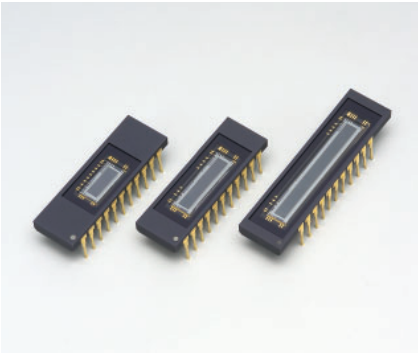
HAMAMATSU

# CMOS linear image sensors



S10111 to S10114 series

## Current-output type sensors with variable integration time function

The S10111 to S10114 series are self-scanning photodiode arrays designed specifically as detectors for spectroscopy. The scanning circuit operates at low power consumption and is easy to handle. Each photodiode has a large active area with high UV sensitivity.

### Features

- **Variable integration time for each pixel**
- **Wide active area**
  **Pixel pitch: 50 µm, 25 µm**
  **Pixel height: 2.5 mm, 0.5 mm**
- **High UV sensitivity**
- **Large saturation output charge**

### Applications

- **Spectrophotometry**

### Absolute maximum ratings

| Parameter | Symbol | Condition | Value | Unit |
|---|---|---|---|---|
| Supply voltage | Vdd | 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 |
| Integration time control pulse | V(INT) | Ta=25 °C | -0.3 to +6 | V |
| Overflow gate voltage | Vofg | Ta=25 °C | -0.3 to +6 | V |
| Overflow drain voltage | Vofd | Ta=25 °C | -0.3 to +6 | V |
| Operating temperature*1 | Topr | | -5 to +65 | °C |
| Storage temperature*1 | Tstg | | -10 to +85 | °C |

*1: No condensation

### Shape specifications

| Type no. | Number of pixels | Pixel pitch (µm) | Pixel height (mm) | Package | Window material | Weight (g) |
|---|---|---|---|---|---|---|
| S10111-128Q | 128 | 50 | 2.5 | Ceramic | Quartz (t=0.5 mm) | 3.0 |
| S10111-256Q | 256 | | | | | |
| S10111-512Q | 512 | | | | | 3.5 |
| S10112-128Q | 128 | | 0.5 | | | 3.0 |
| S10112-256Q | 256 | | | | | |
| S10112-512Q | 512 | | | | | 3.5 |
| S10113-256Q | 256 | 25 | 0.5 | | | 3.0 |
| S10113-512Q | 512 | | | | | |
| S10113-1024Q | 1024 | | | | | 3.5 |
| S10114-256Q | 256 | | 2.5 | | | 3.0 |
| S10114-512Q | 512 | | | | | |
| S10114-1024Q | 1024 | | | | | 3.5 |

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

| 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 | - | 0.4 | |
| Start pulse voltage | High level | V(ST) | Vdd - 0.25 | Vdd | Vdd + 0.25 | V |
| | Low level | | 0 | - | 0.4 | |
| Integration time control pulse voltage | High level | V(INT) | Vdd - 0.25 | Vdd | Vdd + 0.25 | V |
| | Low level | | 0 | - | 0.4 | |
| Overflow drain voltage | | Vofd | 0.5 | 2 | 2.5 | V |
| Overflow gate voltage | | Vofg | 0.17 | 0.2 | 0.23 | V |

## Electrical characteristics [Ta=25 °C, Vdd=5 V, Vb=Vofd=2 V, Vofg=0.2 V]

| Parameter | | Symbol | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| Clock pulse frequency | S10111/S10114 series | f(CLK) | 10 k | - | 250 k | Hz |
| | S10112/S10113 series | | 10 k | - | 500 k | |
| Video data rate | | VR | - | f(CLK) | - | Hz |
| Power consumption*2 | S10111-128Q | P | - | 0.75 | - | mW |
| | S10111-256Q | | - | 1.75 | - | |
| | S10111-512Q | | - | 4.25 | - | |
| | S10112-128Q | | - | 1.5 | - | |
| | S10112-256Q | | - | 3.5 | - | |
| | S10112-512Q | | - | 8.25 | - | |
| | S10113-256Q | | - | 3.25 | - | |
| | S10113-512Q | | - | 7.25 | - | |
| | S10113-1024Q | | - | 18.25 | - | |
| | S10114-256Q | | - | 1.75 | - | |
| | S10114-512Q | | - | 3.75 | - | |
| | S10114-1024Q | | - | 8.25 | - | |
| Video line capacitance (Vb=2 V) | S10111/S10112-128Q | Cv | - | 10 | - | pF |
| | S10111/S10112-256Q | | - | 14 | - | |
| | S10111/S10112-512Q | | - | 22 | - | |
| | S10113/S10114-256Q | | - | 13 | - | |
| | S10113/S10114-512Q | | - | 19 | - | |
| | S10113/S10114-1024Q | | - | 32 | - | |

