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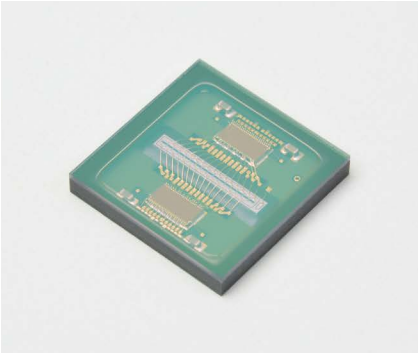
NEW

# Photosensor with front-end IC



S16430-01CR

## Built-in 16-element gain-stabilized APD array suitable for short pulse light detection (parallel output)

This device is for direct TOF (time-of-flight) distance measurement, integrating a 16 ch Si APD array and a transimpedance amplifier. A gain-stabilized APD (GS APD) is used, and there is little gain fluctuation relative to temperature fluctuation, so there is no need for a temperature sensor or microcontroller. It has an increased high-band cutoff frequency (300 MHz) of the transimpedance amplifier compared to previous products, realizing high-speed response.

### Features

- **16 ch parallel output**
- **Stable gain against temperature fluctuations**
- **No gain adjustment according to individual differences required**
- **Built-in high-speed transimpedance amplifier: 300 MHz**
- **Low noise**
- **No ringing**
- **Low crosstalk**

### Applications

- **Distance measurement**
- **Presence or absence of objects**

### Structure

| Parameter | Symbol | Specification | Unit |
|---|---|---|---|
| Detector | - | Si APD array | - |
| Photosensitive area*1 (per element) | A | 0.15 × 0.45 | mm |
| Element pitch | - | 0.5 | mm |
| Number of elements | - | 16 | - |
| Number of output | - | 16 | - |
| Package | - | Glass epoxy | - |
| Window material | - | Glass | - |

*1: Area in which a typical gain can be obtained

### Absolute maximum ratings

| Parameter | Symbol | Condition | Value | Unit |
|---|---|---|---|---|
| Supply voltage (for transimpedance amplifier) | Vcc max | | 4.0 | V |
| Digital input voltage | Vdig | | -0.5 to Vcc+0.5 | V |
| Reverse voltage (for APD) | V_APD | | 0 to $V_{BR}$ | V |
| Photocurrent (DC) | $I_L$ max | | 0.2 | mA |
| Incident pulse light level*2 | Ppulse | | 5 | W |
| Operating temperature | Topr | No dew condensation*3 | -40 to +105 | °C |
| Storage temperature | Tstg | No dew condensation*3 | -40 to +125 | °C |
| Transimpedance amplifier chip temperature*4 | Tj | | 150 | °C |
| Soldering temperature*5 | Tsol | | 260 (twice) | °C |

*2: FWHM=1 ns (repetition frequency: 1 kHz)
*3: When there is a temperature difference between a product and the surrounding area in high humidity environments, dew condensation may occur on the product surface. Dew condensation on the product may cause deterioration in characteristics and reliability.
*4: Do heat dissipation from the PCB to keep the temperature of the transimpedance amplifier chip below 150 °C. The thermal resistance between the transimpedance amplifier chip and the package is 6 °C/W.
*5: Reflow soldering, JEDEC J-STD-020 MSL 3, see P.12
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, Vcc=3.3 V, Power save=high, AC coupling + 50 Ω load, dark state, per element]**

| Parameter | Symbol | Condition | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| Spectral response range | λ | | | 400 to 1100 | | nm |
| Peak sensitivity wavelength | λp | | - | 840 | - | nm |
| Photosensitivity | S | λ=905 nm, M=1 | - | 0.5 | - | A/W |
| Breakdown voltage*6 | VBR | Vcc=0 V, ID=10 μA Gain_APD terminal: open*7 *9 | 180 | 200 | 220 | V |
| Operating reverse voltage | Vop | Gain-stabilized mode operation*8 *9 | 185 + 1.1 × (Ta opr - 25)*10 | - | - | V |
| Temperature coefficient of operating reverse voltage | ΔTVop | *9 | 0.95 | 1.1 | 1.25 | V/°C |
| Sensitivity uniformity | - | M=50 (averaged over all pixels), including transimpedance amplifier Ianode=100 μA max. | - | ±5 | ±15 | % |
| APD gain*6 | M | Gain-stabilized mode operation*8 λ=905 nm | 35 | 50 | 65 | - |
| Transimpedance amplifier gain | G | Differential | - | 30 | - | kV/A |
| Current consumption | Icc | Power save=high | - | 750 | 900 | mA |
| | | Power save=low | - | 200 | 250 | |
| High-band cutoff frequency | fch | | 200 | 300 | - | MHz |
| Equivalent input current noise*6 | en | f=100 MHz | - | 6 | 9 | pA/Hz$^{1/2}$ |
| Output impedance*6 | Zo | f=100 MHz | - | 50 | 80 | Ω |
| Maximum output voltage amplitude | Vp-p max | Differential | 0.4 | 0.7 | - | V |
| Supply voltage | Vcc | | 3.135 | 3.3 | 3.465 | V |
| Crosstalk*6 *11 | - | FWHM=1 ns, 1 mW | - | -60 | - | dB |
| DC current rejection*6 | Idc | | 1 | - | - | mA |
| Wakeup time*6 | Tset | Power save=low→high | - | 100 | - | μs |
| Digital voltage*6 | VH | High | 0.8Vcc | - | - | V |
| | VL | Low | - | - | 0.2Vcc | |

