Ordering number : ENA2079A

SANYO Semiconductors
DATA SHEET

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LV0104CS — Monolithic Linear IC Halogen-free Digital Ambient Light Sensor

Overview

LV0104CS is a Photo IC for micro-sized 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.

Functions

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

Specifications

Absolute Maximum Ratings at Ta=25°C

Parameter	Symbol	Conditions	Ratings	Unit
Power Supply Voltage	V_{DD}		4.0	V
Logic I/O levels	V_{IO}		-0.3 to V_{DD}+0.3	V
Operating temperature range	Topr		-30 to 85	°C
Storage temperature range	Tstg		-40 to 100	°C

Recommended Operating Conditions at Ta = 25°C

Parameter	Symbol	Condition	Min.	Typ	Max.	Unit
Recommended Supply Voltage	V_{DD} op		2.3	2.5	3.6	V
Input low level voltage	V_IL	SCL, SDA			0.55	V
Input high level voltage	V_IH	SCL, SDA ,VDD=2.8V	1.26			V
Output low level voltage	V_OL	SDA, IOL=3mA			0.4	V
Input leak current	I_{LEAK}	SCL,SDA	-5		5	μA

* I^2C interface(SCL,SDA) is for Vio=1.8V operation.

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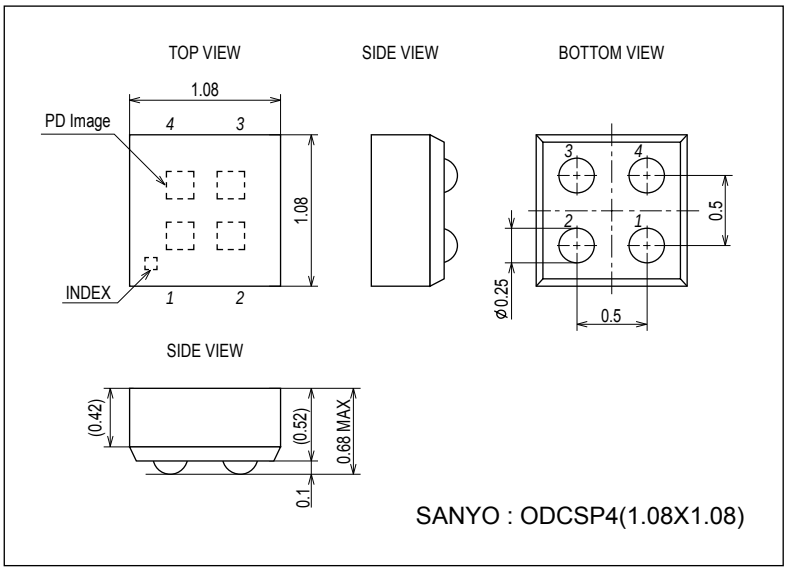
Electrical Characteristics at Ta = 25°C, V_{CC} = 5V

Parameter	Symbol	Conditions	Min.	Typ	Max.	Unit
Supply Current	I_{DD}	Ev=0 lux		70	100	μA
Sleep Current	I_{SLP}	Sleep mode, Ev=0 lux			1	μA
Internal Oscillator Frequency	f_{OSC}			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×8mode, 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

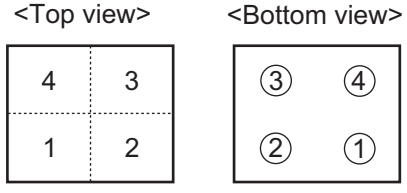
Package Dimensions

unit : mm (typ)

3371



Pad layout

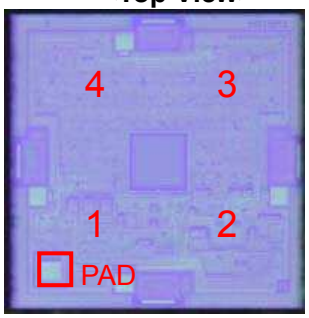


Ball Pitch: 0.5mm, Ball Size: 0.25mm

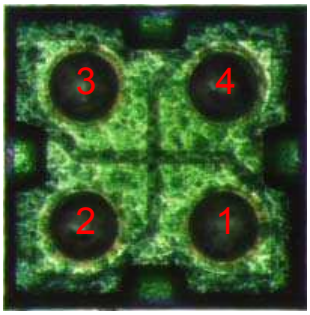
No.	Name	Function
1	V_{CC}	Supply voltage pin
2	GND	GND pin
3	SCL	I^2C serial clock
4	SDA	I^2C serial data

