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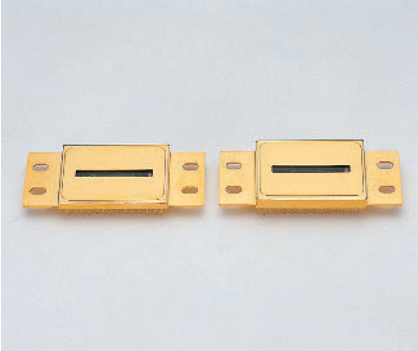
InGaAs linear image sensors



G11508 series
G11475 to G11478 series

Near infrared sensors (0.9 to 1.67 µm/2.55 µm)

The G11508/G11475 to G11478 series is an InGaAs linear image sensor designed for near infrared multichannel spectrophotometry. These linear image sensors consist an InGaAs photodiode array and charge amplifiers, offset compensation circuit, shift register, and timing generator formed on a CMOS chip. Charge amplifiers are configured with CMOS transistor array and are connected to each pixel of the InGaAs photodiode array. Since the signal from each pixel is read in charge integration mode, high sensitivity and stable operation are attained in the near infrared region. These sensors feature higher data rates and better linearity characteristics at high gain than the previous products. The package is hermetically sealed providing excellent reliability.
The signal processing circuit on the CMOS chip enables the selection of a conversion efficiency (CE) from the available two types using external voltage.

Features

- **Low noise, low dark current**
- **Selectable from two conversion efficiency types**
- **Built-in saturation countermeasure circuit**
- **Built-in CDS circuit*1**
- **Built-in thermistor**
- **Easy operation (built-in timing generator*2)**
- **High resolution: 25 µm pitch (G11508-512SA, G11475 to G11478-512WB)**

Applications

- **Near infrared multichannel spectrophotometry**
- **Radiation thermometers**
- **Non-destructive inspection equipment**

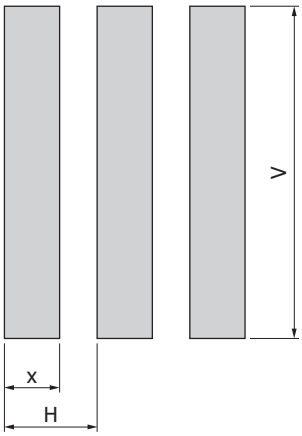
*1: On charge amplifiers, the reset noise that occurs when the integration capacitance is reset is dominant. However, the CDS circuit, which takes the difference between the signal after the completion of the integration time and the signal immediately after resetting, greatly reduces the reset noise.

*2: Previously, multiple timing signals were applied using external PLDs or the like to run the shift register. This image sensor has a built-in CMOS circuit for timing generation. All timing signals are generated inside the image sensor by simply applying CLK and Reset signals.

Structure

Type no.	Cooling	Image size (mm)	Pixel size (H) × (V) (µm)	Pixel pitch (µm)	Total number of pixels	Number of effective pixels	Fill factor (%)	Package	Window material
G11508-256SA	One-stage TE-cooled	12.8 × 0.5	50 × 500	50	256	256	100	28-pin metal	Sapphire with AR coating
G11508-512SA			25 × 500	25	512	512			
G11475-256WB	Two-stage TE-cooled	12.8 × 0.25	50 × 250	50	256	256			
G11475-512WB			25 × 250	25	512	512			
G11476-256WB			50 × 250	50	256	256			
G11477-256WB			50 × 250	50	256	256			
G11477-512WB			25 × 250	25	512	512			
G11478-256WB			50 × 250	50	256	256			
G11478-512WB			25 × 250	25	512	512			

Enlarged view of photosensitive area



Number of pixels	x	H	V
256	30	50	250
			500
512	10	25	250
			500

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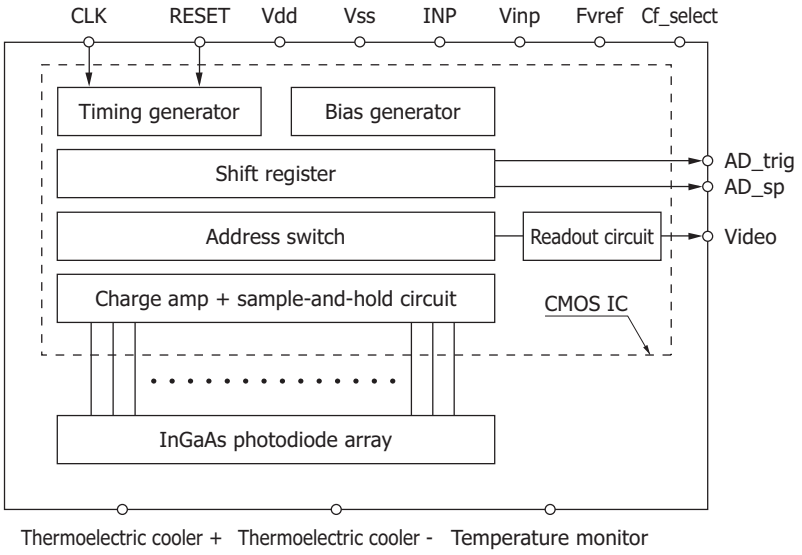
Block diagram