*6: Reference values defined by simulation or characteristic evaluation
*7: Opening the Gain_APD terminal enables operation as a typical APD instead of a GS-APD
*8: Apply bias voltage to anode. IR anode limit=10 μA
*9: Characteristics for APD only
*10: Ta opr=assumed maximum operating temperature
*11: $\text{Crosstalk [dB]} = 20\ \text{Log}_{10}\left(\dfrac{\text{Crosstalk [V]/Transimpedance amplifier gain [V/W]}}{\text{Incident pulse light level [W]}}\right)$

## Standby/operation mode selection
The power save setting selects either standby mode or operation mode.

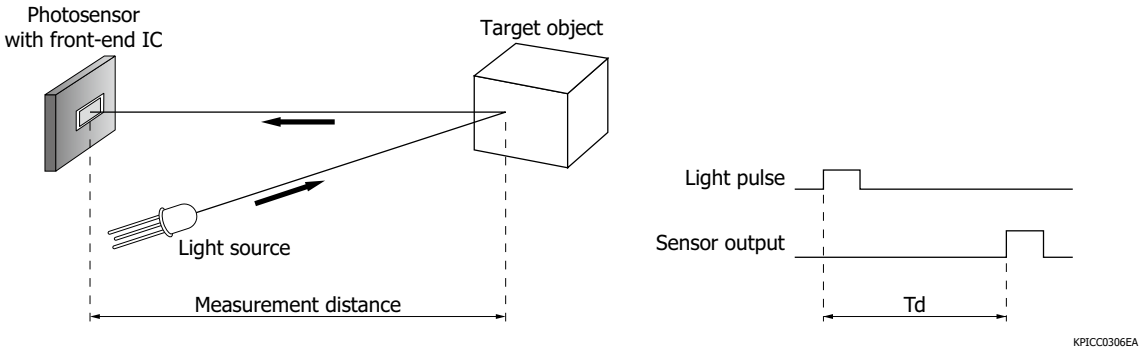
| Power save | Mode |
|---|---|
| Low | Standby mode |
| High | Operation mode |

