» Technical note

Photosensors with front-end IC S13282-01CR, S13645-01CR

Contents

1. Features

The photosensor with front-end IC is a compact optical device that integrates a Si APD 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.

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

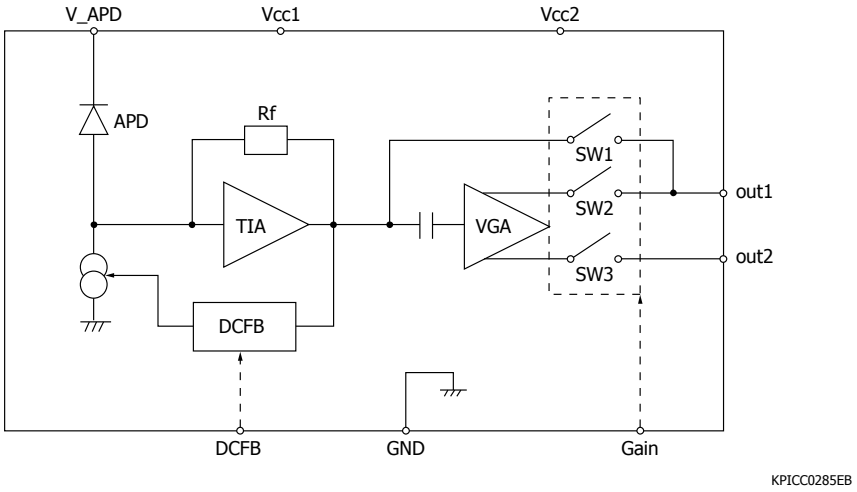
[Table 1-1] Product lineup

Type no.	Structure	Evaluation kit
S13282-01CR	1 ch element Si APD and preamp	C13283-03
S13645-01CR	16 ch element Si APD array and preamp	C13666-03

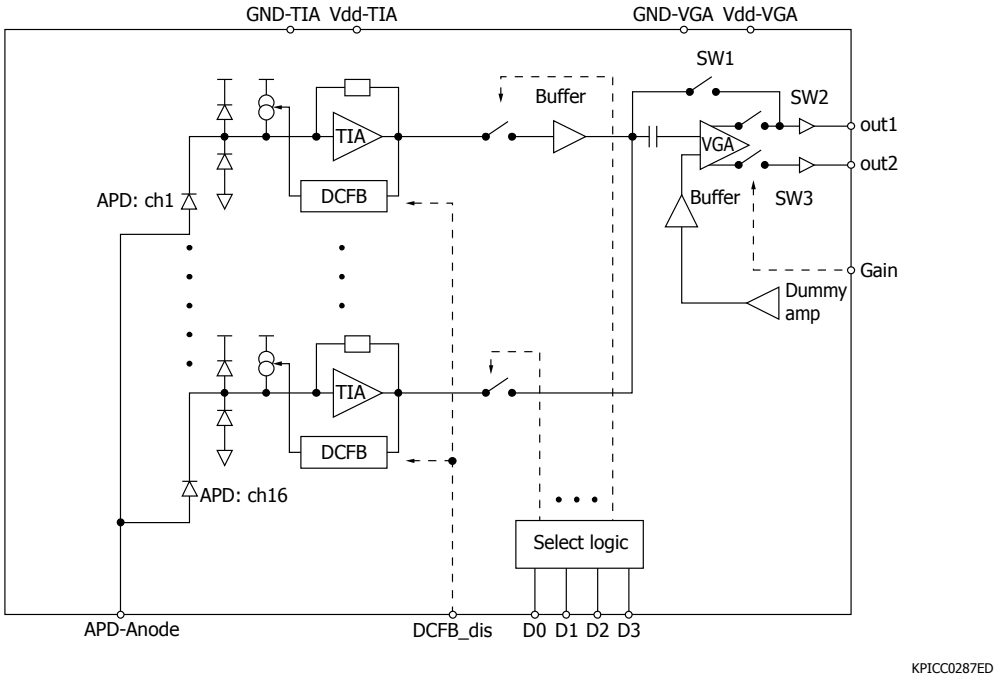
2. Structure

[Figure 2-1] Block diagram

(a) S13282-01CR



(b) S13645-01CR



APD	1 ch Si APD (S13282-01CR), 16 ch Si APD array (S13645-01CR)
TIA	First-stage transimpedance amplifier
DCFB	Ambient light elimination circuit (on/off switching with the DCFB terminal)
VGA	Latter-stage transimpedance amplifier
SW1, SW2, SW3	Gain selection switch (Low gain: SW1=ON, SW2, SW 3=OFF, high gain: SW1=OFF, SW2, SW3=ON)
Selection logic	Channel switching (S13645-01CR only)

