

## LED Driver Series for Compact LCD Backlight

# Chopper Type White LED Drivers With Synchronous Rectification

## BD6061GUT, BD6063HFN, BD6071HFN, BD6072HFN



### ●Description

The BD6061GUT/BD6063HFN/BD6072HFN are white LED driver ICs with synchronous rectification that can drive 4 series LEDs. With synchronous rectification (no external schottky diode required) and small package, they can save mount space. And the brightness can be adjusted to use PWM pulse on EN pin.

BD6071HFN suited over voltage and over current limit from BD6072HFN for driving 3 white LEDs.

### ●Features

- 1) Synchronous rectification Boost DC/DC converter
- 2) No external schottky diode required
- 3) Driving 4 series white LEDs ( BD6061GUT/BD6063HFN/ BD6072HFN )
- 4) Driving 3 series white LEDs ( BD6071HFN )
- 5) Current overload protection circuit
- 6) Output Open · Short protect
- 7) Thermal shut down
- 8) Adjustment of brightness by external PWM pulse
- 9) CSP 8Pin Small and Thin package (BD6061GUT)
- 10) HSON 8Pin Small and Thin package ( BD6063HFN/BD6071HFN/BD6072HFN )

### ●Applications

White LED Backlight  
Auxiliary light and easy flash of camera for mobile phone

### ●Line up

| Parameter                   | BD6061GUT    | BD6063HFN    | BD6071HFN    | BD6072HFN    |
|-----------------------------|--------------|--------------|--------------|--------------|
| Input voltage range         | 2.7 ~ 5.5V   | 2.7 ~ 5.5V   | 2.7 ~ 5.5V   | 2.7 ~ 5.5V   |
| Switching frequency         | 0.8 ~ 1.2MHz | 0.8 ~ 1.2MHz | 0.8 ~ 1.2MHz | 0.8 ~ 1.2MHz |
| White LED number            | 4            | 4            | 3            | 4            |
| Operating temperature range | -30 ~ +85 °C | -30 ~ +85 °C | -30 ~ +85 °C | -30 ~ +85 °C |
| Package                     | VCSP60N1     | HSON8        | HSON8        | HSON8        |

●Absolute maximum ratings (Ta=25 °C)

| Parameter                   |           | Symbol | Limits            | Unit | Condition          |
|-----------------------------|-----------|--------|-------------------|------|--------------------|
| Maximum applied voltage 1   |           | VMAX1  | 7* <sup>1</sup>   | V    | Vin, EN, VFB, TEST |
| Maximum applied voltage 2   |           | VMAX2  | 20* <sup>1</sup>  | V    | SW, Vout           |
| Power dissipation           | BD6061GUT | Pd     | 800* <sup>2</sup> | mW   |                    |
|                             | BD6063HFN |        | 630* <sup>3</sup> | mW   |                    |
|                             | BD6071HFN |        |                   |      |                    |
|                             | BD6072HFN |        |                   |      |                    |
| Operating temperature range |           | Topr   | −30 ~ +85         | °C   |                    |
| Storage temperature range   |           | Tstg   | −55 ~ +150        | °C   |                    |

\*1 These value are based on GND and GNDA pins.

\*2 50mm×58mm×1.75mm At glass epoxy board mounting. When it's used by more than Ta=25 °C, it's reduced by 6.4mW/°C.

\*3 70mm×70mm×1.6mm At glass epoxy board mounting. When it's used by more than Ta=25 °C, it's reduced by 5.04mW/°C.

●Recommended operating range (Ta=−30 °C ~ +85 °C)

| Parameter            |           | Symbol | Limits |      |      | Unit | Condition |
|----------------------|-----------|--------|--------|------|------|------|-----------|
|                      |           |        | Min.   | Typ. | Max. |      |           |
| Power supply voltage | BD6061GUT | Vin    | 2.7    | 3.6  | 5.5  | V    |           |
|                      | BD6063HFN |        |        |      |      |      |           |
|                      | BD6071HFN |        |        |      |      |      |           |
|                      | BD6072HFN |        |        |      |      |      |           |

