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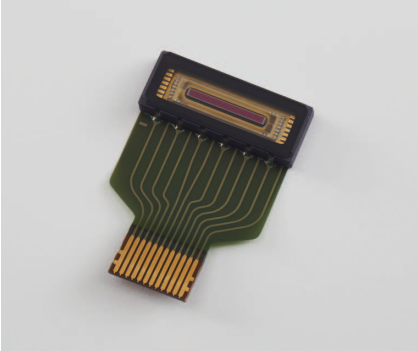
# InGaAs linear image sensors



G13913 series

## Near infrared image sensors for portable analytical instruments

The compact low-cost near infrared linear image sensors are designed for portable analytical instruments. They consume less current than the previous product (DIP package products: G11620 series). They are suitable for integration into compact thin devices because they employ a compact LCC package with a flexible board.

### Features

- **Compact (with flexible board)**
- **3.3 V drive**
- **Low current consumption: 15 mA (G13913-128FB)**
- **Low cost**
- **128 pixels (50 × 250 µm/pixel): G13913-128FB**
  **256 pixels (25 × 250 µm/pixel): G13913-256FG**
- **Selectable from two conversion efficiency levels**
- **Built-in anti-saturation circuit**
- **Easy operation (built-in timing generator*1)**
- **High resolution: 25 µm pitch (G13913-256FG)**

### Applications

- **Portable analytical instruments**

*1: Previously, multiple timing signals were applied using external PLD (programmable logic device) 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.

### Selection guide

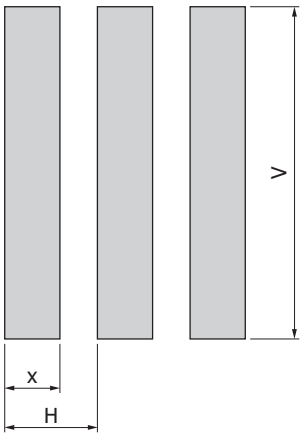
| Type no. | Cooling | Image size (mm) | Total number of pixels | Number of effective pixels |
|---|---|---|---|---|
| G13913-128FB | Non-cooled | 6.4 × 0.25 | 128 | 128 |
| G13913-256FG | | | 256 | 256 |

### Structure

| Type no. | Pixel size [µm (H) × µm (V)] | Pixel pitch (µm) | Package | Window material |
|---|---|---|---|---|
| G13913-128FB | 50 × 250 | 50 | Ceramic with flexible board (refer to dimensional outline) | Borosilicate glass*2 (no anti-reflective coating) |
| G13913-256FG | 25 × 250 | 25 | | |

*2: Windowless types are also available.

## Enlarged view of photosensitive area (unit: μm)




| Type no. | x | H | V |
|---|---|---|---|
| G13913-128FB | 30 | 50 | 250 |
| G13913-256FG | 10 | 25 | 250 |

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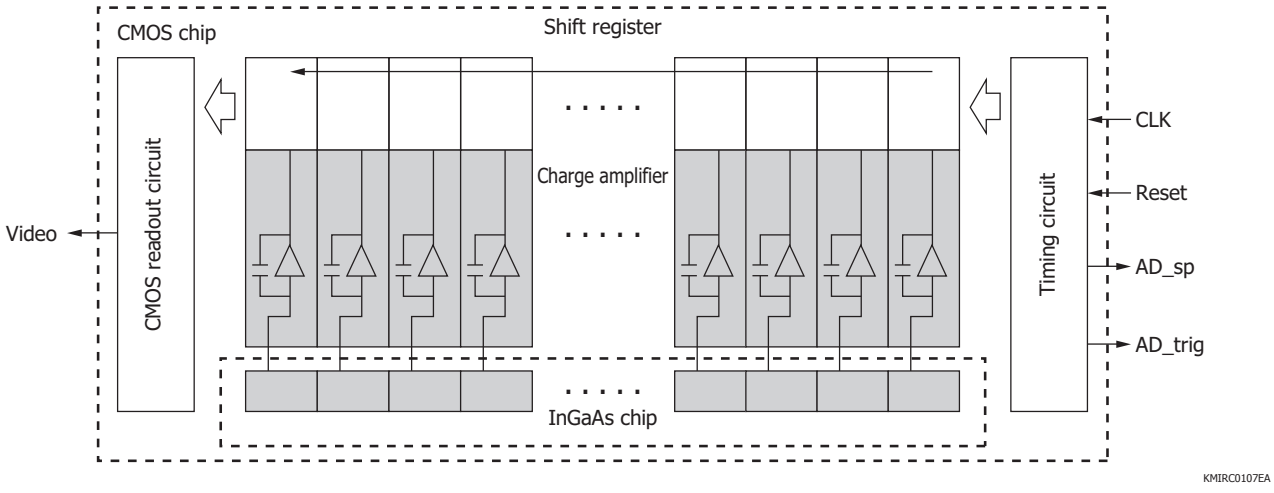
## Block diagram

