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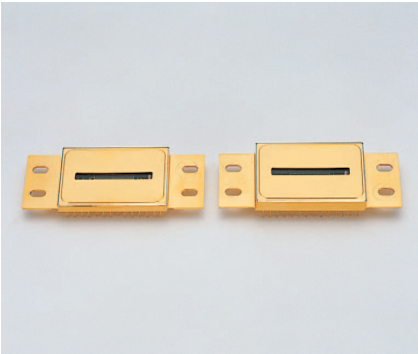
InGaAs linear image sensors

G9211 to G9214 series
G9205 to G9208 series



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

The G9211 to G9214/G9205 to G9208 series InGaAs linear image sensors are specifically designed for near infrared multichannel spectrophotometry. These linear image sensors consist of an InGaAs photodiode array, a charge amplifier array, an offset compensation circuit, a shift register and a timing generator formed on a CMOS chip. The charge amplifier array is made up of CMOS transistors connected to each pixel of the InGaAs photodiode array. Signals from each pixel are read out in charge integration mode to achieve high sensitivity and stable operation in the near infrared spectral range. The package is hermetically sealed for high reliability.
Signal processing circuits on the CMOS chip can be selected from two conversion efficiencies (CE) by external voltage. The image sensor operates over a wide dynamic range when CE=16 nV/e^- and delivers high gain when CE=320 nV/e^-.

Features

- **Wide dynamic range**
- **Low noise and low dark current**
- **Two selectable conversion efficiencies**
- **Anti-saturation circuit**
- **CDS circuit*1**
- **Offset compensation circuit**
- **Simple operation (by built-in timing generator)*2**
- **High resolution: 25 µm pitch (512 ch)**
- **Low cross-talk**
- **256 ch: 1 video line**
  512 ch: 2 video lines

Applications

- **Near infrared multichannel spectrophotometry**
- **Radiation thermometry**
- **Non-destructive inspection**

Related products

- **InGaAs multichannel detector head C8061-01, C8062-01**
- **Multichannel detector head controller C7557-01**

*1: A major source of noise in charge amplifiers is the reset noise generated when the integration capacitance is reset. A CDS (correlated double sampling) circuit greatly reduces this reset noise by holding the signal immediately after reset to find the noise differential.
*2: Different signal timings must be properly set in order to operate a shift register. In conventional image sensor operation, external PLDs (programmable logic device) are used to input the required timing signals. However, the G9211 to G9214/G9205 to G9208 series image sensors internally generate all timing signals on the CMOS chip just by supplying CLK and RESET pulses. This makes it simple to set the timings.

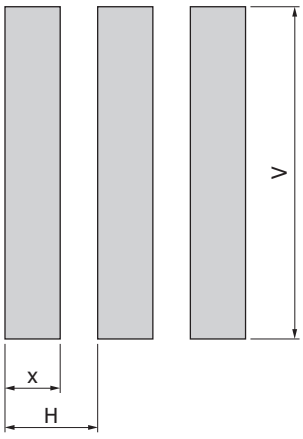
Selection guide

Type no.	Cooling	Image size (mm)	Number of total pixels	Number of effective pixels	Applicable multichannel detector head
G9211-256SB	One-stage TE-cooled	12.8 × 0.25	256	256	C8061-01
G9212-512SB			512	512	
G9213-256SA		12.8 × 0.50	256	256	
G9214-512SA			512	512	
G9205-256WB	Two-stage TE-cooled	12.8 × 0.25	256	256	C8062-01
G9205-512WB			256	256	
G9206-02B			256	256	
G9206-256WB			256	256	
G9206-512WB			512	512	
G9207-256WB			256	256	
G9208-256WB			256	256	
G9208-512WB			512	512	

Shape specifications

Type no.	Pixel size [μm (H) × μm (V)]	Pixel size (μm)	Package	Window material
G9211-256SB	50 × 250	50	28-pin metal (refer to the dimensionl outline)	Sapphire glass with anti-reflective coating
G9212-512SB	25 × 250	25		
G9213-256SA	50 × 500	50		
G9214-512SA	25 × 500	25		
G9205-256WB	50 × 250	50		
G9205-512WB	25 × 250	25		
G9206-02B	50 × 250	50		
G9206-256WB	50 × 250	50		
G9206-512WB	25 × 250	25		
G9207-256WB	50 × 250	50		
G9208-256WB	50 × 250	50		
G9208-512WB	25 × 250	25		

Details of photosensitive area (unit: μm)



