Ambient Light Sensor ICs

# Analog Current Output Type Ambient Light Sensor IC

**BH1603FVC**

No.12046EDT05

## ●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

| Parameter | Symbol | Limits | Units |
|---|---|---|---|
| Supply Voltage | Vmax | 7 | V |
| Operating Temperature | Topr | -40～85 | ℃ |
| Storage Temperature | Tstg | -40～100 | ℃ |
| Iout Current | Ioutmax | 7.5 | mA |
| Power Dissipation | Pd | 260※ | mW |

※ 70mm × 70mm × 1.6mm glass epoxy board. Derating at 3.47mW/℃ for operating above Ta=25℃.

## ●Operating Conditions

| Parameter | Symbol | Min. | Typ. | Max. | Units |
|---|---|---|---|---|---|
| VccVoltage $V_{CC}$ | $V_{CC}$ | 2.4 | 3.0 | 5.5 | V |

## ●Electrical Characteristics ( VCC = 3.0V, Ta = 25℃, unless otherwise noted )

| Parameter | Symbol | Min. | Typ. | Max. | Units | Conditions |
|---|---|---|---|---|---|---|
| Supply Current1 (Operate) | Icc1 | 51 | 74 | 97 | uA | Ev=100 lx (H-Gain Mode) ※ |
| Supply Current2 (0 lx) | Icc2 | 4.5 | 9 | 13.5 | uA | Ev=0 lx (H-Gain Mode) |
| Supply Current3(Shutdown) | Icc3sd | - | 0.2 | 0.4 | uA | $V_{GC1}$=$V_{GC2}$=0 No Input Light |
| IOUT Output Current1 (Dark Current) | Iout1 | - | - | 0.2 | uA | Ev=0 lx |
| IOUT Output Current2 | Iout2 | 51 | 60 | 69 | uA | Ev=100 lx (H-Gain Mode) ※ |
| Peak Wave Length | λp | - | 560 | - | nm | |
| Incandescent/Fluorescent Light Current Ratio | rIF | - | 1.0 | - | times | Ev=100 lx |
| Saturated Output Voltage | $V_{OMAX}$ | 2.6 | 2.9 | 3.0 | V | Ev=100 lx, RL=220kΩ(H-Gain Mode)※ |
| GC1, GC2 Input 'L' Voltage | $V_{IL}$ | 0 | - | 0.4 | V | |
| GC1,GC2 Input 'H' Voltage1 | $V_{IH1}$ | 1.4 | - | Vcc | V | 2.4V ≦ $V_{CC}$ ≦ 3.6V |
| GC1,GC2 Input 'H' Voltage2 | $V_{IH2}$ | 2.0 | - | Vcc | V | 3.6V ＜ $V_{CC}$ ≦ 5.5V |
| Wake-up Time | twu | - | 45 | 128 | us | Shutdown→H-Gain Mode ,Ev=100lx※ |
| Gain Ratio H-Gain Mode/M-Gain Mode | rHM | 9.5 | 10 | 10.5 | times | Ev=100lx ※ |
| Gain Ratio M-Gain Mode/L-Gain Mode | rML | 9.5 | 10 | 10.5 | times | Ev=100lx ※ |

※ White LED is used as optical source


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## ●Reference Data

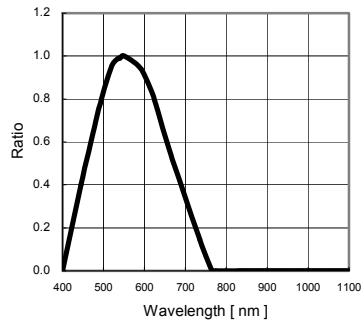



Fig.1 Spectral Response

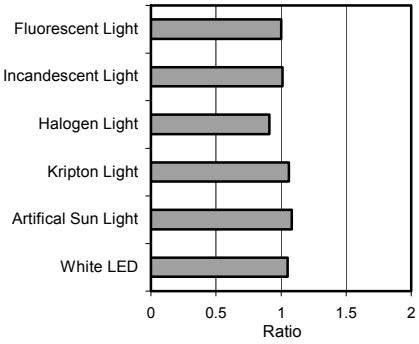



Fig.2 Light Source Dependency
( Fluorescent Light is set to '1' )

