

AND9239/D

Ultra-small Ambient Light Sensor Linear Current Output, 2-Stage Gain Switching using the LA0151CS



ON Semiconductor®

www.onsemi.com

APPLICATION NOTE

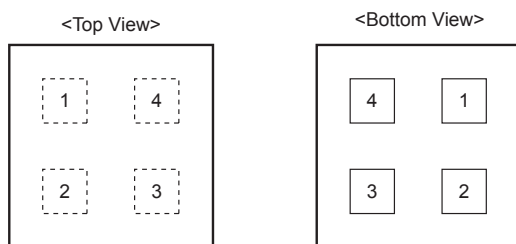
Overview

The LA0151CS is a photo IC for micro-sized ambient light sensor. It enables to be mounted on a very small limited space such as on the cell phones which is becoming small and thinner and on other mobile applications. It is suitable for application like mobile phone, tablet PC, digital still camera and camcorder.

Features

- Smallest ODCSP package in the world (1.01mm × 1.01mm, thickness : 0.6mm)
- Low gain mode function (Low gain -38dB)
- Low power consumption (150μA at 1,000Lux)
- Low dark current (Max current 0.1μA)
- No sensibility in infrared area
- Less difference in sensibility depending on the type of light source (Fluorescent/Incandescent:1.0/1.1)
- Linear current output
- Wide dynamic range (1 to 100,000Lux)
- Halogen free compliant

Pin Assignment



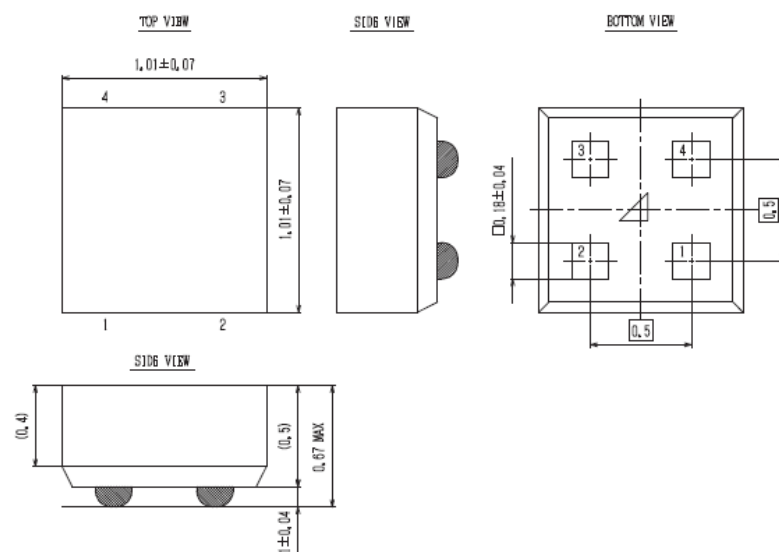
No.	Name	Function
1	VCC	Power supply
2	SW	Gain change
3	GND	Ground
4	OUT	Output

Ball Pitch : 0.5mm , Ball Size : 0.18mm □

Package Dimensions

unit : mm

ODCSP4 1.01x1.01
CASE 570AC
ISSUE 0



Pad Layout (Photos)

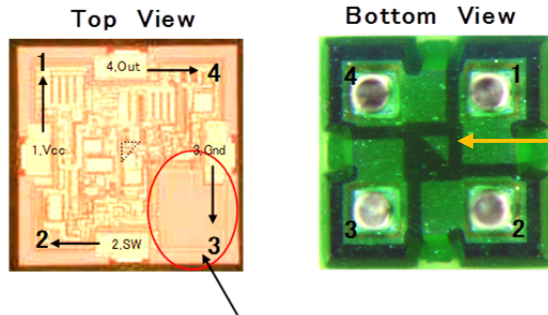
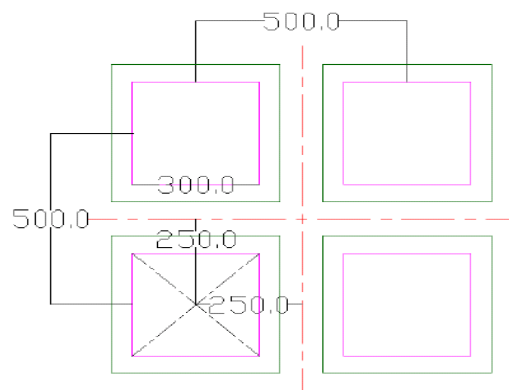


Photo diode: Only this part looks dark.

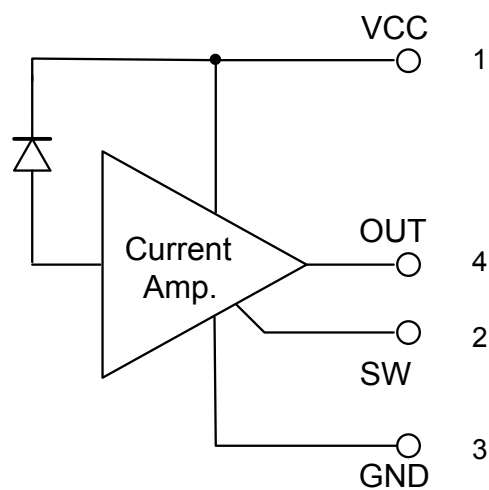
Recommended Land Pattern

unit : μm

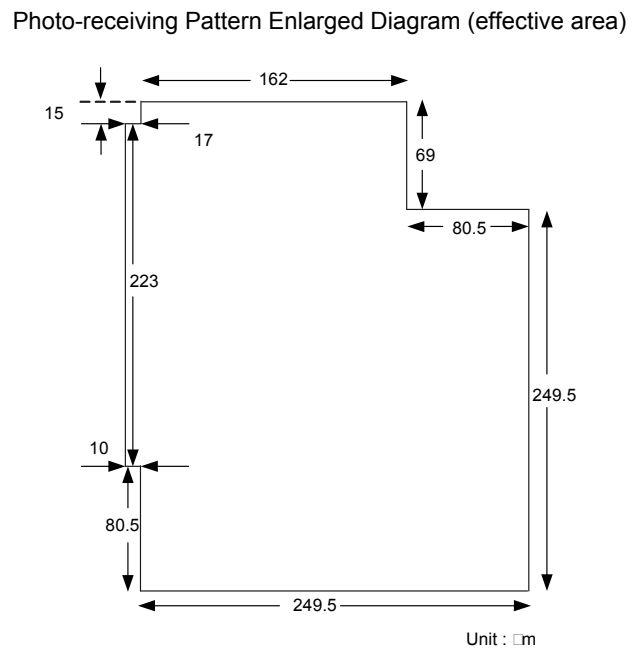
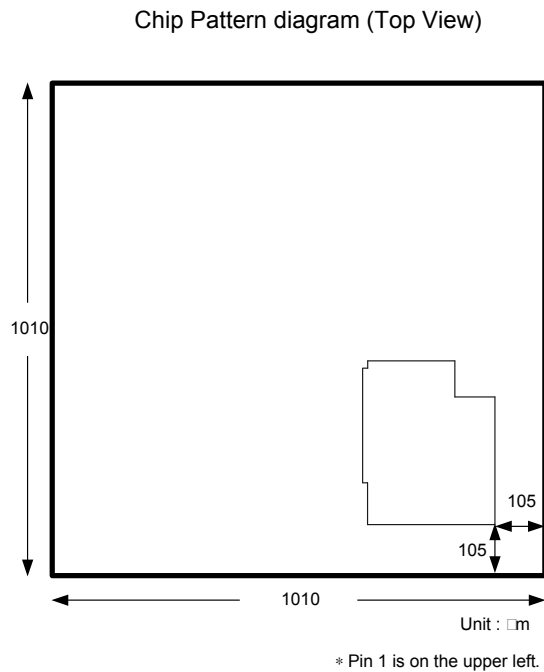


Land (pink) : 300 μm square
Solder resist opening (green) : 400 μm square

Block Diagram



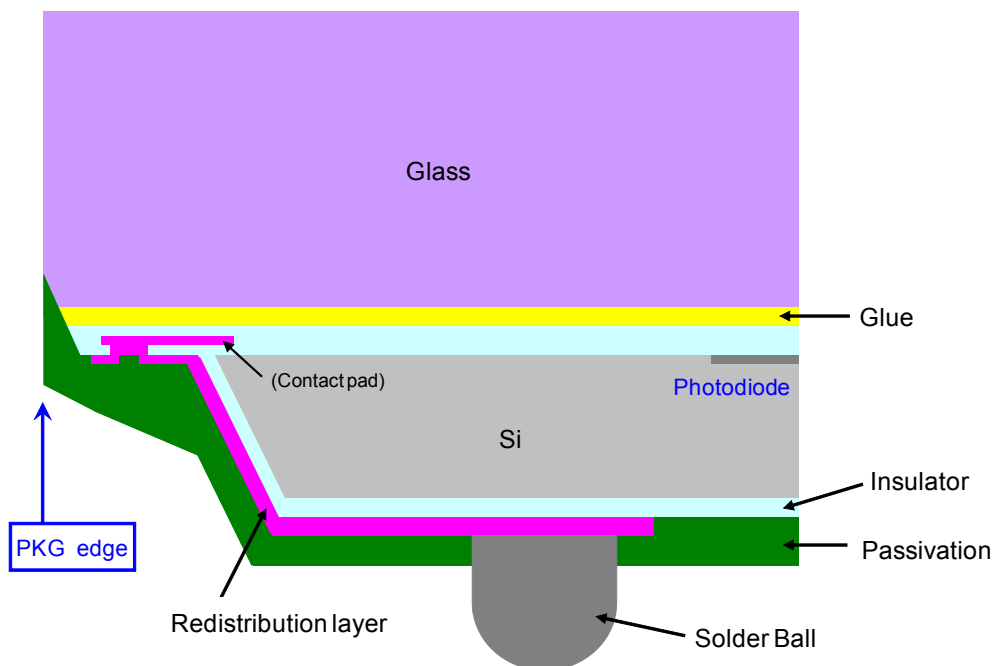
Chip Pattern and Photo-receiving Pattern Diagrams



ODCSP Cross Section Structure

Optical Device Chip Size Package

ON Semiconductor original wafer level package for optical device.



