

G14714 series

High-speed line rate near infrared sensor (0.95 to 1.7 μm)

The G14714 series are InGaAs linear image sensors designed for foreign object detection. The CMOS chip consists of charge amplifiers, shift registers, and timing generator. Charge amplifiers are configured with CMOS transistor array and are bump-bonded to each pixel of the InGaAs photodiode array. Since the signal from each pixel is read out in charge integration mode, high sensitivity and stable operation are attained in a wide spectral response range.

The signal processing circuit on the CMOS chip enables the selection of an optimum conversion efficiency (CE) for your application from the available four types using external voltage.

Features

- High-speed line rate: 40000 lines/s max.
- High-speed data rate: 15 MHz max.
- Selectable from four conversion efficiency types
- Built-in timing generator
- Built-in temperature sensor
- Room temperature operation

Applications

- Foreign object detection
- Farm product inspection

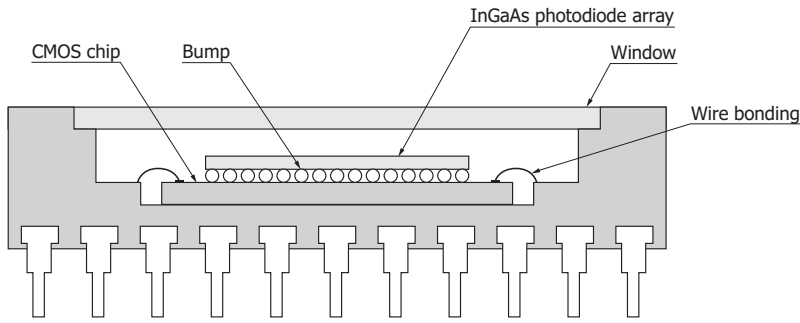
Structure

| Parameter | G14714-512DE | G14714-1024DK | Unit |
|----------------------------|--|---------------|---------------|
| Cooling | Non-cooled type | | - |
| Total number of pixels | 512 | 1024 | pixels |
| Number of effective pixels | 512 | 1024 | pixels |
| Image size*1 | 12.8 × 0.025 | 12.8 × 0.0125 | mm |
| Pixel size*2 (H × V) | 25 × 25 | 12.5 × 12.5 | μm |
| Pixel pitch | 25 | 12.5 | μm |
| Package | 22-pin ceramic (see dimensional outline) | | - |
| Window material | Borosilicate glass (AR coated) | | - |

*1: Actual sensitivity region G14714-512DE: 12.8 × 0.045 mm, G14714-1024DK: 12.8 × 0.0325 mm

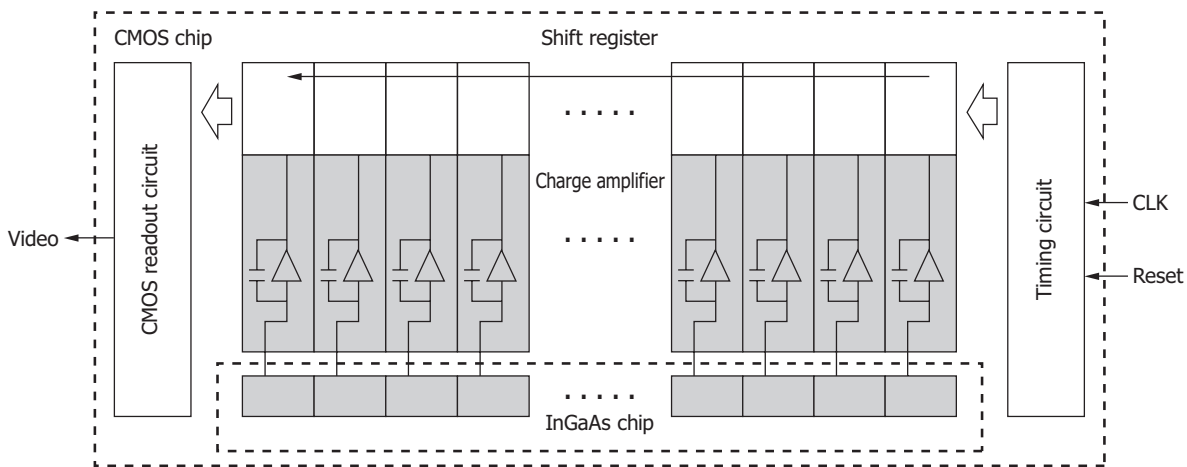
*2: Actual sensitivity region G14714-512DE: 25 × 45 μm , G14714-1024DK: 12.5 × 32.5 μm

