HAMAMATSU

PHOTON IS OUR BUSINESS

NEW

# CMOS linear image sensors

## S11637/S12198 series

## Built-in electronic shutter function and gain switching function

The S11637/S12198 series are CMOS linear image sensors with electronic shutter function and gain switching function. The S11637 series has a pixel pitch that is one-half that of our previous type (S10453 series).

## Features

- **Electronic shutter function**
- **Gain switching function**
- **Pixel size:**
  **S11637 series: 12.5 × 500 μm**
  **S12198 series: 25 × 500 μm**
- **Readout speed: 10 MHz max.**
- **Voltage output type**
- **5 V single power supply operation**
- **Simultaneous charge integration for all pixels**
- **Built-in timing generator allows operation with only start and clock pulse inputs.**
- **Spectral response range: 200 to 1000 nm**

## Applications

- **Spectrophotometers**
- **Image reading**

## Structure

| Parameter | S11637-1024Q | S11637-2048Q | S12198-512Q | S12198-1024Q | Unit |
|---|---|---|---|---|---|
| Number of total pixels | 1024 | 2048 | 512 | 1024 | - |
| Number of effective pixels | 1024 | 2048 | 512 | 1024 | - |
| Fill factor | 100 | | | | % |
| Pixel pitch | 12.5 | | 25 | | μm |
| Pixel height | 500 | | | | μm |
| Photosensitive area length | 12.8 | 25.6 | 12.8 | 25.6 | mm |
| Package | Ceramic | | | | - |
| Window material*1 *2 | Quartz (without AR coating) | | | | - |

*1: Resin sealing
*2: Refractive index=1.46

## Absolute maximum ratings

| Parameter | Symbol | Condition | Value | Unit |
|---|---|---|---|---|
| Supply voltage | Vdd | Ta=25 °C | -0.3 to +6 | V |
| Gain selection terminal voltage | Vg | 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*3 | Topr | | -5 to +65 | °C |
| Storage temperature*3 | Tstg | | -10 to +85 | °C |

*3: No dew condensation
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: 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 | 4.75 | 5 | 5.25 | V |
| Gain selection terminal voltage | High gain | Vg | 0 | - | 0.4 | V |
| | Low gain | | 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 |

## Input terminal capacitance

| Parameter | Symbol | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|
| Gain selection input terminal capacitance | C(Vg) | - | 5 | - | pF |
| Clock pulse input terminal capacitance | C(CLK) | - | 5 | - | pF |
| Start pulse input terminal capacitance | C(ST) | - | 5 | - | pF |

## Electrical characteristics

| Parameter | | Symbol | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| Clock pulse frequency | | f(CLK) | 200 k | - | 10 M | Hz |
| Video data rate | | VR | - | f(CLK) | - | Hz |
| Line rate | S11637-1024Q | LR | - | - | 9487 | lines/s |
| | S11637-2048Q | | - | - | 4812 | |
| | S12198-512Q | | - | - | 18450 | |
| | S12198-1024Q | | - | - | 9487 | |
| Output impedance | | Zo | - | 80 | - | Ω |
| Current consumption*4 | S11637-1024Q | I | - | 55 | 70 | mA |
| | S11637-2048Q | | - | 95 | 125 | |
| | S12198-512Q | | - | 32 | 40 | |
| | S12198-1024Q | | - | 46 | 61 | |

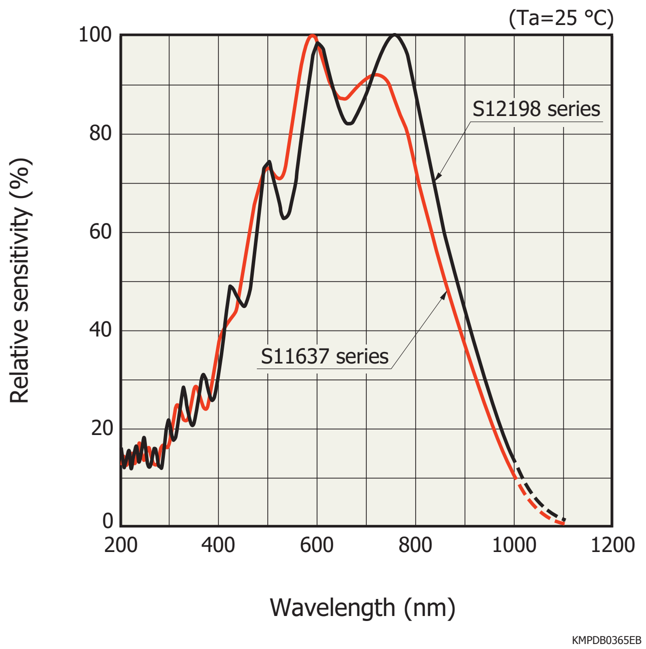
*4: Ta=25 °C, Vdd=V(ST)=5 V, f(CLK)=10 MHz, dark state