Pull-up resistor of digital input terminal =100 kΩ

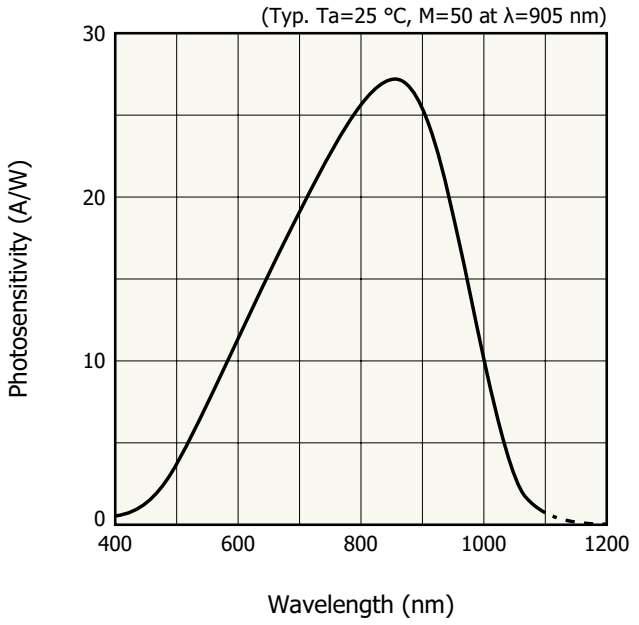
## Distance measurement method

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

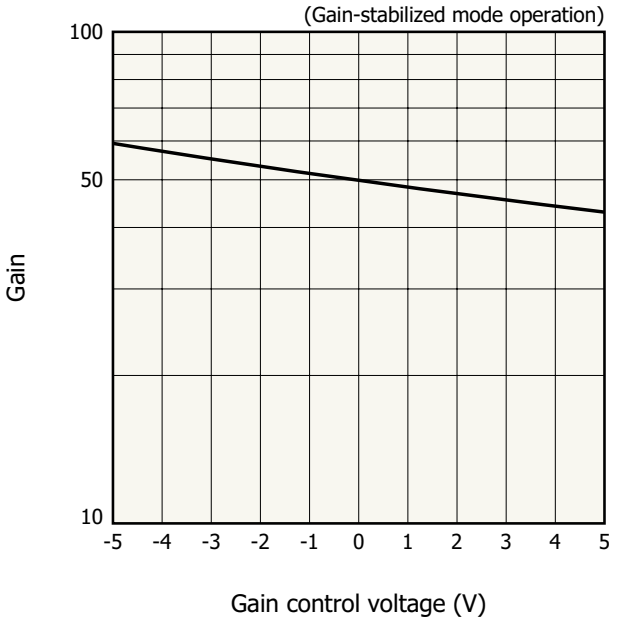
L = (1/2) × c × Td




## Spectral response

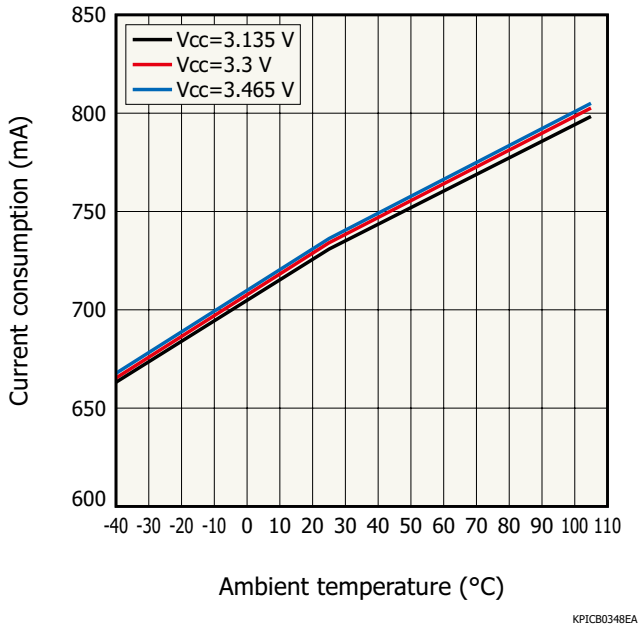



## Gain - gain control voltage (typical example)



## Current consumption vs. ambient temperature (typical example)

Power save=high

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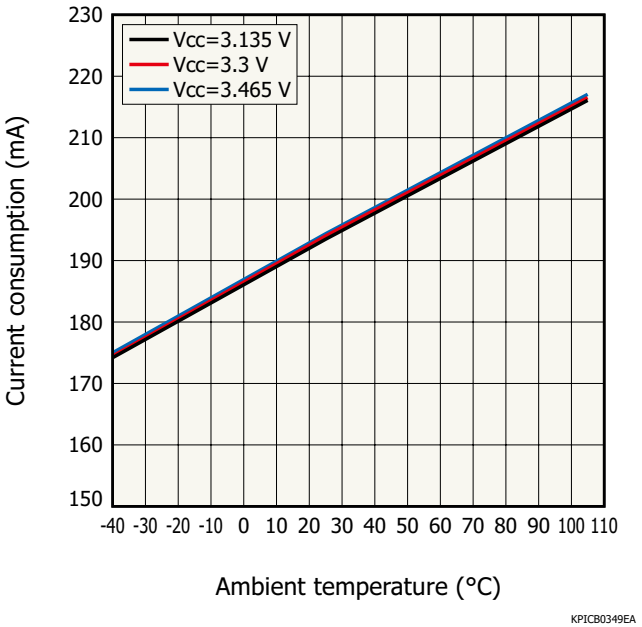
Power save=low

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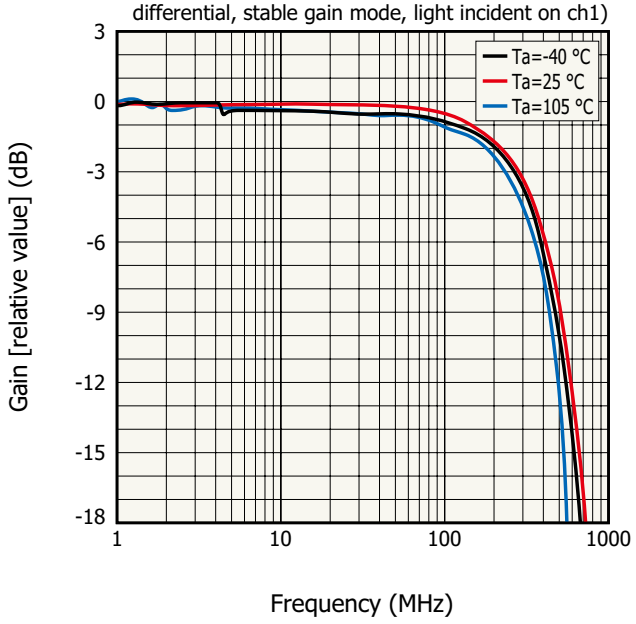
## Frequency characteristics (typical example)

(λ=905 nm, Vcc=3.3 V, 0.1 µF + 50 Ω load, differential, stable gain mode, light incident on ch1)

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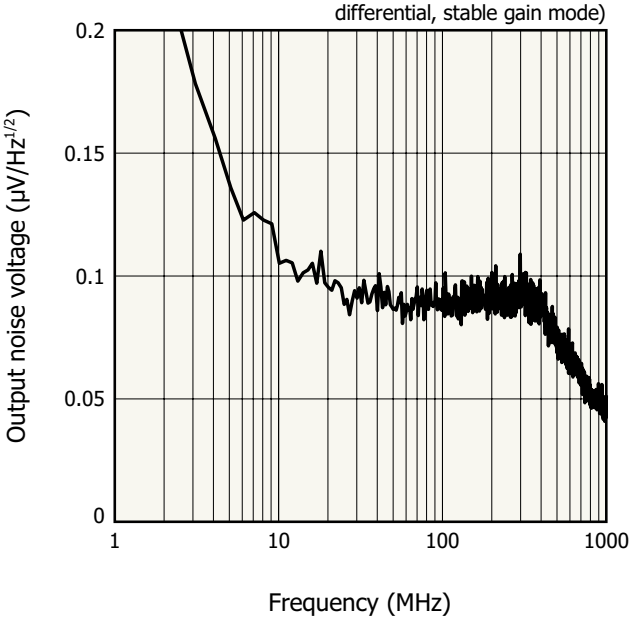
## Output noise voltage vs. frequency (typical example)

(Ta=25 °C, Vcc=3.3 V, 0.1 µF + 50 Ω load, differential, stable gain mode)

