



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)	V _{cc} 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	-		V _{cc} + 0.7	V
Gain terminal voltage	-		V _{cc} + 0.7	V
Channel selection terminal voltage	-		V _{cc} + 0.7	V
Operating temperature	T _{opr}	No dew condensation*1	-40 to +105	°C
Storage temperature	T _{stg}	No dew condensation*1	-40 to +125	°C
Soldering temperature*2	T _{sol}		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)

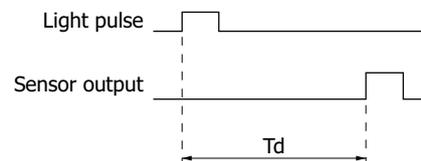
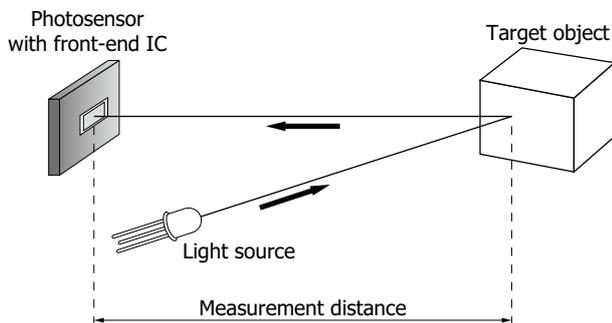
Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
Spectral response range	λ		400 to 1150			nm
Peak sensitivity wavelength	λ_p	M=100	-	840	-	nm
Photosensitivity	S	$\lambda=905$ nm, M=1	-	0.5	-	A/W
Breakdown voltage	V _{BR}	I _D =100 μ A	120	160	200	V
Temperature coefficient of breakdown voltage	Δ T _{VBR}		-	1.1	-	V/°C
Dark current	I _D	M=50	-	0.4	4	nA
Temperature coefficient of dark current	Δ T _{I_D}	M=50	-	1.1	-	times/°C
Terminal capacitance	C _t	M=50, f=1 MHz	-	1.6	-	pF
Excess noise figure	x	M=50, $\lambda=905$ nm	-	0.3	-	-
APD gain	M	$\lambda=905$ nm	40	50	60	-
Transimpedance amplifier gain	G	Low gain	-	1.8	-	kV/A
		High gain	-	36	-	
Current consumption	I _{cc}	Low gain	45	65	85	mA
		High gain	45	65	85	
Low cutoff frequency	f _{cl}	Low gain	-	0.01	0.1	MHz
		High gain	-	0.5	5	
High cutoff frequency	f _{ch}	Low gain	120	180	240	MHz
		High gain	100	160	220	
Equivalent input current noise*3	e _n	f=10 MHz, M=50	-	4	5.5	pA/Hz ^{1/2}
		f=100 MHz, M=50	-	6	8.25	
Output voltage level	-	Low gain	0.65	1.15	1.65	V
		High gain	0.5	1	1.5	
Output offset voltage	V _{offset}	High gain	-	-	±100	mV
Maximum output voltage amplitude	V _{p-p max}	Low gain	0.3	-0.6	-	V
		High gain	0.4	±0.8	-	
Supply voltage	V _{cc1} , V _{cc2}		3.135	3.3	3.465	V
Crosstalk	-		-	-25	-20	dB