Cross section



KMIRC0053EA

Block diagram



KMIRC0119EA

Absolute maximum ratings

| Parameter | Symbol | Condition | Min. | Typ. | Max. | Unit |
|---------------------------------|--|------------------------|-----------------------------------|------|------|------|
| Supply voltage | V _{dd} , DV _{dd} , I _{NP} V _{inp} , P _{DN} | T _a =25 °C | -0.3 | - | +4.2 | V |
| Clock pulse voltage | V _{clk} | T _a =25 °C | -0.3 | - | +4.2 | V |
| Reset pulse voltage | V _{res} | T _a =25 °C | -0.3 | - | +4.2 | V |
| Gain selection terminal voltage | V _{cf} sel | T _a =25 °C | -0.3 | - | +4.2 | V |
| Operating temperature | T _{opr} | No dew condensation*3 | -10 | - | +60 | °C |
| Storage temperature | T _{stg} | No dew condensation*3 | -20 | - | +70 | °C |
| Soldering conditions | - | | 260 °C or less, 5 seconds or less | | | - |
| Thermistor power dissipation | P _d th | T _a = 25 °C | - | - | 400 | mW |

*3: When there is a temperature difference between a product and the surrounding area in high humidity environments, 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

| Parameter | | Symbol | Min. | Typ. | Max. | Unit |
|---|------|-----------|-----------|------|-----------|------|
| Supply voltage | | Vdd, DVdd | 3.2 | 3.3 | 3.4 | V |
| Video line reset voltage | | Vinp | 2.4 | 2.5 | 2.6 | V |
| Input stage amplifier reference voltage | | INP | 2.4 | 2.5 | 2.6 | V |
| Pixel voltage*4 | | PDN | 2.5 | 2.6 | 2.7 | V |
| Ground | | GND | - | 0 | - | V |
| Clock pulse voltage | High | Vclk | Vdd - 0.4 | Vdd | Vdd + 0.4 | V |
| | Low | | - | 0 | 0.4 | |
| Reset pulse voltage | High | Vres | Vdd - 0.4 | Vdd | Vdd + 0.4 | V |
| | Low | | - | 0 | 0.4 | |

*4: Set the pixel voltage about 0.1 V higher than the input stage amplifier reference voltage.

Electrical and optical characteristics (Ta=25 °C, Vdd, DVdd=3.3 V, INP, Vinp=2.5 V, PDN=2.6 V, fop=15 MHz, per pixel)

