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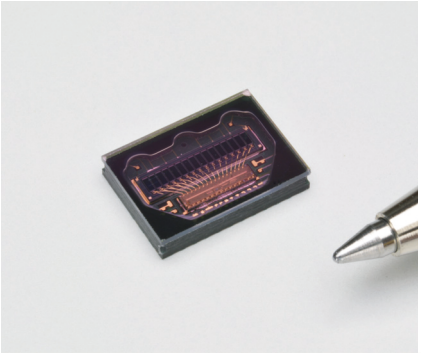
Photosensor with front-end IC



S13645-01CR

Compact 16-element APD array suitable for various light level detection (serial output)

The S13645-01CR is a compact optical device that integrates 16-element Si APD array and preamp. It has a built-in DC feedback circuit for reducing the effects of background light. It also provides excellent noise and frequency characteristics. In the S13645-01CR, output can be obtained from any one channel specified in the selection logic.

Features

- **High-speed response: 180 MHz**
- **Two-level gain switch function (low gain: single output, high gain: differential output)**
- **Reduced background light effects**
- **Small waveform distortion when excessive light is incident**

Applications

- **Distance measurement**

Structure

Parameter	Symbol	Specification	Unit
Detector	-	Si APD array	-
Photosensitive area (per element)	A	1.0 × 0.4	mm
Element pitch	-	0.5	mm
Number of elements	-	16	-
Package	-	Plastic	-

Absolute maximum ratings

Parameter	Symbol	Condition	Value	Unit
Supply voltage (for preamp)	Vcc max		4.5	V
Reverse voltage (for APD)	V_APD		0 to V_{BR}	V
Reverse current (DC)	I_R max		0.2	mA
DCFB terminal voltage	-		Vcc + 0.7	V
Gain terminal voltage	-		Vcc + 0.7	V
Channel selection terminal voltage	-		Vcc + 0.7	V
Operating temperature	Topr	No dew condensation*1	-40 to +105	°C
Storage temperature	Tstg	No dew condensation*1	-40 to +125	°C
Soldering temperature*2	Tsol		260 (twice)	°C

*1: When there is a temperature difference between a product and the surrounding area in high humidity environment, dew condensation may occur on the product surface. Dew condensation on the product may cause deterioration in characteristics and reliability.
*2: Reflow soldering, IPC/JEDEC J-STD-020 MSL 3, see P.8
Note: Exceeding the absolute maximum ratings even momentarily may cause a drop in product quality. Always be sure to use the product within the absolute maximum ratings.

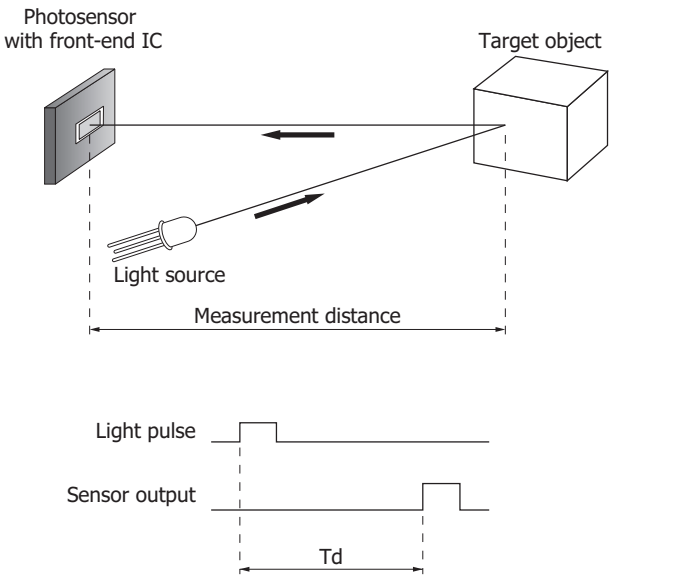
Electrical and optical characteristics (Ta=25 °C)