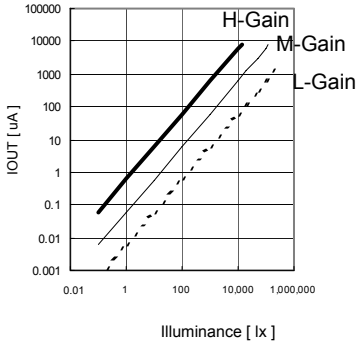



Fig.3 Illuminance – IOUT Characteristics

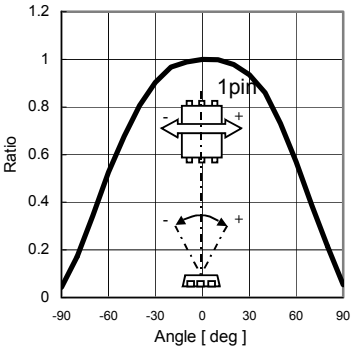



Fig.4 Directional Characteristics 1

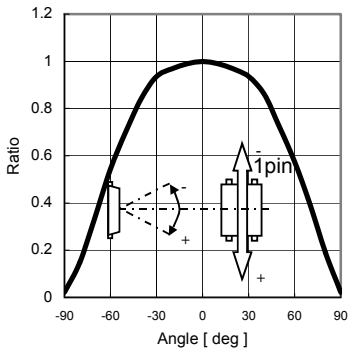



Fig.5 Directional Characteristics 2

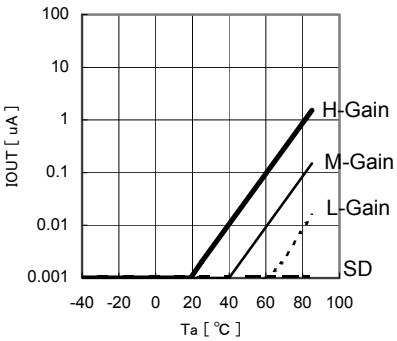



Fig.6 Ta – IOUT ( 0 lx )

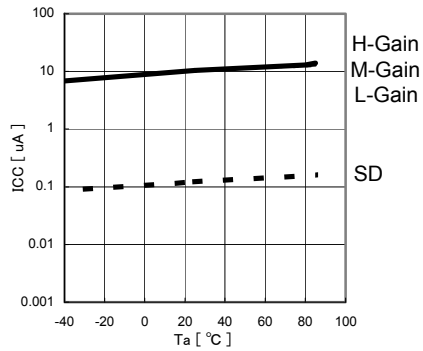



Fig.7 Ta – ICC ( 0 lx )

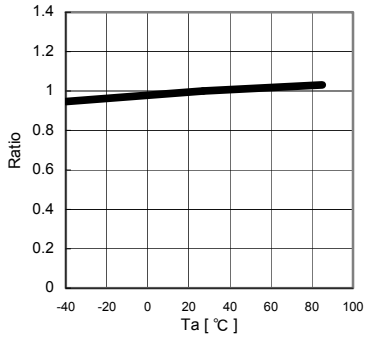



Fig.8 IOUT Temperature dependency
( 100 lx )

