Power Management IC Series for Mobile Phones

# High-efficiency Power Management IC

## BH6053GU, BH6951GU, BH6952GU

Pb Free ROHM Electronic Components RoHS Directive Compliance

● **Description**

The High-Efficiency Power Management IC is considered to be the best power supply for CPU application. It integrates a step-down DC/DC converter and a multi channel LDO for portable devices. Each LDO can be controlled externally.

● **Features**

1) Fixed operation frequency (f=1.1MHz)
2) Low-current consumption at low load by using a LDO configured with a DC/DC converter
3) Includes soft start
4) Compact package
5) Includes over current limiter
6) Includes TSD (Thermal Shut Down)
7) Includes UVLO (Under Voltage Look Out)

● **Applications**

The device is suitable for use with all portable equipment, such as cellular phones, digital cameras, portable music players, portable video games and PDAs.

● **Product Lineup**

| Parameter | BH6053GU | BH6951GU | BH6952GU |
|---|---|---|---|
| LDO ch number | 5ch | - | 2ch |
| DC/DC converter ch number | 1ch | 1ch | 1ch |
| Package | VCSP85H3 (32pin)<br>3.54mm×3.54mm | VCSP85H2 (16pin)<br>2.60mm×2.60mm | VCSP85H3 (24pin)<br>3.06 mm×3.06mm |

Ver.B Nov.2005

● **Absolute maximum ratings**

<table>
<tr><th colspan="2">Parameter</th><th>Symbol</th><th>Limits</th><th>Unit</th></tr>
<tr><td colspan="2">Maximum applied voltage</td><td>Vmax</td><td>7</td><td>V</td></tr>
<tr><td rowspan="3">Power dissipation</td><td>BH6053GU</td><td rowspan="3">Pd</td><td>1350*1</td><td rowspan="3">mW</td></tr>
<tr><td>BH6951GU</td><td>870*2</td></tr>
<tr><td>BH6952GU</td><td>1210*3</td></tr>
<tr><td colspan="2">Operating temperature range</td><td>Topr</td><td>−30 to 75</td><td>°C</td></tr>
<tr><td colspan="2">Storage temperature range</td><td>Tstr</td><td>−55 to 125</td><td>°C</td></tr>
</table>

*1 50mm×58mm×1.75mm At glass epoxy board mounting. Reduced by 13.5mW/°C when more than Ta=25°C,
*2 50mm×58mm×1.75mm At glass epoxy board mounting. Reduced by 8.7mW/°C when more than Ta=25°C.
*3 50mm×58mm×1.75mm At glass epoxy board mounting. Reduced by 12.1mW/°C when more than Ta=25°C.

● **Recommended operating range**

<table>
<tr><th colspan="2">Parameter</th><th>Symbol</th><th>Limits</th><th>Unit</th><th>Condition</th></tr>
<tr><td rowspan="3">Power supply voltage</td><td>BH6053GU</td><td rowspan="3">VCC</td><td rowspan="3">3.0 ~ 4.5</td><td rowspan="3">V</td><td>REG1I~5I, BATP voltage</td></tr>
<tr><td>BH6951GU</td><td>BATP voltage</td></tr>
<tr><td>BH6952GU</td><td>REG1I~2I, BATP voltage</td></tr>
</table>

● **Electrical characteristics**

[BH6053GU circuit current]

Unless otherwise specified Ta=25°C, VCC=VBAT= REG1I= REG23I= REG4I = BATP= REG5I=3.6V

| Parameter | Symbol | Min. | Typ. | Max. | Unit | Condition |
|---|---|---|---|---|---|---|
| [Circuit current (No load)] | | | | | | |
| Circuit current 1 | ICC1 | - | 9.1 | 14.0 | µA | CNT1,2,3,4,5 SWEN=0V (Operated only reference voltage source) |
| Circuit current 2 | ICC2 | - | 4.2 | 5.7 | mA | CNT1,2,3,4,5 =0V SWEN,MODE=2.8V |
| Circuit current 3 | ICC3 | - | 25 | 42.4 | µA | CNT1,2,3,4,5=0V SWEN =2.8V, MODE=0V |
| Circuit current 4 | ICC4 | - | 82 | 145 | µA | CNT1,2,5=2.8V, CNT3,4 =0V SWEN =2.8V, MODE=0V |
| Circuit current 5 | ICC5 | - | 65 | 116 | µA | CNT1,2,5=2.8V, CNT3,4=0V SWEN=0V, MODE=0V |
| Circuit current 6 | ICC6 | - | 116 | 189 | µA | CNT1,2,3,4,5=2.8V, SWEN=0V, MODE=0V |

[BH6951GU circuit current]

Unless otherwise specified Ta=25°C, VCC=VBAT= BATP=3.6V

| Parameter | Symbol | Min. | Typ. | Max. | Unit | Condition |
|---|---|---|---|---|---|---|
| [Circuit current (No load)] | | | | | | |
| Circuit current 1 | ICC1 | - | 8.1 | 12.8 | µA | SWEN=0V (Operated only reference voltage source) |
| Circuit current 2 | ICC2 | - | 4.2 | 5.8 | mA | SWEN, MODE=2.8V |
| Circuit current 3 | ICC3 | - | 24 | 42.5 | µA | SWEN =2.8V, MODE=0V |

[BH6952GU circuit current]
Unless otherwise specified Ta=25 °C, VCC=VBAT= REG1I= REG2I= BATP=3.6V

| Parameter | Symbol | Min. | Typ. | Max. | Unit | Condition |
|---|---|---|---|---|---|---|
| [Circuit current (No load)] | | | | | | |
| Circuit current 1 | ICC1 | - | 8.1 | 13.0 | μA | CNT1, 2, SWEN=0V (Operated only reference voltage source) |
| Circuit current 2 | ICC2 | - | 4.2 | 5.7 | mA | CNT1, 2=0V SWEN, MODE=2.8V |
| Circuit current 3 | ICC3 | - | 24 | 41.4 | μA | CNT1, 2=0V SWEN =2.8V, MODE=0V |
| Circuit current 4 | ICC4 | - | 54 | 91.8 | μA | CNT1, 2=2.8V SWEN =2.8V, MODE=0V |
| Circuit current 5 | ICC5 | - | 37 | 62.9 | μA | CNT1, 2=2.8V SWEN=0V, MODE=0V |

