

# LV0104CS



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Bi-CMOS LSI

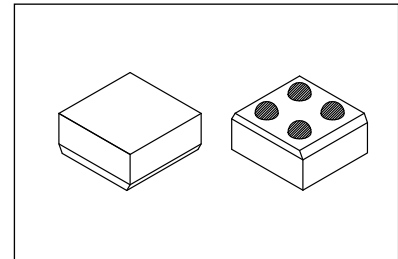
## Ambient Light Sensor, I<sup>2</sup>C Interface, Ultra-small Package

### 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.

### Feature

- Smallest OD-CSP package in the world  
(1.08mm × 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



ODCSP4 (1.08×1.08)

### Typical Applications

- mobile phone (Digital-TV, One-segment)
- LCD-TV
- laptop computer
- PDA
- DSC
- Camcorder

### Specifications

**Absolute Maximum Ratings** at Ta = 25°C

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	Tstg		-40 to 100	°C

Stresses exceeding those listed in the Maximum Ratings 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.

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

### ORDERING INFORMATION

See detailed ordering and shipping information on page 9 of this data sheet.

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## Recommended Operating Conditions at Ta = 25°C

Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
Recommended Supply Voltage	V <sub>DD OP</sub>		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, V <sub>DD</sub> =2.8V	1.26			V
Output low level voltage	V <sub>OL</sub>	SDA, IOL=3mA			0.4	V
Input leak current	I <sub>LEAK</sub>	SCL, SDA	-5		5	μA

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

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.

## Electrical Characteristics at Ta = 25°C, V<sub>DD</sub> = 2.5V

Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
Supply Current	I <sub>DD</sub>	Ev=0 lux		70	100	μA
Sleep Current	I <sub>SLP</sub>	Sleep mode, Ev=0 lux			1	μA
Internal Oscillator Frequency	f <sub>OSC</sub>			655		kHz
Dark ADC count value	D0	Ev=0 lux, High gain mode			5	counts
Full scale ADC count value	D max				65535	counts
ADC count value	Data HH	Gain × 8 mode, Ev=1000lx		8000		counts
	Data HM	Gain × 2 mode, Ev=1000lx		2000		counts
	Data N	Gain × 1 mode, Ev=1000lx	750	1000	1250	counts
	Data L	Gain × 0.25 mode, Ev=1000lx		250		counts
Resolution	ReHH1	Tint=200ms, Gain × 8 mode		0.125		lx
	ReHH2	Tint=100ms, Gain × 8 mode		0.25		lx
	ReHH3	Tint=12.5ms, Gain × 8 mode		2		lx
	ReHM1	Tint=200ms, Gain × 2 mode		0.5		lx
	ReHM2	Tint=100ms, Gain × 2 mode		1		lx
	ReHM3	Tint=12.5ms, Gain × 2 mode		8		lx
	ReN1	Tint=200ms, Gain × 1 mode		1		lx
	ReN2	Tint=100ms, Gain × 1 mode		2		lx
	ReN3	Tint=12.5ms, Gain × 1 mode		16		lx
	ReL1	Tint=200ms, Gain × 0.25 mode		4		lx
ReL2	Tint=100ms, Gain × 0.25 mode		8		lx	
ReL3	Tint=12.5ms, Gain × 0.25 mode		64		lx	