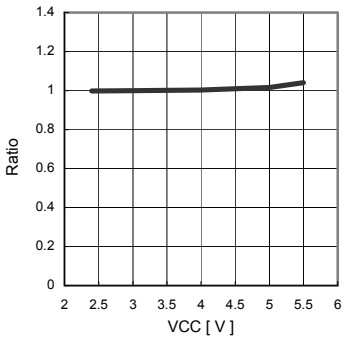



Fig.9 IOUT VCC dependency

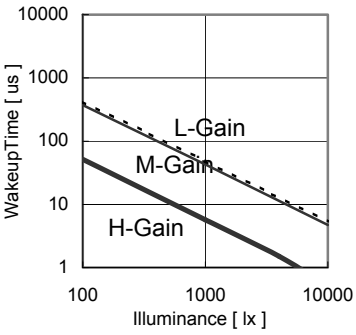
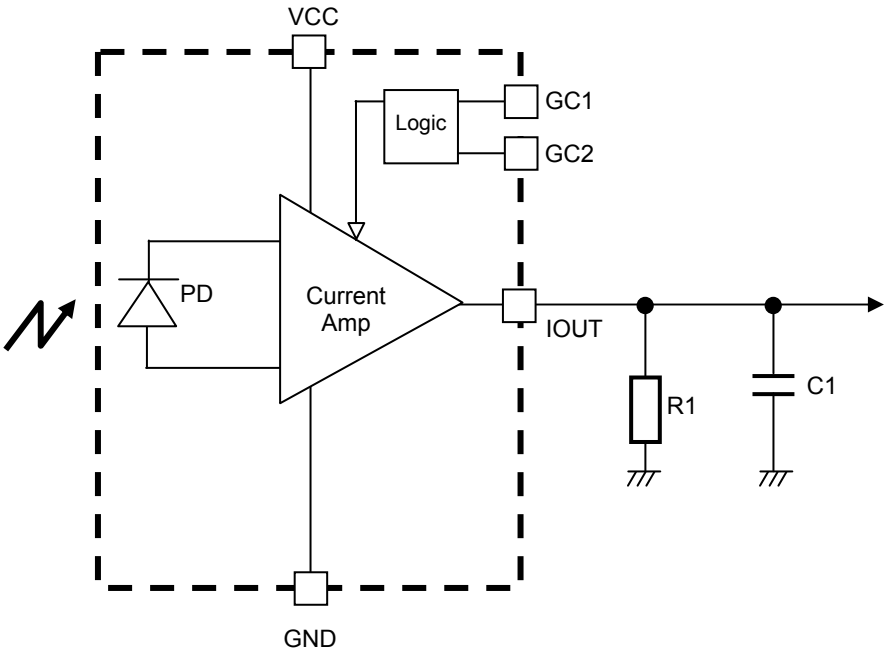



Fig.10 Illuminance – Wake up Time


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**●Block Diagram**




**●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**

| GC2 | GC1 | Mode |
|---|---|---|
| 0 | 0 | Shutdown |
| 0 | 1 | H-Gain Mode |
| 1 | 0 | M-Gain Mode |
| 1 | 1 | L-Gain Mode |


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**●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.

| Illuminance detection range [lx] | Gain Mode |
|---|---|
| ~1,000 | H-Gain Mode |
| ~10,000 | M-Gain Mode |
| ~100,000 | L-Gain Mode |

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.

**Viout= 0.6 x $10^{-6}$ x Ev x R1**

Viout is IOUT output voltage [V]. Ev is an illuminance of the ALS surface [lx].
R1 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.

R1 = Viout/(0.6 x $10^{-6}$ x Ev)
= 2 /(0.6 x $10^{-6}$ x 500) = 6667[Ω]
⇒6.8[kΩ]

(2) M-Gain mode

The output voltage is calculated as follows.

**Viout= 0.06 x $10^{-6}$ x Ev x R1**

(3) L-Gain mode

The output voltage is calculated as follows.

**Viout= 0.006 x $10^{-6}$ x Ev x R1**

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.