[DC/DC converter]
Unless otherwise specified Ta=25 °C, VCC=VBAT=3.6V

| Parameter | | Symbol | Min. | Typ. | Max. | Unit | Condition |
|---|---|---|---|---|---|---|---|
| [DC/DC converter] | | | | | | | |
| 1.5V Output voltage | DC/DC mode | Vosw1 | 1.450 | 1.500 | 1.550 | V | Io=400mA,MODE=3.6V SWVSEL=0V |
| | REG_L mode | Voldo1 | 1.450 | 1.500 | 1.550 | V | Io=50mA,MODE=0V SWVSEL=0V |
| 1.2V Output voltage | DC/DC mode | Vosw2 | 1.150 | 1.200 | 1.250 | V | Io=400mA,MODE=3.6V SWVSEL=3.6V |
| | REG_L mode | Voldo2 | 1.150 | 1.200 | 1.250 | V | Io=50mA,MODE=0V SWVSEL=3.6V |
| Output current | DC/DC mode | Iosw | - | - | 400 | mA | |
| | REG_L mode | Ioldo | - | - | 100 | mA | |
| Efficiency | | Eff | - | 85 | - | % | Io=100mA, Vo=1.5V |
| | | | - | 85 | - | % | Io=200mA, Vo=1.5V |
| Switching frequency | | Fosc | 0.78 | 1.05 | 1.35 | MHz | DC/DC mode |

Inductor: D312C (TOKO, INC)

[REG1]

Unless otherwise specified Ta=25 °C, VCC=VBAT =3.6V

| Parameter | Symbol | Min. | Typ. | Max. | Unit | Condition |
|---|---|---|---|---|---|---|
| [REG1] | | | | | | |
| Circuit current | Iq | - | 15 | 28 | μA | Io=0mA |
| 2.6V Output voltage | Vo1 | 2.544 | 2.600 | 2.656 | V | Io=150mA, REG1VSEL=0V |
| 2.85V Output voltage | Vo2 | 2.794 | 2.850 | 2.906 | V | Io=150mA, REG1VSEL=3.6V |
| Output current | Io | 200 | - | - | mA | |
| I/O voltage difference | Vsat1 | - | 0.2 | 0.3 | V | VBAT=2.6V, Io=150mA |
| I/O voltage difference | Vsat2 | - | 0.2 | 0.3 | V | VBAT=2.85V, Io=150mA |
| Load stability | dVo1 | - | 24 | 70 | mV | Io=1 ~ 150mA |
| Input stability | dVo2 | - | 3 | 30 | mV | VBAT=3.1 ~ 4.5V, Io=150mA |
| Output voltage temperature coefficient | dVo3 | - | ±100 | - | ppm/ °C | Ta=-30 ~ 75 °C, Io=150mA |
| 2.6V Ripple rejection ratio | RR260 | 50 | 60 | - | dB | Io=150mA, VBAT=3.6V, *1 |
| 2.85V Ripple rejection ratio | RR280 | 50 | 60 | - | dB | Io=150mA, VBAT=3.7V, *1 |
| Current overload limiter | Iolim | - | 150 | - | mA | Fold back, Vo=0V |
| Output noise voltage | VNO | - | 129 | 180 | μVrms | BW=20 ~ 80kHz, Io=150mA |

*1 Input signal level : -14dBV, Input frequency : 1KHz, Measurement frequency band width : 20Hz to 80kHz

[REG2]

Unless otherwise specified Ta=25 °C, VCC= VBAT =3.6V

| Parameter | Symbol | Min. | Typ. | Max. | Unit | Condition |
|---|---|---|---|---|---|---|
| [REG2] | | | | | | |
| Circuit current | Iq | - | 15 | 28 | μA | Io=0mA |
| Output voltage | Vo | 1.755 | 1.800 | 1.845 | V | Io=120mA |
| Output current | Io | 150 | - | - | mA | |
| Load stability | dVo1 | - | 13 | 60 | mV | Io=1 ~ 120mA |
| Input stability | dVo2 | - | 6 | 30 | mV | VBAT=3.0 ~ 4.5V, Io=120mA |
| Output voltage temperature coefficient | dVo3 | - | ±100 | - | ppm/ °C | Ta=－30 ~ 75 °C, Io=120mA |
| Ripple rejection ratio | RR52 | 50 | 60 | - | dB | Io=120mA, *1 |
| Current overload limiter | Iolim | - | 160 | - | mA | Fold back, Vo=0V |
| Output noise voltage | VNO | - | 119 | 160 | μVrms | BW=20~80kHz, Io=120mA |

*1 Input signal level : -14dBV, Input frequency : 1KHz, Measurement frequency band width : 20Hz to 80kHz

[REG3]

Unless otherwise specified Ta=25 °C, VCC=VBAT =3.6V

| Parameter | Symbol | Min. | Typ. | Max. | Unit | Condition |
|---|---|---|---|---|---|---|
| [REG3] | | | | | | |
| Output voltage | Vo | 3.240 | 3.300 | 3.360 | V | Io=150mA |
| Output current | Io | 150 | - | - | mA | |
| I/O voltage difference | Vsat | - | 0.2 | 0.3 | V | VBAT=3.3V, Io=150mA |
| Load stability | dVo1 | - | 13 | 60 | mV | Io=1~150mA |
| Input stability | dVo2 | - | 6 | 30 | mV | VBAT=3.5~4.5V, Io=150mA |
| Output voltage temperature coefficient | dVo3 | - | ±100 | - | ppm/ °C | Ta=-30~75 °C, Io=150mA |
| Ripple rejection ratio | RR62 | 50 | 60 | - | dB | Io=150mA, VBAT=4.2V, *1 |
| Current overload limiter | Iolim | - | 150 | - | mA | Fold back, Vo=0V |
| Output noise voltage | VNO | - | 123 | 160 | μVrms | BW=20~80kHz, Io=150mA |

*1 Input signal level : -14dBV, Input frequency : 1KHz, Measurement frequency band width : 20Hz to 80kHz

[REG4]

Unless otherwise specified, Ta=25 °C, VCC=VBAT =3.6V

| Parameter | Symbol | Min. | Typ. | Max. | Unit | Condition |
|---|---|---|---|---|---|---|
| [REG4] | | | | | | |
| Circuit current | Iq | - | 35 | 54 | μA | Io=0mA |
| Output voltage | Vo | 1.755 | 1.800 | 1.845 | V | Io=50mA |
| Output current | Io | 50 | - | - | mA | |
| Load stability | dVo1 | - | 8 | 60 | mV | Io=1~50mA |
| Input stability | dVo2 | - | 1 | 30 | mV | VBAT=3.0~4.5V, Io=50mA |
| Output voltage temperature coefficient | dVo3 | - | ±100 | - | ppm/°C | Ta=-30~75 °C, Io=50mA |
| Ripple rejection ratio | RR52 | 50 | 60 | - | dB | Io=50mA, *1 |
| Current overload limiter | Iolim | - | 90 | - | mA | Fold back, Vo=0V |
| Output noise voltage | VNO | - | 110 | 190 | μVrms | BW=20~80kHz, Io=50mA |

*1 Input signal level : -14dBV, Input frequency : 1KHz, Measurement frequency band width : 20Hz to 80kHz

[REG5]