Set the gain, DC feedback circuit, and channel as Table 2-1:

[Table 2-1] Truth table

(a) Gain

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

(b) DC feedback circuit

DC feedback circuit	Ambient light elimination function
0	ON
1	OFF

(c) Channel (S13645-01CR)

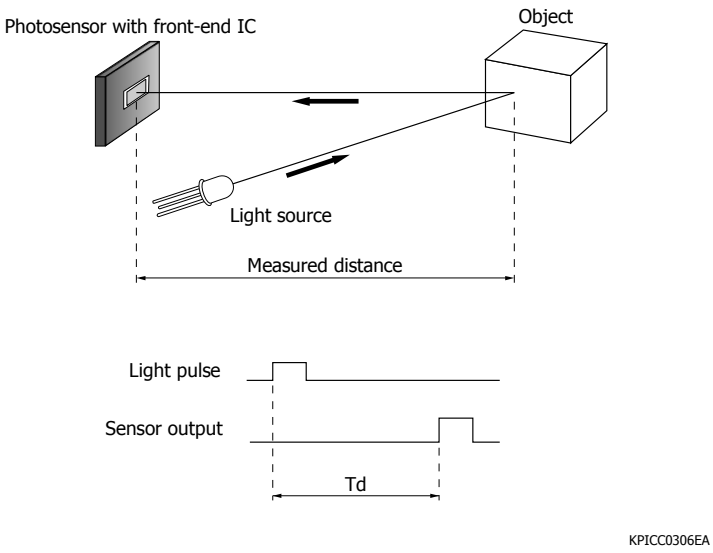
D3	D2	D1	D0	Output
0	0	0	0	C0
0	0	0	1	C1
0	0	1	0	C2
0	0	1	1	C3
0	1	0	0	C4
0	1	0	1	C5
0	1	1	0	C6
0	1	1	1	C7
1	0	0	0	C8
1	0	0	1	C9
1	0	1	0	C10
1	0	1	1	C11
1	1	0	0	C12
1	1	0	1	C13
1	1	1	0	C14
1	1	1	1	C15

Note: 0: Vcc × 0.2 V or less, 1: Vcc × 0.8 V or more

3. Operating principle

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 [equation (3-1)].

[Figure 3-1] Distance measurement method



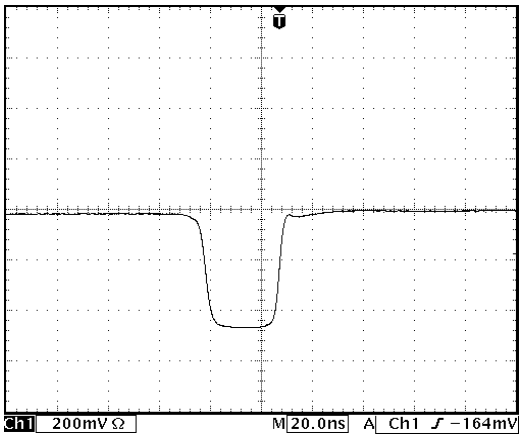
$$L = (1/2) \times c \times Td \quad \ldots \quad (3\text{-}1)$$

4. Characteristics

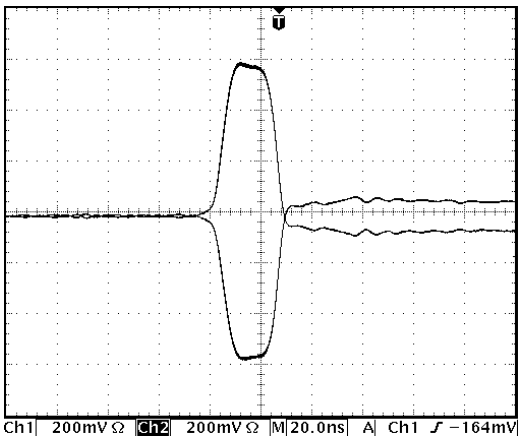
Figures 4-1 to 4-6 show the various characteristics of the S13282-01CR photosensor with front-end IC.

