

# LV0104CS

## Ambient Light Sensor, I<sup>2</sup>C Interface



### Overview

LV0104CS is a Photo IC for ultra- small package Ambient Light sensor which has the characteristics of spectral response similar to that of human eyes. It is suitable for the applications like mobile phone (for Digital-TV, One-segment), LCD-TV, laptop computer, PDA, DSC and Camcorder.

### Features

- Smallest OD-CSP package in the world (1.08mm x 1.08mm, thickness : 0.6mm)
- Great spectrum sensitivity characteristic
- 16-Bit Digital Output for I<sup>2</sup>C-BUS
- Low Current consumption, Integrated Sleep function

### Typical Applications

- Mobile Phone (Digital-TV, One-segment)
- LCD-TV
- Laptop Computer
- PDA
- DSC
- Camcorder

### SPECIFICATION

#### ABSOLUTE MAXIMUM RATINGS at Ta = 25°C (Note 1)

| Parameter                   | Symbol           | Conditions | Ratings                      |  | Unit |
|-----------------------------|------------------|------------|------------------------------|--|------|
| Power Supply Voltage        | V <sub>DD</sub>  |            | 4.0                          |  | V    |
| Logic I/O levels            | V <sub>IO</sub>  |            | -0.3 to V <sub>DD</sub> +0.3 |  | V    |
| Operating temperature range | Topr             |            | -30 to 85                    |  | °C   |
| Storage temperature range   | T <sub>stg</sub> |            | -40 to 100                   |  | °C   |

1. Stresses exceeding those listed in the Absolute Maximum Rating table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

#### RECOMMENDED OPERATING CONDITIONS AND

#### OPERATING VOLTAGE RANGE at Ta = 25°C (Note 2, 3)

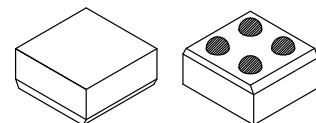
| Parameter                  | Symbol             | Conditions                         | Ratings |     |      | Unit |
|----------------------------|--------------------|------------------------------------|---------|-----|------|------|
|                            |                    |                                    | min     | typ | max  |      |
| Recommended Supply Voltage | V <sub>DD</sub> op |                                    | 2.3     | 2.5 | 3.6  | V    |
| Input low level voltage    | V <sub>IL</sub>    | SCL, SDA                           |         |     | 0.55 | V    |
| Input high level voltage   | V <sub>IH</sub>    | SCL, SDA,<br>V <sub>DD</sub> =2.8V | 1.26    |     |      | V    |
| Output low level voltage   | V <sub>OL</sub>    | SDA, I <sub>OL</sub> =3mA          |         |     | 0.4  | V    |
| Input leak current         | I <sub>LEAK</sub>  | SCL, SDA                           | -5      |     | 5    | µA   |

2. Functional operation above the stresses listed in the Recommended Operating Ranges is not implied. Extended exposure to stresses beyond the Recommended Operating Ranges limits may affect device reliability.

3. I<sup>2</sup>C interface (SCL,SDA) is for V<sub>IO</sub>=1.8V operation

\* I<sup>2</sup>C Bus is a trademark of Philips Corporation.

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ODCSP4 1.08 mm x 1.08 mm

### ORDERING INFORMATION

Ordering Code:  
LV0104CS-TLM-H

Package  
ODCSP4  
(Pb-Free / Halogen Free)

Shipping (Qty / packing)  
5000 / Tape & Reel

† For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.  
[http://www.onsemi.com/pub\\_link/Collateral/BRD8011-D.PDF](http://www.onsemi.com/pub_link/Collateral/BRD8011-D.PDF)

# LV0104CS

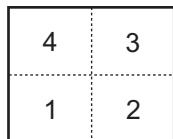
## ELECTRICAL AND OPTICAL CHARACTERISTICS at $T_a = 25^\circ\text{C}$ , $V_{CC} = 2.5\text{V}$ (Note 4)