Pad layout (Photos)

<Top View>

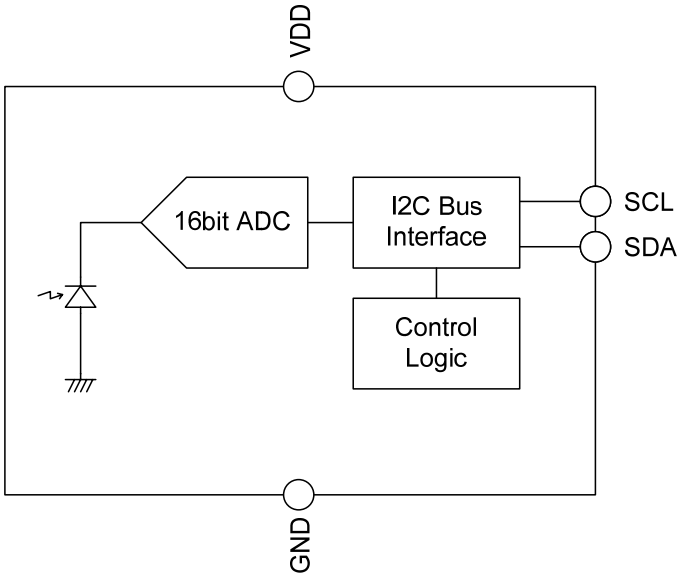


<Bottom View>

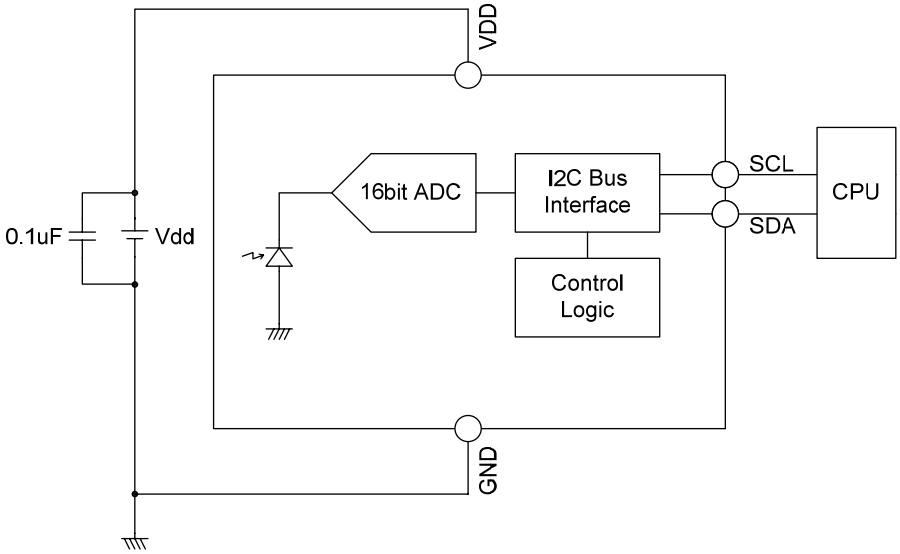


* The position with PAD becomes pin 1.

