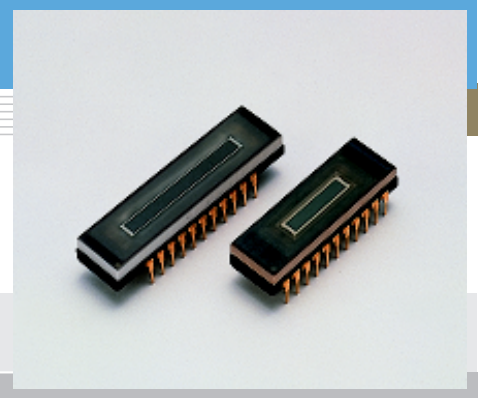


# NMOS linear image sensor S3901/S3904-F series

## 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  $\mu\text{m}$ . The photodiodes of S3904-F series also have a height of 2.5 mm but are arrayed at a spacing of 25  $\mu\text{m}$ . 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.

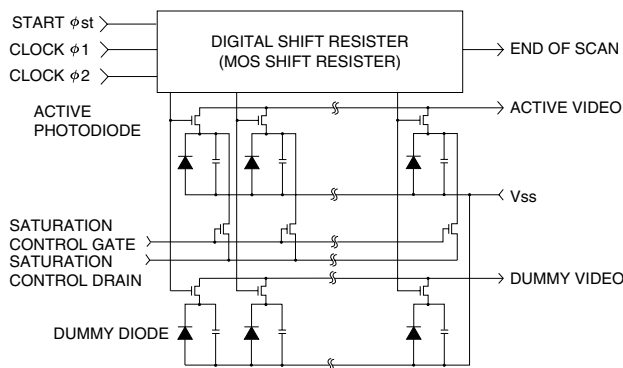
### Features

- Wide active area  
Pixel pitch: 50  $\mu\text{m}$  (S3901-F series)  
25  $\mu\text{m}$  (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

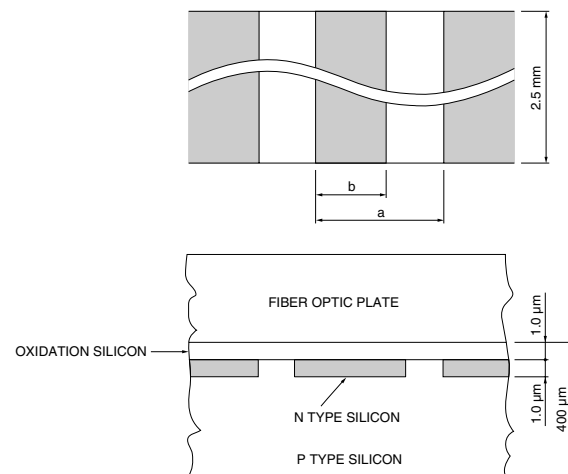
- Multichannel spectrophotometry
- Image readout system

### Equivalent circuit



KMPDC0020EA

### Active area structure



S3901-F SERIES: a=50  $\mu\text{m}$ , b=45  $\mu\text{m}$   
S3904-F SERIES: a=25  $\mu\text{m}$ , b=20  $\mu\text{m}$

KMPDA0131EA

### Absolute maximum ratings

Parameter	Symbol	Value	Unit
Input pulse ( $\phi_1$ , $\phi_2$ , $\phi_{st}$ ) 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:  $V_\phi=5.0$  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

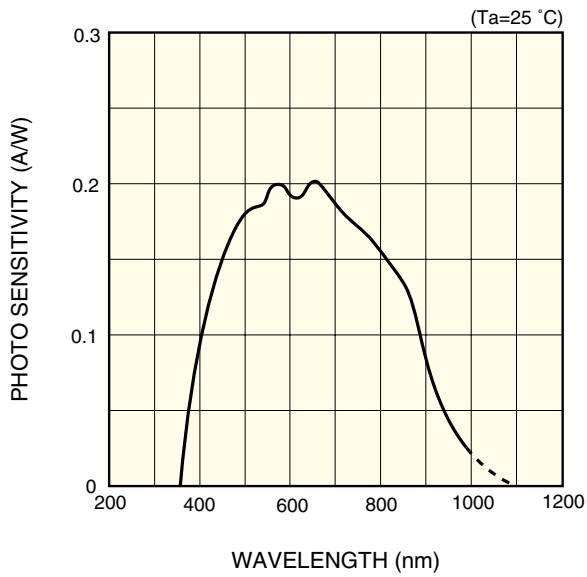
\*6: Vφ is input pulse voltage.