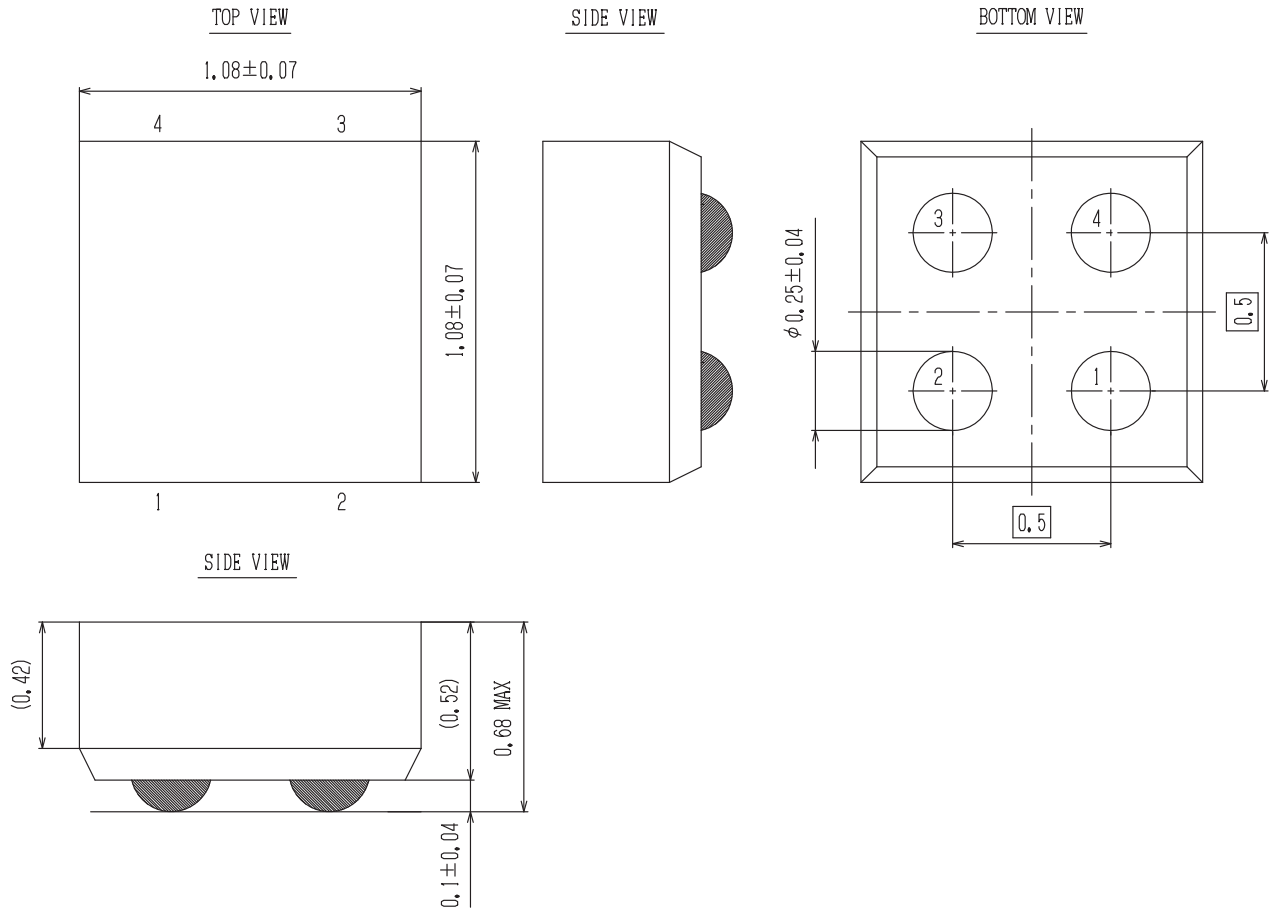
Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

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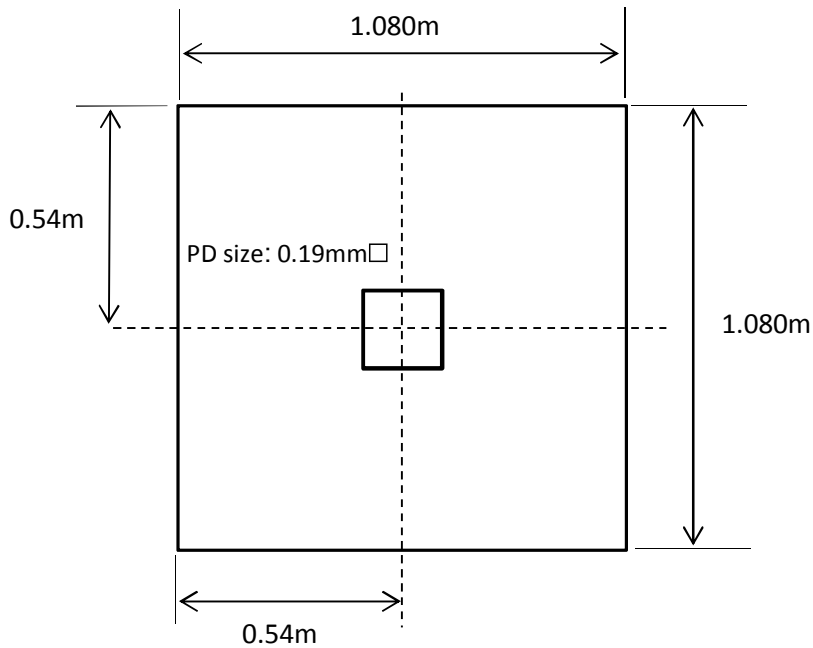
## Package Dimensions

