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NMOS linear image sensor

S3901-FX series

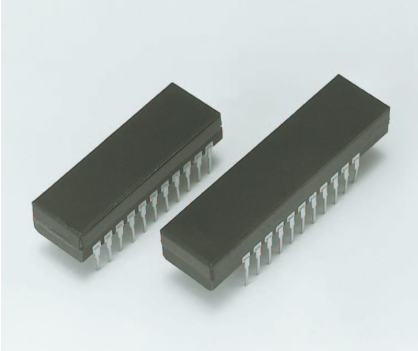


Image sensor highly sensitive to X-rays from 10 k to 100 keV

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, has low power consumption and is easy to handle. Each photodiode has a large active area, high UV sensitivity yet very low noise, delivering a high S/N even at low light levels. Current output type NMOS linear image sensors also offer excellent output linearity and wide dynamic range.

S3901-FX series image sensors are variants of S3901-F series NMOS image sensors. Having a phosphor-coated fiber optic plate (FOP) as the light input window, the S3901-FX series was developed for detection of X-rays and electrons. The S3901-FX offers particularly high sensitivity to X-rays from 10 k to 100 keV. The phosphor material used is gadolinium ox sulfide (Gd_2O_2S:Tb) whose composition is carefully selected to provide optimum sensitivity and resolution with a peak emission at 550 nm wavelength.

The S3901-FX series active area consists of a photodiode array with pixels formed at 50 µm pitches and a height of 2.5 mm. The number of pixels can be selected from 256 or 512.

Hamamatsu S3904 series NMOS linear image sensors are also available with FOP windows coated with the same phosphor material as S3901-FX series.

Using photodiodes with no phosphor and FOP window also allows direct detection of X-rays at energy levels below 10 keV.

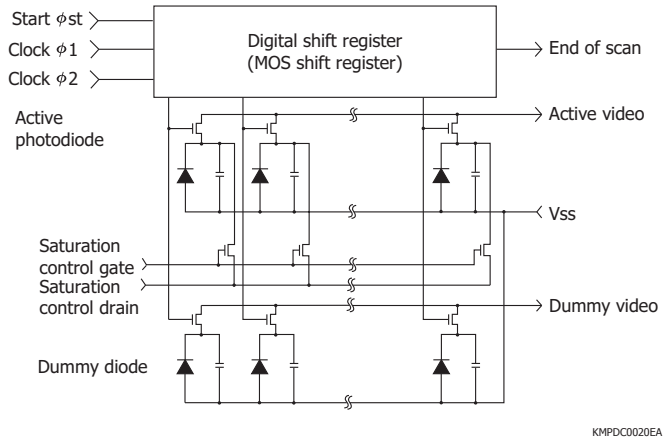
Features

- **Wide active area**
  Pixel pitch: 50 µm
  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**
- **Low power consumption: 1 mW max.**
- **Start pulse and clock pulse are CMOS logic compatible**

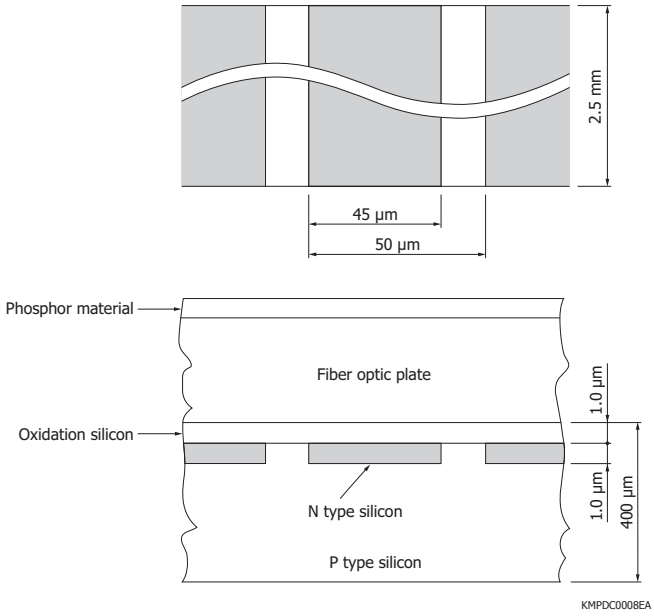
Applications

- **Test equipment using X-ray and electron beam transmission**
- **X-ray non-destructive inspection**
- **X-ray and electron beam detector**