*2: f(CLK)=250 kHz (S10111/S10114 series), 500 kHz (S10112/S10113 series)

## Electrical and optical characteristics [Ta=25 °C, Vdd=5 V, Vb=Vofd=2 V, Vofg=0.2 V, f(CLK)=200 kHz]

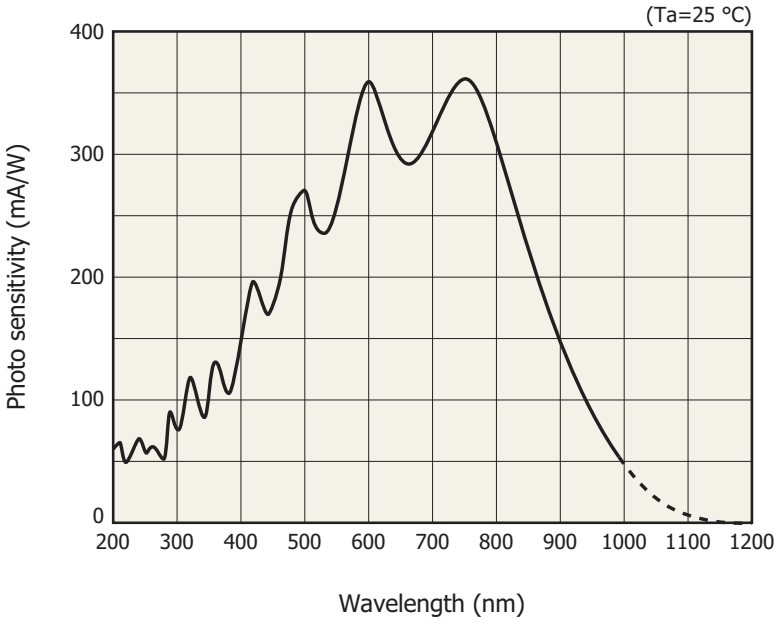
| Parameter | | Symbol | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| Spectral response range | | λ | 200 | - | 1000 | nm |
| Peak sensitivity wavelength | | λp | - | 750 | - | nm |
| Dark current | S10111 series | ID | - | 0.2 | 0.6 | pA |
| | S10112 series | | - | 0.04 | 0.12 | |
| | S10113 series | | - | 0.04 | 0.12 | |
| | S10114 series | | - | 0.2 | 0.6 | |
| Saturation output charge | S10111 series | Qsat | 110 | 140 | - | pC |
| | S10112 series | | 22 | 28 | - | |
| | S10113 series | | 11 | 14 | - | |
| | S10114 series | | 55 | 70 | - | |
| Saturation exposure*3 | | Esat | | 580 | | $mlx \cdot s$ |
| Photo response non-uniformity*3 *4 *5 | | PRNU | - | - | ±3 | % |

*3: Measured with a tungsten lamp of 2856 K

*4: Photo response non-uniformity is defined under the condition that the device is uniformly illuminated by light which is 50 % of the saturation exposure level as follows:
PRNU= ΔX/X × 100 (%)
X: the average output of all pixels, ΔX: difference between X and maximum or minimum output.

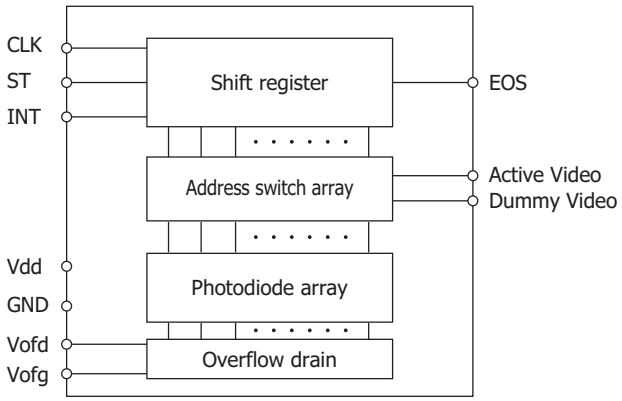
*5: Except for the first and last pixels

