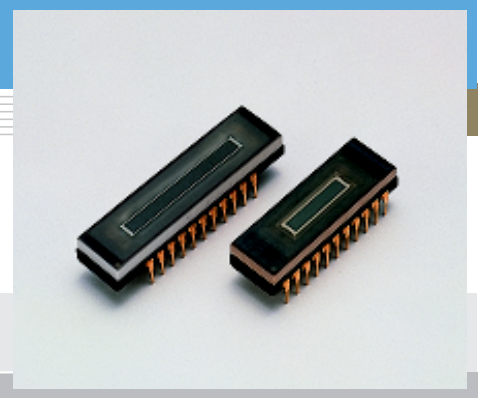


NMOS linear image sensor S3901/S3904-F series

NMOS linear image sensors with fiber optic windows



NMOS linear image sensors are self-scanning photodiode arrays designed specifically as detectors for multichannel spectroscopy. The scanning circuit is made up of N-channel MOS transistors, operates at low power consumption and is easy to handle. Each photodiode has a large active area, high sensitivity yet very low noise, delivering a high S/N even at low light levels.

S3901/S3904-F series are current-output type NMOS linear image sensors with fiber optic windows and feature superior output linearity and wide dynamic range. The fiber optic windows allow efficient optical coupling to an image device such as image intensifiers suitable for low-light-level detection.

The photodiodes of S3901-F series have a height of 2.5 mm and are arrayed in a row at a spacing of 50 μm . The photodiodes of S3904-F series also have a height of 2.5 mm but are arrayed at a spacing of 25 μm . The photodiodes are available in 2 different pixel quantities for each series: 256 (S3901-256F), 512 (S3901-512F, S3904-512F), 1024 (S3904-1024F).

Hamamatsu also provides S3902/S3903-F series having a pixel height of 0.5 mm.

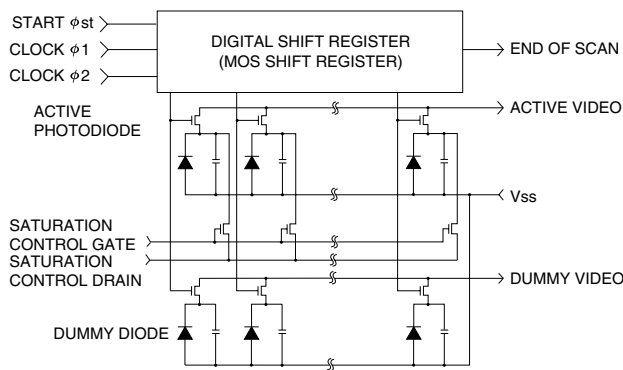
Features

- Wide active area
Pixel pitch: 50 μm (S3901-F series)
25 μm (S3904-F series)
Pixel height: 2.5 mm
- Low dark current and high saturation charge allow a long integration time and a wide dynamic range at room temperature
- Excellent output linearity and sensitivity spatial uniformity
- Lower power consumption: 1 mW Max.
- Start pulse and clock pulses are CMOS logic compatible

Applications

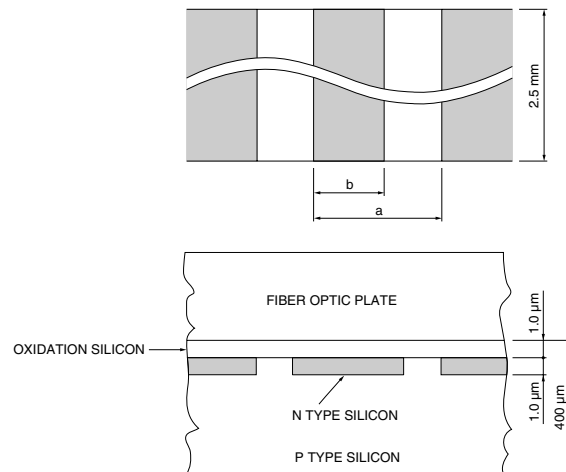
- Multichannel spectrophotometry
- Image readout system