| Parameter | Symbol | Condition | G14714-512DE | | | G14714-1024DK | | | Unit |
|-------------------------------|-------------|---------------------------|--------------|-------------|------|---------------|-------------|------|-------------------|
| | | | Min. | Typ. | Max. | Min. | Typ. | Max. | |
| Spectral response range | λ | | - | 0.95 to 1.7 | - | - | 0.95 to 1.7 | - | μm |
| Peak sensitivity wavelength | λ_p | | 1.45 | 1.55 | 1.65 | 1.45 | 1.55 | 1.65 | μm |
| Photosensitivity | S | $\lambda = \lambda_p$ | 0.7 | 0.82 | - | 0.7 | 0.82 | - | A/W |
| Conversion efficiency | CE | Cf=1.25 pF | - | 0.128 | - | - | 0.128 | - | $\mu\text{V}/e^-$ |
| | | Cf=0.13 pF | - | 1.23 | - | - | 1.23 | - | |
| | | Cf=0.04 pF | - | 4.0 | - | - | 4.0 | - | |
| | | Cf=0.02 pF | - | 8.0 | - | - | 8.0 | - | |
| Saturation charge*5 | Csat | | 0.2 | 0.219 | - | 0.2 | 0.213 | - | Me ⁻ |
| Saturation output voltage*5 | Vsat | | 1.6 | 1.75 | - | 1.6 | 1.7 | - | V |
| Photoresponse nonuniformity*6 | PRNU | | - | ±5 | ±20 | - | ±5 | ±20 | % |
| Dark current*5 | Id | | -0.1 | 0.5 | 5 | -0.1 | 0.5 | 5 | pA |
| Dark output*5 | Vd | | -5 | 25 | 250 | -5 | 25 | 250 | V/s |
| Readout noise | Nread | CE=1.23 $\mu\text{V}/e^-$ | - | 1.5 | 3 | - | 1.2 | 2 | mV rms |
| | | CE=8.0 $\mu\text{V}/e^-$ | - | 10 | 15 | - | 8 | 13 | |
| Dynamic range | Drange | CE=1.23 $\mu\text{V}/e^-$ | 533 | 1167 | - | 800 | 1417 | - | - |
| | | CE=8.0 $\mu\text{V}/e^-$ | 107 | 175 | - | 123 | 213 | - | |
| Defective pixels*7 | - | | - | - | 1 | - | - | 1 | % |

*5: CE=8.0 $\mu\text{V}/e^-$

*6: CE=1.23 $\mu\text{V}/e^-$, measured at 50% saturation after subtracting the dark output, excluding the first and last pixels

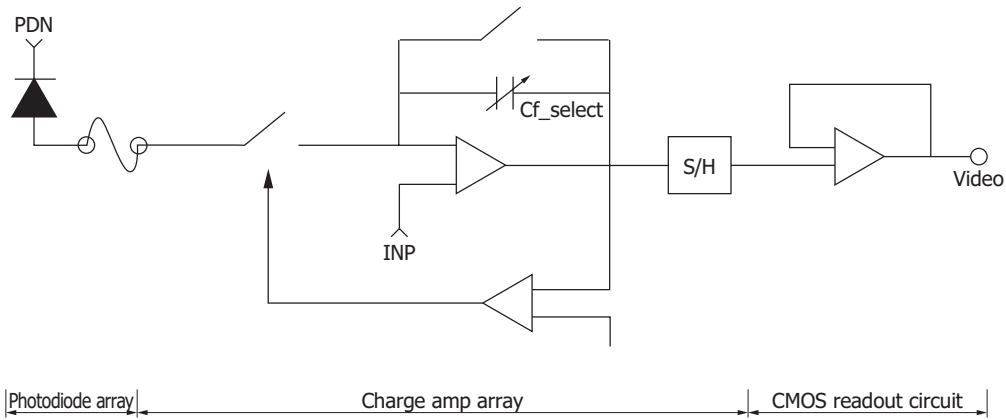
*7: Pixels whose photoresponse nonuniformity, dark current, or readout noise is outside the specifications

Electrical characteristics (Ta=25 °C)

| Parameter | Symbol | G14714-512DE | | | G14714-1024DK | | | Unit | |
|---|------------|--------------|------|------|---------------|------|------|------------|---|
| | | Min. | Typ. | Max. | Min. | Typ. | Max. | | |
| Supply current | Ivdd | - | 60 | 100 | - | 85 | 120 | mA | |
| | Idvdd | - | 10 | 15 | - | 10 | 15 | | |
| Video line reset current | Ivinp | - | - | 10 | - | - | 10 | mA | |
| Input stage amplifier reference current | Iinp | - | - | 10 | - | - | 10 | mA | |
| Pixel current | Ipdn | - | - | 20 | - | - | 20 | mA | |
| Output voltage | Dark | Video(dark) | - | 2.6 | 2.9 | - | 2.55 | 2.9 | V |
| | Saturation | Video(sat) | 0.6 | 0.85 | - | 0.6 | 0.85 | - | |
| Clock frequency | fop | 0.1 | - | 15 | 0.1 | - | 15 | MHz | |
| Output offset voltage | Vos | - | Vinp | - | - | Vinp | - | V | |
| Output impedance | Zo | - | 5 | - | - | 5 | - | k Ω | |
| Data rate | DR | - | fop | - | - | fop | - | MHz | |
| Thermistor resistance | Rth | - | 10 | - | - | 10 | - | k Ω | |
| Thermistor B constant*8 | B | - | 3950 | - | - | 3950 | - | K | |