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
Spectral response range	λ			400 to 1150		nm
Peak sensitivity wavelength	λp	M=100	-	840	-	nm
Photosensitivity	S	λ=905 nm, M=50, low gain	31.5	45	58.5	kV/W
		λ=905 nm, M=50, high gain	630	900	1170	
Breakdown voltage	V_{BR}	I_D=100 µA	120	160	200	V
Temperature coefficient of breakdown voltage	ΔTV_{BR}		-	1.1	-	V/°C
Dark current	I_D	M=50	-	0.4	4	nA
Temperature coefficient of dark current	ΔT_{ID}	M=50	-	1.1	-	times/°C
Terminal capacitance	Ct	M=50, f=1 MHz	-	1.6	-	pF
Excess noise figure	x	M=50, λ=905 nm	-	0.3	-	-
Gain	M	λ=905 nm	40	50	60	-
Current consumption	Icc	Low gain	45	65	85	mA
		High gain	45	65	85	
Low cutoff frequency	fcl	Low gain	-	0.01	0.1	MHz
		High gain	-	0.5	5	
High cutoff frequency	fch	Low gain	120	180	240	MHz
		High gain	100	160	220	
Input conversion noise power	e_n	f=10 MHz, M=50	-	160	220	$fW/Hz^{1/2}$
		f=100 MHz, M=50	-	240	330	
Output voltage level	-	Low gain	0.65	1.15	1.65	V
		High gain	0.5	1	1.5	
Output offset voltage	Voffset	High gain	-	-	±100	mV
Maximum output voltage amplitude	Vp-p max	Low gain	0.3	-0.6	-	V
		High gain	0.4	±0.8	-	
Supply voltage	Vcc1, Vcc2		3.135	3.3	3.465	V
Crosstalk	-		-	-25	-20	dB

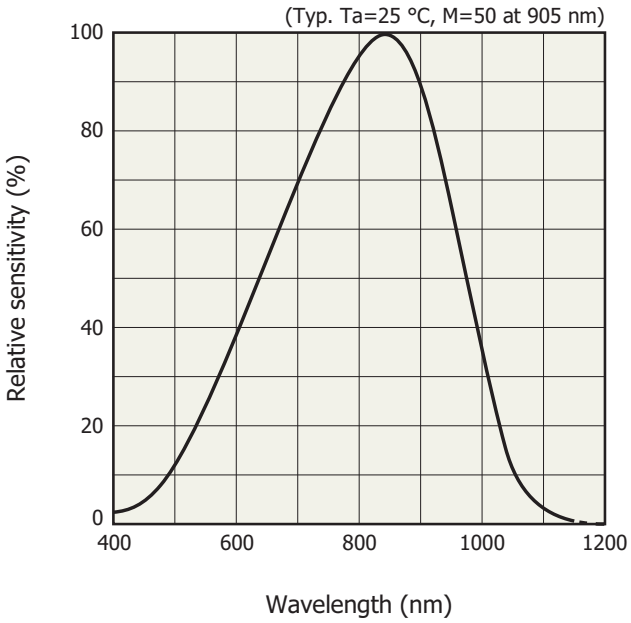
Distance measuring method

Distance L is calculated from the time difference Td between the light source's light emission timing and sensor output and the speed of light c.

$L = (1/2) \times c \times Td$



Spectral response



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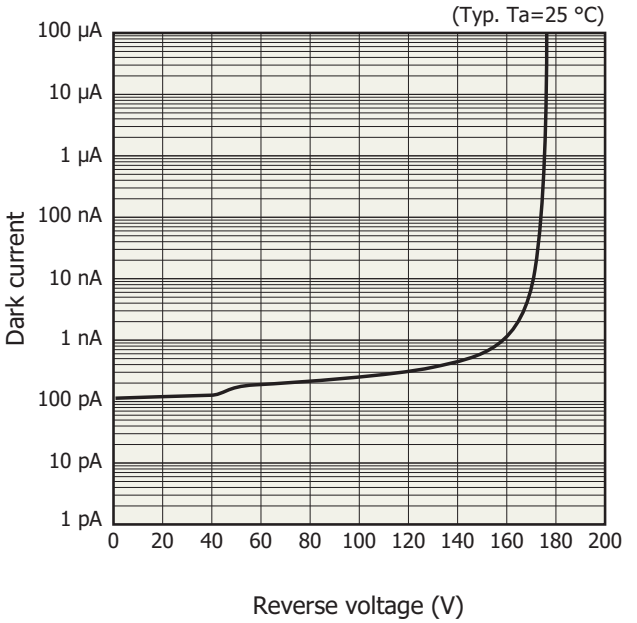
Dark current vs. reverse voltage