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## Absolute maximum ratings

| Parameter | Symbol | Condition | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| Supply voltage | Vdd, INP, Fvref Vhold, PDN | Ta=25 °C | -0.3 | - | +4.2 | V |
| Clock pulse voltage | Vclk | Ta=25 °C | -0.3 | - | +4.2 | V |
| Reset pulse voltage | V(RES) | Ta=25 °C | -0.3 | - | +4.2 | V |
| Gain selection terminal voltage | Vcfsel | Ta=25 °C | -0.3 | - | +4.2 | V |
| Operating temperature | Topr | No dew condensation*3 | -10 | - | +60 | °C |
| Storage temperature | Tstg | No dew condensation*3 | -20 | - | +70 | °C |

*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: 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 | 3.0 | 3.3 | 3.6 | V |
| Differential reference voltage | | Fvref | 2.4 | 2.5 | 2.6 | V |
| Sample hold voltage | | Vhold | 2.4 | 2.5 | 2.6 | V |
| Input stage amplifier reference voltage | | INP | 2.4 | 2.5 | 2.6 | V |
| Photodiode cathode voltage | | PDN | 2.4 | 2.5 | 2.6 | V |
| Ground | | GND | - | 0 | - | V |
| Clock pulse voltage | High | Vclk | Vdd - 0.25 | Vdd | Vdd + 0.25 | V |
| | Low | | - | 0 | +0.25 | |
| Reset pulse voltage | High | V(RES) | Vdd - 0.25 | Vdd | Vdd + 0.25 | V |
| | Low | | - | 0 | +0.25 | |

## Electrical characteristics (Ta=25 °C)

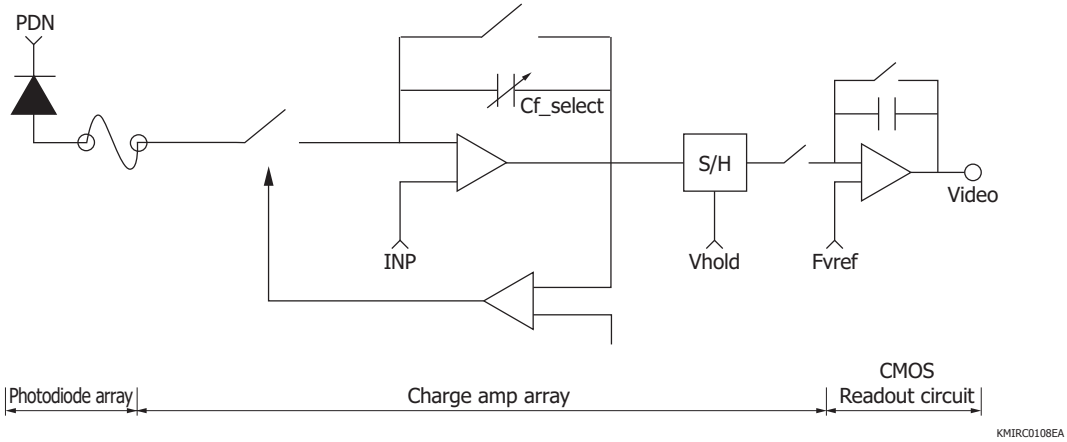
| Parameter | | Symbol | | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|---|
| Current consumption | | I(Vdd) | G13913-128FB | - | 15 | 25 | mA |
| | | | G13913-256FG | - | 20 | 30 | |
| | | Ifvref | | - | - | 1 | |
| | | Ivhold | | - | - | 1 | |
| | | Iinp | | - | - | 1 | |
| | | Ipdn | | - | - | 1 | |
| Clock frequency | | fop | | 0.1 | 1 | 2 | MHz |
| Data rate | | DR | | - | fop | - | MHz |
| Video output voltage | Dark | Vdark | | - | 2.5 | 2.9 | V |
| | Saturation | Vsat | | 0.2 | 0.3 | - | |
| Output offset voltage | | Vos | | - | Fvref | - | V |
| Output impedance | | Zo | | - | 6 | - | 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=Fvref=Vhold=PDN=2.5 V, Vclk=3.3 V, fop=1 MHz)