## Electrical and optical characteristics [Ta=25 °C, Vdd=5 V, V(CLK)=V(ST)=5 V, f(CLK)=10 MHz]

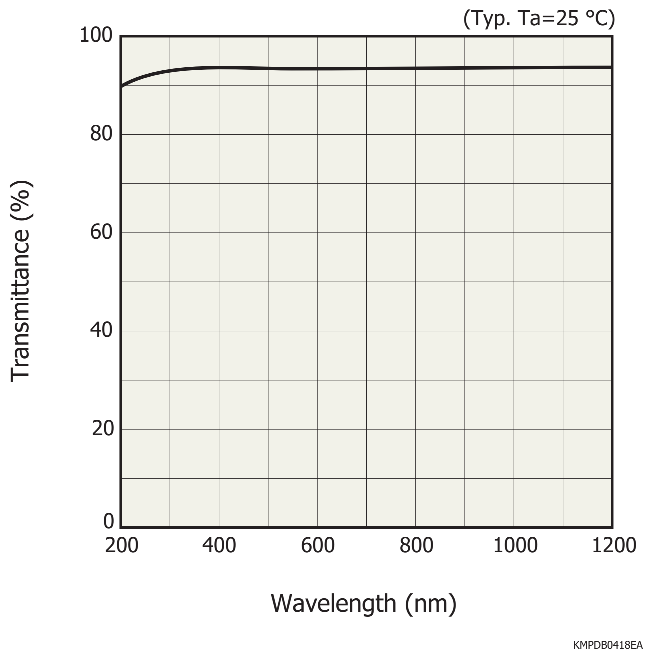
| Parameter | | Symbol | S11637 series | | | S12198 series | | | Unit |
|---|---|---|---|---|---|---|---|---|---|
| | | | Min. | Typ. | Max. | Min. | Typ. | Max. | |
| Spectral response range | | λ | 200 to 1000 | | | 200 to 1000 | | | nm |
| Peak sensitivity wavelength | | λp | - | 600 | - | - | 750 | - | nm |
| Photosensitivity*5 | High gain | S | 122 | 153 | - | 152 | 189 | - | V/(lx·s) |
| | Low gain | | 31 | 38 | - | 34 | 42 | - | |
| Conversion efficiency*6 | High gain | CE | 0.95 | 1.18 | - | 0.45 | 0.56 | - | µV/e⁻ |
| | Low gain | | 0.24 | 0.30 | - | 0.10 | 0.13 | - | |
| Output offset voltage | | Vo | 0.3 | 0.6 | 0.9 | 0.3 | 0.6 | 0.9 | V |
| Saturation charge | High gain | Qsat | - | 0.45 | - | - | 0.94 | - | pC |
| | Low gain | | - | 1.77 | - | - | 4.19 | - | |
| Dark output voltage*7 | High gain | Vd | - | 5 | 50 | - | 2.6 | 26 | mV |
| | Low gain | | - | 1.4 | 14 | - | 0.6 | 6 | |
| Dark output nonuniformity*7 *11 | | DSNU | - | - | ±200 | - | - | ±200 | % |
| Temperature coefficient of dark output | | ΔTd | - | 1.1 | - | - | 1.1 | - | times/°C |
| Saturation output voltage*8 | | Vsat | 2.7 | 3.3 | - | 2.7 | 3.3 | - | V |
| Saturation exposure | High gain | Esat | - | 22 | - | - | 17 | - | mlx·s |
| | Low gain | | - | 86 | - | - | 78 | - | |
| Readout noise | High gain | Nr | - | 1.5 | 2.5 | - | 1.1 | 2 | mV rms |
| | Low gain | | - | 0.7 | 1.2 | - | 0.6 | 1.1 | |
| Photoresponse nonuniformity*5 *9 | | PRNU | - | - | ±10 | - | - | ±10 | % |
| Dynamic range*10 | High gain | DR | - | 2200 | - | - | 3000 | - | - |
| | Low gain | | - | 4714 | - | - | 5500 | - | |

*5: Measured with a 2856 K tungsten lamp
*6: Output voltage generated per one electron
*7: Integration time=10 ms
*8: Voltage difference from Vo
*9: 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 pixels excluding pixels each at both ends, and is defined as follows:
PRNU = ΔX/X × 100 [%]
X: average output of all pixels, ΔX: difference between X and maximum output or minimum output
*10: DR=Vsat/Nr
*11: Dark output nonuniformity (DSNU) is the output nonuniformity of dark output voltage. DSNU is measured using pixels excluding pixels each at both ends, and is defined as follows:
DSNU = ΔY/Y × 100 [%]
Y: average dark output voltage of all pixels, ΔY: difference between Y and maximum dark output voltage or minimum dark output voltage

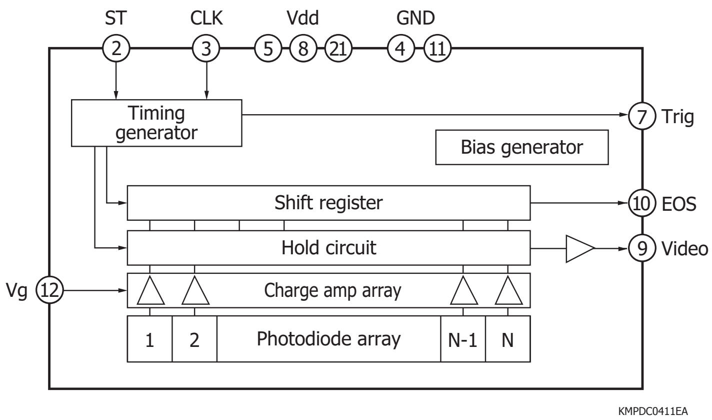
## Spectral response (typical example)