*8: T₁=25 °C, T₂=50 °C

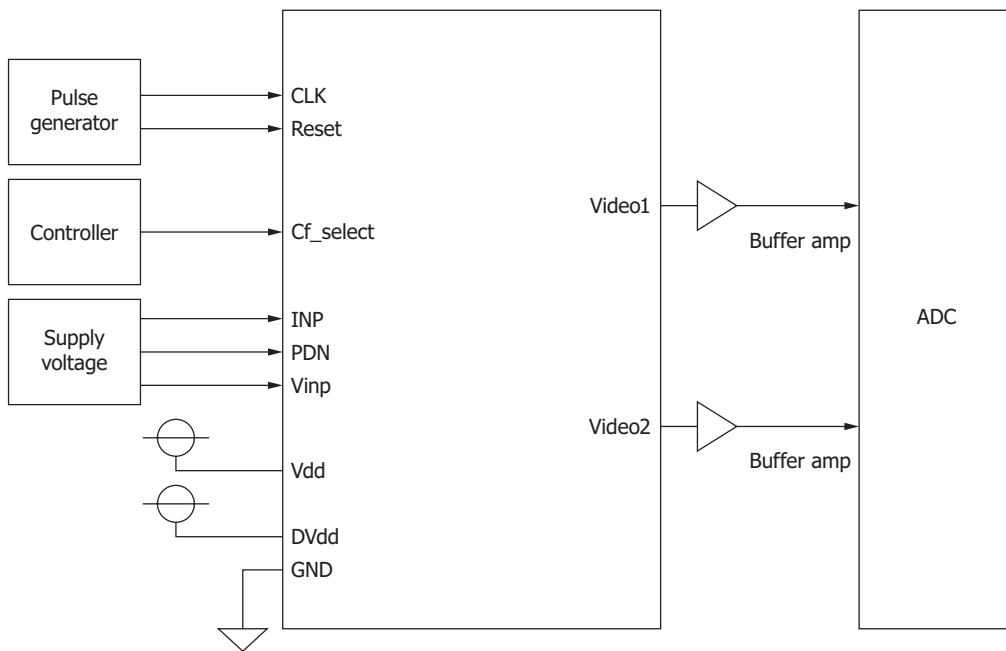
Equivalent circuit



KMIRC0120EA

Connection examples

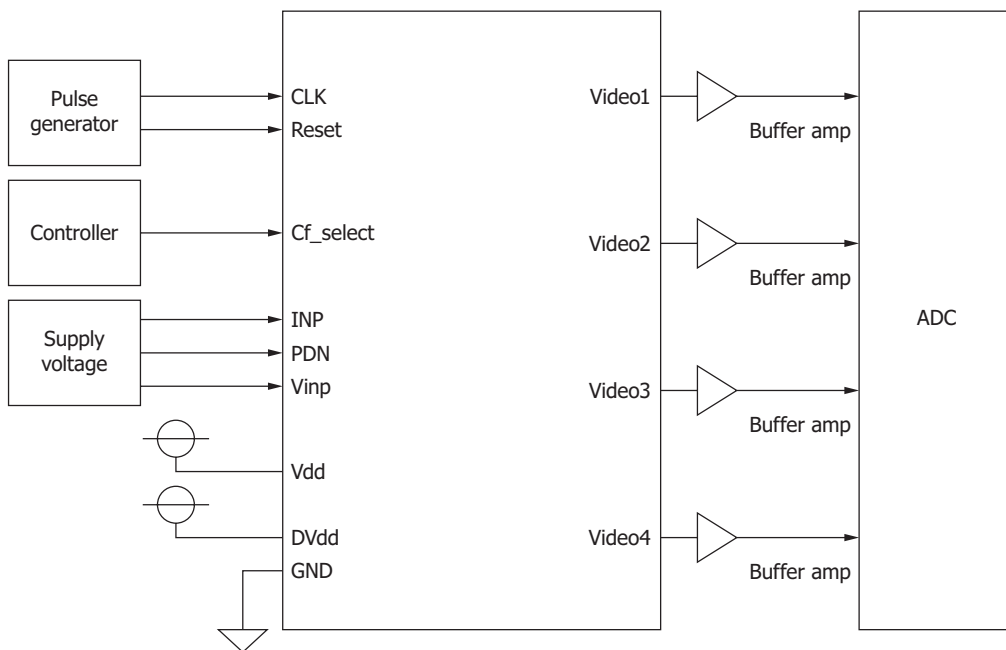
G14714-512DE



Note: buffer amp example: LT1818

