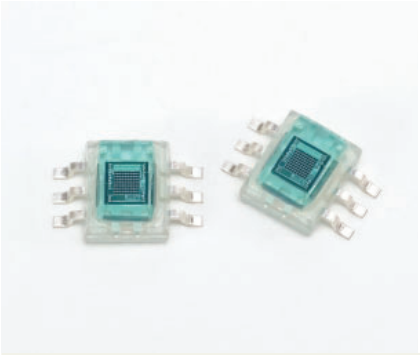
HAMAMATSU

Digital color sensor



S9706

12-bit digital output

The S9706 is a digital color sensor sensitive to red (λ=615 nm), green (λ=540 nm) and blue (λ=465 nm) regions of the spectrum. Detected signals are serially output as 12-bit digital data. Built-in three 12-bit registers allow simultaneous measurement of RGB three colors. Sensitivity level is adjustable in two steps to cover a wide photometric range.

Features

- **12-bit digital output**
- **Simultaneous measurement of RGB three colors**
- **2-step sensitivity switching (sensitivity ratio of 1 : 9)**
- **Low voltage (3.3 V) operation**
- **CMOS monolithic photo IC**
- **No external components required**

Applications

- **Display color adjustment**
- **Various applications involving color detection**

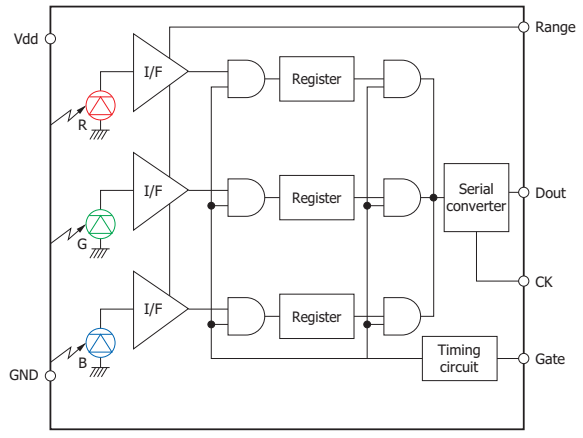
Feature 01 12-bit digital output

Light signals detected by the photodiode are amplified and converted into 12-bit digital signals. An amplifier is also formed for each of the RGB photodiode elements arrayed in the mosaic pattern, allowing simultaneous accurate measurement of the RGB components of incident light.

Feature 02 Simultaneous measurement of RGB three colors

The photodiode consists of 9 × 9 elements arrayed in a mosaic pattern. Each element has an on-chip filter that it sensitive to one color of light, either red (λp=615 nm), green (λp=540 nm) or blue (λp=465 nm).

Block diagram



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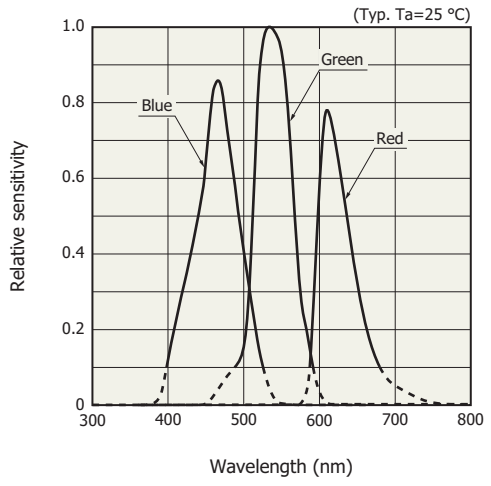
Spectral response



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Feature 03 2-step sensitivity switching

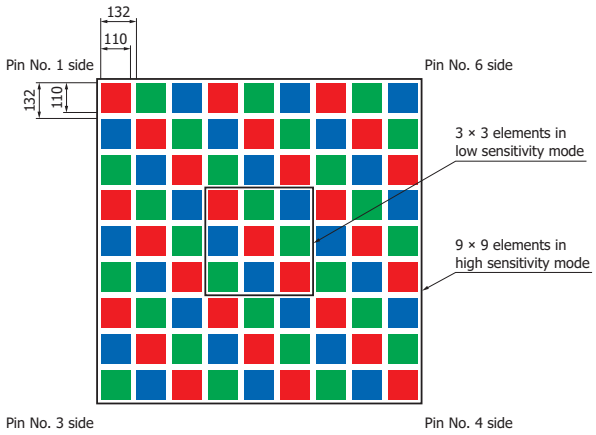
To enable measurement over a wide range of illuminance, the photodiode sensitivity can be selected from two setting modes (high sensitivity mode and low sensitivity mode). The photodiode active area used to detect light differs depending on which sensitivity mode is selected (high sensitivity mode: 9 × 9 elements, low sensitivity mode: 3 × 3 elements in center).