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Absolute maximum ratings

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
Supply voltage	Vdd, INP, Fvref Vinp, PDN	Ta=25 °C	-0.3	-	+6	V
Clock pulse voltage	Vclk	Ta=25 °C	-0.3	-	+6	V
Reset pulse voltage	V(res)	Ta=25 °C	-0.3	-	+6	V
Gain selection terminal voltage	Vcfsel	Ta=25 °C	-0.3	-	+6	V
Operating temperature*3	Topr	No dew condensation*4	-20	-	+70	°C
Storage temperature	Tstg	No dew condensation*4	-40	-	+85	°C

*3: Chip temperature and package temperature

*4: 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: Absolute maximum ratings indicate values that must not be exceeded. 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	4.7	5.0	5.3	V
Differential reference voltage		Fvref	1.1	1.2	1.3	V
Video line reset voltage		Vinp	3.9	4.0	4.1	V
Input stage amplifier reference voltage		INP	3.9	4.0	4.1	V
Photodiode cathode voltage		PDN	3.9	4.0	4.1	V
Ground		Vss	-	0	-	V
Clock pulse voltage	High	Vclk	4.7	5.0	5.3	V
	Low		0	0	0.4	
Reset pulse voltage	High	V(res)	4.7	5.0	5.3	V
	Low		0	0	0.3	

Electrical characteristics (Ta=25 °C)

Parameter		Symbol		Min.	Typ.	Max.	Unit
Current consumption		I(Vdd)	256 ch	-	45	80	mA
			512 ch	-	85	120	
		Ifvref		-	-	1	
		Ivinp		-	-	1	
		Iinp		-	-	1	
		Ipdn		-	-	1	
Clock frequency		fop		0.1	1	5	MHz
Video data rate		DR		0.1	fop	5	MHz
Video output voltage	High	V_H		-	4.0	-	V
	Low	V_L		-	1.2	-	
Output offset voltage		Vos		-	Fvref	-	V
Output impedance		Zo		-	5	-	kΩ
AD_trig, AD_sp Pulse voltage	High	Vtrig, Vsp		-	Vdd	-	V
	Low			-	GND	-	

Electrical and optical characteristics (Ta=25 °C, Vdd=5 V, INP=Vinp=PDN=4 V, Fref=1.2 V, Vclk=5 V, fop=1 MHz, CE=16 nV/e⁻)

