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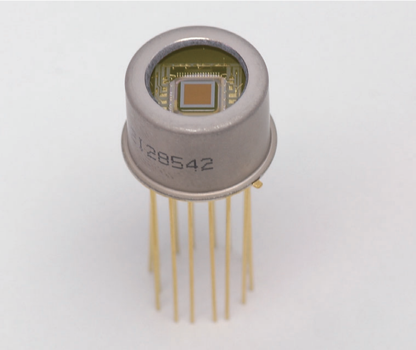


InGaAs area image sensor

G12242-0707W

Near infrared area image sensor with 128 × 128 pixels

The G12242-0707W has a hybrid structure consisting of a CMOS readout circuit (ROIC: readout integrated circuit) and back-illuminated InGaAs photodiodes. Each pixel is made up of an InGaAs photodiode and a ROIC electrically connected by indium bumps. The timing generator in the ROIC provides an analog video output and AD-TRIG output which are obtained by just supplying a master clock (MCLK) and master start pulse (MSP) as digital inputs from external sources.
The G12242-0707W has 128 × 128 pixels arrayed at a 20 μm pitch and their signals are read out from a video line. Light incident on the InGaAs photodiodes is converted into electrical signals which are then input to the ROIC through indium pumps. Electrical signals in the ROIC are converted into voltage signals by charge amplifiers and then sequentially output from the video line by the shift register. The G12242-0707W is hermetically sealed in a TO-8 package together with a two-stage thermoelectric cooler to deliver low-cost yet highly stable operation.

Features

- **Spectral response range: 0.95 to 1.7 μm**
- **High sensitivity: 1 μV/e-**
- **Frame rate: 258 fps max.**
- **Global shutter mode and rolling shutter mode switchable**
- **Simple operation (built-in timing generator)**
- **Two-stage TE-cooled**
- **Low cost**

Applications

- **Thermal image monitor**
- **Laser beam profiler**
- **Near infrared image detection**
- **Foreign object detection**

Block diagram

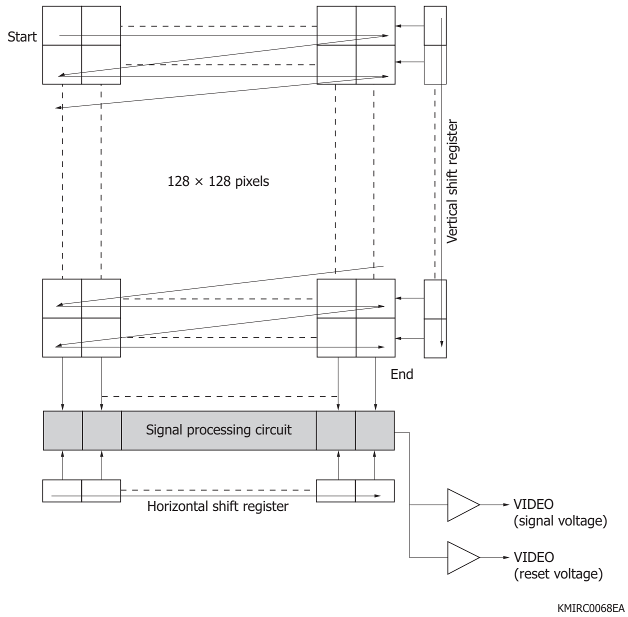
The G12242-0707W operates in either global shutter mode or rolling shutter mode which are switchable. The operation of the readout circuit in each mode is described below.

■ Rolling shutter mode

The sample-and-hold switches in all pixels are always ON. Pixel scanning starts from the top left point as shown in the figure on the right.
The vertical shift register scans from top to bottom while sequentially selecting each row. The following operations ① to ③ are performed on each pixel of the selected row.

① Transfers the integrated optical signal information to the signal processing circuit as a signal voltage, and samples and holds the signal voltage.
② Resets each pixel after having transferred the signal, transfers the reset signal voltage to the signal processing circuit, and samples and holds the reset signal voltage.
③ The horizontal shift register performs a sequential scan to output the signal voltage and reset signal voltage as serial data. The offset voltage in each pixel can be eliminated by finding a difference between the signal voltage and the reset signal voltage with a circuit outside the sensor.

