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NMOS linear image sensor

S3901-1024Q S3904-2048Q

Large active area type with 51.2 mm detection length

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 UV sensitivity yet very low noise, delivering a high S/N even at low light levels. The current output type NMOS linear image sensors also feature excellent output linearity and wide dynamic range. S3901-1024Q uses photodiodes with a height of 2.5 mm, arrayed at a spacing of 50 µm. S3904-2048Q has photodiodes with a height of 2.5 mm, arrayed at a spacing of 25 µm. The photodiode arrays are available in 2 different pixel quantities, 1024 (S3901-1024Q) and 2048 (S3904-2048Q). Quartz glass is the standard window material.

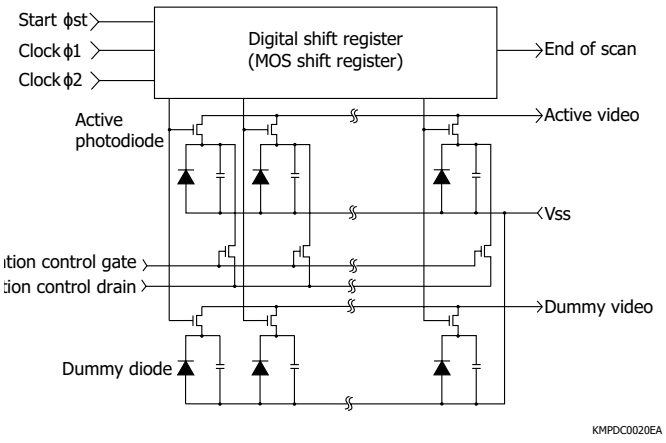
Features

- **Large active area, long detection length**
  Pixel pitch: 50 µm (S3901-1024Q)
  25 µm (S3904-2048Q)
  Pixel height: 2.5 mm
  Active area length: 51.2 mm
- **High UV sensitivity with good stability**
- **Low dark current and large saturation charge allow 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 pulses are CMOS logic compatible**

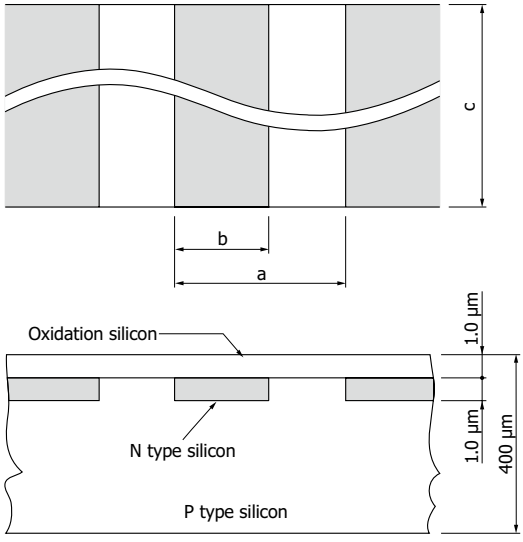
Applications

- **Multichannel spectrophotometry**
- **Image readout system**

Equivalent circuit



Active area structure



S3901-1024Q: a=50 µm, b=45 µm, c=2.5 mm
S3904-2048Q: a=25 µm, b=20 µm, c=2.5 mm

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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	-40 to +65	°C
Storage temperature	Tstg	-40 to +85	°C

*1: Vϕ=5.0 V
*2: No condensation

Shape specifications

Parameter	S3901-1024Q	S3904-2048Q	Unit
Number of pixels	1024	2048	-
Package length	65.0		mm
Number of pin	22		-
Window material*3	Quartz		-
Weight	8.5		g

*3: Fiber optic plate is available.

Specifications (Ta=25 °C)

Parameter	Symbol	S3901-1024Q			S3904-2048Q			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	200 to 1000			200 to 1000			nm
Peak sensitivity wavelength	λp	-	600	-	-	600	-	nm
Photodiode dark current*4	ID	-	0.2	0.6	-	0.1	0.3	pA
Photodiode capacitance*4	Cph	-	20	-	-	10	-	pF
Saturation exposure*4 *5	Esat	-	180	-	-	180	-	$mlx \cdot s$
Saturation output charge*4	Qsat	-	50	-	-	25	-	pC
Photo response non-uniformity*6	PRNU	-	-	±3	-	-	±3	%