*3: Reference values defined by simulation or characteristic evaluation

Distance measuring method

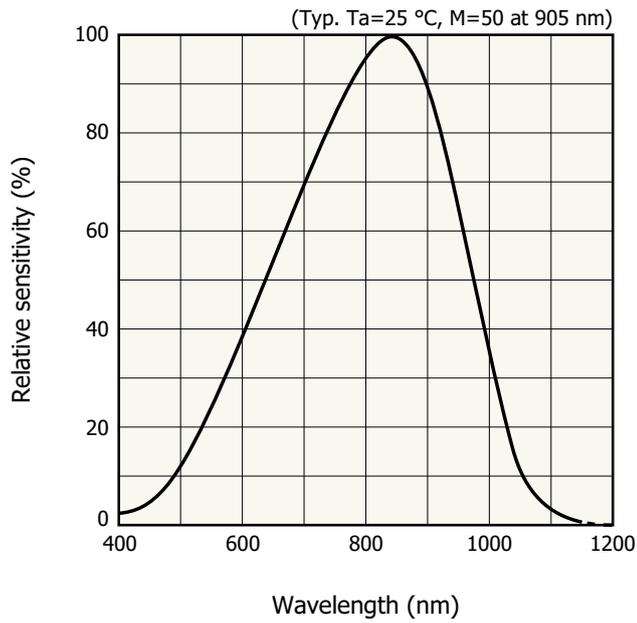
Distance L is calculated from the time difference T_d between the light source's light emission timing and sensor output and the speed of light c.

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



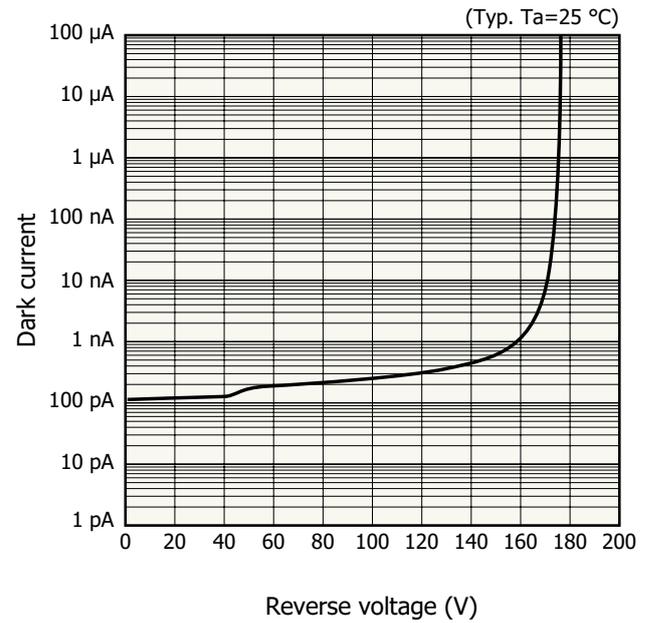
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Spectral response



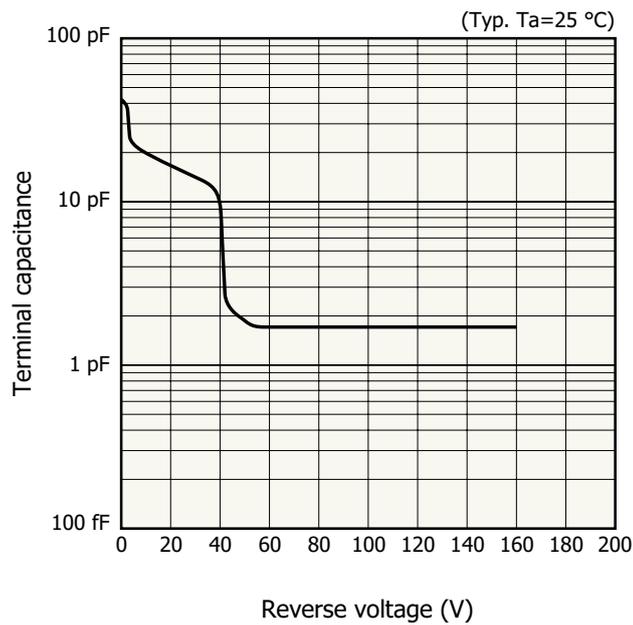
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Dark current vs. reverse voltage