●Electrical characteristic

【BD6061GUT】

Unless otherwise specified Ta = −30 ~ +85 °C, Vin=3.6V

| Parameter                   | Symbol | Min. | Typ. | Max. | Unit | Condition                 |
|-----------------------------|--------|------|------|------|------|---------------------------|
| 【EN Terminal】               |        |      |      |      |      |                           |
| EN threshold voltage (Low)  | VthL   | -    | -    | 0.4  | V    |                           |
| EN threshold voltage (High) | VthH   | 1.4  | -    | -    | V    |                           |
| EN terminal input current   | Iin    | -    | 18.3 | 30.0 | μA   | EN=5.5V                   |
| EN terminal output current  | Iout   | −2.0 | −0.1 | -    | μA   | EN=0                      |
| 【Switching regulator】       |        |      |      |      |      |                           |
| Input voltage range         | Vin    | 3.1  | -    | 5.5  | V    |                           |
| Quiescent Current           | Iq     | -    | 0.1  | 2.0  | μA   | EN=0V                     |
| Current Consumption         | Idd    | -    | 4.3  | 5.8  | mA   | EN=2.6V,VFB=1.0V,VIN=3.6V |
| Feedback voltage            | Vfb    | 0.47 | 0.50 | 0.53 | V    |                           |
| Inductor current limit      | Icoil  | 270  | 350  | 430  | mA   | Vin=3.6V **               |
| SW saturation voltage       | Vsat   | -    | 0.3  | 0.8  | V    | Isw=200mA,Vout=13V        |
| SW on resistance P          | Ronp   | -    | 4.0  | 8.0  | Ω    | Ipch=200mA,Vout=13V       |
| Switching frequency         | fSW    | 0.8  | 1.0  | 1.2  | MHz  |                           |
| Duty cycle limit            | Duty   | 82.7 | 85.0 | -    | %    | VFB=0V                    |
| Output voltage range        | Vo     | -    | -    | 18.0 | V    |                           |
| Over voltage limit          | Ovl    | 18.0 | 18.5 | 19.0 | V    | VFB=0V                    |
| Start up time               | Ts     | -    | 0.5  | 1.0  | ms   |                           |

\*\*1 This parameter is tested with dc measurement.

**【BD6063HFN/BD6071HFN/BD6072HFN】**

Unless otherwise specified Ta = +25 °C, Vin=3.6V

| Parameter                    | Symbol | Min. | Typ. | Max. | Unit | Condition                                            |
|------------------------------|--------|------|------|------|------|------------------------------------------------------|
| <b>【EN terminal】</b>         |        |      |      |      |      |                                                      |
| EN threshold voltage (Low)   | VthL   | -    | -    | 0.4  | V    |                                                      |
| EN threshold voltage (High)  | VthH   | 1.4  | -    | -    | V    |                                                      |
| EN terminal input current    | Iin    | -    | 18.3 | 30.0 | μA   | EN=5.5V                                              |
| EN terminal output current   | Iout   | -2.0 | -0.1 | -    | μA   | EN=0                                                 |
| <b>【Switching regulator】</b> |        |      |      |      |      |                                                      |
| Input voltage range          | Vin    | 3.1  | -    | 5.5  | V    |                                                      |
| Quiescent Current            | Iq     | -    | 0.1  | 2.0  | μA   | EN=0V                                                |
| Current Consumption          | Idd    | -    | 4.3  | 5.8  | mA   | EN=2.6V, VFB=1.0V, VIN=3.6V<br>(BD6063HFN)           |
|                              |        | -    | 1.1  | 1.5  |      | EN=2.6V, VFB=1.0V, VIN=3.6V<br>(BD6071HFN/BD6072HFN) |
| Feedback voltage             | Vfb    | 0.45 | 0.50 | 0.55 | V    | (BD6063HFN)                                          |
|                              |        | 0.47 | 0.50 | 0.53 |      | (BD6071HFN/BD6072HFN)                                |
| Inductor current limit       | Icoil  | 270  | 350  | 430  | mA   | Vin=3.6V <sup>*1</sup><br>(BD6063HFN/BD6072HFN)      |
|                              |        | 200  | 265  | 330  |      | Vin=3.6V <sup>*1</sup><br>(BD6071HFN)                |
| SW saturation voltage        | Vsat   | -    | 0.3  | 0.8  | V    | Isw=200mA, Vout=13V<br>(BD6063HFN)                   |
|                              |        | -    | 0.14 | 0.28 |      | Isw=200mA, Vout=13V<br>(BD6071HFN/BD6072HFN)         |
| SW on resistance P           | Ronp   | -    | 4.0  | 8.0  | Ω    | Ipch=200mA, Vout=13V<br>(BD6063HFN)                  |
|                              |        | -    | 2.1  | 3.2  |      | Ipch=200mA, Vout=13V<br>(BD6071HFN/BD6072HFN)        |
| Switching frequency          | fSW    | 0.8  | 1.0  | 1.2  | MHz  |                                                      |
| Duty cycle limit             | Duty   | 82.7 | 85.0 | -    | %    | VFB=0V                                               |
| Output voltage range         | Vo     | -    | -    | 18.0 | V    | (BD6063HFN/BD6072HFN)                                |
|                              |        |      |      | 14.0 |      | (BD6071HFN)                                          |
| Over voltage limit           | Ovl    | 18.0 | 18.5 | 19.0 | V    | VFB=0V<br>(BD6063HFN/BD6072HFN)                      |
|                              |        | 14.0 | 14.5 | 15.0 |      | VFB=0V<br>(BD6071HFN)                                |
| Start up time                | Ts     | -    | 0.5  | 1.0  | ms   |                                                      |