| Parameter                     | Symbol    | Conditions  | Ratings |       |       | Unit          |
|-------------------------------|-----------|---|---------|-------|-------|---------------|
|                               |           |   | min     | typ   | max   |               |
| Supply Current                | $I_{DD}$  | $E_v=0$ lux                                       |         | 70    | 100   | $\mu\text{A}$ |
| Sleep Current                 | $I_{SLP}$ | Sleep mode, $E_v=0$ lux                           |         |       | 1     | $\mu\text{A}$ |
| Internal Oscillator Frequency | $f_{OSC}$ |   |         | 655   |       | kHz           |
| Dark ADC count value          | D0        | $E_v=0$ lux, High gain mode                       |         |       | 5     | counts        |
| Full scale ADC count value    | D max     |   |         |       | 65535 | counts        |
| ADC count value               | Data HH   | Gain $\times 8$ mode, $E_v=1000$ lx               |         | 8000  |       | counts        |
|                               | Data HM   | Gain $\times 2$ mode, $E_v=1000$ lx               |         | 2000  |       | counts        |
|                               | Data N    | Gain $\times 1$ mode, $E_v=1000$ lx               | 750     | 1000  | 1250  | counts        |
|                               | Data L    | Gain $\times 0.25$ mode, $E_v=1000$ lx            |         | 250   |       | counts        |
| Resolution                    | ReHH1     | $T_{int}=200\text{ms}$ , Gain $\times 8$ mode     |         | 0.125 |       | lx            |
|                               | ReHH2     | $T_{int}=100\text{ms}$ , Gain $\times 8$ mode     |         | 0.25  |       | lx            |
|                               | ReHH3     | $T_{int}=12.5\text{ms}$ , Gain $\times 8$ mode    |         | 2     |       | lx            |
|                               | ReHM1     | $T_{int}=200\text{ms}$ , Gain $\times 2$ mode     |         | 0.5   |       | lx            |
|                               | ReHM2     | $T_{int}=100\text{ms}$ , Gain $\times 2$ mode     |         | 1     |       | lx            |
|                               | ReHM3     | $T_{int}=12.5\text{ms}$ , Gain $\times 2$ mode    |         | 8     |       | lx            |
|                               | ReN1      | $T_{int}=200\text{ms}$ , Gain $\times 1$ mode     |         | 1     |       | lx            |
|                               | ReN2      | $T_{int}=100\text{ms}$ , Gain $\times 1$ mode     |         | 2     |       | lx            |
|                               | ReN3      | $T_{int}=12.5\text{ms}$ , Gain $\times 1$ mode    |         | 16    |       | lx            |
|                               | ReL1      | $T_{int}=200\text{ms}$ , Gain $\times 0.25$ mode  |         | 4     |       | lx            |
|                               | ReL2      | $T_{int}=100\text{ms}$ , Gain $\times 0.25$ mode  |         | 8     |       | lx            |
|                               | ReL3      | $T_{int}=12.5\text{ms}$ , Gain $\times 0.25$ mode |         | 64    |       | lx            |

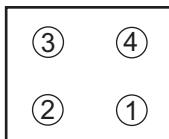
4. Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

## PAD LAYOUT

<Top view>



<Bottom view>

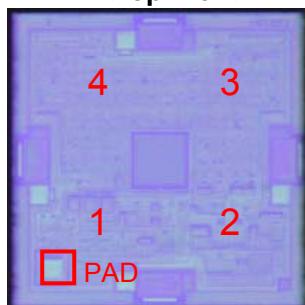


| No. | Name     | Function                          |
|-----|----------|-----------------------------------|
| 1   | $V_{DD}$ | Supply voltage pin                |
| 2   | GND      | GND pin                           |
| 3   | SCL      | $\text{I}^2\text{C}$ serial clock |
| 4   | SDA      | $\text{I}^2\text{C}$ serial data  |