Unless otherwise specified, Ta=25 °C, VCC=VBAT =3.6V

| Parameter | Symbol | Min. | Typ. | Max. | Unit | Condition |
|---|---|---|---|---|---|---|
| [REG5] | | | | | | |
| Circuit current | Iq | - | 20 | 38 | μA | Io=0mA |
| 1.5V output voltage | Vo1 | 1.460 | 1.500 | 1.540 | V | Io=30mA,SWVSEL=0V |
| 1.2V output voltage | Vo2 | 1.160 | 1.200 | 1.240 | V | Io=30mA,SWVSEL=3.6V |
| Output current | Io | 50 | - | - | mA | |
| Load stability | dVo1 | - | 8 | 60 | mV | Io=1~30mA |
| Input stability | dVo2 | - | 1 | 30 | mV | VBAT=3.0~4.5V, Io=30mA |
| Output voltage temperature coefficient | dVo3 | - | ±100 | - | ppm/°C | Ta=-30~75 °C, Io=30mA |
| Ripple rejection ratio | RR62 | 50 | 60 | - | dB | Io=30mA |
| Current overload limiter | Iolim | - | 90 | - | mA | Fold back, Vo=0V |
| Output noise voltage | VNO | - | 110 | 160 | μVrms | BW=20~80kHz, Io=30mA |

*1 Input signal level : -14dBV, Input frequency : 1KHz, Measurement frequency band width : 20Hz to 80kHz

[Interface, UVLO]

Unless otherwise specified, Ta=25 °C, VCC=VBAT= 3.6V

| Parameter | Symbol | Min. | Typ. | Max. | Unit | Condition |
|---|---|---|---|---|---|---|
| [CPU Interface 1 (CNT1,2,3,4,5,SWEN,MODE)] | | | | | | |
| H Level Input current | IIH1 | -10 | 1.95 | 10 | μA | VIH=3.6V |
| L Level Input current | IIL1 | -10 | 0 | 10 | μA | VIL=0V |
| [CPU Interface 2 (SWVSEL,REG1VSEL)] | | | | | | |
| H Level Input current | IIH2 | -10 | 0 | 10 | μA | VIH=3.6V |
| L Level Input current | IIL2 | -10 | 0 | 10 | μA | VIL=0V |
| [CPU Interface 3 (CNT1,2,3,4,5,SWEN,MODE)] | | | | | | |
| H Level Input voltage | VIH | 1.4 | - | - | V | |
| L Level Input voltage | VIL | - | 0 | 0.25 | V | |
| [CPU Interface 4 (SWVSEL,REG1VSEL)] | | | | | | |
| H Level Input voltage | VIH | VCC×0.8 | - | VCC | V | |
| L Level Input voltage | VIL | - | - | VCC×0.2 | V | |
| [UVLO (Under Voltage Lock Out)] | | | | | | |
| Detecting voltage 1 | VDETHL | 2.4 | 2.5 | 2.6 | V | VBAT=3.6→0V SWEEP |
| Detection release hysteresis | VHYS | 25 | 50 | 100 | mV | |

## ●Reference data

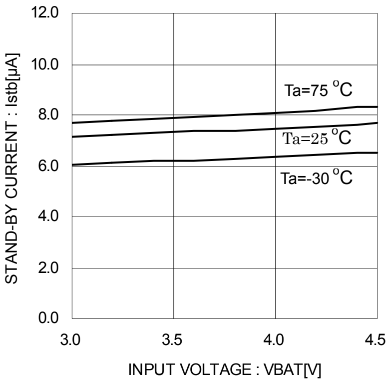


Fig.1 Circuit current
(At BH6053GU stand by)

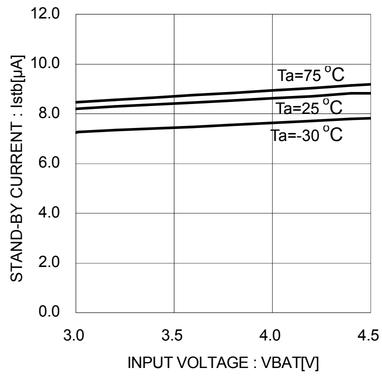


Fig.2 Circuit current
(At BH6951GU stand by)

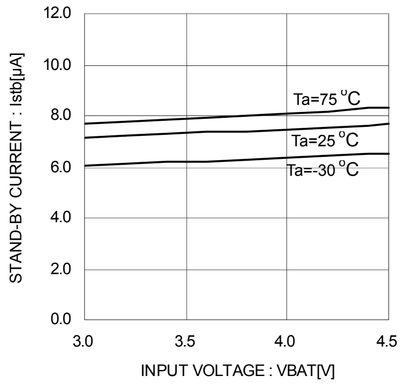


Fig.3 Circuit current
(At BH6952GU stand-by)

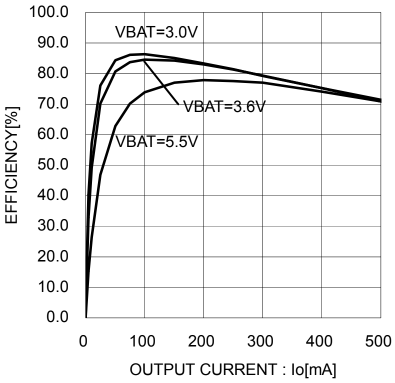


Fig.4 Efficiency
(DC/DC converter 1.5V)

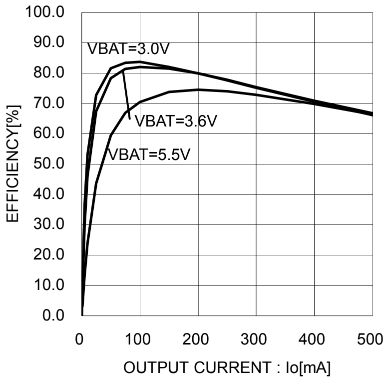


Fig.5 Efficiency
(DC/DC converter 1.2V)

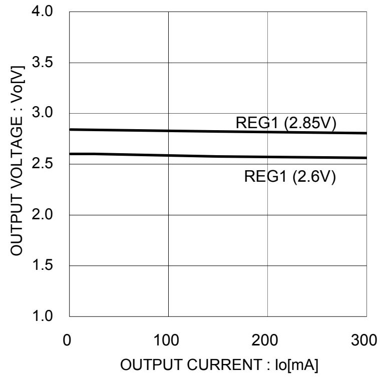


Fig.6 Load stability
(REG1)

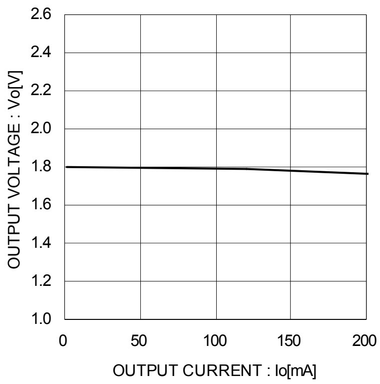


Fig.7 Load stability
(REG2)

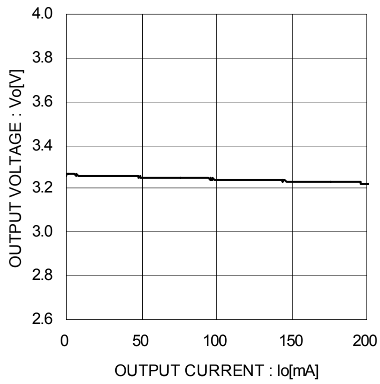


Fig.8 Load stability
(REG3)