<sup>\*1</sup> This parameter is tested with dc measurement.

●Typical characteristics

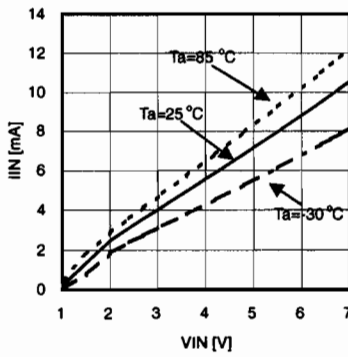


Fig.1

Current Consumption vs power source voltage  
BD6061GUT/BD6063HFN

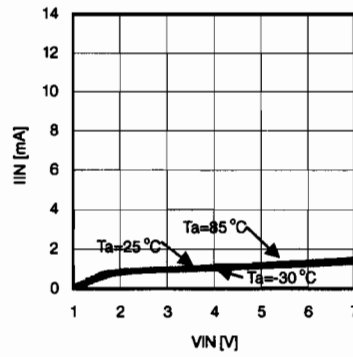


Fig.2

Current Consumption vs power source voltage  
BD6071HFN/BD6072HFN

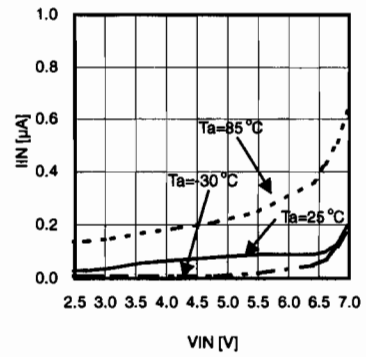


Fig.3

Quiescent current vs power source voltage  
BD6061GUT/BD6063HFN

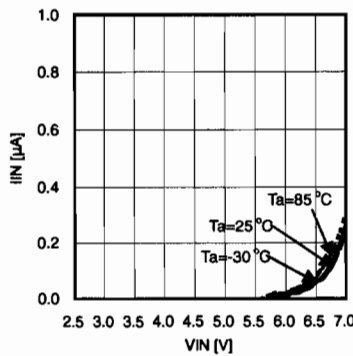


Fig.4

Quiescent current vs power source voltage  
BD6071HFN/BD6072HFN

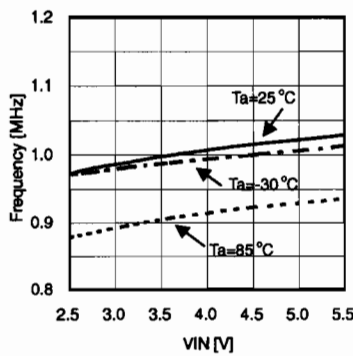


Fig.5

Oscillation frequency vs power source voltage  
BD6061GUT/BD6063HFN

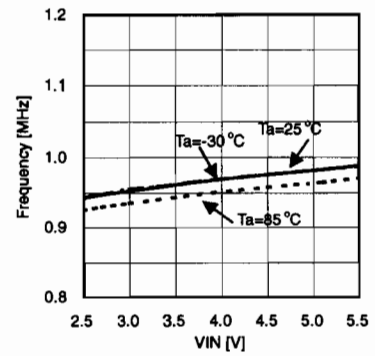


Fig.6

Oscillation frequency vs power source voltage  
BD6071HFN/BD6072HFN

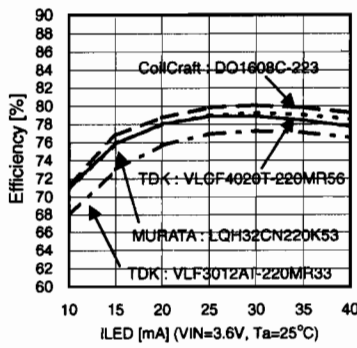


Fig.7

Efficiency vs LED current in each coil  
(2LED=VOUT7.5V)  
BD6061GUT/BD6063HFN

