LV0111CF — Monolithic Linear IC
For Ultra-small Ambient Light Sensor
Photo IC

Overview
The LV0111CF 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, security camera and camcorder.

Features
- Logarithmic current output
- Smallest ODCSP package in the world (1.08mmX1.08mm, thickness:0.6mm)
- Integrated sleep mode (Max current 0.1uA)
- Low power consumption (75uA at 1,000Lux)
- Less sensibility in infrared area
- Low output temperature variation
- Halogen free compliant

Pin Assignment

<table>
<thead>
<tr>
<th>No.</th>
<th>Name</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>VCC</td>
<td>Power supply</td>
</tr>
<tr>
<td>2</td>
<td>EN</td>
<td>Enable</td>
</tr>
<tr>
<td>3</td>
<td>GND</td>
<td>Ground</td>
</tr>
<tr>
<td>4</td>
<td>OUT</td>
<td>Output</td>
</tr>
</tbody>
</table>

Package Dimensions
unit : mm (typ)
3350A

Ball Pitch : 0.5mm , Ball Size : 0.25mm
Pad Layout (Photos)

* The position with PAD becomes pin 1.

Recommended Land Pattern

Land (pink) : 300um φ
Solder resist opening (green) : 400um φ

Block Diagram
Chip Pattern and Photo-receiving Pattern Diagrams

< Top view >

ODCSP Cross Section Structure

Optical Device Chip Size Package

SANYO original wafer level package for optical device.
**Specifications**

**Absolute Maximum Ratings at \( Ta=25^\circ C \)**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Conditions</th>
<th>Ratings</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum supply voltage</td>
<td>( V_{CC} )</td>
<td></td>
<td>6</td>
<td>V</td>
</tr>
<tr>
<td>Operating temperature</td>
<td>( T_{opr} )</td>
<td>-30 to 85 ( ^\circ )C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Storage temperature</td>
<td>( T_{stg} )</td>
<td>-40 to 100 ( ^\circ )C</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Recommended operating conditions and operating voltage range at\( Ta=25^\circ C \)**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Conditions</th>
<th>min</th>
<th>typ</th>
<th>max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recommended supply voltage</td>
<td>( V_{CC} )</td>
<td></td>
<td>2.3</td>
<td>3.3</td>
<td>5.5</td>
<td>V</td>
</tr>
<tr>
<td>EN pin low voltage</td>
<td>( V_{L} )</td>
<td>Sleep mode</td>
<td>0</td>
<td>0.4</td>
<td>0.4</td>
<td>V</td>
</tr>
<tr>
<td>EN pin high voltage</td>
<td>( V_{H} )</td>
<td>Normal operation mode</td>
<td>1.5</td>
<td>( V_{CC} )</td>
<td>V</td>
<td></td>
</tr>
</tbody>
</table>