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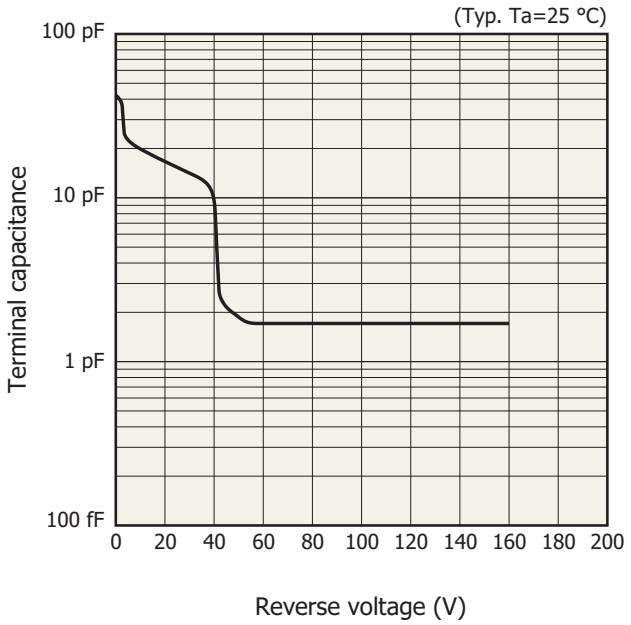
Terminal capacitance vs. reverse voltage



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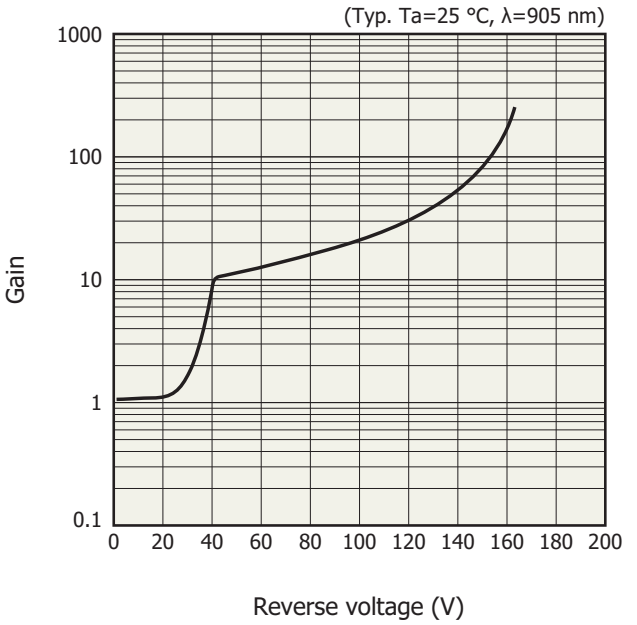
APD gain vs. reverse voltage



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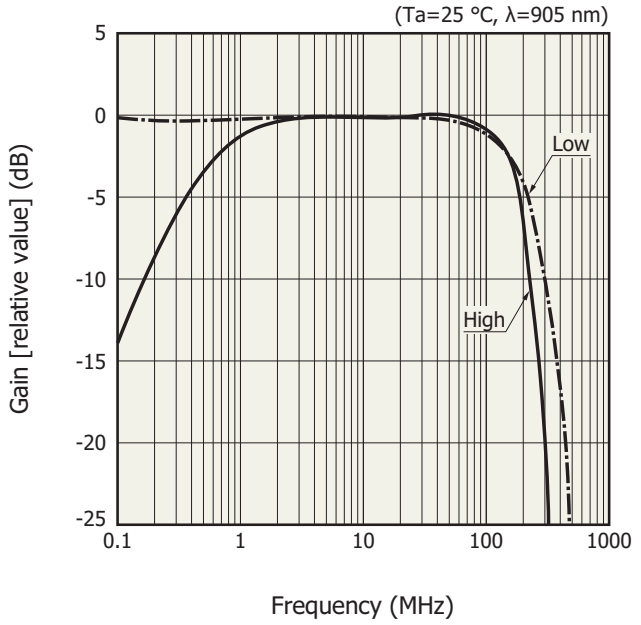
Frequency characteristics (typical example)