SPECIFICATIONS

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

Parameter	Symbol	Conditions	Ratings	Unit
Maximum supply voltage	V _{CC}		6	V
Operating temperature	T _{opr}		-30 to 85	°C
Storage temperature	T _{stg}		-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.

RECOMMENED OPERATING CONDITIONS AND OPERATING VOLTAGE RANGE at Ta=25 °C (Note 2)

Parameter	Symbol	Conditions	min	typ	max	Unit
Recommended supply voltage	V _{CC}		2.2	3.3	5.5	V
SW pin low voltage	V _L	Normal gain mode	0		0.4	V
SW pin high voltage	V _H	Low gain mode	1.4		V _{CC}	V

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.

ELECTRICAL AND OPTICAL CHARACTERISTICS at V_{CC}=3.3V, Ta=25 °C (Note 3)

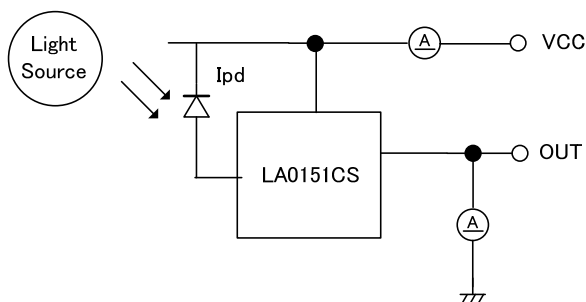
Parameter	Symbol	Conditions	min	typ	max	Unit
Current dissipation (Note 4,6)	I _{CC}	Ev=1000 lux, R _L =5kΩ	90	150	210	μA
Sleep current (1) (Note 6)	I _{sl1}	Ev=0 lux			0.1	μA
Sleep current (2) (Note 6)	I _{sl2}	Ev=1000 lux			0.3	μA
Output current (1) (Note 4,6)	I _{O1}	Ev=100 lux	6	8	10	μA
Output current (2) (Note 4,6)	I _{O2}	Ev=1000 lux	60	80	100	μA
Dark current (Note 6)	I _{leak}	Ev=0 lux			0.1	μA
Temperature coefficient (Note 5)	I _{tc}	Ev=100 lx, Ta=-20 to 60°C		0.34		% / °C
Rise time (1) (Note 7)	T _{r1}	Ev=1000 lux, R _L =5kΩ		15	40	μs
Fall time (1) (Note 7)	T _{f1}	Ev=1000 lux, R _L =5kΩ		150	500	μs
Peak sensitivity wave length (Note 5)	λ _p			550		nm
Saturation output voltage (Note 4,6)	V _O	R _L =150kΩ, Ev=1000 lx	3.0	3.2		V

3. 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.

4. Measured with the standard light source A. White LED is used instead in the mass production line.

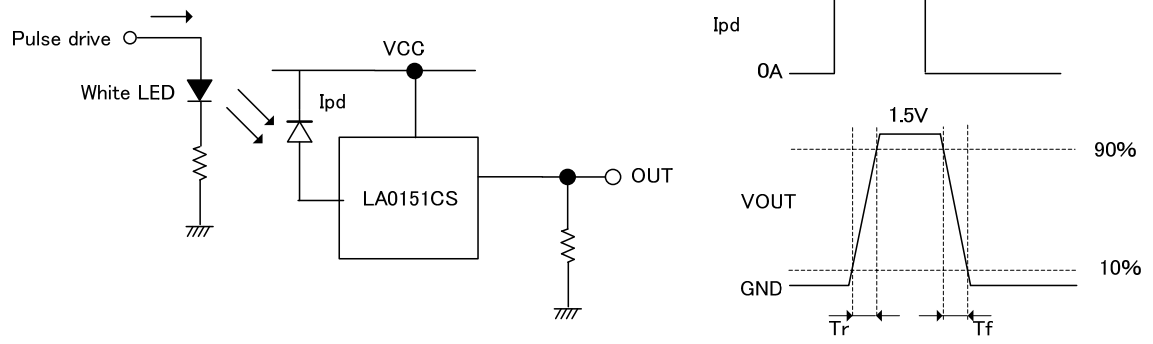
5. Design guaranteed item

6. Test circuit for measuring current dissipation and output current

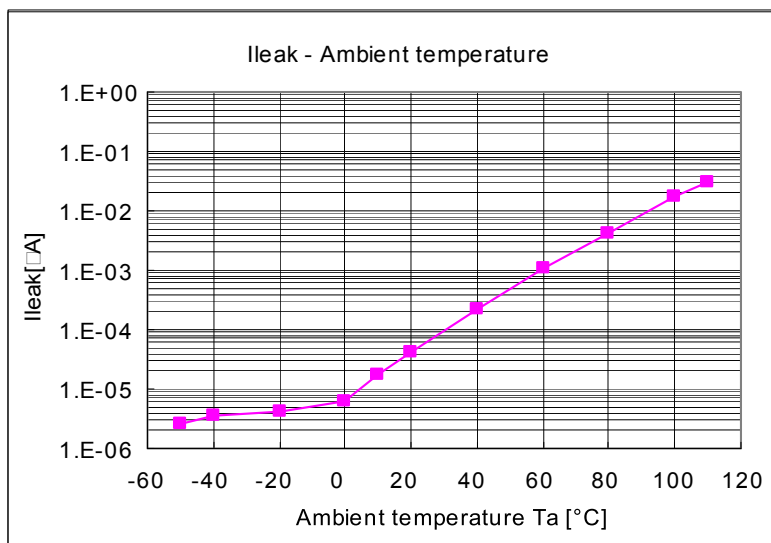
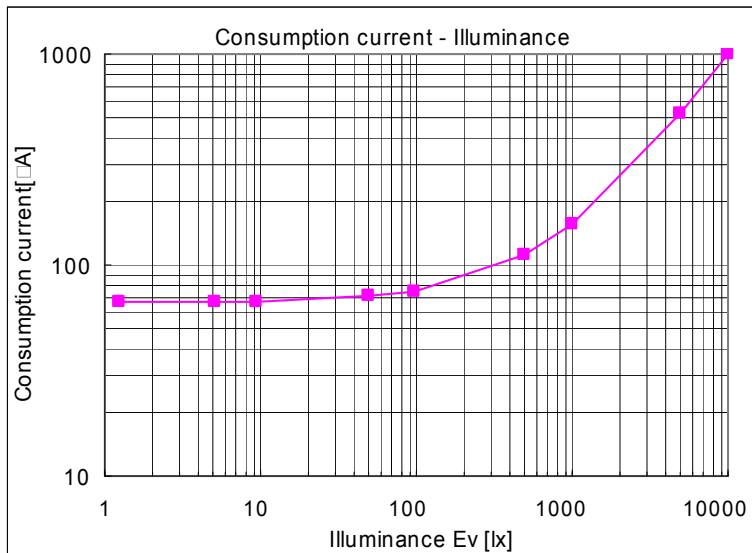
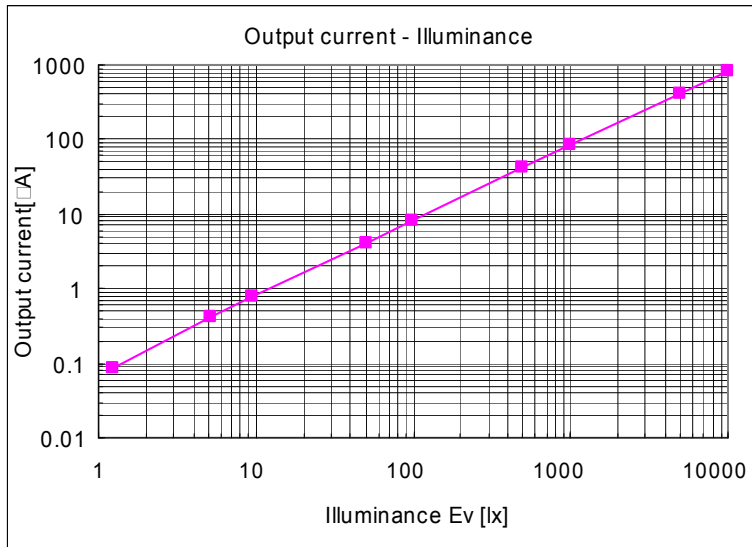