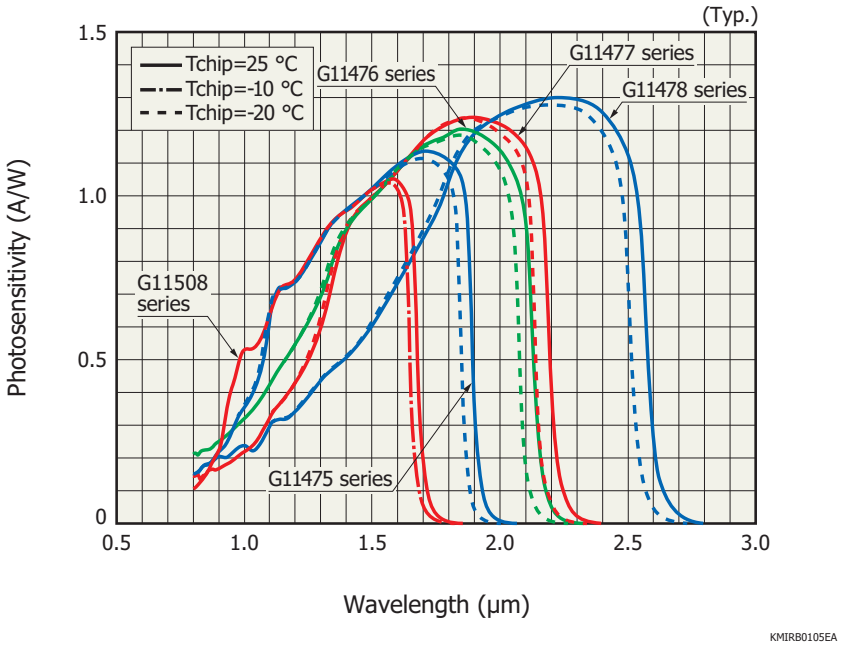
Parameter	Symbol	Condition	G11508 series*5			G11475 to G11478 series*6				Unit
			Min.	Typ.	Max.	Type no.	Min.	Typ.	Max.	
Spectral response range	λ		-	0.9 to 1.67	-	G11475	-	0.9 to 1.85	-	μm
						G11476	-	0.9 to 2.05	-	
						G11477	-	0.9 to 2.15	-	
						G11478	-	0.9 to 2.55	-	
Peak sensitivity wavelength	λp		-	1.55	-	G11475	-	1.75	-	μm
						G11476	-	1.95	-	
						G11477	-	1.95	-	
						G11478	-	2.3	-	
Photosensitivity	S	λ=λp	0.9	1.0	-	G11475	0.9	1.1	-	A/W
						G11476	0.9	1.2	-	
						G11477	0.9	1.2	-	
						G11478	0.9	1.3	-	
Conversion efficiency*7	CE	Cf=10 pF	-	16	-		-	16	-	nV/e⁻
		Cf=1 pF	-	160	-		-	160	-	nV/e⁻
Photoresponse nonuniformity*8	PRNU		-	±3	±5		-	±5	±10	%
Saturation output voltage	Vsat		2.7	2.8	-		2.7	2.8	-	V
Full well capacity	Csat	CE=16 nV/e⁻	-	175	-		-	175	-	Me⁻
		CE=160 nV/e⁻	-	17.5	-		-	17.5	-	
Readout noise*9	Nread	CE=16n V/e⁻	-	200	400		-	200	400	μV rms
		CE=160 nV/e⁻	-	300	500		-	400	500	
Readout noise*10	Nread	CE=16 nV/e⁻	-	-	-		-	220	500	μV rms
		CE=160 nV/e⁻	-	-	-		-	400	1000	
Dynamic range	Drange	*11	6750	14000	-		6750	14000	-	-
		*12	-	-	-		5400	12700	-	-
Defect pixels*13	-		-	-	0		-	-	5	%

*5: Spectral response range: Tchip=-10 °C, other characteristics: Tchip=25 °C
*6: Tchip=-20 °C
*7: For switching the conversion efficiency, see the pin connections.
*8: Measured at approximately 50% saturation and 10 ms integration time, pixel deviation after subtracting the dark output, excluding the first and last pixels
*9: G11508 series: Integration time when CE=16 nV/e⁻ is 10 ms. Integration time when CE=160 nV/e⁻ is 1 ms.
G11475 to G11477 series: Integration time when CE=16 nV/e⁻ is 1 ms. Integration time when CE=160 nV/e⁻ is 0.1 ms.
*10: G11478 series: Integration time when CE=16 nV/e⁻ is 1 ms. Integration time when CE=160 nV/e⁻ is 0.1 ms.
*11: G11508/G11475 to G11477 series
*12: G11478 series
*13: Pixels whose photoresponse nonuniformity, readout noise, or dark current is outside the specifications

Dark output characteristics (CE=16 nV/e⁻, G11508 series: Tchip=25 °C, G11475 to G11478 series: Tchip=-20 °C)

Parameter		Symbol	Min.	Typ.	Max.	Unit
Dark output (Dark output nonuniformity)	G11508-256SA	V_D	-1	±0.1	1	V/s
	G11508-512SA		-0.5	±0.05	0.5	
	G11475-256WB		-2	±0.2	2	
	G11475-512WB		-2	±0.2	2	
	G11476-256WB		-4	±0.4	4	
	G11477-256WB		-5	±0.5	5	
	G11477-512WB		-5	±0.5	5	
	G11478-256WB		-100	±10	100	
	G11478-512WB		-100	±10	100	
Dark current	G11508-256SA	I_D	-10	±1	10	pA
	G11508-512SA		-5	±0.5	5	
	G11475-256WB		-20	±2	20	
	G11475-512WB		-20	±2	20	
	G11476-256WB		-40	±4	40	
	G11477-256WB		-50	±5	50	
	G11477-512WB		-50	±5	50	
	G11478-256WB		-1000	±100	1000	
	G11478-512WB		-1000	±100	1000	