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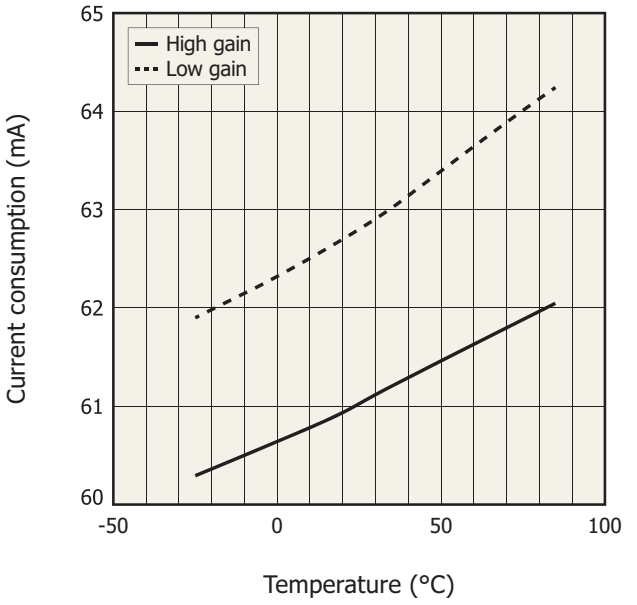
Current consumption vs. temperature (typical example)



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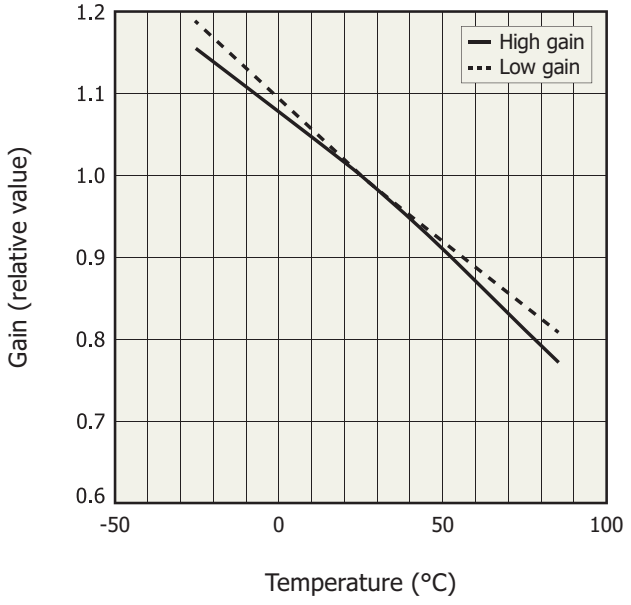
Gain vs. temperature (typical example)



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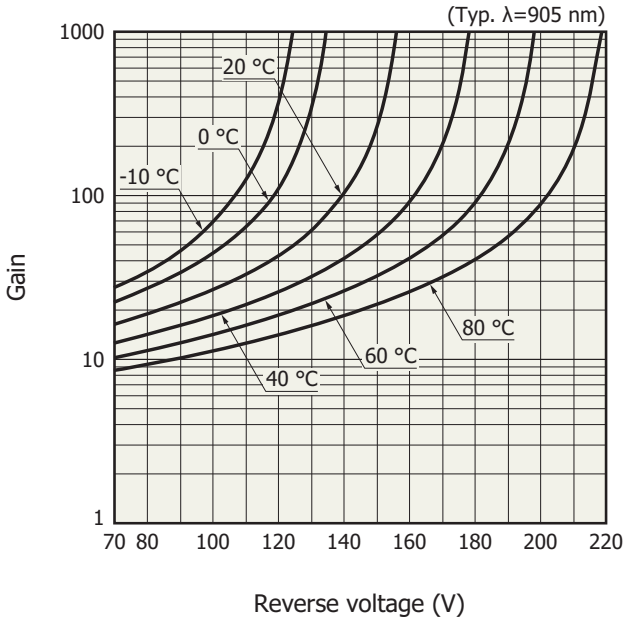
Gain vs. reverse voltage



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Truth table

■ Channel

D3	D2	D1	D0	Output
0	0	0	0	ch1
0	0	0	1	ch2
0	0	1	0	ch3
0	0	1	1	ch4
0	1	0	0	ch5
0	1	0	1	ch6
0	1	1	0	ch7
0	1	1	1	ch8
1	0	0	0	ch9
1	0	0	1	ch10
1	0	1	0	ch11
1	0	1	1	ch12
1	1	0	0	ch13
1	1	0	1	ch14
1	1	1	0	ch15
1	1	1	1	ch16