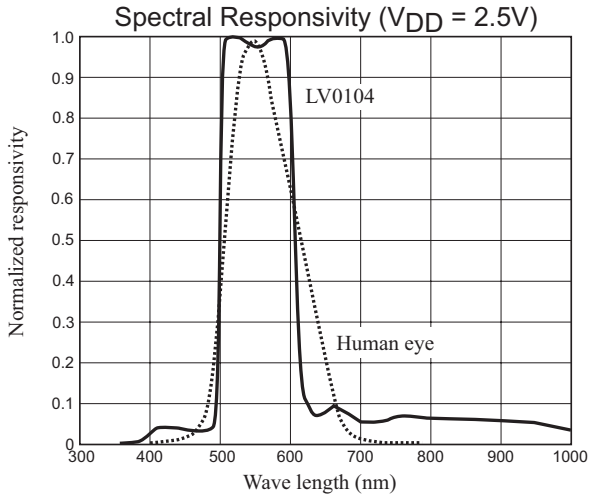
Block Diagram



Application circuits



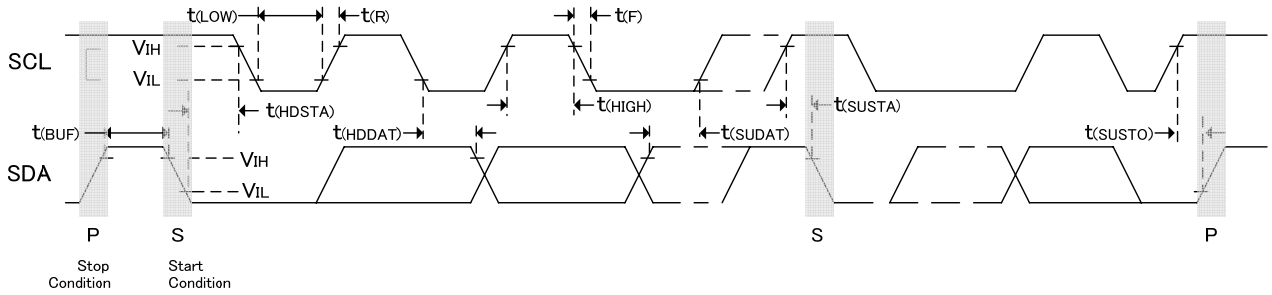
Spectrum Sensitivity Characteristic

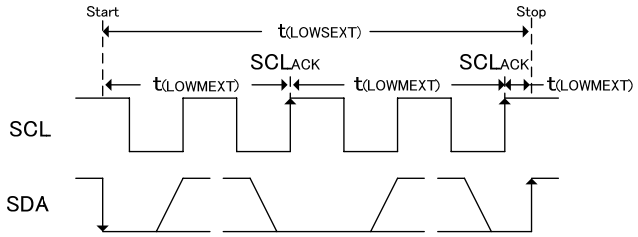


I²C Interface

The control command is received from the operation of the device by the I²C bus (Two-wire serial interface). The obtained data is output to the operation by the I²C bus.

I²C Bus Timing Diagram



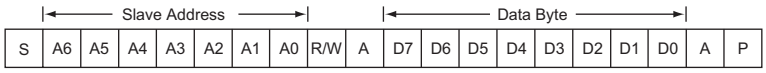


Serial Interface Timing

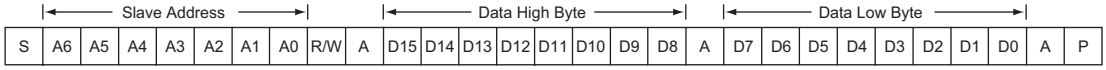
Parameter	Symbol	Standard Mode		Fast Mode		Unit
		Min	Min	Min	Max	
Clock frequency	f(SCL)	10	100	10	400	kHz
Bus free time between start and stop condition	t(BUF)	4.7		1.3		µs
Hold time after (repeated) start condition. After this period, the first	t(HDSTA)	4.0		0.6		µs
Repeated start condition setup 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
I²C clock (SCL) low period	t(LOW)	4.7		1.3		µs
I²C 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.

Data Format (Write)



Data Format (Read)

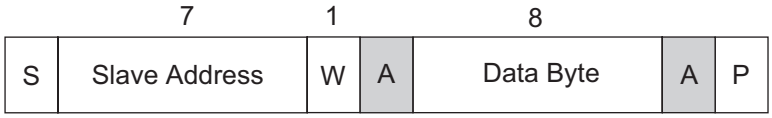


●Slave Address

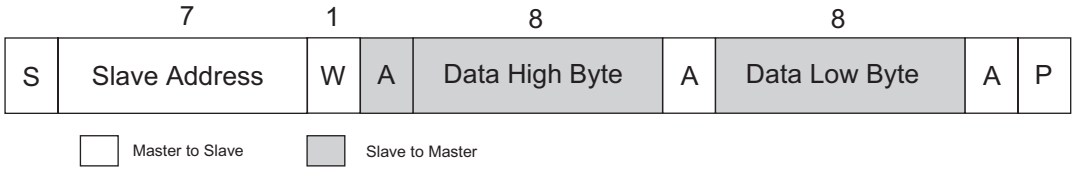
A6	A5	A4	A3	A2	A1	A0	R/W
0	0	1	0	0	1	1	X