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

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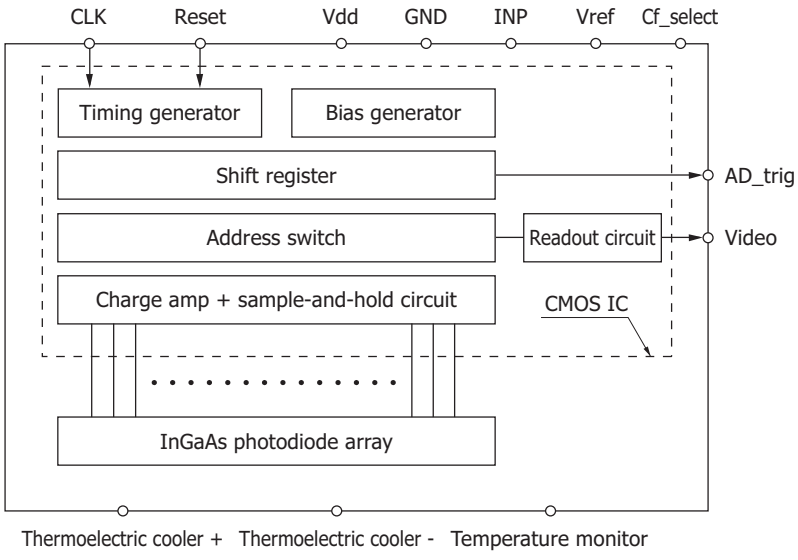
Block diagram



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Absolute maximum ratings

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
Operating temperature	Topr	Chip temperature, No dew condensation*3	-40	-	+70	°C
Storage temperature	Tstg	Chip temperature, No dew condensation*3	-40	-	+85	°C
Supply voltage	Vdd, INP, Vref	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

*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

Parameter		Symbol	Min.	Typ.	Max.	Unit
Supply voltage		Vdd	4.9	5.0	5.1	V
		Vref	1.0	1.26	1.3	V
Element bias		INP	3.5	4.5	4.6	V
Ground		GND	-	0	-	V
Clock pulse voltage	High	Vclk	Vdd - 0.5	Vdd	Vdd + 0.5	V
	Low		0	0	0.4	
Reset pulse voltage	High	V(res)	Vdd - 0.5	Vdd	Vdd + 0.5	V
	Low		0	0	0.4	

Electrical characteristics (Ta=25 °C)

Parameter		Symbol		Min.	Typ.	Max.	Unit
Consumption current		I(Vdd)	256 pixels	-	45	50	mA
			512 pixels	-	90	100	
		I(Vref)		-	-	1	mA
		I(INP)		-	-	1	mA
Operation frequency		fop		0.1	-	4	MHz
Video data rate		DR		0.0125	fop/8	0.5	MHz
Video output voltage	High	V_H		-	4.5	INP	V
	Low	V_L		Vref	1.26	-	V
Output offset voltage		Vos		-	Vref	-	V
Output impedance		Zo		-	2	-	kΩ
A/D trigger voltage	High	V_{trigH}		-	Vdd	-	V
	Low	V_{trigL}		-	GND	-	V

Electrical and optical characteristics (Ta=25 °C, Vdd=5 V, INP=4.5 V, Vref=1.26 V, Vclk=5 V, CE=16 nV/e-, fop=250 kHz)