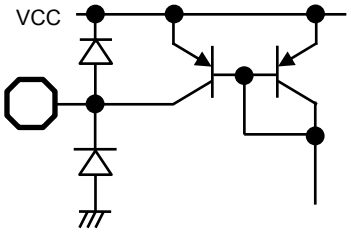
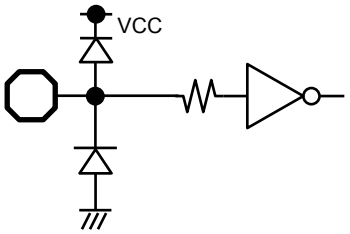
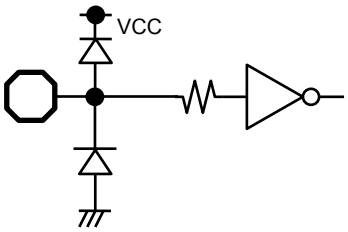
(2) To control backlight smoothly by using illuminance value.

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.

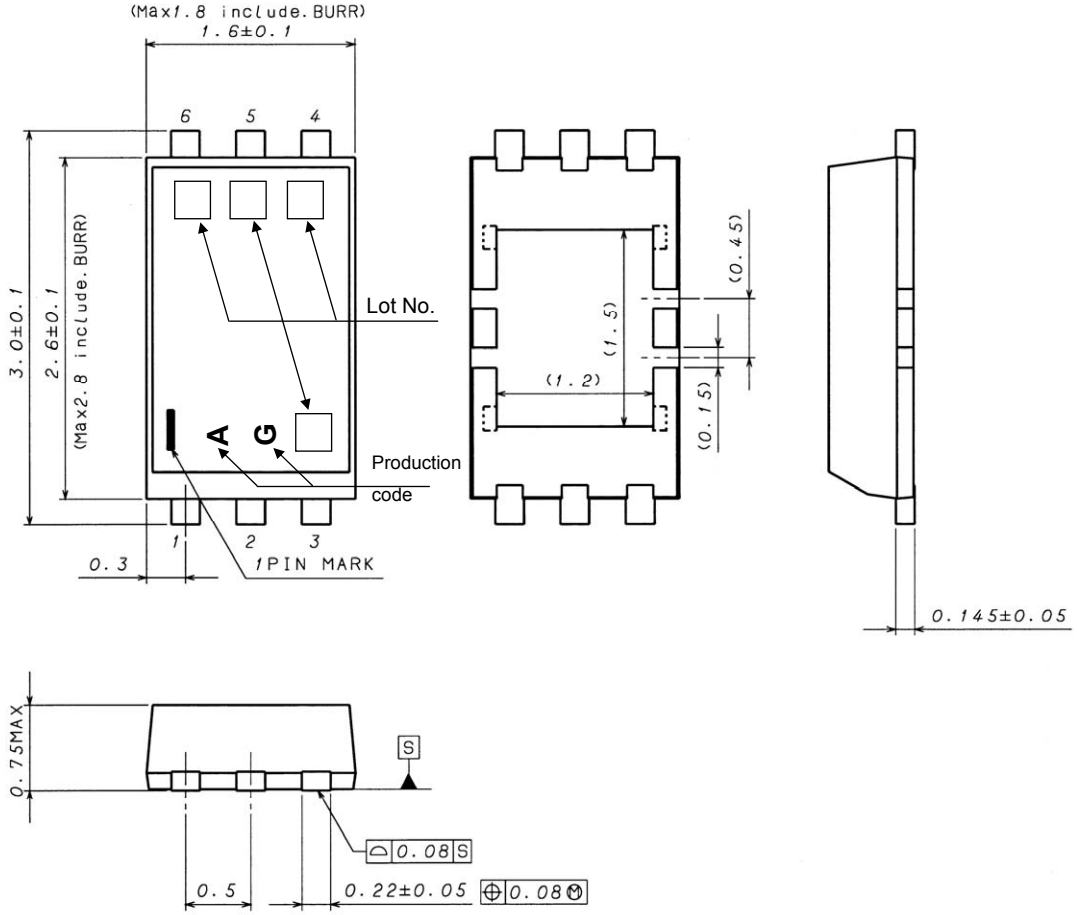

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●**Terminal Descriptions**

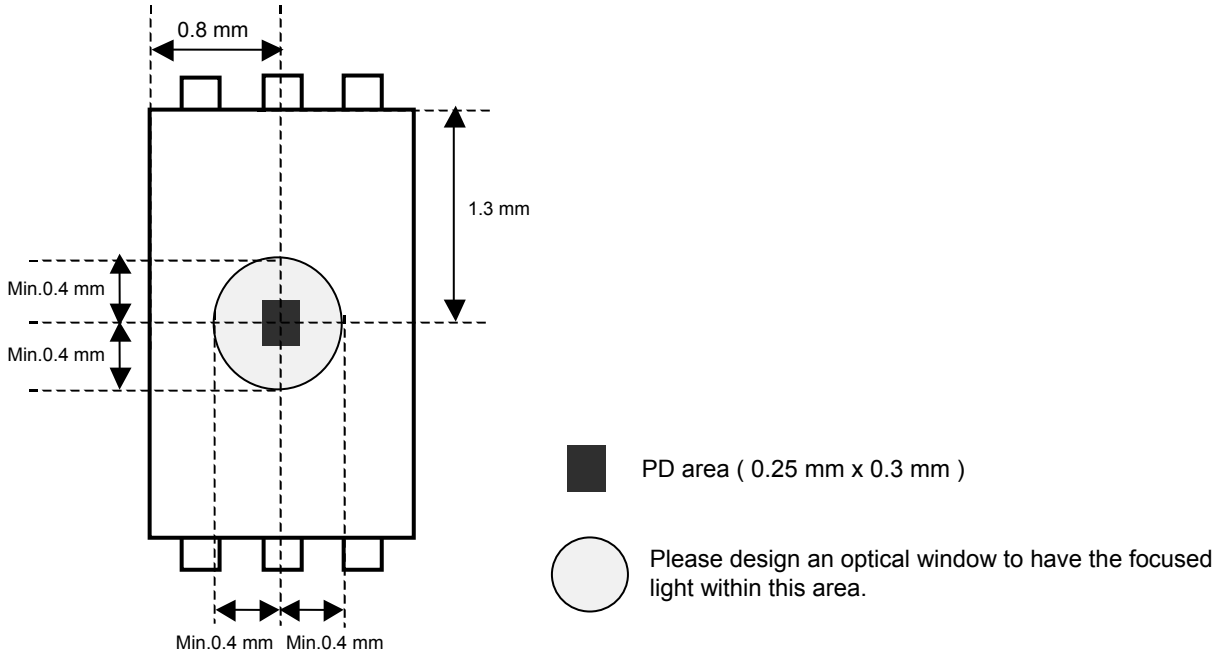
| Pin No. | Pin Name | Equivalent Circuit | Function |
|---|---|---|---|
| 1 | IOUT |  | This terminal outputs current depending on illuminance level.<br>Use this pin by putting resistor between GND. |
| 2 | GND | | GND Terminal |
| 3 | VCC | | Power Supply Terminal |
| 4 | NC | | NC( Non connection)Terminal<br>Open or short to GND |
| 5 | GC1 |  | Mode Setting Terminal 1 |
| 6 | GC2 |  | Mode Setting Terminal 2 |


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**●Package Outlines**




**●Optical design for the device**





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**●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.


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**●Ordering part number**

| B | H | 1 | 6 | 0 | 3 | F | V | C | - | T | R |
|---|---|---|---|---|---|---|---|---|---|---|---|

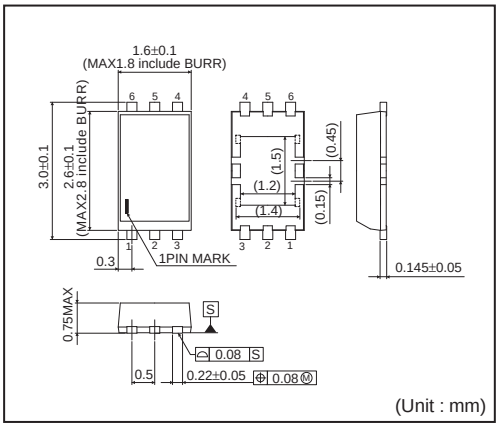
Part No.