Spectral response



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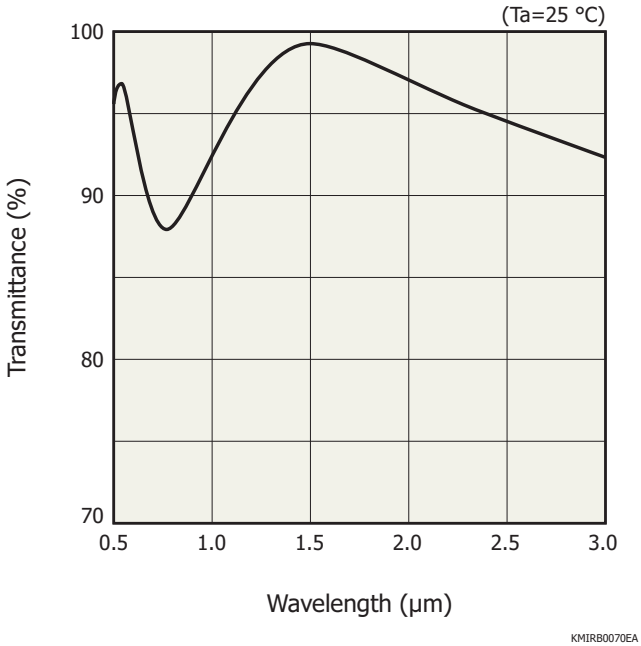
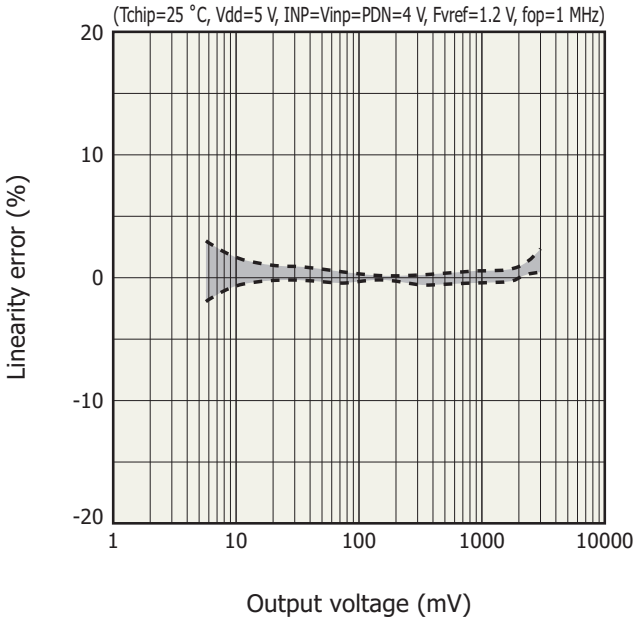
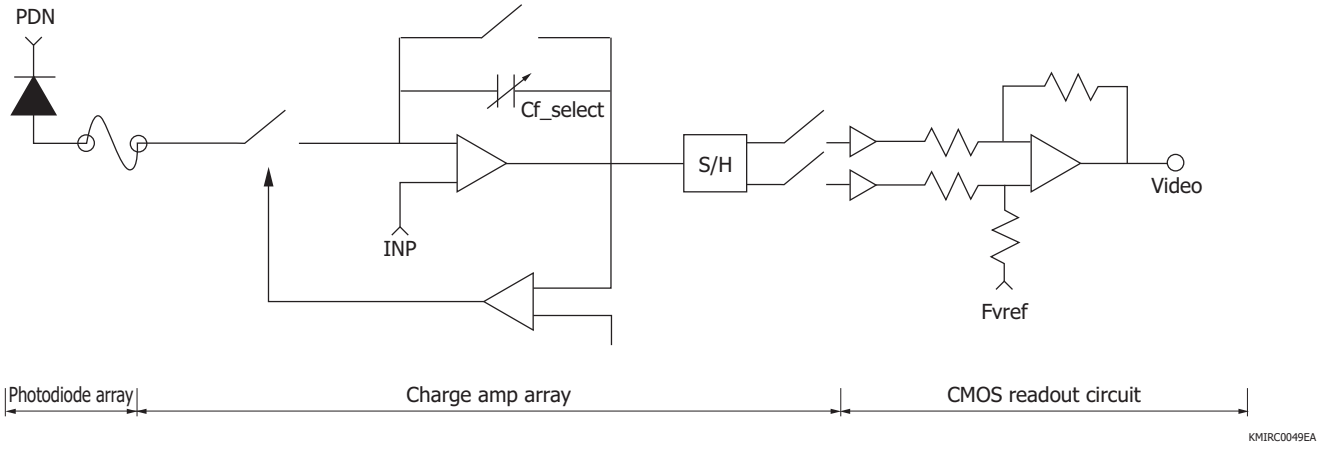
Spectral transmittance characteristics of window material (typical example)



