Ambient Light Sensor ICs

Analog Current Output Type Ambient Light Sensor IC

BH1603FVC

● Descriptions
BH1603FVC is an analog current output ambient light sensor. BH1603FVC is the most suitable to obtain the ambient light data for adjusting LCD and Keypad backlight of Mobile phone for power saving and better visibility.

● Features
1) Compact surface mount package 3.0 × 1.6 mm
2) Spectral sensitivity close to human eyes sensitivity.
3) Output current in proportion to brightness.
4) Minimum supply voltage 2.4V
5) Built-in shutdown function
6) 3 steps controllable output current gain.
7) 1.8V logic input interface
8) Low sensitivity variation (+/-15%)

● Applications
Mobile phone, LCD TV, PDP TV, Laptop PC, Portable game console, Digital camera, Digital video camera, PDA, LCD display.

● Absolute Maximum Ratings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Limits</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply Voltage</td>
<td>Vmax</td>
<td>7</td>
<td>V</td>
</tr>
<tr>
<td>Operating Temperature</td>
<td>Topr</td>
<td>-40~85</td>
<td>℃</td>
</tr>
<tr>
<td>Storage Temperature</td>
<td>Tstg</td>
<td>-40~100</td>
<td>℃</td>
</tr>
<tr>
<td>Iout Current</td>
<td>Ioutmax</td>
<td>7.5</td>
<td>mA</td>
</tr>
<tr>
<td>Power Dissipation</td>
<td>Pd</td>
<td>260</td>
<td>mW</td>
</tr>
</tbody>
</table>

* 70mm × 70mm × 1.6mm glass epoxy board. Derating at 3.47mW/°C for operating above Ta=25°C.

● Operating Conditions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vcc Voltage</td>
<td>Vcc</td>
<td>2.4</td>
<td>3.0</td>
<td>5.5</td>
<td>V</td>
</tr>
</tbody>
</table>

● Electrical Characteristics (VCC = 3.0V, Ta = 25°C, unless otherwise noted)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Units</th>
<th>Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply Current1 (Operate)</td>
<td>Icc1</td>
<td>51</td>
<td>74</td>
<td>97</td>
<td>uA</td>
<td>Ev=100lx (H-Gain Mode) ※</td>
</tr>
<tr>
<td>Supply Current2 (0 lx)</td>
<td>Icc2</td>
<td>4.5</td>
<td>9</td>
<td>13.5</td>
<td>uA</td>
<td>Ev=0 lx (H-Gain Mode)</td>
</tr>
<tr>
<td>Supply Current3 (Shutdown)</td>
<td>Icc3sd</td>
<td>-</td>
<td>0.2</td>
<td>0.4</td>
<td>uA</td>
<td>VGC1=VGC2=0 No Input Light</td>
</tr>
<tr>
<td>IOUT Output Current1 (Dark Current)</td>
<td>Iout1</td>
<td>-</td>
<td>-</td>
<td>0.2</td>
<td>uA</td>
<td>Ev=0 lx</td>
</tr>
<tr>
<td>IOUT Output Current2</td>
<td>Iout2</td>
<td>51</td>
<td>60</td>
<td>69</td>
<td>uA</td>
<td>Ev=100 lx (H-Gain Mode) ※</td>
</tr>
<tr>
<td>Peak Wave Length</td>
<td>Ap</td>
<td>-</td>
<td>560</td>
<td>-</td>
<td>nm</td>
<td></td>
</tr>
<tr>
<td>Incandescent/Fluorescent Light Current Ratio</td>
<td>rIF</td>
<td>-</td>
<td>1.0</td>
<td>-</td>
<td>times</td>
<td>Ev=100 lx</td>
</tr>
<tr>
<td>Saturated Output Voltage</td>
<td>VOMAX</td>
<td>2.6</td>
<td>2.9</td>
<td>3.0</td>
<td>V</td>
<td>Ev=100 lx, RL=220kΩ(H-Gain Mode) ※</td>
</tr>
<tr>
<td>GC1, GC2 Input 'L' Voltage</td>
<td>VIL</td>
<td>0</td>
<td>-</td>
<td>0.4</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>GC1, GC2 Input 'H' Voltage1</td>
<td>VILH1</td>
<td>1.4</td>
<td>-</td>
<td>Vcc</td>
<td>V</td>
<td>2.4V &lt; VCC 3.6V</td>
</tr>
<tr>
<td>GC1, GC2 Input 'H' Voltage2</td>
<td>VILH2</td>
<td>2.0</td>
<td>-</td>
<td>Vcc</td>
<td>V</td>
<td>3.6V &lt; VCC 5.5V</td>
</tr>
<tr>
<td>Wake-up Time</td>
<td>twu</td>
<td>-</td>
<td>45</td>
<td>128</td>
<td>us</td>
<td>Shutdown→H-Gain Mode Ev=100lx ※</td>
</tr>
<tr>
<td>Gain Ratio H-Gain Mode/M-Gain Mode</td>
<td>rHM</td>
<td>9.5</td>
<td>10</td>
<td>10.5</td>
<td>times</td>
<td>Ev=100lx ※</td>
</tr>
<tr>
<td>Gain Ratio M-Gain Mode/L-Gain Mode</td>
<td>rML</td>
<td>9.5</td>
<td>10</td>
<td>10.5</td>
<td>times</td>
<td>Ev=100lx ※</td>
</tr>
</tbody>
</table>

