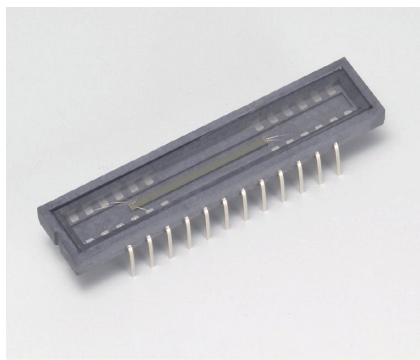


# CMOS linear image sensor



S10077

**Digital output, built-in 8/10-bit A/D converter, single power supply operation**

The S10077 is a CMOS linear image sensor designed for image input applications. The signal processing circuit has a charge amplifier with excellent input/output characteristics. The circuit also includes a 8-bit/10-bit A/D converter.

## Features

- Pixel pitch: 14  $\mu\text{m}$   
Pixel height: 50  $\mu\text{m}$
- 1024 pixels
- Single power supply operation: 3.3 to 5 V
- 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: 1 MHz max.
- Spectral response range: 400 to 1000 nm
- Digital output
- 8-bit/10-bit switchable ADC
- Simultaneous all-pixel integration and variable integration time function
- Low power consumption

## Applications

- Analytical instruments
- Position detection
- Image reading

## Structure

| Parameter                  | Specification                | Unit          |
|----------------------------|------------------------------|---------------|
| Number of pixels           | 1024                         | -             |
| Pixel pitch                | 14                           | $\mu\text{m}$ |
| Pixel height               | 50                           | $\mu\text{m}$ |
| Photosensitive area length | 14.336                       | mm            |
| Package                    | LCP (liquid crystal polymer) | -             |
| Window material            | Tempax                       | -             |

## Absolute maximum ratings

| Parameter                  | Symbol | Condition | Value      | Unit |
|----------------------------|--------|-----------|------------|------|
| Supply voltage             | Vdd    | Ta=25 °C  | -0.3 to +6 | V    |
| A/D mode selection voltage | Vsel   | Ta=25 °C  | -0.3 to +6 | V    |
| Clock pulse voltage        | V(CLK) | Ta=25 °C  | -0.3 to +6 | V    |
| Start pulse voltage        | V(ST)  | Ta=25 °C  | -0.3 to +6 | V    |
| Operating temperature*1    | Topr   |           | -5 to +50  | °C   |
| Storage temperature*1      | Tstg   |           | -10 to +60 | °C   |

\*1: No condensation

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.

### Recommended terminal voltage

| Parameter                 |            | Symbol | Min.       | Typ. | Max.       | Unit |
|---------------------------|------------|--------|------------|------|------------|------|
| Supply voltage            |            | Vdd    | 3.3        | 5    | 5.25       | V    |
| AD mode selection voltage | 8-bit      | Vsel   | 0          | -    | 0.4        | V    |
|                           | 10-bit     |        | Vdd - 0.25 | Vdd  | Vdd + 0.25 | V    |
| Clock pulse voltage       | High level | V(CLK) | Vdd - 0.25 | Vdd  | Vdd + 0.25 | V    |
|                           | Low level  |        | 0          | -    | 0.4        | V    |
| Start pulse voltage       | High level | V(ST)  | Vdd - 0.25 | Vdd  | Vdd + 0.25 | V    |
|                           | Low level  |        | 0          | -    | 0.4        | V    |

### Electrical characteristics (Ta=25 °C)

| Parameter                            |            | Symbol   | Min. | Typ.      | Max. | Unit |
|--------------------------------------|------------|----------|------|-----------|------|------|
| Clock pulse frequency                | 8-bit      | f(CLK)   | 1 M  | -         | 12 M | Hz   |
|                                      | 10-bit     |          | 1 M  | -         | 6 M  |      |
| Video data rate                      |            | VR       | -    | f(CLK)/12 | -    | Hz   |
| Digital output rise time (10 to 90%) | CL=10 pF*2 | tr       | -    | -         | 30   | ns   |
|                                      | CL=30 pF*2 |          | -    | -         | 60   |      |
| Digital output fall time (90 to 10%) | CL=10 pF*2 | tf       | -    | -         | 30   | ns   |
|                                      | CL=30 pF*2 |          | -    | -         | 60   |      |
| Current consumption                  | Vdd=3.3 V  | 8-bit*3  | -    | 12        | -    | mA   |
|                                      |            | 10-bit*4 | -    | 10        | -    |      |
|                                      | Vdd=5 V    | 8-bit*3  | -    | 16        | -    |      |
|                                      |            | 10-bit*4 | -    | 14        | -    |      |