Sensitivity setting

Range	Mode	Effective active area *
High	High sensitivity	9 × 9 elements
Low	Low sensitivity	3 × 3 elements

* The active area of S9706 consists of 9 × 9 elements in a mosaic pattern. The effective active area changes depending on which sensitivity mode is used, "high" or "low", as explained below.
· High sensitivity mode: 9 × 9 elements
· Low sensitivity mode: 3 × 3 elements in center

Details of active area (unit: µm)



Note: Spaceing between elements is light-shielded.

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Absolute maximum ratings (Ta=25 °C)

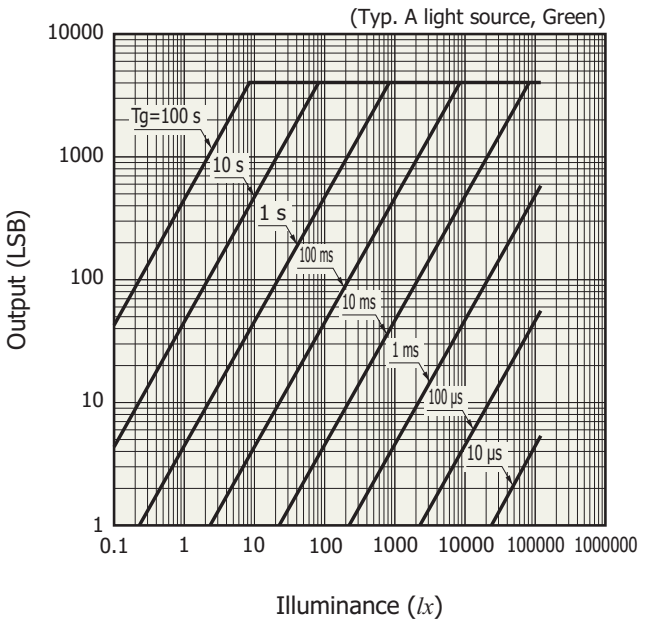
Parameter	Symbol	Value	Unit
Supply voltage	Vdd	-0.3 to 6	V
Load current	Io	±10	mA
Power dissipation	P	100	mW
Operating temperature	Topr	-20 to +85	°C
Storage temperature	Tstg	-20 to +85	°C

Electrical and optical characteristics (Ta=25 °C, Vdd=5 V, Tg=100 ms, A light source, unless otherwise noted)

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
Active area size	-	All elements (9 × 9 elements)	-	1.2 × 1.2	-	mm
Effective active area	-	Per 1 color, High range	-	0.32	-	mm^2
Spectral response range	λ	Blue	-	400 to 540	-	nm
		Green	-	480 to 600	-	
		Red	-	590 to 720	-	
Peak sensitivity wavelength	λp	Blue	-	465	-	nm
		Green	-	540	-	
		Red	-	615	-	
Supply voltage	Vdd		3.0	-	5.5	V
Current consumption	Idd	Dark state, no load	-	5	10	mA
Photo sensitivity	Sbl	Blue, Low range	0.15	0.21	0.27	LSB/*lx*
	Sgl	Green, Low range	0.32	0.45	0.59	
	Srl	Red, Low range	0.45	0.64	0.83	
	Sbh	Blue, High range	1.3	1.9	2.5	
	Sgh	Green, High range	2.8	4.1	5.4	
	Srh	Red, High range	4.0	5.8	7.6	
Incident light power (Conversion value in A light source)	Ibl	Blue, Low range	-	-	240	k*lx*
	Igl	Green, Low range	-	-	110	
	Irl	Red, Low range	-	-	78	
	Ibh	Blue, High range	-	-	26	
	Igh	Green, High range	-	-	12	
	Irh	Red, High range	-	-	8.6	
Dark output	Dark	Tg=0.5 s	-	-	1	LSB
Input high level	Vih		Vdd × 0.82	-	-	V
Input low level	Vil		-	-	Vdd × 0.18	V
Integration time	Tg		Refer to “Output vs. illuminance”			-
Hold time	t1		4	-	-	µs
	t2		3	-	-	µs
	t3		3	-	-	µs
	t4		2000	-	-	µs
	t5		3	-	-	µs
Readout clock period	tck		500	-	-	ns
Readout pulse width (positive)	tw		200	-	-	ns
Readout pulse width (negative)	tck-tw		200	-	-	ns