※ White LED is used as optical source.
Reference Data

- Fig.1: Spectral Response
- Fig.2: Light Source Dependency (Fluorescent Light is set to ‘1’)
- Fig.3: Illuminance – IOUT Characteristics
- Fig.4: Directional Characteristics 1
- Fig.5: Directional Characteristics 2
- Fig.6: Ta – IOUT (0 lx)
- Fig.7: Ta – ICC (0 lx)
- Fig.8: IOUT Temperature dependency (100 lx)
- Fig.9: IOUT VCC dependency
- Fig.10: Illuminance – Wake up Time
● Block Diagram

![Block Diagram Image]

● Block Diagram Descriptions

- **PD**
  Photo diode close to human eyes sensitivity.

- **Current AMP**
  To amplify Photo diode current (H-Gain / M-Gain / L-Gain)
  Gain controllable in 3 steps by input voltage from GC1 and GC2.

- **Logic**
  Logic block for mode setting by input voltage from GC1 and GC2

● Mode Setting

<table>
<thead>
<tr>
<th>GC2</th>
<th>GC1</th>
<th>Mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>Shutdown</td>
</tr>
<tr>
<td>0</td>
<td>1</td>
<td>H-Gain Mode</td>
</tr>
<tr>
<td>1</td>
<td>0</td>
<td>M-Gain Mode</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>L-Gain Mode</td>
</tr>
</tbody>
</table>
External parts Setting

1) Gain setting of BH1603FVC
   Please select the best gain controlled by 5 and 6pin based on the required illuminance range.
   The reference is as follows.

<table>
<thead>
<tr>
<th>Illuminance detection range [lx]</th>
<th>Gain Mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>~1,000</td>
<td>H-Gain Mode</td>
</tr>
<tr>
<td>~10,000</td>
<td>M-Gain Mode</td>
</tr>
<tr>
<td>~100,000</td>
<td>L-Gain Mode</td>
</tr>
</tbody>
</table>

   This device will be mounted under the optical window in actual designing. Therefore, there is a possibility that the illuminace to ALS (Ambient Light Sensor) will be less than the illuminance on the final product surface. Please consider the attenuation of light through the optical window. Please set output resistance value (R1) within the range of 1 kΩ ~1MΩ which needs to be smaller than the input impedance of the next circuit.