\*2: CL=Load capacitance of digital output terminal

\*3: f(CLK)=12 MHz

\*4: f(CLK)=6 MHz

### Electrical and optical characteristics (Ta=25 °C)

| Parameter                         |           |          | Symbol      | Min.        | Typ. | Max. | Unit     |
|-----------------------------------|-----------|----------|-------------|-------------|------|------|----------|
| Spectral response range           |           |          | $\lambda$   | 400 to 1000 |      |      | nm       |
| Peak sensitivity wavelength       |           |          | $\lambda_p$ | -           | 700  | -    | nm       |
| Photosensitivity*5                |           |          | R           | -           | 30   | -    | V/lx · s |
| Dark output*6                     | Vdd=3.3 V | 8-bit*7  | Dd          | -           | 0.04 | 0.6  | digit    |
|                                   |           | 10-bit*8 |             | -           | 0.16 | 2.4  |          |
|                                   | Vdd=5 V   | 8-bit*7  |             | -           | 0.03 | 0.6  |          |
|                                   |           | 10-bit*8 |             | -           | 0.12 | 2.4  |          |
|                                   |           |          |             |             |      |      |          |
| Saturation output*9               | Vdd=3.3 V | 8-bit*7  | Dsat        | 255         | -    | -    | digit    |
|                                   |           | 10-bit*8 |             | 1023        | -    | -    |          |
|                                   | Vdd=5 V   | 8-bit*7  |             | 255         | -    | -    |          |
|                                   |           | 10-bit*8 |             | 1023        | -    | -    |          |
|                                   |           |          |             |             |      |      |          |
| Readout noise                     | Vdd=3.3 V | 8-bit*7  | Nr          | -           | 0.7  | 2    | digit    |
|                                   |           | 10-bit*8 |             | -           | 2.8  | 8    |          |
|                                   | Vdd=5 V   | 8-bit*7  |             | -           | 0.7  | 2    |          |
|                                   |           | 10-bit*8 |             | -           | 2.8  | 8    |          |
|                                   |           |          |             |             |      |      |          |
| Offset output                     | Vdd=3.3 V | 8-bit*7  | Do          | 11          | 29   | 41   | digit    |
|                                   |           | 10-bit*8 |             | 44          | 116  | 164  |          |
|                                   | Vdd=5 V   | 8-bit*7  |             | 7           | 19   | 27   |          |
|                                   |           | 10-bit*8 |             | 28          | 76   | 108  |          |
|                                   |           |          |             |             |      |      |          |
| Photoresponse nonuniformity*5 *10 |           |          | PRNU        | -           | -    | ±10  | %        |

\*5: Measured with a tungsten lamp of 2856 K

\*6: Integration time Ts=10 s

\*7: f(CLK)=12 MHz

\*8: f(CLK)=6 MHz

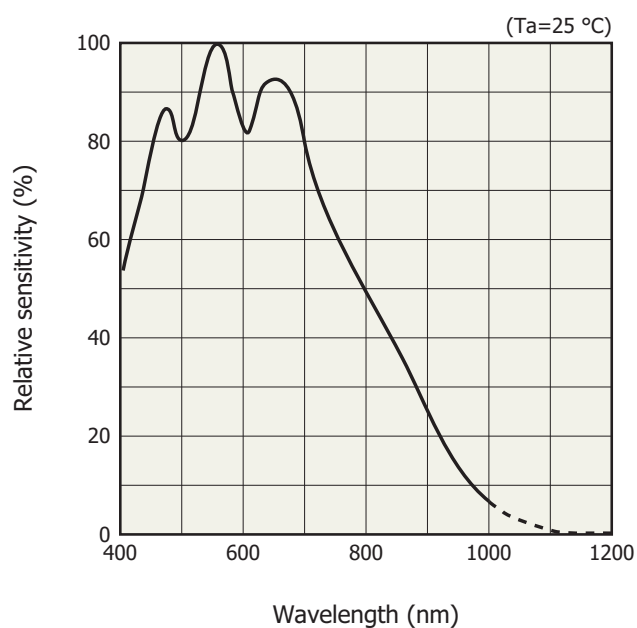
\*9: Absolute value with respect to 0 digit

\*10: 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:

$$\text{PRNU} = \Delta X / X \times 100 (\%)$$

X: average output of all pixels,  $\Delta X$ : difference between X and maximum or minimum output