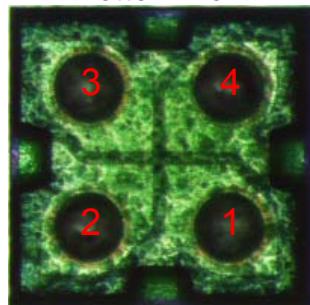
Ball Pitch: 0.5mm, Ball Size: 0.25mm

## Pad layout (Photos)

<Top View>



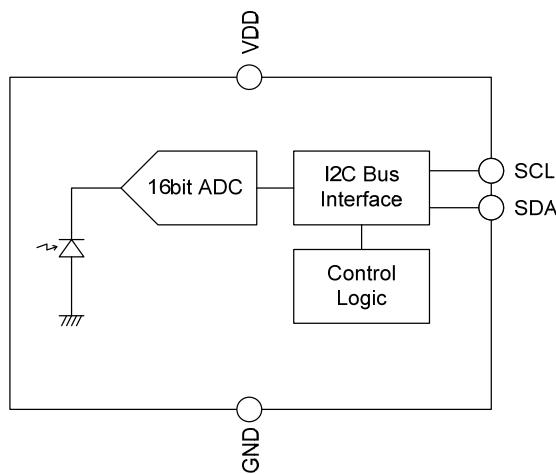
<Bottom View>



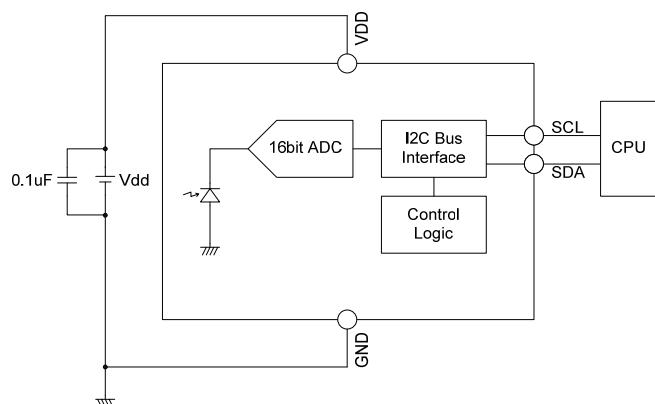
\* The position with PAD becomes pin 1.

# LV0104CS

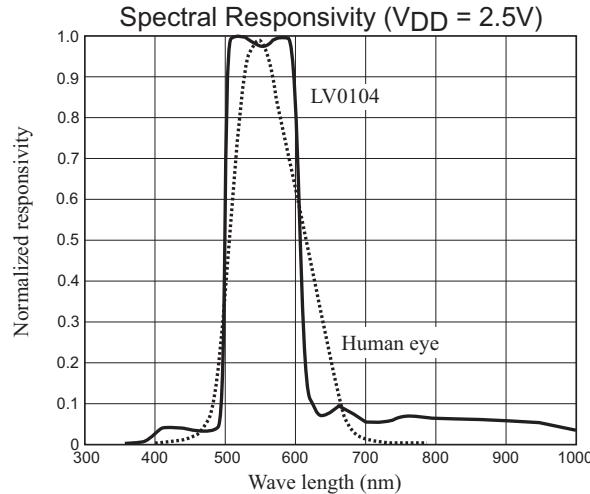
## Block Diagram



## Application circuits



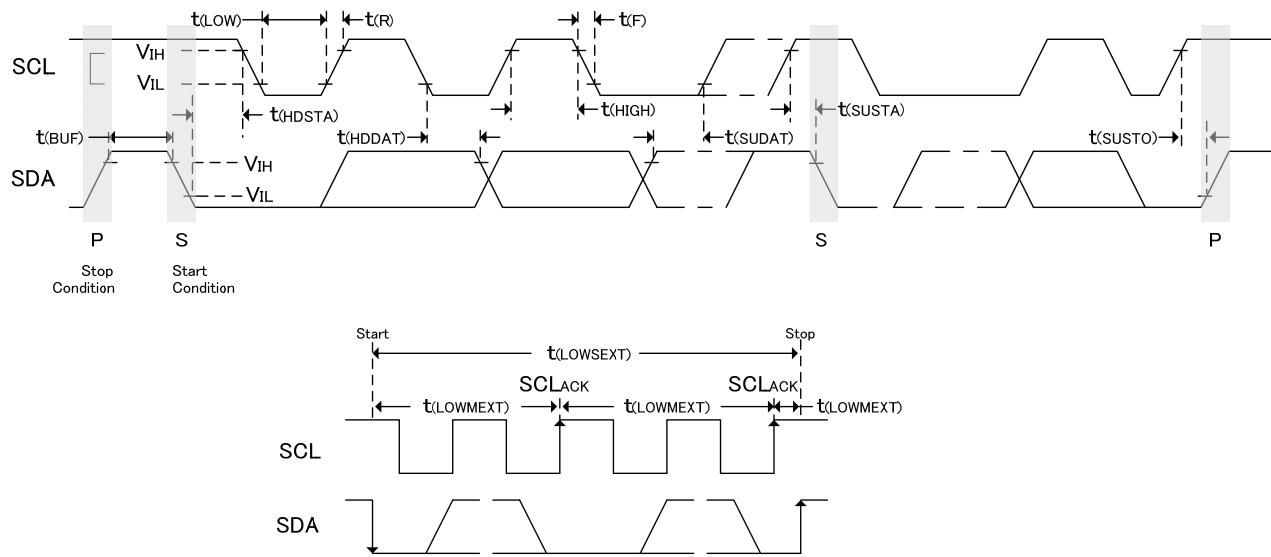
## Spectrum Sensitivity Characteristic



## I<sup>2</sup>C Interface

The control command is received from the operation of the device by the I<sup>2</sup>C bus (Two-wire serial interface). The obtained data is output to the operation by the I<sup>2</sup>C bus.