KMIRC0125EA

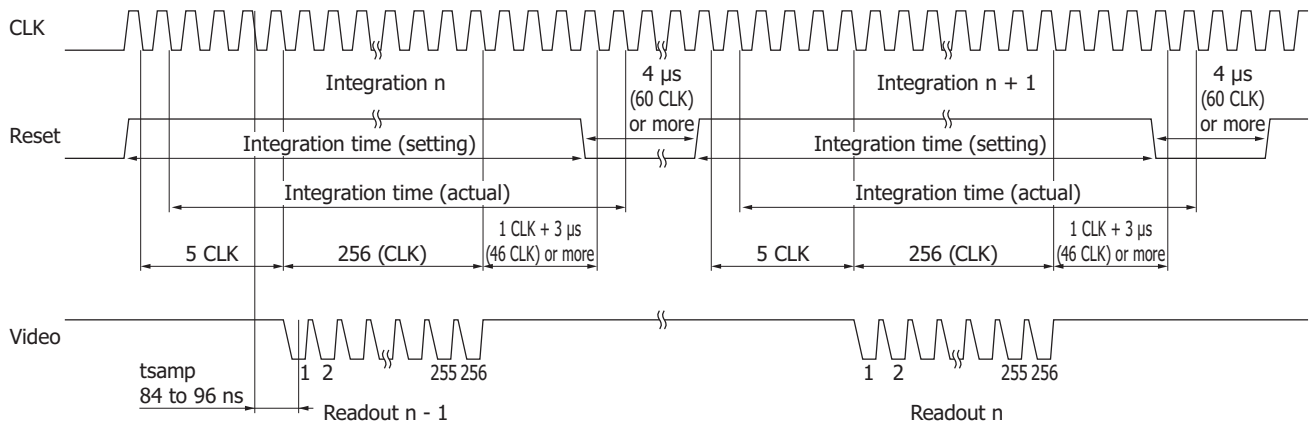
G14714-1024DK



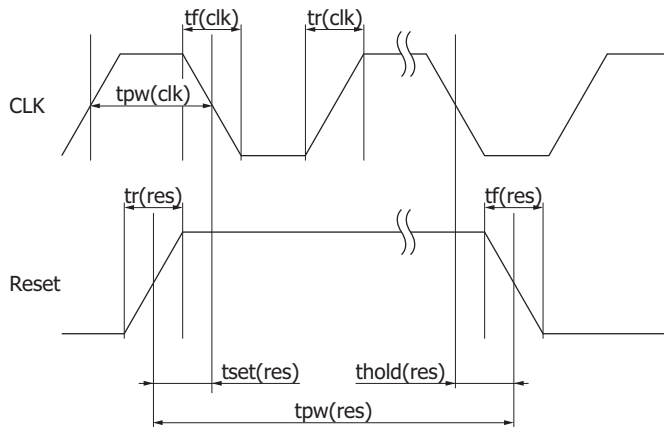
Note: buffer amp example: LT1818

KMIRC0122EA

Timing chart (fop=15 MHz, 256 ch/port)



