The S9226 series is a small CMOS linear image sensor designed for image input applications. The signal processing circuit has a charge amplifier with excellent input/output characteristics. Two package styles are provided: a DIP type and a surface mount type.

Features
- Pixel pitch: 7.8 μm
- Pixel height: 125 μm
- 1024 pixels
- 3.3 V single power supply operation available
- High sensitivity, low dark current, low noise
- On-chip charge amplifier with excellent input/output characteristics
- Built-in timing generator allows operation with only start and clock pulse inputs.
- Video data rate: 200 kHz max.
- Spectral response range: 400 to 1000 nm
- Two package styles are provided:
  - DIP (dual inline package) type: S9226-03
  - Surface mount type: S9226-04

Applications
- Analytical instruments
- Position detection
- Image reading

Structure
<table>
<thead>
<tr>
<th>Parameter</th>
<th>S9226-03</th>
<th>S9226-04</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of pixels</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pixel pitch</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pixel height</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Photosensitive area length</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Package</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Window material</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Absolute maximum ratings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Condition</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage</td>
<td>Vdd</td>
<td>Ta=25 °C</td>
<td>-0.3 to +6</td>
<td>V</td>
</tr>
<tr>
<td>Gain selection terminal voltage</td>
<td>Vg</td>
<td>Ta=25 °C</td>
<td>-0.3 to +6</td>
<td>V</td>
</tr>
<tr>
<td>Clock pulse voltage</td>
<td>V(CLK)</td>
<td>Ta=25 °C</td>
<td>-0.3 to +6</td>
<td>V</td>
</tr>
<tr>
<td>Start pulse voltage</td>
<td>V(ST)</td>
<td>Ta=25 °C</td>
<td>-0.3 to +6</td>
<td>V</td>
</tr>
<tr>
<td>Operating temperature</td>
<td>Topr</td>
<td>No dew condensation</td>
<td>-20 to +60</td>
<td>°C</td>
</tr>
<tr>
<td>Storage temperature</td>
<td>Tstg</td>
<td>No dew condensation</td>
<td>-20 to +70</td>
<td>°C</td>
</tr>
<tr>
<td>Soldering temperature</td>
<td>S9226-03</td>
<td>Tsol</td>
<td>260 (5 s)^2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>S9226-04</td>
<td></td>
<td>240 (twice)^3</td>
<td></td>
</tr>
</tbody>
</table>

*1: 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.
*2: Solder temperature
*3: Reflow soldering, JEDEC J-STD-020 MSL 5, see P.10
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.
CMOS linear image sensors  
S9226 series

**Recommended terminal voltage (Ta=25 °C)**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage</td>
<td>Vdd</td>
<td>3.3</td>
<td>5</td>
<td>5.25</td>
<td>V</td>
</tr>
<tr>
<td>Gain selection terminal voltage</td>
<td>High gain</td>
<td>Vg</td>
<td>-</td>
<td>0</td>
<td>- V</td>
</tr>
<tr>
<td></td>
<td>Low gain</td>
<td></td>
<td>Vdd</td>
<td>0.25</td>
<td>- V</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Vdd</td>
<td>0.25</td>
<td>- V</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Vdd</td>
<td>0.25</td>
<td>- V</td>
</tr>
<tr>
<td>Clock pulse voltage</td>
<td>V(CLK)</td>
<td>Vdd</td>
<td>-0.25</td>
<td>Vdd</td>
<td>Vdd + 0.25</td>
</tr>
<tr>
<td>Start pulse voltage</td>
<td>V(ST)</td>
<td>Vdd</td>
<td>-0.25</td>
<td>Vdd</td>
<td>Vdd + 0.25</td>
</tr>
</tbody>
</table>