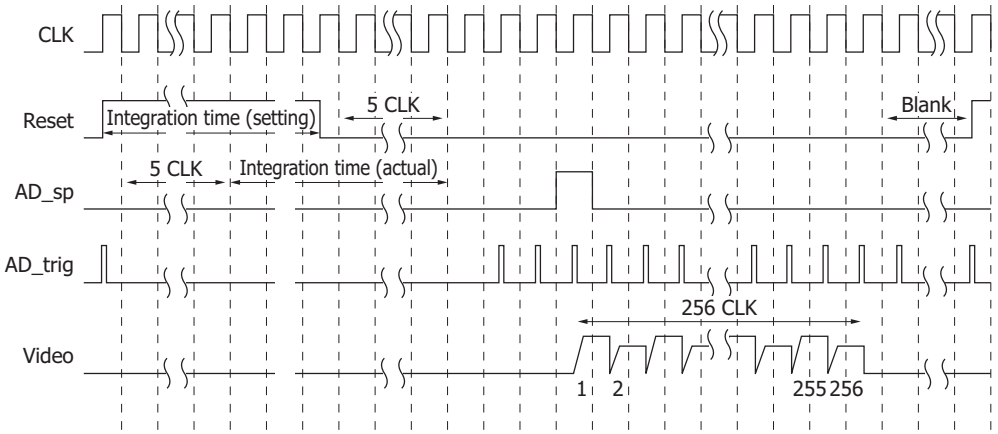
Linearity error (G11508 series, typical example)

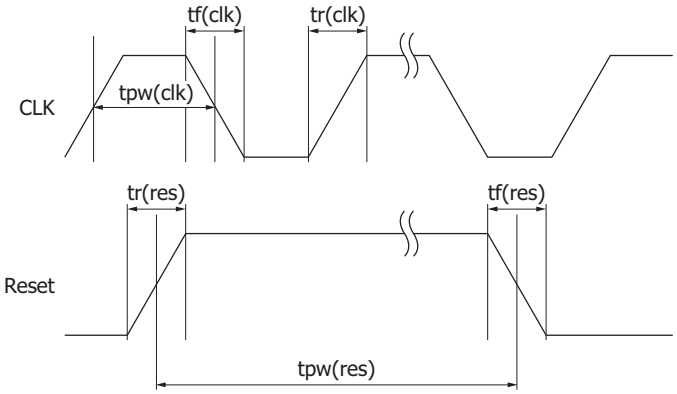


Equivalent circuit



Timing chart (each video line)