■ Gain

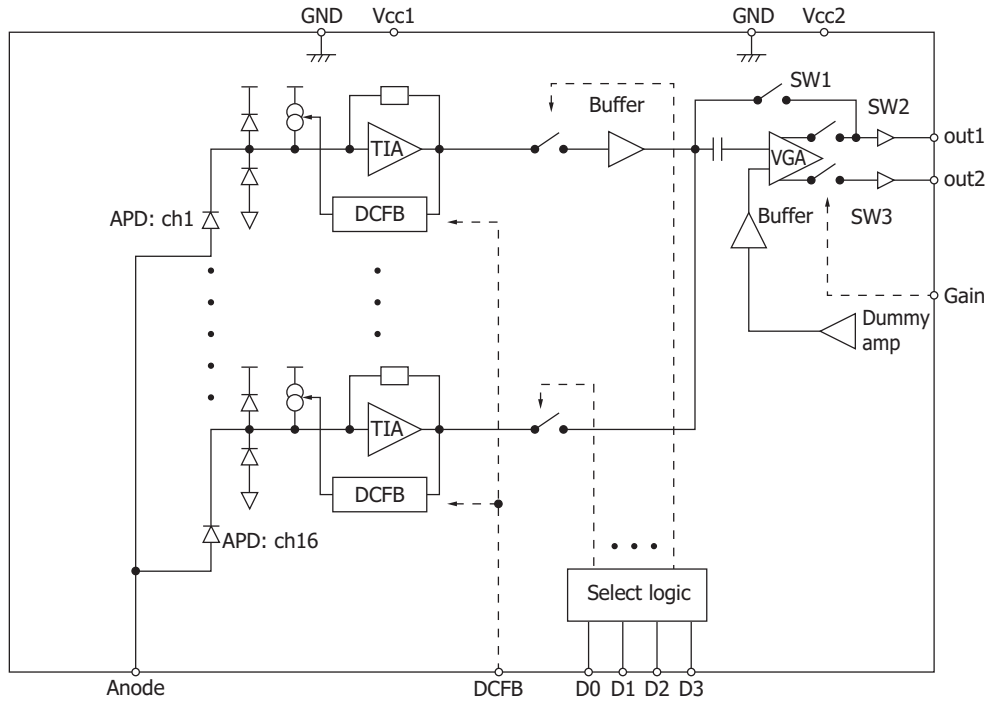
Setting	Gain
0	Low gain (× 1)
1	High gain (× 20)

■ DC feedback circuit

Setting	Background light elimination function
0	ON
1	OFF

Note: 0=Vcc × 0.2 V or less, 1=Vcc × 0.8 V or over
The pull-down resistor of the digital input terminal is 10 kΩ.

Block diagram



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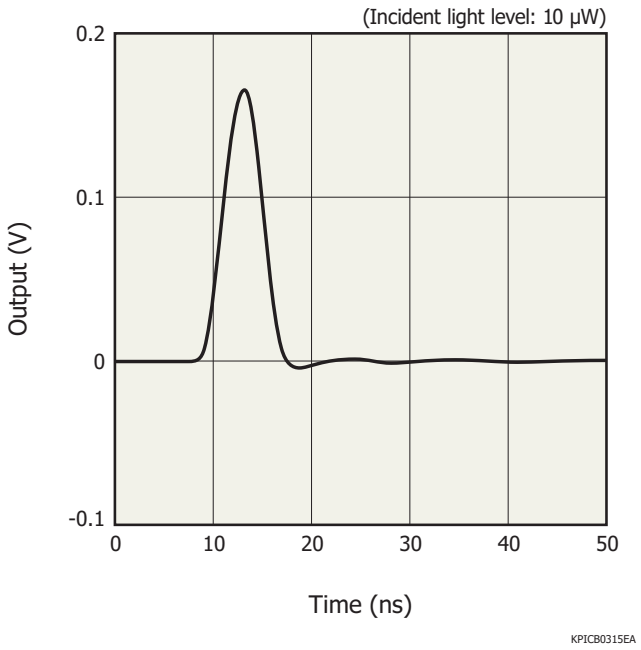
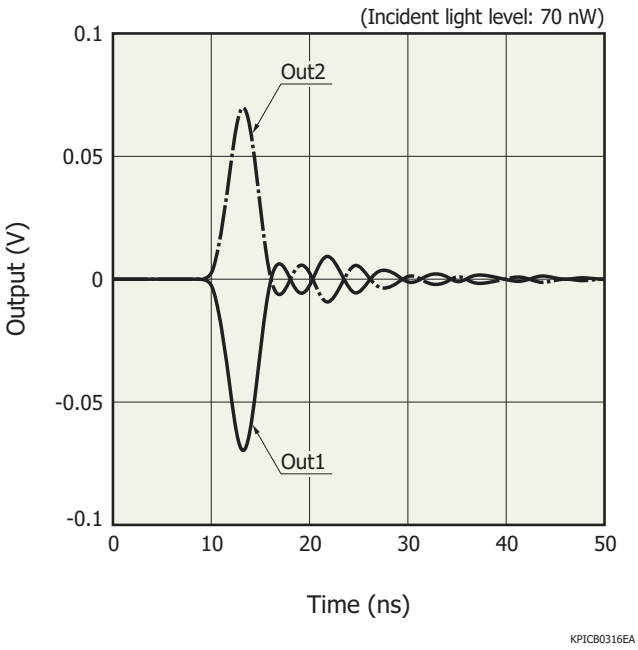
Output waveform examples (Ta=25 °C, M=50, linear region, pulse width=5 ns)