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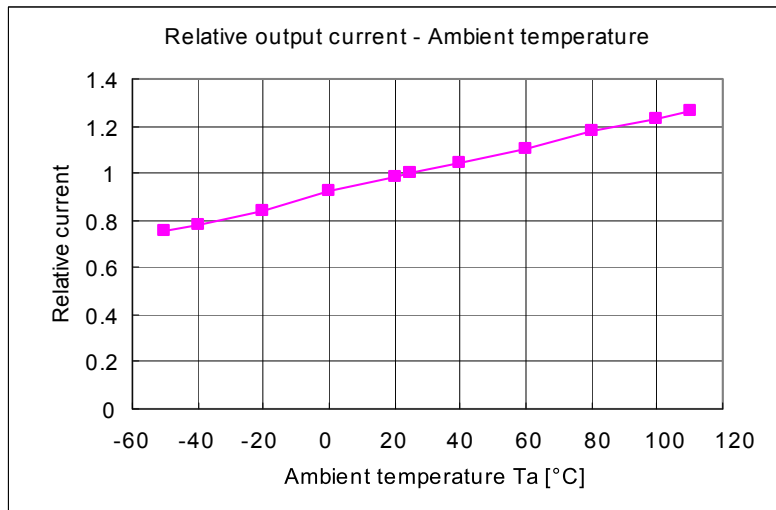
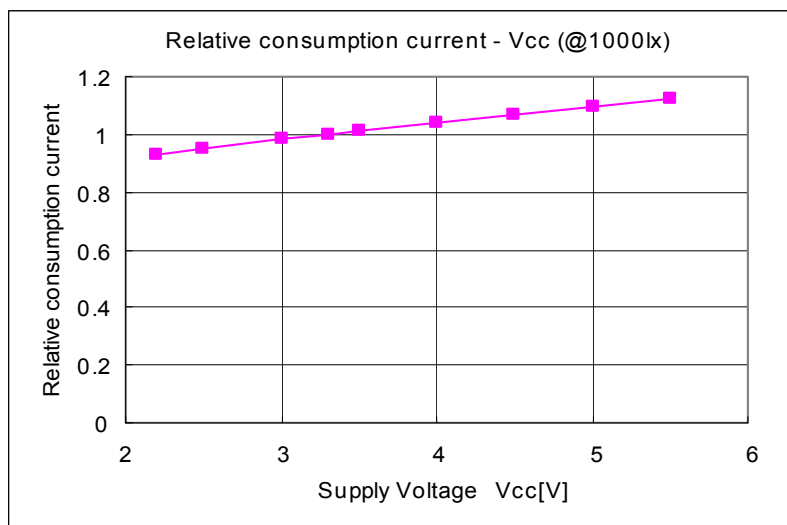
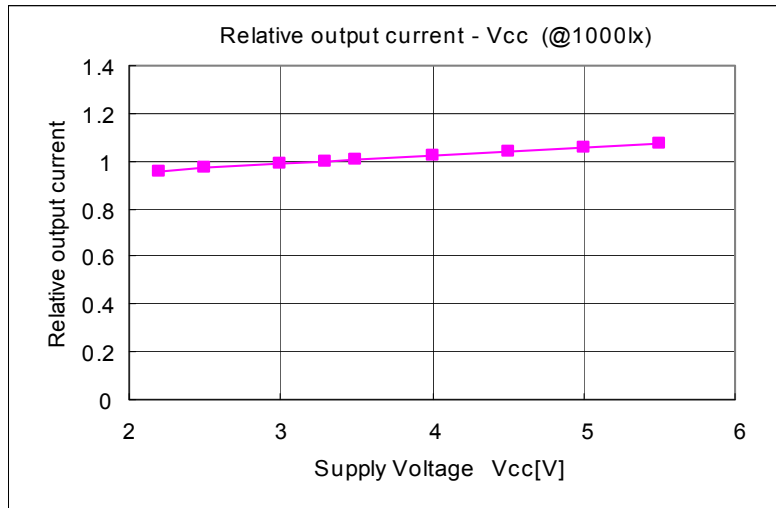
7. Measuring method of rise time (T_r) and fall time (T_f)



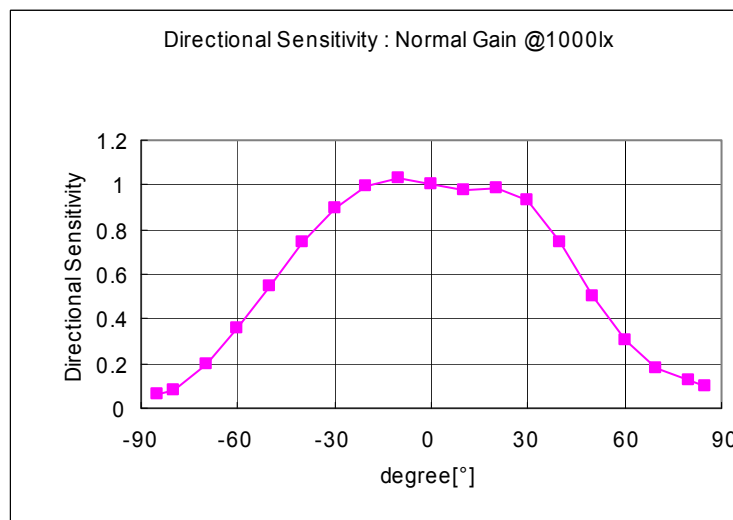
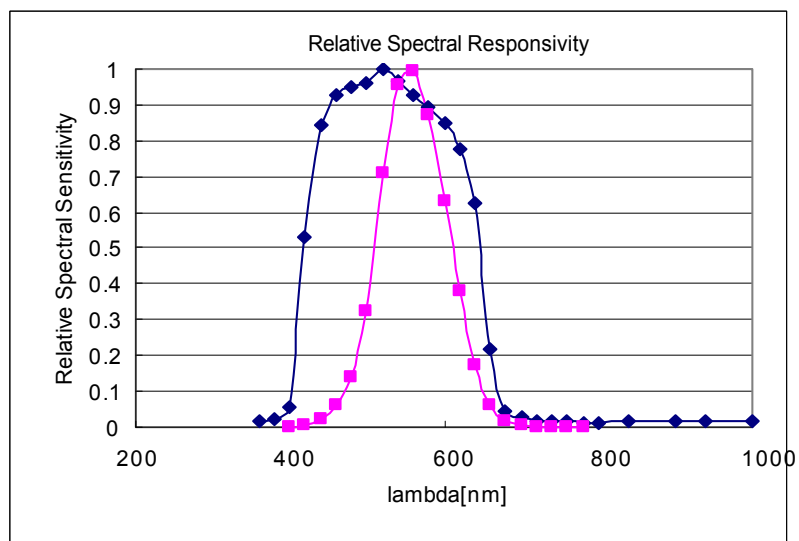
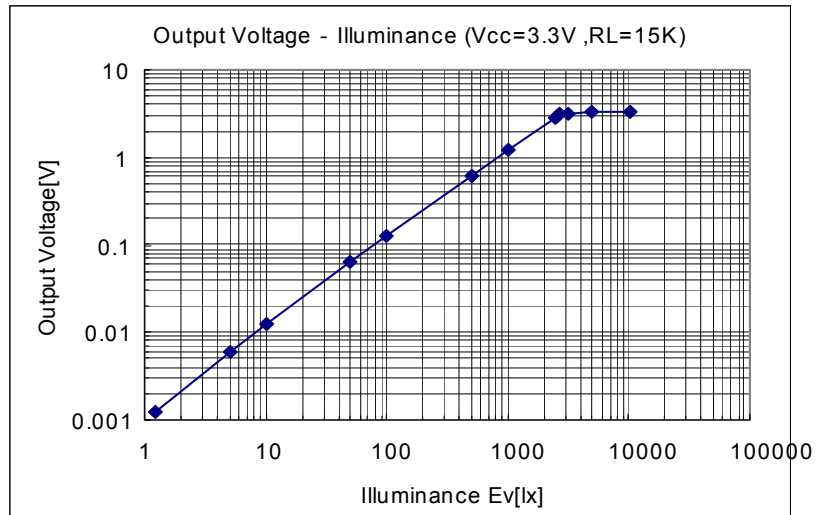
Typical Performance Characteristics



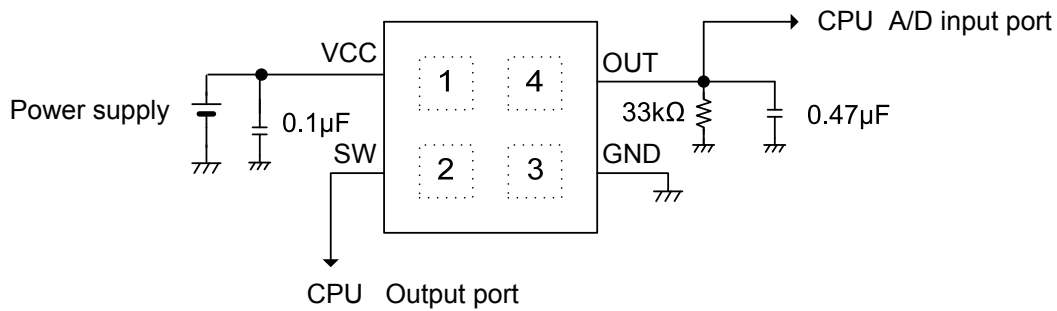
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Sample Application Circuit



*The receiving photoresponse changes depending on the distance from the diameter, the material, and the case to IC of the sensor window etc.