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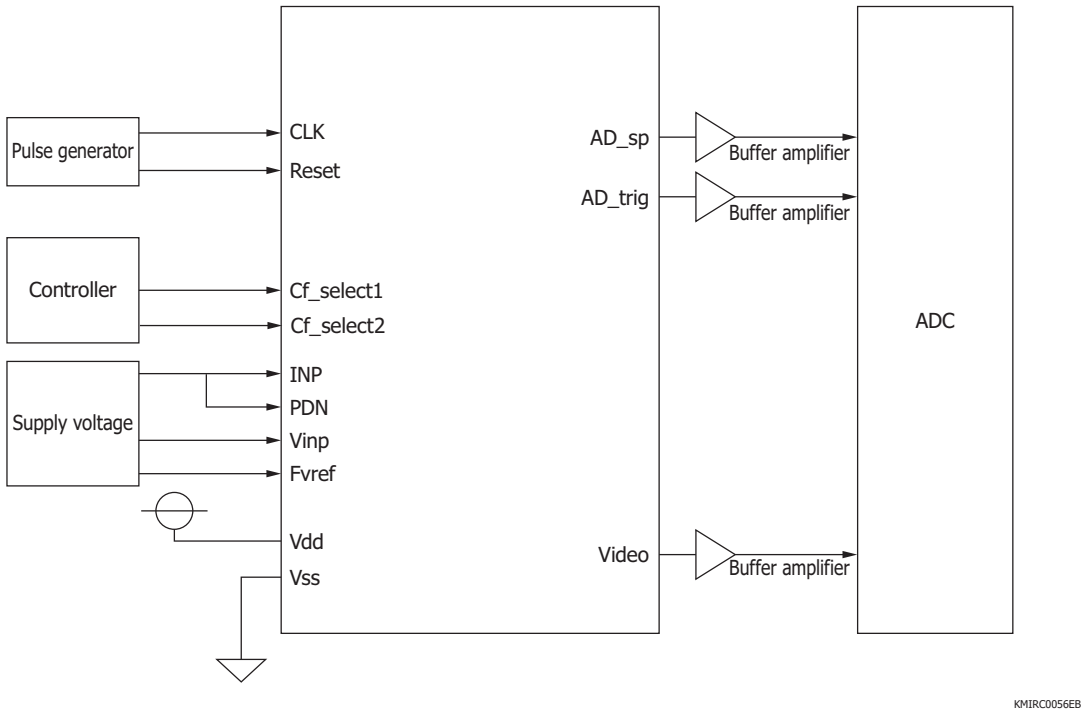
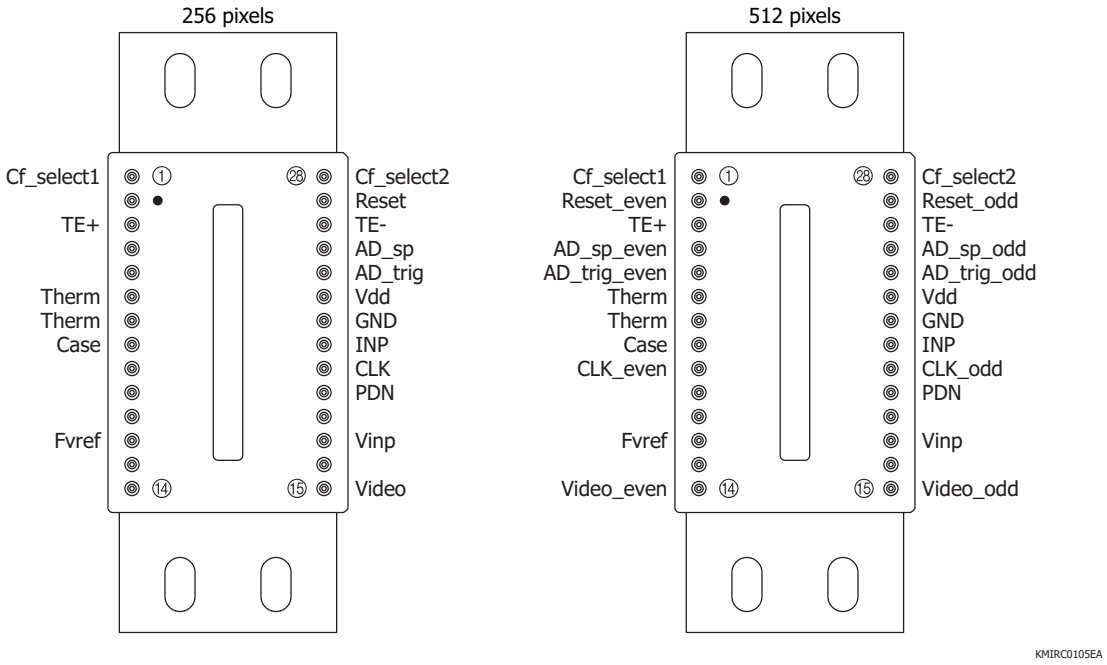
Parameter		Symbol	Min.	Typ.	Max.	Unit
Clock pulse frequency		fop	0.1	1	5	MHz
Clock pulse width		tpw(clk)	60	500	5000	ns
Clock pulse rise/fall times		tr(clk), tf(clk)	0	20	30	ns
Reset pulse width	High	tpw(res)	6	-	-	clocks
	Low		284	-	-	
Reset pulse rise/fall times		tr(res), tf(res)	0	20	30	ns

Connection example



Pin connections (top view)



Terminal name	Input/ output	Function and recommended connection	Note
PDN	Input	InGaAs photodiode's cathode bias terminal Set to the same potential as INP.	4.0 V
AD_sp	Output	Digital start signal for A/D conversion	0 to 5 V
Cf_select1, 2	Input*14	Signal for selecting the feedback capacitance (integration capacitance) on the CMOS chip	0 V or 5 V
Thermistor	Output	Thermistor for monitoring the temperature inside the package	-
AD_trig	Output	Sampling sync signal for A/D conversion	0 to 5 V
Reset	Input	Reset pulse for initializing the feedback capacitance in the charge amplifier formed on the CMOS chip. Integration time is determined by the high level period of this pulse.	0 to 5 V
CLK	Input	Clock pulse for operating the CMOS shift register	0 to 5 V
INP	Input	Input stage amplifier reference voltage. This is the supply voltage for operating the signal processing circuit on the CMOS chip. Set to the same potential as PDN.	4.0 V
Vinp	Input	Video line reset voltage. This is the supply voltage for operating the signal processing circuit on the CMOS chip.	4.0 V
Fvref	Input	Differential amplifier reference voltage. This is the supply voltage for operating the signal processing circuit on the CMOS chip.	1.2 V
Video	Output	Differential amplifier output. This is an analog video signal.	1.2 to 4.0 V
Vdd	Input	Supply voltage (+5 V) for operating the signal processing circuit on the CMOS chip	5 V
GND	Input	Ground for the signal processing circuit on the CMOS chip (0 V)	0 V
Case	-	This terminal is connected to the package.	-
TE+, TE-	Input	Power supply terminal for the thermoelectric cooler for cooling the photodiode array	-

*14: The conversion efficiency is determined by the supply voltage to the Cf_select terminal as follows.