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 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%
. .	. .	. .	. .	. .	. .	
1	**0**	**0**	**1**	**1**	**0**	**108.3%**
. .	. .	. .	. .	. .	. .	
1	0	0	0	0	1	150%

<Width of sensitivity adjustment>
66.7% to150% (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.

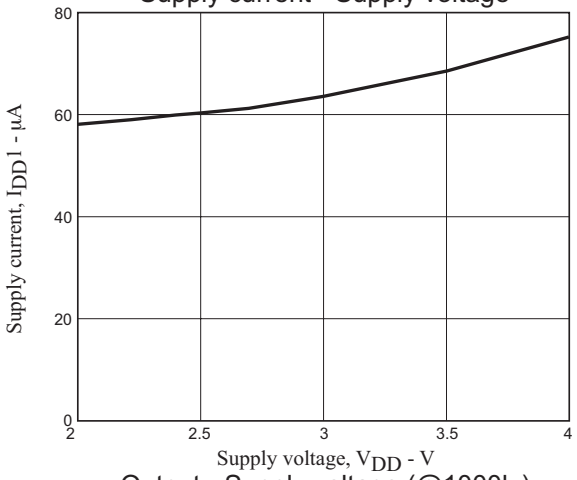
	D15	D14	D13	D12	D11	D10	D9	D8
DH (Data Higher byte)	**DH7(2^{15})**	**DH6(2^{14})**	**DH5(2^{13})**	**DH4(2^{12})**	**DH3(2^{11})**	**DH2(2^{10})**	**DH1(2^{9})**	**DH0(2^{8})**

	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})**

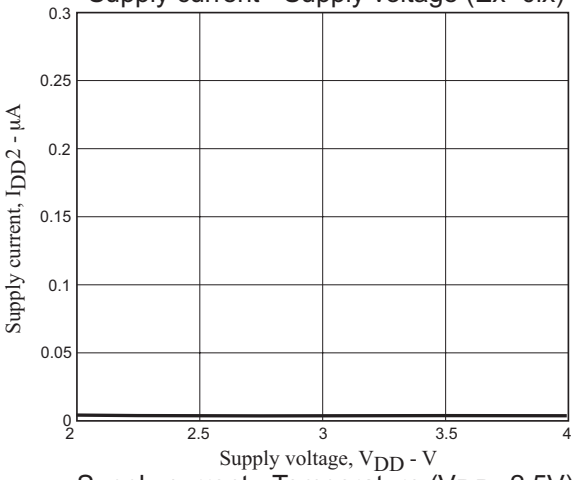
- Lux calculation
  (Example)
  DH = “0010_0100” (DH5, DH2 = 1)
  DL = “1000_0001” (DL7, DL0 = 1)