## Spectral transmittance characteristics of window material

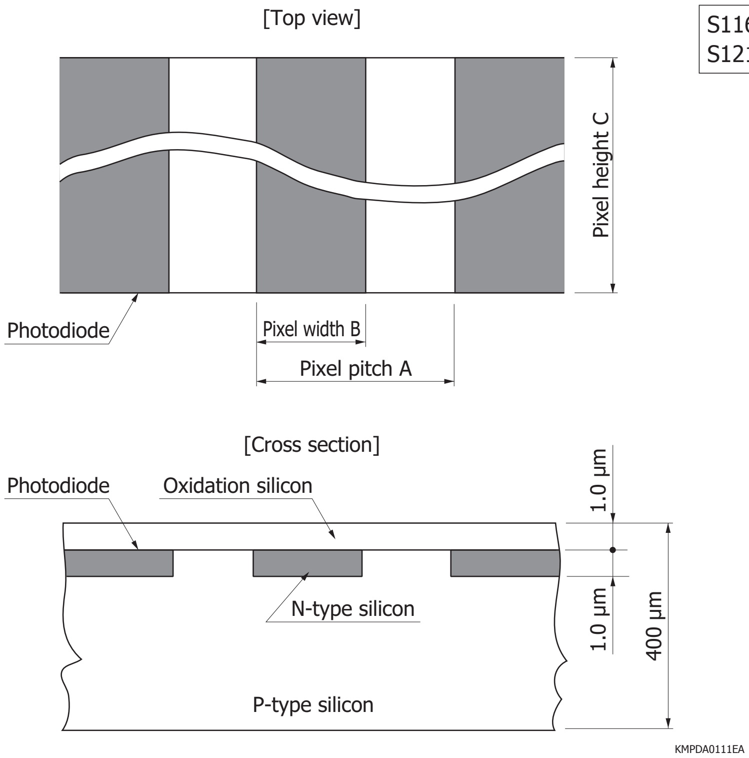



## Block diagram



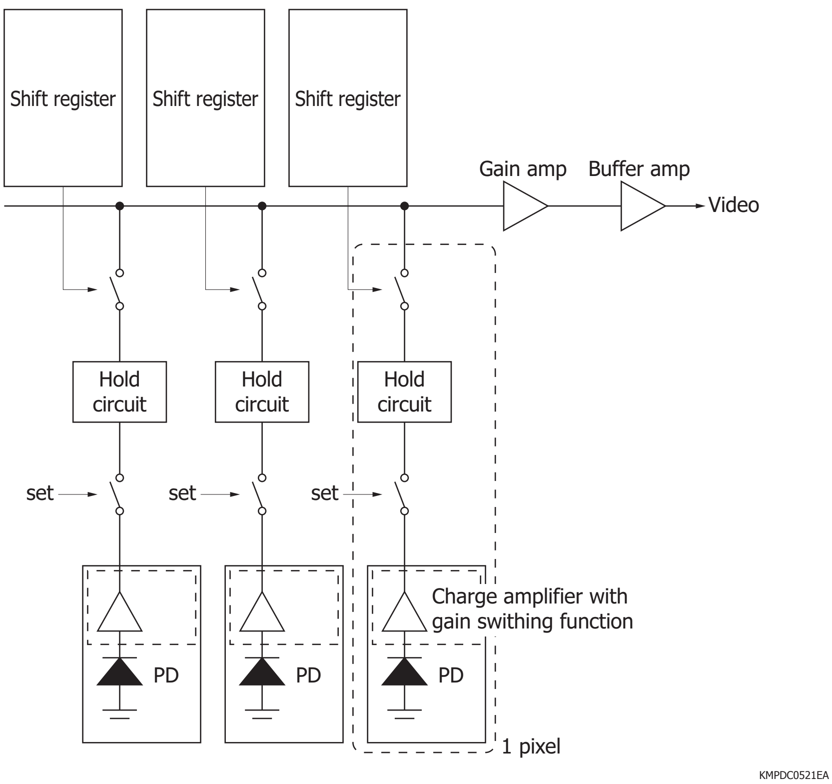
## Device structure

■ Details of photosensitive area (front-illuminance type photodiode)




S11637 series: A=12.5 μm, B=8.5 μm, C=500 μm
S12198 series: A=25 μm, B=20 μm, C=500 μm

