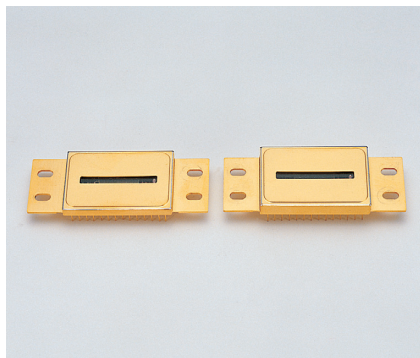


InGaAs linear image sensors



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

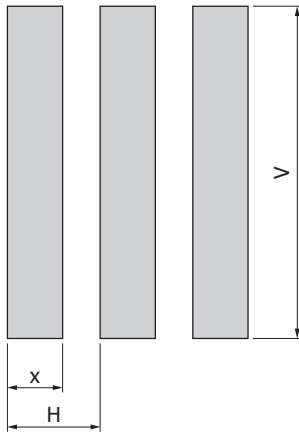
*1: On charge amplifiers, the reset noise that occurs when the integration capacitance is reset is dominant. However, the CDS circuit, which takes the difference between the signal after the completion of the integration time and the signal immediately after resetting, greatly reduces the reset noise.

*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 | | | |

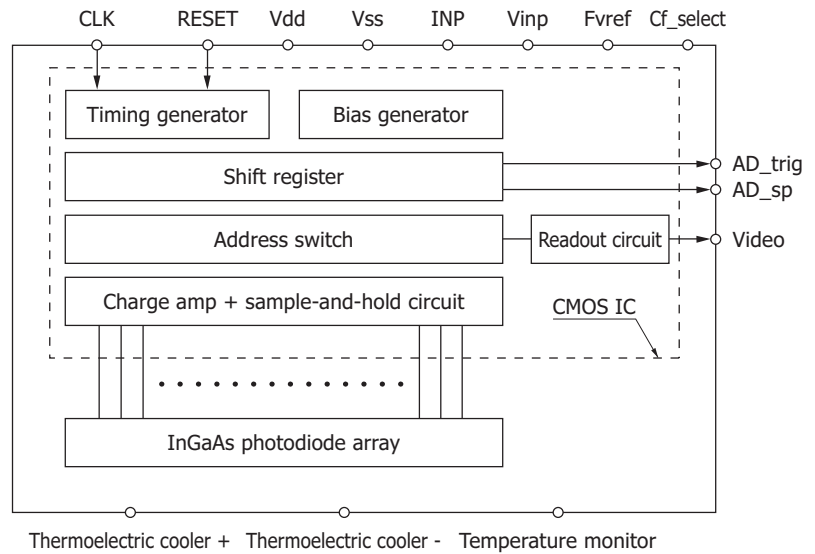
Enlarged view of photosensitive area



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

KMIRC0111EA

Block diagram



KMIRC0103EA

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 | Vcf sel | 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 | VH | - | 4.0 | V | |
| | Low | VL | - | 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

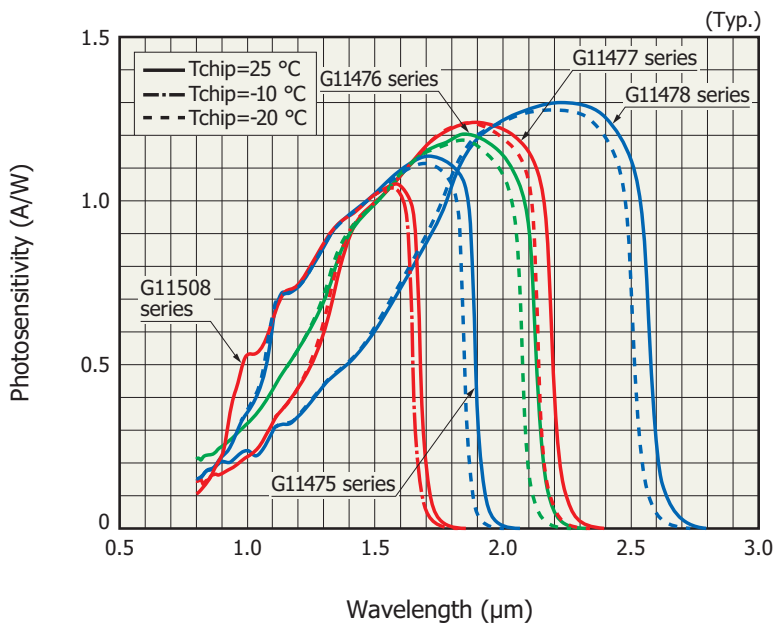
*12: G11478 series

*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)