2) Approximate formula of IOUT output voltage in each Gain Mode

   (1) H-Gain mode
   The output voltage is calculated as below.
   \[ V_{iout} = 0.6 \times 10^{-6} \times E_v \times R_1 \]
   \( V_{iout} \) is IOUT output voltage [V]. \( E_v \) is an illuminance of the ALS surface [lx].
   \( R_1 \) is IOUT output resistor[Ω].
   (For example) In case you want to convert the illuminance value up to 500 lx by ADC.
   If the maximum voltage of ADC input is 2V, output resistor value will be as below.
   \[ R_1 = \frac{V_{iout}}{(0.6 \times 10^{-6} \times E_v)} \]
   \[ = \frac{2}{(0.6 \times 10^{-6} \times 500)} = 6667[Ω] \]
   \[ \Rightarrow 6.8[kΩ] \]

   (2) M-Gain mode
   The output voltage is calculated as follows.
   \[ V_{iout} = 0.06 \times 10^{-6} \times E_v \times R_1 \]

   (3) L-Gain mode
   The output voltage is calculated as follows.
   \[ V_{iout} = 0.006 \times 10^{-6} \times E_v \times R_1 \]

3) C1

   (1) To reject the flicker light.
   In case IOUT output is R1 only and an ALS receives the artificial lights such as fluorescent lamps and incandescent lamps synchronized with 50/60 Hz of AC power supplies, the output current has a ripple. If you want to reject this ripple, please add C1 to R1 in parallel. Please set it to C1 x R1 = about 0.1 as a time constant.

   (2) To control backlight smoothly by using illuminance value.
   C1 is effective to control backlight smoothly for a rapid changing of the illuminance. In this case, please set it to C1 x R1 = about 1 ~ 10 as a time constant. It is not necessary if you average illuminance value with software to change backlight smoothly.

Please note that the rise time becomes slow at power-on and recovery from shutdown mode to operation mode.
### Terminal Descriptions

<table>
<thead>
<tr>
<th>Pin No.</th>
<th>Pin Name</th>
<th>Equivalent Circuit</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>IOUT</td>
<td><img src="image1.png" alt="Equivalent Circuit" /></td>
<td>This terminal outputs current depending on illuminance level. Use this pin by putting resistor between GND.</td>
</tr>
<tr>
<td>2</td>
<td>GND</td>
<td><img src="image2.png" alt="Equivalent Circuit" /></td>
<td>GND Terminal</td>
</tr>
<tr>
<td>3</td>
<td>VCC</td>
<td><img src="image3.png" alt="Equivalent Circuit" /></td>
<td>Power Supply Terminal</td>
</tr>
<tr>
<td>4</td>
<td>NC</td>
<td><img src="image4.png" alt="Equivalent Circuit" /></td>
<td>NC( Non connection)Terminal Open or short to GND</td>
</tr>
<tr>
<td>5</td>
<td>GC1</td>
<td><img src="image5.png" alt="Equivalent Circuit" /></td>
<td>Mode Setting Terminal 1</td>
</tr>
<tr>
<td>6</td>
<td>GC2</td>
<td><img src="image6.png" alt="Equivalent Circuit" /></td>
<td>Mode Setting Terminal 2</td>
</tr>
</tbody>
</table>
● Package Outlines

![Package Diagram]

● Optical design for the device

![Optical Design Diagram]

Please design an optical window to have the focused light within this area.
●Notes for use

1) Absolute Maximum Ratings
An excess in the absolute maximum ratings, such as supply voltage (Vmax), temperature range of operating conditions
(TopR), etc., can break down devices, thus making impossible to identify breaking mode such as a short circuit or an open
circuit. If any special mode exceeding the absolute maximum ratings is assumed, consideration should be given to take
physical safety measures including the use of fuses, etc.

2) GND voltage
Make setting of the potential of the GND terminal so that it will be maintained at the minimum in any operating state.
Furthermore, check to be sure no terminals are at a potential lower than the GND voltage including an actual electric
transient.