Output vs. illuminance

Low range



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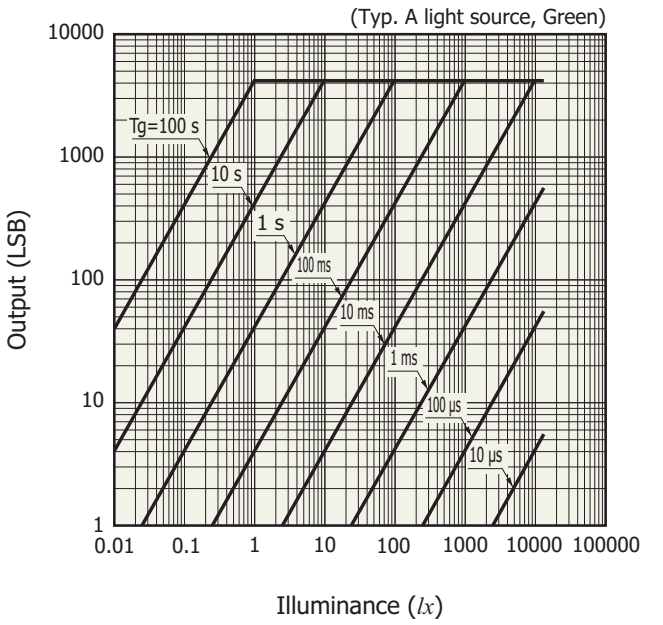
High range



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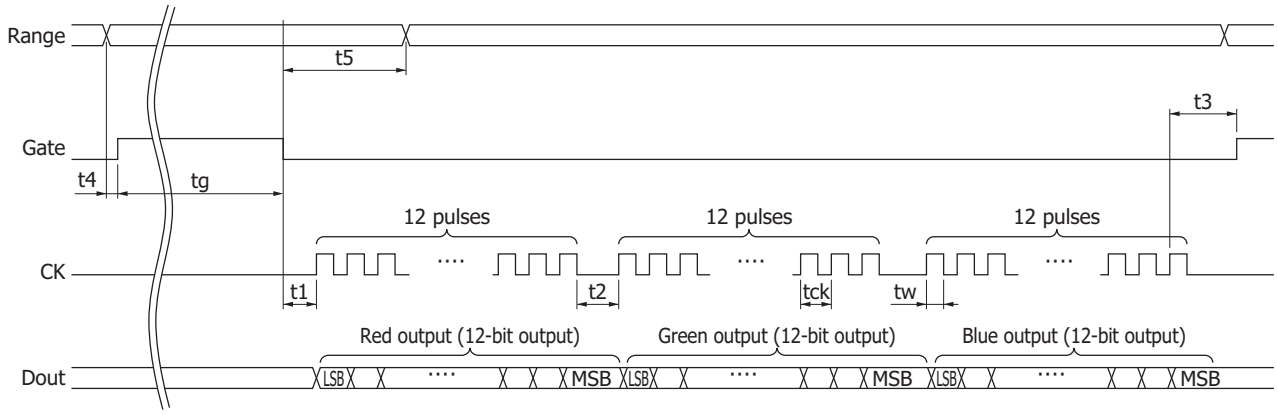
Timing chart



Operating sequence
(1) Set the Gate terminal and CK terminal to "Low".
(2) Select the desired sensitivity with the Range terminal.
(3) Set the Gate terminal from "Low" to "High", to start integrating the light intensity.
(4) After the desired integration time (tg) has passed, set the Gate terminal from "High" to "Low" to end the light intensity integration.
(5) Measurement data is output from the Dout terminal by inputting 36 CK pulses to the CK terminal.

Note 1: A total of 36 CK pulses are required to read out 3-color measurement data. Red data is output by the first 12 pulses, green data by the next 12 pulses, and blue data by the last 12 pulses. Measurement data is output from the LSB side.
Note 2: Measurement data changes at the CK pulse rising edge.
Note 3: Do not switch the Range terminal during integration time (tg).