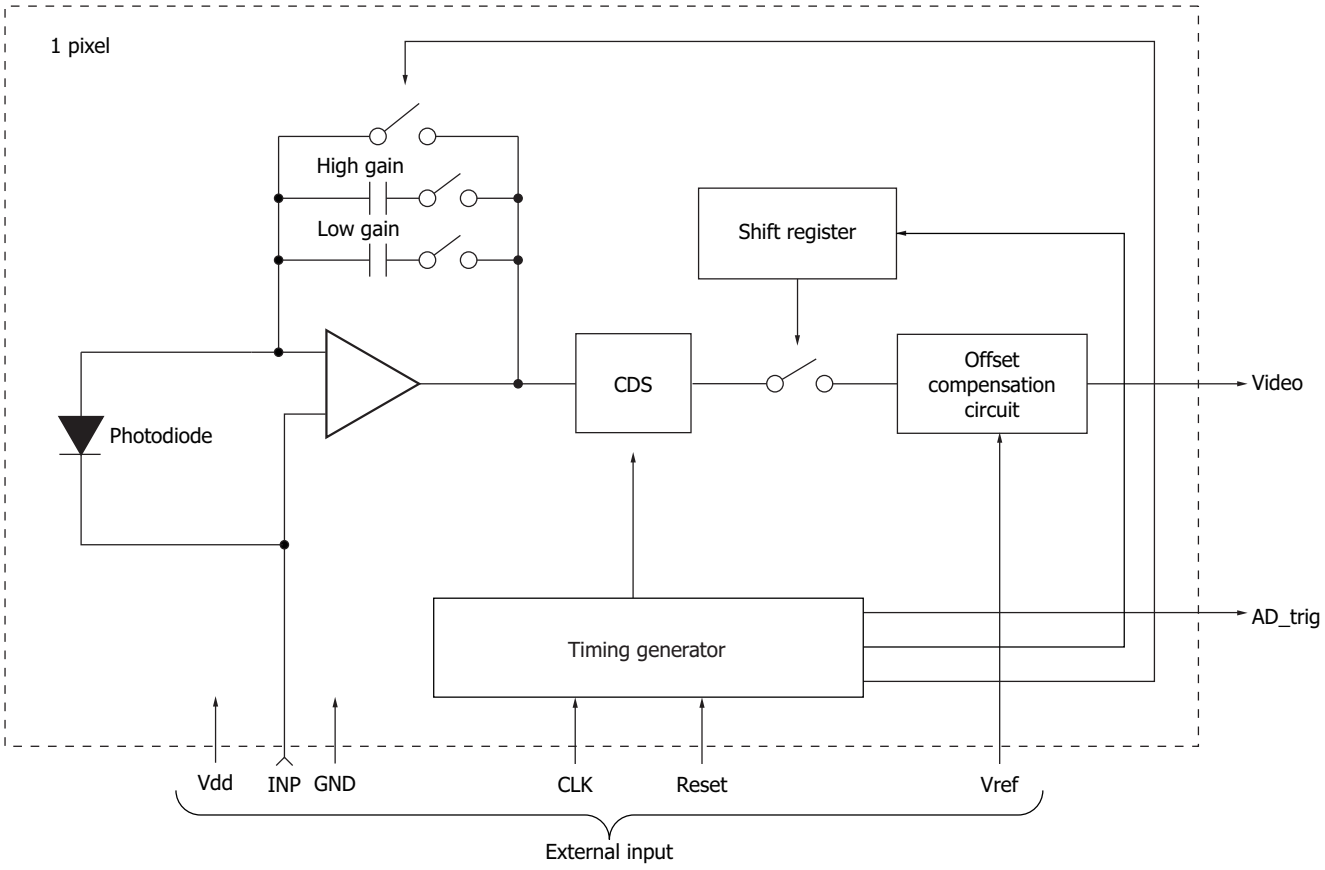
Parameter	Symbol	G9211 to G9214 series*4			G9205 to G9208 series*5				Unit
		Min.	Typ.	Max.	Type no.	Min.	Typ.	Max.	
Spectral response range	λ	-	0.9 to 1.7	-	G9205	-	0.9 to 1.85	-	μm
					G9206	-	0.9 to 2.05*6	-	
					G9207	-	0.9 to 2.25	-	
					G9208	-	0.9 to 2.55	-	
Peak sensitivity wavelength	λp	-	1.55	-	G9205	-	1.75	-	μm
					G9206	-	1.95	-	
					G9207	-	2.05	-	
					G9208	-	2.3	-	
Photosensitivity (λ=λp)	S	0.85	0.95	-	G9205	0.9	1.1	-	A/W
					G9206	1.0	1.2	-	
					G9207	1.0	1.2	-	
					G9208	0.9	1.3	-	
Conversion efficiency	CE	-	16	-		-	16	-	nV/e^-
Photoresponse nonuniformity*7	PRNU	-	±3	±5		-	±5	±10	%
Saturation voltage	Vsat	3	3.2	-		3	3.2	-	V
Saturation charge	Csat	-	187.5	-		-	187.5	-	Me^-
Readout noise*8	Nread	-	180	300		-	180	300	μV rms
Dynamic range	Drange	10000	16666	-		10000	16666	-	-
Defective pixels*9	-	-	-	1		-	-	5	%

*4: Tchip=25 °C
*5: Tchip=-20 °C
*6: G9206-02B, G9206-512WB=2.15
*7: 50% of saturation, after dark output subtraction, excluding first and last pixels
G9211 to G9214 series: integration time=10 ms, G9205 to G9208 series: integration time=3 ms
*8: G9211 to G9214 series: integration time=10 ms, G9205 to G9208-256WB, G9206-02B: integration time=0.8 ms, G9205 to G9208-512WB: integration time=0.5 ms
*9: Pixels with photoresponse nonuniformity, readout noise or dark current higher than the maximum value

Dark output characteristics (CE=16 nV/e⁻, G9211 to G9214 series: Tchip=25 °C, G9205 to G9208 series: Tchip=-20 °C)

Parameter		Symbol	Min.	Typ.	Max.	Unit
Dark output (dark output nonuniformity)	G9211-256SB	V_D	-1	0.2	1	V/s
	G9212-512SB		-0.5	0.1	0.5	
	G9213-256SA		-2	0.4	2	
	G9214-512SA		-0.5	0.1	0.5	
	G9205-256WB		-6	1.5	6	
	G9205-512WB		-6	1.5	6	
	G9206-02B		-7	3	7	
	G9206-256WB		-12	3	12	
	G9206-512WB		-12	3	12	
	G9207-256WB		-80	20	80	
	G9208-256WB		-200	50	200	
	G9208-512WB		-200	50	200	
Dark current	G9211-256SB	I_D	-10	2	10	pA
	G9212-512SB		-5	1	5	
	G9213-256SA		-20	4	20	
	G9214-512SA		-5	1	5	
	G9205-256WB		-60	15	60	
	G9205-512WB		-60	15	60	
	G9206-02B		-70	30	70	
	G9206-256WB		-120	30	120	
	G9206-512WB		-120	30	120	
	G9207-256WB		-800	200	800	
	G9208-256WB		-2000	500	2000	
	G9208-512WB		-2000	500	2000	