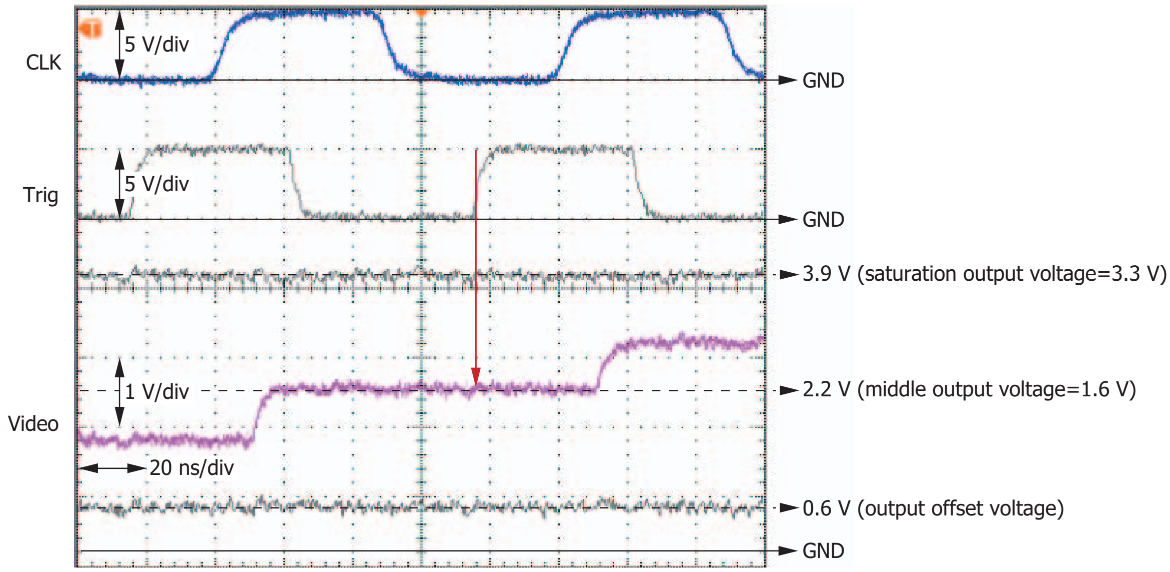
■ Overall structure



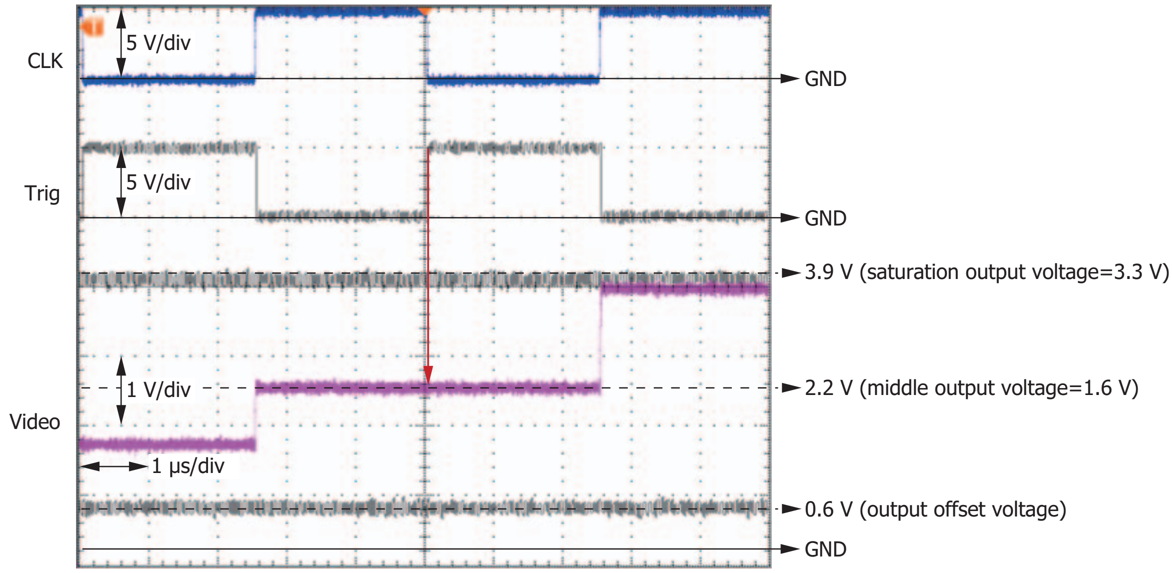
## Output waveform examples of one pixel

The timing for acquiring the Video signal is synchronized with the rising edge of a trigger pulse (see red arrows below).