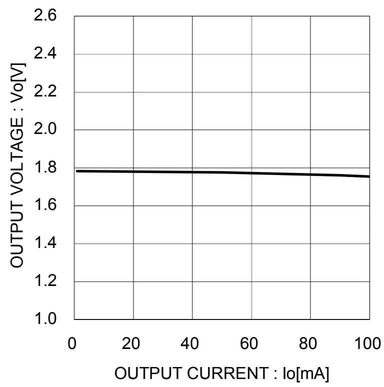


Fig.9 Load stability
(REG4)

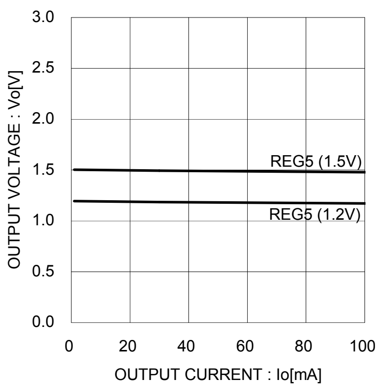


Fig.10 Load stability
(REG5)

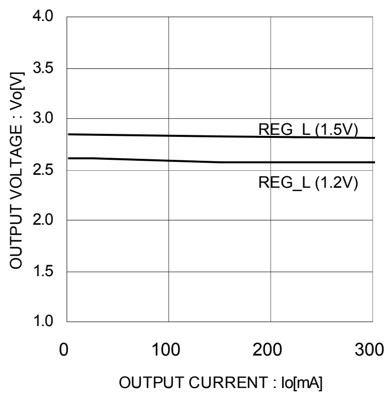


Fig.11 Load stability
(REG_L)

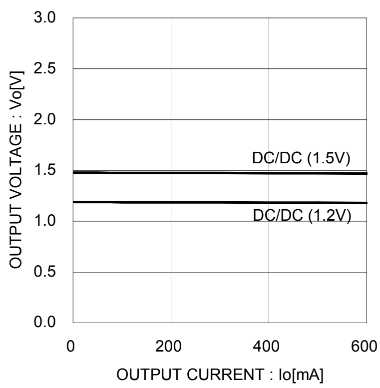


Fig.12 Load stability
(DC/DC converter)

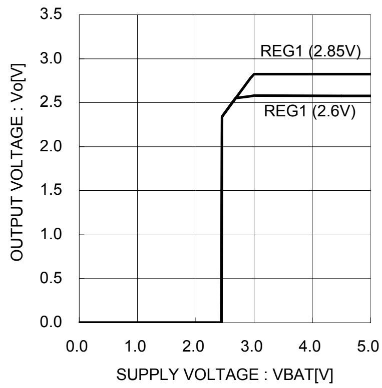


Fig.13 Input stability
(REG1)

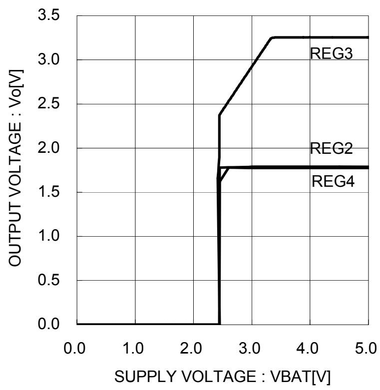


Fig.14 Input stability
(REG2, REG3, REG4)

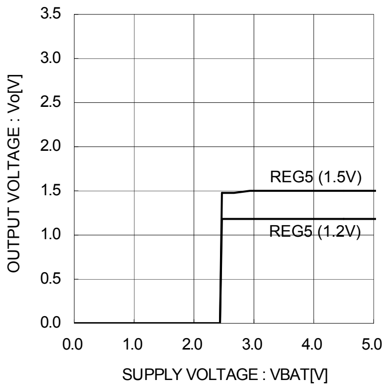


Fig.15 Input stability
(REG5)

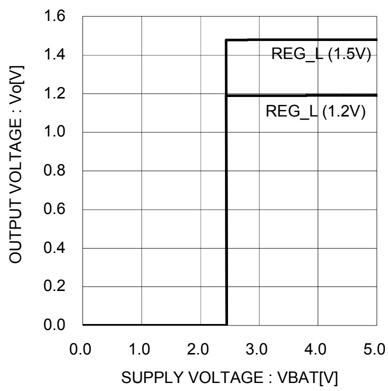


Fig.16 Input stability
(REG_L)

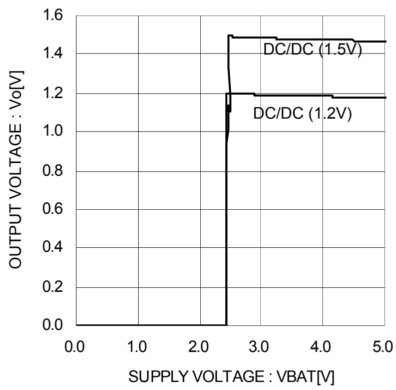


Fig.17 Input stability
(DC/DC converter)

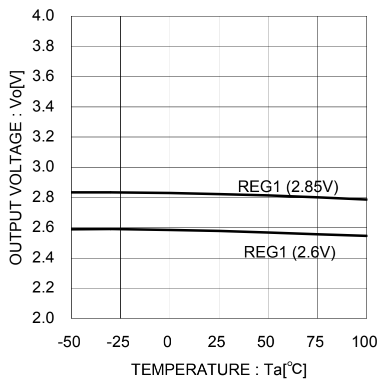


Fig.18 Output temperature
fluctuation rate
(REG1)

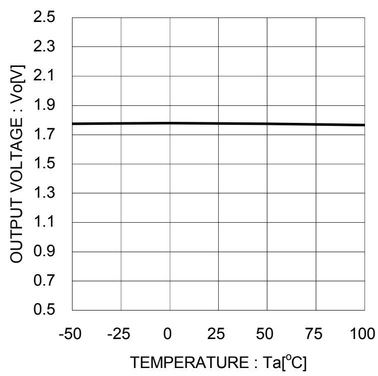


Fig19. Output temperature
fluctuation rate
(REG2)

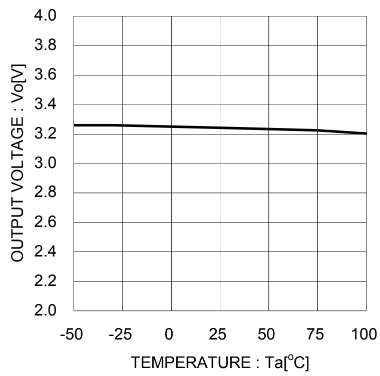


Fig.20 Output temperature
fluctuation rate
(REG3)