**Electrical characteristics [Ta=25 °C, Vdd=5 V, V(CLK)=V(ST)=5 V]**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clock pulse frequency</td>
<td>f(CLK)</td>
<td>10</td>
<td>800</td>
<td>kHz</td>
<td>kHz</td>
</tr>
<tr>
<td>Data rate</td>
<td>DR</td>
<td>-</td>
<td>f(CLK)/4</td>
<td>-</td>
<td>kHz</td>
</tr>
<tr>
<td>Current consumption</td>
<td>Ic</td>
<td>4</td>
<td>6</td>
<td>8</td>
<td>mA</td>
</tr>
<tr>
<td>Conversion efficiency High gain</td>
<td>CE</td>
<td>-</td>
<td>3.2</td>
<td>-</td>
<td>μV/e-</td>
</tr>
<tr>
<td>Output impedance</td>
<td>Zo</td>
<td>-</td>
<td>185</td>
<td>- Ω</td>
<td></td>
</tr>
</tbody>
</table>

**Electrical and optical characteristics [Ta=25 °C, Vdd=5 V, V(CLK)=V(ST)=5 V]**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spectral response range</td>
<td>λ</td>
<td>400</td>
<td>1000</td>
<td>nm</td>
<td></td>
</tr>
<tr>
<td>Peak sensitivity wavelength</td>
<td>λp</td>
<td>-</td>
<td>650</td>
<td>-</td>
<td>nm</td>
</tr>
<tr>
<td>Dark current</td>
<td>Id</td>
<td>5</td>
<td>50</td>
<td>fA</td>
<td></td>
</tr>
<tr>
<td>Dark output voltage*4</td>
<td>VD</td>
<td>-</td>
<td>0.8</td>
<td>-</td>
<td>mV</td>
</tr>
<tr>
<td>Saturation output voltage*5</td>
<td>Vsat</td>
<td>2.2</td>
<td>3.2</td>
<td>-</td>
<td>V</td>
</tr>
<tr>
<td>Readout noise</td>
<td>Nread</td>
<td>1.4</td>
<td>2.2</td>
<td>mV rms</td>
<td></td>
</tr>
<tr>
<td>Offset output voltage*6</td>
<td>Voffset</td>
<td>0.2</td>
<td>0.35</td>
<td>0.6</td>
<td>V</td>
</tr>
<tr>
<td>Photoresponse nonuniformity*6+7</td>
<td>PRNU</td>
<td>-</td>
<td>±5</td>
<td>%</td>
<td></td>
</tr>
</tbody>
</table>

*4: Integration time=10 ms  
*5: Voltage difference with respect to Voffset  
*6: Photoresponse nonuniformity (PRNU) is the output nonuniformity that occurs when the entire photosensitive area is uniformly illuminated by light which is 50% of the saturation exposure level. PRNU is measured using 1022 pixels excluding the pixels at both ends, and is defined as follows:  
PRNU = ΔX/X × 100 (%)  
X: average output of all pixels, ΔX: difference between X and maximum or minimum output  
*7: Measured with a tungsten lamp of 2856 K

**Block diagram**

[Block diagram image]
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)

(Ta=25 °C, Low gain)

Spectral response (typical example)

(Ta=25 °C)
**Dark output voltage vs. temperature (typical example)**

![Graph showing dark output voltage vs. temperature]

**Current consumption vs. temperature (typical example)**

![Graph showing current consumption vs. temperature]
Output waveform of one element

High gain

- $f(\text{CLK})=4 \times DR=800 \text{ kHz}$

![Output waveform diagram](Typ. Ta=25 °C, Vdd=5 V, f(\text{CLK})=4 \times DR=800 \text{ kHz}]

- $f(\text{CLK})=4 \times DR=100 \text{ kHz}$

![Output waveform diagram](Typ. Ta=25 °C, Vdd=5 V, f(\text{CLK})=4 \times DR=100 \text{ kHz}]

HAMAMATSU
PHOTON IS OUR BUSINESS
CMOS linear image sensors  |  S9226 series

Low gain

- $f(\text{CLK}) = 4 \times \text{DR} = 800 \text{ kHz}$

- $f(\text{CLK}) = 4 \times \text{DR} = 100 \text{ kHz}$
**Timing chart**

![Timing chart diagram]