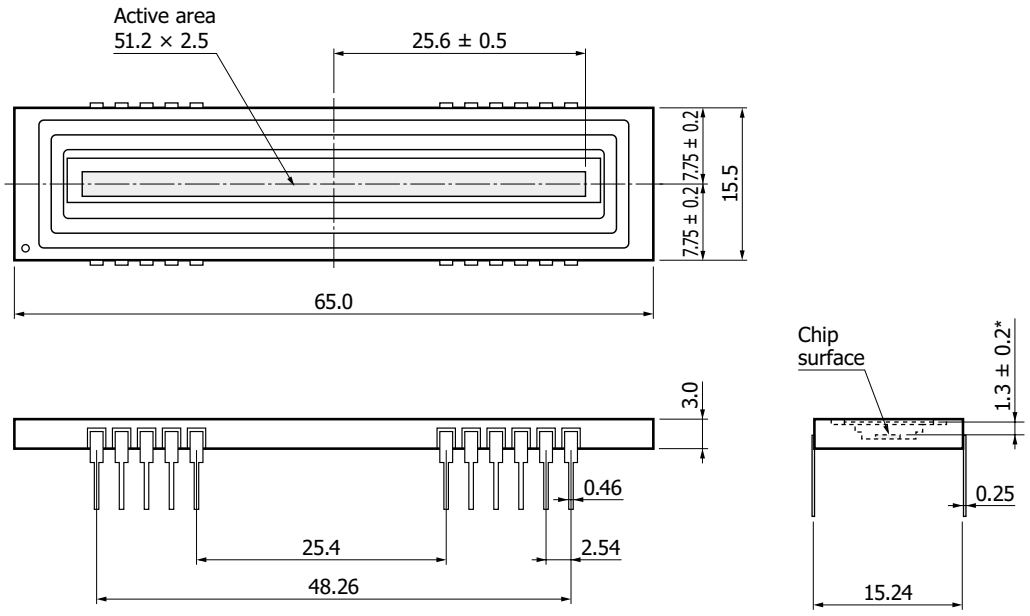
*4: Vb=2.0 V, Vϕ=5.0 V
*5: 2856 K, tungsten lamp
*6: 50% of saturation, excluding the start pixel and last pixel

Electrical characteristics (Ta=25 °C)

Parameter		Symbol	Condition	S3901-1024Q			S3904-2048Q			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*7		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*8		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*8		X1, X2		trf - 20	-	-	trf - 20	-	-	ns
Data rate*9		f		0.1	-	2000	0.1	-	2000	kHz
Video delay time		tvd	50% of saturation*9	-	200	-	-	250	-	ns
Clock pulse (ϕ1, ϕ2) line capacitance		Cϕ	5 V bias	-	134	-	-	200	-	pF
Saturation control gate (Vscg) line capacitance		Cscg	5 V bias	-	63	-	-	87	-	pF
Video line capacitance		Cv	2 V bias	-	45	-	-	60	-	pF

*7: Vϕ is input pulse voltage (refer to P.6 "Video bias voltage margin").
*8: trf is the clock pulse rise or fall time. A clock pulse space of "rise time/fall time - 20 " ns or more should be input if the clock pulse rise or fall time is longer than 20 ns (refer to P.5 "Timing chart").
*9: Vb=2.0 V, Vϕ=5.0 V

Dimensional outline (unit: mm)



* Distance from upper surface of the quartz window to chip surface

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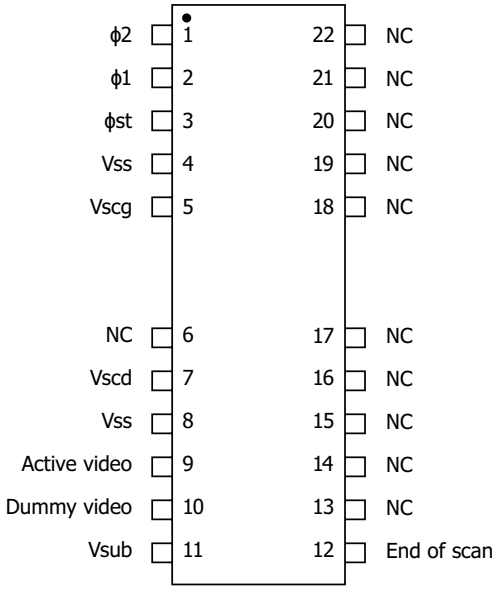
Pin connection



Vss, Vsub and NC should be grounded.

