70	ns
Time from rising edge of master clock pulse to output signal 1, 2 (output 50%)*7	td(Vout)	-	40	80	ns

*7: CL=3 pF

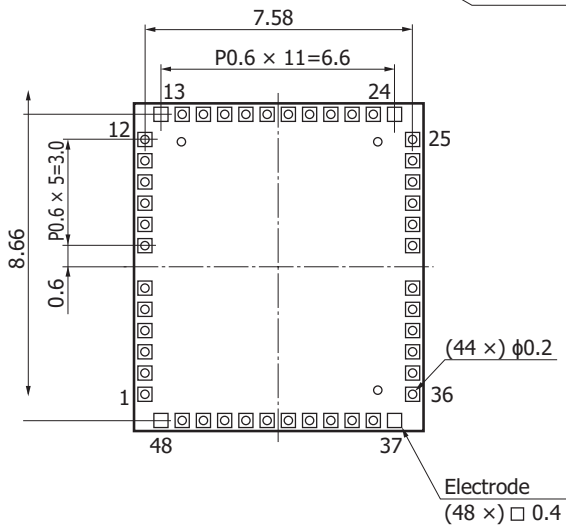
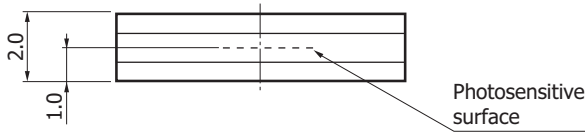
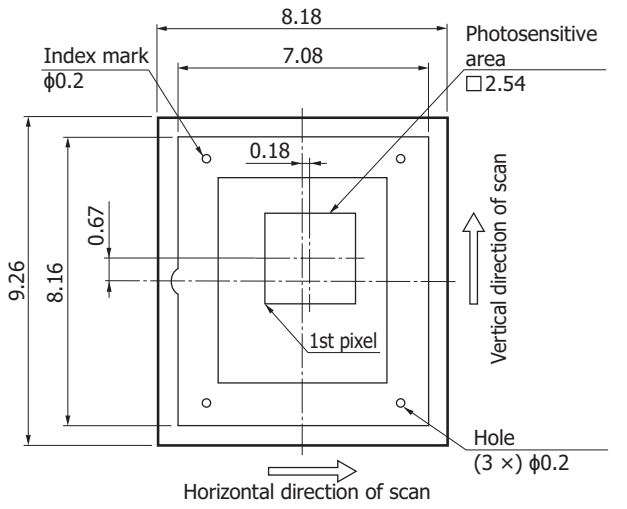
*8: Output voltage=0.1 V

Parameter	Symbol	Min.	Typ.	Max.	Unit
Charge transfer clock pulse interval	t _{pi} (VTX)	60	-	-	ns
Charge transfer clock pulse (VTX1) high period	t _{hp} (VTX1)	30	-	-	ns
Charge transfer clock pulse (VTX1) low period	t _{lp} (VTX1)	-	t _{pi} (VTX) - t _{hp} (VTX2) - t _{hp} (VTX3)	-	ns
Charge transfer clock pulse (VTX2) high period	t _{hp} (VTX2)	30	-	-	ns
Charge transfer clock pulse (VTX2) low period	t _{lp} (VTX2)	-	t _{pi} (VTX) - t _{hp} (VTX1) - t _{hp} (VTX3)	-	ns
Charge transfer clock pulse (VTX3) high period	t _{hp} (VTX3)	0	-	-	ns
Charge transfer clock pulse (VTX3) low period	t _{lp} (VTX3)	-	t _{pi} (VTX) - t _{hp} (VTX1) - t _{hp} (VTX2)	-	ns
Charge transfer clock pulse voltage rise time	t _r (VTX)	-	3	-	ns
Charge transfer clock pulse voltage fall time	t _f (VTX)	-	3	-	ns
Charge transfer clock pulse voltage	High level	VTX1, VTX2, VTX3	3	-	V
	Low level		0	-	
Time from falling edge of pixel reset pulse to "VTX enable period=on"	t ₁₆	0	-	-	s
Time from "VTX enable period=off" to falling edge of frame reset pulse	t ₁₇	0	-	-	s
Time from rising edge of line synchronous trigger pulse (last pulse) to rising edge of pixel reset pulse	t ₁₈	0	-	-	s
Pixel reset pulse high period	t ₁₉	10	-	-	μs
Time from rising edge of line synchronous trigger pulse to rising edge of non-readout period pulse*7	t _d (dis_read)	-	25	50	ns
Non-readout period pulse rise time (10 to 90%)*7	t _r (dis_read)	-	20	40	ns
Non-readout period pulse fall time (10 to 90%)*7	t _f (dis_read)	-	20	40	ns

Input terminal capacitance (Ta=25 °C, Vdd=5 V)

Parameter	Symbol	Min.	Typ.	Max.	Unit
Charge transfer clock pulse internal load capacitance	CLTX	-	100	-	pF