After the above operations ① to ③ are complete, the reset switch for each pixel on the selected row turns off and signal integration begins. At the same time, the vertical shift register shifts by one row to select the next row and the operations ① to ③ are repeated.
After the vertical shift register advances to the 128th row, the master start pulse (MSP), which is a frame scan signal, changes from low (0 V) to high (5 V), and the next frame scan begins when the MCLK goes low. The signal integration time is the time period from right after the end of the n-th row scan to the timing for holding the optical signal information integrated on the n-th row in the next frame.



■ Global shutter mode

In this mode, the integration time is equal to the low period of the MSP and the output voltage is sampled and held simultaneously at all pixels. Then the signals are sequentially read out in the same way as the rolling shutter mode.

The vertical shift register scans from top to bottom while sequentially selecting each row. The following operations ① to ③ are performed on each pixel of the selected row:

① Transfers the optical signal information sampled and held in each pixel to the signal processing circuit as a signal voltage, and samples and holds the signal voltage.

② Resets each pixel after having transferred the signal, transfers the reset signal voltage to the signal processing circuit, and samples and holds the reset signal voltage.

③ The horizontal shift register performs a sequential scan to output the signal voltage and reset signal voltage as serial data. The offset voltage in each pixel can be eliminated by finding a difference between the signal voltage and the reset voltage with a circuit outside the sensor.

Then the vertical shift register shifts by one row to select the next row and the operations ① to ③ are repeated.

When the MSP, which is a frame scan signal, goes low after the vertical shift register advances to the 128th row, the reset switches for all pixels simultaneously turn off and the next frame integration begins.

Structure

Parameter	Specification	Unit
Image size	2.56 × 2.56	mm
Cooling	Two-stage TE-cooled	-
Number of total pixels	16384 (128 × 128)	pixels
Number of effective pixels	16384 (128 × 128)	pixels
Pixel size	20 × 20	µm
Pixel pitch	20	µm
Package	TO-8 16-pin metal (refer to dimensional outline)	-
Window	Borosilicate glass with anti-reflective coating	-

Absolute maximum ratings

Parameter	Symbol	Value	Unit
Supply voltage	Vdd	-0.3 to +5.5	V
Clock pulse voltage	V(MCLK)	Vdd +0.5	V
Start pulse voltage	V(MSP)	Vdd +0.5	V
Operating temperature	Topr	-10 to +60	°C
Storage temperature	Tstg	-20 to +70	°C
TE-cooler allowable current	Ic	0.9	A
TE-cooler allowable voltage	Vc	0.8	V
Thermistor power dissipation	Pth	0.2	mW

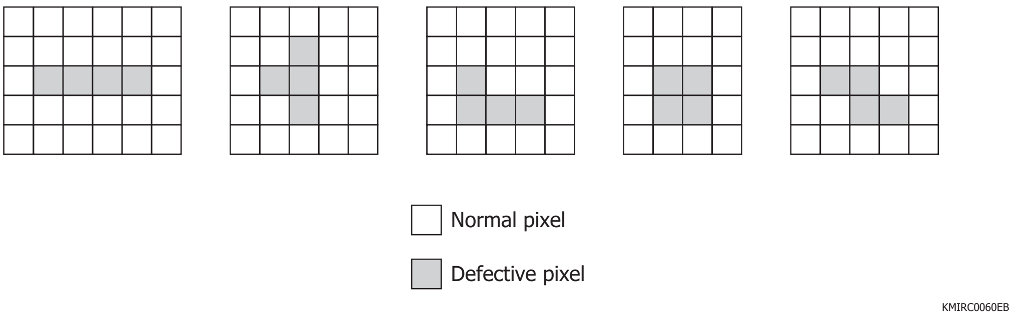
Note: Exceeding the absolute maximum ratings even momentarily may cause a drop in product quality. Always be sure to use the product within the absolute maximum ratings.

Electrical and optical characteristics (Td=15 °C, Vdd=5 V, PD_bias=3 V)

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
Spectral response range	λ		-	0.95 to 1.7	-	μm
Peak sensitivity wavelength	λp		-	1.55	-	μm
Photosensitivity	S	λ=λp	0.7	0.8	-	A/W
Conversion efficiency	CE	Cf=0.08 pF	-	1	-	μV/e⁻
Saturation charge	Qsat		-	1000	-	ke⁻
Saturation output voltage	Vsat		0.6	1.1	-	V
Photoresponse nonuniformity*1	PRNU	After subtracting dark output, Integration time=5 ms	-	±10	±20	%
Dark output	V_D		-0.2	0.3	0.5	V
Dark current	I_D		-	0.5	2.5	pA
Dark output nonuniformity	DSNU		-	±0.05	±0.2	V
Temperature coefficient of dark output	ΔT_{DS}		-	1.1	-	times/°C
Readout noise	Nr	Integration time=10 ms	-	500	1000	μV rms
Dynamic range	DR		-	2200	-	-
Defective pixel*2	-		-	-	1	%