## Spectral response (typical example)




KMPDB0250ED

## Block diagram

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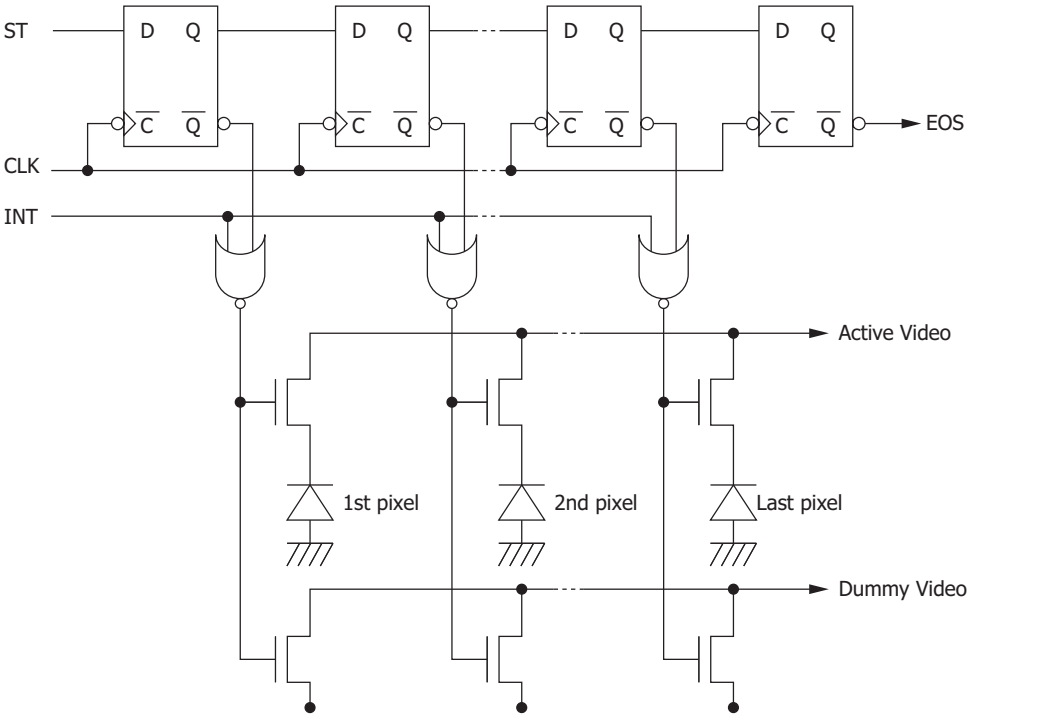
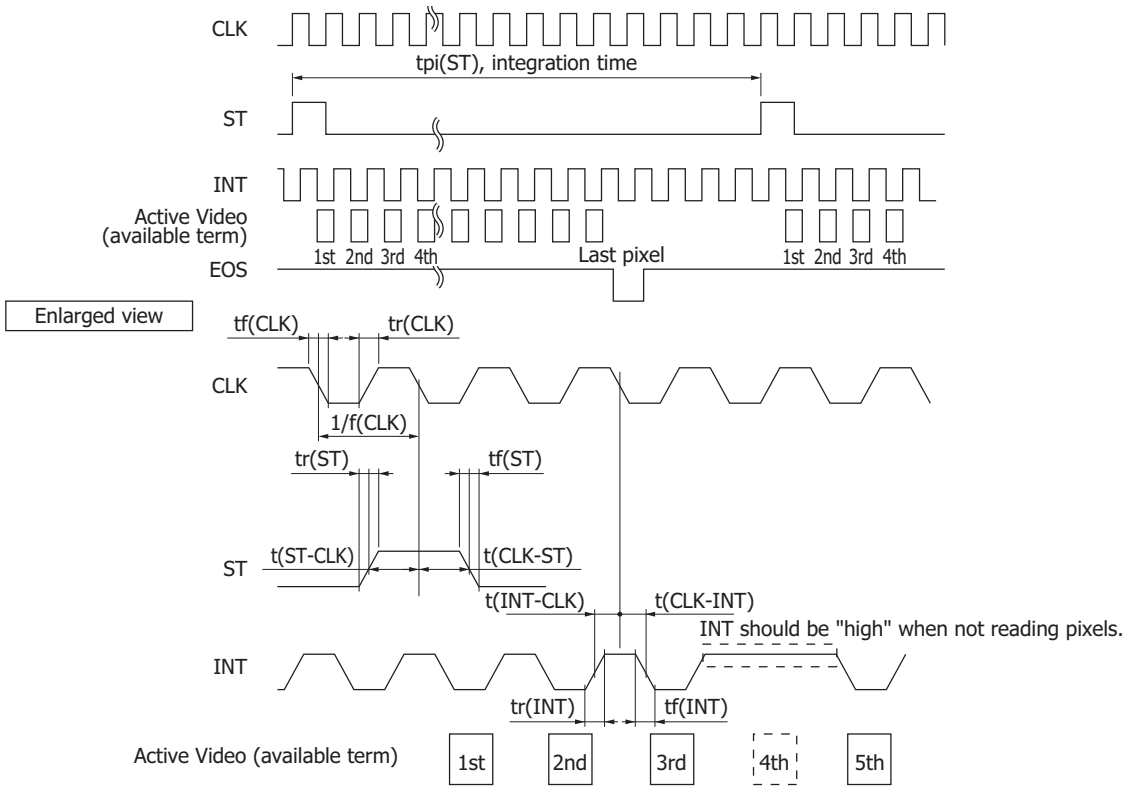
## Equivalent circuit