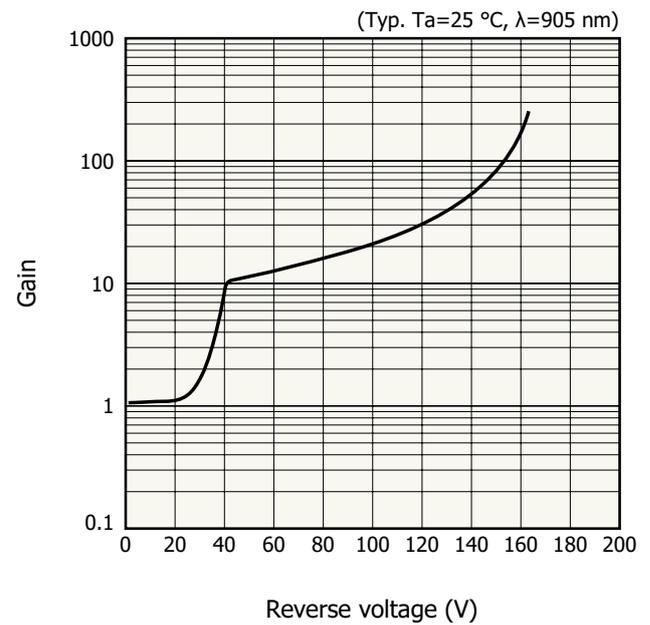
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Terminal capacitance vs. reverse voltage



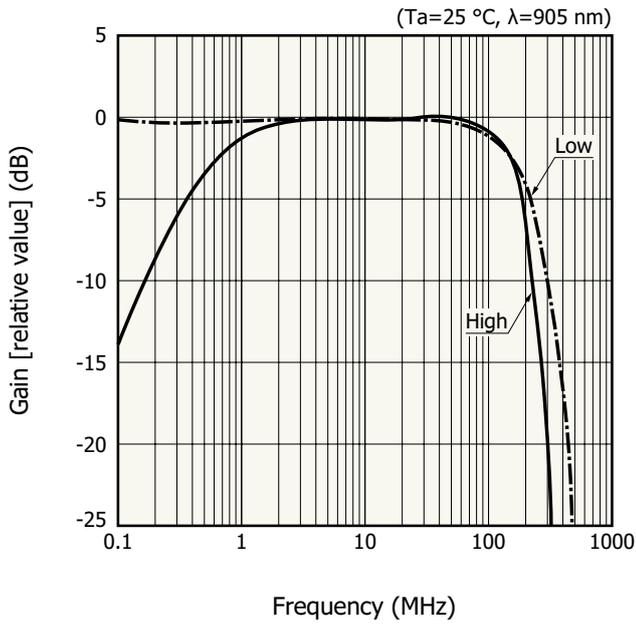
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APD gain vs. reverse voltage