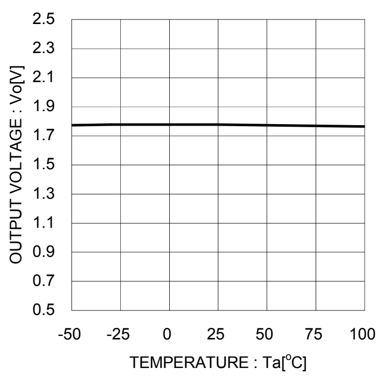


Fig.21 Output temperature
fluctuation rate
(REG4)

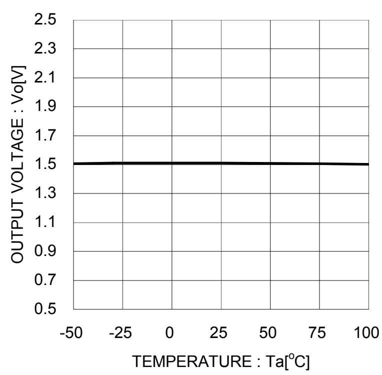


Fig.22 Output temperature
fluctuation rate
(REG5)

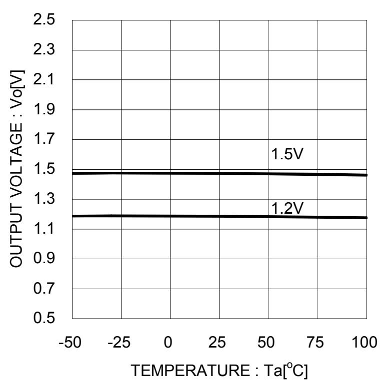


Fig.23 Output temperature
fluctuation rate
(DC/DC converter, REG_L)

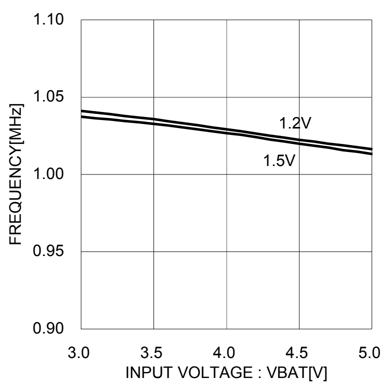


Fig.24 Switching frequency

## ●Block diagram, recommended circuit example, pin location diagram

| | | | | | |
|---|---|---|---|---|---|
| F1 T4 | F2 CNT4 | F3 CNT2 | F4 VREF24 | F5 VREF12 | F6 T3 |
| E1 REG4V | E2 REG4I | E3 CNT3 | E4 CNT1 | E5 REG1VSEL | E6 CNT5 |
| D1 GND2 | D2 SWVSEL | | | D5 GND1 | D6 REG5V |
| C1 LDOOUT | C2 BATP | C3 INDEX post | | C5 REG5I | C6 REG3V |
| B1 SWOUT | B2 GNDP | B3 SOFT | B4 SWEN | B5 REG1I | B6 REG23I |
| A1 T1 | A2 FBIN | A3 MODE | A4 REG1V | A5 REG2V | A6 T2 |

Fig.25 Pin location diagram
(BH6053GU Bottom View)

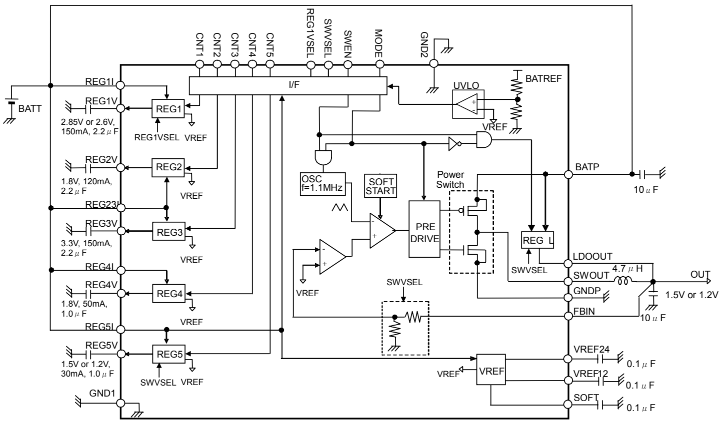


Fig.26 Block diagram and
recommended circuit diagram
(BH6053GU)

| | | | |
|---|---|---|---|
| D1 T4 | D2 SWVSEL | D3 GND1 | D4 T3 |
| C1 LDOOUT | C2 BATP | C3 VREF24 | C4 VREF12 |
| B1 SWOUT | B2 GNDP | B3 SOFT | B4 SWEN |
| A1 T1 | A2 FBIN | A3 MODE | A4 T2 |

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Fig.27 Pin location diagram
(BH6951GU Bottom View)

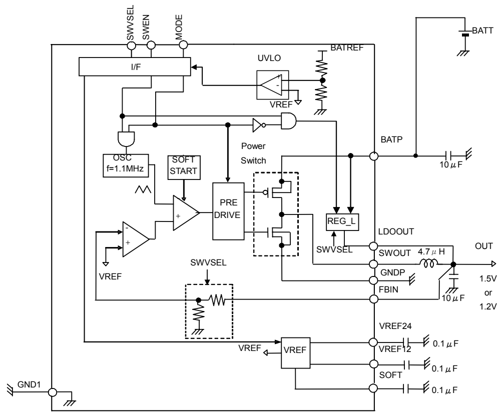


Fig.28 Block diagram and
recommended circuit diagram
(BH6951GU)

| | | | | |
|---|---|---|---|---|
| E1 T4 | E2 VREF24 | E3 VREF12 | E4 REG1VSEL | E5 T3 |
| D1 GND2 | D2 SWVSEL | D3 GND1 | D4 REG2I | D5 REG2V |
| C1 LDOOUT | C2 BATP | | C4 CNT1 | C5 CNT2 |
| B1 SWOUT | B2 GNDP | B3 SOFT | B4 SWEN | B5 REG1I |
| A1 T1 | A2 FBIN | A3 MODE | A4 REG1V | A5 T2 |

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Fig.29 Pin location diagram
(BH6952GU Bottom View)

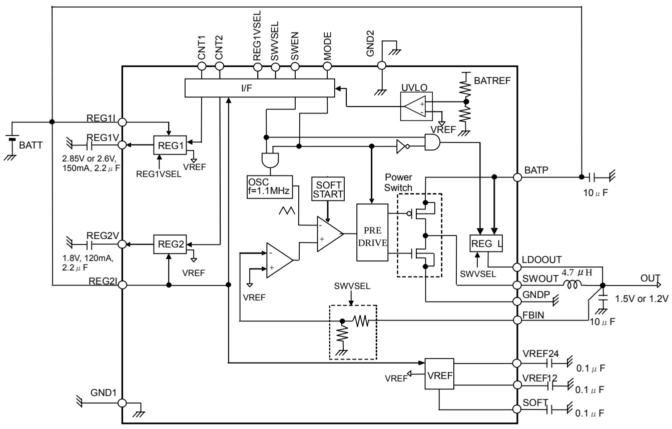



Fig.30 Block diagram and
recommended circuit diagram
(BH6952GU)