KMPDC0279EB

## Timing chart




Allow CLK pulse transition from "high" to "low" only one time while ST pulse is "high".
Integration time is determined by the interval between start pulses.

Only the switching noise component is output from the Dummy Video line.
Do not use the Dummy Video output during integration readout.
The INT signal is not needed between EOS and the rising edge of the next ST signal.

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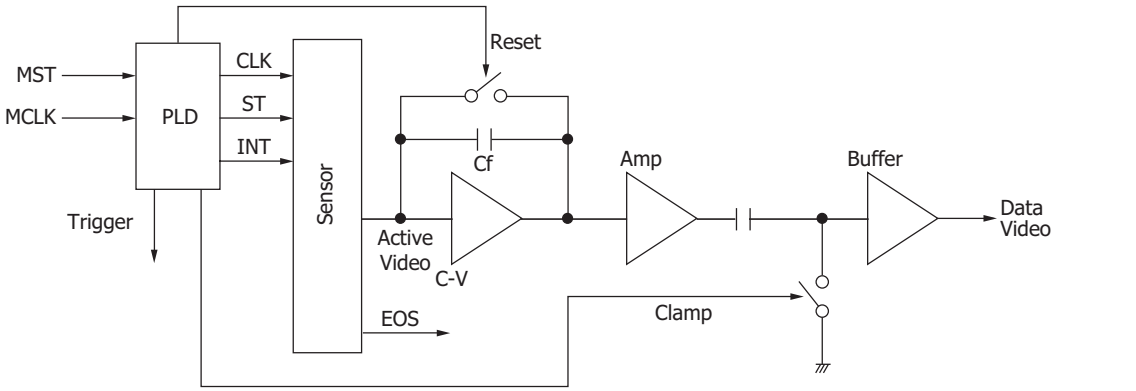
| Parameter | | Symbol | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| Start pulse (ST) interval | S1011*-128 | tpi(ST) | 130/f(CLK) | - | - | s |
| | S1011*-256 | | 258/f(CLK) | - | - | |
| | S1011*-512 | | 514/f(CLK) | - | - | |
| | S1011*-1024 | | 1026/f(CLK) | - | - | |
| INT pulse rise and fall times | | tr(INT), tf(INT) | 0 | 20 | 30 | ns |
| INT pulse - clock pulse timing | | t(INT-CLK) | 30 | - | 1 / [2 × f(CLK)] | ns |
| Clock pulse - INT pulse timing | | t(CLK-INT) | 30 | - | 1 / [2 × f(CLK)] | ns |
| Start pulse rise and fall times | | tf(ST), tr(ST) | 0 | 20 | 30 | ns |
| Clock pulse duty ratio | | - | 40 | 50 | 60 | % |
| Clock pulse rise and fall times | | tf(CLK), tr(CLK) | 0 | 20 | 30 | ns |
| Clock pulse - start pulse timing | | t(CLK-ST) | 20 | - | - | ns |
| Start pulse - clock pulse timing | | T(ST-CLK) | 20 | - | - | ns |