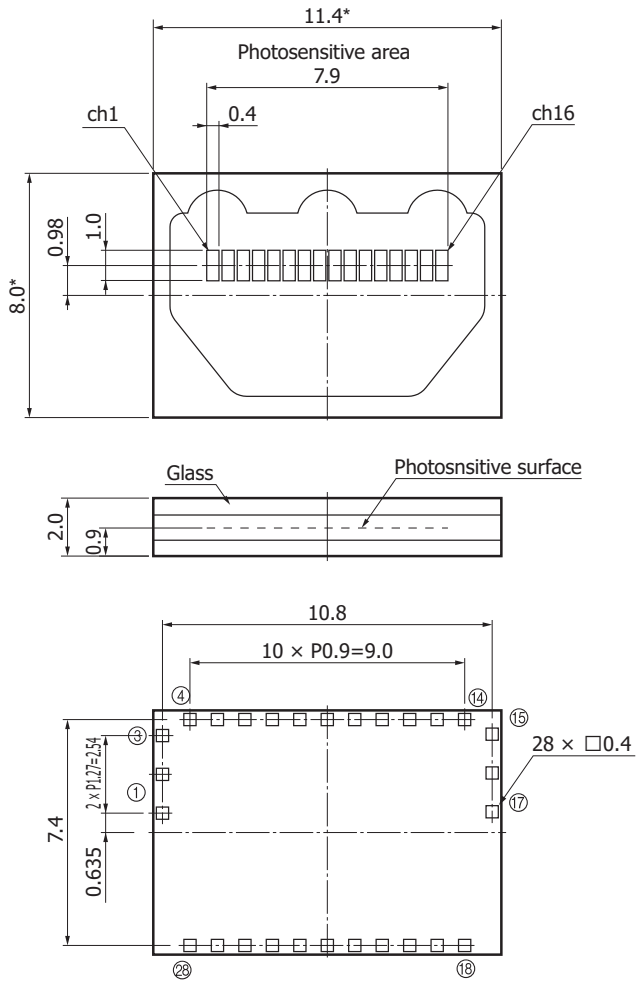
Low gain



High gain



Dimensional outline (unit: mm)



Tolerance unless otherwise noted: ±0.2
Chip position accuracy with respect to the package dimensions marked*:
X, Y≤±0.2, θ≤±2°

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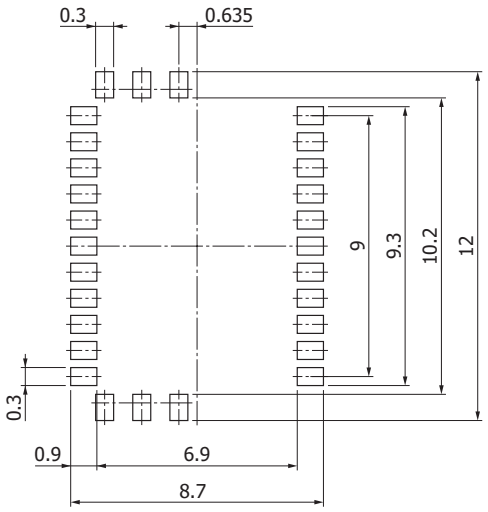
Pin connections

Pin no.	Function	Pin no.	Pin no.
1	NC	15	GND
2	NC	16	DCFB_dis
3	GND	17	NC
4	Vcc1	18	Anode
5	Vcc2	19	Anode
6	out2	20	Anode
7	out1	21	Anode
8	GND	22	Anode
9	Gain	23	Anode
10	D3	24	Anode
11	D2	25	Anode
12	D1	26	Anode
13	D0	27	Anode
14	Vcc1	28	Anode

Leave terminals 1, 2, and 17 open.
Do not connect them to Vcc1, Vcc2, or GND.