[Figure 4-1] Output waveforms
(S13282-01CR, typical example, Ta=25 °C, M=100, linear region, input pulse width=20 ns)

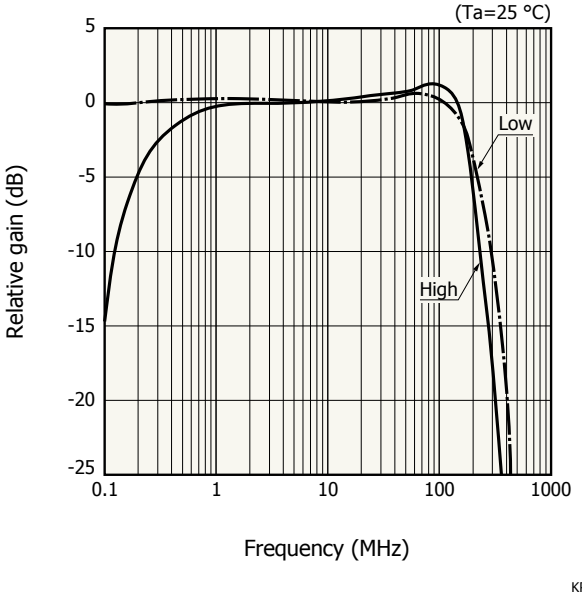
(a) Low gain



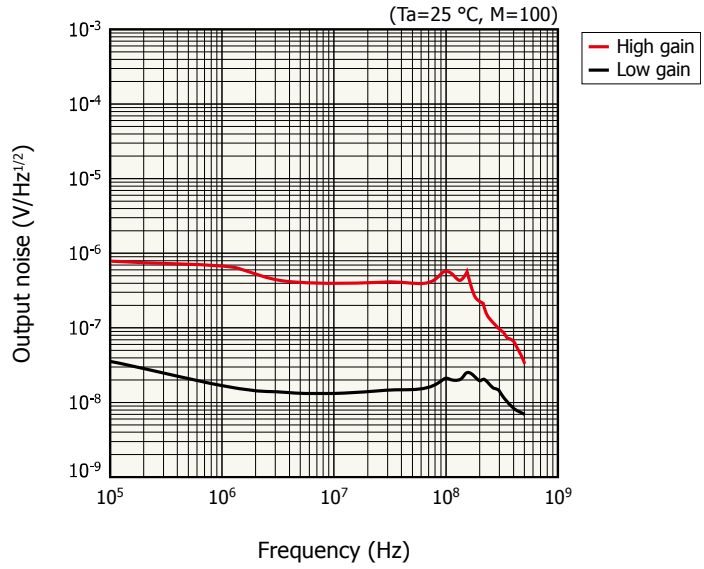
(b) High gain



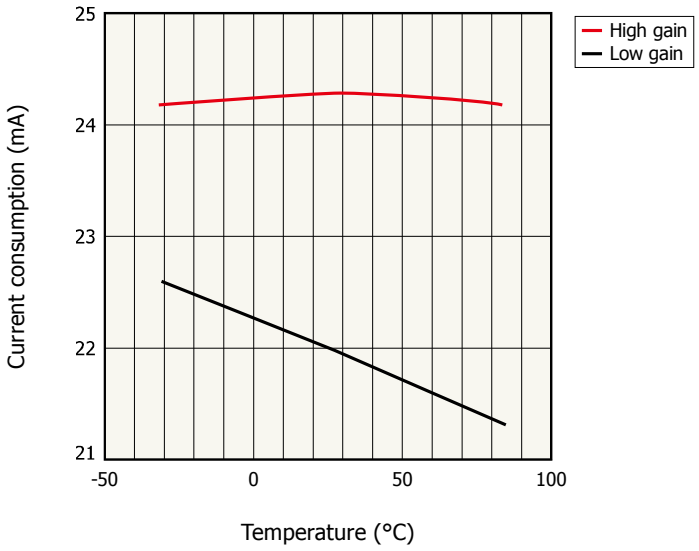
[Figure 4-2] Frequency characteristics (S13282-01CR, typical example, M=100, linear region)