CLK=10 MHz

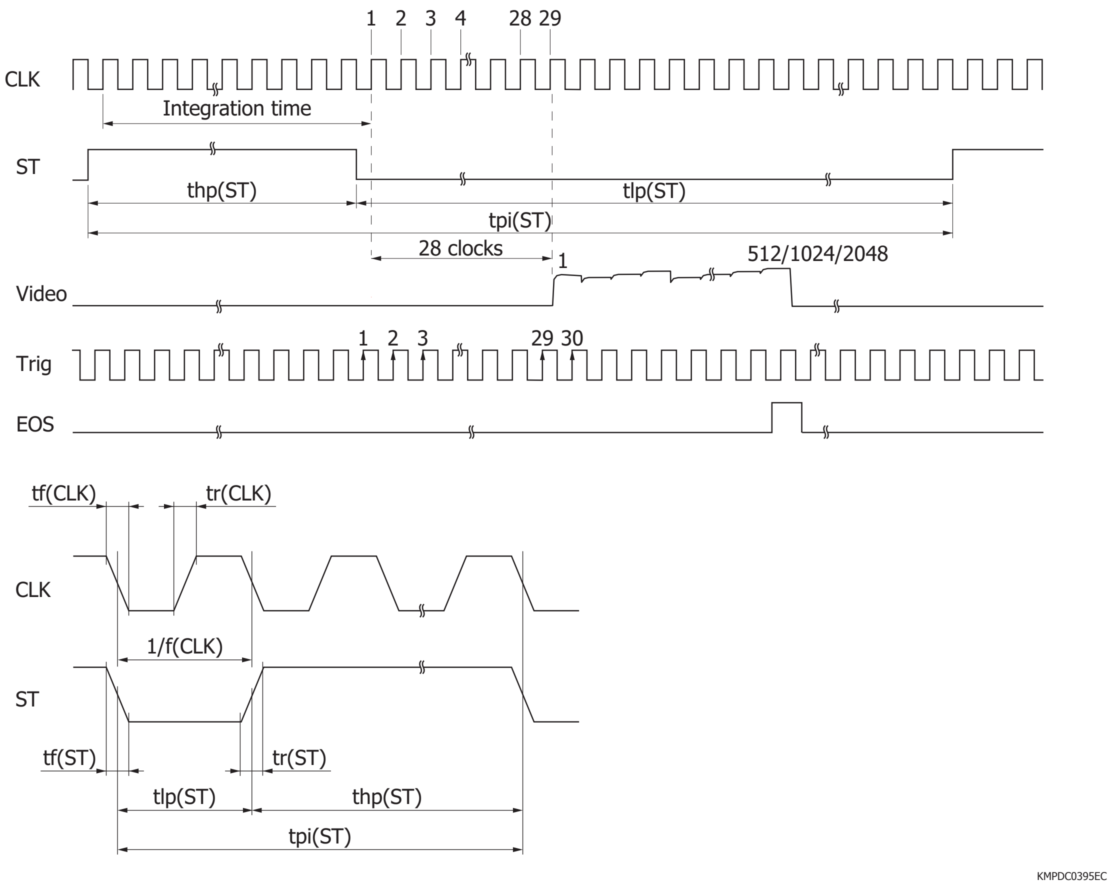



CLK=200 kHz




Note: On the waveform of the middle output voltage shown above, in order to make it easier to identify the output of each pixel, the light was input so that the outputs of the adjacent pixels appeared in a step form.

## Timing chart



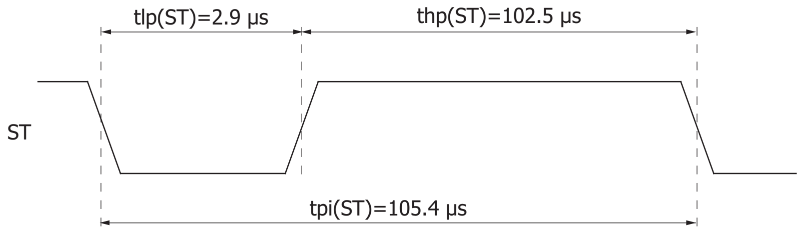

| Parameter | Symbol | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|
| Start pulse cycle | tpi(ST) | 37/f(CLK) | - | - | s |
| Start pulse high period | thp(ST) | 8/f(CLK) | - | - | s |
| Start pulse low period | tlp(ST) | 29/f(CLK) | - | - | s |
| Start pulse rise and fall times | tr(ST), tf(ST) | 0 | 10 | 30 | ns |
| Clock pulse duty ratio | - | 45 | 50 | 55 | % |
| Clock pulse rise and fall times | tr(CLK), tf(CLK) | 0 | 10 | 30 | ns |

Note: Dark output increases if the start pulse high period is lengthened.
The internal timing generator starts operation at the rising edge of CLK immediately after ST goes low.
The integration time equals the high period of ST.
If the first Trig pulse after ST goes low is counted as the first pulse, the Video signal of the first pixel is acquired at the rising edge of the 30th Trig pulse.
When the ST pulse is set to low while the shift register is operating, the operation of the shift register is reset and the next shift register operation will start.

## Operation examples

**S11637-1024Q, S12198-1024Q**

When the clock pulse frequency is maximized (video data rate is also maximized), the time of one scan is minimized, and the integration time is maximized (for outputting signals from all 1024 channels)
Clock pulse frequency = Video data rate = 10 MHz
Start pulse cycle = 1054/f(CLK) = 1054/10 MHz = 105.4 μs
High period of start pulse = Start pulse cycle - Start pulse's low period min.
= 1054/f(CLK) - 29/f(CLK) = 1054/10 MHz - 29/10 MHz = 102.5 μs
Integration time is equal to the high period of start pulse, so it will be 102.5 μs.

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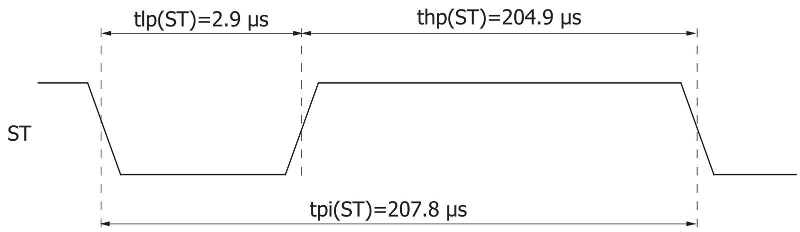
**S11637-2048Q**

When the clock pulse frequency is maximized (video data rate is also maximized), the time of one scan is minimized, and the integration time is maximized (for outputting signals from 2048 channels)
Clock pulse frequency = Video data rate = 10 MHz
Start pulse cycle = 2078/f(CLK) = 2078/10 MHz = 207.8 μs
High period of start pulse = Start pulse cycle - Start pulse's low period min.
= 2078/f(CLK) - 29/f(CLK) = 2078/10 MHz - 29/10 MHz = 204.9 μs
Integration time is equal to the high period of start pulse, so it will be 204.9 μs.