Equivalent circuit



KMPDC0020EA

Active area structure



S3901-F SERIES: a=50 μm , b=45 μm
S3904-F SERIES: a=25 μm , b=20 μm

KMPDA0131EA

Absolute maximum ratings

| Parameter | Symbol | Value | Unit |
|---|-----------|------------|--------------------|
| Input pulse ($\phi 1$, $\phi 2$, ϕst) voltage | $V\phi$ | 15 | V |
| Power consumption *1 | P | 1 | mW |
| Operating temperature *2 | T_{opr} | -40 to +65 | $^{\circ}\text{C}$ |
| Storage temperature | T_{stg} | -40 to +85 | $^{\circ}\text{C}$ |

*1: $V\phi=5.0\text{ V}$

*2: No condensation

■ Shape specifications

| Parameter | S3901-256F | S3901-512F | S3904-512F | S3904-1024F | Unit |
|------------------|-------------------|------------|-------------------|-------------|------|
| Number of pixels | 256 | 512 | 512 | 1024 | - |
| Package length | 31.75 | 40.6 | 31.75 | 40.6 | mm |
| Number of pins | 22 | | 22 | | - |
| Window material | Fiber optic plate | | Fiber optic plate | | - |
| Weight | 8.0 | 10.0 | 8.0 | 10.0 | g |

■ Specifications (Ta=25 °C)

| Parameter | Symbol | S3901-F series | | | S3904-F series | | | Unit |
|--|--------|----------------|------|------|----------------|------|------|--------|
| | | Min. | Typ. | Max. | Min. | Typ. | Max. | |
| Pixel pitch | - | - | 50 | - | - | 25 | - | μm |
| Pixel height | - | - | 2.5 | - | - | 2.5 | - | mm |
| Spectral response range (10 % of peak) | λ | 360 to 1000 | | | 360 to 1000 | | | nm |
| Peak sensitivity wavelength | λp | - | 600 | - | - | 600 | - | nm |
| Photodiode dark current *3 | Id | - | 0.2 | 0.6 | - | 0.1 | 0.3 | pA |
| Photodiode capacitance *3 | Cph | - | 20 | - | - | 10 | - | pF |
| Saturation exposure *3, *4 | Esat | - | 200 | - | - | 200 | - | mk · s |
| Saturation output charge *3 | Qsat | - | 50 | - | - | 25 | - | pC |
| Photo response non-uniformity *5 | PRNU | - | - | ±5 | - | - | ±5 | % |

*3: Vb=2.0 V, Vφ=5.0 V

*4: 2856 K, tungsten lamp

*5: 50 % of saturation, excluding the start pixel and last pixel

■ Electrical characteristics (Ta=25 °C)