unit : mm

ODCSP4 1.08x1.08  
CASE 570AK  
ISSUE O

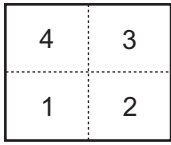


## PD assignment

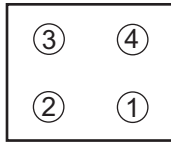


**Pad layout**

<Top view>



<Bottom view>

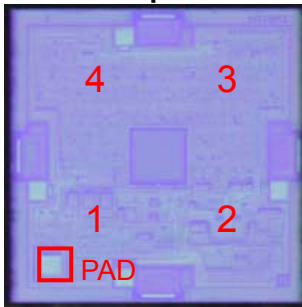


Ball Pitch: 0.5mm, Ball Size: 0.25mm

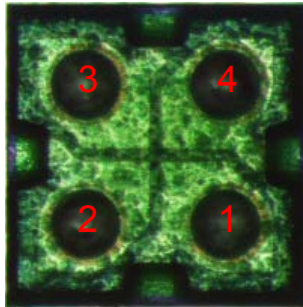
No.	Name	Function
1	V <sub>DD</sub>	Supply voltage pin
2	GND	GND pin
3	SCL	I <sup>2</sup> C serial clock
4	SDA	I <sup>2</sup> C serial data

**Pad layout (Photos)**

<Top View>

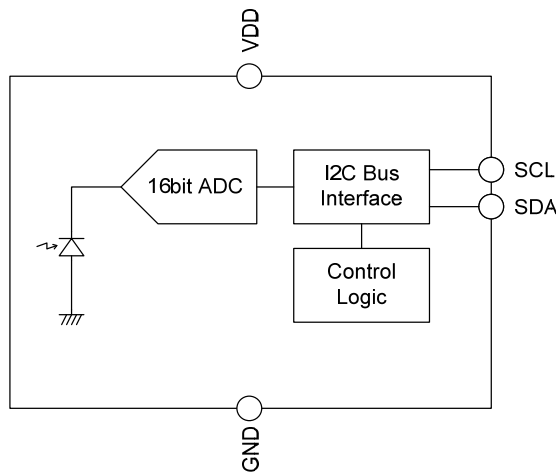


<Bottom View>

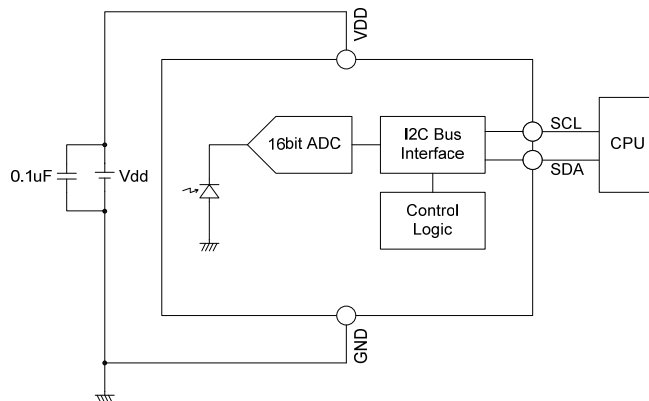


\* The position with PAD becomes pin 1.