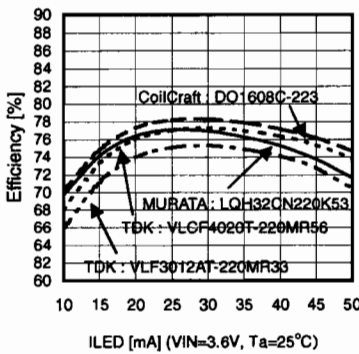


Fig.8

Efficiency vs LED current in each coil  
(3LED=VOUT10.5V)  
BD6061GUT/BD6063HFN

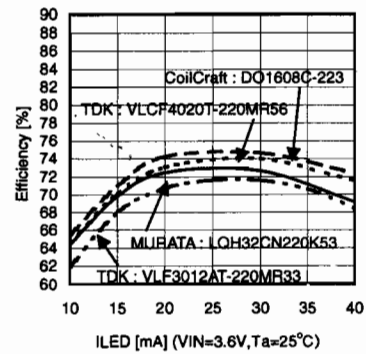


Fig.9

Efficiency vs LED current in each coil  
(4LED=VOUT14V)  
BD6061GUT/BD6063HFN

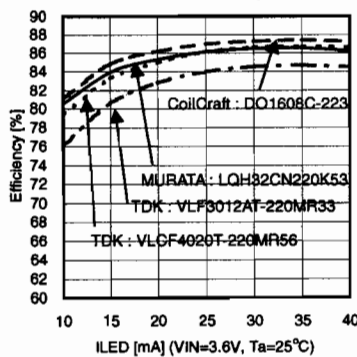


Fig.10

Efficiency vs LED current in each coil  
(2LED=VOUT7.5V)  
BD6071HFN

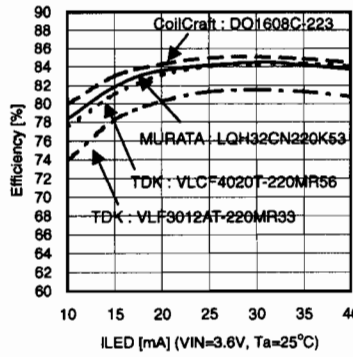


Fig.11

Efficiency vs LED current in each coil  
(3LED=VOUT10.5V)  
BD6071HFN

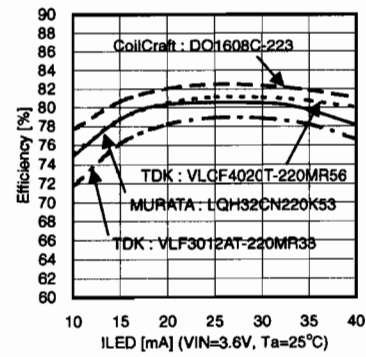


Fig.12

Efficiency vs LED current in each coil  
(4LED=VOUT14V)  
BD6072HFN

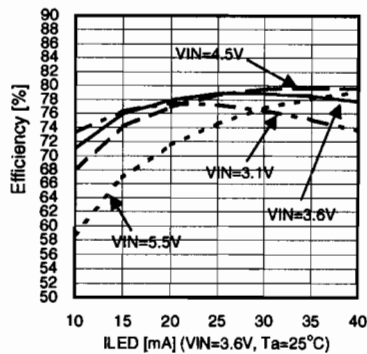


Fig.13 Efficiency vs LED current  
(2LED=VOUT7.5V)  
BD6061GUT/BD6063HFN

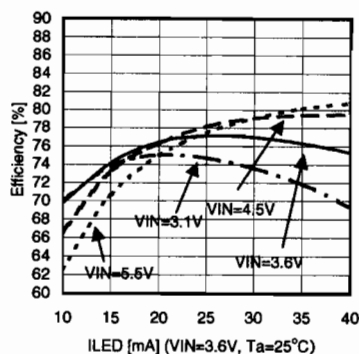


Fig.14 Efficiency vs LED current  
(3LED=VOUT10.5V)  
BD6061GUT/BD6063HFN

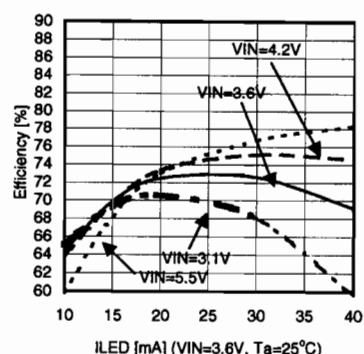


Fig.15 Efficiency vs LED current  