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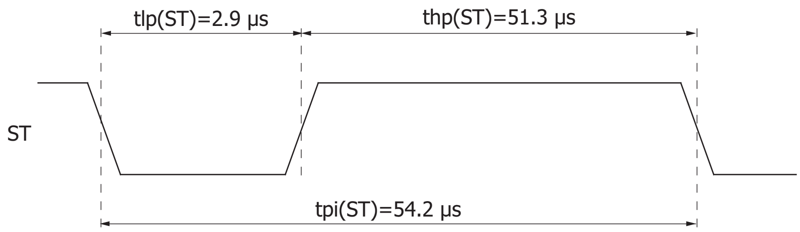
**S12198-512Q**

When the clock pulse frequency is maximized (video data rate is also maximized), the time of one scan is minimized, and the integration time is maximized (for outputting signals from all 512 channels)
Clock pulse frequency = Video data rate = 10 MHz
Start pulse cycle = 542/f(CLK) = 542/10 MHz = 54.2 μs
High period of start pulse = Start pulse cycle - Start pulse's low period min.
= 542/f(CLK) - 29/f(CLK) = 542/10 MHz - 29/10 MHz = 51.3 μs
Integration time is equal to the high period of start pulse, so it will be 51.3 μs.

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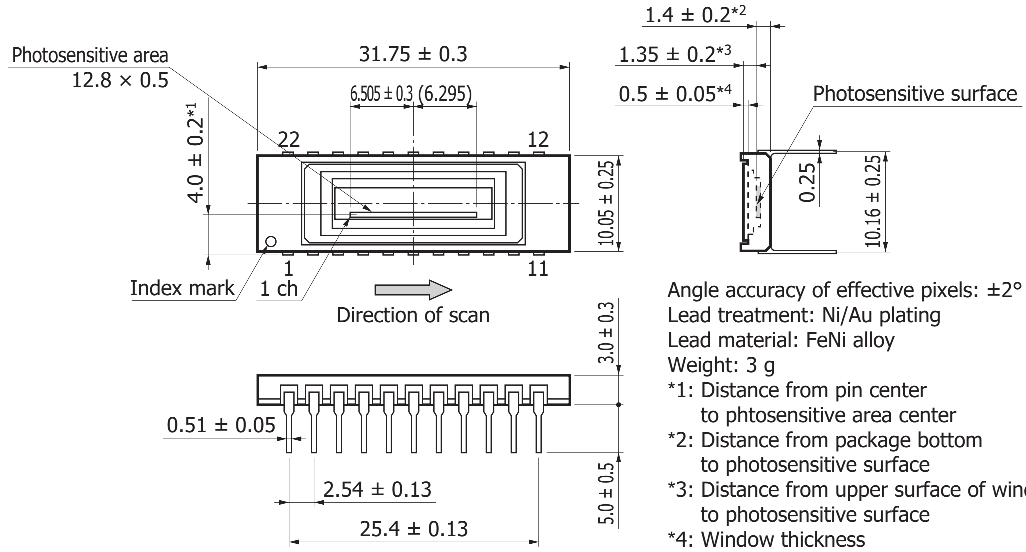
## Dimensional outlines (unit: mm, tolerance unless otherwise noted: ±0.2)

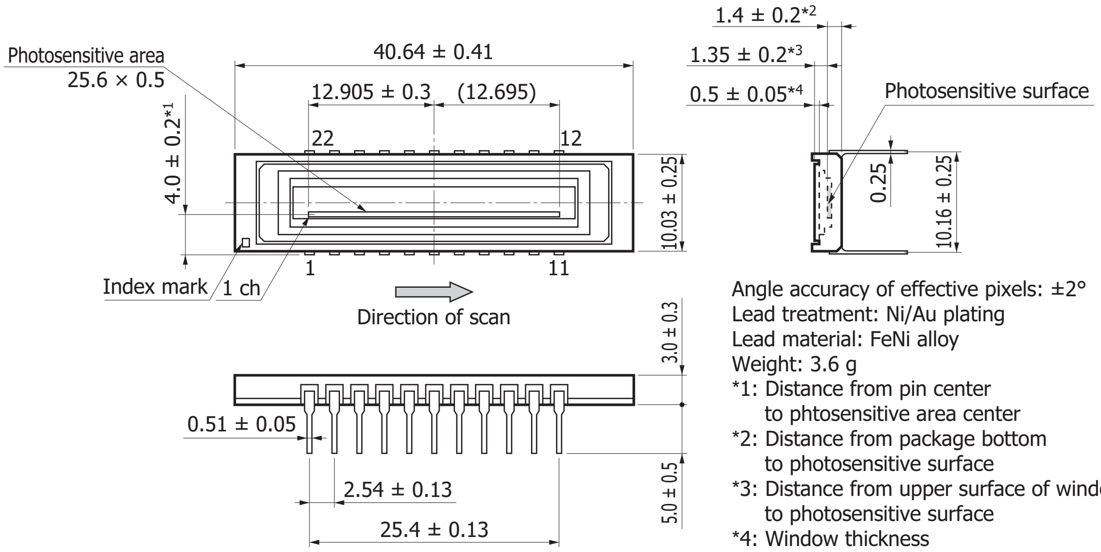
S11637-1024Q




Angle accuracy of effective pixels: ±2°
Lead treatment: Ni/Au plating
Lead material: FeNi alloy
Weight: 3 g
*1: Distance from pin center to phtosensitive area center
*2: Distance from package bottom to photosensitive surface
*3: Distance from upper surface of window to photosensitive surface
*4: Window thickness