Conversion efficiency	Cf_select1	Cf_select2
16 nV/e$^-$ (low gain)	High	High
160 nV/e$^-$ (high gain)	High	Low

Low: 0 V (GND), High: 5 V (Vdd)

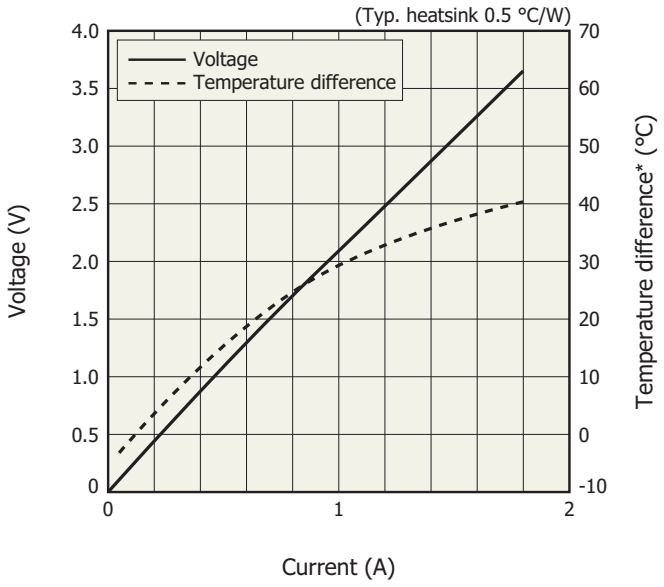
TE-cooler specifications (Ta=25 °C, Vdd=5 V, INP=Vinp=PDN=4 V, Fvref=1.2 V, Vclk=5 V, fop=1 MHz)

Parameter	Condition	Symbol	G11508 series			G11475 to G11478 series			Unit
			Min.	Typ.	Max.	Min.	Typ.	Max.	
Allowable TE-cooler current		Ic max.	-	-	1.8	-	-	2.8	A
Allowable TE-cooler voltage		Vc max.	-	-	5.0	-	-	4.0	V
Temperature difference*15	*16	ΔT	40	-	-	50	-	-	°C
Thermistor resistance		Rth	9	10	11	9	10	11	kΩ
Thermistor B constant	T1=25 °C, T2=-20 °C	B	-	3660	-	-	3660	-	K
Thermistor power dissipation		Pth	-	-	400	-	-	400	mW

*15: Temperature difference between the photosensitive area and package heat dissipation area
*16: One-stage TE-cooler: Ic=1.7 A, two-stage TE-cooler: Ic=2.6 A

TE-cooler temperature characteristics (Ta=25 °C, Vdd=5 V, INP=Vinp=PDN=4 V, Fvref=1.2 V, Vclk=5 V, fop=1 MHz)

G11508 series



* Temperature difference between the photosensitive area and package heat dissipation area

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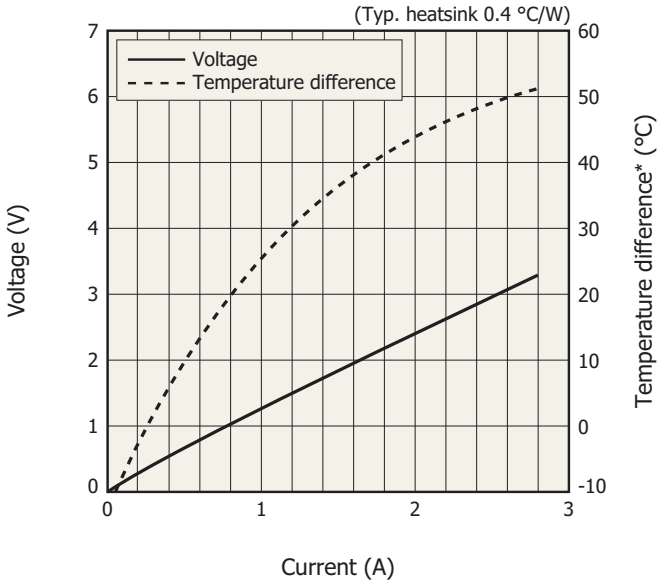
G11475 to G11478 series



* Temperature difference between the photosensitive area and package heat dissipation area