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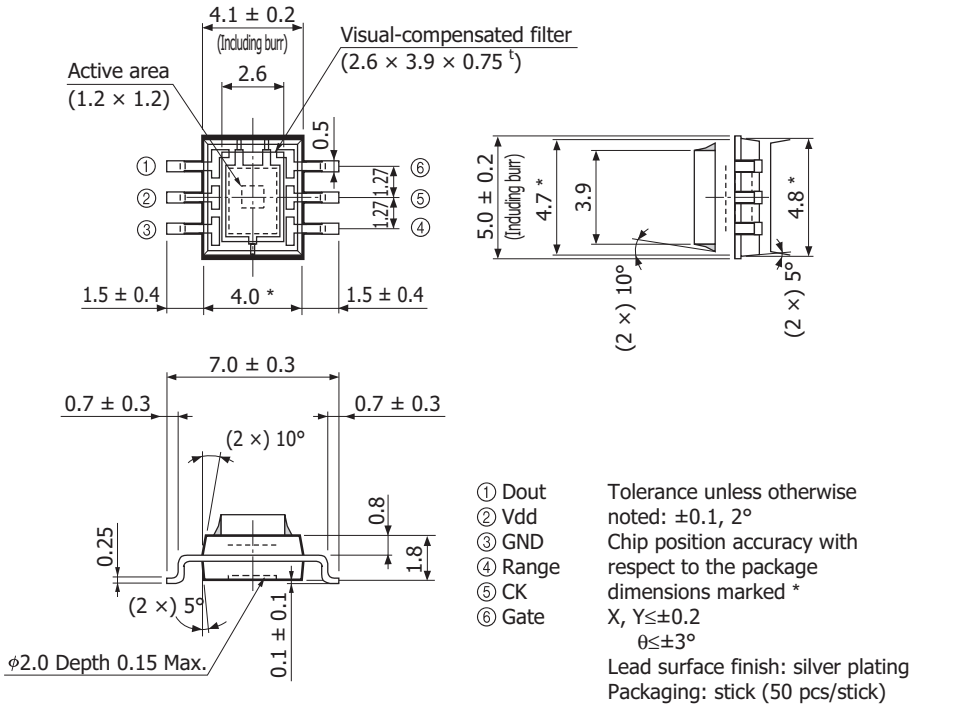
Dimensional outline (unit: mm)



① Dout
② Vdd
③ GND
④ Range
⑤ CK
⑥ Gate

Tolerance unless otherwise noted: ±0.1, 2°
Chip position accuracy with respect to the package dimensions marked *
X, Y≤±0.2
θ≤±3°
Lead surface finish: silver plating
Packaging: stick (50 pcs/stick)

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Note: If excessive vibration is continuously applied to the glass filter, there is a risk that the filter may come off, so secure the glass filter with a holder.

Line-up of RGB color sensors

Type No.	Type	Active area size (mm)	Package (mm)	Peak sensitivity wavelength (nm)		Photo sensitivity						Photo
S9032-02	Photodiode	ϕ2.0	4 × 4.8 × 1.8t 6-pin (filter 0.75t)	B	460	B	0.18 (A/W) [λ=460 nm]					
				G	540	G	0.23 (A/W) [λ=540 nm]					
				R	620	R	0.16 (A/W) [λ=620 nm]					
S9702	Photodiode	1.0 × 1.0	3 × 4 × 1.3t 4-pin (filter 0.75t)	B	460	B	0.18 (A/W) [λ=460 nm]					
				G	540	G	0.23 (A/W) [λ=540 nm]					
				R	620	R	0.16 (A/W) [λ=620 nm]					
S10917-35GT	Photodiode	1.0 × 1.0	3 × 1.6 × 1.0t COB (on-chip filter)	B	460	B	0.2 (A/W) [λ=460 nm]					
				G	540	G	0.23 (A/W) [λ=540 nm]					
				R	620	R	0.17 (A/W) [λ=620 nm]					
S10942-01CT	Photodiode	1.0 × 1.0	3 × 1.6 × 1.0t COB (on-chip filter)	See the spectral response.		B	0.21 A/W (λ=460 nm)					
						G	0.25 A/W (λ=540 nm)					
						R	0.48 A/W (λ=640 nm)					
S9706	Digital Photo IC	1.2 × 1.2	4 × 4.8 × 1.8t 6-pin (filter 0.75t)	B	465	Low	B	0.21 (LSB/lx)	High	B	1.9 (LSB/lx)	
				G	540		G	0.45 (LSB/lx)		G	4.1 (LSB/lx)	
				R	615		R	0.64 (LSB/lx)		R	5.8 (LSB/lx)	

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