*1: Measured at one-half of the saturation, excluding first and last pixels on each row
*2: Pixels with photoresponse nonuniformity (integration time 5 ms), readout noise, or dark current higher than the maiximum value
One or less cluster of four or more contiguous defective pixels

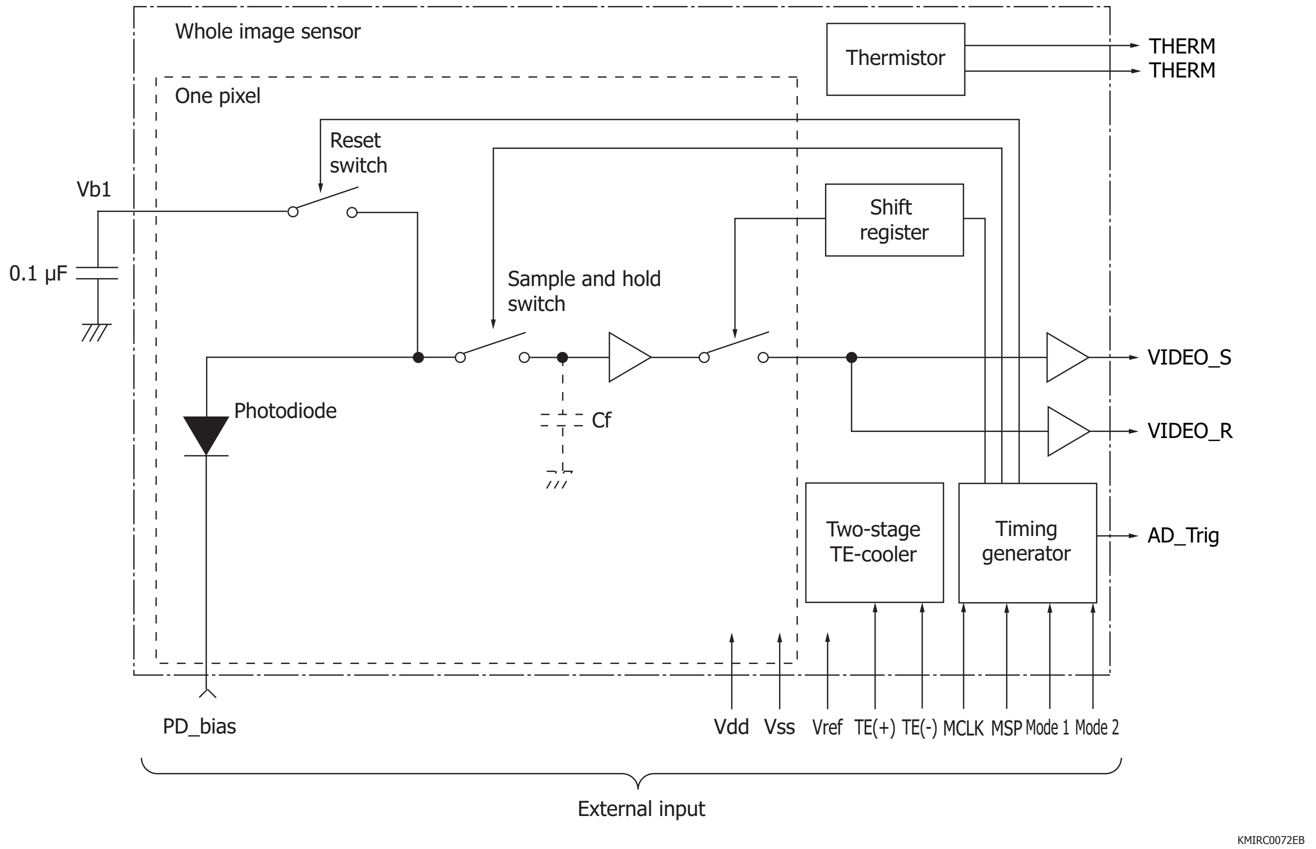
<Examples of four contiguous defective pixels>