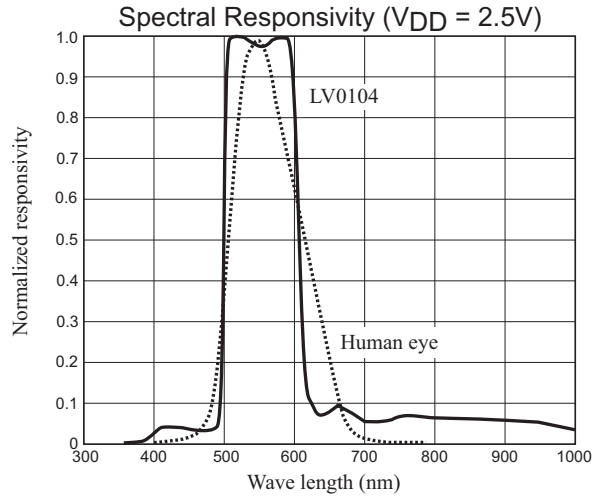
**Block Diagram**



**Application circuits**



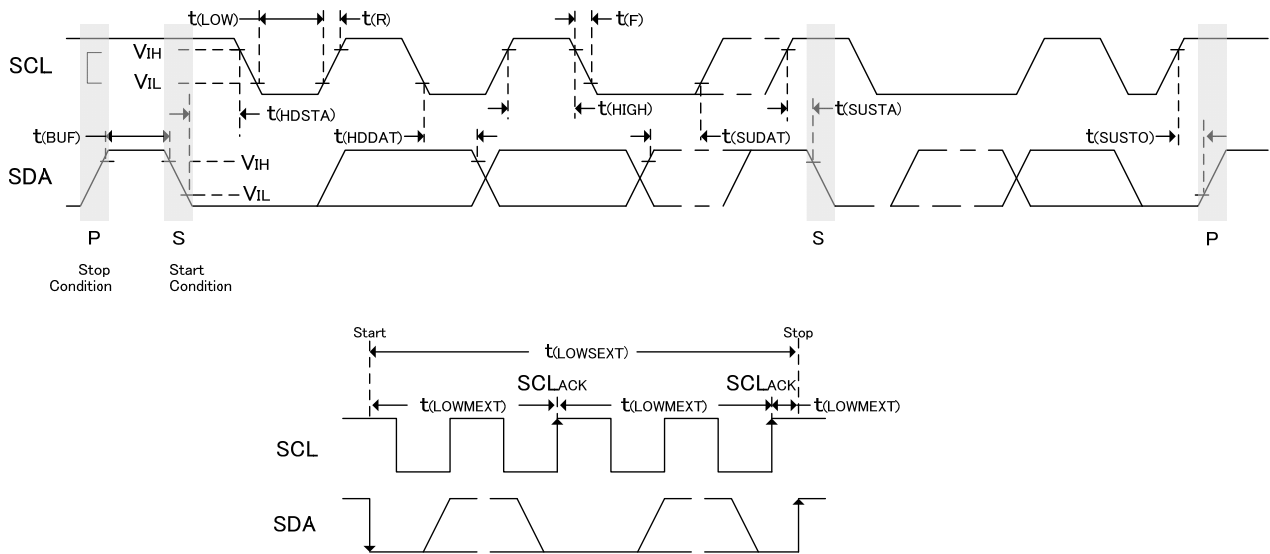
## Spectrum Sensitivity Characteristic



## 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

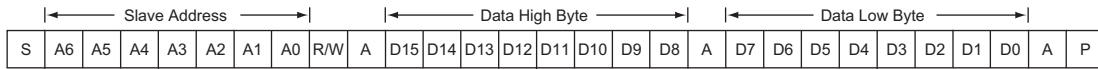
\*Specified by design and characterization ; not production tested.

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## Data Format (Write)



## Data Format (Read)

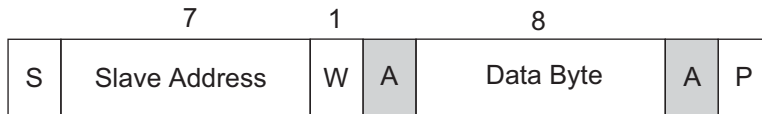


### Slave Address

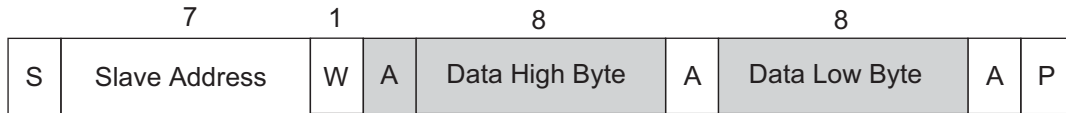
A6	A5	A4	A3	A2	A1	A0	R/W
0	0	1	0	0	1	1	X

R/W: Read: 1, Write: 0

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



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



Master to Slave       Slave to Master

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 01: x1 10: x2 11: x8		00: 12.5ms 01: 100ms 10: 200ms 11: Manual		0: Start 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

### (3) Setting Sensitivity

	D7	D6	D5	D4	D3	D2	D1	D0
Name	MODE1	MODE0	ADJ5	ADJ4	ADJ3	ADJ2	ADJ1	ADJ0
	10:Setting		0: Minus 1: Plus	ADJ4	ADJ3	ADJ2	ADJ1	ADJ0
Default	00		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%
.	.	.	.	.	.	
<b>1</b>	<b>0</b>	<b>0</b>	<b>1</b>	<b>1</b>	<b>0</b>	<b>108.3%</b>
.	.	.	.	.	.	
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)

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

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

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

- Increasing Sensitivity (ADJ5=1)