Recommended land pattern (unit: mm)



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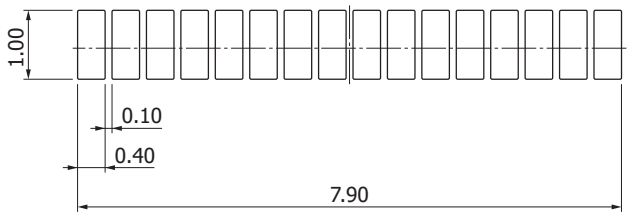
Enlarged view of photosensitive area (unit: mm)



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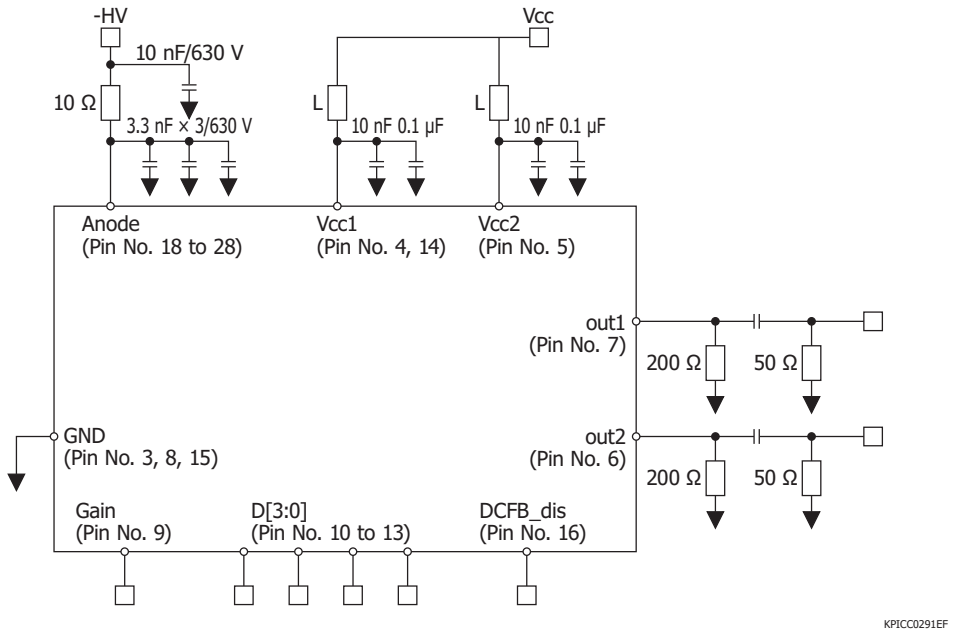
Connection example (50 Ω system)



When using the photosensor with front-end IC in a 50 Ω system, connect resistors with the same resistance (200 Ω in the above figure) to output loads Out1 and Out2. If resistors with the same resistance are not connected to the output loads, the waveform may be distorted or the output may oscillate.

Handling of temperature characteristics of APD gain

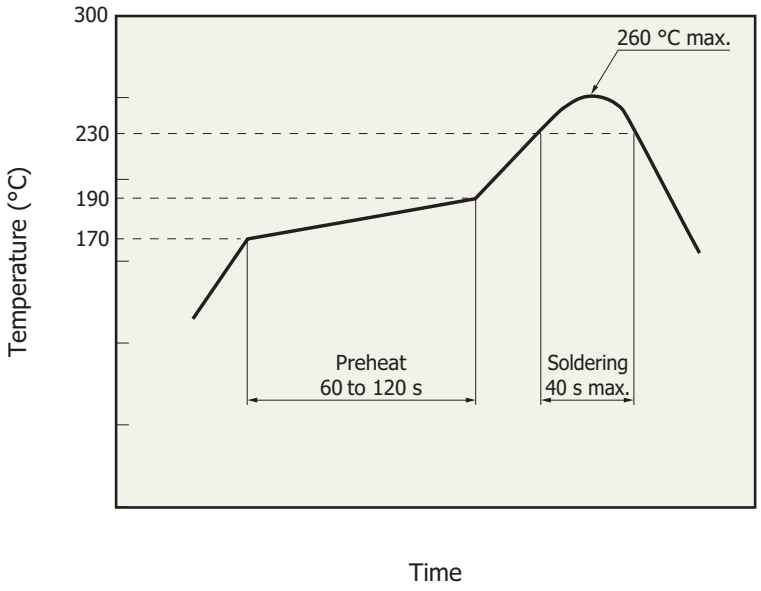
The gain of the APD built into the photosensor with front-end IC varies depending on the temperature. The following two methods are available for handling this issue in using the sensor over a wide temperature range.