KMPDA0289EC

S11637-2048Q




Angle accuracy of effective pixels: ±2°
Lead treatment: Ni/Au plating
Lead material: FeNi alloy
Weight: 3.6 g
*1: Distance from pin center to phtosensitive area center
*2: Distance from package bottom to photosensitive surface
*3: Distance from upper surface of window to photosensitive surface
*4: Window thickness

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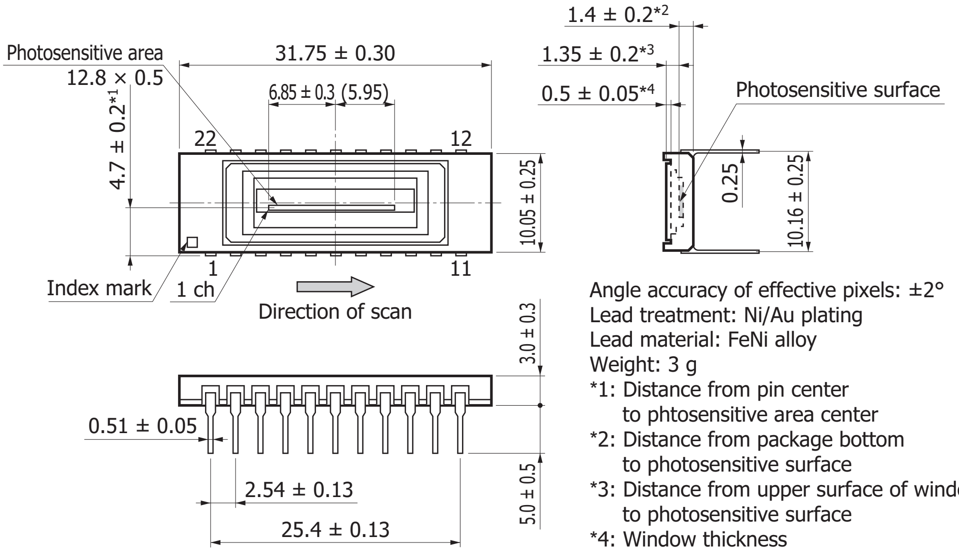
S12198-512Q




Angle accuracy of effective pixels: ±2°
Lead treatment: Ni/Au plating
Lead material: FeNi alloy
Weight: 3 g
*1: Distance from pin center to phtosensitive area center
*2: Distance from package bottom to photosensitive surface
*3: Distance from upper surface of window to photosensitive surface
*4: Window thickness

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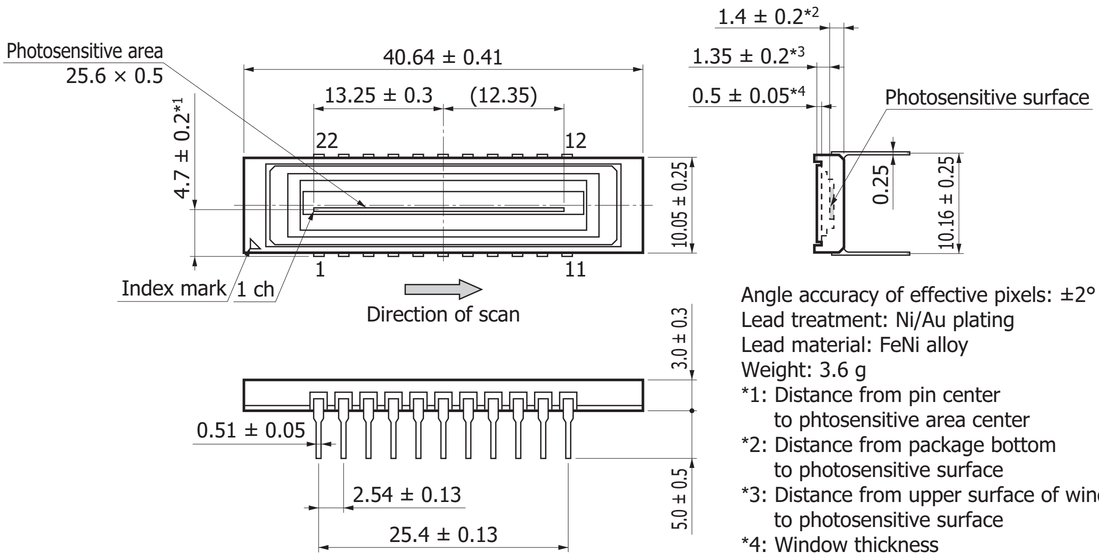
S12198-1024Q