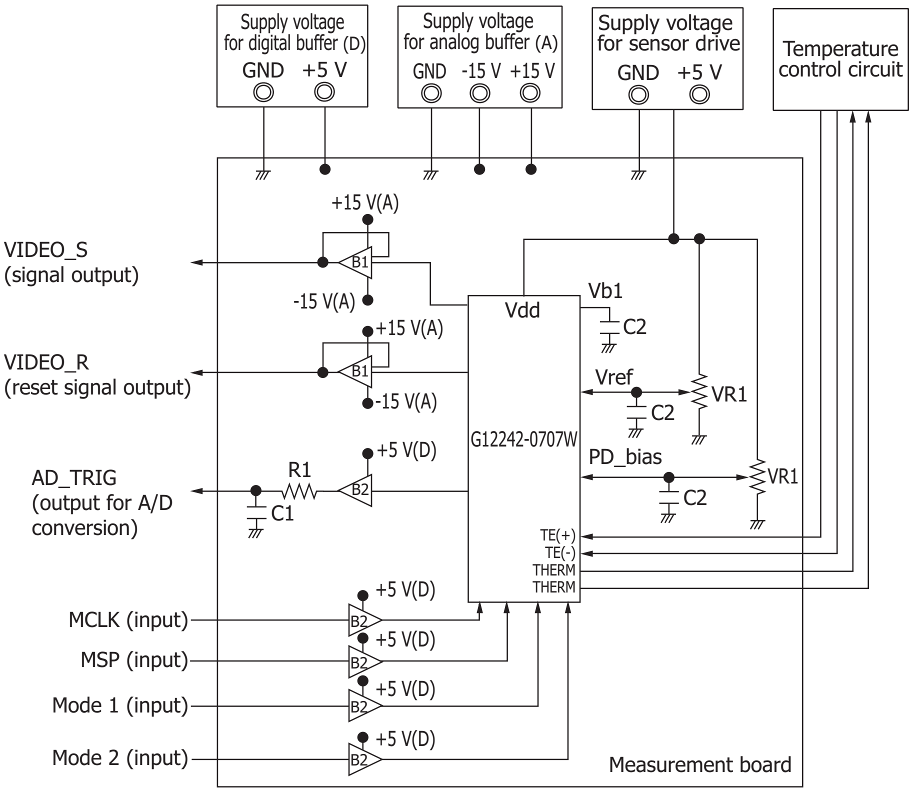
Electrical characteristics (Ta=25 °C)

Parameter		Symbol	Min.	Typ.	Max.	Unit
Supply voltage		Vdd	4.9	5	5.1	V
Supply current		I(Vdd)	-	20	40	mA
Ground		Vss	-	0	-	V
Element bias		PD_bias	2.9	3.0	3.1	V
Element bias current		I(PD_bias)	-	-	1	mA
Video output voltage (VIDEO_S)	High	V_{SH}	3.6	4.0	4.1	V
	Low	V_{SL}	2.8	2.9	3.0	
Video output voltage (VIDEO_R)		V_R	2.8	2.9	3.0	V
Clock frequency		f	-	-	20	MHz
Video data rate		fV	-	f/4	-	MHz
Thermistor resistance		Rth	8.2	9	9.8	kΩ