**Electrical and optical characteristics at \( V_{CC}=3.3V, \ Ta=25^\circ C \)**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Conditions</th>
<th>min</th>
<th>typ</th>
<th>max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current dissipation (^1, ^3)</td>
<td>( I_{CC} )</td>
<td>( Ev=1000 ) lux, ( RL=27k) ( \Omega )</td>
<td>50</td>
<td>75</td>
<td>100</td>
<td>( \mu A )</td>
</tr>
<tr>
<td>Sleep current (^3)</td>
<td>( I_{sL} )</td>
<td>( Ev=0 ) lux</td>
<td>0.01</td>
<td>0.1</td>
<td>0.1</td>
<td>( \mu A )</td>
</tr>
<tr>
<td>Output current (1) (^1, ^3)</td>
<td>( I_{O1} )</td>
<td>( Ev=100 ) lux</td>
<td>18</td>
<td>21</td>
<td>24</td>
<td>( \mu A )</td>
</tr>
<tr>
<td>Output current (2) (^1, ^3)</td>
<td>( I_{O2} )</td>
<td>( Ev=1000 ) lux</td>
<td>27</td>
<td>31</td>
<td>35</td>
<td>( \mu A )</td>
</tr>
<tr>
<td>Dark current (^3)</td>
<td>( I_{leak} )</td>
<td>( Ev=0 ) lux</td>
<td>0.35</td>
<td>0.5</td>
<td>0.5</td>
<td>( \mu A )</td>
</tr>
<tr>
<td>Temperature coefficient (^2)</td>
<td>( I_{tc} )</td>
<td>( Ev=100 ) lux</td>
<td>0.1</td>
<td></td>
<td></td>
<td>% / ( ^\circ )C</td>
</tr>
<tr>
<td>Rise time (^4)</td>
<td>( T_{r1} )</td>
<td>( Ev=1000 ) lux, ( RL=27k) ( \Omega )</td>
<td>40</td>
<td>100</td>
<td></td>
<td>( \mu s )</td>
</tr>
<tr>
<td>Fall time (^4)</td>
<td>( T_{f1} )</td>
<td>( Ev=1000 ) lux, ( RL=27k) ( \Omega )</td>
<td>2</td>
<td>5</td>
<td></td>
<td>ms</td>
</tr>
<tr>
<td>Peak sensitivity wave length (^2)</td>
<td>( \lambda_{p} )</td>
<td></td>
<td>550</td>
<td></td>
<td></td>
<td>nm</td>
</tr>
</tbody>
</table>

\(^1\). Measured with the standard light source A. White LED is used instead in the mass production line.

\(^2\). Design guaranteed item

\(^3\). Test circuit for measuring current dissipation and output current

\(^4\). Measuring method of rise time (\( Tr \)) and fall time (\( Tf \))
Typical Performance Characteristics

Illuminance - Output current

Output current [μA] vs Illuminance Ev [lx]

Illuminance - Consumption current

Consumption current [μA] vs Illuminance Ev [lx]
Illuminance - Sleep current

Output current [μA]

Illuminance Ev [lx]

Vcc - Relative output current (@1000lx)

Relative output current

Supply Voltage - Vcc [V]

Vcc - Relative consumption current (@1000lx)

Relative consumption current

Supply Voltage - Vcc [V]
Ambient temperature - Relative output current (@100lx)

Relative current

0.001
0.01
0.1
1
10

Ileak [μA]

0.0001
0.001
0.01
1
10

Spectral Response

Relative sensitivity

0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

Wavelength λ (nm)

200
300
400
500
600
700
800
900
1000
1100
1200
*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.
## Pin Functions

<table>
<thead>
<tr>
<th>Pin No.</th>
<th>Pin Name</th>
<th>Pin function</th>
<th>Equivalent Circuit</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>VCC</td>
<td>Power supply terminal. Insert a capacitor between this pin and ground to prevent the influence of noise, etc.</td>
<td><img src="image" alt="Equivalent Circuit Diagram" /></td>
</tr>
<tr>
<td>2</td>
<td>EN</td>
<td>Enable terminal. This pin is used to control the IC operational state. When this pin is low, &quot;sleep&quot; state. When this pin is high, &quot;active&quot; state.</td>
<td><img src="image" alt="Equivalent Circuit Diagram" /></td>
</tr>
<tr>
<td>3</td>
<td>GND</td>
<td>Ground terminal.</td>
<td><img src="image" alt="Equivalent Circuit Diagram" /></td>
</tr>
<tr>
<td>4</td>
<td>OUT</td>
<td>Output terminal. This pin is outputted the logarithmic current depending on ambient light.</td>
<td><img src="image" alt="Equivalent Circuit Diagram" /></td>
</tr>
</tbody>
</table>
Relative Output Current vs Distance

- Measuring method

- Evaluation result

- Recommended condition
  Hole size $\Phi$ (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**
Differential Light Sensibility by IC Location

<Top view>

Sensor window
(φ = 2mm)

-0.1 ~ -0.4mm +0.1 ~ 0.4mm
(Distance S)

<Side view>

Sensor window

standard light A

hole size Φ

Illumination Sensor

metal sheet
Thickness 0.4mm

IC location dependency (@1000lx)