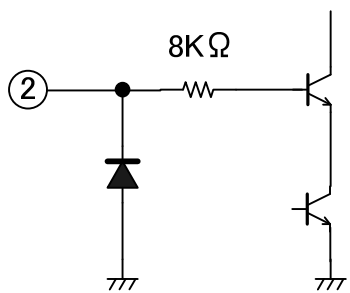
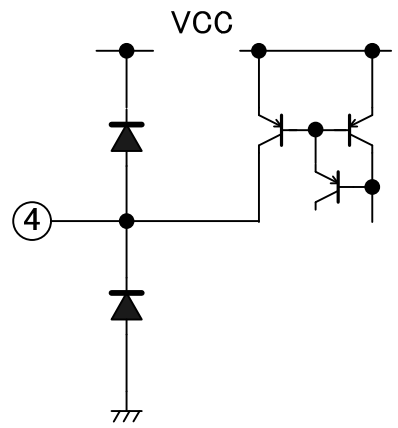
Therefore, the optimum setting is necessary for resistance and the capacity value between 4 pin(OUT) and 3 pin(GND) according to the application.

- You can regulate the output voltage of the light sensitivity by an output resistance value. Please adjust it by application.

$$V_{out} = (80\mu A \text{ at } 1000lx, \text{ Normal mode}) \cdot EV \cdot RI$$
- You can compose LPF by connecting capacity to the output. This is to reduce the 50/60Hz noise of the AC power.

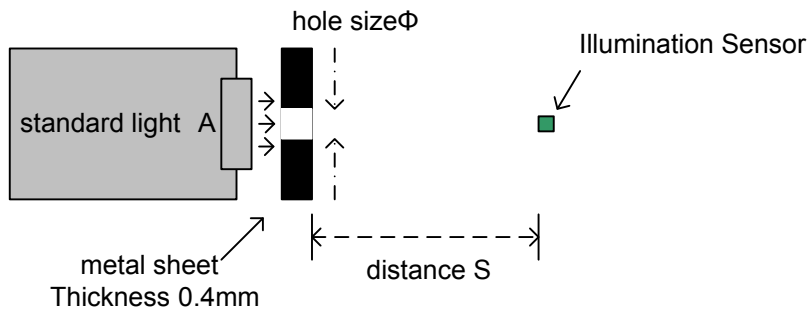
$$CI = 1 / (2 \pi f_c RI)$$
- It is not necessary to place power supply capacity near an IC.
 The power supply capacity recommends from 0.01µF to 0.1µF.

Pin Functions

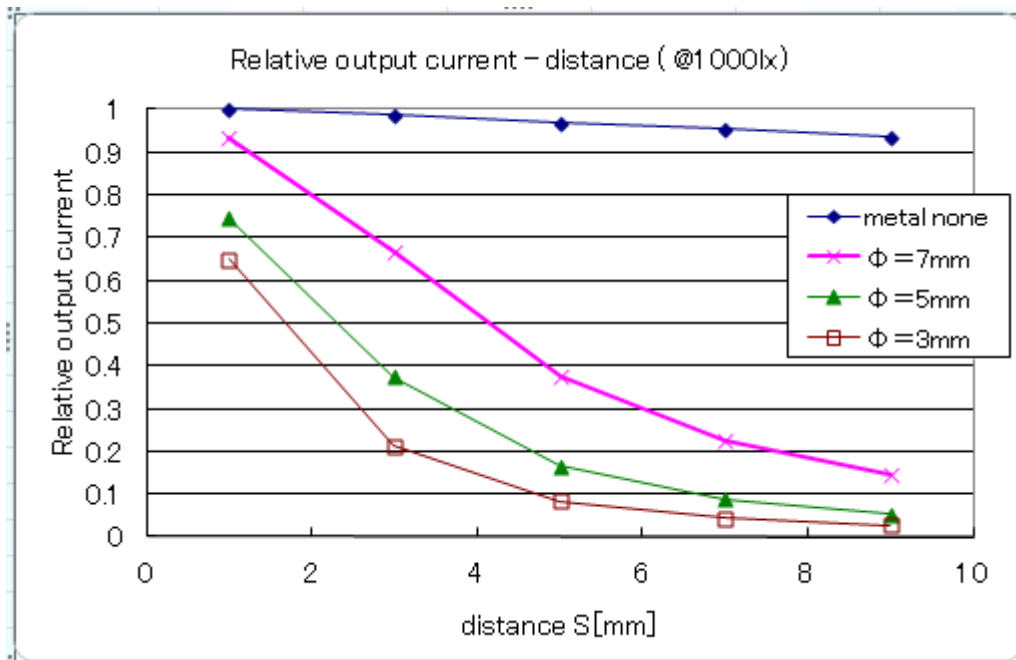
Pin No.	Pin Name	Pin function	Equivalent Circuit
1	V _{CC}	Power supply terminal. Insert a capacitor between this pin and ground to prevent the influence of noise, etc.	
2	SW	Gain change terminal. This pin is used for gain change. When this pin is low, "Normal gain". When this pin is high, "Low gain" .	
3	GND	Ground terminal.	
4	OUT	Output terminal. This pin is outputted the linear current depending on ambient light.	

Relative Output Current vs Distance

- Measuring method

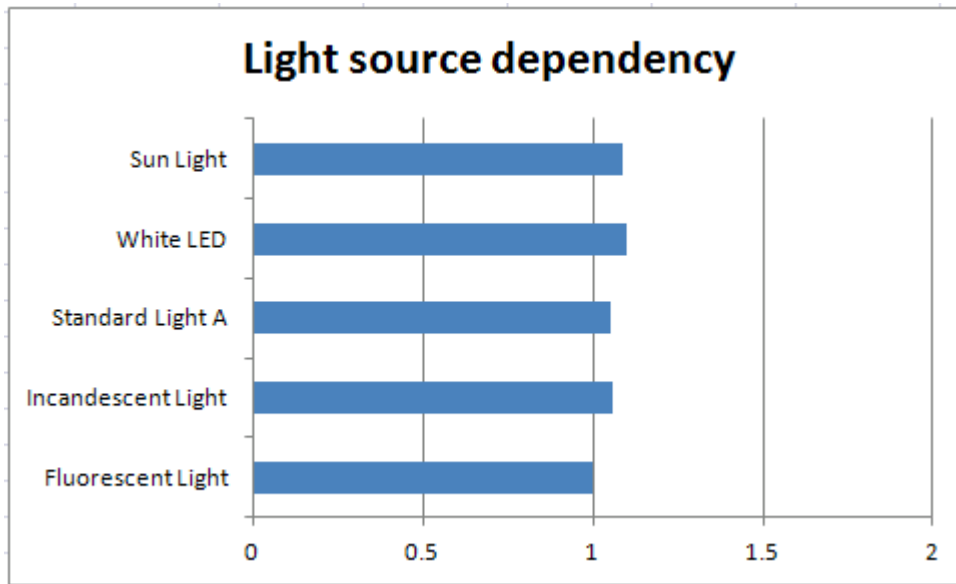


- Evaluation result



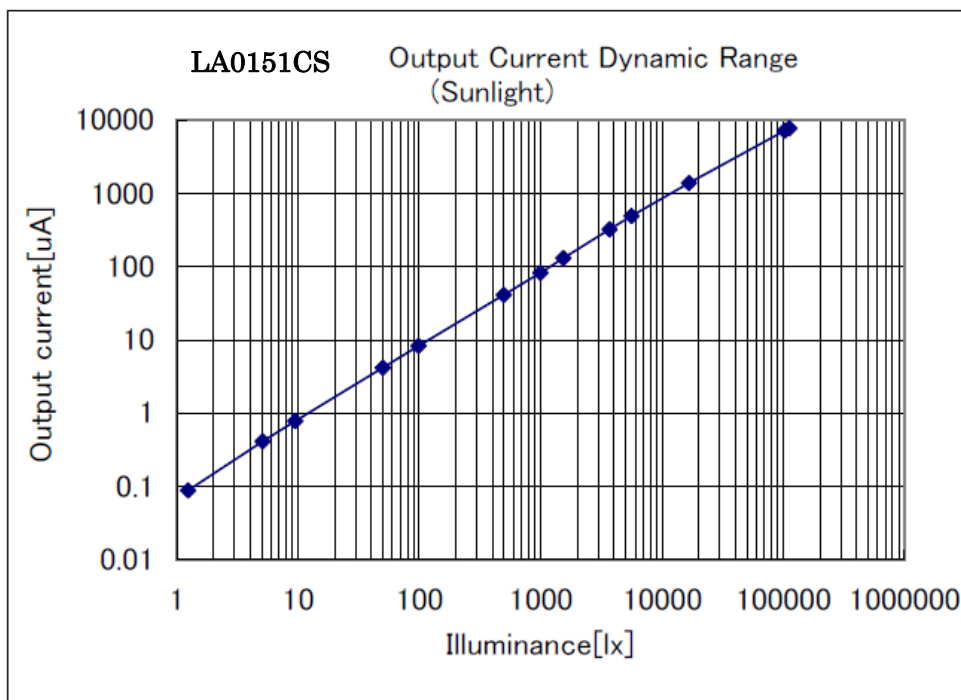
- Recommended condition
 - Hole size ϕ (optical window) = more than 2mm.
 - Distance from sensor to optical window = less than 2mm.