### ▣ Spectral response (typical example)



### ▣ A/D converter specifications (Ta=25 °C)

| Parameter                   |             | Symbol | Specification | Unit |
|-----------------------------|-------------|--------|---------------|------|
| Digital output format       |             | -      | Serial output | -    |
| Resolution*11               | 8-bit mode  | RESO   | 8             | bit  |
|                             | 10-bit mode |        | 10            |      |
| Conversion voltage range*12 | Vdd=3.3 V   | -      | 0 to 2.2      | V    |
|                             | Vdd=5 V     |        | 0 to 3.3      |      |

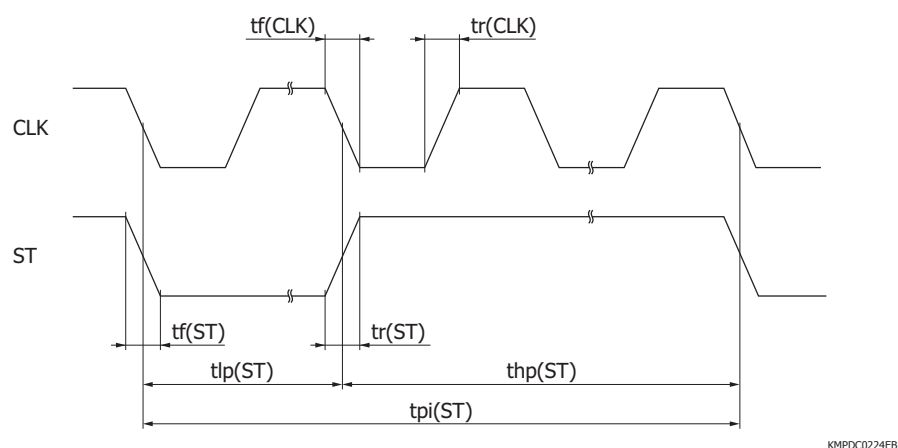
\*11: Vsel=0 V (8-bit mode), Vdd (10-bit mode)

\*12: Digital output is available from MSB as serial output.

8-bit mode: D7 to D0

10-bit mode: D9 to D0

## Timing Chart



| Parameter                              | Symbol               | Min.           | Typ. | Max.            | Unit |
|----------------------------------------|----------------------|----------------|------|-----------------|------|
| Start pulse interval                   | $t_{pi}(ST)$         | $12339/f(CLK)$ | -    | $120000/f(CLK)$ | s    |
| Start pulse low period                 | $t_{lp}(ST)$         | $45/f(CLK)$    | -    | -               | s    |
| Start pulse high period <sup>*13</sup> | $t_{hp}(ST)$         | $6000/f(CLK)$  | -    | -               | s    |
| Start pulse rise and fall times        | $t_r(ST), t_f(ST)$   | 0              | 20   | 30              | ns   |
| Clock pulse duty                       | -                    | 40             | 50   | 60              | %    |
| Clock pulse rise and fall times        | $t_r(CLK), t_f(CLK)$ | 0              | 20   | 30              | ns   |

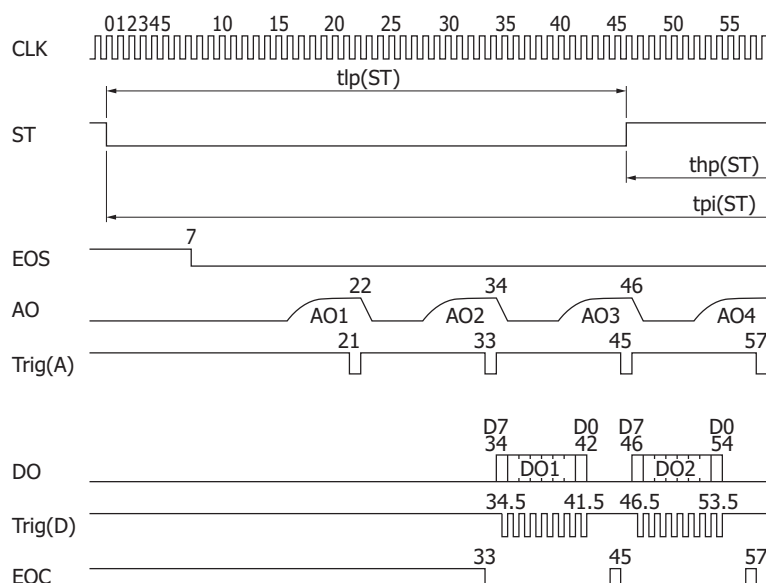
<sup>\*13</sup>: Signal charge integration time equals the high period of start pulse + 7 CLK cycles.

The shift register operation starts at the fall of CLK pulse immediately after ST pulse sets to low.