| Parameter | Symbol | Condition | S3901-F series | | | S3904-F series | | | Unit |
|---|--------------------------|---------------------------|----------------|--------------|----------|----------------|---------------|----------|------|
| | | | Min. | Typ. | Max. | Min. | Typ. | Max. | |
| Clock pulse (φ1, φ2) voltage | High | Vφ1, Vφ2 (H) | 4.5 | 5 | 10 | 4.5 | 5 | 10 | V |
| | Low | Vφ1, Vφ2 (L) | 0 | - | 0.4 | 0 | - | 0.4 | V |
| Start pulse (φst) voltage | High | Vφs (H) | 4.5 | Vφ1 | 10 | 4.5 | Vφ1 | 10 | V |
| | Low | Vφs (L) | 0 | - | 0.4 | 0 | - | 0.4 | V |
| Video bias voltage *6 | Vb | | 1.5 | Vφ - 3.0 | Vφ - 2.5 | 1.5 | Vφ - 3.0 | Vφ - 2.5 | V |
| Saturation control gate voltage | Vscg | | - | 0 | - | - | 0 | - | V |
| Saturation control drain voltage | Vscd | | - | Vb | - | - | Vb | - | V |
| Clock pulse (φ1, φ2) rise / fall time *7 | trφ1, trφ2 tfφ1, tfφ2 | | - | 20 | - | - | 20 | - | ns |
| Clock pulse (φ1, φ2) pulse width | tpwφ1, tpwφ2 | | 200 | - | - | 200 | - | - | ns |
| Start pulse (φst) rise / fall time | trφs, tfφs | | - | 20 | - | - | 20 | - | ns |
| Start pulse (φst) pulse width | tpwφs | | 200 | - | - | 200 | - | - | ns |
| Start pulse (φst) and clock pulse (φ2) overlap | tφov | | 200 | - | - | 200 | - | - | ns |
| Clock pulse space *7 | X1, X2 | | trf - 20 | - | - | trf - 20 | - | - | ns |
| Data rate *8 | f | | 0.1 | - | 2000 | 0.1 | - | 2000 | kHz |
| Video delay time | tvd | 50 % of saturation *8, *9 | - | 120 (-256 F) | - | - | 150 (-512 F) | - | ns |
| | | | - | 160 (-512 F) | - | - | 200 (-1024 F) | - | ns |
| Clock pulse (φ1, φ2) line capacitance | Cφ | 5 V bias | - | 36 (-256 F) | - | - | 50 (-512 F) | - | pF |
| | | | - | 67 (-512 F) | - | - | 100 (-1024 F) | - | pF |
| Saturation control gate (Vscg) line capacitance | Cscg | 5 V bias | - | 20 (-256 F) | - | - | 24 (-512 F) | - | pF |
| | | | - | 35 (-512 F) | - | - | 45 (-1024 F) | - | pF |
| Video line capacitance | Cv | 2 V bias | - | 11 (-256 F) | - | - | 16 (-512 F) | - | pF |
| | | | - | 20 (-512 F) | - | - | 30 (-1024 F) | - | pF |

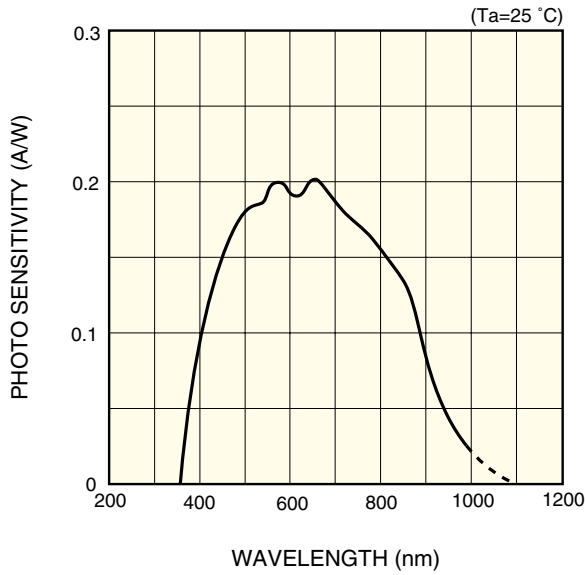
*6: Vφ is input pulse voltage.

*7: trf is the clock pulse rise or fall time. A clock pulse space of "rise time/fall time - 20" ns (nanoseconds) or more should be input if the clock pulse rise or fall time is longer than 20 ns.