(4LED=VOUT14V)  
BD6061GUT/BD6063HFN

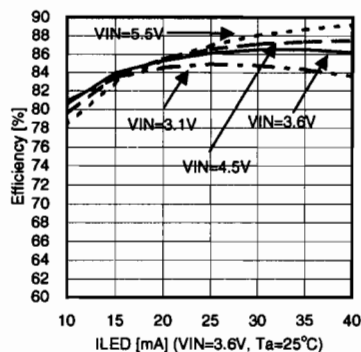


Fig.16 Efficiency vs LED current  
(2LED=VOUT7.5V)  
BD6071HFN

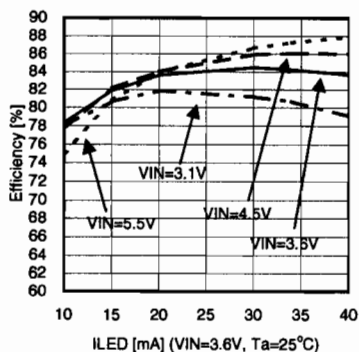


Fig.17 Efficiency vs LED current  
(3LED=VOUT10.5V)  
BD6071HFN

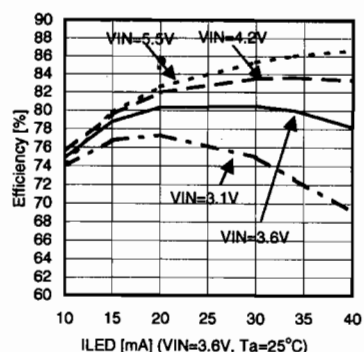


Fig.18 Efficiency vs LED current  
(4LED=VOUT14V)  
BD6072HFN

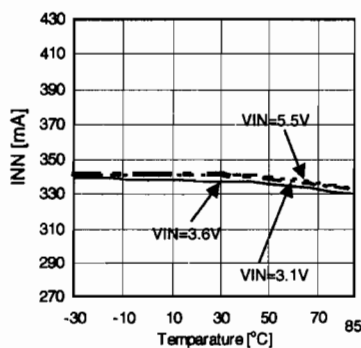


Fig.19  
Inductor current limit vs temperature  
BD6061GUT/BD6063HFN

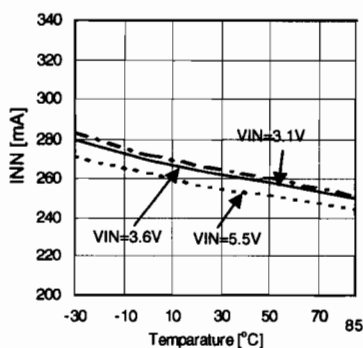


Fig.20  
Inductor current limit vs temperature  
BD6071HFN

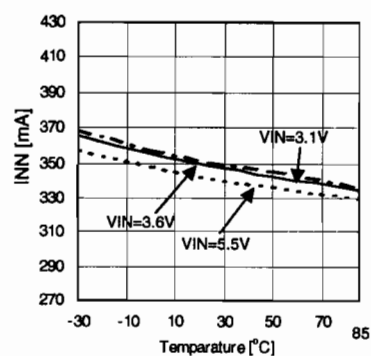


Fig.21  
Inductor current limit vs temperature  
BD6072HFN

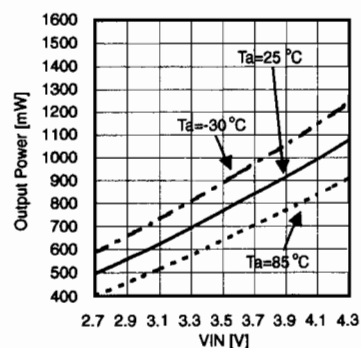


Fig.22  
Output power vs power source voltage  
BD6061GUT/BD6063HFN

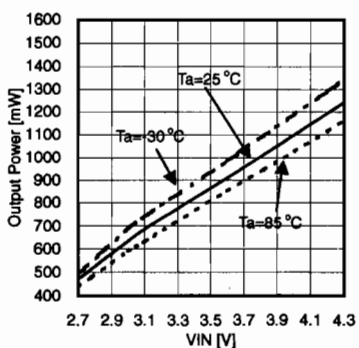


Fig.23  
Output power vs power source voltage  
BD6071HFN

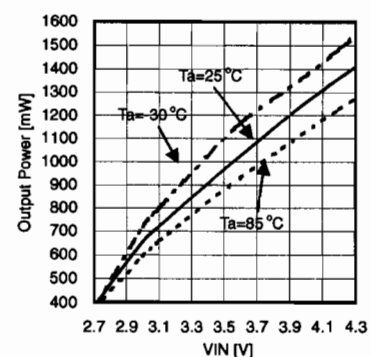