3) Short circuit between terminals and erroneous mounting
In order to mount ICs on a set PCB, pay thorough attention to the direction and offset of the ICs. Erroneous mounting can
break down the ICs. Furthermore, if a short circuit occurs due to foreign matters entering between terminals or between
the terminal and the power supply or the GND terminal, the ICs can break down.

4) Operation in strong electromagnetic field
Be noted that using ICs in the strong electromagnetic field can malfunction them.

5) Inspection with set PCB
On the inspection with the set PCB, if a capacitor is connected to a low-impedance IC terminal, the IC can suffer stress.
Therefore, be sure to discharge from the set PCB by each process. Furthermore, in order to mount or dismount the set
PCB to/from the jig for the inspection process, be sure to turn OFF the power supply and then mount the set PCB to the jig.
After the completion of the inspection, be sure to turn OFF the power supply and then dismount it from the jig. In addition,
for protection against static electricity, establish a ground for the assembly process and pay thorough attention to the
transportation and the storage of the set PCB.

6) Input terminals
In terms of the construction of IC, parasitic elements are inevitably formed in relation to potential. The operation of the
parasitic element can cause interference with circuit operation, thus resulting in a malfunction and then breakdown of the
input terminal. Therefore, pay thorough attention not to handle the input terminals; such as to apply to the input terminals a
voltage lower than the GND respectively, so that any parasitic element will operate. Furthermore, do not apply a voltage to
the input terminals when no power supply voltage is applied to the IC. In addition, even if the power supply voltage is
applied, apply to the input terminals a voltage lower than the power supply voltage or within the guaranteed value of
electrical characteristics.

7) Thermal design
Perform thermal design in which there are adequate margins by taking into account the permissible dissipation (pd) in
actual states of use.

8) Treatment of package
Dusts or scratch on the photo detector may affect the optical characteristics. Please handle it with care.

9) Rush current
When power is first supplied to this IC, rush current may flow instantaneously. Because it is possible that the charge
current to the parasitic capacitance of internal photo diode or the internal logic may be unstable.
Therefore, give special consideration to power coupling capacitance, power wiring, width of GND wiring, and routing of
connections.

10) The exposed central pad on the back side of the package
There is an exposed central pad on the back side of the package. But please do it non connection.
( Don't solder, and don't do electrical connection )
Please mount by Footprint dimensions described in the Jisso Information for WSOF6.
This pad is GND level, therefore there is a possibility that LSI malfunctions and heavy-current is generated.
● Ordering part number

<table>
<thead>
<tr>
<th>BH</th>
<th>1603</th>
<th>FVC</th>
<th>TR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Part No.</td>
<td>Part No.</td>
<td>Package</td>
<td>Packaging and forming specification</td>
</tr>
<tr>
<td>1603</td>
<td></td>
<td>FVC: WSOF6</td>
<td>TR: Embossed tape and reel (WSOF6)</td>
</tr>
</tbody>
</table>

WSOF6

(Tape and Reel information)

<table>
<thead>
<tr>
<th>Tape</th>
<th>Embossed carrier tape</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quantity</td>
<td>3000pcs</td>
</tr>
</tbody>
</table>

- Direction of feed
  - TR: The direction is the 1pin of product is at the upper right when you hold the reel on the left hand and you pull out the tape on the right hand.

+ Order quantity needs to be multiple of the minimum quantity.
Notice

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1. Our Products are designed and manufactured for application in ordinary electronic equipments (such as AV equipment, OA equipment, telecommunication equipment, home electronic appliances, amusement equipment, etc.). If you intend to use our Products in devices requiring extremely high reliability (such as medical equipment (Note 1), transport equipment, traffic equipment, aircraft/spacecraft, nuclear power controllers, fuel controllers, car equipment including car accessories, safety devices, etc.) and whose malfunction or failure may cause loss of human life, bodily injury or serious damage to property ("Specific Applications"), please consult with the ROHM sales representative in advance. Unless otherwise agreed in writing by ROHM in advance, ROHM shall not be in any way responsible or liable for any damages, expenses or losses incurred by you or third parties arising from the use of any ROHM’s Products for Specific Applications.