[Figure 4-3] Output noise vs. frequency (S13282-01CR, typical example)



[Figure 4-4] Current consumption vs. temperature (typical example)
(a) S13282-01CR



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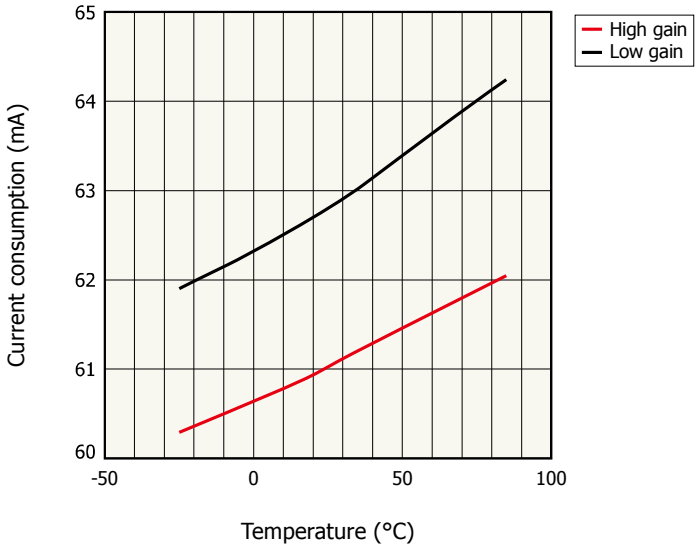
(b) S13645-01CR



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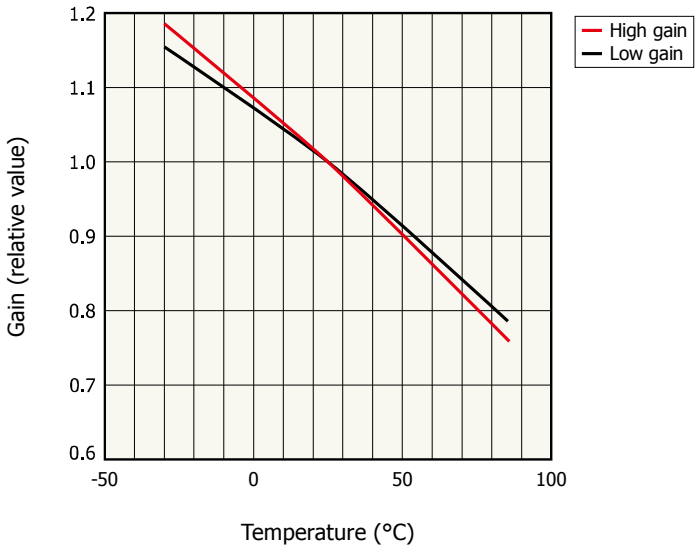
[Figure 4-5] Gain vs. temperature (typical example)
(a) S13282-01CR



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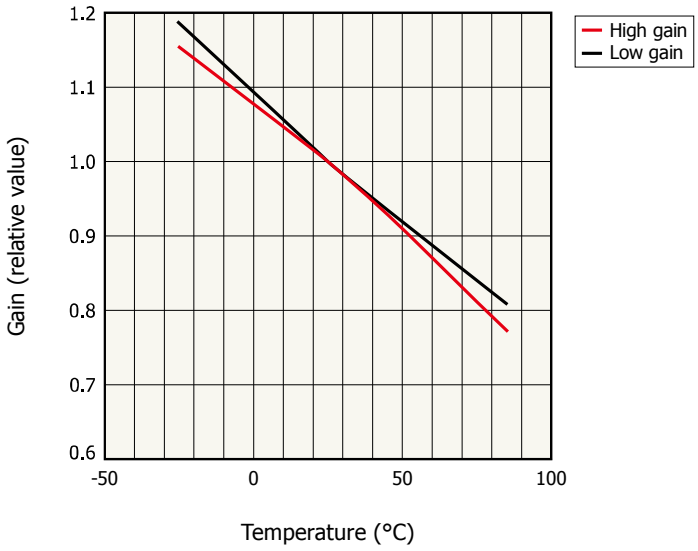
(b) S13645-01CR