\*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

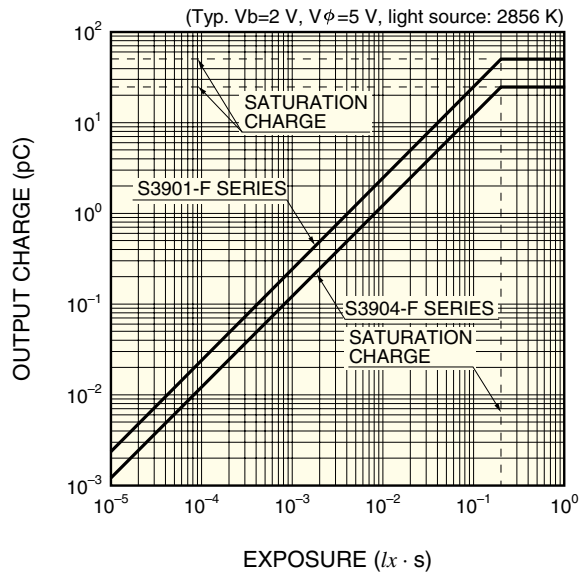
\*9: Measured with C7883 driver circuit.

■ Spectral response (typical example)



KMPDB0173EA

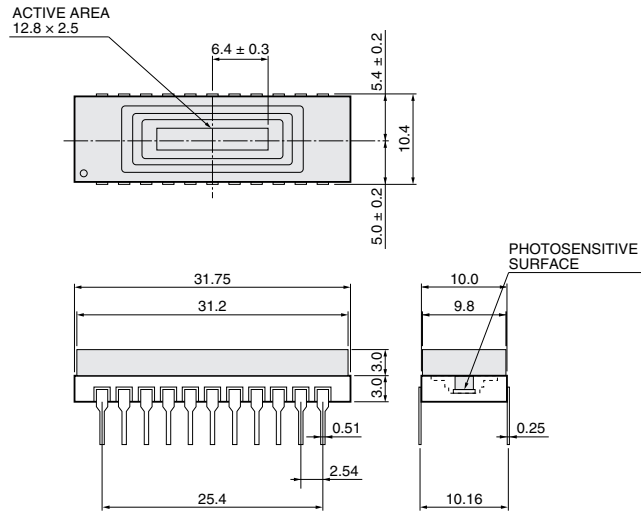
■ Output charge vs. exposure



KMPDB0099EB

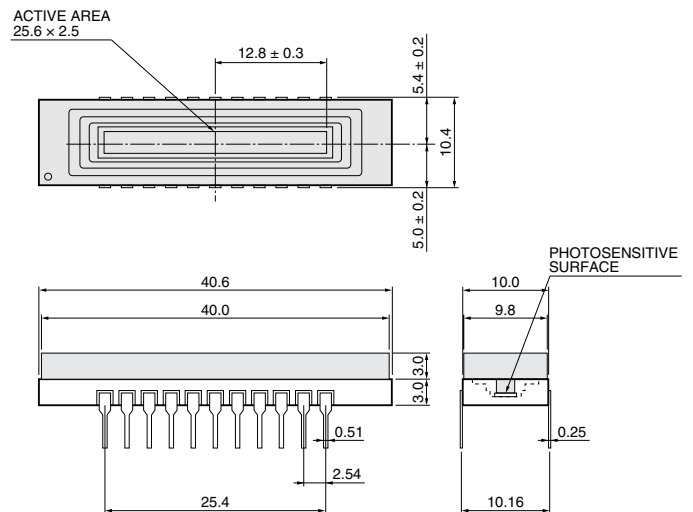
## Dimensional outlines (unit: mm)

S3901-256F, S3904-512F



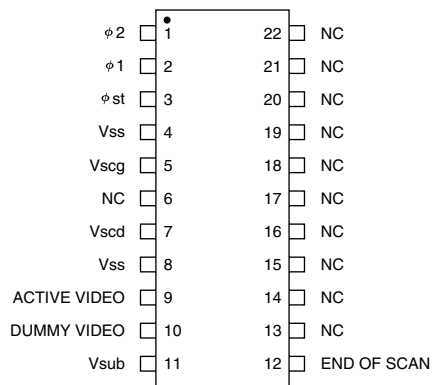
KMPDA0093EA

S3901-512F, S3904-1024F



KMPDA0094EA

## Pin connection



Vss, Vsub and NC should be grounded.

KMPDC0056EA

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