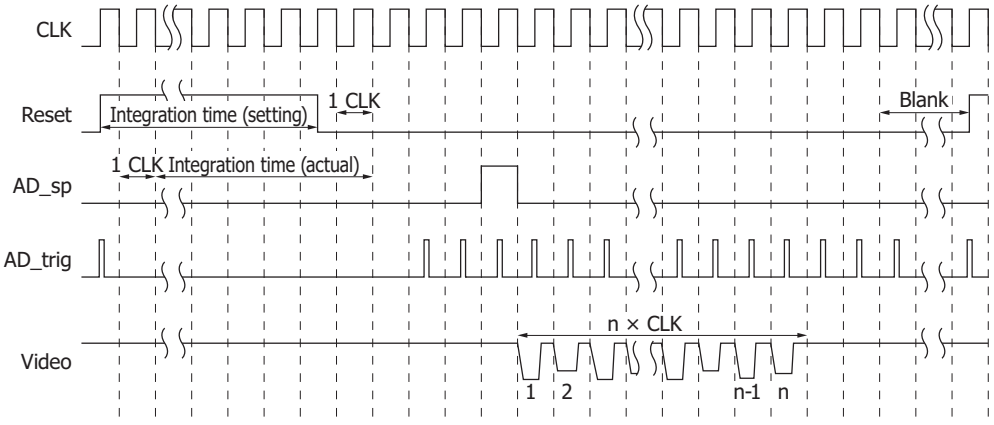
| Parameter | Symbol | Condition | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| Spectral response range | λ | | - | 0.95 to 1.7 | - | μm |
| Peak sensitivity wavelength | λp | | - | 1.55 | - | μm |
| Photosensitivity | S | λ=λp | 0.7 | 0.82 | - | A/W |
| Conversion efficiency*4 | CE | Cf=10 pF | - | 16 | - | nV/e⁻ |
| | | Cf=1 pF | - | 160 | - | |
| Photoresponse nonuniformity*5 | PRNU | CE=16 nV/e⁻ | - | ±5 | ±10 | % |
| Saturation charge | Csat | CE=16 nV/e⁻ | 125 | 137.5 | - | Me⁻ |
| | | CE=160 nV/e⁻ | 12.5 | 13.75 | - | |
| Saturation output voltage | Vsat | t=20 ms | 2.0 | 2.2 | - | V |
| Dark output | VD | CE=16 nV/e⁻ | - | ±0.1 | ±1 | V/s |
| Dark current | ID | CE=16 nV/e⁻ | - | ±5 | ±10 | pA |
| Temperature coefficient of dark output (dark current) | - | | - | 1.1 | - | times/°C |
| Readout noise*6 | Nread | CE=16 nV/e⁻ | - | 150 | 400 | μV rms |
| | | CE=160 nV/e⁻ | - | 300 | 500 | |
| Dynamic range | Drange | CE=16 nV/e⁻ | 5000 | 14667 | - | - |
| Defect pixels*7 | - | CE=16 nV/e⁻ | - | - | 1 | % |