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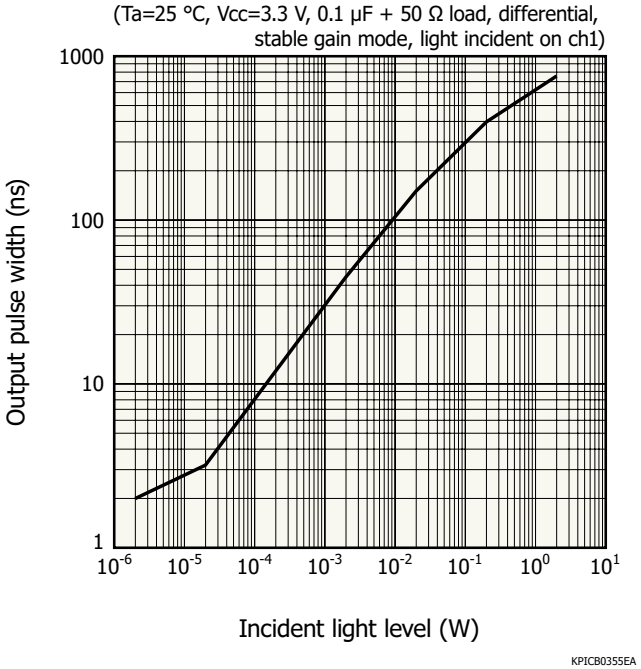
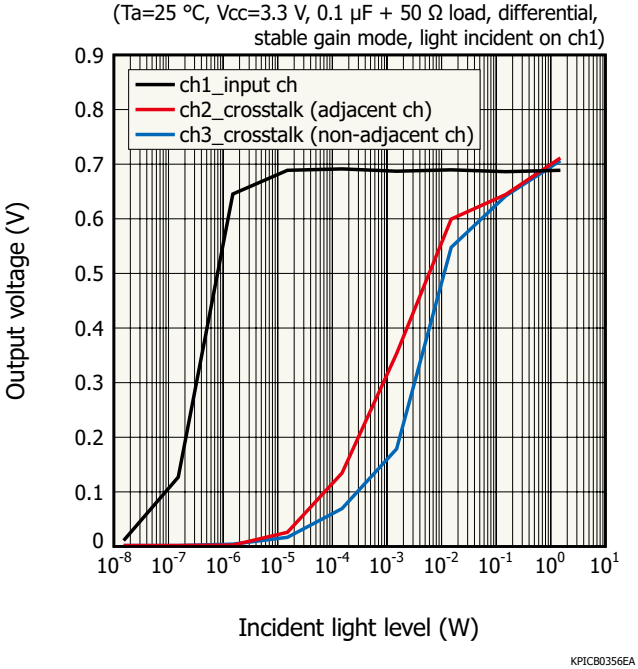
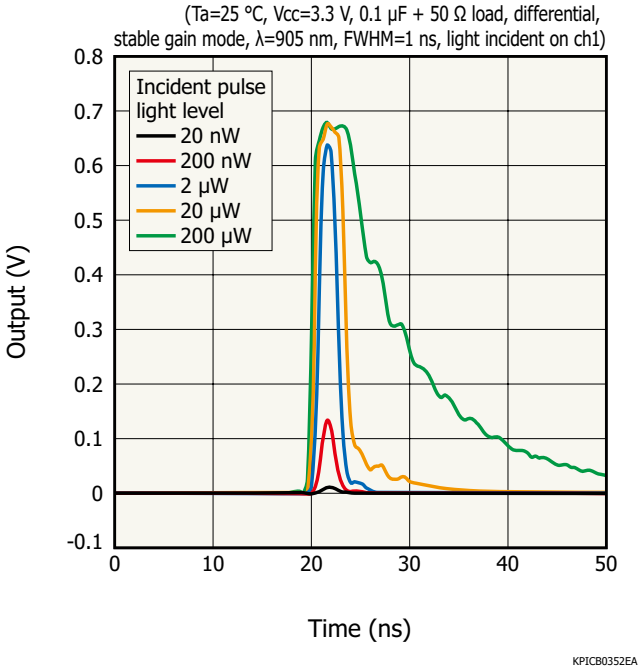
## Output pulse width vs. incident light level (typical example)