Fig.24  
Output power vs power source voltage  
BD6072HFN

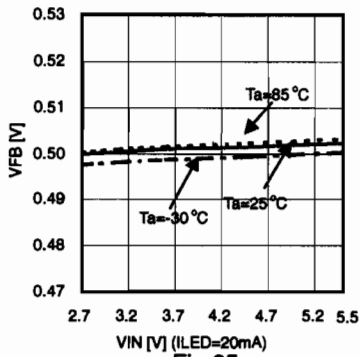


Fig.25

Feedback voltage vs power source voltage  
BD6061GUT/BD6063HFN

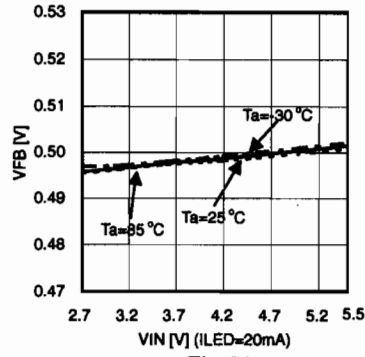
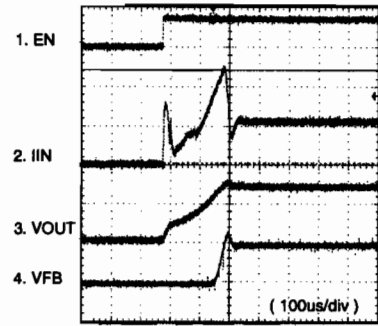


Fig.26

Feedback voltage vs power source voltage  
BD6071HFN/BD6072HFN

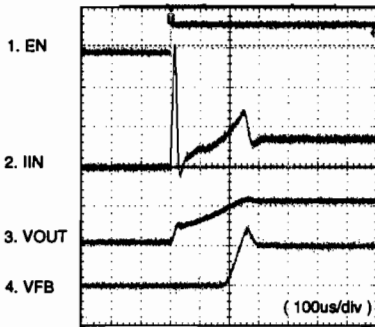


( VIN = 3.6V, Ta = 25 °C, 4LED, 20mA Load )

Fig.27 Soft Start

BD6061GUT/BD6063HFN

1. EN 5V/div DC  
2. IIN 100mA/div DC  
3. VOUT 10V/div DC  
4. VFB 0.5V/div DC



( VIN = 3.6V, Ta = 25 °C, 3LED, 20mA Load )

Fig.28 Soft Start

BD6071HFN

1. EN 5V/div DC  
2. IIN 100mA/div DC  
3. VOUT 10V/div DC  
4. VFB 0.5V/div DC

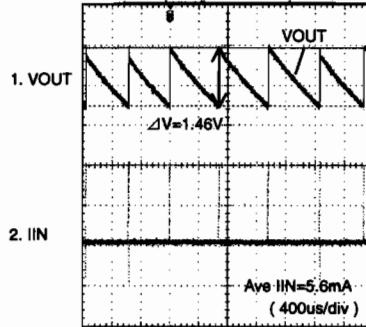


Fig.29 LED Open output voltage

BD6061GUT/BD6063HFN

1. VOUT 1V/div AC  
2. IIN 200mA/div DC

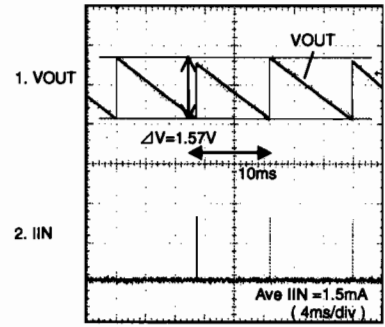
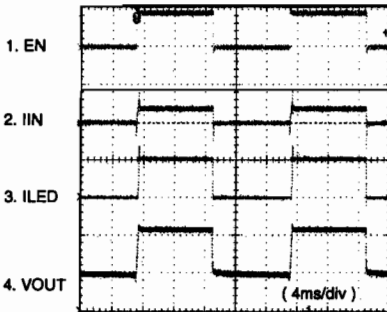