Equivalent circuit



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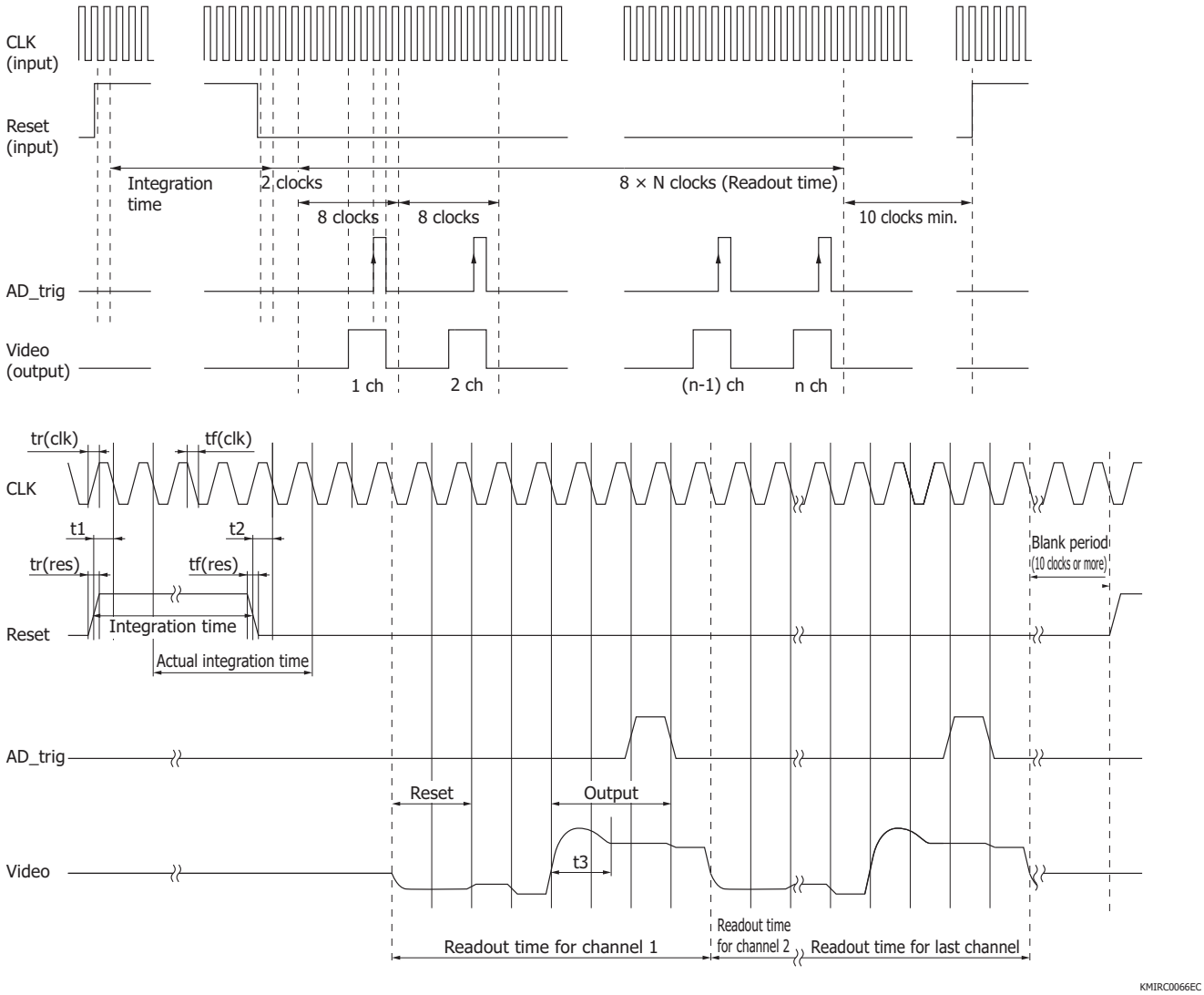
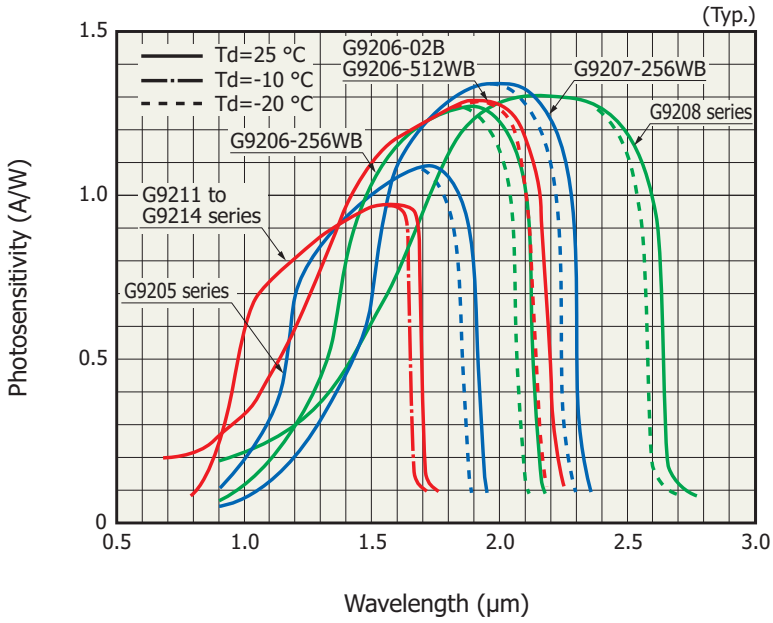
Timing chart