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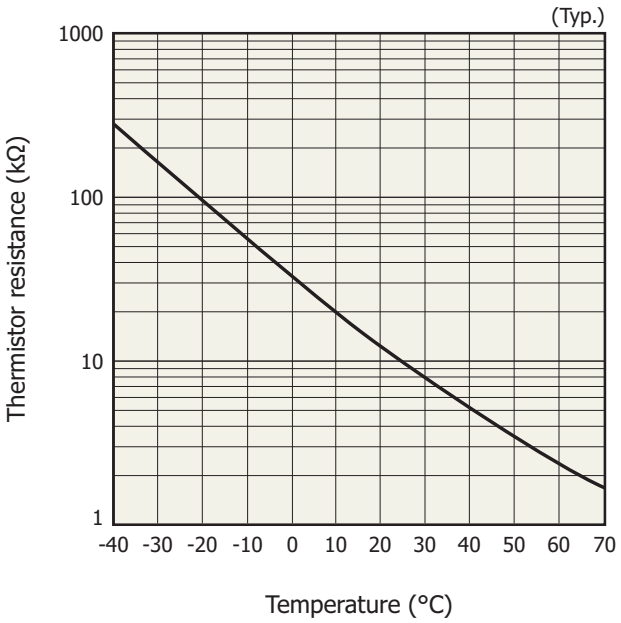
Thermistor temperature characteristics



Temperature (°C)	Thermistor resistance (kΩ)	Temperature (°C)	Thermistor resistance (kΩ)
-40	281	20	12.5
-35	208	25	10.0
-30	155	30	8.06
-25	117	35	6.53
-20	88.8	40	5.32
-15	68.4	45	4.36
-10	53.0	50	3.59
-5	41.2	55	2.97
0	32.1	60	2.47
5	25.1	65	2.07
10	19.8	70	1.74
15	15.7		

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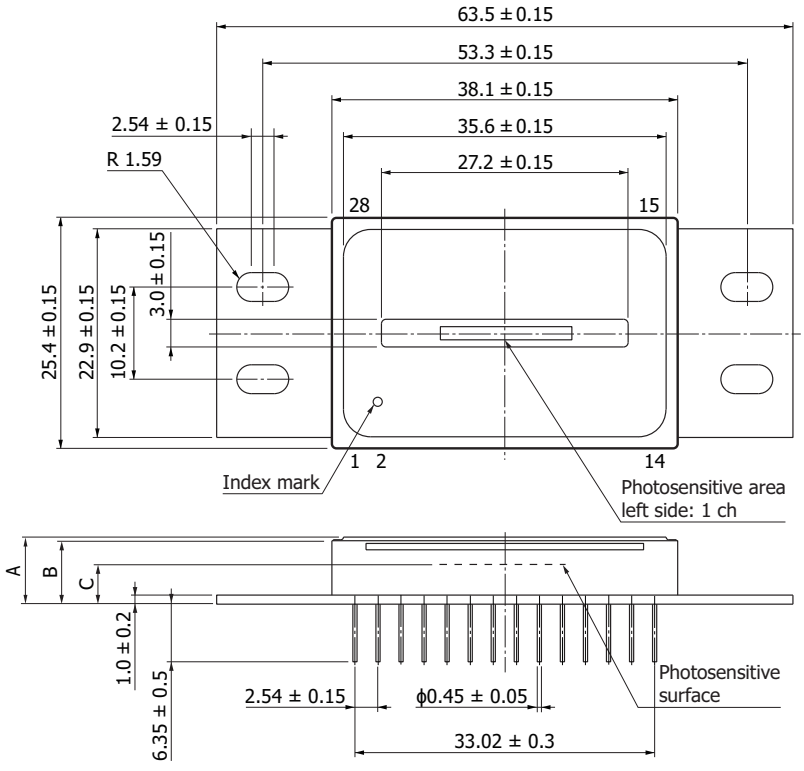
Dimensional outline (unit: mm)



Type no.	A	B	C
G11508 series	6.15 ± 0.2	5.8 ± 0.2	3.4 ± 0.3
G11475 to G11478 series	7.25 ± 0.2	6.85 ± 0.2	4.3 ± 0.3

Center accuracy of photosensitive area: ±0.3 or less
(with respect to package center)
Rotation accuracy of photosensitive area ±2° or less
(with respect to package center)
Chip material: InGaAs
Package material: FeNi alloy
Lead processing: Ni/Au plating
Lead material: FeNiCo alloy
Window material: Sapphire
Window refractive index: 1.76
Window thickness: 0.66
AR coating: 1.55 µm peak
Window sealing method: Brazing
Cap sealing: Welding

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Recommended soldering conditions

· Solder temperature: 260 °C max. (10 s or less, once)
Solder the leads at a point at least 1 mm away from the package body
Note: When you set soldering conditions, check that problems do not occur in the product by testing out the conditions in advance.

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. Also protect this device from surge voltages which might be caused by peripheral equipment.

Related information

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

■ Precautions
· Disclaimer
· Safety precautions
· Image sensors

■ Technical information
· InGaAs linear image sensors / Technical note

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