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

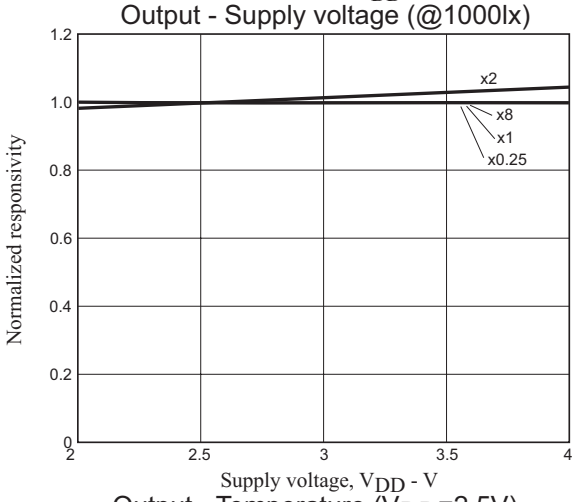
Supply current - Supply voltage



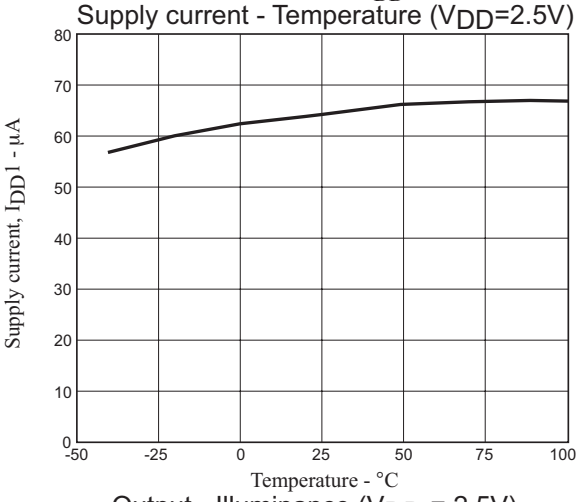
Supply current - Supply voltage (Ex=0lx)



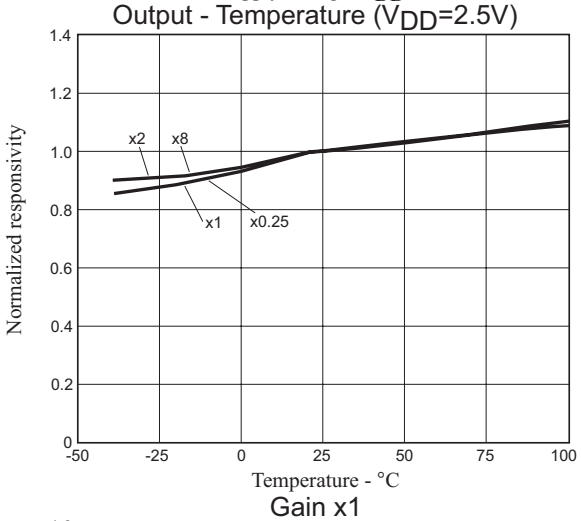
Output - Supply voltage (@1000lx)



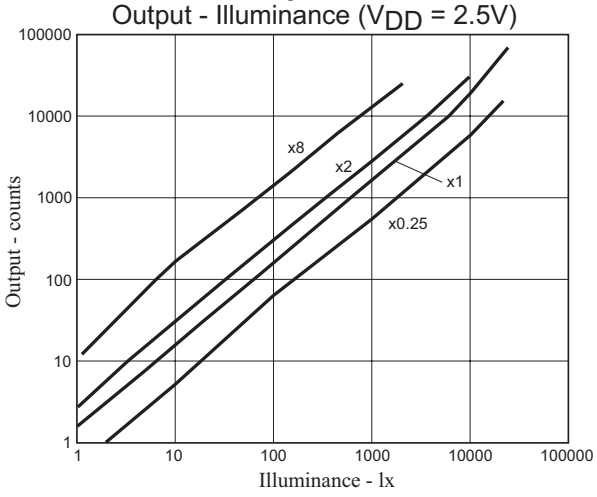
Supply current - Temperature (V_{DD}=2.5V)



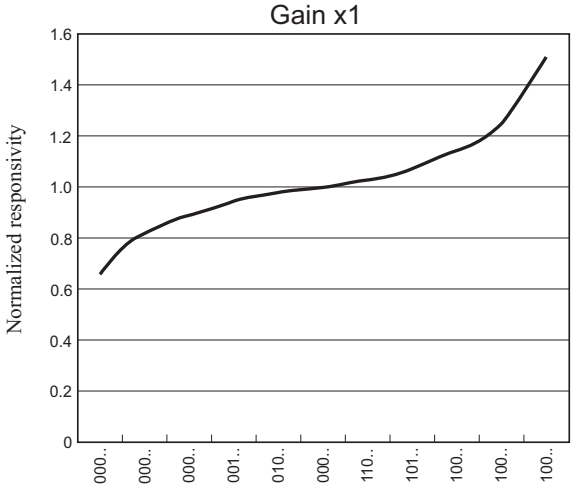
Output - Temperature (V_{DD}=2.5V)



Output - Illuminance (V_{DD} = 2.5V)



Gain x1



Angure response (Fluorescent light @1000lx, V_{DD} = 2.5V)