Equivalent circuit



Connection example



(Reference) Parameter values

Symbol	Value
R1	10 Ω
VR1	10 kΩ
C1	330 pF
C2	0.1 µF

(Reference) Buffer

Symbol	IC
B1	AD847
B2	TC74HCT541

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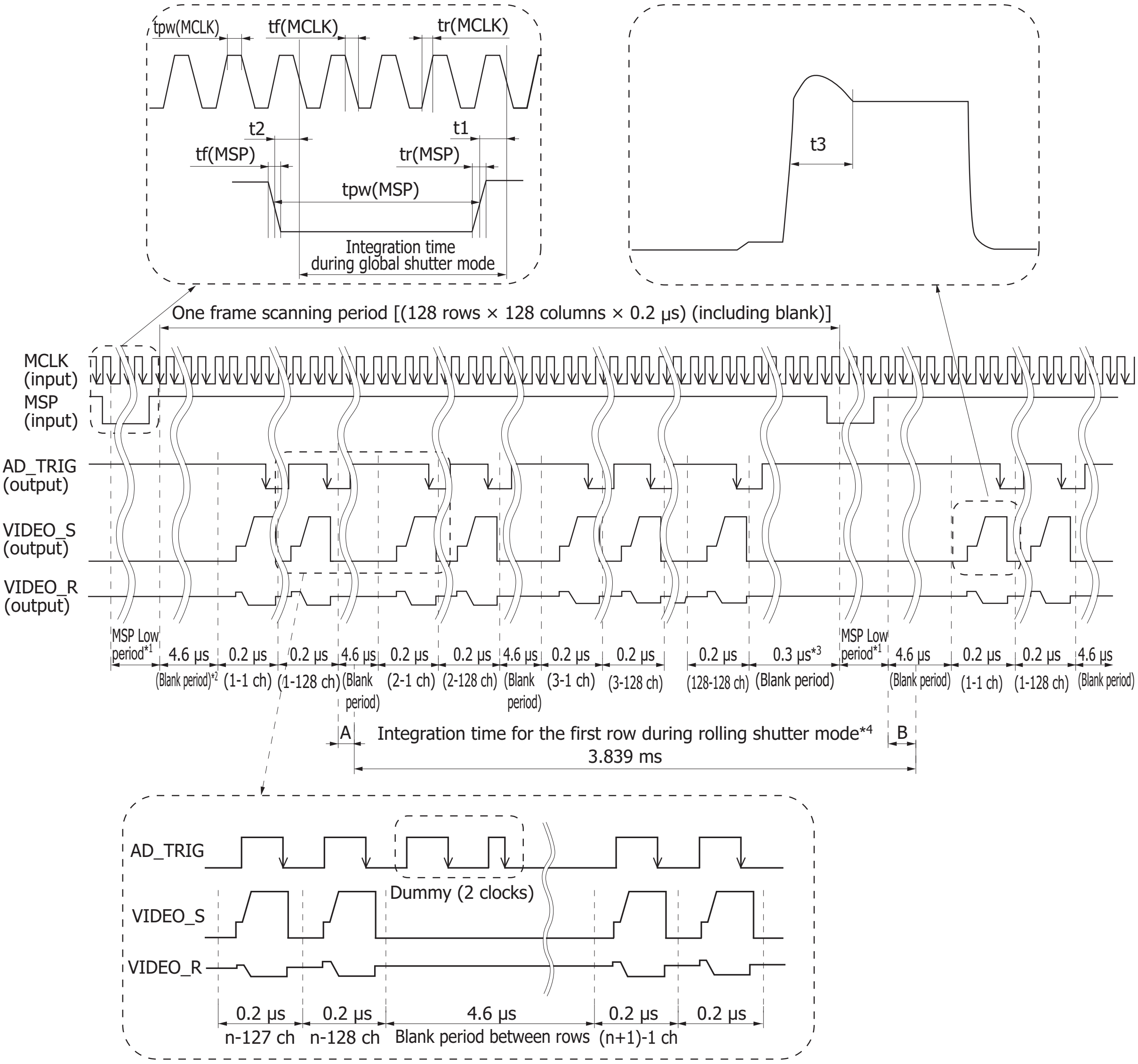
Timing chart

The video output from a single pixel is equal to 4 MCLK (master clock) pulses. The MSP (master start pulse) is a signal for setting the integration time, so making the low (0 V) period of the MSP longer will extend the integration time. The MSP also functions as a signal that triggers each control signal to perform frame scan. When the MSP goes from low (0 V) to high (5 V) , each control signal starts on the falling edge of the MCLK and frame scan is performed during the high period of the MSP. In the global shutter mode, the low (0 V) period of the MSP serves as the integration time. In the rolling shutter mode, the integration time for the n-th row is the time period from right after the end of the n-th row scan to the timing for holding the optical signal information integrated on the n-th row in the next frame. The timing charts when operated at a MCLK frequency of 20 MHz are shown below.



*1: The minimum number of MCLK pulses during the MSP low period is 20. The integration time can be changed by adjusting the MSP low period.
Rolling shutter mode: Integration time = MSP low period + 3.838 ms
Global shutter mode: Integration time = MSP low period
*2: There is a blank of 4.6 µs between each row.
*3: The blank period after scanning the last channel is 0.3 µs.
*4: The integration time for the first row in the rolling shutter mode is the time period from after 0.15 µs (period "A") after the first row is scanned to the timing for holding the optical signal information integrated on the first row in the next frame. (Period "B": 2.45 µs from the falling edge of the MCLK pulse right after the MSP goes high)
As with the first row, the integration time for the second row onward is the time period from right after the end of scan on that row to the timing for holding the optical signal information integrated in the next frame.
From the second row onward, the integration start timing shifts by 30.2 µs right after the end of scan on the preceding row. This operation is repeated until the 128th row and then returns to the first row.

