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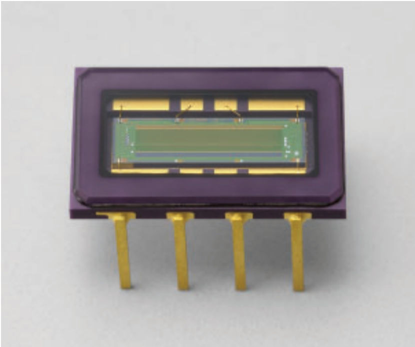
NEW

# CMOS linear image sensor

S9227-03



## High-speed readout, simultaneous integration

The S9227-03 is a small CMOS linear image sensor designed for image input applications. Signal charge is integrated on all pixels simultaneously and then read out at high speeds of 5 MHz.

## Features

- **Pixel pitch: 12.5 µm**
  **Pixel height: 250 µm**
- **512 pixels**
- **5 V single power supply operation**
- **Video data rate: 5 MHz max.**
- **Simultaneous charge integration**
- **Shutter function**
- **High sensitivity, low dark current, low noise**
- **Built-in timing generator allows operation with only start and clock pulse inputs.**
- **Spectral response range: 400 to 1000 nm**
- **8-pin DIP (16-pin surface mount type also available)**

## Applications

- **Position detection**
- **Image reading**

## Absolute maximum ratings

| Parameter | Symbol | Value | Unit |
|---|---|---|---|
| Supply voltage | Vdd | -0.3 to +6 | V |
| Clock pulse voltage | V(clk) | -0.3 to +6 | V |
| Start pulse voltage | V(st) | -0.3 to +6 | V |
| Operating temperature*1 | Topr | -5 to +60 | °C |
| Storage temperature*1 | Tstg | -10 to +70 | °C |

*1: No condensation

## Mechanical specifications

| Parameter | Specification | Unit |
|---|---|---|
| Number of pixels | 512 | - |
| Pixel pitch | 12.5 | µm |
| Pixel height | 250 | µm |
| Active area length | 6.4 | mm |
| Window material | TEMPAX | - |
| Package | Ceramic | - |

## Recommended terminal voltage

| Parameter | | Symbol | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| Supply voltage | | Vdd | 4.75 | 5 | 5.25 | V |
| Clock pulse voltage | High level | V(clk) | Vdd - 0.25 | Vdd | Vdd + 0.25 | V |
| | Low level | | - | 0 | - | V |
| Start pulse voltage | High level | V(st) | Vdd - 0.25 | Vdd | Vdd + 0.25 | V |
| | Low level | | - | 0 | - | V |

## Electrical characteristics [Ta=25 °C, Vdd=5 V, V(clk)=V(st)=5 V]

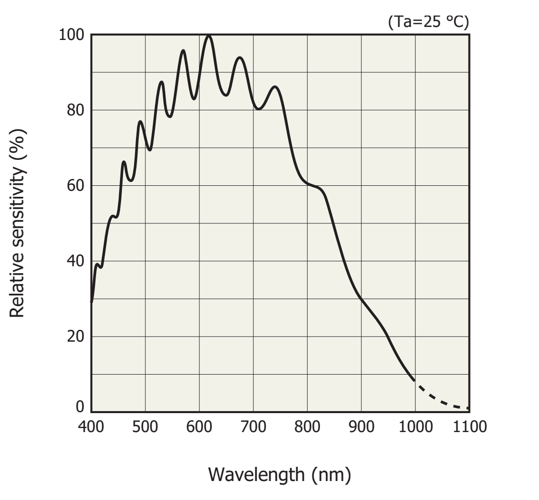
| Parameter | Symbol | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|
| Clock pulse frequency | f(clk) | 50 k | - | 5 M | Hz |
| Video data rate | VR | - | f(clk) | - | Hz |
| Power consumption | P | 100 | 130 | 160 | mW |
| Conversion efficiency | CE | - | 1.6 | - | μV/e⁻ |
| Output impedance*2 | Zo | - | 50 | 200 | Ω |