## Current-integration readout circuit example and timing chart

### Readout circuit example

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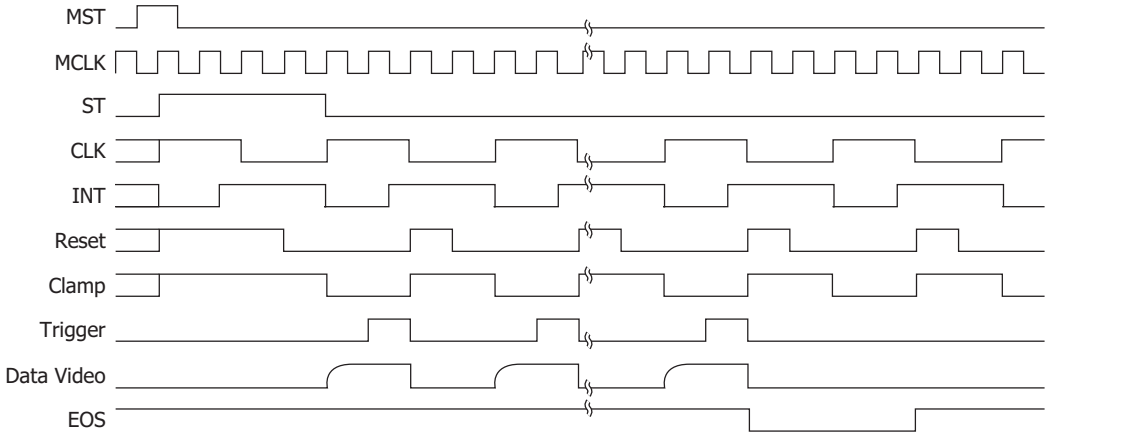
### Timing chart

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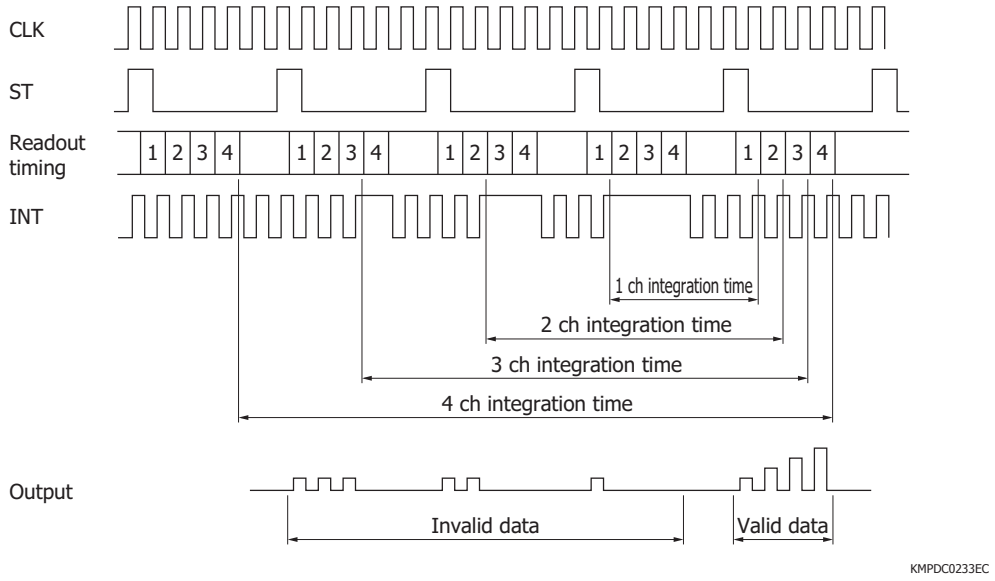
## Variable integration time function

By controlling the clock pulse to the INT terminal, the integration time for each pixel can be changed to any length that is an integer multiple of one readout period. When the clock pulse at the INT terminal is set to "high" at the pixel signal readout timing, then no signal is output from that pixel (see below). This allows the signal charge to continuously accumulate in that pixel as long as no signal is output. For example, when the integration time of one readout period is 100 ms and this function is used to output a signal from a pixel once every 3 readout periods, then the integration time of that pixel will be 300 ms. Using this function to lengthen the integration time of certain pixels makes it possible to effectively detect spectral signals of weak wavelength components.