Relative output current

Distance S [mm]
Window design guide

Flat window lens design

A window lens will surely limit the viewing angle of the LV0111CF. The window lens should be placed directly on top of the LV0111CF. 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 LV0111CF, a cylindrical piece of transparent plastic is needed to trap the light and then focus and guide the light on to the LV0111CF. Hence the name light guide or also known as light pipe. The pipe should be placed directly on top of the LV0111CF with a distance of $Z = 0.5\text{ mm}$ to achieve peak performance. The light pipe should have minimum of $1.5\text{ mm}$ in diameter to ensure that whole area of the sensor will be exposed.

| WD: Distance between window front panel and LV0111CF |
| D1: Window diameter, T: Thickness, L: Length of light pipe |
| D2: Light pipe diameter, Z: Distance between window rear panel and LV0111CF |

<table>
<thead>
<tr>
<th>WD (T+L+Z)</th>
<th>FLAT WINDOW LENS (L=0.0)</th>
<th>WINDOW WITH LIGHT PIPE (D2=1.5, Z=0.5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Z</td>
<td>D1</td>
<td>D2</td>
</tr>
<tr>
<td>1.5</td>
<td>0.5</td>
<td>2.0</td>
</tr>
<tr>
<td>2.0</td>
<td>1.0</td>
<td>3.0</td>
</tr>
<tr>
<td>2.5</td>
<td>1.5</td>
<td>4.0</td>
</tr>
<tr>
<td>3.0</td>
<td>2</td>
<td>5.0</td>
</tr>
</tbody>
</table>

*All dimensions are in mm.

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

Evaluation Board

Photo Diode

R1 27KΩ

C1 0.1μF

Monitoring or To CPU AD port

<table>
<thead>
<tr>
<th>EN</th>
<th>State</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>Sleep</td>
</tr>
<tr>
<td>High</td>
<td>Active</td>
</tr>
</tbody>
</table>
**Test Procedure:**
1. Connect the test setup as shown above.
2. Connect IC power supply (2.3V 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 LV0111CF is outputted roughly 28μA. Therefore, multimeter is showed roughly 0.76V. (0.76V = 28μA × 27kΩ)

**LV0111CF features:**
- Logarithmic current output
- Low current consumption (typ 75μA at 1000lux)
Evaluation Board Circuit Diagram

Bill of Materials for LV0111CF Evaluation Board

<table>
<thead>
<tr>
<th>Designator</th>
<th>Quantity</th>
<th>Description</th>
<th>Value</th>
<th>Tolerance</th>
<th>Footprint</th>
<th>Manufacturer</th>
<th>Manufacturer Part Number</th>
<th>Substitution Allowed</th>
<th>Lead Free</th>
</tr>
</thead>
<tbody>
<tr>
<td>IC1</td>
<td>1</td>
<td>Ambient Light Sensor</td>
<td>-</td>
<td>-</td>
<td>ODCSP4</td>
<td>SANYO</td>
<td>LV0111CF</td>
<td>No</td>
<td>yes</td>
</tr>
<tr>
<td>R1</td>
<td>1</td>
<td>OUT (to GND)</td>
<td>27kΩ</td>
<td>±5%</td>
<td>1005</td>
<td>ROHM</td>
<td>MCR01MZPJ273</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>C1</td>
<td>1</td>
<td>VCC Bypass Capacitor</td>
<td>0.1µF</td>
<td>±10%</td>
<td>1005</td>
<td>MURATA</td>
<td>GRM155B11C104KA</td>
<td>yes</td>
<td>yes</td>
</tr>
</tbody>
</table>

Evaluation Board PCB Design

(Top View)

( Pattern )

( Resist )

( Silk )

Specified circuit board 6X10X0.8mm One layer glass epoxy

Pdmax - Ta
1. ENDOSS 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

<table>
<thead>
<tr>
<th>Type number</th>
<th>Taping symbol</th>
<th>H</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- LEAD FREE and HALOGEN FREE symbol
- Direction indication

4. REEL DIMENSIONS

Model: EIAJ-RGM08B
Unit: mm
### Bar Code Label

- **Parts No.**
- **Lot No.**
- **Quantity**
- **Origin**

### Packing Method

1. **Direction of unreeeling**
2. **Put 1 Reel into Inner box**
   - Aluminium laminating bag
   - Desiccant
   - Thermal seal
3. **Put 8 Inner boxes in the Outer box.**
   - Sealing tape

### Shipping Label

- It is a label at the time of factory shipments.
- The form of a label may change in physical distribution process.