(Note 1) Medical Equipment Classification of the Specific Applications

<table>
<thead>
<tr>
<th>JAPAN</th>
<th>USA</th>
<th>EU</th>
<th>CHINA</th>
</tr>
</thead>
<tbody>
<tr>
<td>CLASS III</td>
<td>CLASS III</td>
<td>CLASS II b</td>
<td>CLASS III</td>
</tr>
</tbody>
</table>

2. ROHM designs and manufactures its Products subject to strict quality control system. However, semiconductor products can fail or malfunction at a certain rate. Please be sure to implement, at your own responsibilities, adequate safety measures including but not limited to fail-safe design against the physical injury, damage to any property, which a failure or malfunction of our Products may cause. The following are examples of safety measures:
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   [b] Use of our Products outdoors or in places where the Products are exposed to direct sunlight or dust
   [c] Use of our Products in places where the Products are exposed to sea wind or corrosive gases, including Cl₂, H₂S, NH₃, SO₂, and NO₂
   [d] Use of our Products in places where the Products are exposed to static electricity or electromagnetic waves
   [e] Use of our Products in proximity to heat-producing components, plastic cords, or other flammable items
   [f] Sealing or coating our Products with resin or other coating materials
   [g] Use of our Products without cleaning residue of flux (even if you use no-clean type fluxes, cleaning residue of flux is recommended); or Washing our Products by using water or water-soluble cleaning agents for cleaning residue after soldering
   [h] Use of the Products in places subject to dew condensation

4. The Products are not subject to radiation-proof design.

5. Please verify and confirm characteristics of the final or mounted products in using the Products.

6. In particular, if a transient load (a large amount of load applied in a short period of time, such as pulse. is applied, confirmation of performance characteristics after on-board mounting is strongly recommended. Avoid applying power exceeding normal rated power; exceeding the power rating under steady-state loading condition may negatively affect product performance and reliability.

7. De-rate Power Dissipation (Pd) depending on Ambient temperature (Ta). When used in sealed area, confirm the actual ambient temperature.

8. Confirm that operation temperature is within the specified range described in the product specification.

9. ROHM shall not be in any way responsible or liable for failure induced under deviant condition from what is defined in this document.

Precaution for Mounting / Circuit board design

1. When a highly active halogenous (chlorine, bromine, etc.) flux is used, the residue of flux may negatively affect product performance and reliability.

2. In principle, the reflow soldering method must be used; if flow soldering method is preferred, please consult with the ROHM representative in advance.

For details, please refer to ROHM Mounting specification
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Precaution for Electrostatic
This Product is electrostatic sensitive product, which may be damaged due to electrostatic discharge. Please take proper caution in your manufacturing process and storage so that voltage exceeding the Products maximum rating will not be applied to Products. Please take special care under dry condition (e.g. Grounding of human body / equipment / solder iron, isolation from charged objects, setting of Ionizer, friction prevention and temperature / humidity control).

Precaution for Storage / Transportation
1. Product performance and soldered connections may deteriorate if the Products are stored in the places where:
   [a] the Products are exposed to sea winds or corrosive gases, including Cl2, H2S, NH3, SO2, and NO2
   [b] the temperature or humidity exceeds those recommended by ROHM
   [c] the Products are exposed to direct sunshine or condensation
   [d] the Products are exposed to high Electrostatic

2. Even under ROHM recommended storage condition, solderability of products out of recommended storage time period may be degraded. It is strongly recommended to confirm solderability before using Products of which storage time is exceeding the recommended storage time period.

3. Store / transport cartons in the correct direction, which is indicated on a carton with a symbol. Otherwise bent leads may occur due to excessive stress applied when dropping of a carton.

4. Use Products within the specified time after opening a humidity barrier bag. Baking is required before using Products of which storage time is exceeding the recommended storage time period.

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