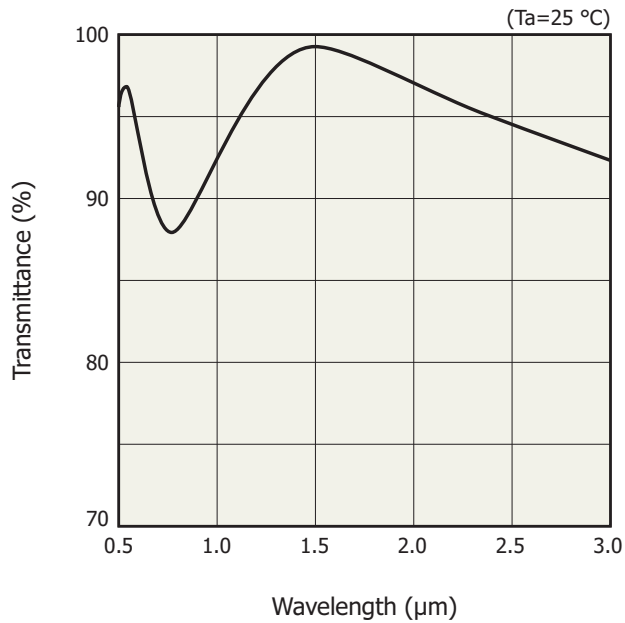
| Parameter | Symbol | Min. | Typ. | Max. | Unit |
|--|--------------|-------|-------|------|------|
| Dark output (Dark output nonuniformity) | G11508-256SA | -1 | ±0.1 | 1 | V/s |
| | G11508-512SA | -0.5 | ±0.05 | 0.5 | |
| | G11475-256WB | -2 | ±0.2 | 2 | |
| | G11475-512WB | -2 | ±0.2 | 2 | |
| | 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 | -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



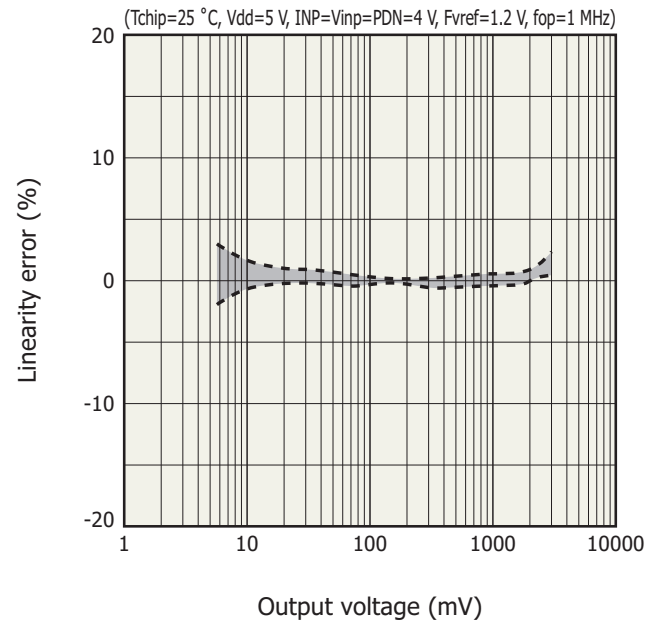
KMIRB0105EA

Spectral transmittance characteristics of window material (typical example)