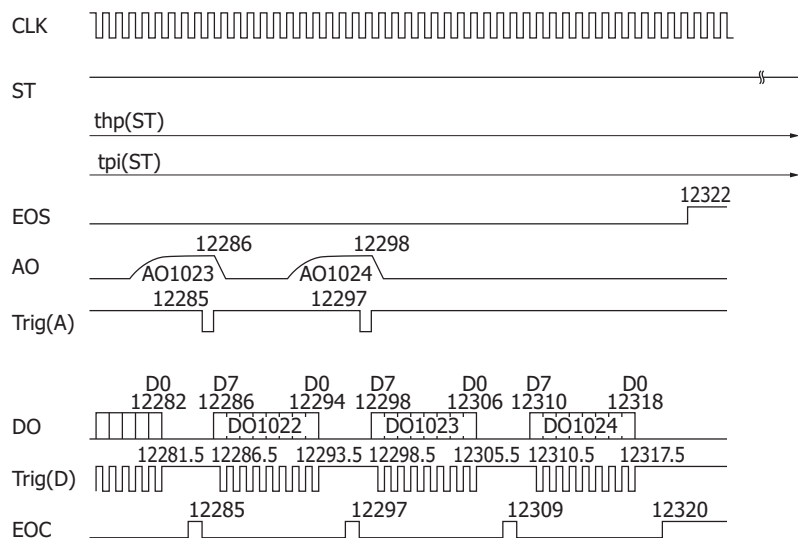
Integration time can be changed by changing the high-to-low ratio of ST pulses.

## 8-bit mode

## ■ In the neighborhood of start pixel



## ■ In the neighborhood of last pixel

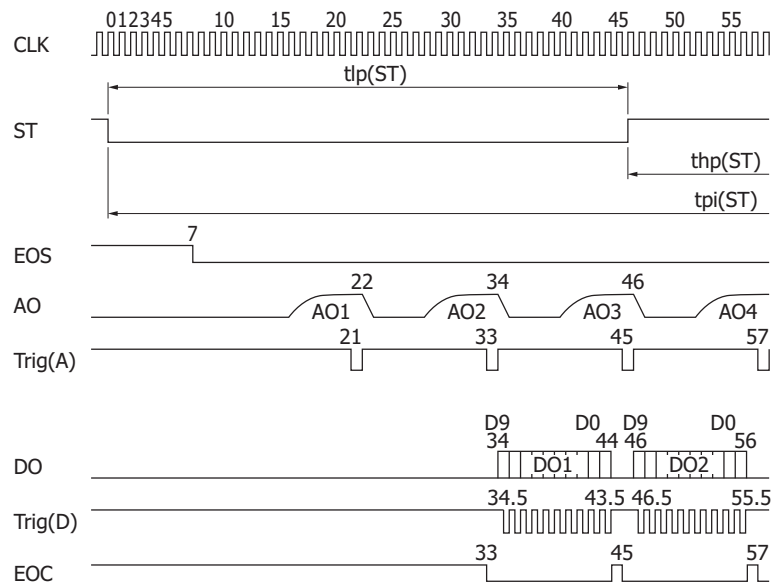


KMPC0225EB

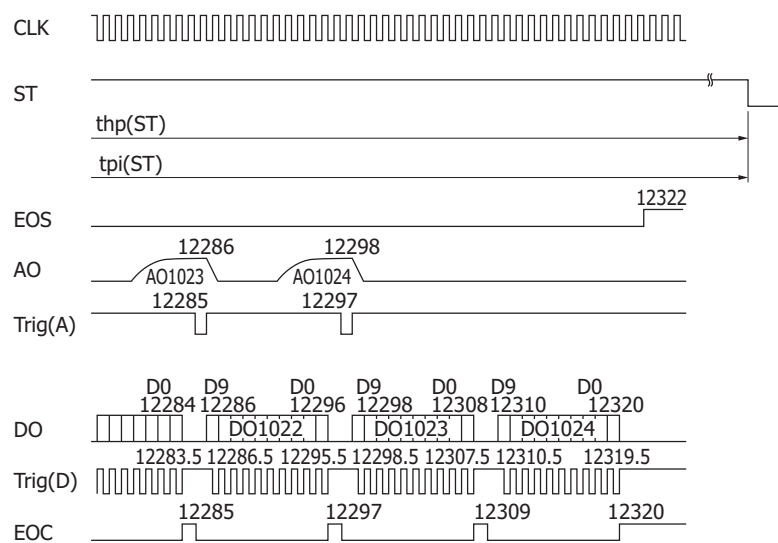
Note: When using analog output AO, read the AO output at the falling edge of Trig(A).  
When using digital output DO, read the DO output at the falling edge of Trig(D).