## Electrical and optical characteristics [Ta=25 °C, Vdd=5 V, V(clk)=V(st)=5 V]

| Parameter | Symbol | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|
| Spectral response range | λ | | 400 to 1000 | | nm |
| Peak sensitivity wavelength | λp | - | 700 | - | nm |
| Dark current | ID | - | 10 | 100 | fA |
| Saturation charge | Qsat | 320 | 420 | - | fC |
| Dark output voltage*3 | Vd | - | 1 | 10 | mV |
| Saturation output voltage*4 | Vsat | 4 | 4.3 | - | V |
| Readout noise | Nr | - | 1 | 2 | mV rms |
| Offset output voltage | Vo | - | 0.6 | 0.9 | V |
| Photo response non-uniformity*5 *6 | PRNU | -5 | - | +5 | % |

*2: An increased current consumption at the video output terminal rises the sensor chip temperature causing an increased dark current. Connect a buffer amplifier for impedance conversion to the video output terminal so that the current flow is minimized. Use a JFET or CMOS input, high-impedance input op amp as the buffer amplifier.
*3: Integration time Ts=10 ms
*4: Voltage difference with respect to Vo, Ts=10 ms
*5: Uniformity is measured using 510 pixels excluding the pixels at both ends under the condition that the device is uniformly illuminated by light which is 50% of the saturation level, and is defined as follows:
PRNU= $\Delta X/X \times 100$ (%)
X: the average output of all pixels, ΔX: difference between X and maximum or minimum output
*6: Measured with a tungsten lamp of 2856 K

## Spectral response (typical example)



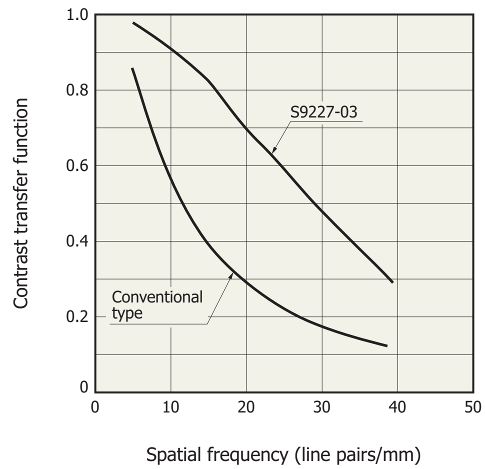
## Resolution

CTF: contrast transfer function

$$CTF = \frac{V_{WO} - V_{BO}}{V_W - V_B}$$

$V_{WO}$ : output white level
$V_{BO}$ : output black level
$V_W$ : output white level (when input pattern pulse width is wide)
$V_B$ : output black level (when input pattern pulse width is wide)

## Contrast transfer function vs. spatial frequency (typical example)

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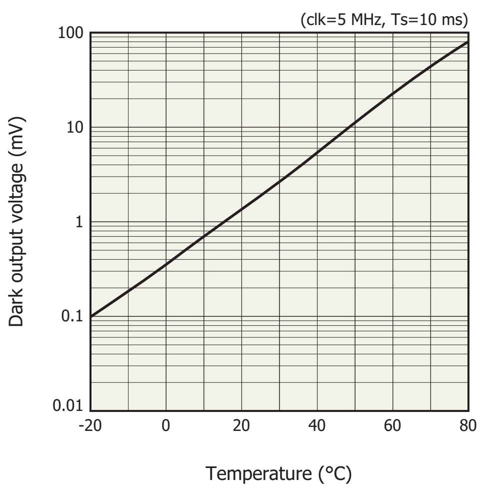
## Dark output voltage vs. temperature (typical example)