Light Source Dependency

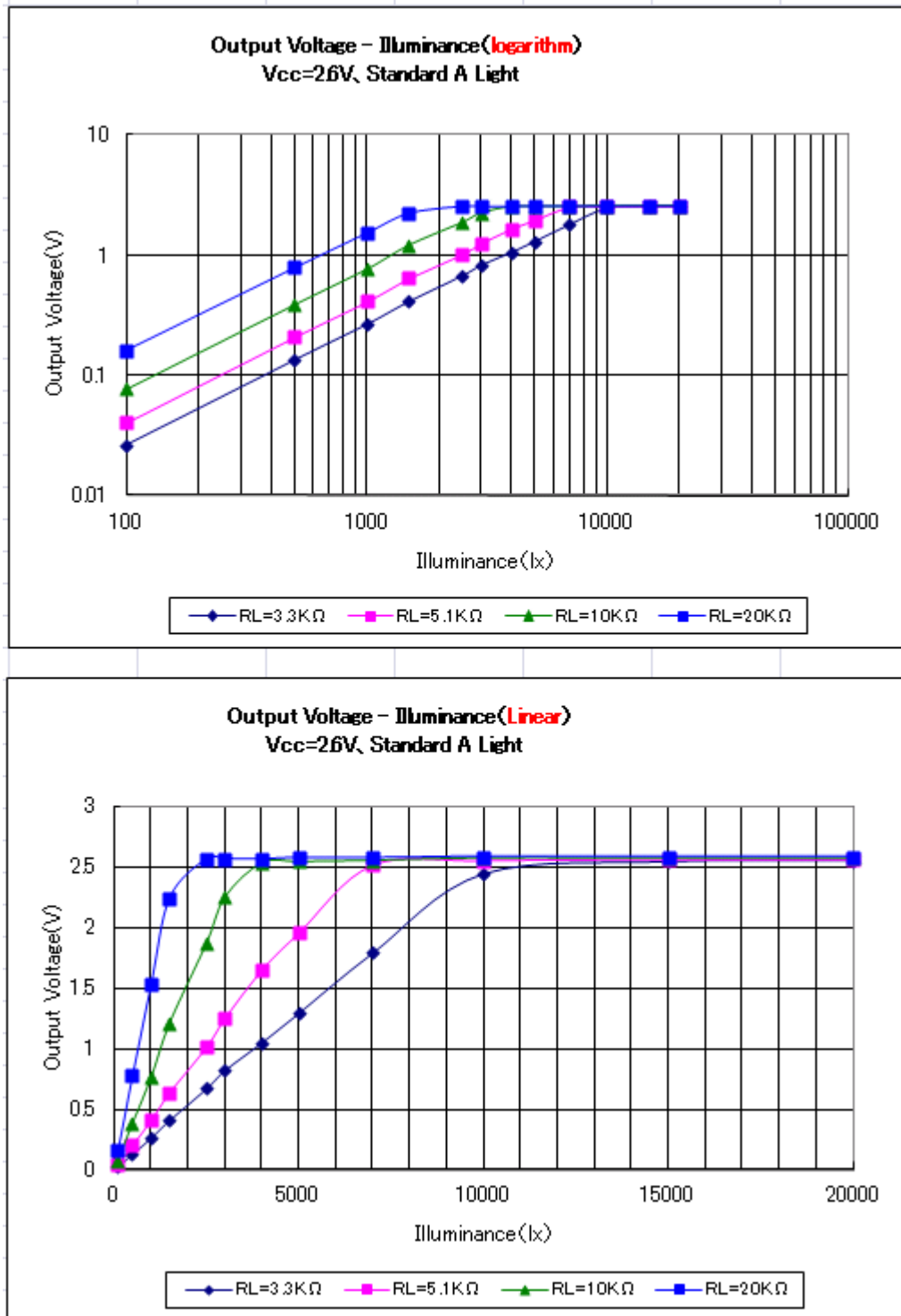


*Fluorescent light is set to "1"

Dynamic Current Range

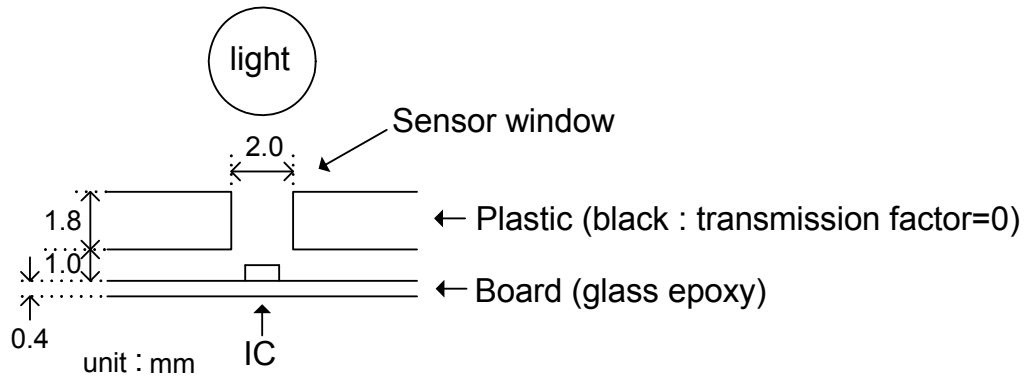


Dynamic Voltage Range

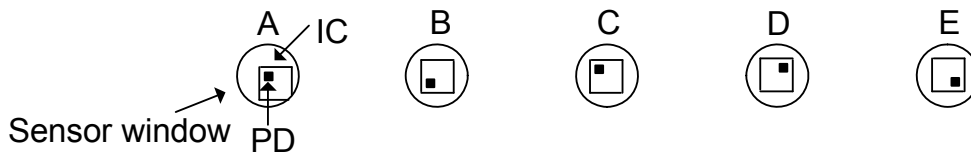


Differential Light Sensibility by PD Location

< Side view >

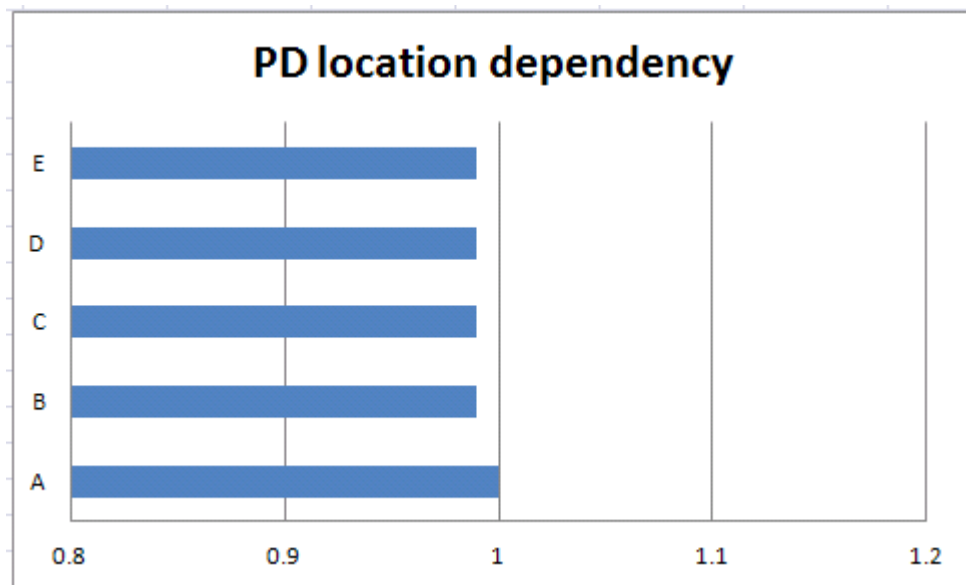


< Top view >



A : PD is arranged at the center of the sensor window.

BtoE : The position of PD was rotated.