## 10-bit mode

## ■ In the neighborhood of start pixel

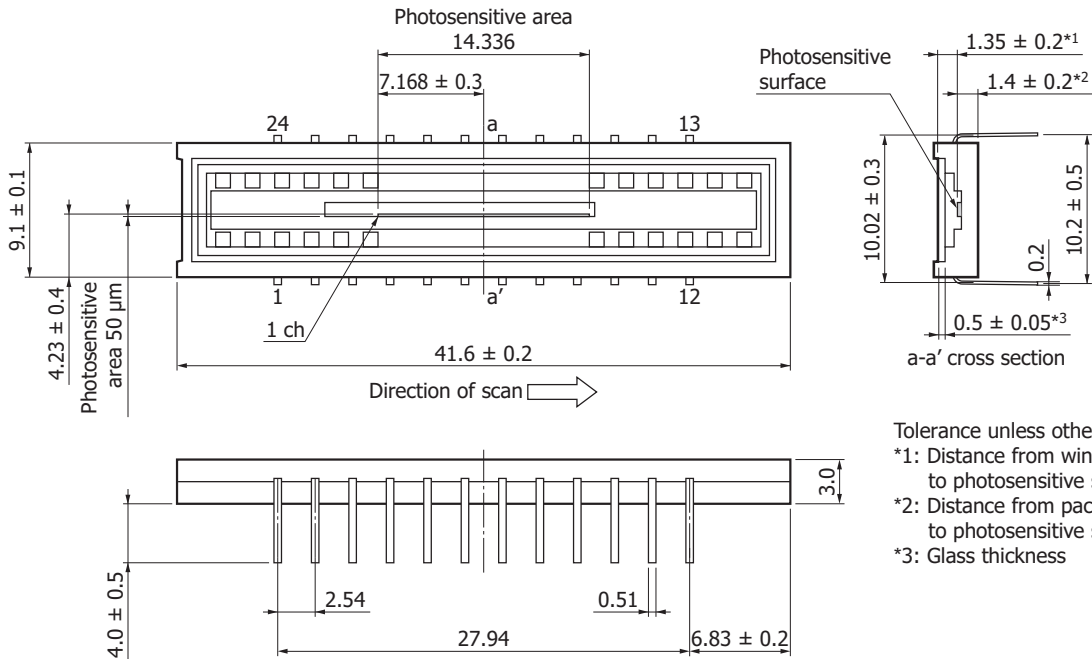


## ■ In the neighborhood of last pixel



KMPC0226EB

### Dimensional outline (unit: mm)



KMPDA0202EE

### Pin connections

| Pin no. | Symbol | I/O | Discription                       | Pin no. | Symbol | I/O | Discription                   |
|---------|--------|-----|-----------------------------------|---------|--------|-----|-------------------------------|
| 1       | NC     |     | No connection                     | 13      | NC     |     | No connection                 |
| 2       | D.Trig | O   | Trigger signal for digital output | 14      | NC     |     | No connection                 |
| 3       | DO     | O   | Digital output                    | 15      | NC     |     | No connection                 |
| 4       | A.Trig | O   | Trigger signal for analog output  | 16      | EOS    | O   | End of scan signal            |
| 5       | AO     | O   | Analog output                     | 17      | EOC    | O   | Digital conversion end signal |
| 6       | NC     |     | No connection                     | 18      | NC     |     | No connection                 |
| 7       | NC     |     | No connection                     | 19      | Vsel   | I   | A/D mode selection voltage    |
| 8       | Vdd    | I   | Supply voltage                    | 20      | Vss    | I   | GND                           |
| 9       | Vss    | I   | GND                               | 21      | Vdd    | I   | Supply voltage                |
| 10      | NC     |     | No connection                     | 22      | CLK    | I   | Clock signal                  |
| 11      | NC     |     | No connection                     | 23      | ST     | I   | Start signal                  |
| 12      | NC     |     | No connection                     | 24      | NC     |     | No connection                 |

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

When using the analog output terminal, connect a buffer amplifier for impedance conversion to it so as to minimize the current flow. As the buffer amplifier, use a high input impedance operational amplifier with JFET or CMOS input.

## ■ 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) Incident window

If dust or dirt gets on the light incident 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.

## ■ Related information

[www.hamamatsu.com/sp/ssd/doc\\_en.html](http://www.hamamatsu.com/sp/ssd/doc_en.html)

### ■ Precautions

- Notice
- Image sensors/Precautions

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