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Parameter		Symbol	Min.	Typ.	Max.	Unit
Clock pulse voltage	High	V(MCLK)	Vdd - 0.5	Vdd	Vdd + 0.5	V
	Low		0	0	0.5	V
Clock pulse rise/fall times		tr(MCLK) tf(MCLK)	0	10	12	ns
Clock pulse width		tpw(MCLK)	10	-	-	ns
Start pulse voltage	High	V(MSP)	Vdd - 0.5	Vdd	Vdd + 0.5	V
	Low		0	0	0.5	V
Start pulse rise/fall times		tr(MSP) tf(MSP)	0	10	12	ns
Start pulse width*3		tpw(MSP)	0.001	-	10	ms
Start (rise) timing*4		t1	10	-	-	ns
Start (fall) timing*4		t2	10	-	-	ns
Output settling time		t3	-	-	50	ns

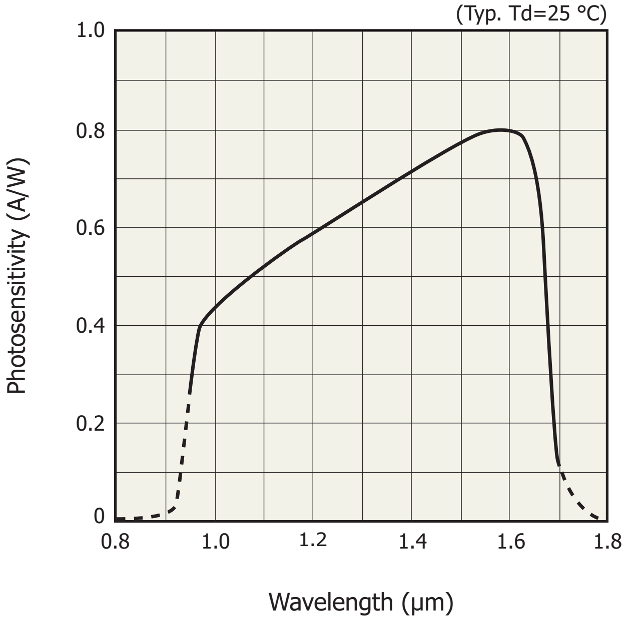
*3: Integration time max.=10 ms
*4: Setting these timings shorter than the minimum value may delay the operation by one MCLK pulse and cause malfunction.

Operation mode selection block

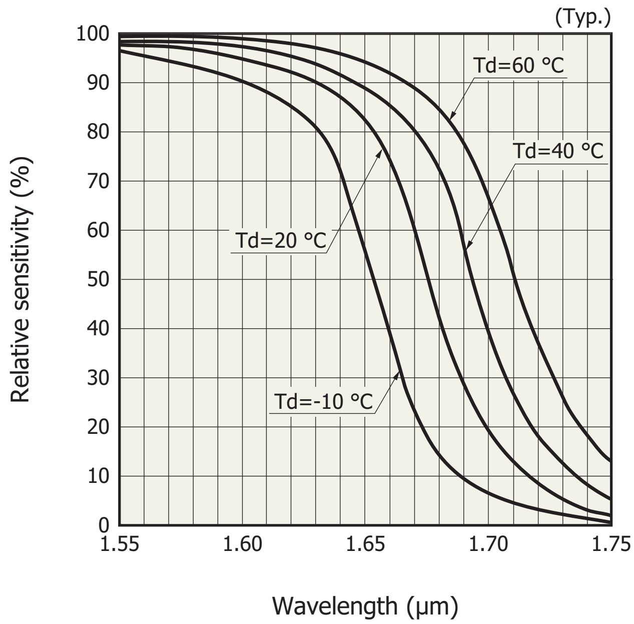
Operating mode	Mode 1	Mode 2
Rolling shutter mode	Low	Low
Global shutter mode	High	Low

* Low=0 V (Vss), High=5 V (Vdd)