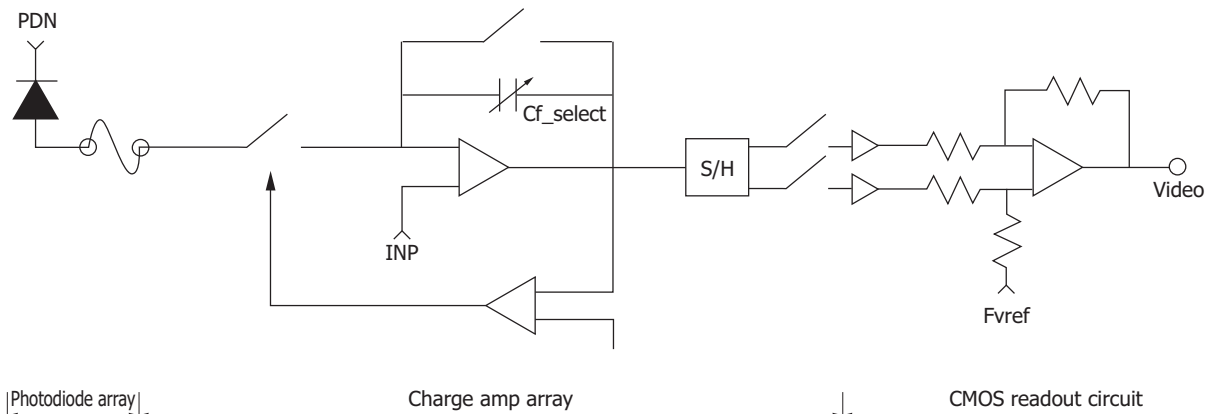
KMIRB0070EA

Linearity error (G11508 series, typical example)



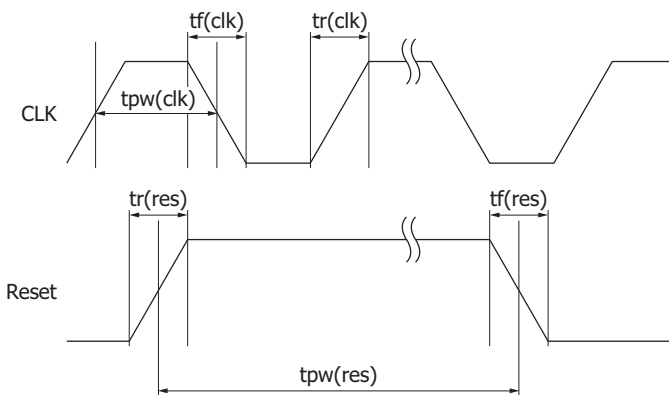
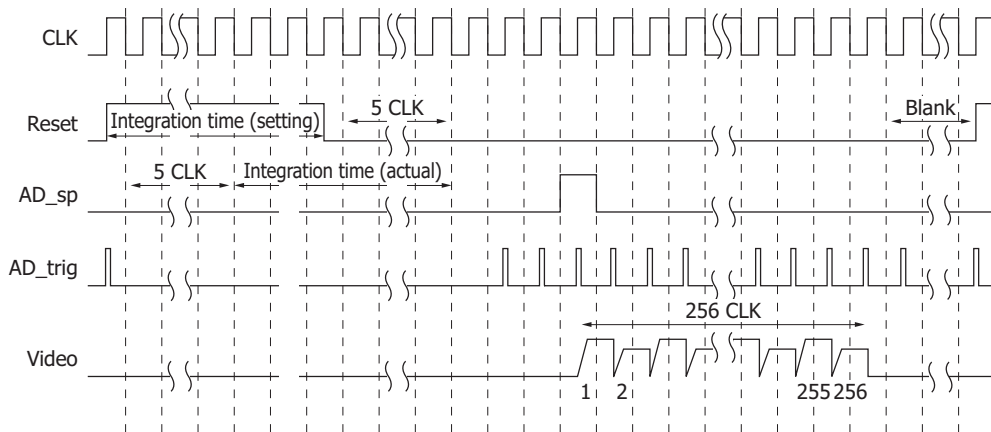
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Equivalent circuit