PD location A is set to "1"

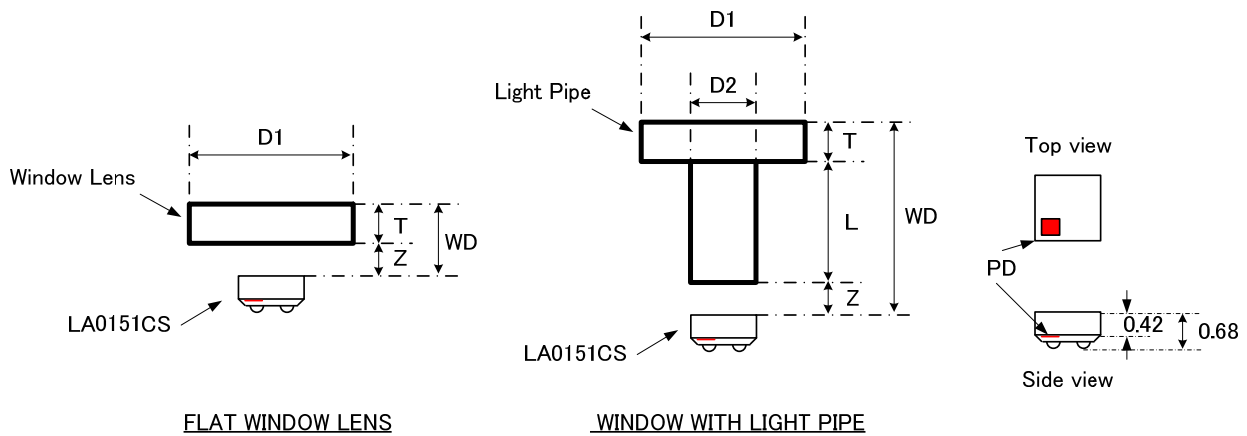
Window design guide

Flat window lens design

A window lens will surely limit the viewing angle of the LA0151CS. The window lens should be placed directly on top of the LA0151CS. The thickness of the lens should be kept at minimum to minimize loss of power due to reflection and also to minimize loss of loss due to absorption of energy in the plastic material. A thickness of $T = 1\text{ mm}$ is recommended for a window lens design.

Window with light pipe design

If a smaller window is desired while maintaining a wide effective viewing angle of the LA0151CS, a cylindrical piece of transparent plastic is needed to trap the light and then focus and guide the light on to the LA0151CS. Hence the name light guide or also known as light pipe. The pipe should be placed directly on top of the LA0151CS with a distance of $Z = 0.5\text{mm}$ to achieve peak performance. The light pipe should have minimum of 1.5mm in diameter to ensure that whole area of the sensor will be exposed.



WD ($T+L+Z$)	FLAT WINDOW LENS ($L=0.0$)		WINDOW WITH LIGHT PIPE ($D2=1.5, Z=0.5$)	
	Z	D1	D1	L
1.5	0.5	2.0	-	-
2.0	1.0	3.0	-	-
2.5	1.5	4.0	-	-
3.0	2	5.0	2.5	1.5

*All dimensions are in mm.

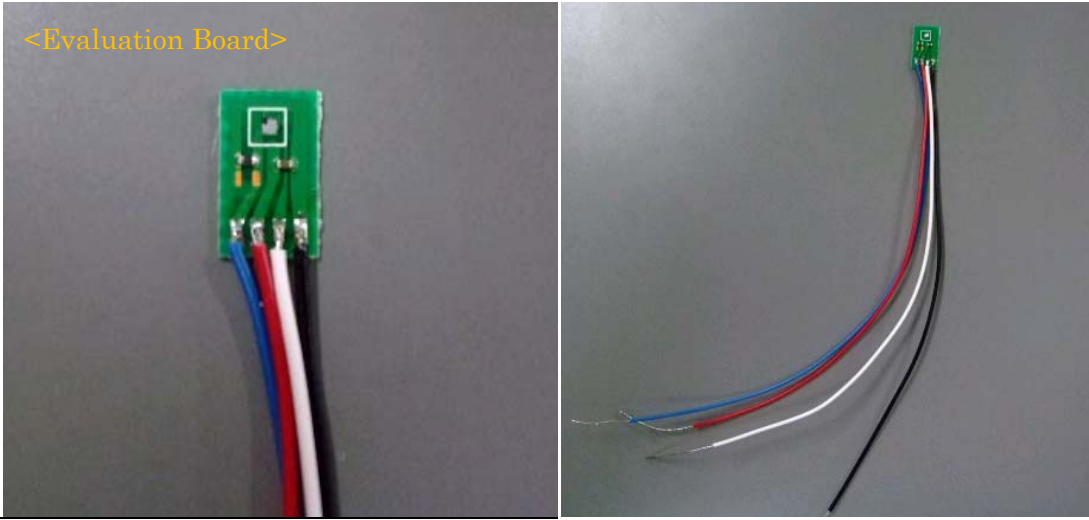
*These dimensions are based on a window lens thickness of 1.0mm and a refractive index of 1.59 .

WD: Distance between window front panel and LA0151CS

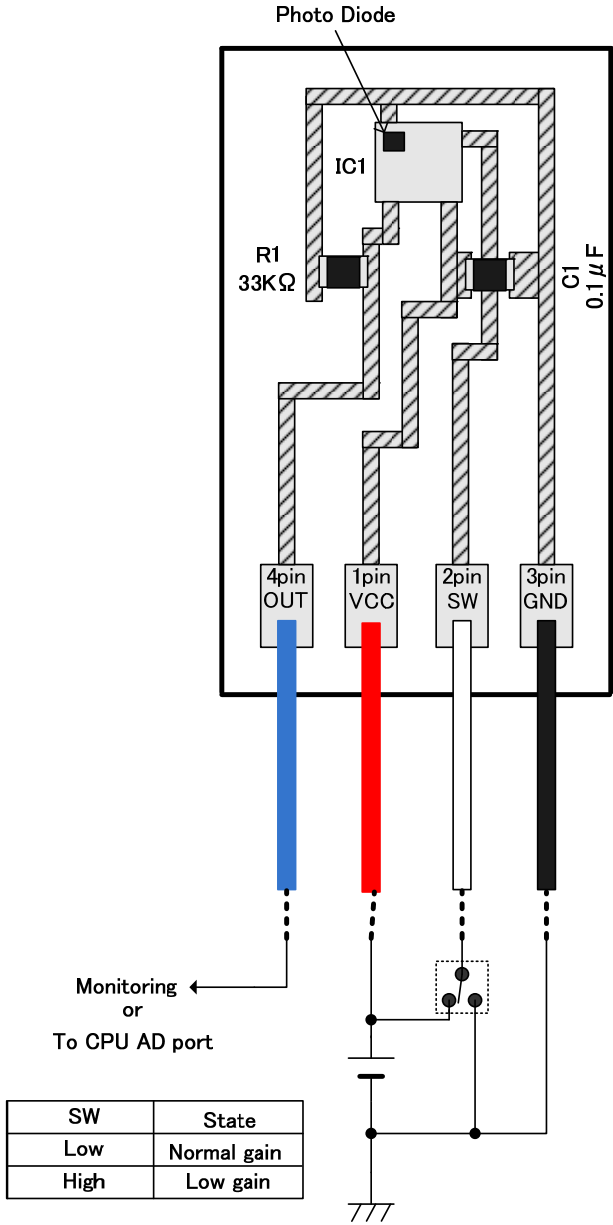
D1: Window diameter, **T:** Thickness, **L:** Length of light pipe

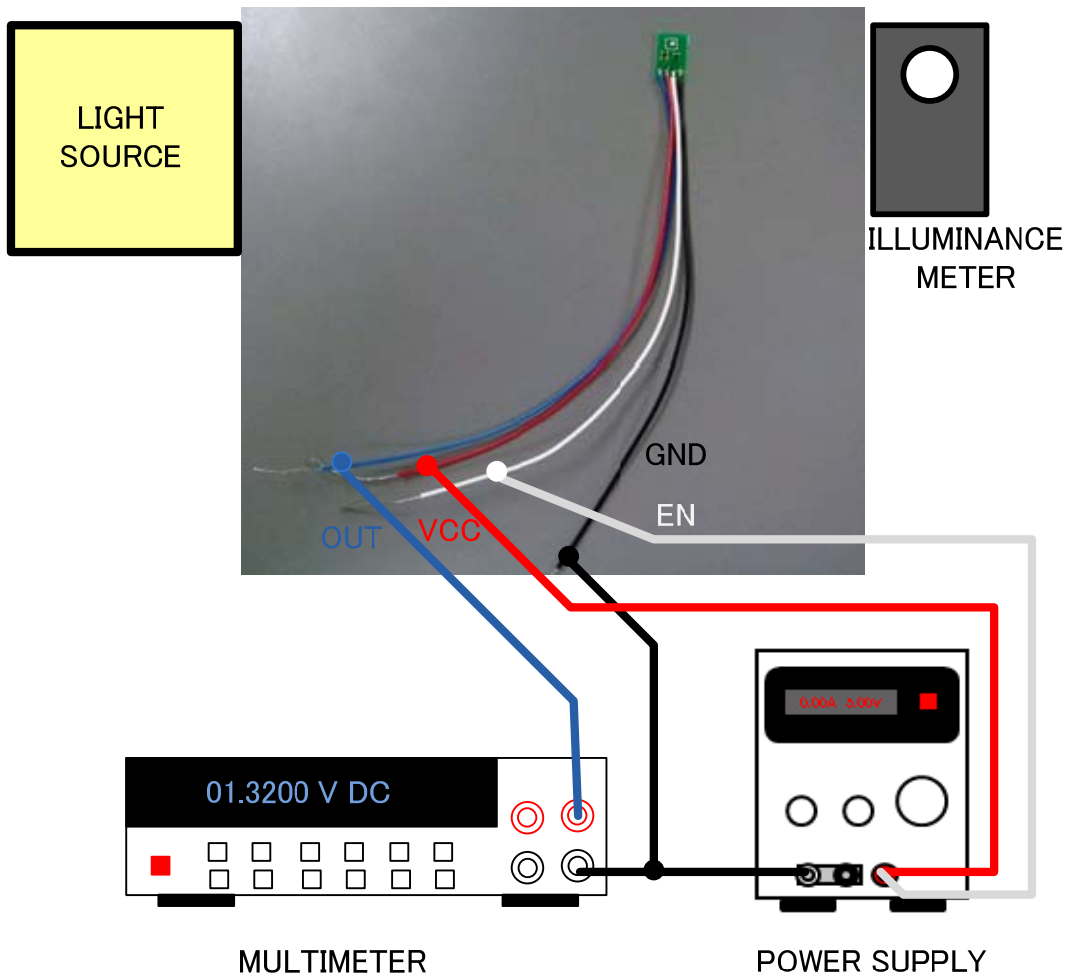
D2: Light pipe diameter, **Z:** Distance between window rear panel and LA0151CS