[Pin assignment table ]

| Pin name | Pin No | | | Equivalent Pin circuit |
|---|---|---|---|---|
| | BH6053 | BH6951 | BH6952 | |
| REG1I | B5 | - | B5 | F |
| REG1V | A4 | - | A4 | I |
| REG2I | - | - | D5 | L |
| REG2V | A5 | - | D4 | I |
| REG23I | B6 | - | - | F |
| REG3V | C6 | - | - | I |
| REG4I | E2 | - | - | F |
| REG4V | E1 | - | - | D |
| REG5I | C5 | - | - | L |
| REG5V | D6 | - | - | I |
| VREF24 | F4 | C3 | E2 | K |
| VREF12 | F5 | C4 | E3 | D |
| GND1 | D5 | D3 | D3 | J |
| GND2 | D1 | - | D1 | J |
| GNDP | B2 | B2 | B2 | J |
| SWOUT | B1 | B1 | B1 | C |
| BATP | C2 | C2 | C2 | L |

| Pin name | Pin No | | | Equivalent Pin circuit |
|---|---|---|---|---|
| | BH6053 | BH6952 | BH6951 | |
| LDOOUT | C1 | C1 | C1 | I |
| FBIN | A2 | A2 | A2 | G |
| SOFT | B3 | B3 | B3 | B |
| MODE | A3 | A3 | A3 | H |
| SWEN | B4 | B4 | B4 | H |
| CNT1 | E4 | - | C4 | H |
| CNT2 | F3 | - | C5 | H |
| CNT3 | E3 | - | - | H |
| CNT4 | F2 | - | - | H |
| CNT5 | E6 | - | - | H |
| REG1VSEL | E5 | - | E4 | A |
| SWVSEL | D2 | D2 | D2 | A |
| T1 | A1 | A1 | A1 | L |
| T2 | A6 | A4 | A5 | L |
| T3 | F6 | D4 | E5 | L |
| T4 | F1 | D1 | E1 | L |

[Control table]

Output voltage Control of each model is shown as follows.

| Pin name | Input level | |
|---|---|---|
| | L | H |
| SWEN | DC/DC converter circuit OFF | DC/DC converter circuit ON |
| MODE | REG_L mode | DC/DC mode |
| SWVSEL | REG_L, DC/DC, REG5=1.5V output | REG_L, DC/DC, REG5=1.2V output |
| CNT1 | REG1 OFF | REG1 ON |
| REG1VSEL | REG1=2.6V output | REG1=2.85V output |
| CNT2 | REG2 OFF | REG2 ON |
| CNT3 | REG3 OFF | REG3 ON |
| CNT4 | REG4 OFF | REG4 ON |
| CNT5 | REG5 OFF | REG5 ON |

●**I/O Equivalent circuit diagram**

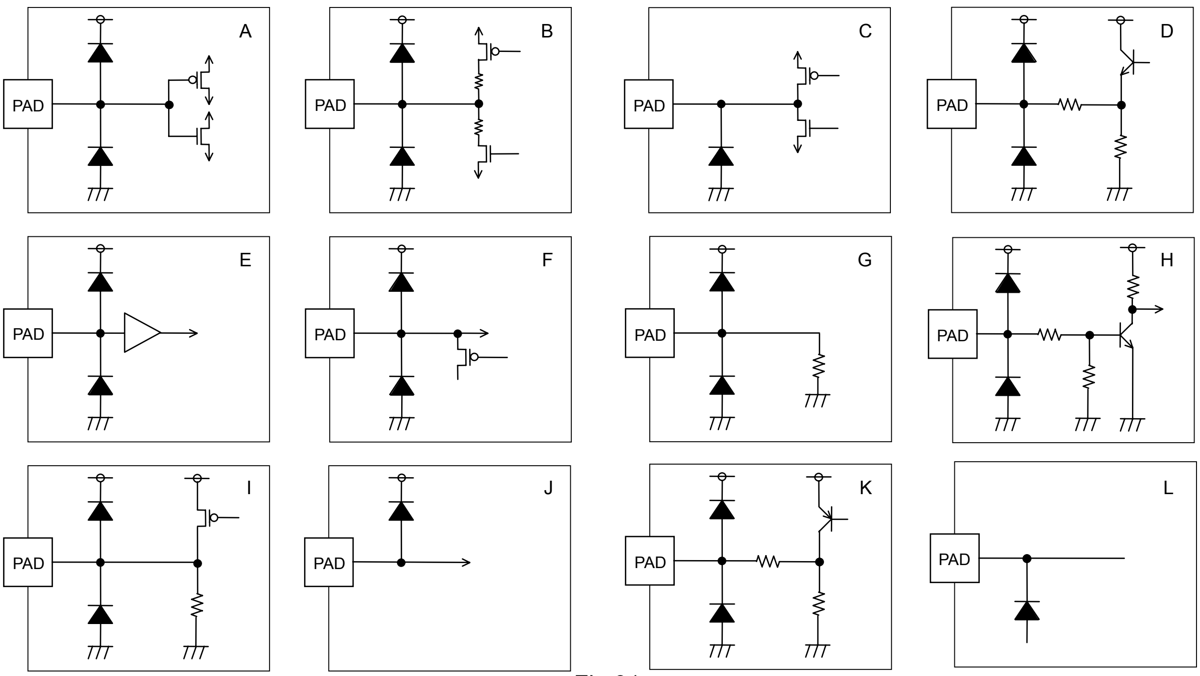


Fig.31

- **Operation dissipation of each block**

1) About LDO

Each LDO can be controlled by input H or L level in the control Pin assignment.

The DC/DC converter can be controlled by input H or L level in SWEN and MODE.

It has 2 modes to obtain a high efficiency at a low load.

This purpose is to use as follows.

| | Application | SWEN | MODE |
|---|---|---|---|
| DC/DC mode | At high-output current. | H | H |
| LDO mode | Stand by, At low-output current | H | L |
| DC/DC OFF mode | DC/DC converter OFF | L | L |

2) Under Voltage Lock Out (UVLO)

When the power supply voltage is decreased, all LDOs, including the DC/DC converter, are shut down.

UVLO operates when the power supply voltage is decreased till reaches the detection voltage. When the power supply voltage is recovered to the detection voltage, UVLO is automatically released.