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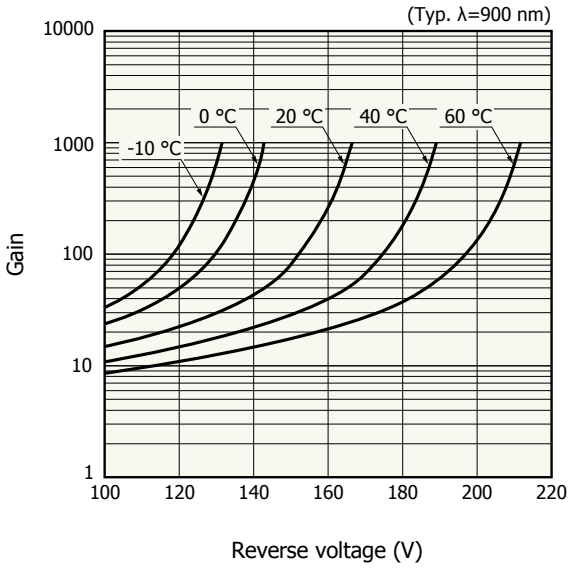
[Figure 4-6] Gain vs. reverse voltage (S13282-01CR)



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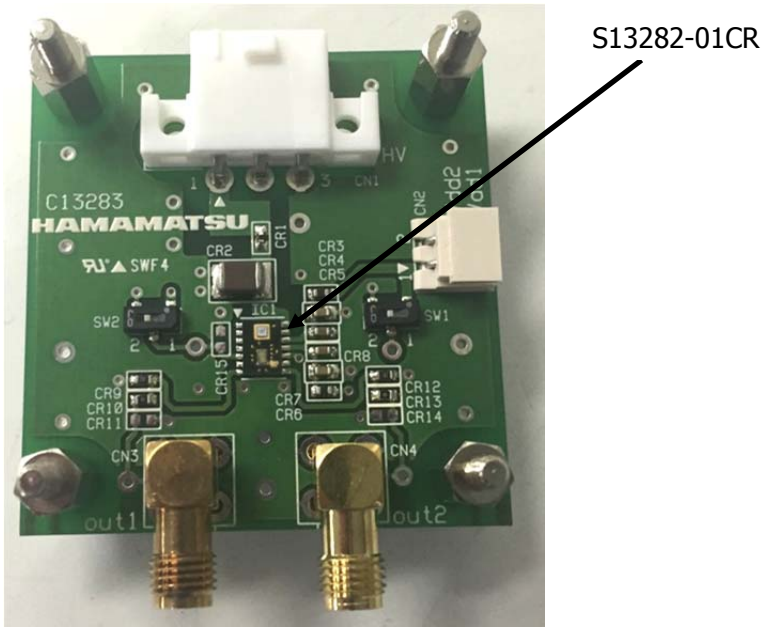
5. Evaluation circuit

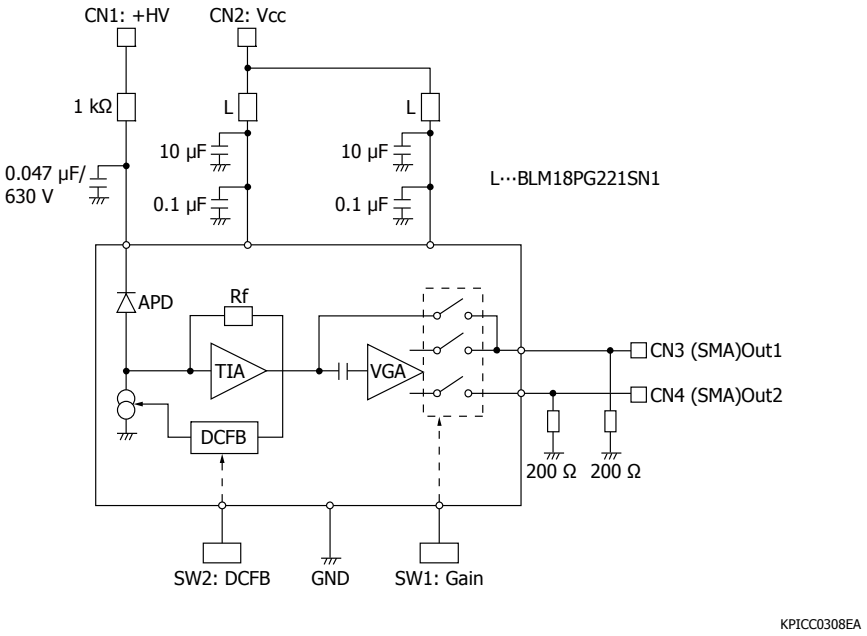
Hamamatsu provides an evaluation circuit for these products. Contact us for detailed information.