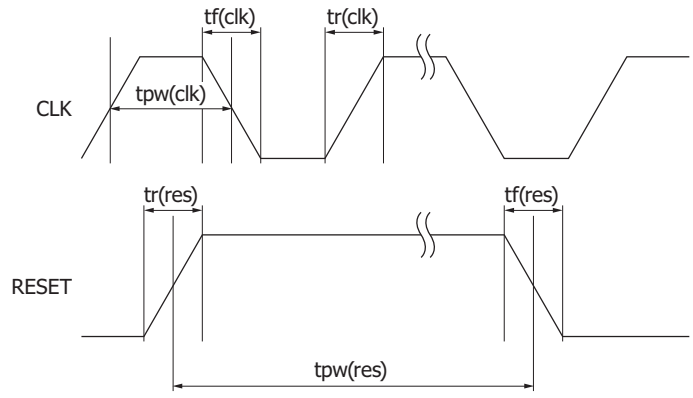
*4: For switching the conversion efficiency, see the pin connections.
*5: Measured at 50% saturation and 10 ms integration time after subtracting the dark output, excluding the first and last pixels
*6: Integration time when CE=16nV/e⁻ is 10 ms. Integration time when CE=160 nV/e⁻ is 1 ms.
*7: Pixels whose photoresponse nonuniformity, readout noise, or dark current is outside the specifications

## Equivalent circuit




## Timing chart

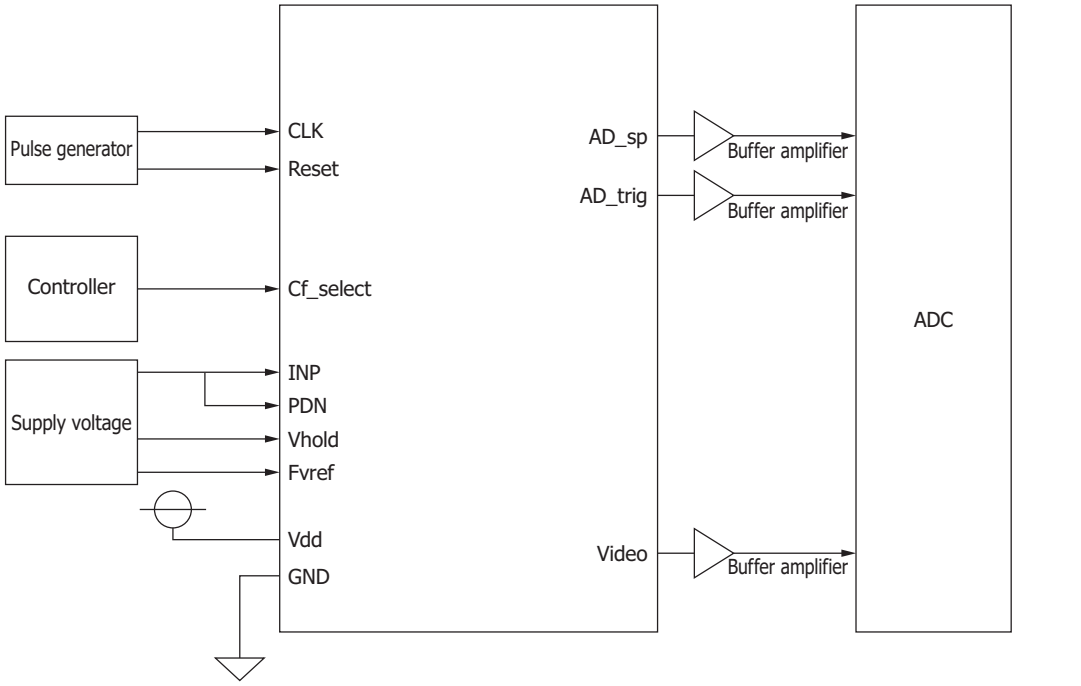



Note: n=number of channels

| Parameter | | Symbol | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| Clock pulse frequency | | fop | 0.1 | 1 | 2 | MHz |
| Clock pulse width | | tpw(clk) | 150 | - | 5000 | ns |
| Clock pulse rise/fall times | | tr(clk), tf(clk) | 0 | 20 | 30 | ns |
| Reset pulse width | High | tpw(res) | 2 | - | - | clocks |
| | Low | | Number of pixels + 16 | - | - | |
| Reset pulse rise/fall times | | tr(res), tf(res) | 0 | 20 | 30 | ns |