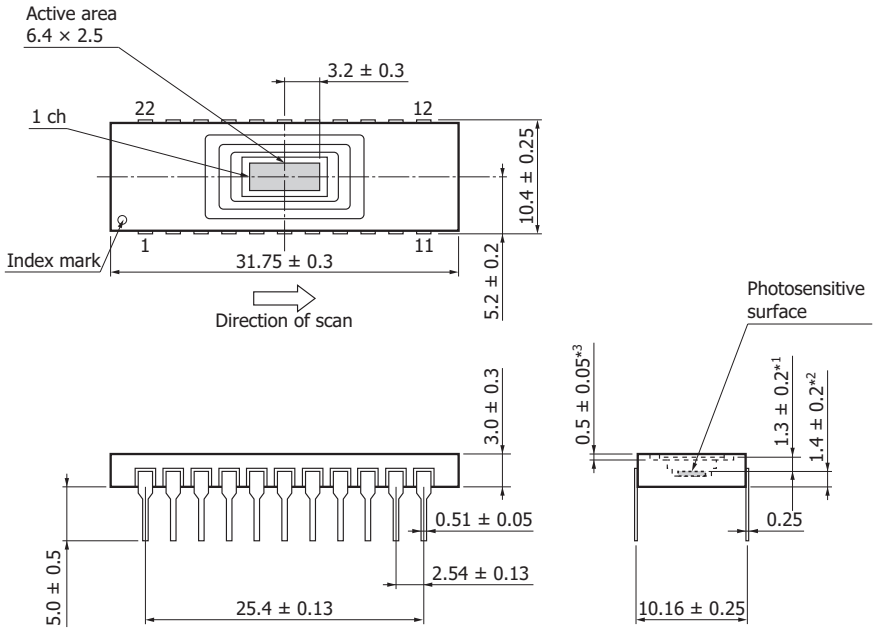
■ Timing chart

(Concept view showing the settings to double, triple and quadruple the integration times at channels 2, 3 and 4, respectively, by using the variable integration time function on the basis of the integration time at channel 1.)



## Dimensional outlines (unit: mm)

S10111-128Q, S10114-256Q




*1: Distance from upper surface of quartz window to chip surface
*2: Distance from photosensitive surface to bottom of package
*3: Window thickness

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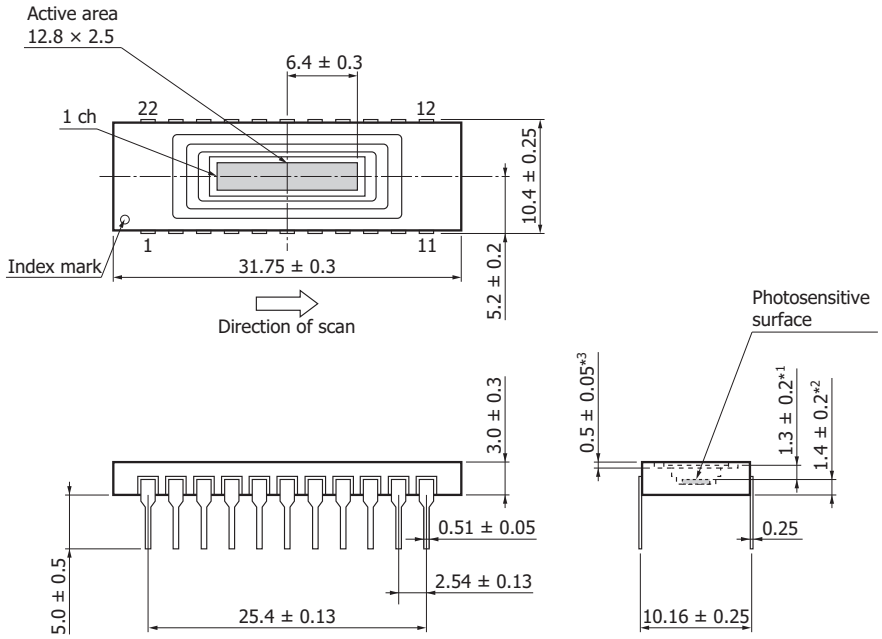
S10111-256Q, S10114-512Q




*1: Distance from upper surface of quartz window to chip surface
*2: Distance from photosensitive surface to bottom of package
*3: Window thickness

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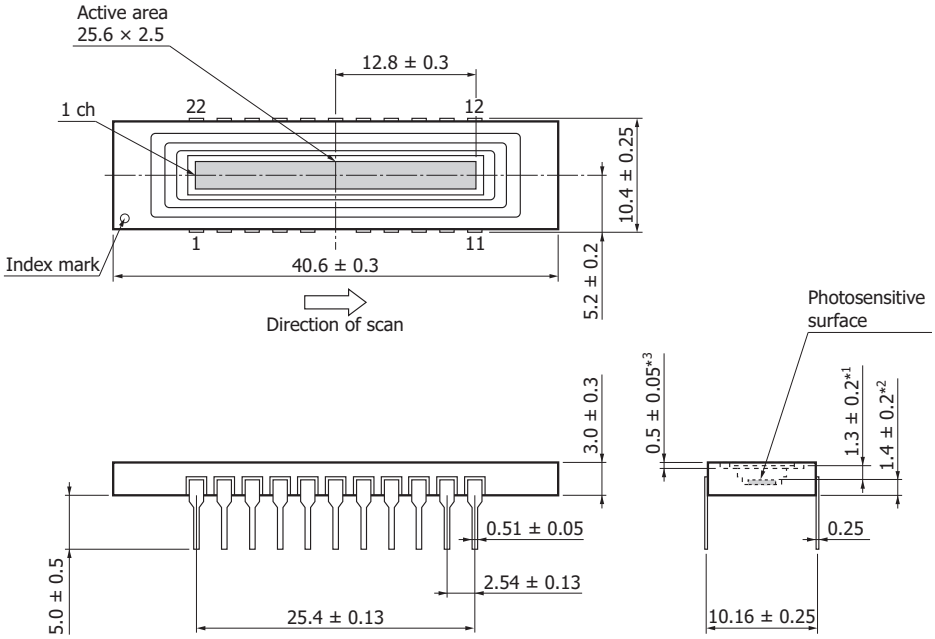
## S10111-512Q, S10114-1024Q