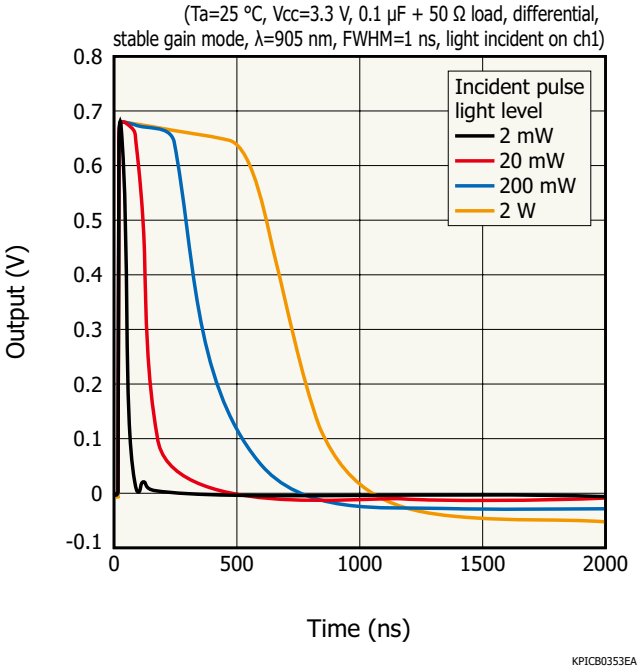



## Output voltage vs. incident light level (typical example)

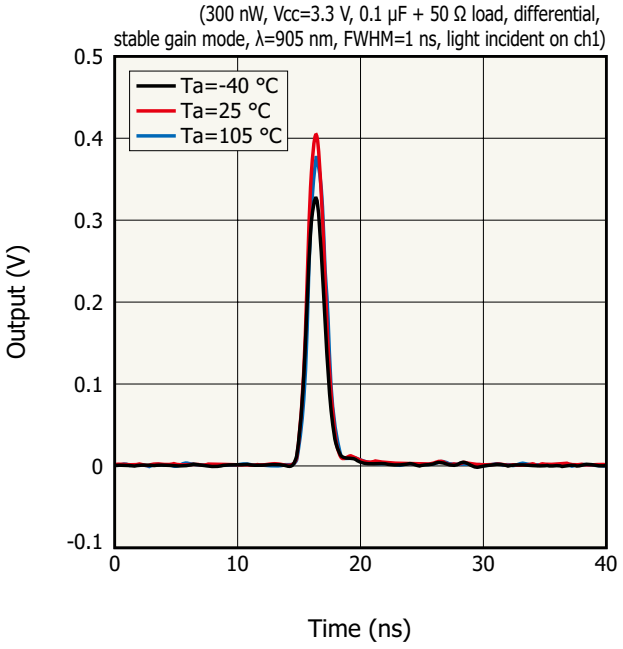



## Output waveform (typical example)



## Temperature characteristics of output waveform (typical example)

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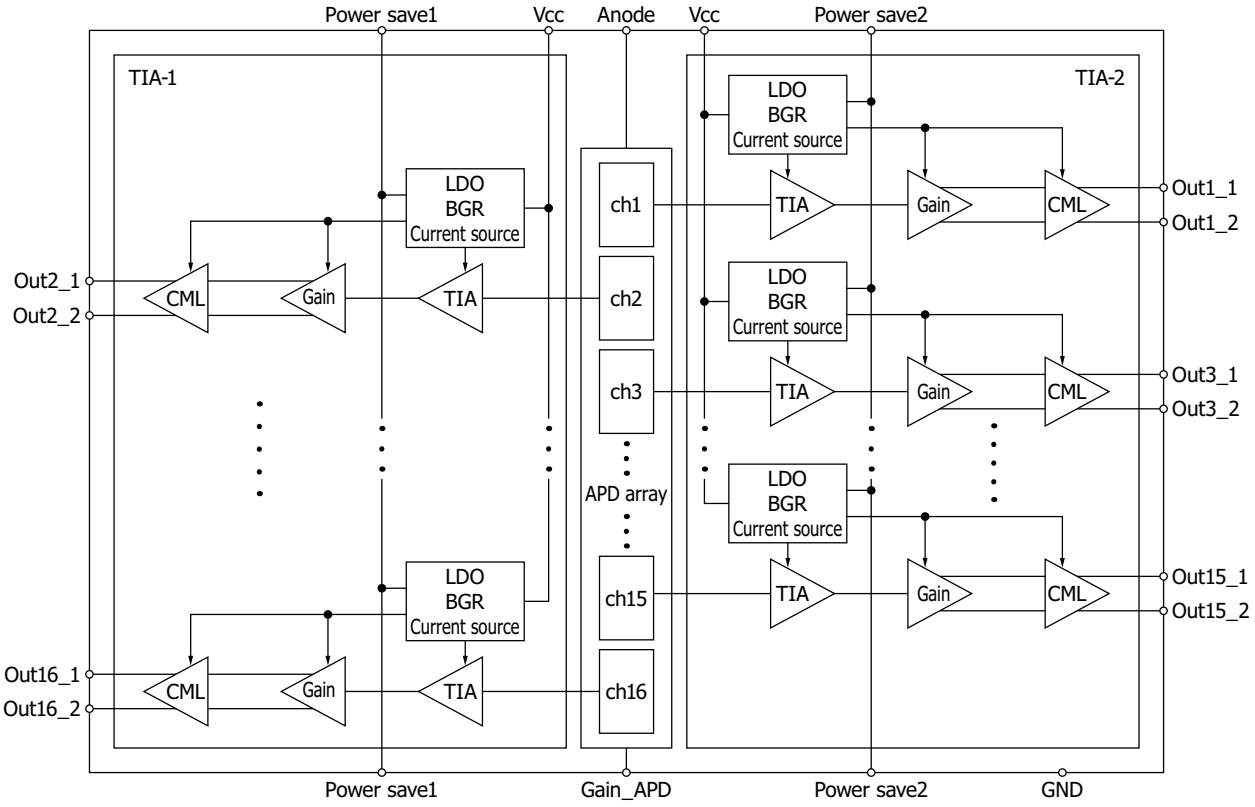
## Block diagram

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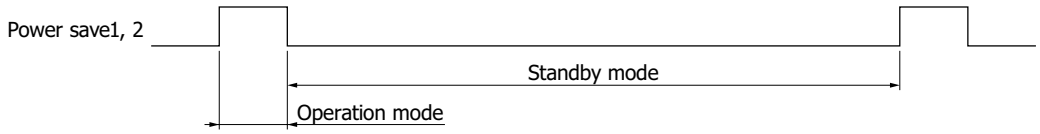
## Timing chart (typical example)

Set the duty ratio of operation mode and standby mode so that the temperature of the transimpedance amplifier chip is below 150 °C.