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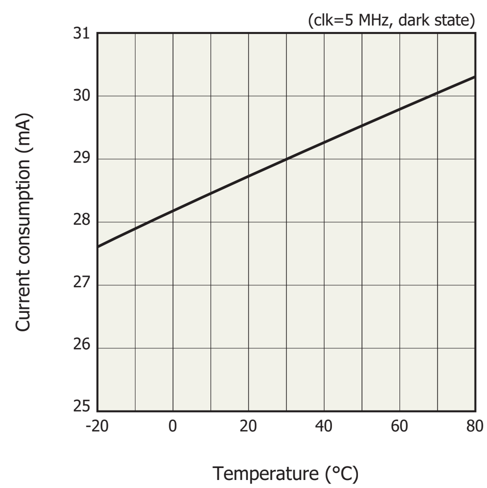
## Current consumption vs. temperature (typical example)

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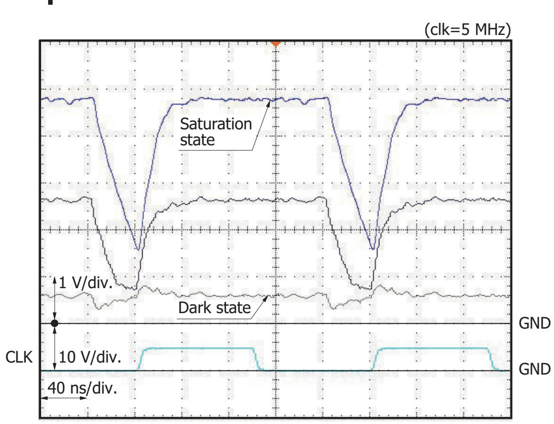
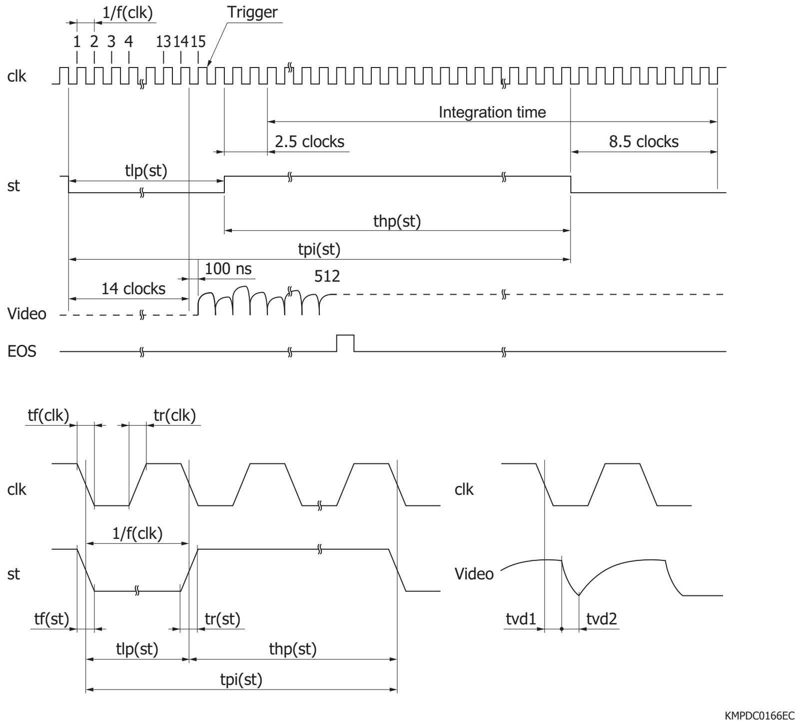
## Output waveform of one element