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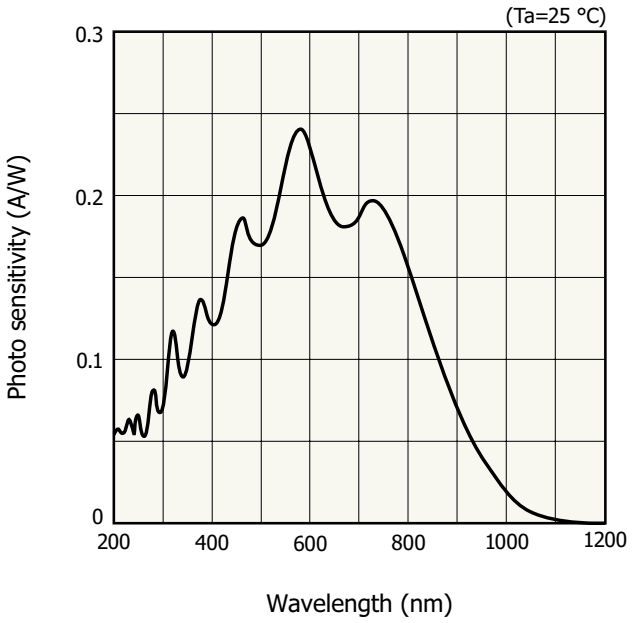
Terminal	Input or output	Description
ϕ1, ϕ2	Input (CMOS logic compatible)	Pulses for operating the MOS shift register. The video data rate is equal to the clock pulse frequency since the video output signal is obtained synchronously with the rise of ϕ2 pulse.
ϕst	Input (CMOS logic compatible)	Pulse for starting the MOS shift register operation. The time interval between start pulses is equal to the signal accumulation time.
Vss	-	Connected to the anode of each photodiode. This should be grounded.
Vscg	Input	Used for restricting blooming. This should be grounded.
Vscd	Input	Used for restricting blooming. This should be biased at a voltage equal to the video bias voltage.
Active video	Output	Video output signal. Connects to photodiode cathodes when the address is on. A positive voltage should be applied to the video line in order to use photodiodes with a reverse voltage. When the amplitude of ϕ1 and ϕ2 is 5 V, a video bias voltage of 2 V is recommended.
Dummy video	Output	This has the same structure as the active video, but is not connected to photodiodes, so only spike noise is output. This should be biased at a voltage equal to the active video or left as an open-circuit when not needed.
Vsub	-	Connected to the silicon substrate. This should be grounded.
End of scan	Output (CMOS logic compatible)	This should be pulled up at 5 V by using a 10 kΩ resistor. This is a negative going pulse that appears synchronously with the ϕ2 timing right after the last photodiode is addressed.
NC	-	Should be grounded.

Spectral response (typical example)



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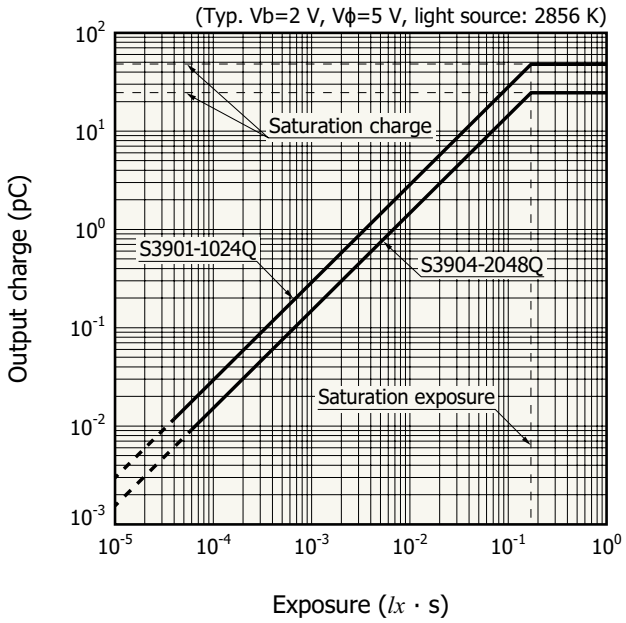
Output charge vs. exposure