3) Current overload limiter

The current overload limiter function of the LDO shows the following characteristics:

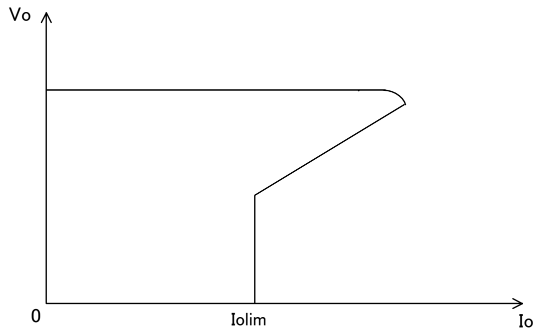


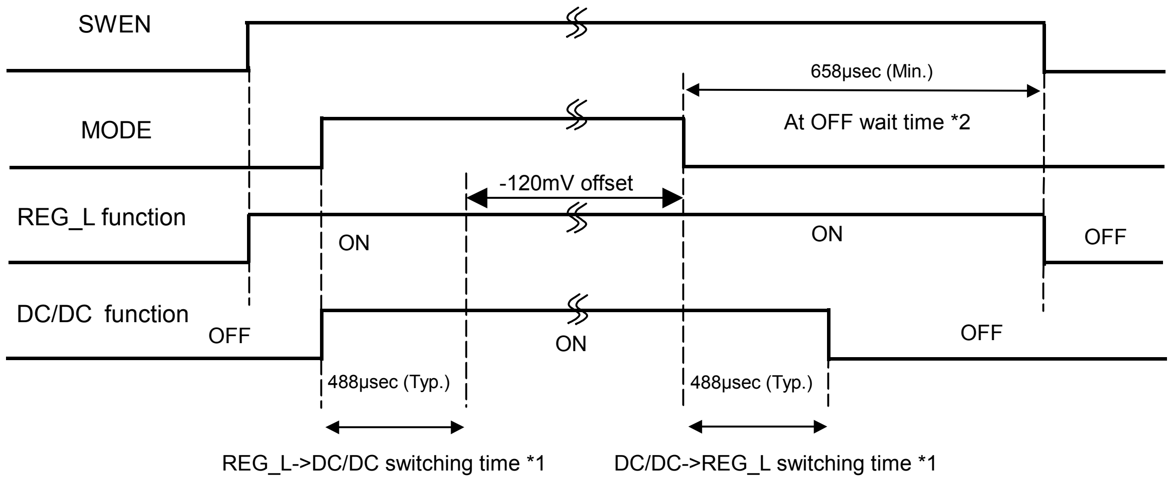

Fig.32

4) Soft start of the DC/DC converter

Soft start operates when the DC/DC converter is turned on. The function of soft start is to raise output voltage gradually, and to prevent an excess output voltage.

● **Timing chart**

The DC/DC converter is operated by the control of SWEN, MODE Pins.




Time is calculated by the standard operation frequency.

*1 REG_L→DC/DC mode switching time and DC/DC→REG_L mode switching time are defined by 512 counts of the switching frequency. The resulting time is 488µsec when switching frequency is 1.05MHz.

*2. When the DC/DC converter is turned off (SWEN=MODE=H→SWEN=L),

1. switch MODE to LOW to change REGL,
2. switch SWEN to L after 658usec.

Note: BH6952GU can turn off the DC/DC converter directly from DC/DC MODE without changing to REG_L.

● **Selection of application parts**

Decoupling capacitor

LDO block

| | Output terminal | Recommended value | Type |
|---|---|---|---|
| BH6053GU | REG1 ~ 3V | 2.2µF | Ceramic capacitor |
| | REG4V, 5V | 1.0µF | Ceramic capacitor |
| BH6952GU | REG1V, 2V | 2.2µF | Ceramic capacitor |

Put these elements near each output part for stable operation.

Reference voltage block

To stabilize the reference voltage, mount the ceramic capacitor of 0.1µF between VREF12, VREF24, and GND pin.

Put 0.1µF at the SOFT pin.

The SOFT Pin is a time setup pin of the Soft start, of the DC/DC converter.

Input voltage block

Connect a capacitor to the power supply pin for stable input voltage supply.

Connect a capacitor near each input pin for a stable operation.

[External component of DC/DC converter]

| | Output terminal | Inductor | Capacitor | |
|---|---|---|---|---|
| | | Recommended value | Recommended value | Type |
| BH6053GU | SWOUT | 4.7µH | 10µF | ceramic capacitor |
| BH6951GU | | | | |
| BH6952GU | | | | |

Put these elements near each output part for stable operation.

●**Attention point of board layout**

In designing the board pattern, the power supply line should be at a low impedance. Connect the bypass capacitor, if necessary. The wiring impedance must be particularly lower around the DC/DC converter.

●**Heat loss**

In heat design, operate the DC/DC converter accordingly:

1. Power temperature Ta must be less than 75 temperature.
2. The power loss of IC must be less than specified dissipation Pd.

Note: The temperature is a guarantee temperature. Take into consideration temperature operation margins.

●**Operation Notes**

1) Absolute maximum ratings
An excess in the absolute maximum ratings, such as supply voltage, temperature range of operating conditions, etc., can break down the devices, thus making impossible to identify breaking mode, such as a short circuit or an open circuit. If any over rated values will expect to exceed the absolute maximum ratings, consider adding circuit protection devices, such as fuses.

2) Operating conditions
Characteristics are guaranteed under the conditions of each specified parameter.

3) Reverse polarity connection of the power supply
Connecting the of power supply in reverse polarity can damage IC. Take precautions when connecting the power supply lines. An external direction diode can be added.

4) Power supply line
Design PCB layout pattern to provide low impedance GND and supply lines. To obtain a low noise ground and supply line, separate the ground section and supply lines of the digital and analog blocks.
Furthermore, for all power supply terminals to ICs, connect a capacitor between the power supply and the GND terminal. When applying electrolytic capacitors in the circuit, note that capacitance characteristic values are reduced at low temperatures.

5) GND voltage
Ground-GND potential should maintain at the minimum ground voltage level. Furthermore, no terminals (except SWOUT) should be lower than the GND potential voltage including an electric transients.

6) Short circuit between terminals and GND or other devices
Pay attention to the assembly direction of the ICs. Wrong mounting direction or shorts between terminals, GND, or other components on the circuits, can damage the IC.

7) Operation in a strong electromagnetic field
Using the ICs in a strong electromagnetic field can cause operation malfunction.

8) Inspection with set PCB
During testing, turn on or off the power before mounting or dismounting the board from the test Jig.
Do not power up the board without waiting for the output capacitors to discharge. The capacitors in the low output impedance terminal can stress the device. Pay attention to the electro static voltages during IC handling, transportation, and storage.

9) 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 breakdown of the input terminal. Therefore, pay thorough attention not to apply a voltage lower than the GND to the input terminals. 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 a voltage lower than the power supply voltage to the input terminals, or a voltage within the guaranteed value of electrical characteristics.

10) Inspection with set PCB

During testing, turn on or off the power before mounting or dismounting the board from the test Jig.
Do not power up the board without waiting for the output capacitors to discharge. The capacitors in the low output impedance terminal can stress the device. Pay attention to the electro static voltages during IC handling, transportation, and storage.

11) 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 breakdown of the input terminal. Therefore, pay thorough attention not to apply a voltage lower than the GND to the input terminals. 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 a voltage lower than the power supply voltage to the input terminals, or a voltage within the guaranteed value of electrical characteristics.

12) Ground wiring pattern

The power supply and ground lines must be as short and thick as possible to reduce line impedance. Fluctuating voltage on the power ground line may damage the device.

13) External capacitor

When using external ceramic capacitors, consider degradation in the nominal capacitance value due to DC bias and changes in the capacitance with temperature.