## Timing chart



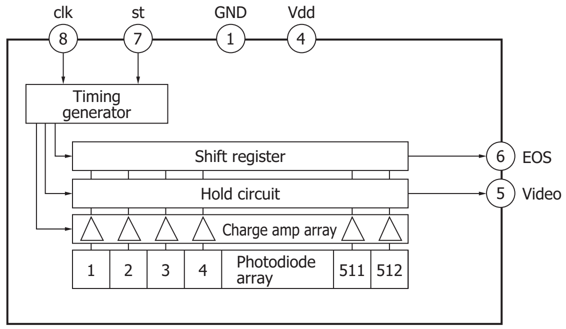

| Parameter | Symbol | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|
| Start pulse interval | tpi(st) | 530/f(clk) | - | 1100 m | s |
| Start pulse high period | thp(st) | 8/f(clk) | - | 1000 m | s |
| Start pulse low period | tlp(st) | 15/f(clk) | - | 100 m | s |
| Start pulse rise and fall times | tr(st), tf(st) | 0 | 20 | 30 | ns |
| Clock pulse duty | - | 45 | 50 | 55 | % |
| Clock pulse rise and fall times | tr(clk), tf(clk) | 0 | 20 | 30 | ns |
| Video delay time 1 | tvd1 | 32 | 40 | 48 | ns |
| Video delay time 2 | tvd2 | 40 | 50 | 60 | ns |

Note: The internal timing circuit starts operating at the rise of clk pulse immediately after st pulse sets to low.
The integration time equals the high period of st pulse plus 6 clk cycles.

- The output from 1st channel appears 14 clocks plus 100 ns after the falling edge of st pulse.
- The EOS pulse is output 39 ns after the falling edge of clk pulse.
- The output voltage after reading the last pixel (512 ch) is indefinite.

Start pulse setting example (for setting the start pulse period to a minimum and the integration time to a maximum)
Start pulse high period=515/f(clk), Start pulse low period=15/f(clk)

## Block diagram

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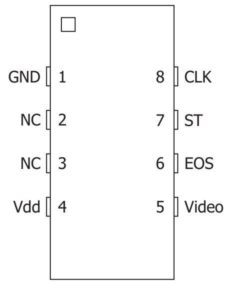
## Pin connections

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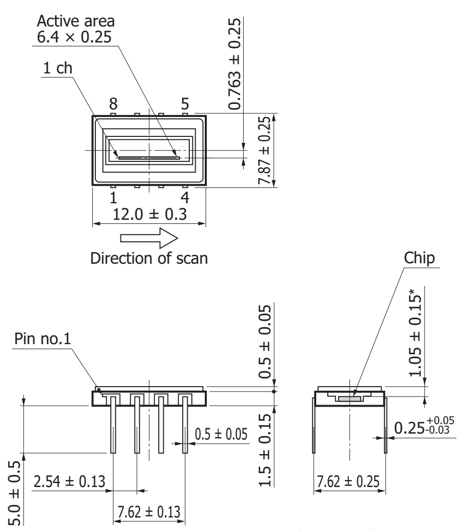
| Pin no. | Symbol | Name of pin | Input/output |
|---|---|---|---|
| 1 | GND | Ground | Input |
| 2 | NC | | Open |
| 3 | NC | | Open |
| 4 | Vdd | Supply voltage | Input |
| 5 | Video | Video output | Output |
| 6 | EOS | End of scan | Output |
| 7 | st | Start pulse | Input |
| 8 | clk | Clock pulse | Input |

## Dimensional outline (unit: mm)




*Distance from the outer of the window to the chip surface

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## Precautions during use

(1) 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.

(2) Light input window

If dust or dirt gets on the light input window, it will show up as black blemishes on the image. When cleaning, avoid rubbing the window surface with dry cloth or dry cotton swab, since doing so may generate static electricity. Use soft cloth, paper or a cotton swab moistened with alcohol to wipe dust and dirt off the window surface. Then blow compressed air onto the window surface so that no spot or stain remains.

(3) Soldering

To prevent damaging the device during soldering, take precautions to prevent excessive soldering temperatures and times. Soldering should be performed within 5 seconds at a soldering temperature below 260 °C.

(4) Operating and storage environments

Always observe the rated temperature range when handling the device. Operating or storing the device at an excessively high temperature and humidity may cause variations in performance characteristics and must be avoided.

(5) UV exposure

This product is not designed to prevent deterioration of characteristics caused by UV exposure, so do not expose it to UV light.



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