Fig.30 LED Open output voltage

BD6071HFN/BD6072HFN

1. VOUT 1V/div AC  
2. IIN 200mA/div DC

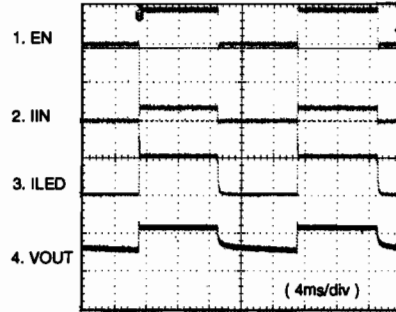


( VIN = 3.6V, Ta = 25 °C, 3LED, 20mA Load )

Fig.31 LED luminance adjustment

BD6061GUT/BD6063HFN

1. EN 2V/div DC  
2. IIN 200mA/div DC  
3. ILED 20mA/div DC  
4. VOUT 5V/div DC



( VIN = 3.6V, Ta = 25 °C, 3LED, 20mA Load )

Fig.32 LED luminance adjustment

BD6071HFN/BD6072HFN

1. EN 2V/div DC  
2. IIN 200mA/div DC  
3. ILED 20mA/div DC  
4. VOUT 5V/div DC

●Block diagram, recommended circuit example, pin location diagram

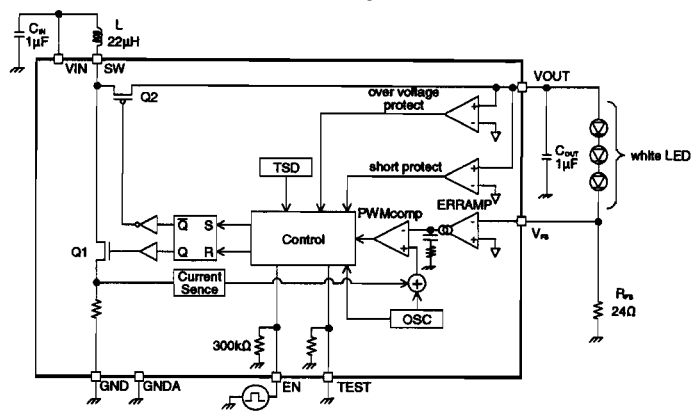


Fig.33 Block diagram and recommended circuit diagram

【BD6061GUT】

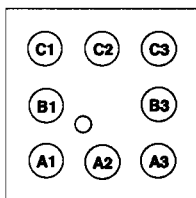


Fig.34 Pin location diagram VCSP60N1 ( 8 pin )

【BD6063HFN, BD6071HFN, BD6072HFN】

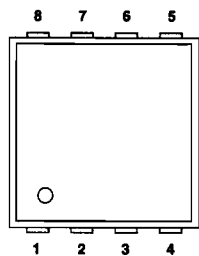


Fig.35 Pin location diagram HSON8 ( 8 pin )

●Pin assignment table

| PIN Name | In/Out | PIN number |           |                        | Function                                                  |
|----------|--------|------------|-----------|------------------------|-----------------------------------------------------------|
|          |        | BD6061GUT  | BD6063HFN | BD6071HFN<br>BD6072HFN |                                                           |
| GNDA     | -      | A1         | 2         | 1                      | Analog GND                                                |
| EN       | In     | A2         | 1         | 2                      | Enable control<br>(pull down is integrated on resistance) |
| TEST     | In     | A3         | 5         | 3                      | TEST input<br>(pull down is integrated on resistance)     |
| VIN      | In     | B1         | 3         | 8                      | Power supply input                                        |
| VFB      | In     | B3         | 4         | 4                      | Feedback input voltage                                    |
| VOUT     | Out    | C1         | 8         | 7                      | Output                                                    |
| SW       | In     | C2         | 7         | 6                      | Switching terminal                                        |
| GND      | -      | C3         | 6         | 5                      | Power GND                                                 |

●Operation

BD6061GUT/BD6063HFN/BD6071HFN/BD6072HFN is a fixed frequency PWM current mode DC/DC converter, and adopts a synchronous rectification architecture. As for the inputs of the PWM comparator as the feature of the PWM current mode, one is overlapped with error components from the error amplifier, and the other is overlapped with a current sense signal that controls the inductor current into Slope waveform for sub harmonic oscillation prevention. This output controls Q1 and Q2 via the RS latch.