5-1. Evaluation circuit for S13282-01CR

[Figure 5-1] Evaluation circuit for S13282-01CR



[Figure 5-2] Equivalent circuit (evaluation circuit for S13282-01CR)

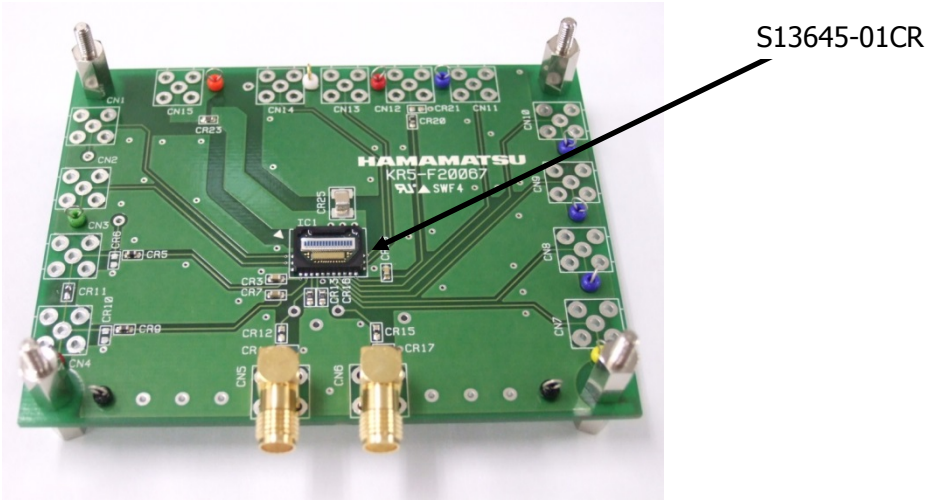


Structure of the evaluation circuit for S13282-01CR

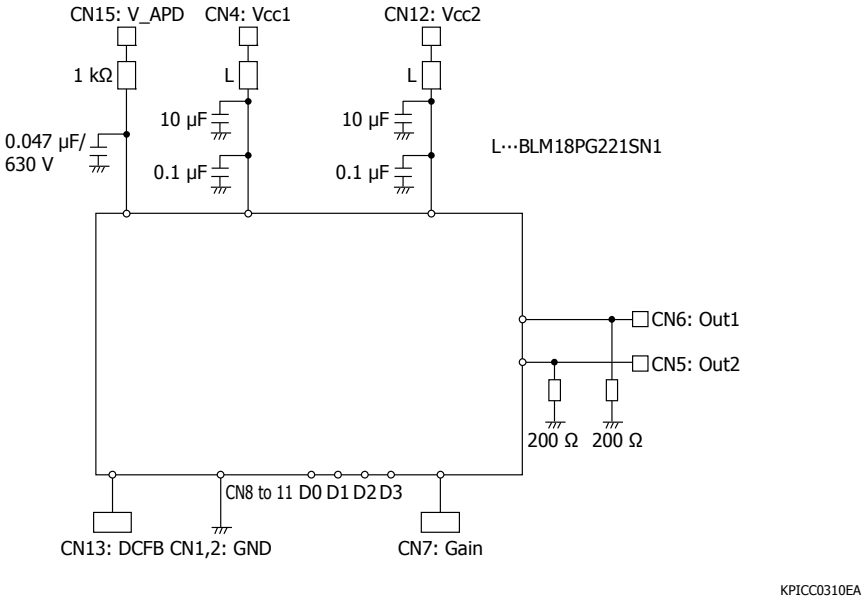
- Sensor circuit board (S13282-01CR is reflow mounted)
- IC power cable
- APD power cable

5-2. Evaluation circuit for S13645-01CR

[Figure 5-3] Evaluation circuit for S13645-01CR



[Figure 5-4] Equivalent circuit (evaluation circuit for S13645-01CR)