### I<sup>2</sup>C Bus Timing Diagram



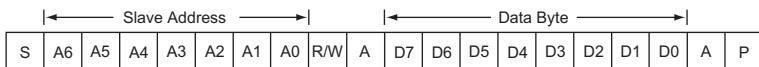
### Serial Interface Timing

| Parameter  | Symbol   | Standard Mode |      | Fast Mode |     | Unit |
|--|----------|---------------|------|-----------|-----|------|
|  |          | min           | max  | min       | max |      |
| Clock frequency  | f(SCL)   | 10            | 100  | 10        | 400 | kHz  |
| Bus free time between start and stop condition                           | t(BUF)   | 4.7           |      | 1.3       |     | μs   |
| Hold time after (repeated) start condition. After this period, the first | t(HDSTA) | 4.0           |      | 0.6       |     | μs   |
| Repeated start condition setup time                                      | t(SUSTA) | 4.7           |      | 0.6       |     | μs   |
| Stop condition setup time  | t(SUSTO) | 4.0           |      | 0.6       |     | μs   |
| Data hold time   | t(HDDAT) | 300           |      | 90        |     | ns   |
| Data setup time  | t(SUDAT) | 250           |      | 100       |     | ns   |
| I <sup>2</sup> C clock (SCL) low period                                  | t(LOW)   | 4.7           |      | 1.3       |     | μs   |
| I <sup>2</sup> C clock (SCL) high period                                 | t(HIGH)  | 4.0           |      | 0.6       |     | μs   |
| Clock / data fall time   | t(F)     |               | 300  |           | 300 | ns   |
| Clock / data rise time   | t(R)     |               | 1000 |           | 300 | ns   |

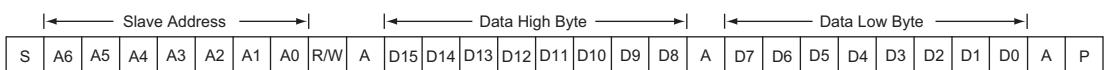
\*Specified by design and characterization ; not production tested.

# LV0104CS

## Data Format (Write)



## Data Format (Read)

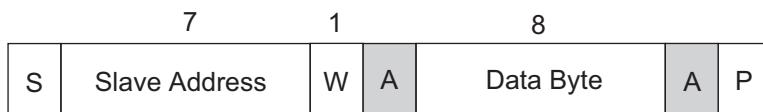


### • Slave Address

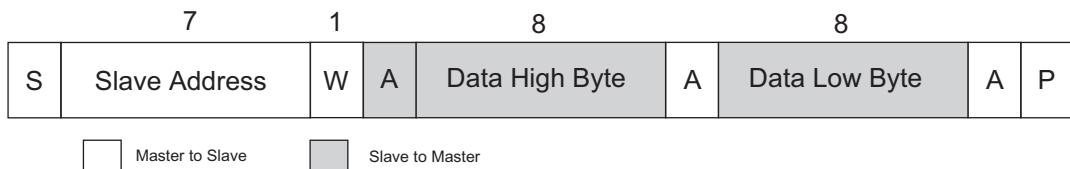
|    |    |    |    |    |    |    |     |
|----|----|----|----|----|----|----|-----|
| A6 | A5 | A4 | A3 | A2 | A1 | A0 | R/W |
| 0  | 0  | 1  | 0  | 0  | 1  | 1  | X   |

R/W: Read: 1, Write: 0

### (1) Write Protocol (R/W=0)



### (2) Read Protocol (R/W=1)



S: Start Condition

P: Stop Condition

A: Acknowledge

W: Write

R: Read

## Register Set

### (1) Measurement

|         | D7        | D6    | D5 | D4                                      | D3    | D2   | D1     | D0                  |
|---------|-----------|-------|----|---|-------|--|--------|---------------------|
| Name    | MODE1     | MODE0 | -  | GAIN1                                   | GAIN0 | INTEG1   | INTEG0 | MANUAL              |
|         | 11:Active |       |    | 00: x0.25<br>01: x1<br>10: x2<br>11: x8 |       | 00: 12.5ms<br>01: 100ms<br>10: 200ms<br>11: Manual |        | 0: Start<br>1: Stop |
| Default | 00        | 1     | 0  | 1                                       |       | 10   |        | 0                   |