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Start pulse cycle</td>
<td>tpi(ST)</td>
<td>4104/f(CLK)</td>
<td>-</td>
<td>-</td>
<td>s</td>
</tr>
<tr>
<td>Start pulse rise and fall times</td>
<td>tr(ST), tf(ST)</td>
<td>0</td>
<td>20</td>
<td>30</td>
<td>ns</td>
</tr>
<tr>
<td>Clock pulse duty ratio</td>
<td>-</td>
<td>40</td>
<td>50</td>
<td>60</td>
<td>%</td>
</tr>
<tr>
<td>Clock pulse rise and fall times</td>
<td>tr(CLK), tf(CLK)</td>
<td>0</td>
<td>20</td>
<td>30</td>
<td>ns</td>
</tr>
<tr>
<td>Video delay time*</td>
<td>tvd</td>
<td>10</td>
<td>20</td>
<td>30</td>
<td>ns</td>
</tr>
</tbody>
</table>

*8: Ta=25 °C, Vdd=5 V, V(CLK)=V(ST)=5 V

Note: The CLK pulse should be set from high to low just once when the st pulse is low. The internal shift register starts operating at this timing.

The integration time is determined by the start pulse cycles. However, since the charge integration of each pixel is carried out between the signal readout of that pixel and the next signal readout of the same pixel, the start time of charge integration differs depending on each pixel. In addition, the next start pulse cannot be input until signal readout from all pixels is completed.
- Dimensional outlines (unit: mm)

**S9226-03**

```
Pin no. Symbol Pin name Input/Output
1 NC No connection
2 NC No connection
3 GND Ground Input
4 CLK Clock pulse Input
5 Trig Trigger pulse Output
6 ST Start pulse Input
7 NC No connection
8 NC No connection
9 NC No connection
10 NC No connection
11 Vg Gain selection voltage Input
12 Video Video signal\(^\ast\) Output
13 NC No connection
14 Vdd Supply voltage Input
```

Note: Leave the "NC" terminals open and do not connect them to GND.

**S9226-04**

```
Pin no. Symbol Pin name Input/Output
1 NC No connection
2 NC No connection
3 GND Ground Input
4 CLK Clock pulse Input
5 Trig Trigger pulse Output
6 ST Start pulse Input
7 NC No connection
8 NC No connection
9 NC No connection
10 NC No connection
11 Vg Gain selection voltage Input
12 Video Video signal\(^\ast\) Output
13 EOS End of scan Output
14 Vdd Supply voltage Input
15 NC No connection
16 NC No connection
```

Note: Leave the "NC" terminals open and do not connect them to GND.

*9: Connect a buffer amplifier for impedance conversion to the video output terminal so as to minimize the current flow. As the buffer amplifier, use a high input impedance operational amplifier with JFET or CMOS input.

Note: Leave the "NC" terminals open and do not connect them to GND.
Application circuit example (S9226-03)*10

*10: The S9226-04 has a different pin connections, but uses the same circuit.
## Recommended reflow soldering conditions (S9226-04)

<table>
<thead>
<tr>
<th>Temperature (°C)</th>
<th>Time (s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>50</td>
<td>0</td>
</tr>
<tr>
<td>100</td>
<td>0</td>
</tr>
<tr>
<td>150</td>
<td>0</td>
</tr>
<tr>
<td>200</td>
<td>0</td>
</tr>
<tr>
<td>250</td>
<td>0</td>
</tr>
<tr>
<td>300</td>
<td>0</td>
</tr>
</tbody>
</table>

**Peak temperature 240 °C max.**

- This product (S9226-04) supports lead-free soldering. After unpacking, store it in an environment at a temperature of 30 °C or less and a humidity of 60% or less, and perform soldering within 24 hours.
- The effect that the product receives during reflow soldering varies depending on the circuit board and reflow oven that are used. Before actual reflow soldering, check for any problems by testing out the reflow soldering methods in advance.
- A sudden temperature rise and cooling may be the cause of trouble, so make sure that the temperature change is within 4 °C per second.
- The bonding portion between the ceramic base and the glass may discolor after reflow soldering, but this has no adverse effects on the hermetic sealing of the product.