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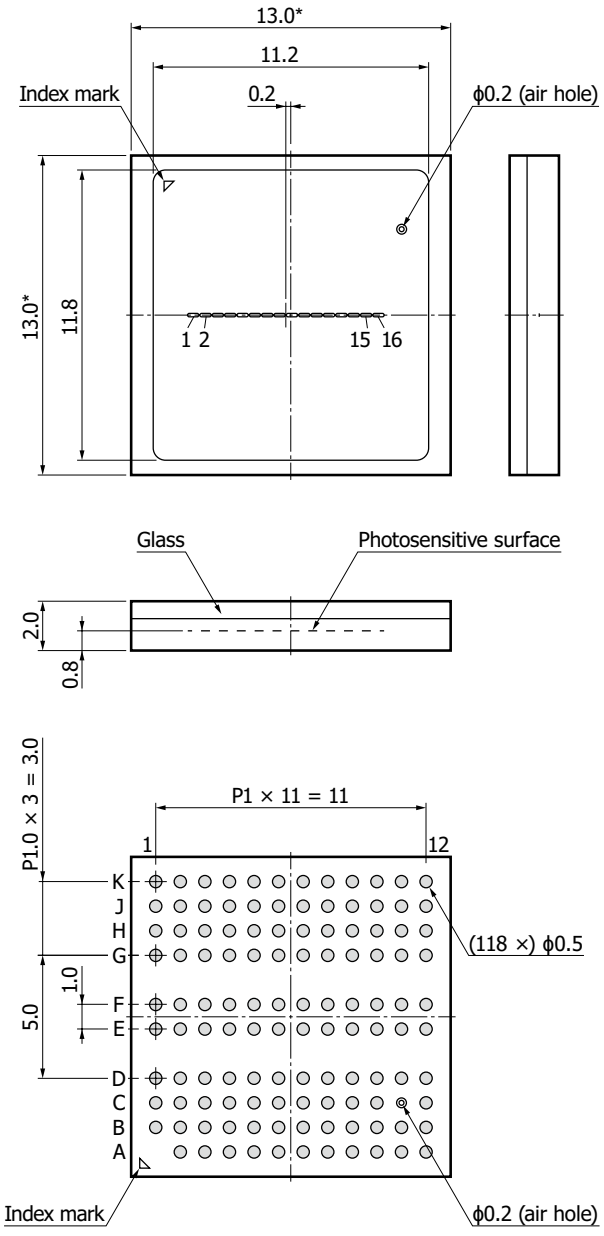
## Dimensional outline (unit: mm)




Tolerance unless otherwise noted: ±0.25, ±2.5°
Chip position accuracy with respect to package dimensions marked*:
X, Y ≤ ±0.3, θ ≤ ±2.5°
Au plating
Packing: tray (60 pcs/tray)

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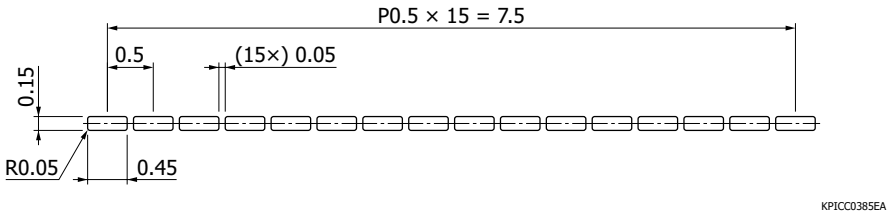
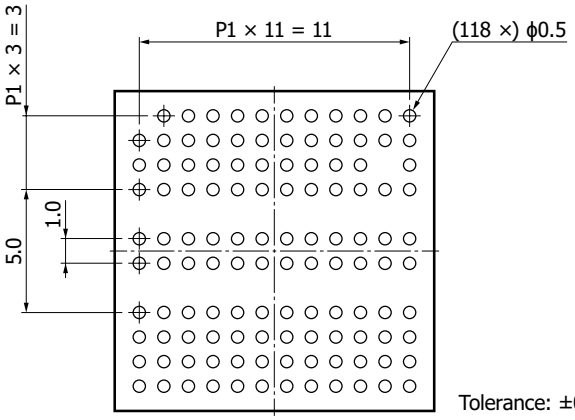
## Enlarged view of photosensitive area (unit: mm)




## Pin connections

| Pin no. | Function | Pin no. | Function | Pin no. | Function | Pin no. | Function | Pin no. | Function |
|---|---|---|---|---|---|---|---|---|---|
| A1 | - | C1 | GND | E1 | Anode | G1 | GND | J1 | Power save2 |
| A2 | Vcc | C2 | GND | E2 | Anode | G2 | GND | J2 | Vcc |
| A3 | Out2_1 | C3 | GND | E3 | Anode | G3 | GND | J3 | Out1_2 |
| A4 | Out4_2 | C4 | GND | E4 | Anode | G4 | GND | J4 | Out3_1 |
| A5 | Out6_1 | C5 | GND | E5 | Anode | G5 | GND | J5 | Out5_2 |
| A6 | Out8_2 | C6 | GND | E6 | Anode | G6 | GND | J6 | Out7_1 |
| A7 | Out10_2 | C7 | GND | E7 | Anode | G7 | GND | J7 | Out9_1 |
| A8 | Out12_1 | C8 | GND | E8 | Anode | G8 | GND | J8 | Out11_2 |
| A9 | Out14_2 | C9 | GND | E9 | Anode | G9 | GND | J9 | Out13_1 |
| A10 | Out16_1 | C10 | GND | E10 | Anode | G10 | GND | J10 | Out15_2 |
| A11 | Vcc | C11 | - | E11 | Anode | G11 | GND | J11 | Vcc |
| A12 | NC | C12 | GND | E12 | Anode | G12 | GND | J12 | Power save2 |
| B1 | Power save1 | D1 | GND | F1 | Anode | H1 | GND | K1 | NC |
| B2 | Vcc | D2 | GND | F2 | Anode | H2 | GND | K2 | Vcc |
| B3 | Out2_2 | D3 | GND | F3 | Anode | H3 | GND | K3 | Out1_1 |
| B4 | Out4_1 | D4 | GND | F4 | Anode | H4 | GND | K4 | Out3_2 |
| B5 | Out6_2 | D5 | GND | F5 | Anode | H5 | GND | K5 | Out5_1 |
| B6 | Out8_1 | D6 | GND | F6 | Anode | H6 | GND | K6 | Out7_2 |
| B7 | Out10_1 | D7 | GND | F7 | Anode | H7 | GND | K7 | Out9_2 |
| B8 | Out12_2 | D8 | GND | F8 | Anode | H8 | GND | K8 | Out11_1 |
| B9 | Out14_1 | D9 | GND | F9 | Anode | H9 | GND | K9 | Out13_2 |
| B10 | Out16_2 | D10 | GND | F10 | Anode | H10 | GND | K10 | Out15_1 |
| B11 | Vcc | D11 | GND | F11 | Anode | H11 | GND | K11 | Vcc |
| B12 | Power save1 | D12 | Gain_APD | F12 | Anode | H12 | GND | K12 | NC |