Equivalent circuit



Active area structure



Absolute maximum ratings

Parameter	Symbol	Value	Unit
Input pulse (ϕ1, ϕ2, ϕst) voltage	Vϕ	15	V
Power consumption*1	P	1	mW
Operating temperature*2	Topr	-30 to +60	°C
Storage temperature	Tstg	-40 to +80	°C

*1: Vϕ=5.0 V
*2: No condensation

Shape specifications

Parameter	S3901-256FX	S3901-512FX	Unit
Number of pixels	256	512	-
Package length	31.75	40.6	mm
Number of pin	22		-
Window material*3	Fiber optic plate		-
Weight	8.0	10.0	g

*3: To prevent unwanted effects from stray light, S3901-FX series is supplied with an aluminum cover fitted on the phosphor-coated FOP.

Specifications (Ta=25 °C)

Parameter	Symbol	Min.	Typ.	Max.	Unit
Pixel pitch	-	-	50	-	µm
Pixel height	-	-	2.5	-	mm
Spectral response range (20% of peak)	λ		10 to 100		keV
Photo sensitivity	S	-	0.013	-	pC/mR
Photodiode dark current*4	ID	-	0.2	0.6	pA
Photodiode capacitance*4	Cph	-	20	-	pF
Saturation exposure*4	Esat	-	4	-	R
Saturation output charge*4	Qsat	-	50	-	pC
Photo response non-uniformity*5	PRNU	-	-	±10	%

*4: Vb=2.0 V, Vϕ=5.0 V
*5: Measured under the following conditions including uniformity in the phosphor emission (but excluding dark current components).
X-ray tube voltage: 40 kV, tube current: 3 mA
Distance between S3901-FX series and X-ray tube: 4 cm
Phosphor material: Gd2O2S · Tb (thickness=200 µm, λp=550 nm, decay time=1 ms)

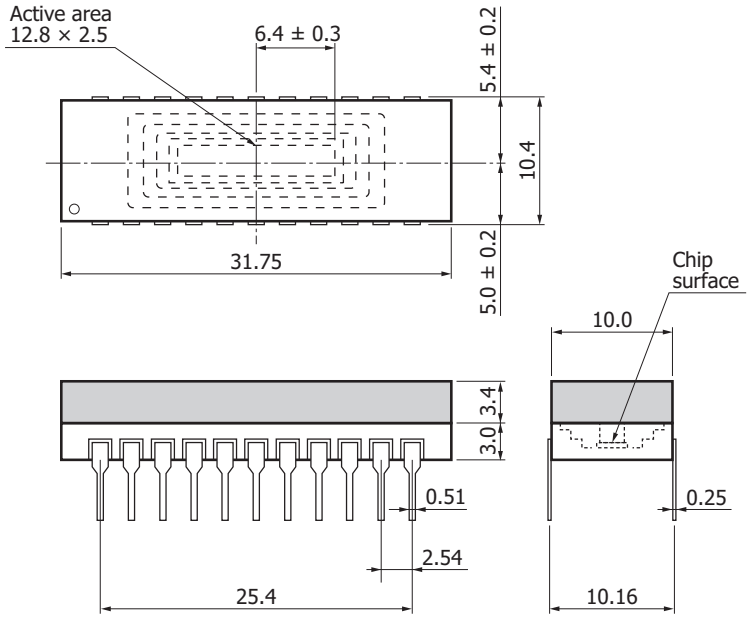
Electrical characteristics (Ta=25 °C)

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

Dimensional outlines (unit: mm)