Parameter	Symbol	Min.	Typ.	Max.	Unit
Operation frequency	fop	0.1	-	4	MHz
Clock pulse width	tpw(clk)	100	-	-	ns
Clock pulse rise/fall times	tr(clk), tf(clk)	0	20	100	ns
Reset pulse width	tpw(res)	6000	-	-	ns
Reset pulse rise/fall times	tr(res), tf(res)	0	20	100	ns
Reset (rise) timing	t1	50	-	-	ns
Reset (fall) timing	t2	50	-	-	ns
Output settling time	t3	-	-	600	ns

Spectral response



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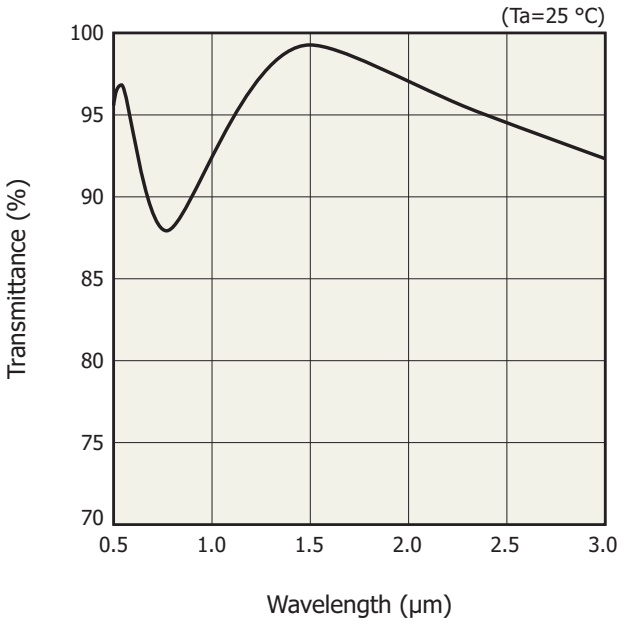
Spectral transmittance characteristic of window material (typical example)



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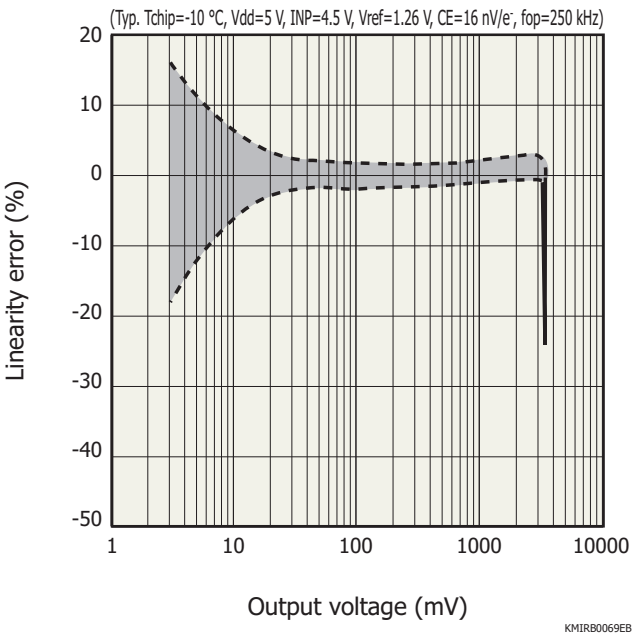
Linearity error (G9213-256SA)