## Recommended land pattern (unit: mm)

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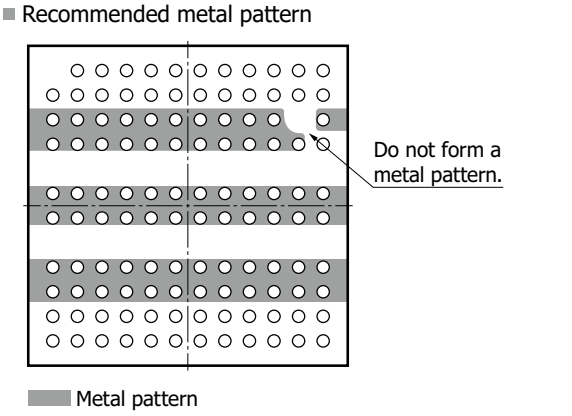
## Precautions during reflow soldering

Take care to prevent excess flux. If there is excess flux, then flux may enter the product through the air hole.

We recommend forming metal patterns as shown in the figure on the right. Form the GND and anode metal patterns long horizontally for heat dissipation. To prevent flux from entering through the air hole, do not form a metal pattern on part of the 3rd and 4th rows of the land patterns.

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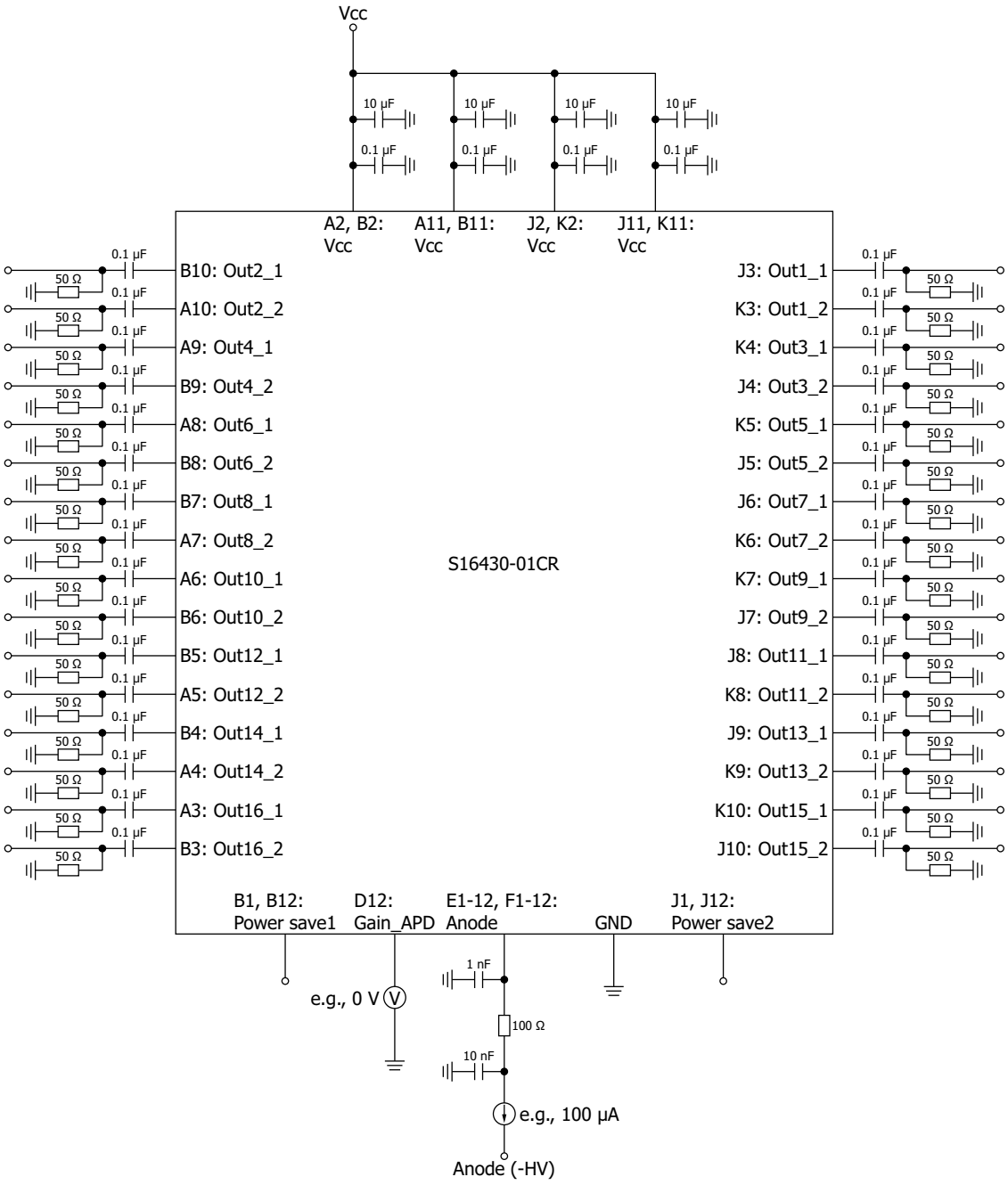
## Operating circuit example