KMIRC0049EA

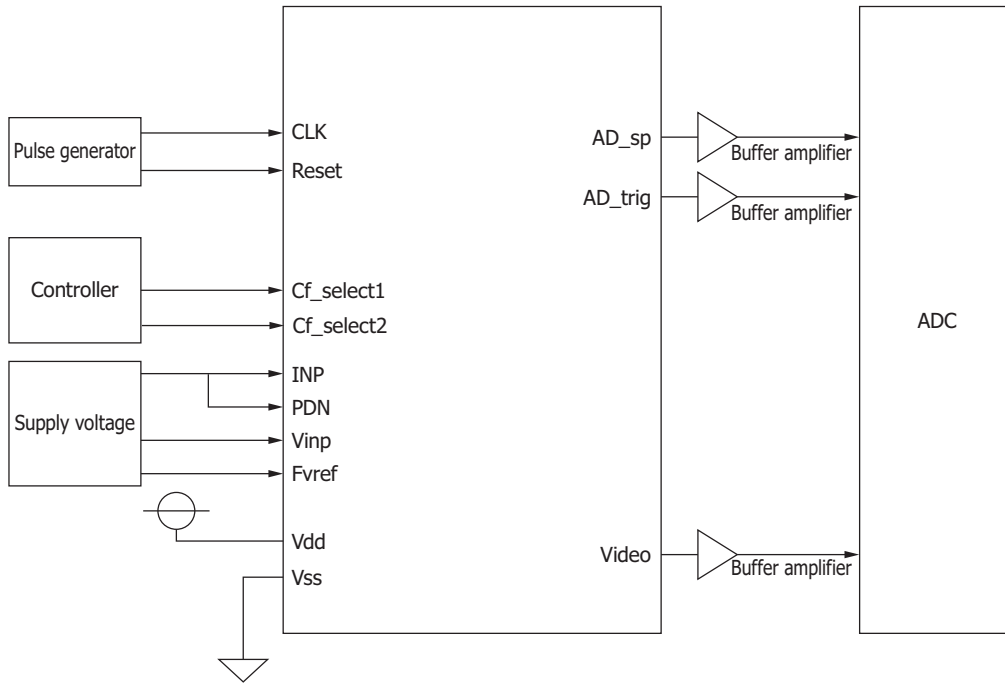
Timing chart (each video line)



KMIRC0104EA

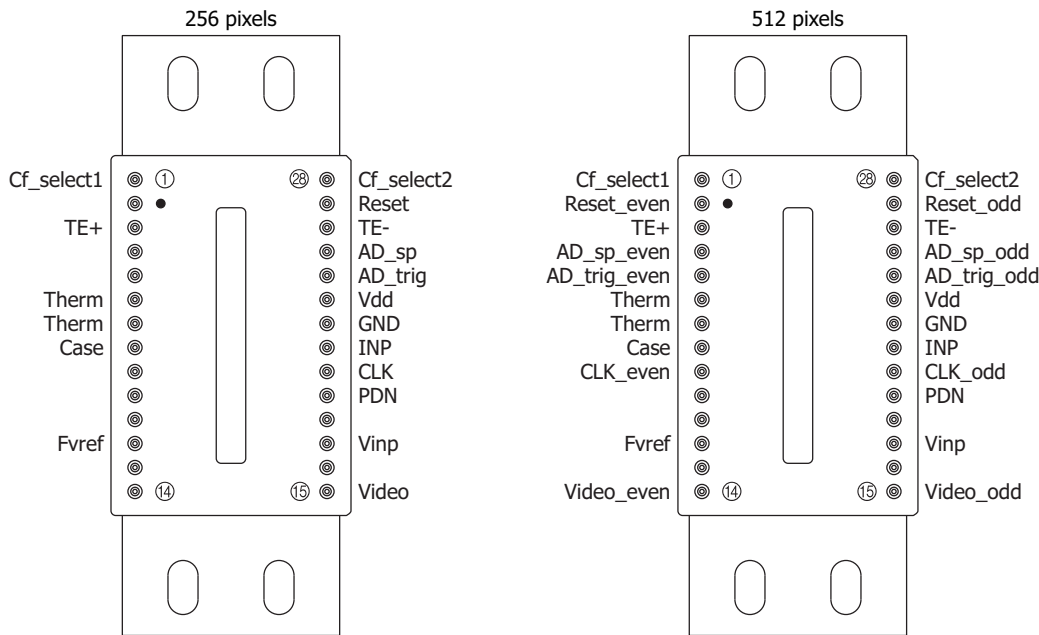
| Parameter | Symbol | Min. | Typ. | Max. | Unit |
|-----------------------------|------------------|------|------|------|--------|
| Clock pulse frequency | fop | 0.1 | 1 | 5 | MHz |
| Clock pulse width | tpw(clk) | 60 | 500 | 5000 | ns |
| Clock pulse rise/fall times | tr(clk), tf(clk) | 0 | 20 | 30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