14) Not connecting input terminals

Unused input terminals should be connected to the power supply or GND line. Open terminals of high impedance CMOS gate can cause unstable states in the logic gate, consequently causing an increase in the power supply current.

15) Thermal shutdown circuit (TSD)

When junction temperatures become 150°C (typ) or higher, the thermal shutdown circuit operates and turns a switch OFF. The thermal shutdown circuit, which is aimed at isolating the LSI from thermal runaway as much as possible, is not aimed at the protection or guarantee of the LSI. Therefore, do not continuously use the LSI with this circuit operating or use the LSI assuming its operation.

16) Thermal design

Use a thermal design that allows for a sufficient margin in light of the power dissipation (Pd) in actual operating conditions.

17) LDO

Use each output of the LDO separately. Do not use in connection with each output.

18) DC/DC converter

Select the low DCR inductors to decrease power loss for the DC/DC converter.

●**Power dissipation characteristics**

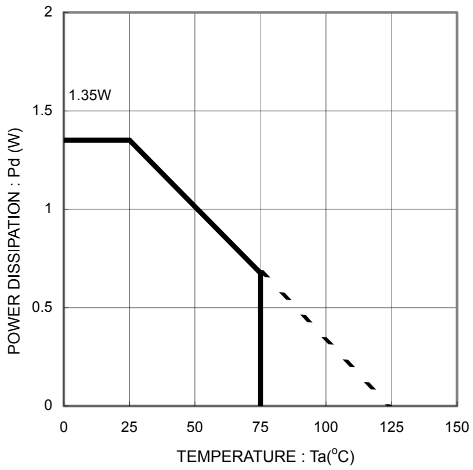



Fig.33 BH6053GU

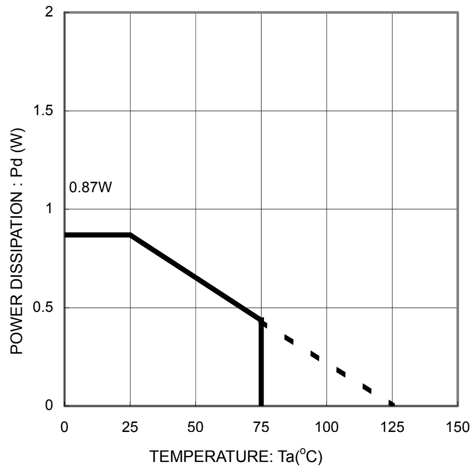



Fig.34 BH6951GU

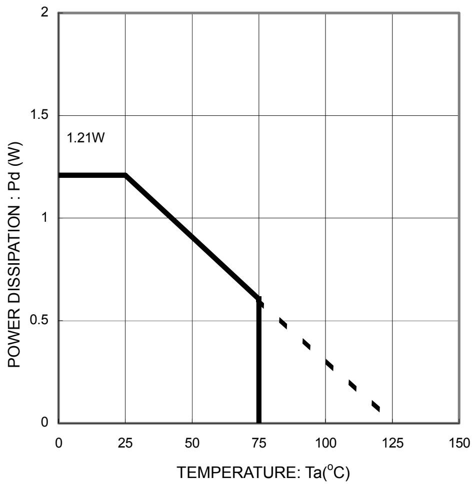
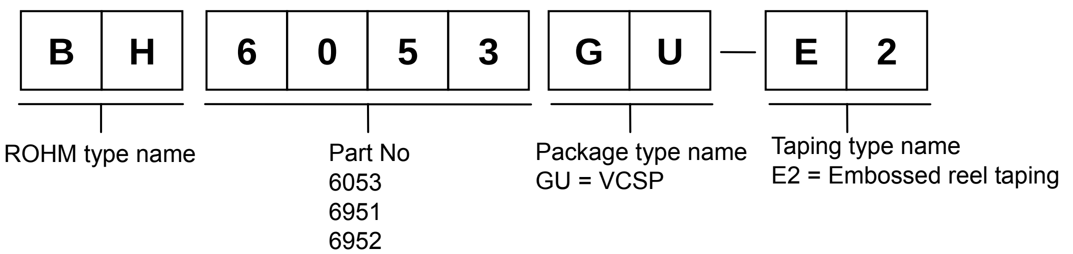



Fig.35 BH6952GU

Mounting board specification
Material Glass epoxy
Size 50mm×58mm×1.75mm (8 layer)

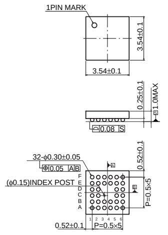
●**Order type name selection**



BH6053GU

## VCSP85H3

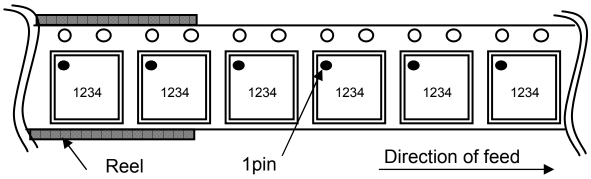
<Dimension>




(Unit:mm)

<Tape and Reel information>

| | |
|---|---|
| Tape | Embossed carrier tape |
| Quantity | 2500pcs |
| Direction of feed | E2<br>(The direction is the 1pin of product is at the upper left when you hold reel on the left hand and you pull out the tape on the right hand) |

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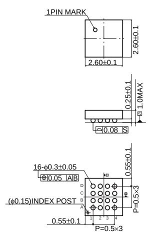
BH6951GU

## VCSP85H2

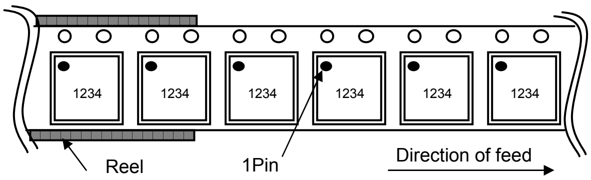
<Dimension>




(Unit:mm)

<Tape and Reel information>

| | |
|---|---|
| Tape | Embossed carrier tape |
| Quantity | 3000pcs |
| Direction of feed | E2<br>(The direction is the 1pin of product is at the upper left when you hold reel on the left hand and you pull out the tape on the right hand) |

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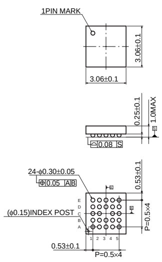
## VCSP85H3

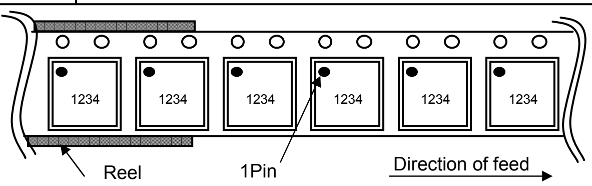
<Dimension>




(Unit:mm)

<Tape and Reel information>

| | |
|---|---|
| Tape | Embossed carrier tape |
| Quantity | 2500pcs |
| Direction of feed | E2<br>(The direction is the 1pin of product is at the upper left when you hold reel on the left hand and you pull out the tape on the right hand) |

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