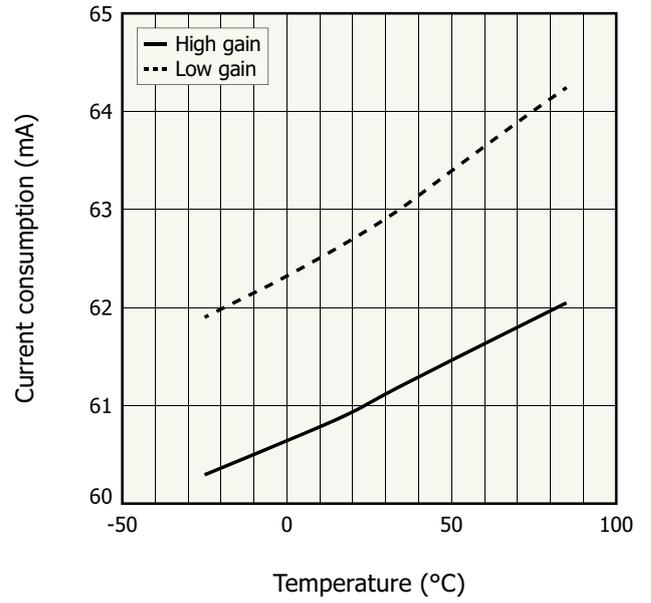


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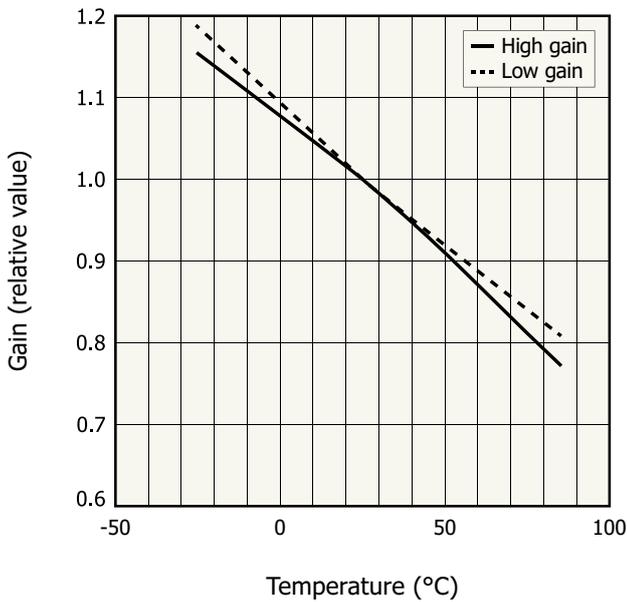
Frequency characteristics (typical example)



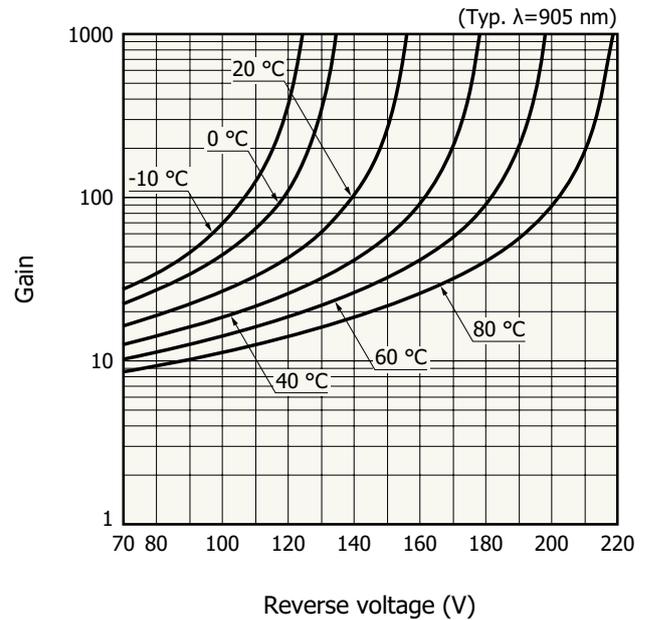