Connection example



KM1RC0056EB

Pin connections (top view)



KMIRC0105EA

| 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=Vin=PDN=4 V, Fvref=1.2 V, Vclk=5 V, fop=1 MHz)

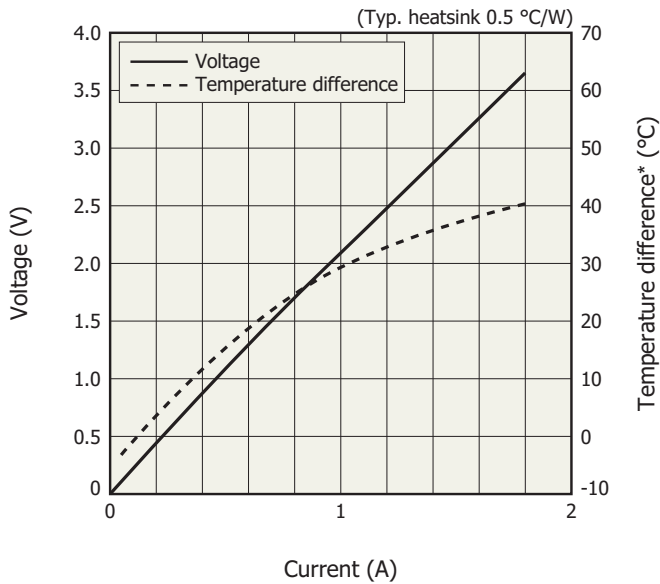
| Parameter | Condition | Symbol | G11508 series | | | G11475 to G11478 series | | | Unit |
|------------------------------|---------------------|------------|---------------|------|------|-------------------------|------|------|------------|
| | | | Min. | Typ. | Max. | Min. | Typ. | Max. | |
| Allowable 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 | k Ω |
| 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=Vin=PDN=4 V, Fvref=1.2 V, Vclk=5 V, fop=1 MHz)