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

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

(Example) ADJ5 to ADJ0 = 100110,  $S_n = 4 + 2 = 6$ ,  $S = 13 / 12 = 1.083$ . 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 <sup>15</sup> )	DH6(2 <sup>14</sup> )	DH5(2 <sup>13</sup> )	DH4(2 <sup>12</sup> )	DH3(2 <sup>11</sup> )	DH2(2 <sup>10</sup> )	DH1(2 <sup>9</sup> )	DH0(2 <sup>8</sup> )

	D7	D6	D5	D4	D3	D2	D1	D0
DL (Data Lower byte)	DL7(2 <sup>7</sup> )	DL6(2 <sup>6</sup> )	DL5(2 <sup>5</sup> )	DL4(2 <sup>4</sup> )	DL3(2 <sup>3</sup> )	DL2(2 <sup>2</sup> )	DL1(2 <sup>1</sup> )	DL0(2 <sup>0</sup> )

- Lux calculation

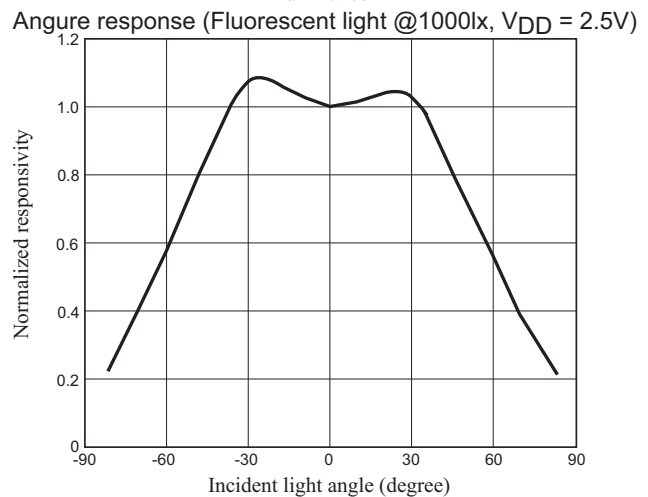
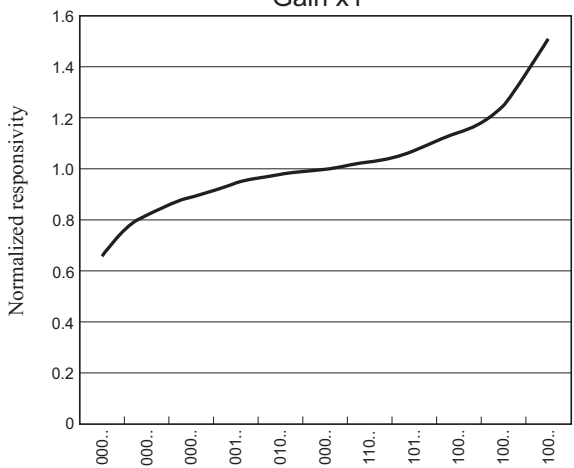
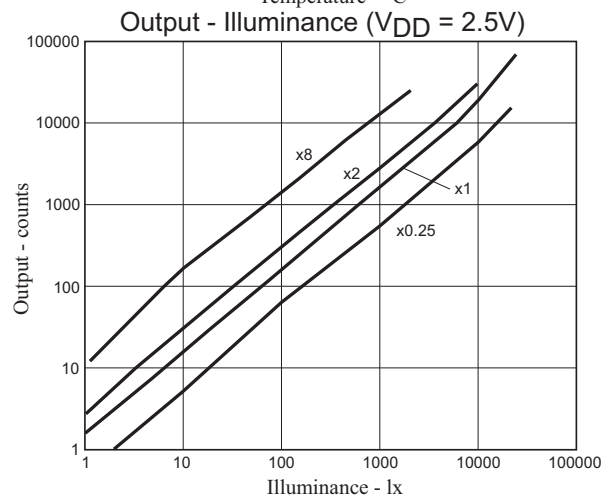
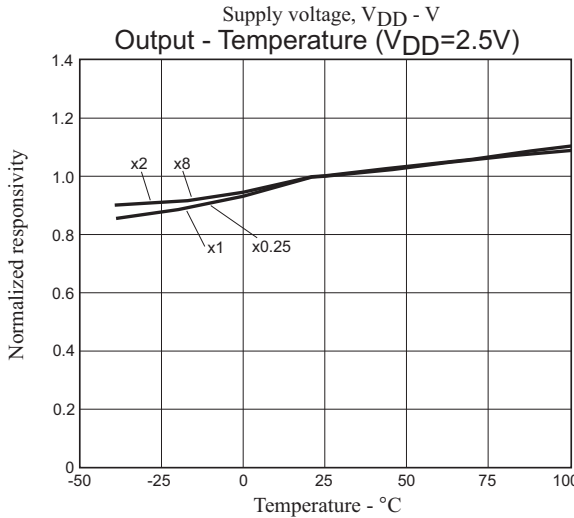
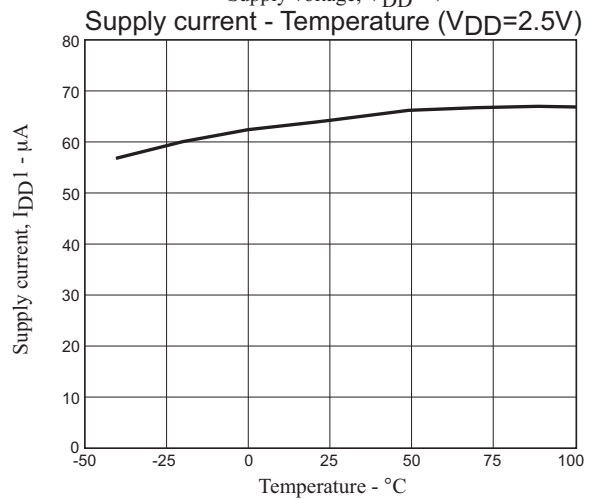
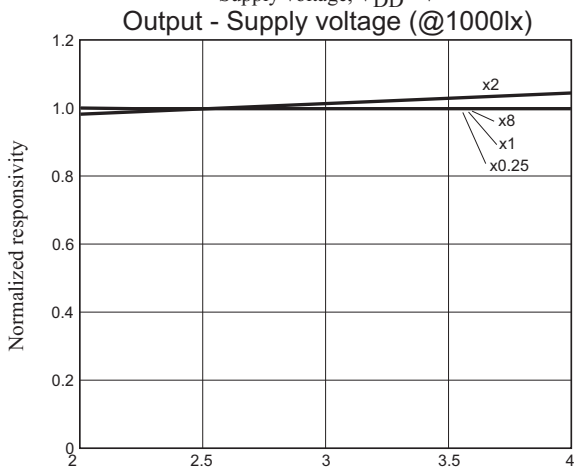
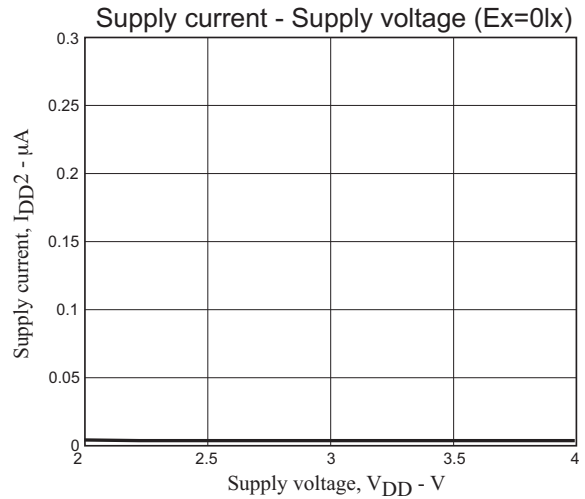
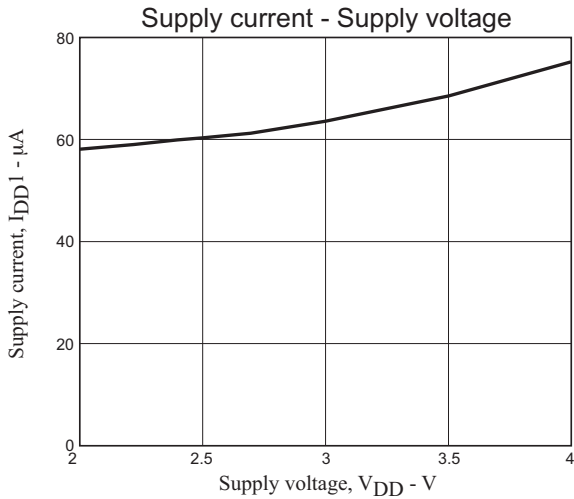
(Example)

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





## ORDERING INFORMATION

Device	Package	Shipping (Qty / Packing)
LV0104CS-TLM-H	ODCSP4 (1.08×1.08) (Pb-Free / Halogen Free)	5000 / Tape & Reel

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