Current consumption vs. temperature (typical example)



Gain vs. temperature (typical example)



Gain vs. reverse voltage



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

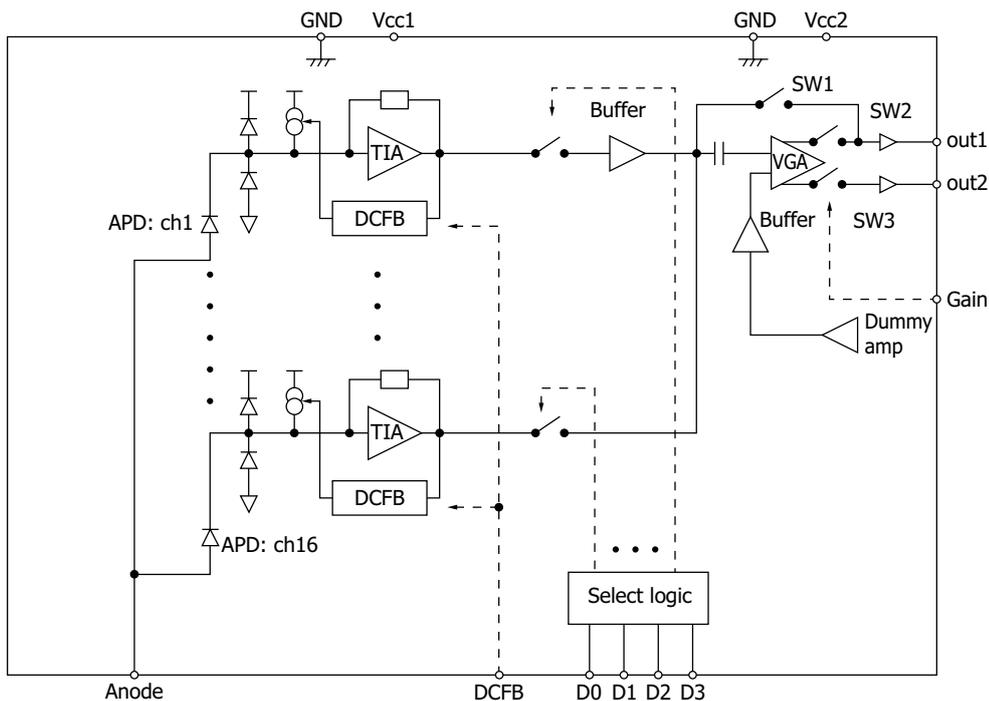
Setting	Gain
0	Low gain (× 1)
1	High gain (× 20)