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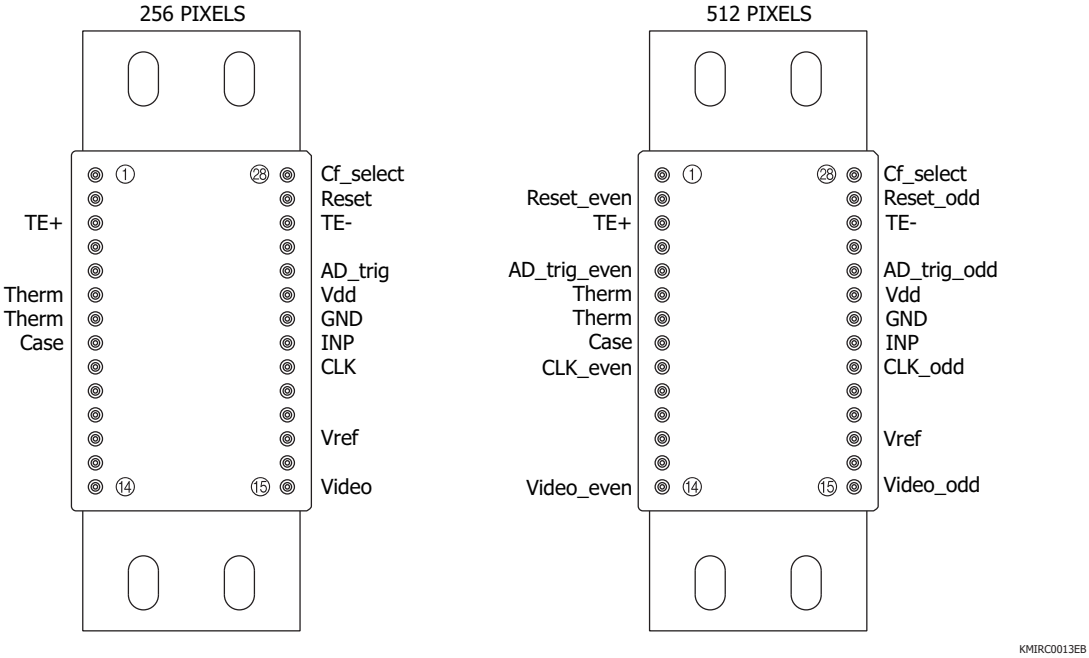
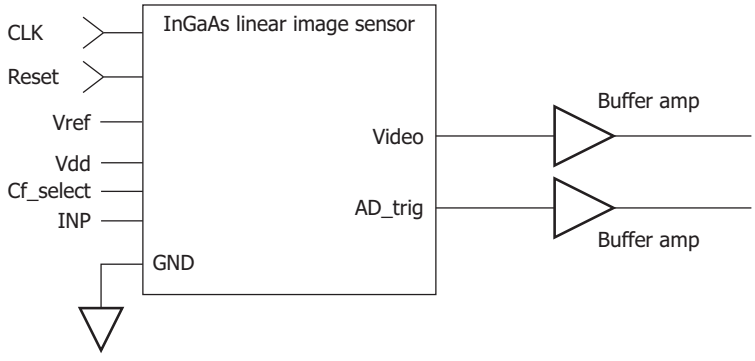
Pin connections (top view)



Terminal name	Input/Output	Function and recommended connection
CLK	Input (CMOS logic compatible)	Clock pulse for operating the CMOS shift register
Reset	Input (CMOS logic compatible)	Reset pulse for initializing the feedback capacitance in the charge amplifier formed in the CMOS chip. The width of the reset pulse is integration time.
Vdd	Input	Supply voltage for operating the signal processing circuit in the CMOS chip
GND	Input	Ground for the signal processing circuit in the CMOS chip
INP	Input	Reset voltage for the charge amplifier array in the CMOS chip
Cf_select	Input	Voltage that determines the conversion efficiency in the CMOS chip. Low gain (CE=16 nV/e^-) at 0 V, and high gain (CE=320 nV/e^-) at 5 V.
Case	-	This terminal is electrically connected to the package.
Therm	Output	Thermistor for monitoring temperature inside the package
TE+, TE-	Input	Power supply terminal for the thermoelectric cooler that cools the photodiode array. No connection for room temperature operation type.
AD_trig	Output	Digital signal for AD conversion; positive polarity
Video	Output	Analog video signal; positive polarity
Vref	Input	Reset voltage for the offset compensation circuit in the CMOS chip

Connection example



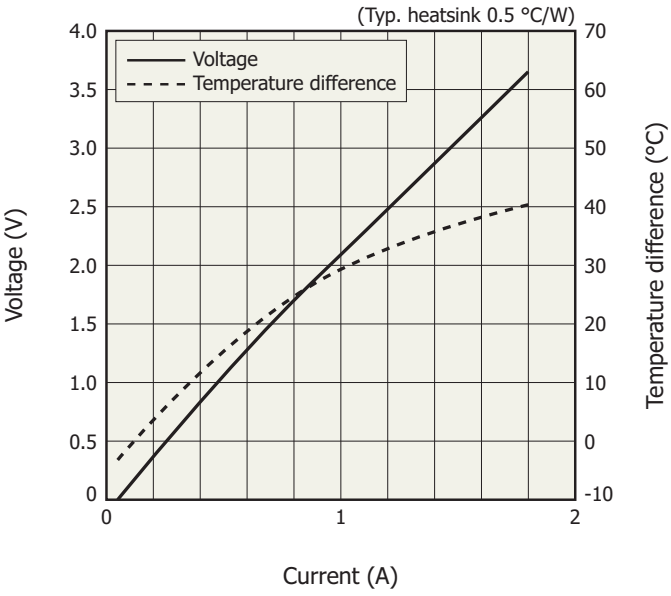
Specifications of TE-cooler (Ta=25 °C, Vdd=5 V, INP=4.5 V)

Parameter	Condition	Symbol	One-stage TE-cooler			Two-stage TE-cooler			Unit
			Min.	Typ.	Max.	Min.	Typ.	Max.	
TE-cooler allowable current		Ic Max.	-	-	1.8	-	-	2.8	A
TE-cooler allowable voltage		Vc Max.	-	-	5.0	-	-	4.0	V
Temperature difference*10	*11	Δt	40	-	-	50	-	-	°C
Thermistor resistance		Rth	4.85	5.00	5.15	4.85	5.00	5.15	kΩ
Thermistor power dissipation		Pth	-	-	0.2	-	-	0.2	mW

*10: This is a temperature difference between the surface of active area and the heat radiating portion of package.
*11: One-stage thermoelectrically cooled type: Ic=1.4 A, two-stage thermoelectrically cooled type: Ic=2.6 A.