## Connection example

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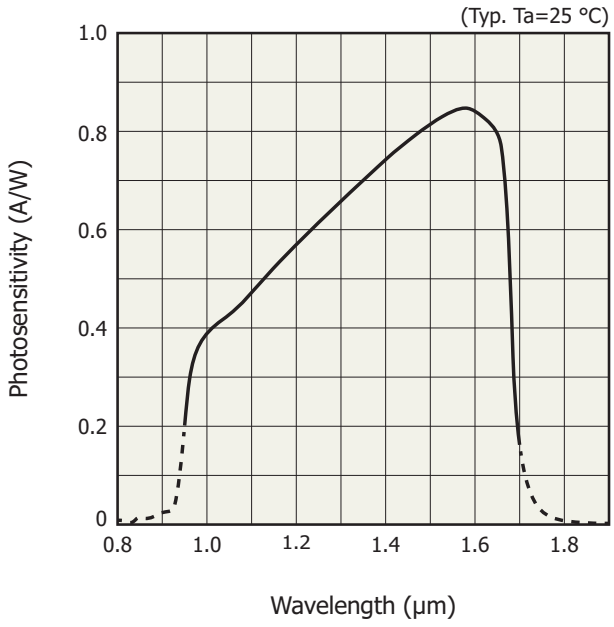
## Spectral response (typical example)

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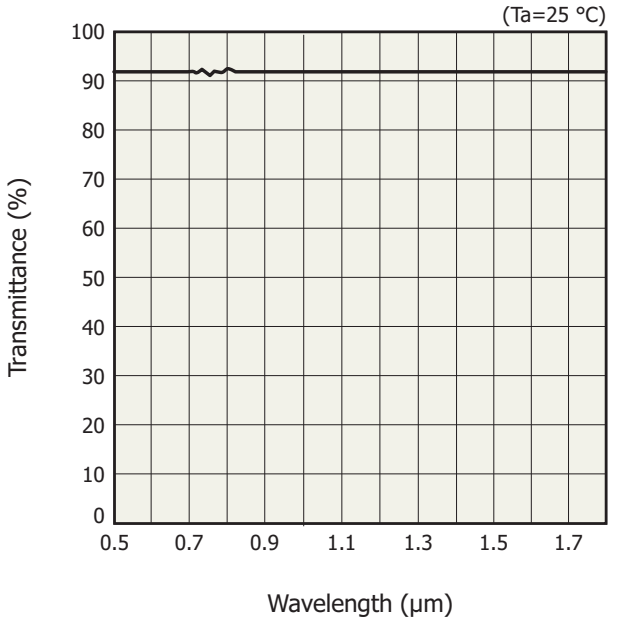
## Spectral transmittance of window material (typical example)