*1: Distance from upper surface of quartz window to chip surface
*2: Distance from photosensitive surface to bottom of package
*3: Window thickness

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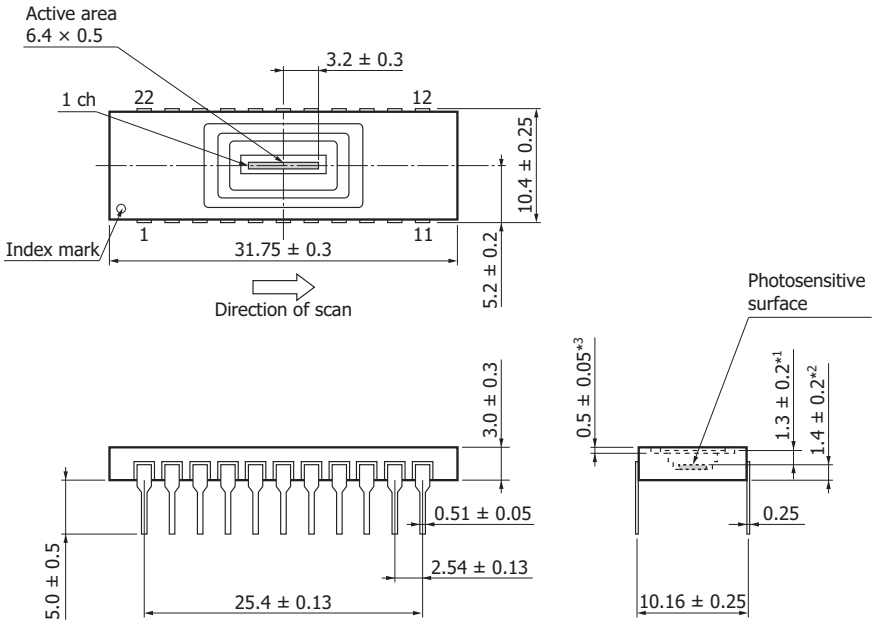
## S10112-128Q, S10113-256Q




*1: Distance from upper surface of quartz window to chip surface
*2: Distance from photosensitive surface to bottom of package
*3: Window thickness

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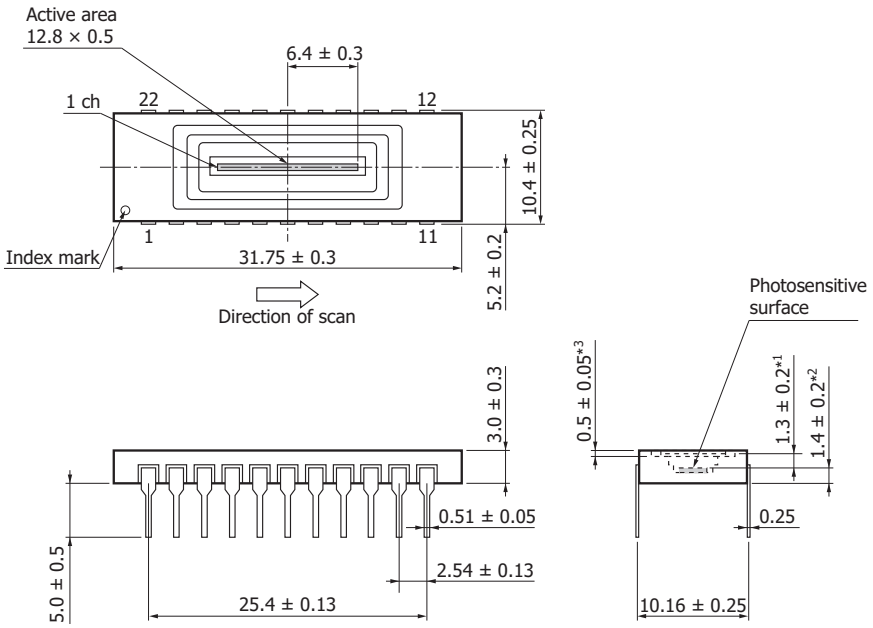
## S10112-256Q, S10113-512Q