<table>
<thead>
<tr>
<th>Carrier tape type number</th>
<th>SANYO Package code</th>
<th>Maximum number of ICs contained (pcs.)</th>
<th>Packing form</th>
</tr>
</thead>
<tbody>
<tr>
<td>GARR(3DD0115X0115)</td>
<td>QDCEP4/1 (1.08X1.08)</td>
<td>5,000 5,000 40,000</td>
<td>Reel Inner box Outer box Inner box BOX (TE-1268) Outer box L-BOX (TE-1268)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1 Reels contained Dimensions: mm 190 x 37 x 190</td>
<td>8 Inner boxes contained Dimensions: mm 222 x 175 x 402</td>
</tr>
</tbody>
</table>
### Lineup of Ambient Light Sensor by SANYO

<table>
<thead>
<tr>
<th>Product name</th>
<th>LA0151CS</th>
<th>LA0152CS</th>
<th>LV0111CF</th>
<th>LV0104CS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Output type</strong></td>
<td>Linear current</td>
<td>Linear current</td>
<td>Logarithmic current</td>
<td>16bitAD digital</td>
</tr>
<tr>
<td><strong>Overall size (mm)</strong></td>
<td>1.01<em>1.01</em>0.6</td>
<td>1.01<em>1.01</em>0.6</td>
<td>1.08<em>1.08</em>0.6</td>
<td>1.08<em>1.08</em>0.6</td>
</tr>
<tr>
<td><strong>Spectral characteristics</strong></td>
<td>Normal</td>
<td>Normal</td>
<td>Closer to visibility</td>
<td>Closer to visibility</td>
</tr>
<tr>
<td><strong>Gain switching</strong></td>
<td>○</td>
<td>—</td>
<td>—</td>
<td>○</td>
</tr>
<tr>
<td><strong>Standby function</strong></td>
<td>—</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td><strong>Operating voltage (V)</strong></td>
<td>2.2～5.5</td>
<td>2.2～5.5</td>
<td>2.3～5.5</td>
<td>2.3～3.6</td>
</tr>
<tr>
<td><strong>Operating temperature range (°C)</strong></td>
<td>-30～85</td>
<td>-30～85</td>
<td>-30～85</td>
<td>-30～85</td>
</tr>
<tr>
<td><strong>Consumption current 1000 lx</strong></td>
<td>150uA</td>
<td>150uA</td>
<td>75uA</td>
<td>70uA</td>
</tr>
<tr>
<td><strong>Output current 100 lx</strong></td>
<td>8uA</td>
<td>8uA</td>
<td>20uA</td>
<td>100 counts</td>
</tr>
<tr>
<td><strong>Output current 1000 lx</strong></td>
<td>80uA</td>
<td>80uA</td>
<td>30uA</td>
<td>1000 counts</td>
</tr>
<tr>
<td><strong>Peak sensitivity (nm)</strong></td>
<td>550</td>
<td>550</td>
<td>550</td>
<td>550</td>
</tr>
<tr>
<td><strong>D range</strong></td>
<td>1～100k lx</td>
<td>1～100k lx</td>
<td>1～100k lx</td>
<td>0.125～65k lx</td>
</tr>
<tr>
<td><strong>Pb free</strong></td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td><strong>Halogen free</strong></td>
<td>-</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td><strong>Status</strong></td>
<td>Mass production</td>
<td>Mass production</td>
<td>Mass production</td>
<td>Sep.2012 MP</td>
</tr>
</tbody>
</table>

![LA0151CS/LA0152CS](image1)

![LV0111CF/LV0104CS](image2)

This catalog provides information as of February, 2012. Specifications and information herein are subject to change without notice.