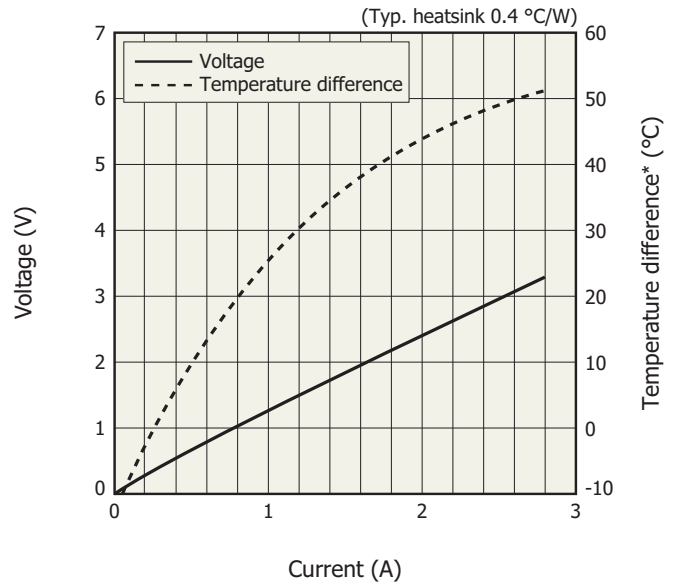
G11508 series



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

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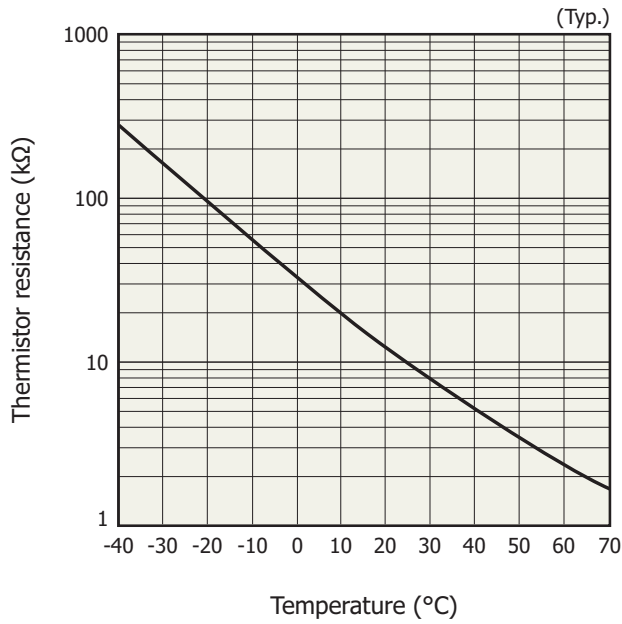
G11475 to G11478 series



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

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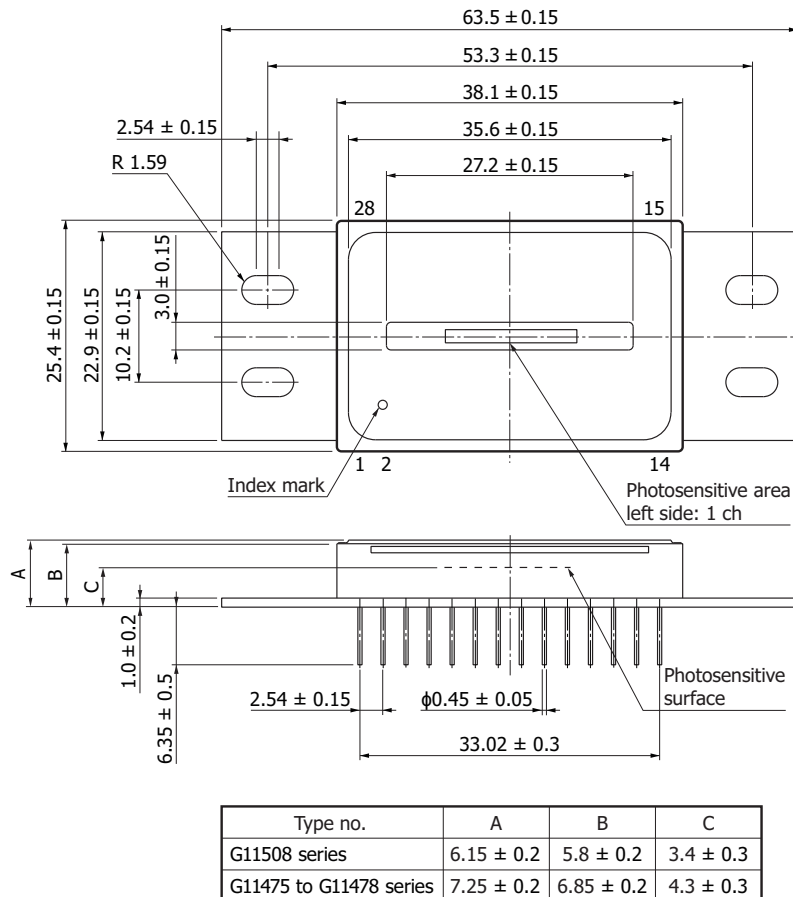
Thermistor temperature characteristics



| 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 | | |

KMIRB0061EA

Dimensional outline (unit: mm)



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

KMIRA0037EA

❏ 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

Information described in this material is current as of October 2021.

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