Evaluation Board Manual



Evaluation Board





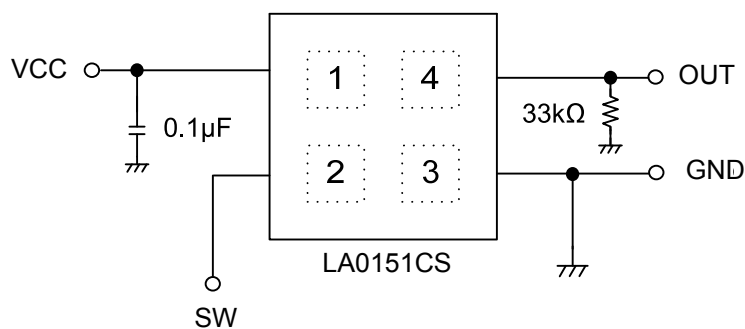
Test Procedure:

1. Connect the test setup as shown above.
2. Connect IC power supply (2.2V to 5.5V) between VCC and GND.
3. Connect multimeter between OUT and GND.
4. Irradiate a light, and put on the illuminance meter near the IC.
5. Control the light source and to be adjusted 500 lux.
6. Then , OUT terminal of LA0151CS is outputted roughly $40\mu\text{A}$. Therefore, multimeter is showed roughly 1.32V. ($1.32\text{V} = 40\mu\text{A} \times 33\text{k}\Omega$)

LA0151CS features:

- No sensibility in infrared area.
- Less difference in sensibility depending on the type of light source.
(Please see to page 11 "Light Source Dependency".)

Evaluation Board Circuit Diagram



Bill of Materials for LA0151CS Evaluation Board

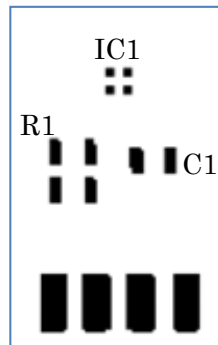
Designator	Quantity	Description	Value	Tolerance	Footprint	Manufacturer	Manufacturer Part Number	Substitution Allowed	Lead Free
IC1	1	Ambient Light Sensor	-	-	ODCSP4 (0.5mm ,pitch)	ON Semiconductor	LA0151CS	No	yes
R1	1	OUT (to GND)	33k (0.063W)	±5%	1005 (0402Inch)	ROHM	MCR01MZPJ333	yes	yes
C1	1	VCC Bypass Capacitor	0.1uF /16V	±10%	1005 (0402Inch)	MURATA	GRM155B11C104KA	yes	yes

Evaluation Board PCB Design

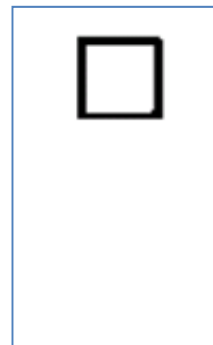
(Top View)



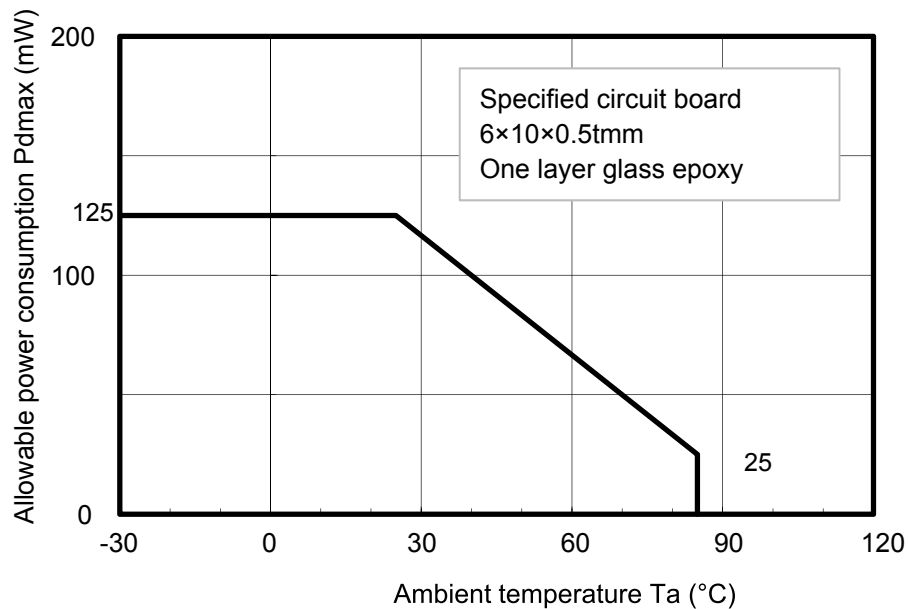
(Pattern)



(Resist)



(Silk)



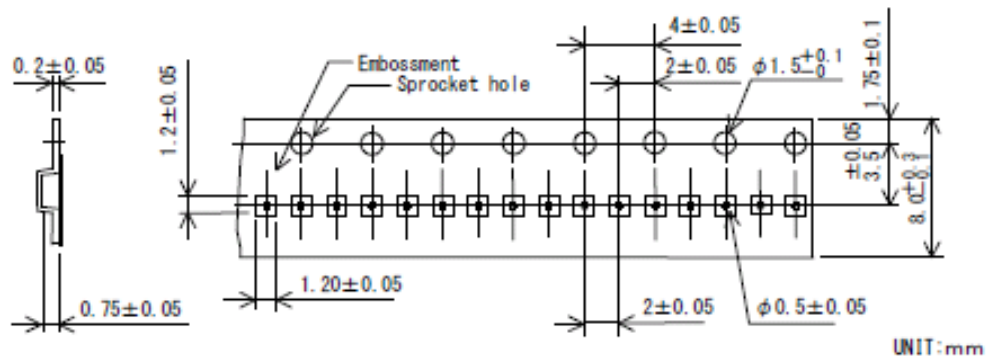
Pdmax - Ta

Packing Specification of Embossed Carrier Taping

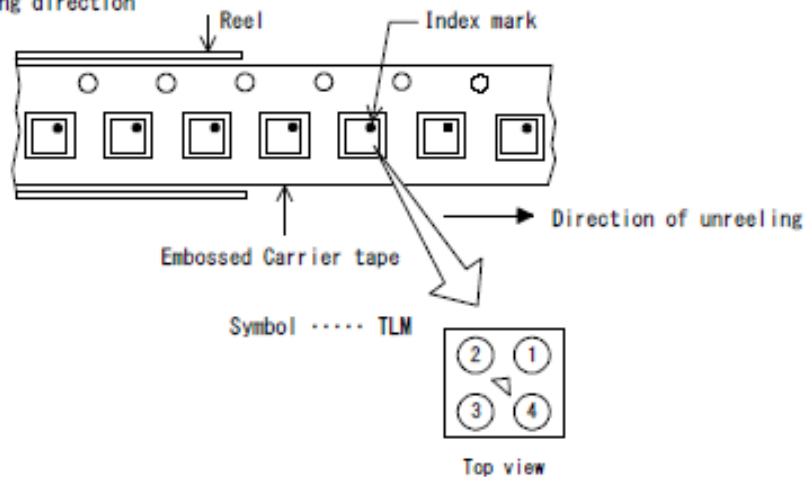
ODCSP4 (1.01X1.01)