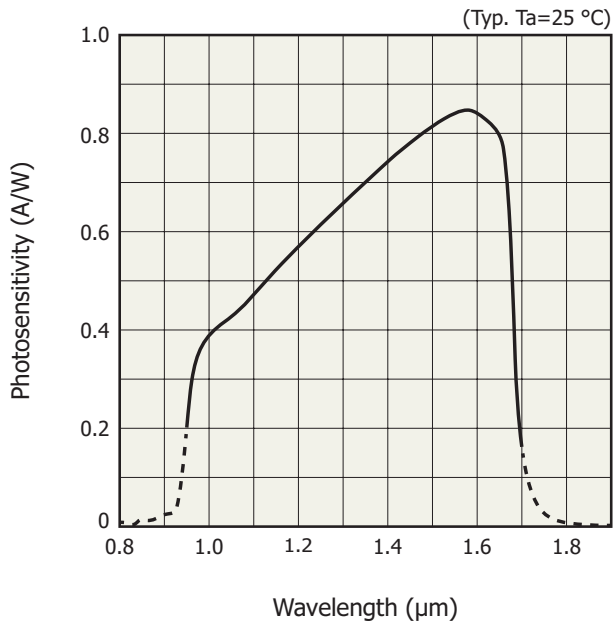
Integration time (actual) = Reset high period



KMIRC0121EB

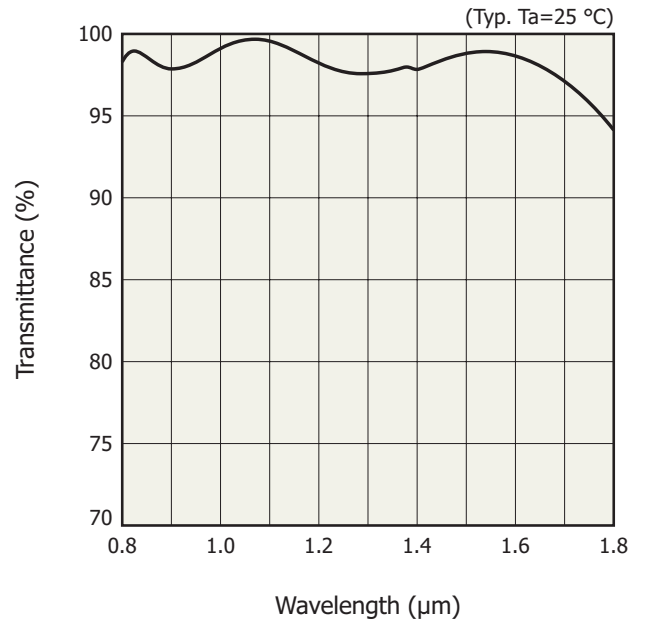
| Parameter | Symbol | Min. | Typ. | Max. | Unit |
|-----------------------------|------------------|------|----------------|------|------|
| Operating frequency | fop | 0.1 | - | 15 | MHz |
| Clock pulse width | tpw(clk) | - | 33.3 | 5000 | ns |
| Clock pulse rise/fall times | tr(clk), tf(clk) | 0 | 5 | 10 | ns |
| Reset pulse width | tpw(res) | High | 262 CLK + 3 μs | - | - |
| | | Low | 4 μs | - | - |
| Reset pulse rise/fall times | tr(res), tf(res) | 0 | 10 | 20 | ns |
| Clock setup time | tset(res) | 10 | - | - | ns |
| Clock hold time | thold(res) | 10 | - | - | ns |