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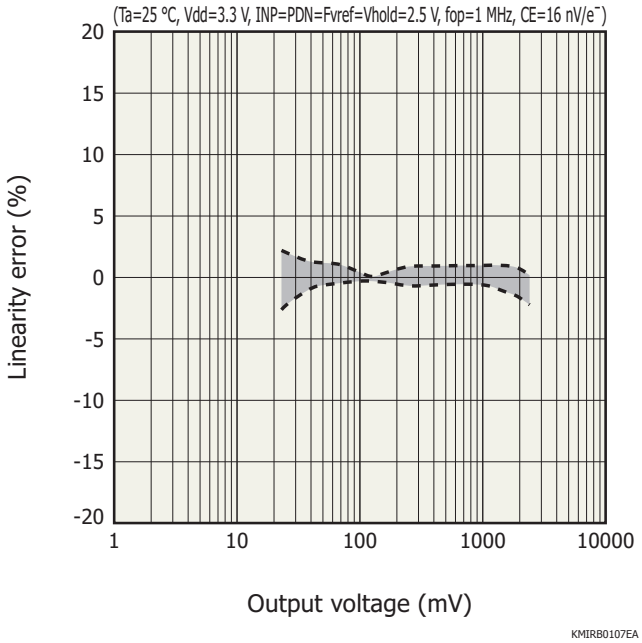
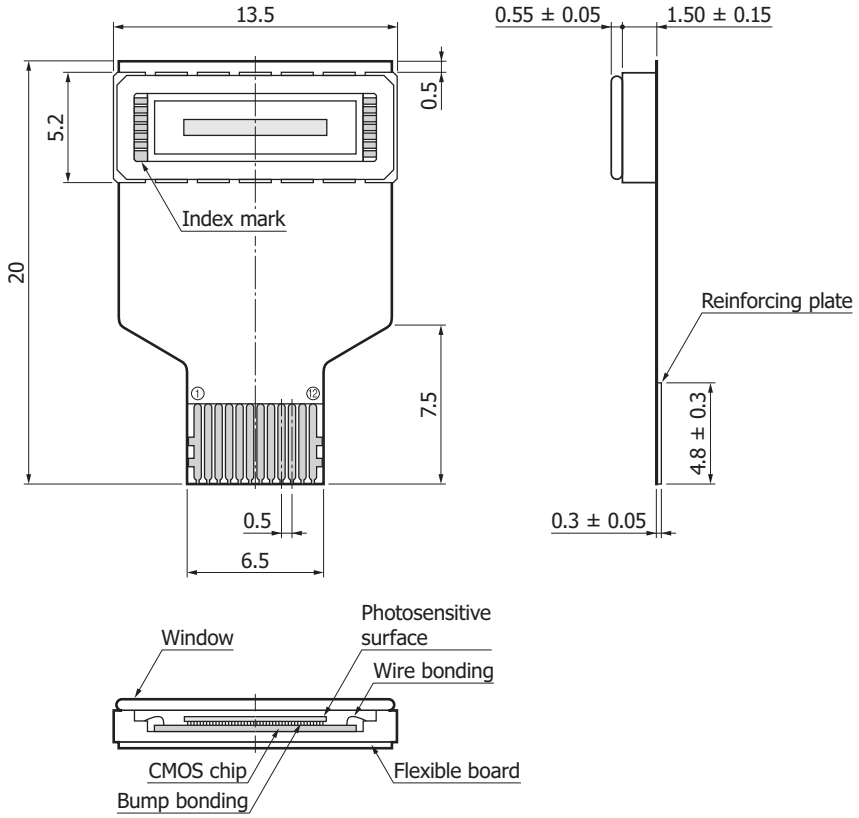
## Linearity error



## Dimensional outline (unit: mm)




| | | | |
|---|---|---|---|
| 1 | AD_trig | 7 | Fvref |
| 2 | GND | 8 | Video |
| 3 | AD_sp | 9 | PDN* |
| 4 | Vhold | 10 | INP* |
| 5 | CLK | 11 | Vdd |
| 6 | Reset | 12 | Cf_select |

Tolerance unless otherwise noted: ±0.25
Window refractive index: 1.47
Window thickness: 0.55 ± 0.05
Window sealing method: Resin adhesion
Center position accuracy of photosensitive area
-0.3≤X≤+0.3
-0.3≤Y≤+0.3
-2°≤θ≤+2°

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## Pin connections

| Terminal name | Input/ output | Function and recommended connection | Note |
|---|---|---|---|
| PDN | Input | InGaAs photodiode's cathode bias terminal. Set to the same potential as INP. | 2.5 V |
| AD_sp | Output | Digital start signal for A/D conversion | 0 to 3.3 V |
| Cf_select | Input*8 | Signal for selecting the feedback capacitance (integration capacitance) on the CMOS chip | 0 to 3.3 V |
| AD_trig | Output | Sampling sync signal for A/D conversion | 0 to 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 this pulse. | 0 to 3.3 V |
| CLK | Input | Clock pulse for operating the CMOS shift register | 0 to 3.3 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. | 2.5 V |
| Vhold | Input | Reference voltage for sample-and-hold circuit. This is the supply voltage for operating the signal processing circuit on the CMOS chip. | 2.5 V |
| Fvref | Input | Differential amplifier reference voltage. This is the supply voltage for operating the signal processing circuit on the CMOS chip. | 2.5 V |
| Video | Output | Differential amplifier output. This is an analog video signal. Nagative polarity. | 0.3 to 2.5 V |
| Vdd | Input | Supply voltage for operating the signal processing circuit on the CMOS chip (+3.3 V) | 3.3 V |
| GND | Input | Ground for the signal processing circuit on the CMOS chip (0 V) | 0 V |

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

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

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

## 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



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