1. EMBOSS CARRIER TAPING

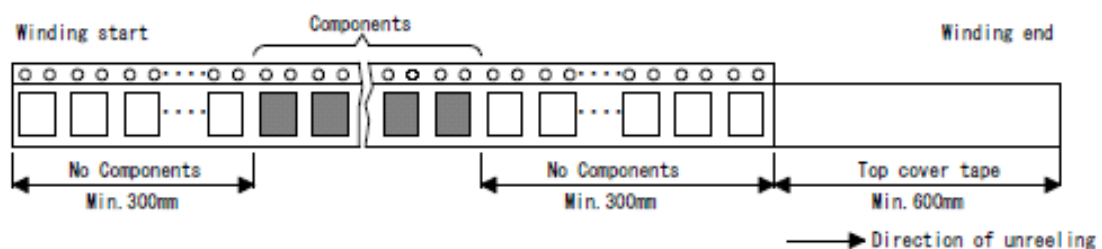
1-1. Emboss carrier tape dimensions



1-2. Tape mounting direction



1-3. Reel winding start and reel winding end



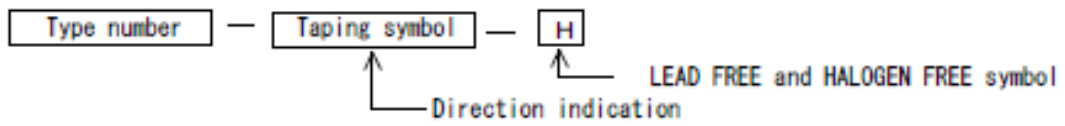
2. TAPE STRENGTH

2-1. Tensile strength of the carrier tape : Min. 10N

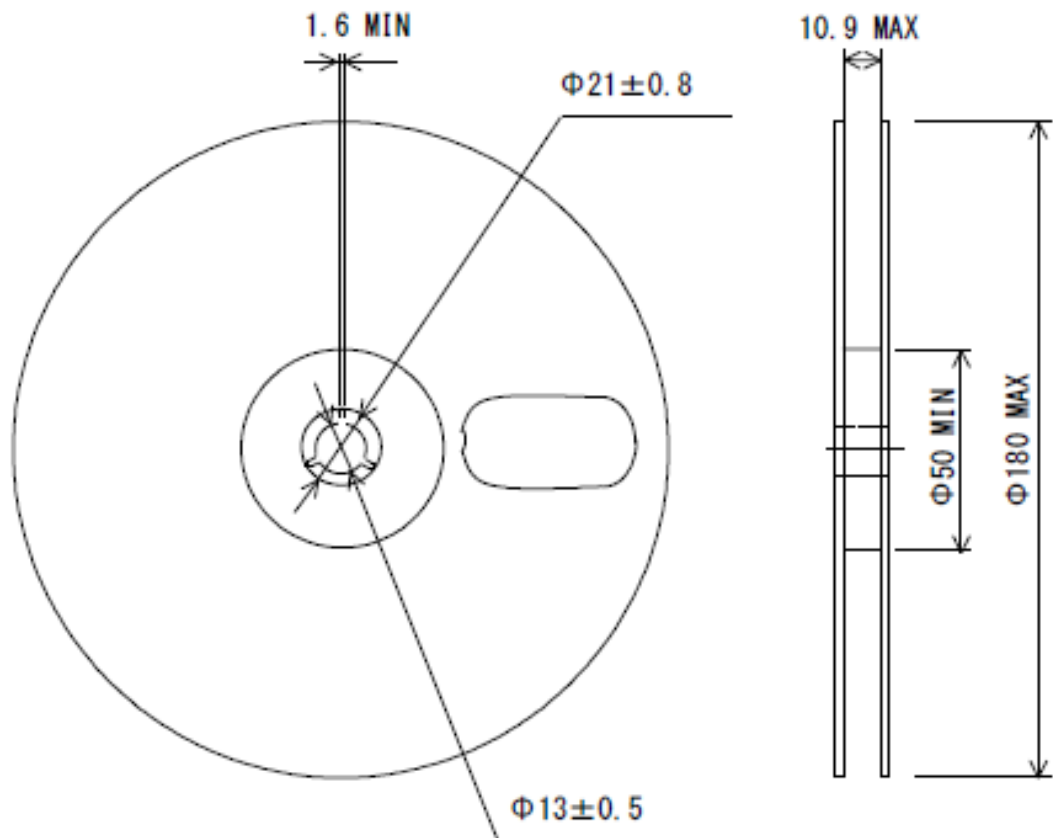
2-2. Peel strength of the top cover tape

- (a) Peel angle : 165° to 180° relative to the tape adhesive surface
- (b) Peel rate : 300mm / minute
- (c) Peel of strength : 0.1N to 1.0N

3. PARTS No. ON BAR CODE LABEL



4. REEL DIMENSIONS



MODEL : RRM-08B

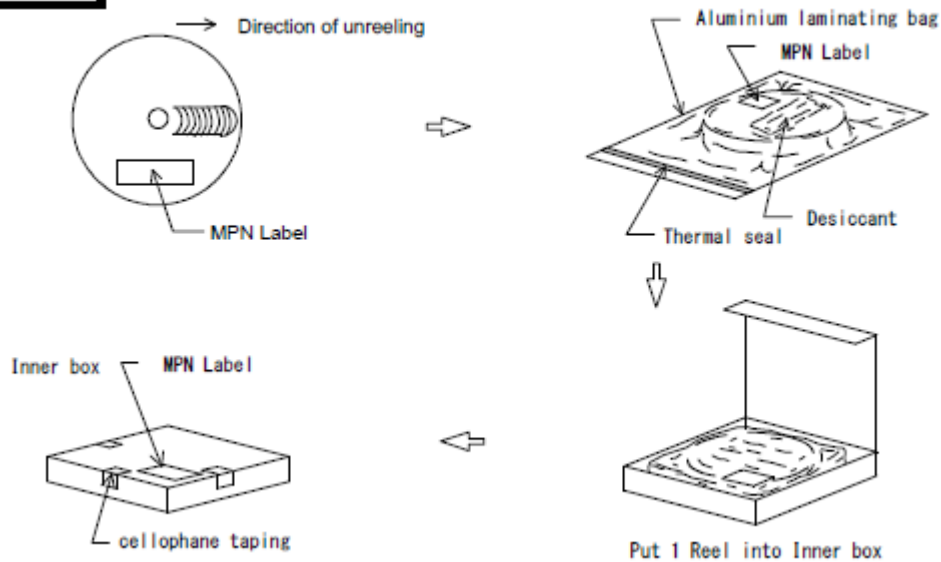
UNIT : mm

Carrier tape type number	Package code	Maximum number of ICs contained (pcs.)		Packing form
		Reel	Inner box	
CARR (WLP1X1X750)	ODCSP4 (1.01X1.01)	5,000	5,000	Inner box. BOX (TE-1208) 1 Reels contained Dimensions:mm 190×37×190

MPN Label

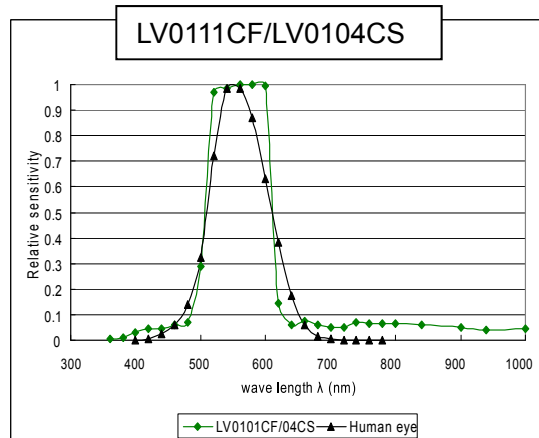
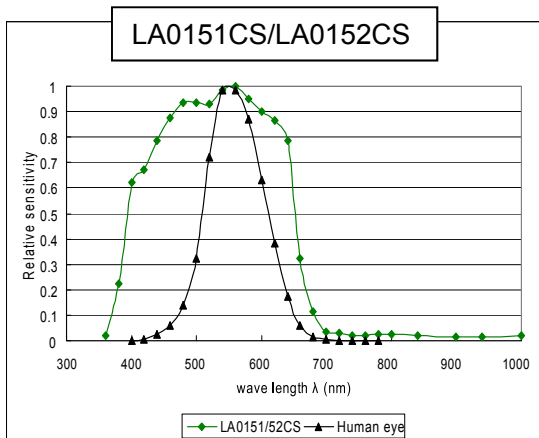
(1P) MPN : *****		MS LEVEL: HOURS: 168 TEMP: 260C SEALED DATE: 19Jan12 3
(11) LOT: *****		
(9D) DTE: *****	CS: **	
(Q) QTY: *****	ASSY IN: *****	
(21L) ASSY LOC: **		
(S) SERIAL NBR: *****		
HF RoHS Pb 2LI e3 e ON		

Packing Method



Lineup of Ambient Light Sensor

Product name	LA0151CS	LA0152CS	LV0111CF	LV0104CS
Output type	Linear current	Linear current	Logarithm current	16bitAD digital
Overall size(mm)	1.01×1.01×0.6	1.01×1.01×0.6	1.08×1.08×0.6	1.08×1.08×0.6
Spectral characteristics	Normal	Normal	Closer to visibility	Closer to visibility
Gain switching	○	—	—	○
Standby function	—	○	○	○
Operating voltage (V)	2.2 to 5.5	2.2 to 5.5	2.3 to 5.5	2.3 to 3.6
Operating temperature range (°C)	−30 to 85	−30 to 85	−30 to 85	−30 to 85
Consumption current 1000 lx	150uA	150uA	75uA	70uA
Output current 100 lx	8uA	8uA	20uA	100 counts
Output current 1000 lx	80uA	80uA	30uA	1000 counts
Peak sensitivity (nm)	550	550	550	550
D range	1 to 100k lx	1 to 100k lx	1 to 100k lx	1 to 65k lx
Pb free	○	○	○	○
Halogen free	○	○	○	○
Status	Mass production	Mass production	Mass production	Mass production



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