Spectral response



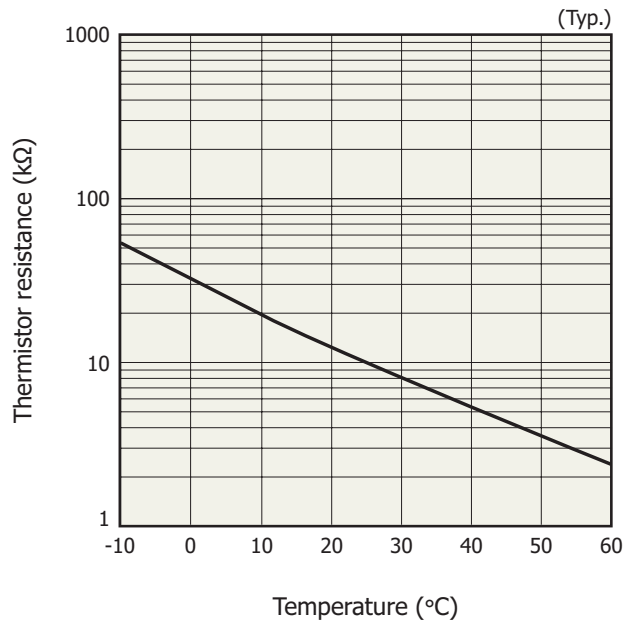
KMIRB0051EC

Spectral transmittance of window material



KMIRB0090EA

Thermistor temperature characteristics



(Typ.)

| Temperature | Thermistor resistance (kΩ) |
|-------------|----------------------------|
| -10 | 53.0 |
| -5 | 41.2 |
| 0 | 32.1 |
| 5 | 25.1 |
| 10 | 19.8 |
| 15 | 15.7 |
| 20 | 12.5 |
| 25 | 10.0 |
| 30 | 8.06 |
| 35 | 6.53 |
| 40 | 5.32 |
| 45 | 4.36 |
| 50 | 3.59 |
| 55 | 2.97 |
| 60 | 2.47 |

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Pin connections

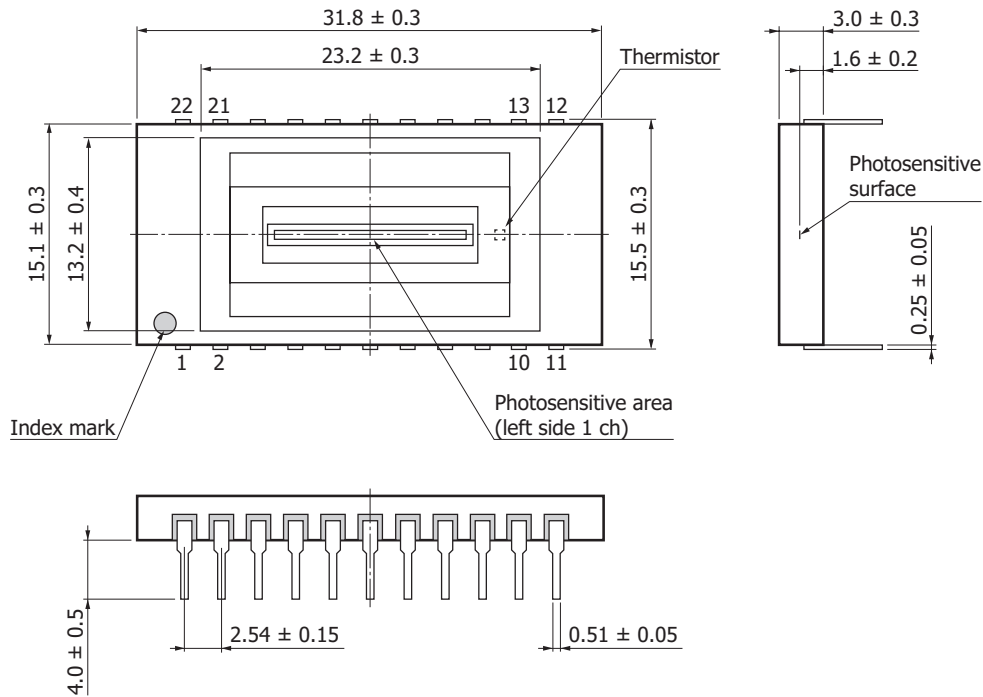
| Terminal name | Input/output | Function and recommended connection | Note |
|-------------------------|--------------|--|--|
| PDN | Input | InGaAs photodiode's cathode bias terminal. Set it about 0.1 V higher than the INP terminal. | 2.6 V |
| Cf_select* ⁹ | Input | Signal for selecting the feedback capacitance (conversion efficiency) on the CMOS chip | 0 V or 3.3 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 the pulse. | 0 to 3.3 V |
| CLK | Input | Clock pulse for operating the CMOS shift register | 0 to 3.3 V |
| INP | Input | Charge amplifier reset voltage. This is the supply voltage for operating the signal processing circuit on the CMOS chip. | 2.5 V |
| Vinp | Input | Video line reset voltage. This is the supply voltage for operating the signal processing circuit on the CMOS chip. | 2.5 V |
| Video | Output | Analog video signal. The polarity is negative. | G14714-512DE: 0.85 to 2.6 V G14714-1024DK: 0.85 to 2.55 V |
| DVdd | Input | Supply voltage for operating the digital signal processing circuit on the CMOS chip | 3.3 V |
| Vdd | Input | Supply voltage for operating the analog signal processing circuit on the CMOS chip | 3.3 V |
| GND | - | Ground for the signal processing circuit on the CMOS chip | 0 V |
| Therm | Output | Thermistor terminal for monitoring the package temperature | - |