■ DC feedback circuit

Setting	Background light elimination function
0	ON
1	OFF

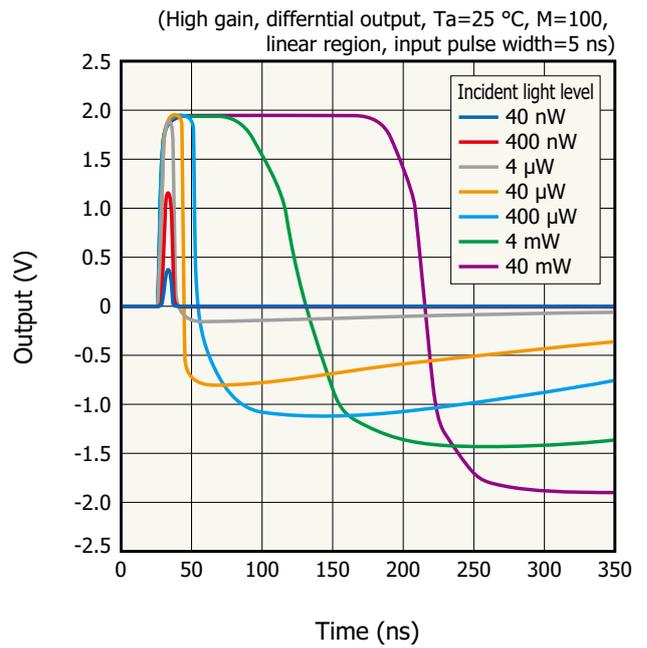
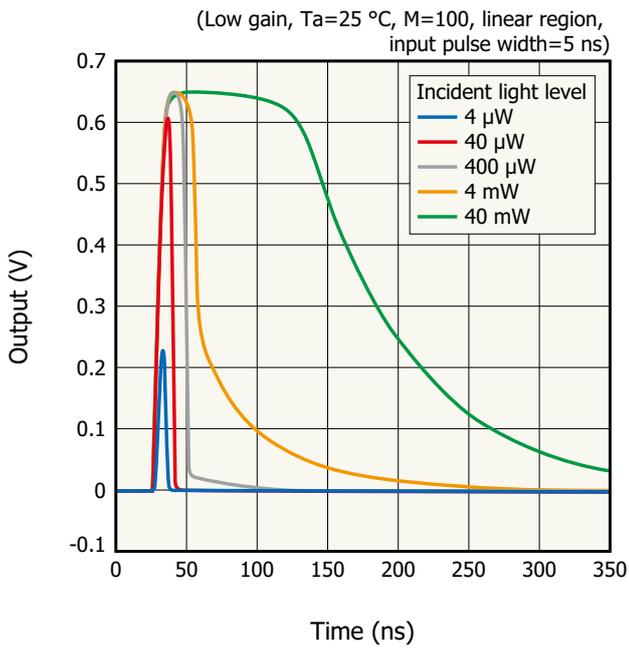
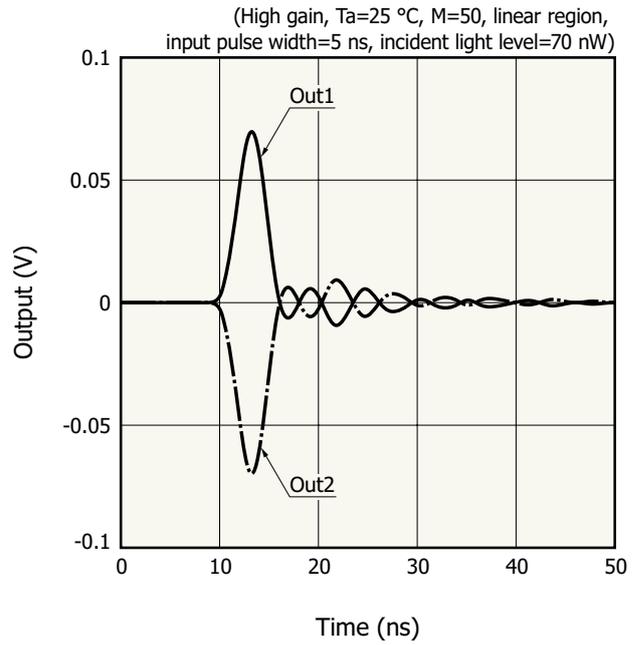
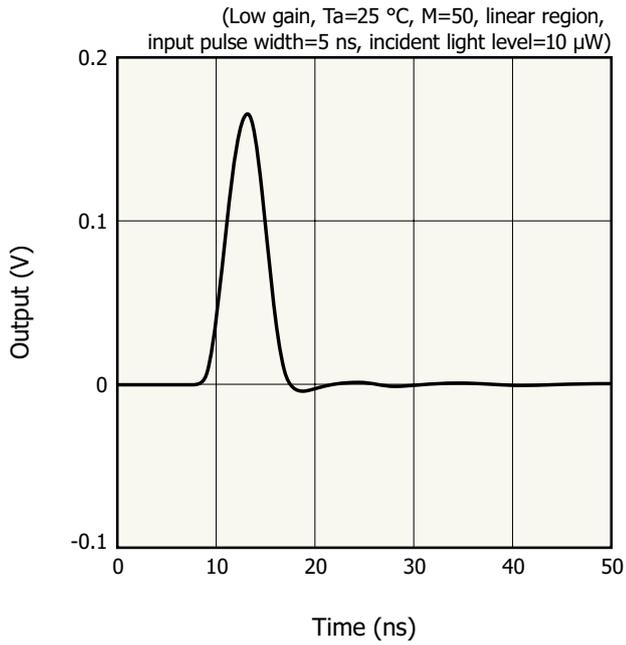
Note: 0=Vcc × 0.2 V or less, 1=Vcc × 0.8 V or over
 The pull-down resistor of the digital input terminal is 10 kΩ.