TE-cooler temperature characteristic (Ta=25 °C, Vdd=5 V, INP=4.5 V)

G9211 to G9214 series



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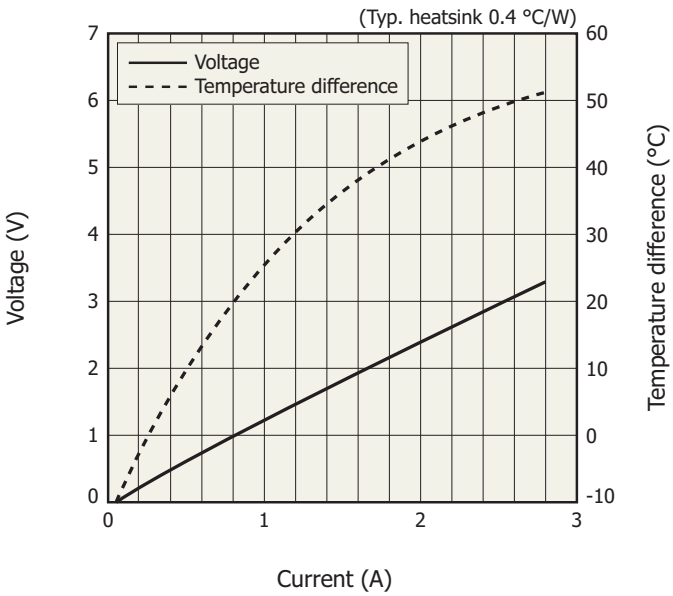
G9205 to G9208 series



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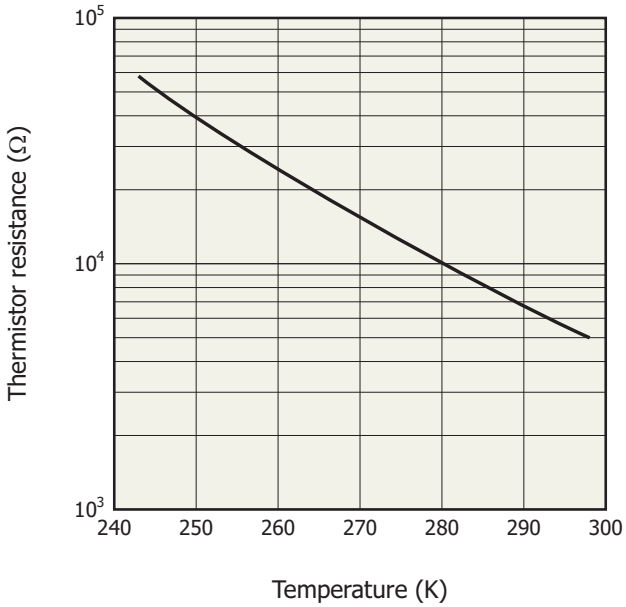
Thermistor temperature characteristic



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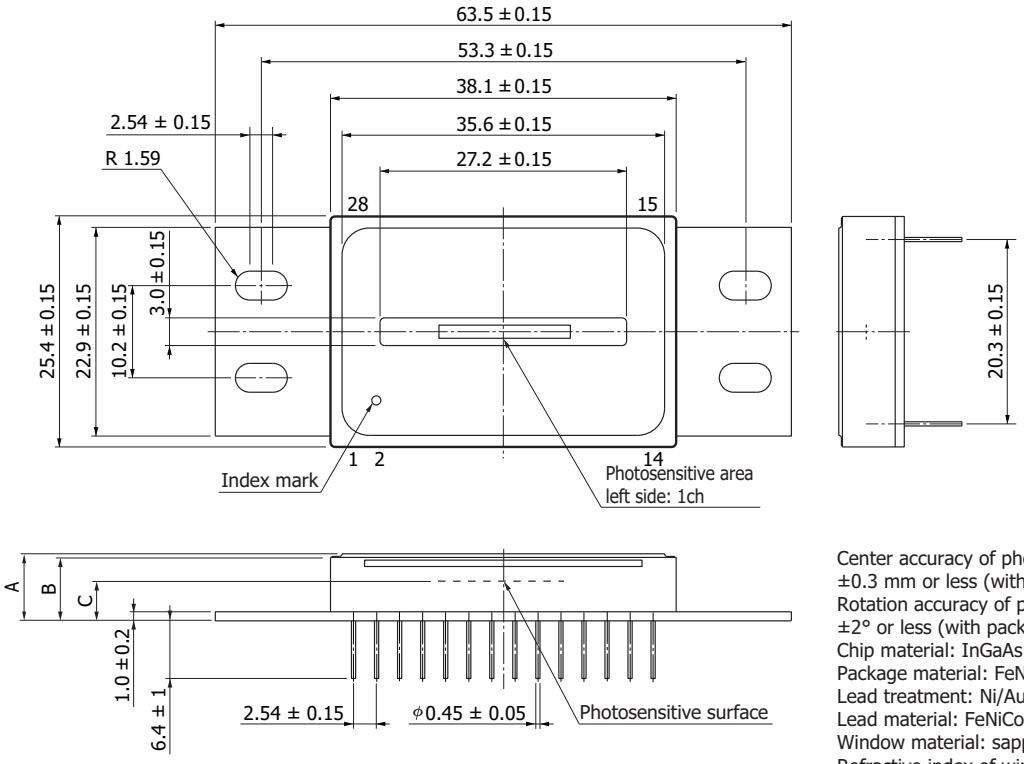
A relation between the thermistor resistance and absolute temperature is expressed by the following equation.