Part No.
1603

Package
FVC: WSOF6

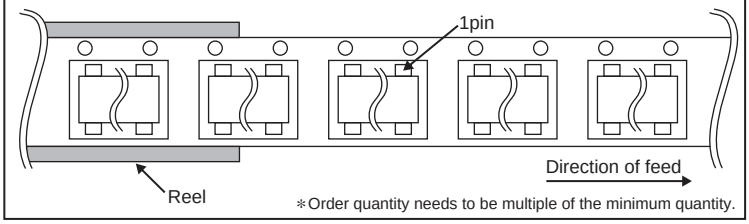
Packaging and forming specification
TR: Embossed tape and reel
(WSOF6)

**WSOF6**




<Tape and Reel information>

| | |
|---|---|
| Tape | Embossed carrier tape |
| Quantity | 3000pcs |
| Direction of feed | TR<br>( The direction is the 1pin of product is at the upper right when you hold 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.


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| JAPAN | USA | EU | CHINA |
|---|---|---|---|
| CLASSⅢ | CLASSⅢ | CLASSⅡb | CLASSⅢ |
| CLASSⅣ | | CLASSⅢ | |

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:
   [a] Installation of protection circuits or other protective devices to improve system safety
   [b] Installation of redundant circuits to reduce the impact of single or multiple circuit failure

3. Our Products are designed and manufactured for use under standard conditions and not under any special or extraordinary environments or conditions, as exemplified below. Accordingly, ROHM shall not be in any way responsible or liable for any damages, expenses or losses arising from the use of any ROHM's Products under any special or extraordinary environments or conditions. If you intend to use our Products under any special or extraordinary environments or conditions (as exemplified below), your independent verification and confirmation of product performance, reliability, etc, prior to use, must be necessary:
   [a] Use of our Products in any types of liquid, including water, oils, chemicals, and organic solvents
   [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 $Cl_2$, $H_2S$, $NH_3$, $SO_2$, and $NO_2$
   [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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1. If change is made to the constant of an external circuit, please allow a sufficient margin considering variations of the characteristics of the Products and external components, including transient characteristics, as well as static characteristics.

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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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QR code printed on ROHM Products label is for ROHM's internal use only.

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BH1603FVC - Web Page

Buy

Distribution Inventory

| | |
|---|---|
| Part Number | BH1603FVC |
| Package | WSOF6 |
| Unit Quantity | 3000 |
| Minimum Package Quantity | 3000 |
| Packing Type | Taping |
| Constitution Materials List | inquiry |
| RoHS | Yes |

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BD9702T-V5 RRH050P03GZETB RB162LAM-60TR BD90640UEFJ-CE2 ESR18EZPF2002 ESR18EZPF6R80 BD00GC0WEFJ-E2 BD2232G-GTR BU18TD2WNVX-TL RB060MM-30TR RGW50TK65DGVC11 YQ8RSM10SDTL1 2SD2701TL 2SD1782KT146R BD14220G-CTR BR24G08FJ-5E2 BR25G128FVM-5ATR ESR18EZPF1302 YQ3RSM10SDTL1 RB-D62Q1367TB32 RBR5L40ADDTE25 YQ3RSM10SDTFTL1 SMLK28WBNCW1 BD5291GWL-E2 BD9G201UEFJ-ME2 ESR10EZPF2004 ESR25JZPF3R00 LTR100LJZPFSR036 R6524KNX3C16 SML-D12M8WT86