Block diagram

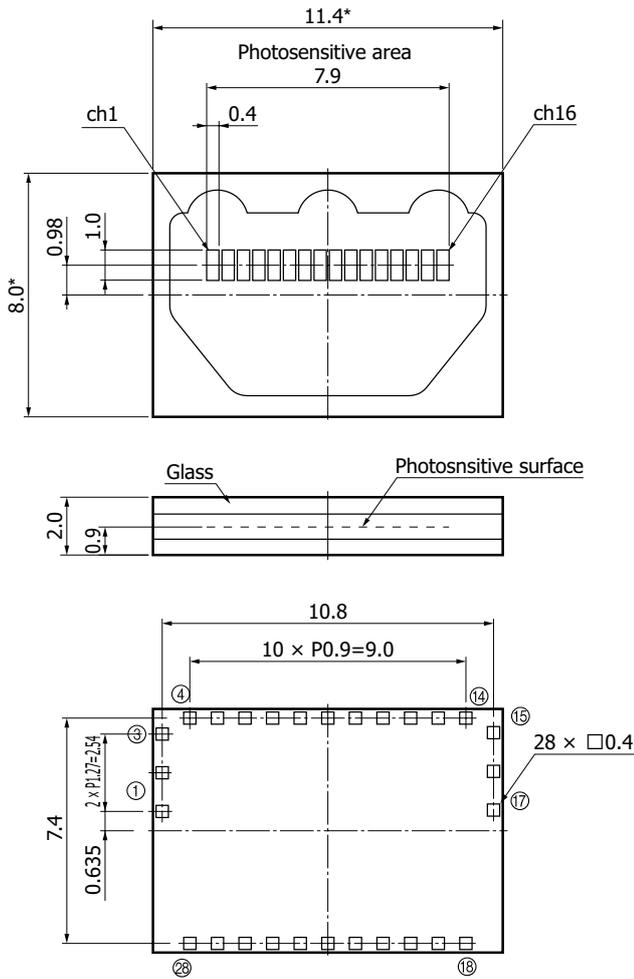


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Output waveform examples



Dimensional outline (unit: mm)



Tolerance unless otherwise noted: ± 0.2
 Chip position accuracy with respect to the package dimensions marked*:
 $X, Y \leq \pm 0.2, \theta \leq \pm 2^\circ$

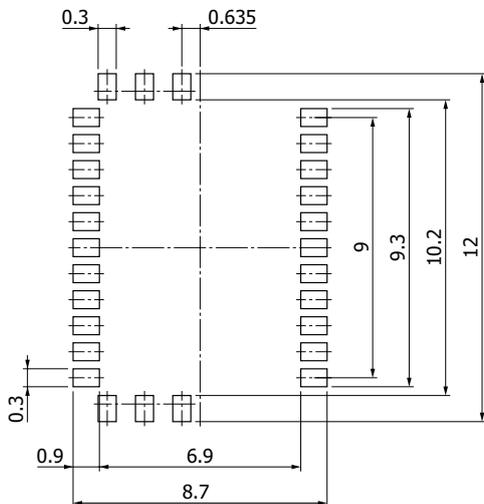
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Pin connections

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

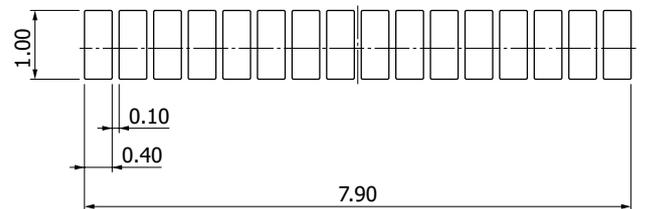
Leave terminals 1, 2, and 17 open.
 Do not connect them to Vcc1, Vcc2, or GND.

Recommended land pattern (unit: mm)



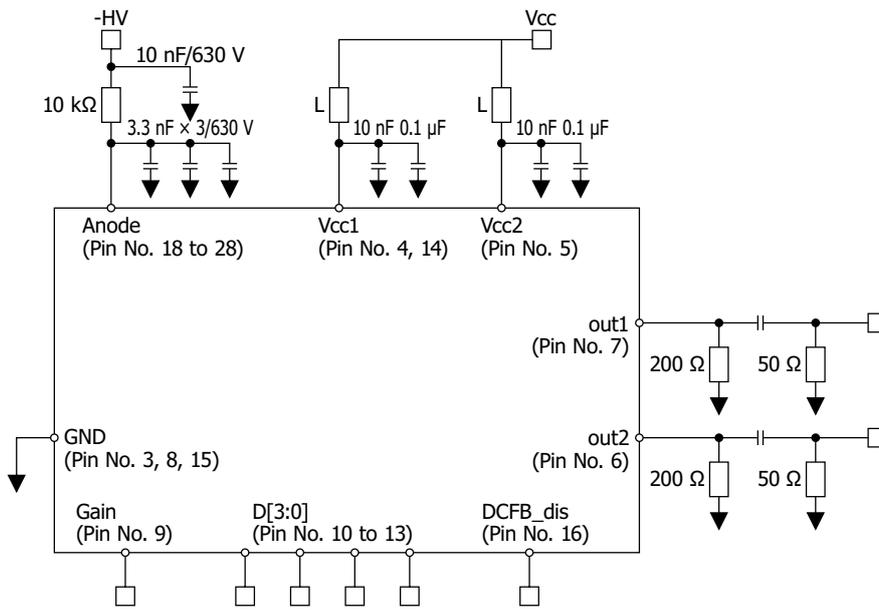
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Enlarged view of photosensitive area (unit: mm)