Stable gain mode

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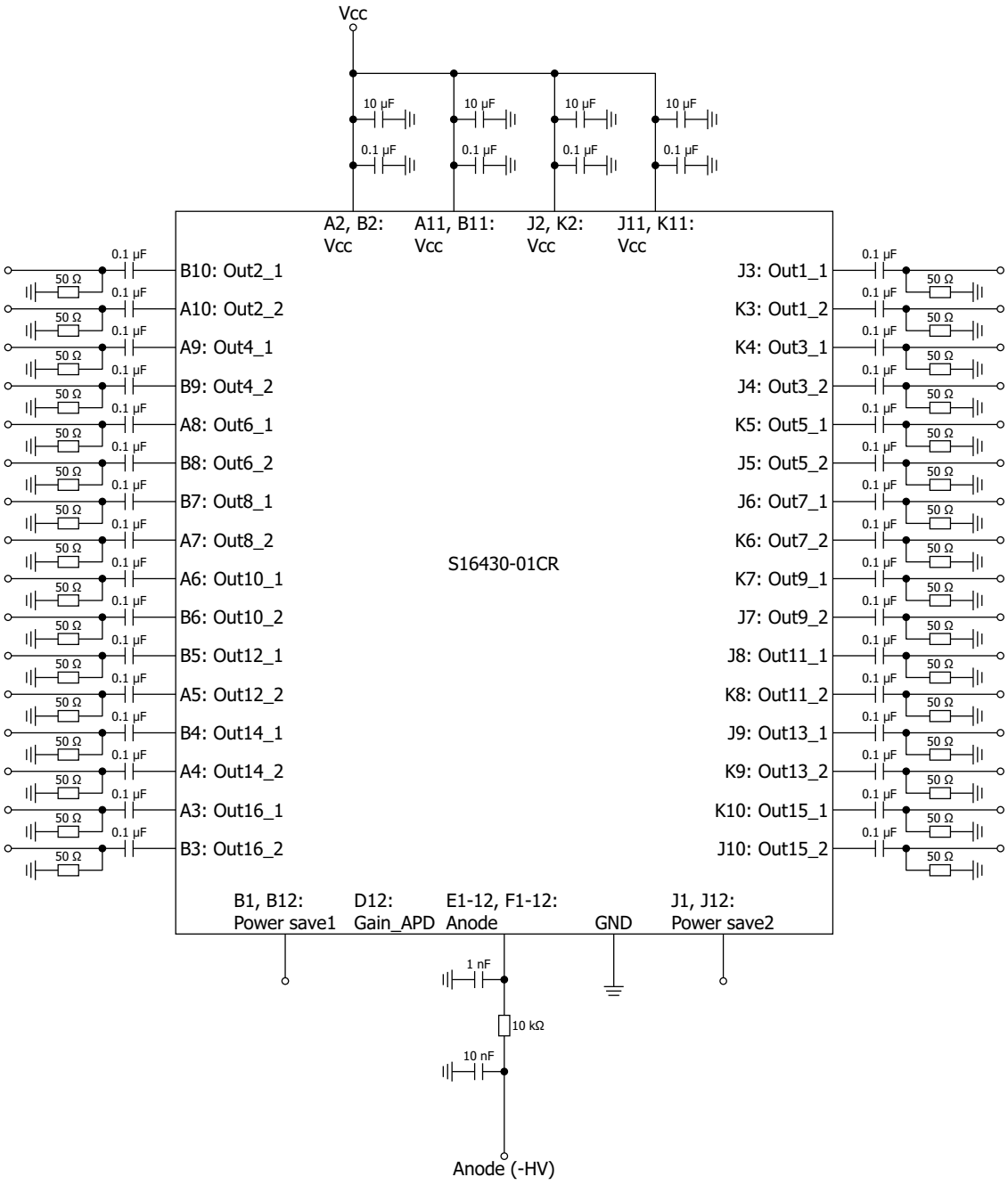
Normal APD mode

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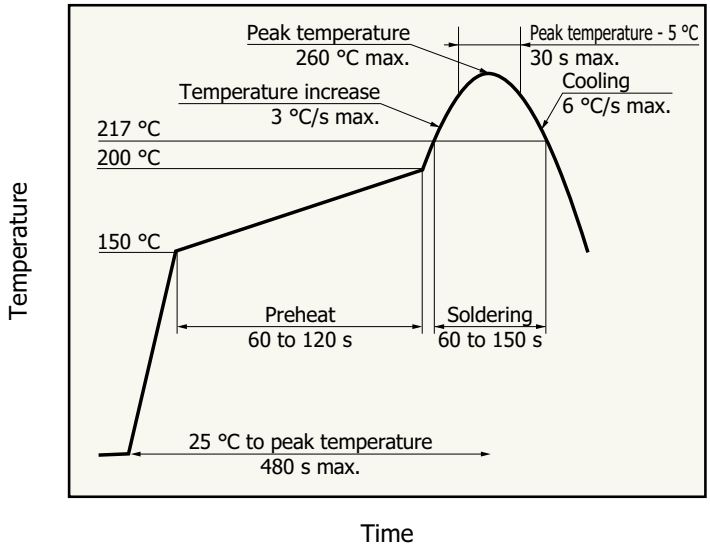
## Precautions

· Do not do cleaning or vapor phase soldering, as cleaning liquid or water may get inside the package through the air hole on the bottom of the package.
· High voltage is applied to the anode terminal. Beware of electric shock.
· Apply negative voltage (-165 V, etc.) with respect to GND to the anode terminal.
· The top of the package is glass. Be careful not to pinch it too hard with metal tweezers, as this can cause cracks or flakes.

## Recommended reflow soldering conditions




KSPDB0419EA

· 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 168 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.

## Related information

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

■ Precautions
· Disclaimer
· Surface mount type products



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