### (2) Sleep mode

|         | D7       | D6    | D5 | D4 | D3 | D2 | D1 | D0 |
|---------|----------|-------|----|----|----|----|----|----|
| Name    | MODE1    | MODE0 | -  | -  | -  | -  | -  | -  |
|         | 00:Sleep |       | x  | x  | x  | x  | x  | x  |
| Default | 00       | x     | x  | x  | x  | x  | x  | x  |

### (3) Setting Sensitivity

|         | D7         | D6    | D5                  | D4   | D3   | D2   | D1   | D0   |
|---------|------------|-------|---------------------|------|------|------|------|------|
| Name    | MODE1      | MODE0 | ADJ5                | ADJ4 | ADJ3 | ADJ2 | ADJ1 | ADJ0 |
|         | 10:Setting |       | 0: Minus<br>1: Plus | ADJ4 | ADJ3 | ADJ2 | ADJ1 | ADJ0 |
| Default | 00         | 0     | 0                   | 0    | 0    | 0    | 0    | 0    |

| Bits D5 to D0 |      |      |      |      |      | Description |
|---------------|------|------|------|------|------|-------------|
| ADJD          | ADJ4 | ADJ3 | ADJ2 | ADJ1 | ADJ0 |             |
| 0             | 0    | 0    | 0    | 0    | 1    | 66.7%       |
| .             | .    | .    | .    | .    | .    |             |
| .             | .    | .    | .    | .    | .    |             |
| 0             | 0    | 1    | 0    | 1    | 0    | 95.2%       |
| .             | .    | .    | .    | .    | .    |             |
| .             | .    | .    | .    | .    | .    |             |
| 1             | 0    | 0    | 1    | 1    | 0    | 108.3%      |
| .             | .    | .    | .    | .    | .    |             |
| 1             | 0    | 0    | 0    | 0    | 1    | 150%        |

<Width of sensitivity adjustment>

66.7% to 150% (ADJ5 to ADJ0=000001=66.7%, ADJ5 to ADJ0 = 100001 = 150%)

<Sensitivity Calculation>

- Decreasing Sensitivity (ADJ5=0)

$$Sn = 16*ADJ4 + 8*ADJ3 + 4*ADJ2 + 2*ADJ1 + ADJ0$$

$$S = 2*Sn / (2*Sn+1)$$

(Example) ADJ5 to ADJ0 = 001010, Sn=8+2=10, S=20/21=0.952. The sensitivity is 95.2%

- Increasing Sensitivity (ADJ5=1)

$$Sn = 16*ADJ4 + 8*ADJ3 + 4*ADJ2 + 2*ADJ1 + ADJ0$$

$$S = (2*Sn+1) / 2*Sn$$

(Example) ADJ5 to ADJ0=100110, Sn=4+2=6, S=13/12=1.083. The sensitivity is 108.3%.

#### (4) Read data

Measurement result is registered to ADC channel data registers (DH,DL) in below format.

|                       | D15             | D14             | D13             | D12             | D11             | D10             | D9           | D8           |
|-----------------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|--------------|--------------|
| DH (Data Higher byte) | DH7( $2^{15}$ ) | DH6( $2^{14}$ ) | DH5( $2^{13}$ ) | DH4( $2^{12}$ ) | DH3( $2^{11}$ ) | DH2( $2^{10}$ ) | DH1( $2^9$ ) | DH0( $2^8$ ) |

|                      | D7           | D6           | D5           | D4           | D3           | D2           | D1           | D0           |
|----------------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|
| DL (Data Lower byte) | DL7( $2^7$ ) | DL6( $2^6$ ) | DL5( $2^5$ ) | DL4( $2^4$ ) | DL3( $2^3$ ) | DL2( $2^2$ ) | DL1( $2^1$ ) | DL0( $2^0$ ) |