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Connection example (50 Ω system)



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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

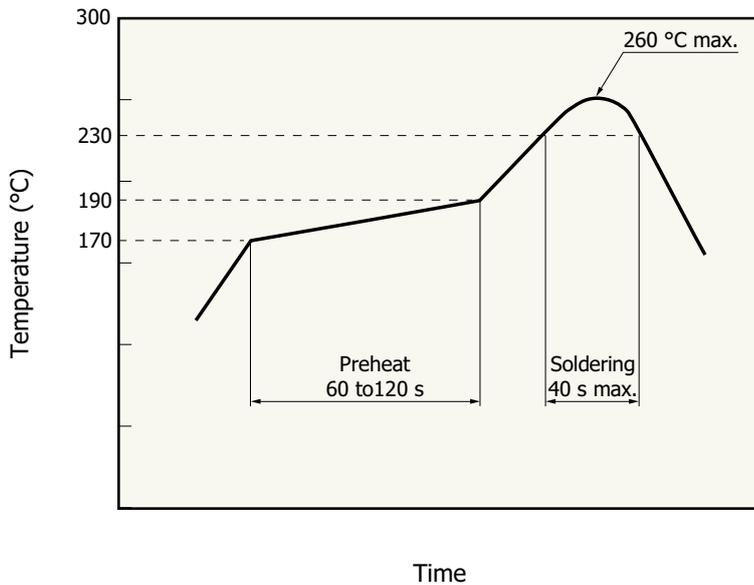
The gain of the APD built into the photosensor with front-end IC varies depending on the temperature. The following two methods are available for handling this issue in using the sensor over a wide temperature range.

- 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.

$$V_R \text{ (after temperature correction)} = V_R \text{ (at 25 °C)} + (T - 25) \times \Delta TV_{BR}$$

- 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



KPICC0346EA

- 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

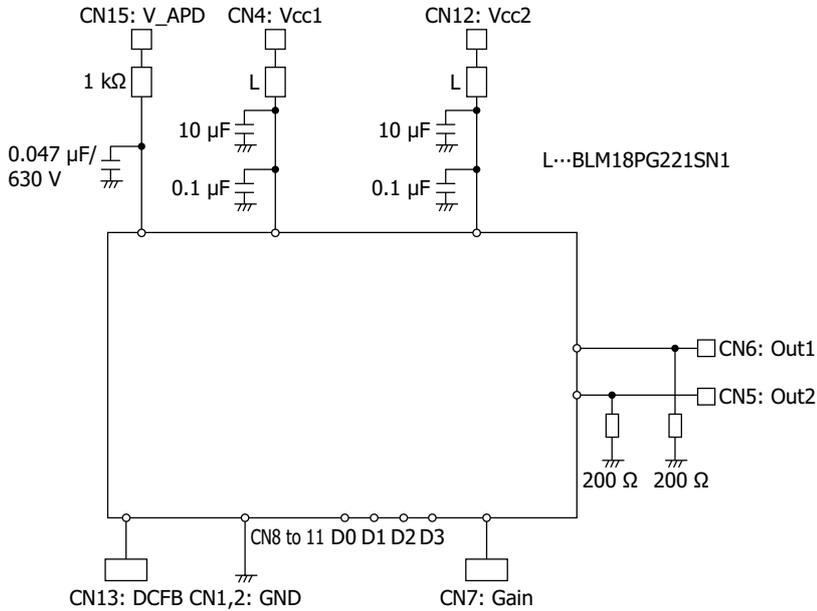
- Precautions
 - Disclaimer
 - Precautions / Metal, ceramic, plastic package products
 - Precautions / Surface mount type products
- Catalogs
 - Selection guide / Photo IC

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

Evaluation kit equipped with S13645-01CR is available. Contact us for detailed information.



Equivalent circuit



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Information described in this material is current as of November 2024.

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