*8: Vb=2.0 V, Vφ=5.0 V

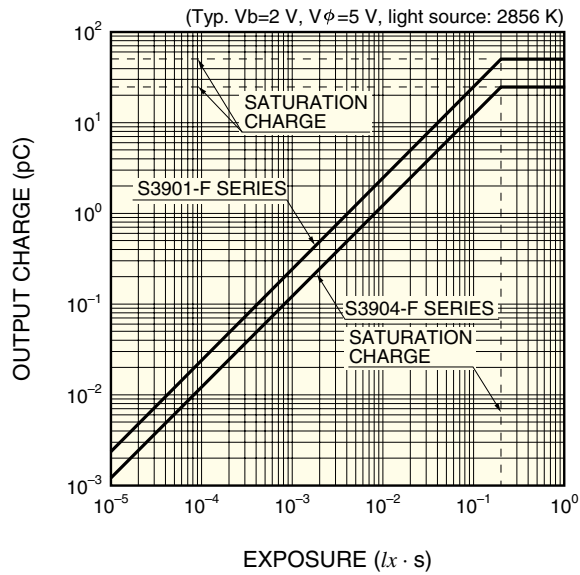
*9: Measured with C7883 driver circuit.

■ Spectral response (typical example)



KMPDB0173EA

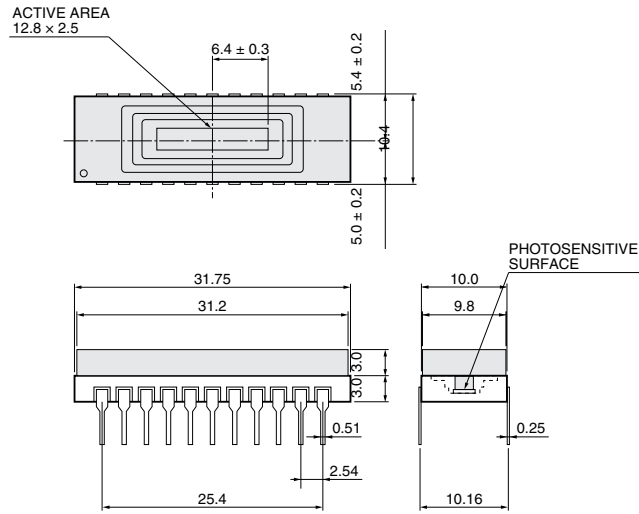
■ Output charge vs. exposure



KMPDB0099EB

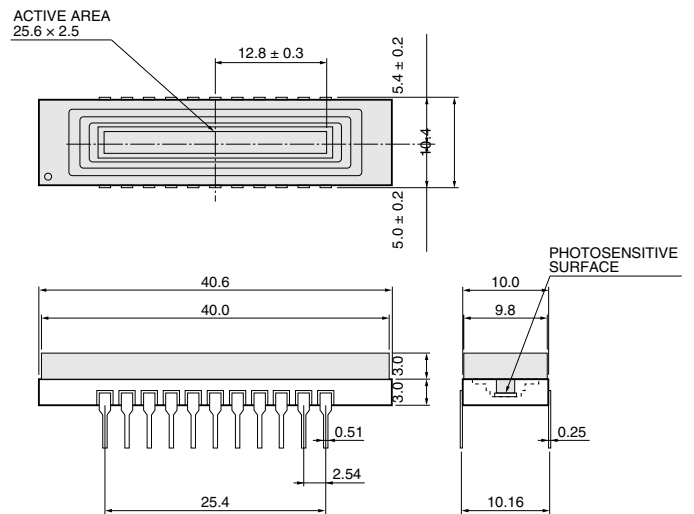
Dimensional outlines (unit: mm)

S3901-256F, S3904-512F



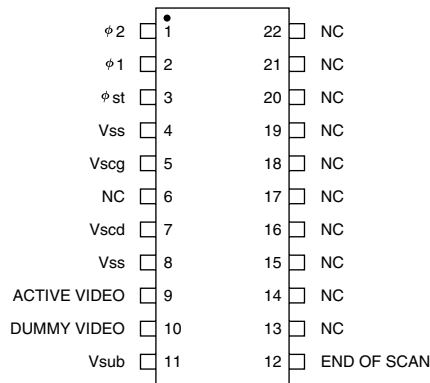
KMPDA0093EA

S3901-512F, S3904-1024F



KMPDA0094EA

Pin connection



Vss, Vsub and NC should be grounded.

KMPDC0056EA