S3901-256FX



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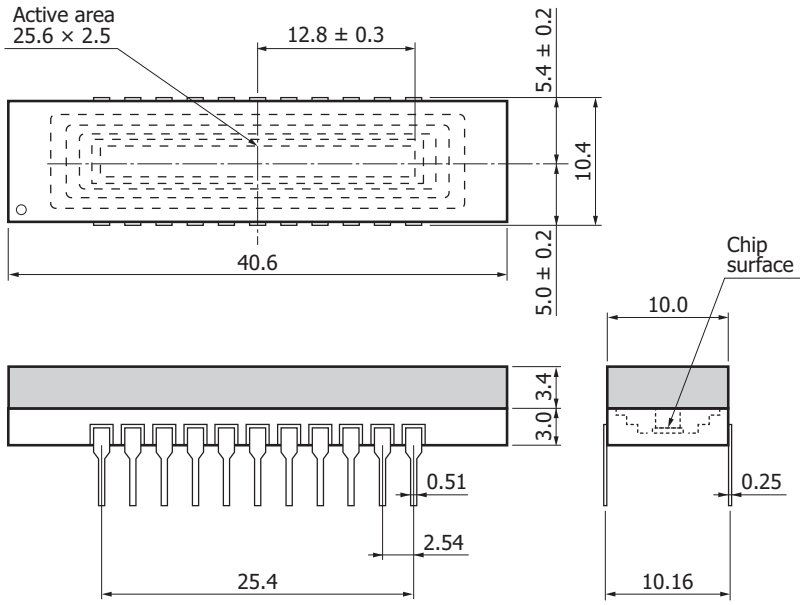
S3901-512FX



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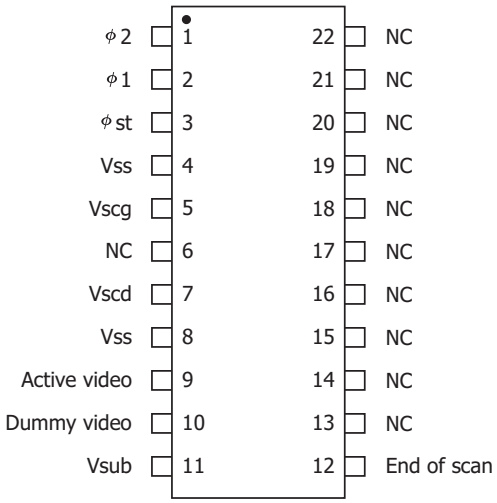
Pin connection



Vss, Vsub and NC should be grounded.

KMPDC0056EA

Related information

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

■ Precautions

· Disclaimer
· Image sensors

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HAMAMATSU PHOTONICS K.K., Solid State Division
1126-1 Ichino-cho, Higashi-ku, Hamamatsu City, 435-8558 Japan, Telephone: (81) 53-434-3311, Fax: (81) 53-434-5184
U.S.A.: Hamamatsu Corporation: 360 Foothill Road, Bridgewater, N.J. 08807, U.S.A., Telephone: (1) 908-231-0960, Fax: (1) 908-231-1218
Germany: Hamamatsu Photonics Deutschland GmbH: Arzbergerstr. 10, D-82211 Herrsching am Ammersee, Germany, Telephone: (49) 8152-375-0, Fax: (49) 8152-265-8
France: Hamamatsu Photonics France S.A.R.L.: 19, Rue du Saule Trapu, Parc du Moulin de Massy, 91882 Massy Cedex, France, Telephone: 33-(1) 69 53 71 00, Fax: 33-(1) 69 53 71 10
United Kingdom: Hamamatsu Photonics UK Limited: 2 Howard Court, 10 Tewin Road, Welwyn Garden City, Hertfordshire AL7 1BW, United Kingdom, Telephone: (44) 1707-294888, Fax: (44) 1707-325777
North Europe: Hamamatsu Photonics Norden AB: Torshamnsgatan 35 16440 Kista, Sweden, Telephone: (46) 8-509-031-00, Fax: (46) 8-509-031-01
Italy: Hamamatsu Photonics Italia S.r.l.: Strada della Moia, 1 int. 6, 20020 Arese (Milano), Italy, Telephone: (39) 02-93581733, Fax: (39) 02-93581741
China: Hamamatsu Photonics (China) Co., Ltd.: B1201, Jiaming Center, No.27 Dongsanhuan Beilu, Chaoyang District, Beijing 100020, China, Telephone: (86) 10-6586-6006, Fax: (86) 10-6586-2866

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