## Precautions

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 the incident window is contaminated or scratched, the output uniformity will deteriorate considerably, so care should be taken in handling the window. Avoid touching it with bare hands.
   - The window surface should be cleaned before using the device. If dry cloth or dry cotton swab is used to rub the window surface, static electricity may be generated, and therefore this practice should be avoided. Use soft cloth, cotton swab or soft paper moistened with ethyl alcohol to wipe off dirt and foreign matter on the window surface.

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

- Precautions
- Disclaimer
- Image sensors/Precautions
- Surface mount type products/Precautions

Information described in this material is current as of March 2020.
Product specifications are subject to change without prior notice due to improvements or other reasons. This document has been carefully prepared and the information contained is believed to be accurate. In rare cases, however, there may be inaccuracies such as text errors. Before using these products, always contact us for the delivery specification sheet to check the latest specifications.
The product warranty is valid for one year after delivery and is limited to product repair or replacement for defects discovered and reported to us within that one year period. However, even if within the warranty period we accept absolutely no liability for any loss caused by natural disasters or improper product use.
Copying or reprinting the contents described in this material in whole or in part is prohibited without our prior permission.

HAMAMATSU PHOTOactics K.K., Solid State Division
1126-1 Ichino-cho, Higashi-ku, Hamamatsu City, 435-8558 Japan, Telephone: (81)53-434-3311, Fax: (81)53-434-5184
U.S.A.: Hamamatsu Corporation: 360 Post Hill Road, Bridgewater, NJ 08807, U.S.A., Telephone: (908)231-0960, Fax: (908)231-1218, Email: usa@hamamatsu.com
Germany: Hamamatsu Photonics Deutschland GmbH: Ardbergstr. 30, D-62211 Herrsching am Ammersee, Germany, Telephone: (49)6152-375-0, Fax: (49)6152-295-9, Email: info@hamamatsu.de
France: Hamamatsu Photonics France S.A.R.L.: 19, Rue du Saule Tripu, Parc du Moulin de Messo, 91882 Massy Cedex, France, Telephone: (33)1 69 33 71 00, Fax: (33)1 69 33 71 10, Email: info@hamamatsu.fr
United Kingdom: Hamamatsu Photonics UK Limited: J Howard Court, ST Teun Road, Welwyn Garden City, Hertfordshire, AL7 1BN, United Kingdom, Telephone: (44)707-294888, Fax: (44)707-325777, Email: info@hamamatsu.co.uk
North Europe: Hamamatsu Photonics Norden AB: Tennhammargatan 35 16440 Kista, Sweden, Telephone: (46)8-509 031 00, Fax: (46)8-509 031 01, Email: info@hamamatsu.se
Italy: Hamamatsu Photonics Italia S.r.l.: Stradella della Mula, 1 int. A, 20020 Anese (Milano), Italy, Telephone: (39)02-93 58 17 33, Fax: (39)02-93 58 17 41, Email: info@hamamatsu.it
China: Hamamatsu Photonics (China) Co., Ltd.: 81201, Jinding Center, No.27 Dongzihe 4th Road, Chaoyang District, 100022 Beijing, P.R.China, Telephone: (86)10-6586-6000, Fax: (86)10-6586-2866, Email: hpc@hamamatsu.com.cn
Taiwan: Hamamatsu Photonics Taiwan Co., Ltd.: B1F-3, No. 156, Section 2, Gongdiao 5th Road, East District, Hsinchu, 300, Taiwan R.O.C., Telephone: (886)3-659-0000, Fax: (886)3-659-0001, Email: info@hamamatsu.com.tw