- Lux calculation

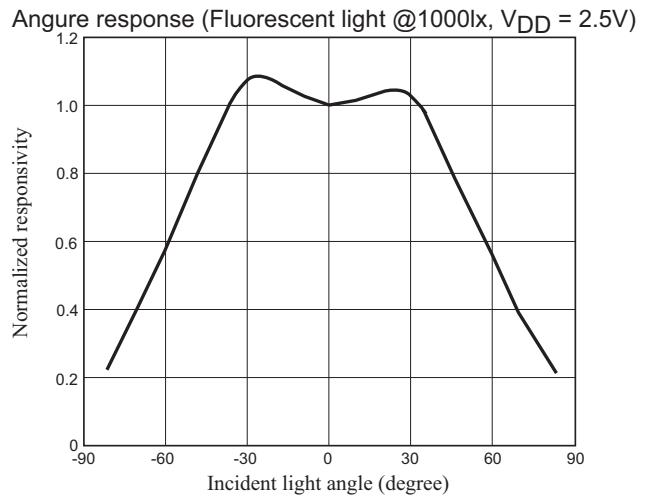
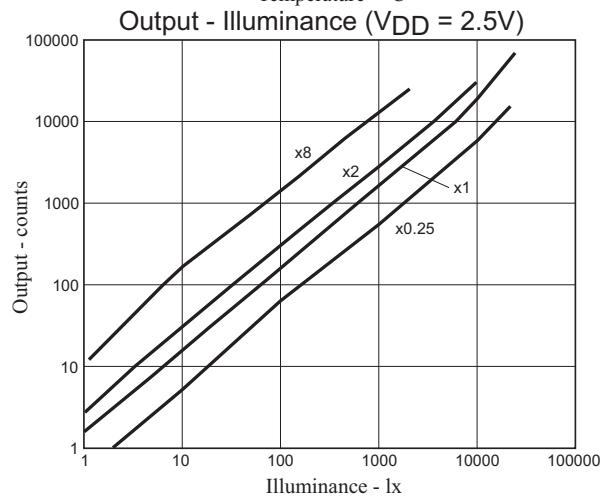
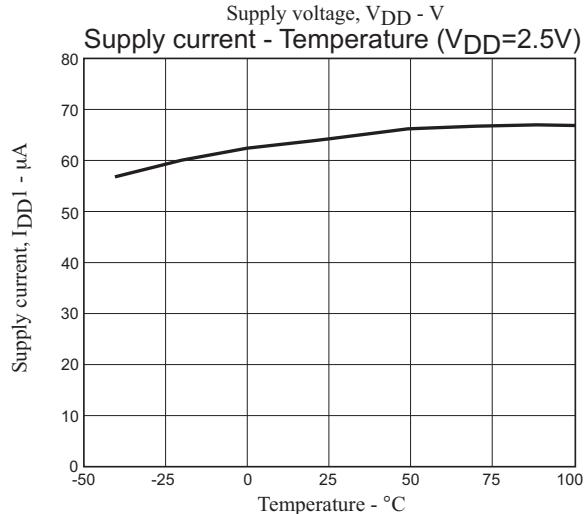
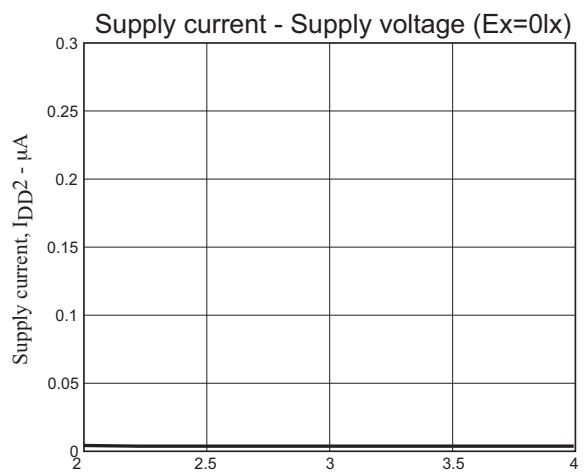