Spectral response



Photosensitivity temperature characteristics



Note: chip temperature

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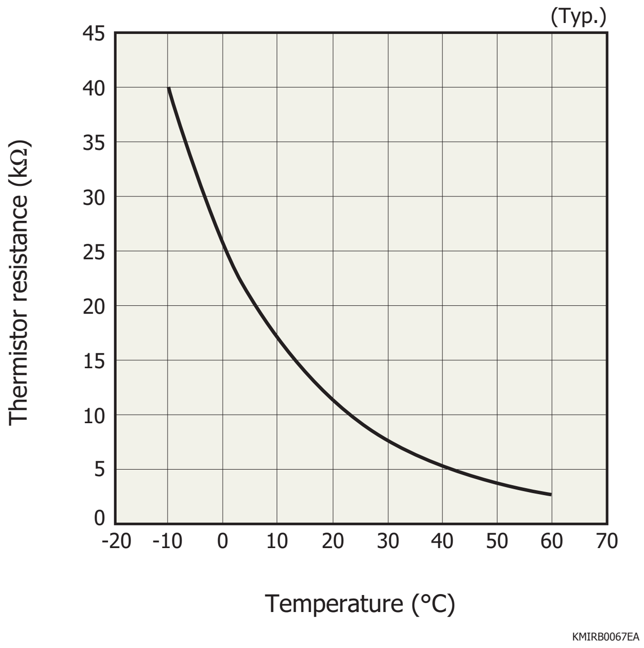
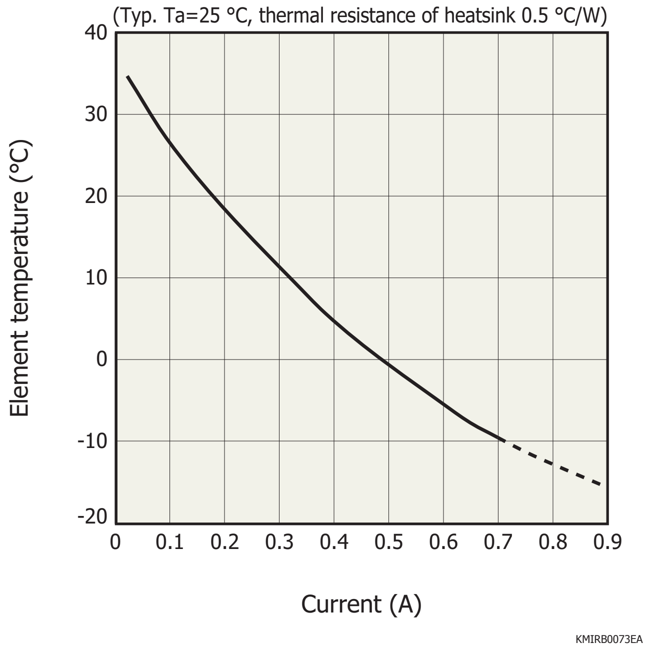
Thermistor temperature characteristics



Cooling characteristics of TE-cooler

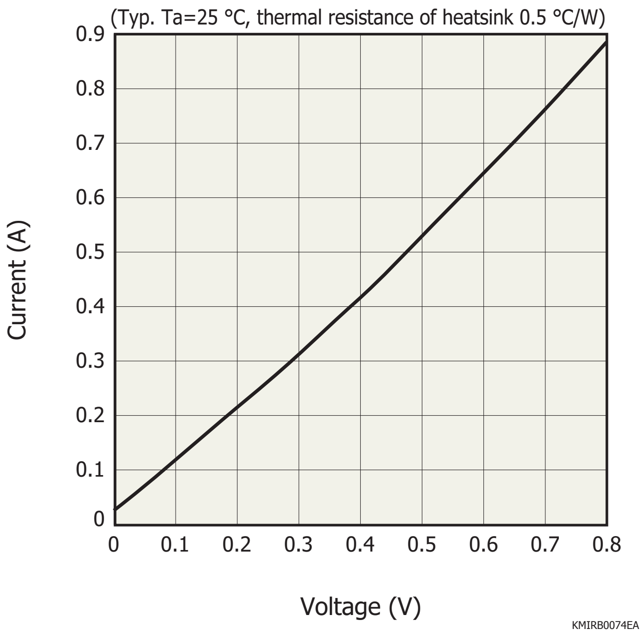


There is the following relation between the thermistor resistance and temperature (°C).