Structure of the evaluation circuit for S13645-01CR

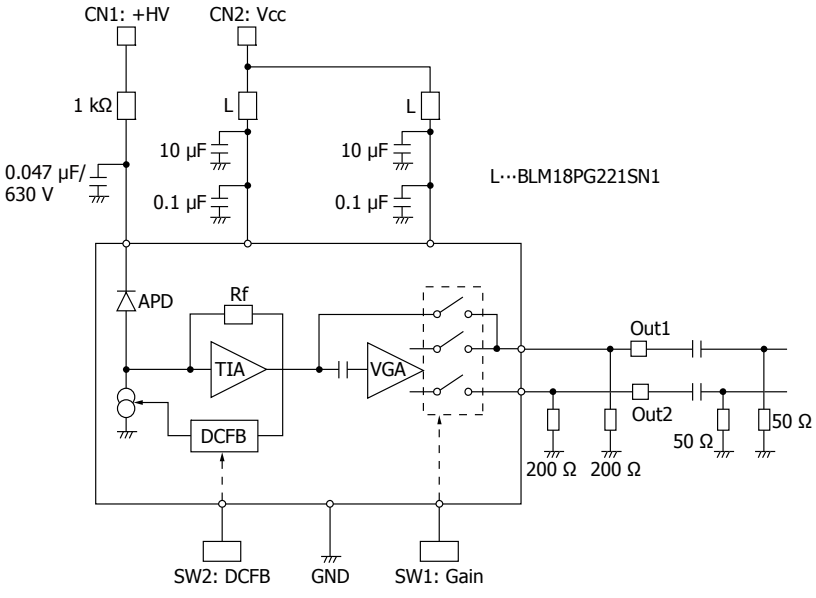
• Sensor circuit board (S13645-01CR is reflow mounted)

6. How to use

6-1. How to use in a 50 Ω system

To use a photosensor with front-end IC in a 50 Ω system, align output loads out1 and out2 as shown in Figure 6-1. If the output loads are not aligned, the waveform may distort or the output may oscillate.

[Figure 6-1] Equivalent circuit (S13282-01CR evaluation circuit, 50 Ω system)



6-2. Handling of the temperature characteristics of the APD gain

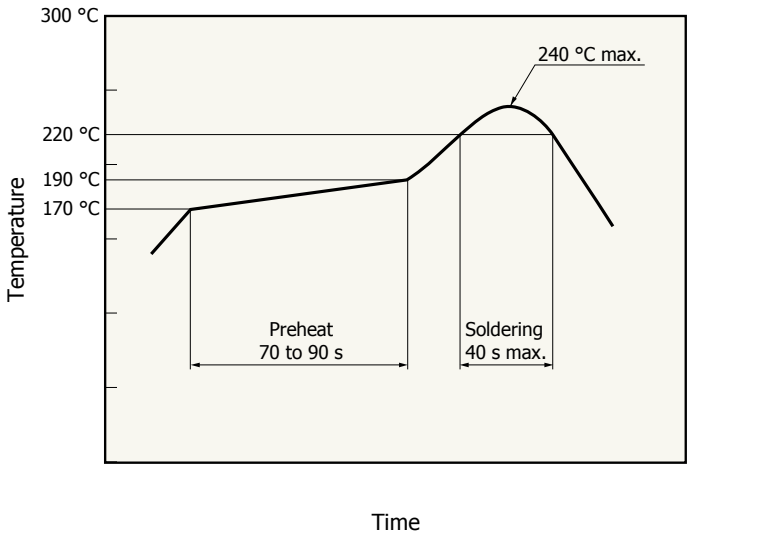
The gain of the APD built into the photosensor with front-end IC varies depending on the temperature. The following two methods are available for handling this issue in using the sensor over a wide temperature range.

① Temperature compensation method, which controls the reverse voltage according to the temperature change
A thermistor or other temperature sensor is installed near the APD to control the reverse voltage according the APD's temperature coefficient.

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.

6-3. Recommended reflow condition

[Figure 6-2] Measured example of temperature profile with our hot-air reflow oven for product testing



- 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. When you set reflow soldering conditions, check that problems do not occur in the product by testing out the conditions in advance.

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