① Temperature correction method, which controls the reverse voltage according to the temperature change
A thermistor or other temperature sensor is installed near the APD to measure the APD's temperature. The reverse voltage after APD temperature correction is expressed by the following equation using temperature T of the APD.

V_R (after temperature correction) = V_R (at 25 °C) + (T - 25) × ΔTV_{BR}

② Temperature control method, which keeps the APD temperature constant
A TE-cooler or an equivalent device is used to maintain a constant APD temperature.

Recommended soldering conditions



· This product supports lead-free soldering. After unpacking, store it in an environment at a temperature of 30 °C or less and a humidity of 60% or less, and perform soldering within 24 hours.
· The effect that the product receives during reflow soldering varies depending on the circuit board and reflow oven that are used. Before actual reflow soldering, check for any problems by testing out the reflow soldering methods in advance.

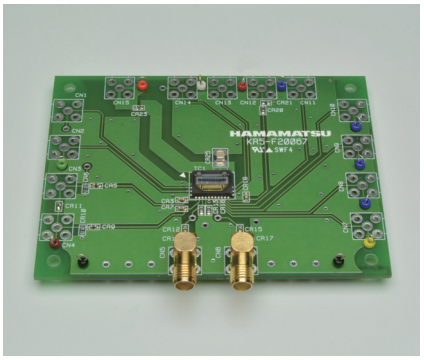
Related information

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

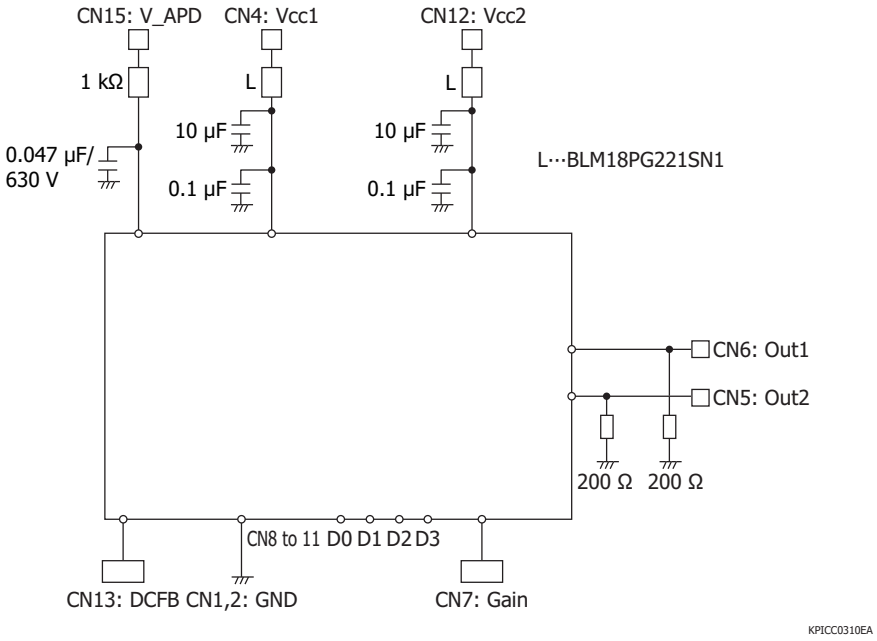
■ Precautions
· Disclaimer
· Metal, ceramic, plastic packages
· Surface mount type products

Evaluation kit for photosensor with front-end IC C13666-03

Evaluation kit [95 × 72 (H × V) mm] for photosensor with front-end IC is available (with the S13645-01CR). Contact us for detailed information.



Equivalent circuit



Information described in this material is current as of December 2020.
Product specifications are subject to change without prior notice due to improvements or other reasons. This document has been carefully prepared and the information contained is believed to be accurate. In rare cases, however, there may be inaccuracies such as text errors. Before using these products, always contact us for the delivery specification sheet to check the latest specifications.
The product warranty is valid for one year after delivery and is limited to product repair or replacement for defects discovered and reported to us within that one year period. However, even if within the warranty period we accept absolutely no liability for any loss caused by natural disasters or improper product use.

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