Angle accuracy of effective pixels: ±2°
Lead treatment: Ni/Au plating
Lead material: FeNi alloy
Weight: 3.6 g
*1: Distance from pin center to phtosensitive area center
*2: Distance from package bottom to photosensitive surface
*3: Distance from upper surface of window to photosensitive surface
*4: Window thickness

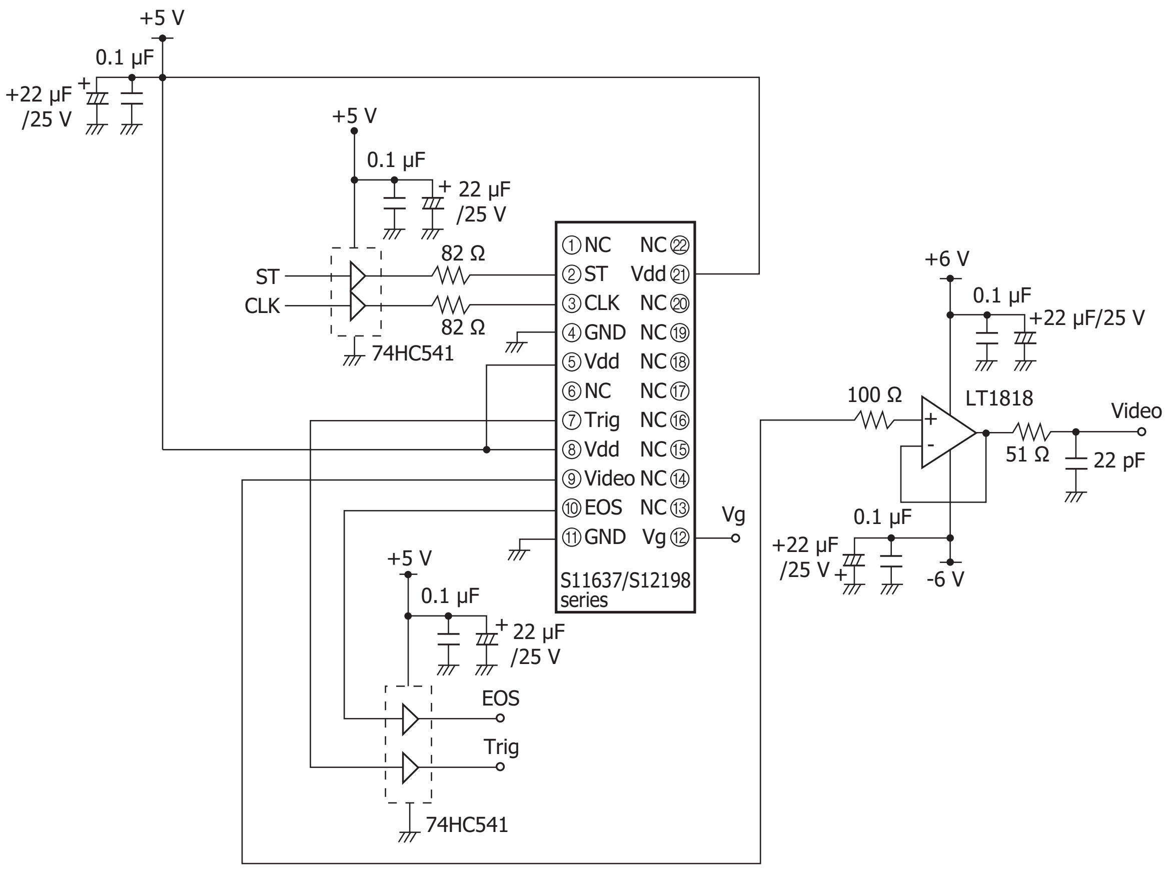
KMPDA0312EB

## Pin connections

| Pin no. | Symbol | I/O | Pin name |
|---|---|---|---|
| 1 | NC | | No connection |
| 2 | ST | I | Start pulse |
| 3 | CLK | I | Clock pulse |
| 4 | GND | | Ground |
| 5 | Vdd | I | Supply voltage |
| 6 | NC | | No connection |
| 7 | Trig | O | Trigger pulse for video signal acquisition |
| 8 | Vdd | I | Supply voltage |
| 9 | Video | O | Video output |
| 10 | EOS | O | End of scan |
| 11 | GND | | Ground |
| 12 | Vg | I | Gain selection terminal voltage |
| 13 | NC | | No connection |
| 14 | NC | | No connection |
| 15 | NC | | No connection |
| 16 | NC | | No connection |
| 17 | NC | | No connection |
| 18 | NC | | No connection |
| 19 | NC | | No connection |
| 20 | NC | | No connection |
| 21 | Vdd | I | Supply voltage |
| 22 | NC | | No connection |

Note: Leave the "NC" terminals open and do not connect them to GND.
Connect a buffer amplifier for impedance conversion to the video output terminal so as to minimize the current flow.

## Application circuit example

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## 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 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 dry cotton swab, or the like, 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
Operate and store the product within the temperature range defined by the absolute maximum ratings. 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 device is designed to suppress performance deterioration due to UV exposure. Even so, avoid unnecessary UV exposure to the device. Also, be careful not to allow UV light to strike the sealed portion of the glass.

## Related information

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

■ Precautions

· Disclaimer
· Image sensors



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