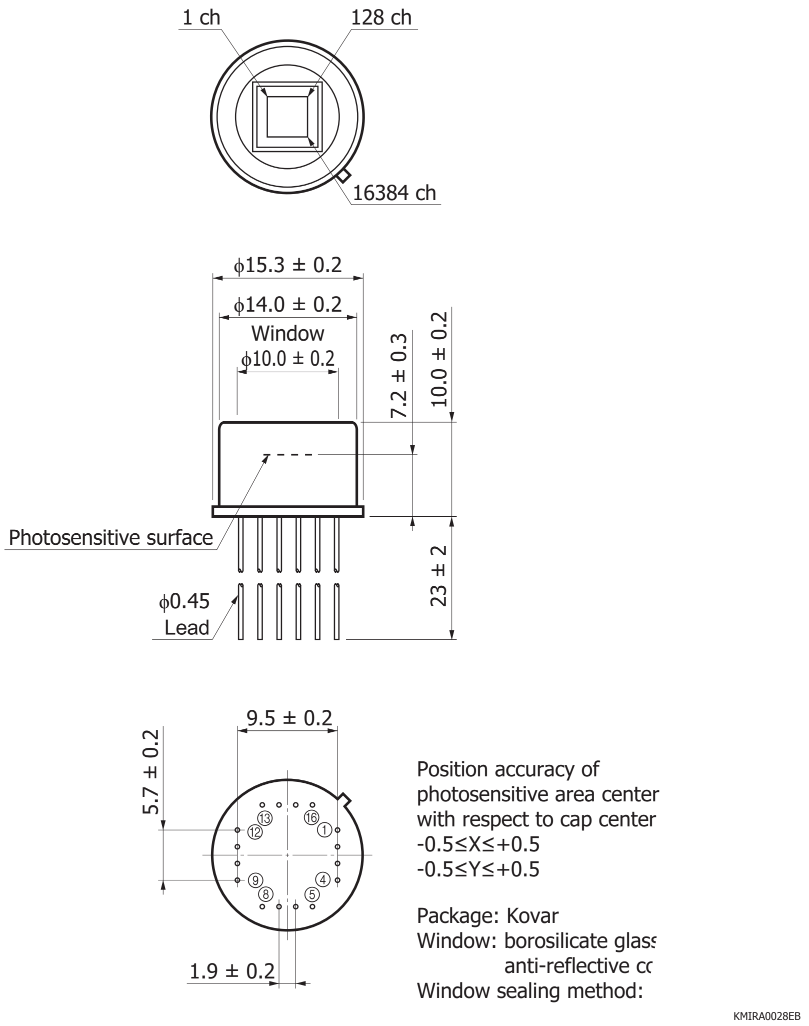
R1 = R2 × exp B {1/(T1 + 273.15) - 1/(T2 + 273.15)}

R1: Resistance at T1 (°C)
R2: Resistance at T2 (°C)
B: B constant (B=3410 K ± 2%)
Thermistor resistance=9 kΩ (at 25 °C)

Current vs. voltage (TE-cooler)



Dimensional outline (unit: mm)



Pin connections

Pin no.	Name	Input/Output	Function	Remark
1	Vss	Input	0 V ground	0 V
2	Vdd	Input	+5 V power supply	5 V
3	MCLK	Input	Control pulse for timing generator	Syochronized with falling edge
4	AD_TRIG	Output	A/D sampling signal	Syochronized with falling edge
5	MSP	Input	Frame scan start pule	
6	Mode 1	Input	Mode switching	
7	Mode 2	Input	Mode switching	
8	Vb1	Output	Pixel bias voltage (internally generated)	0.5 V
9	PD_bias	Input	Photodiode bias voltage	3.0 V
10	Vref	Input	CMOS drive voltage	3.0 V
11	VIDEO_R	Output	Video output after reset	2.9 V typ.
12	VIDEO_S	Output	Video output after integration	2.9 to 4.0 V typ.
13	TE (-)	Input	Terminal for thermoelectric cooler (-)	
14	THERM	Output	Terminal for thermistor	
15	THERM	Output	Terminal for thermistor	
16	TE (+)	Input	Terminal for thermoelectric cooler (+)	

Note: Connect a bypass capacitor of 0.1 μF to the Vb1 terminal.

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) 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) 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.

(4) 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.

Related information

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

■ Precautions
- Notice
- Image sensors/Precautions

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