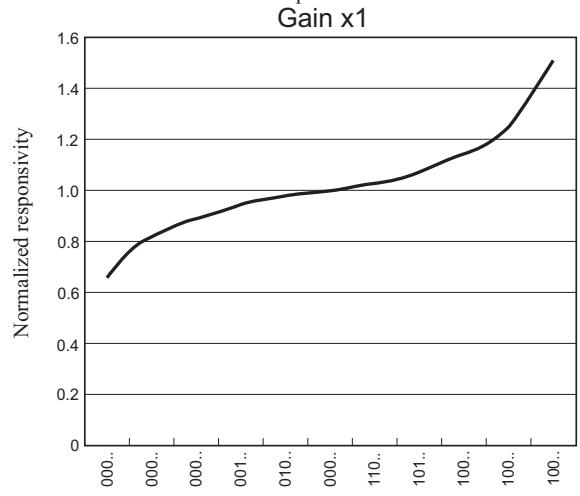
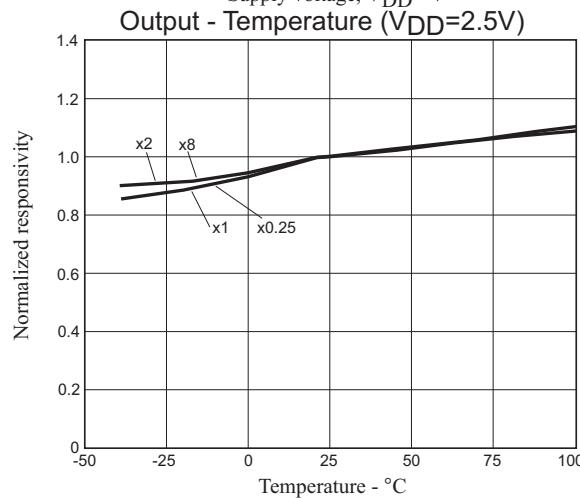
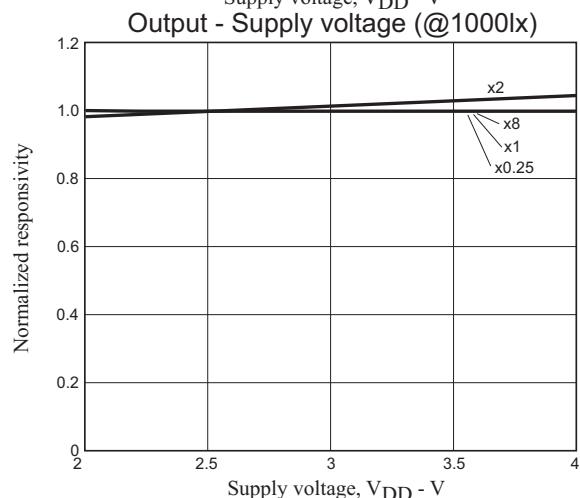
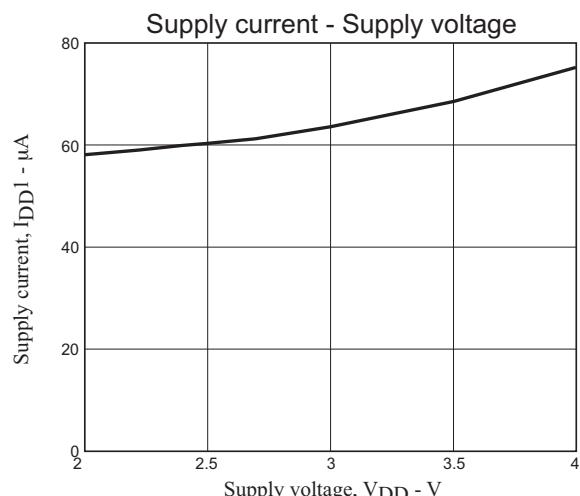
(Example)