*1: Distance from upper surface of quartz window to chip surface
*2: Distance from photosensitive surface to bottom of package
*3: Window thickness

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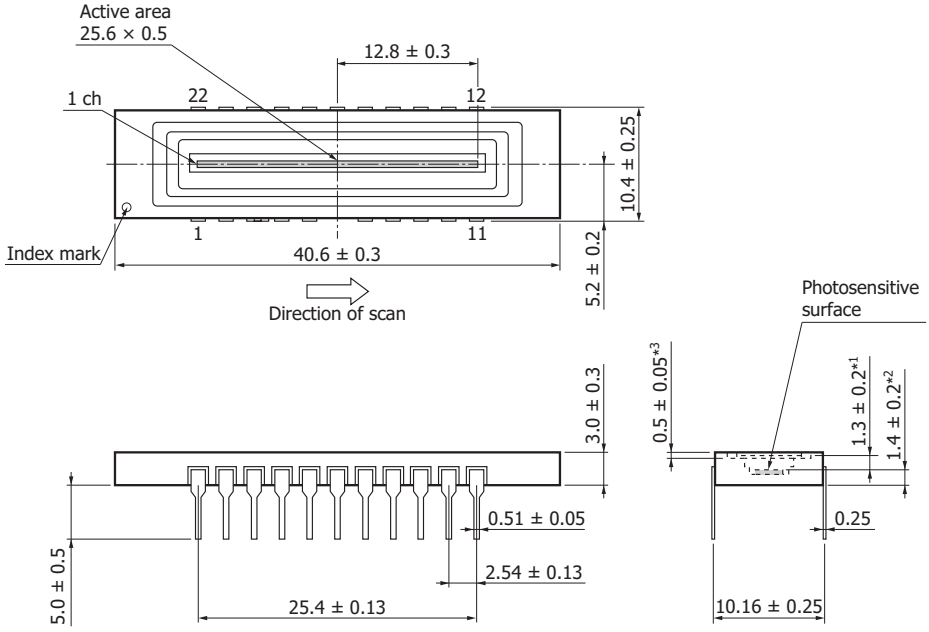
## S10112-512Q, S10113-1024Q




*1: Distance from upper surface of quartz window to chip surface
*2: Distance from photosensitive surface to bottom of package
*3: Window thickness

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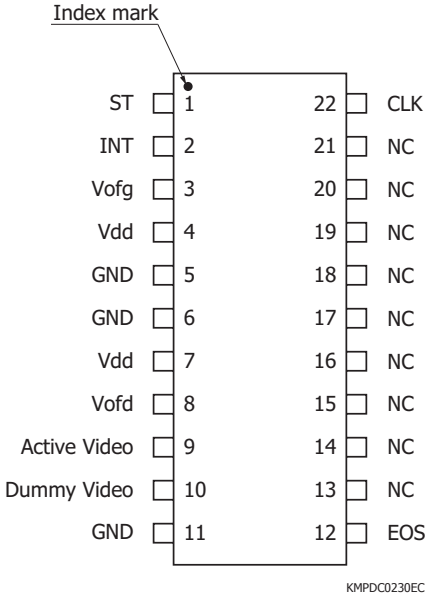
## Pin connection




| Pin no. | Symbol | Name of pin | I/O |
|---|---|---|---|
| 1 | ST | Start pulse | Input |
| 2 | INT | Integration time control pulse | Input |
| 3 | Vofg | Overflow gate voltage | Input |
| 4 | Vdd | Supply voltage | Input |
| 5 | GND | Ground | Input |
| 6 | GND | Ground | Input |
| 7 | Vdd | Supply voltage | Input |
| 8 | Vofd | Overflow drain voltage | Input |
| 9 | Active Video | Video output | Output |
| 10 | Dummy Video | Dummy video output | Output |
| 11 | GND | Ground | Input |
| 12 | EOS | End of scan | Output |
| 13 | NC | No connection | |
| 14 | NC | | |
| 15 | NC | | |
| 16 | NC | | |
| 17 | NC | | |
| 18 | NC | | |
| 19 | NC | | |
| 20 | NC | | |
| 21 | NC | | |
| 22 | CLK | Clock pulse | Input |

## 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) 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.



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