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

| Conversion efficiency | Cf_select1 | Cf_select2 |
|--------------------------------|------------|------------|
| 0.128 $\mu\text{V}/\text{e}^-$ | Low | Low |
| 1.23 $\mu\text{V}/\text{e}^-$ | Low | High |
| 4.0 $\mu\text{V}/\text{e}^-$ | High | Low |
| 8.0 $\mu\text{V}/\text{e}^-$ | High | High |

Low: 0 V (GND), High: 3.3 V (Vdd)

Dimensional outline (unit: mm)



| Pin no. | G14714-512DE | G14714-1024DK |
|---------|--------------|---------------|
| 1 | NC | |
| 2 | NC | |
| 3 | Vdd | |
| 4 | NC | Video1 |
| 5 | Video1 | Video2 |
| 6 | Vinp | |
| 7 | NC | Video3 |
| 8 | Video2 | Video4 |
| 9 | PDN | |
| 10 | NC | |
| 11 | NC | |
| 12 | Therm | |
| 13 | Therm | |
| 14 | INP | |
| 15 | Cf_select2 | |
| 16 | Cf_select1 | |
| 17 | GND | |
| 18 | DVdd | |
| 19 | NC | |
| 20 | NC | |
| 21 | Reset | |
| 22 | CLK | |

Package material: Ceramic
 Lead processing: Ni/Au plating
 Lead material: FeNi alloy
 Window material: Borosilicate glass
 Window thickness: 0.75 ± 0.05 mm
 Window refractive index: $n_d=1.47$
 AR coating: Available ($1.55 \mu\text{m}$ peak)
 Window sealing method: Resin adhesion
 Center position accuracy of photosensitive area: $-0.3 \leq X \leq +0.3$
 $-0.3 \leq Y \leq +0.3$
 Angle accuracy of photosensitive area: $-5^\circ \leq \theta \leq +5^\circ$

Note: Leave NC open; do not connect to GND.

Output of pixels at each video output
 [G14714-512DE]
 Video1=1 to 256 ch, Video2=257 to 512 ch
 [G14714-1024DK]
 Video1=1 to 256 ch, Video2=257 to 512 ch,
 Video3=513 to 768 ch, Video4=769 to 1024 ch

KMIRA0039EC

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 consideration
- Image sensors

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

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