DH = “0010\_0100” (DH5, DH2 = 1)

DL = “1000\_0001” (DL7, DL0 = 1)

$$2^{13}(8192) + 2^{10}(1024) + 2^7(128) + 2^0(1) = 9345[\text{lx}]$$

# LV0104CS



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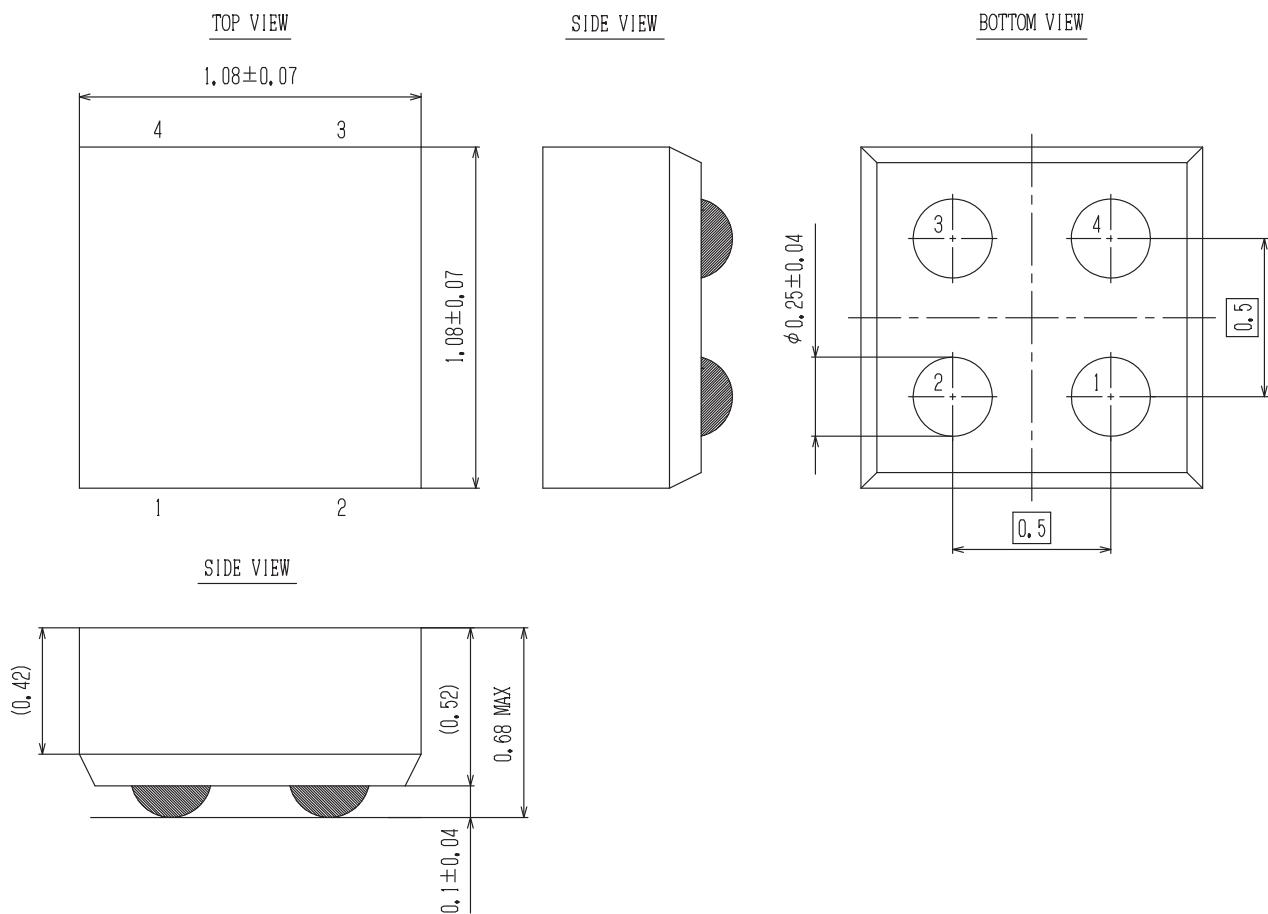
## PACKAGE DIMENSIONS

unit : mm

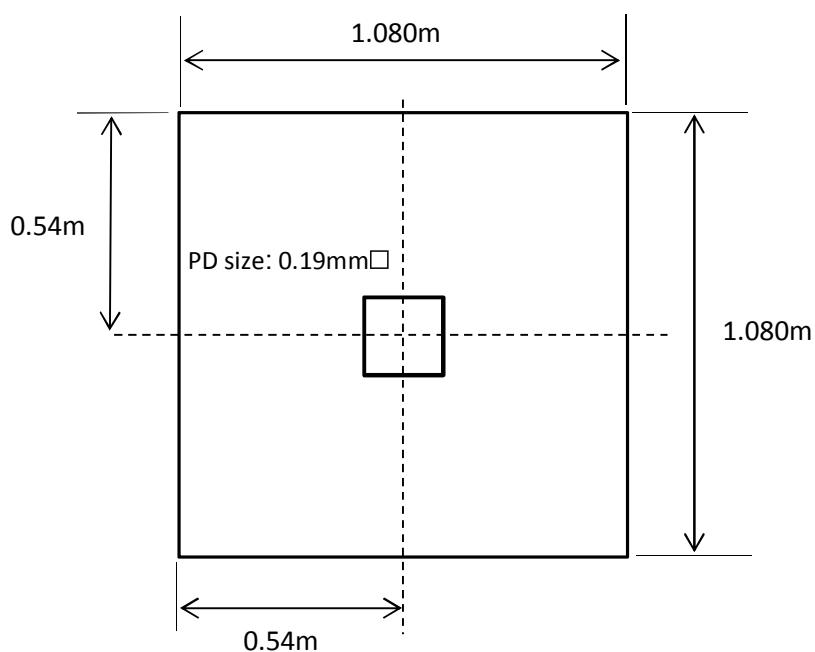
ODCSP4 1.08x1.08

CASE 570AK

ISSUE O



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