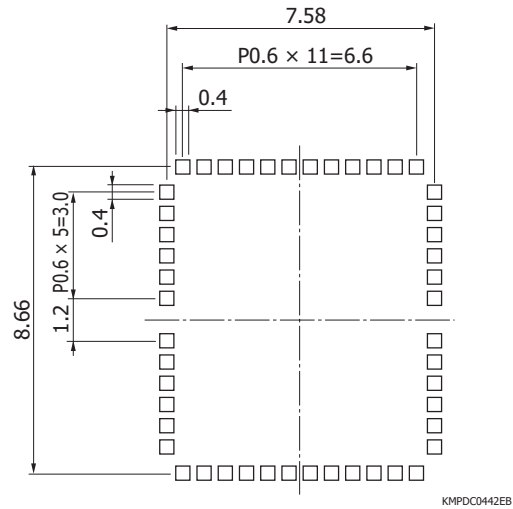
Dimensional outline (unit: mm)



Tolerance unless otherwise noted: ± 0.2 , $\pm 2^\circ$

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Recommended land pattern (unit: mm)



KMPDC0442EB

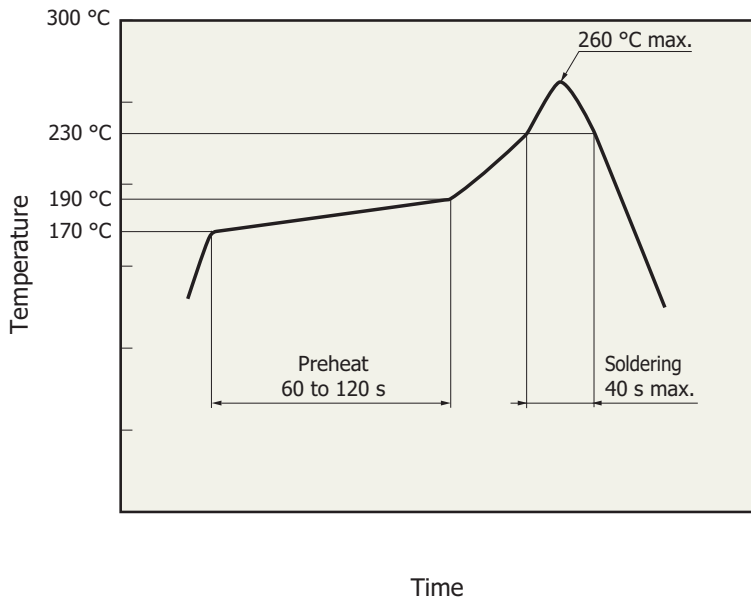
Pin connections

Pin no.	Symbol	I/O	Description
1	GND	I	Ground
2	Vdd(A)	I	Analog supply voltage
3	GND	I	Ground
4	NC	-	No connection
5	dis_read	O	Non-readout period pulse
6	ext_reset	I	Pixel reset pulse
7	reset	I	Frame reset pulse
8	vst	I	Frame synchronous trigger pulse
9	oe	O	Output signal effective period pulse
10	hst	I	Line synchronous trigger pulse
11	mclk	I	Master clock pulse
12	GND	I	Ground
13	NC	-	No connection
14	dclk	O	Output signal synchronous pulse
15	GND	I	Ground
16	Vdd(D)	I	Digital supply voltage
17	NC	-	No connection
18	NC	-	No connection
19	NC	-	No connection
20	GND	I	Ground
21	Vdd(D)	I	Digital supply voltage
22	GND	I	Ground
23	Vdd(A)	I	Analog supply voltage
24	NC	-	No connection
25	GND	I	Ground
26	Vout2	O	Output signal 2
27	Vout1	O	Output signal 1
28	Vref	I	Bias voltage (output offset)
29	Vr	I	Bias voltage (pixel reset)
30	Vsf	I	Bias voltage (pixel amplifier)
31	Vpg	I	Bias voltage (photosensitive area)
32	GND	I	Ground
33	Vdd(A)	I	Analog supply voltage
34	NC	-	No connection
35	NC	-	No connection
36	GND	I	Ground
37	NC	-	No connection
38	NC	-	No connection
39	Vdd(A)	I	Analog supply voltage
40	GND	I	Ground
41	VTX3	I	Charge transfer clock pulse 3
42	VTX2	I	Charge transfer clock pulse 2
43	VTX1	I	Charge transfer clock pulse 1
44	Vdd(A)	I	Analog supply voltage
45	GND	I	Ground
46	NC	-	No connection
47	NC	-	No connection
48	NC	-	No connection

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

Connect impedance converging buffer amplifiers to Vout1/Vout2 so as to minimize the current flow.

Recommended soldering conditions



KMPDB0381EA

- 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 168 hours.
- The effect that the product receives during reflow soldering varies depending on the circuit board and reflow oven that are used. Before actual reflow soldering, check for any problems by testing out the reflow soldering methods in advance.

Related information

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

■ Precautions

- Disclaimer
- Surface mount type products

■ Technical information

- Distance image sensors (Front-illuminated type)

Information described in this material is current as of July 2020.

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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