$R1=R2 \times \exp B\,(1/T1 - 1/T2)$

R1: Resistance at T1 [K]
R2: Resistance at T2 [K]
B : B constant (B=3200 K ± 2%)
Thermistor resistance = 5 kΩ ± 3% (298 K)

Dimensional outline (unit: mm)



Type no.	A	B	C
G9211 to G9214 series	6.15 ± 0.2	5.8 ± 0.2	3.4 ± 0.3
G9205 to G9208 series	7.25 ± 0.2	6.85 ± 0.2	4.3 ± 0.3

Center accuracy of photosensitive area:
±0.3 mm or less (with package center as reference point)
Rotation accuracy of photosensitive area:
±2° or less (with package center as reference point)
Chip material: InGaAs
Package material: FeNi alloy
Lead treatment: Ni/Au plating
Lead material: FeNiCo alloy
Window material: sapphire
Refractive index of window material: n=1.76
Window material thickness: 0.66 mm
AR coat: coated (1.55 µm peak)
Window sealing method: brazing
Cap sealing: welding

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Multichannel detector head C8061-01, C8062-01 (sold separately)

The C8061/C8062-01 series are high sensitivity multichannel detector heads for use with InGaAs linear image sensors. The C8061-01 is designed for the one-stage TE-cooled InGaAs linear image sensors and the C8062-01 for two-stage TE-cooled InGaAs linear image sensors.

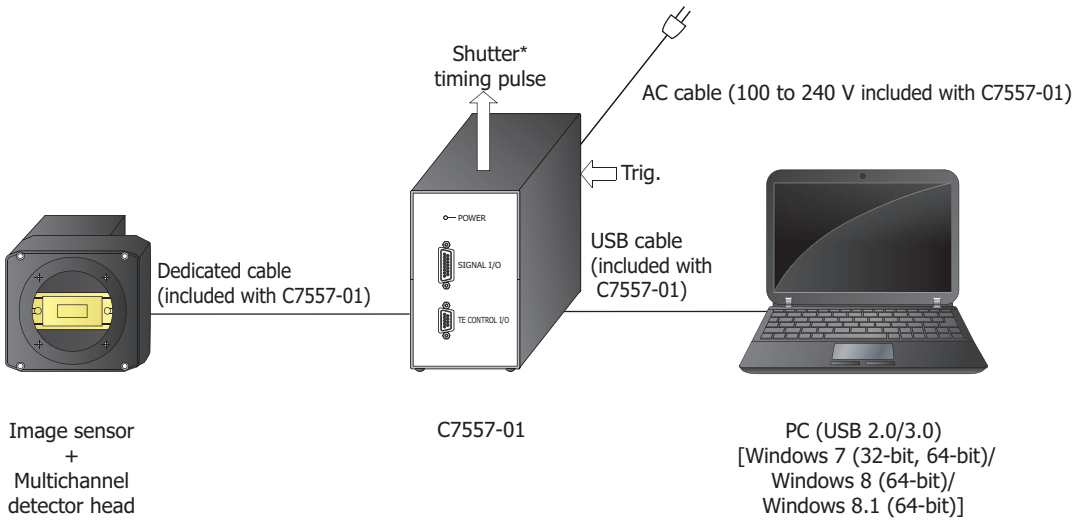
The C8061-01 and C8062-01 incorporate a low-noise driver/amplifier circuit that provide reliable operation from simple external signals. They also include a highly stable temperature controller that cools the sensor to a preset temperature level (C8061-01: Ts= -10 °C, C8062-01: Ts= -20 °C) as soon as the power is turned on. If the cooler fails and overheat occurs, the built-in protection circuit automatically turns off the power to maintain safety. Despite its compact size, the housing configuration is designed for good heat dissipation, and threaded mounting holes on the front panel allow connections to other devices such as monochromators.

Controller for multichannel detector head C7557-01 is also available. The software supplied with the C7557-01 allows easy control of the multichannel detector head and data acquisition.

Features

- **Designed for InGaAs linear image sensor**
  C8061-01: One-stage TE-cooled type
  C8062-01: Two-stage TE-cooled type
- **Built-in driver/amplifier and temperature circuit**
- **Highly stable temperature controller**
  Cooling temperature (Ta=10 to 30 °C)
  fixed at -10 ± 0.1 °C (C8061-01), -20 ± 0.1 °C (C8062-01)
- **Simple signal input operation**
- **Compact configuration**

Connection



* Shutter, etc. are not available.

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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.

Related information

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

■ Precautions
· Disclaimer
· Image sensors

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