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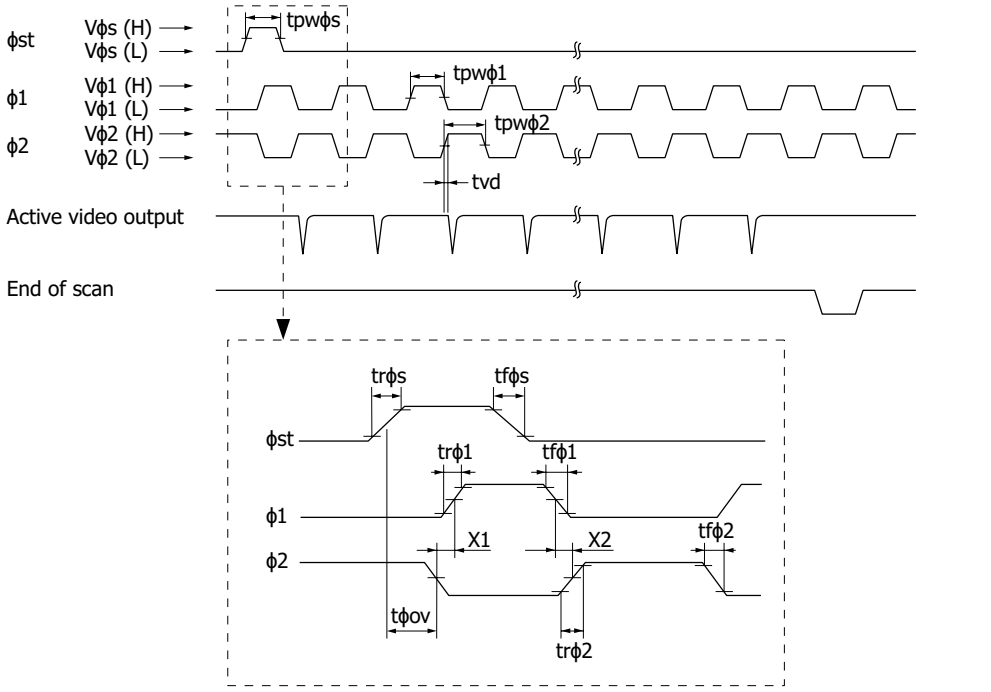
Timing chart



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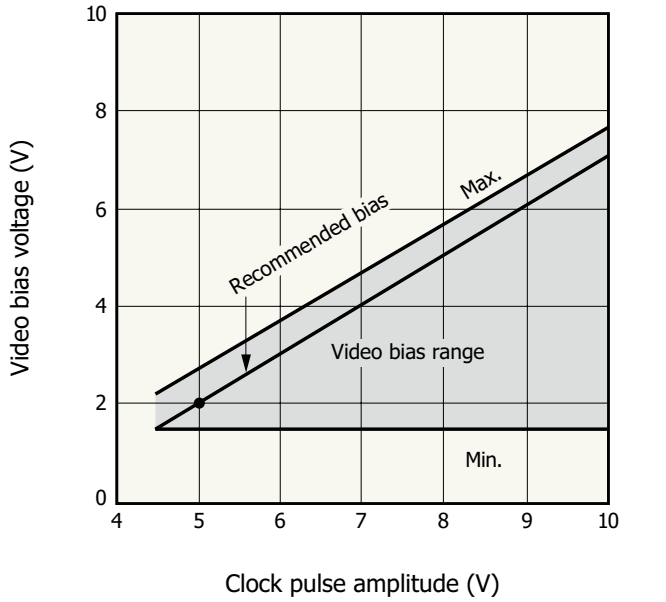
Video bias voltage margin



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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, Chuo-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, NJ 08807, U.S.A., Telephone: (1)908-231-0960, Fax: (1)908-231-1218
Germany: HAMAMATSU PHOTONICS DEUTSCHLAND GMBH: Arzbergerstr. 10, 82211 Herrsching am Ammersee, Germany, Telephone: (49)8152-375-0, Fax: (49)8152-265-8 E-mail: info@hamamatsu.de
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 E-mail: infos@hamamatsu.fr
United Kingdom: HAMAMATSU PHOTONICS UK LIMITED: 2 Howard Court,10 Tewin Road, Welwyn Garden City, Hertfordshire, AL7 1BW, UK, Telephone: (44)1707-294888, Fax: (44)1707-325777 E-mail: info@hamamatsu.co.uk
North Europe: HAMAMATSU PHOTONICS NORDEN AB: Torshamnsgatan 35, 16440 Kista, Sweden, Telephone: (46)8-509-031-00, Fax: (46)8-509-031-01 E-mail: info@hamamatsu.se
Italy: HAMAMATSU PHOTONICS ITALIA S.R.L.: Strada della Moia, 1 int. 6 20044 Arese (Milano), Italy, Telephone: (39)02-93 58 17 33, Fax: (39)02-93 58 17 41 E-mail: info@hamamatsu.it
China: HAMAMATSU PHOTONICS (CHINA) CO., LTD.: 1201, Tower B, Jiaming Center, 27 Dongsanhuan Beilu, Chaoyang District, 100020 Beijing, P.R. China, Telephone: (86)10-6586-6006, Fax: (86)10-6586-2866 E-mail: hpc@hamamatsu.com.cn
Taiwan: HAMAMATSU PHOTONICS TAIWAN CO., LTD.: 13F-1, No.101, Section 2, Gongdao 5th Road, East Dist., Hsinchu City, 300046, Taiwan(R.O.C) Telephone: (886)3-659-0080, Fax: (886)3-659-0081 E-mail: info@hamamatsu.com.tw

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