Timing of Q1 and Q2 is precisely adjusted so that they will not turn ON at the same time, thus putting them into non-overlapped relation.

In the period where Q1 is ON, energy is accumulated in the external inductor, and in the period where Q1 is OFF, energy is transferred to the capacitor of VOUT via Q2.

Further, BD6061GUT/BD6063HFN/BD6071HFN/BD6072HFN has many safety functions, and their detection signals stop switching operation at once.

## ●Description of Functions

### 1) Soft start and off status

BD6061GUT/BD6063HFN/BD6071HFN/BD6072HFN has soft start function and off status function.

The soft start function and the off status function prevent large current from flowing to the IC via coil.

Occurrence of rush current at turning on is prevented by the soft start function, and occurrence of invalid current at turning off is prevented by the off status function.

### 2) Isolation control

BD6061GUT/BD6063HFN/BD6071HFN/BD6072HFN has isolation control to prevent LED wrong lighting at power off. The cause of the LED wrong lighting is leak current from VIN to the white LED.

Therefore, when BD6061GUT/BD6063HFN/BD6071HFN/BD6072HFN gets in power off (EN = L), the isolation control cuts the DC path between SW and Vout, thereby the leak current from VIN to LED is prevented.

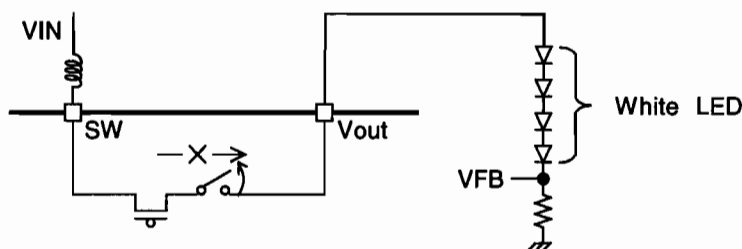


Fig.36 Isolation control

### 3) Shortcircuit protection and over voltage protection

BD6061GUT/BD6063HFN/BD6071HFN/BD6072HFN has shortcircuit protection and over voltage protection. These detect the voltage of VOUT, and at error, they stop the output Tr. Details are as shown below.

#### • Shortcircuit protection

In the case of shortcircuit of the DC/DC output (VOUT) to GND, the coil or the IC may be destructed.

Therefore, at such an error as VOUT becoming 0.7V or below, the Under Detector shown in the figure works, and turns off the output Tr, and prevent the coil and the IC from being destructed.

And the IC changes from its action condition into its non action condition, and current does not flow to the coil (0mA).

#### • Over voltage protection

At such an error as the IC and the LED being cut off, over voltage causes the SW terminal and the VOUT terminal exceed the absolute maximum ratings, and may destruct the IC. Therefore, when VOUT becomes

18.5V(BD6061GUT/BD6063HFN/BD6072HFN), 14.5V(BD6071HFN) or higher, the over voltage limit works, and turns off the output Tr, and prevents the SW terminal and the VOUT terminal from exceeding the absolute maximum ratings.

At this moment, the IC changes from its action condition into its non action condition, and the output voltage goes down slowly. And, when the output voltage becomes the hysteresis of the over voltage limit or below, the output voltage goes on up to 18.5V(BD6061GUT/BD6063HFN/BD6072HFN), 14.5V(BD6071HFN) once again.

This protection action is shown in Fig.37.

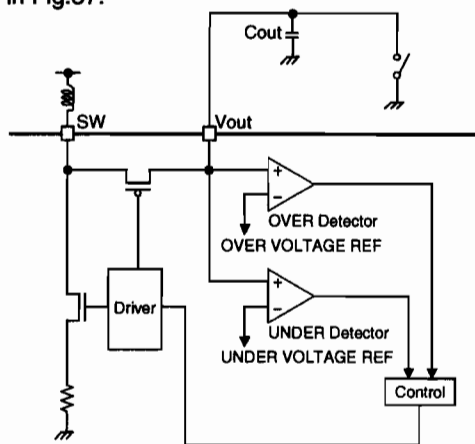


Fig.37 Block diagram of shortcircuit protection and over voltage

### 4) Thermal shut down

BD6061GUT/BD6063HFN/BD6071HFN/BD6072HFN has thermal shut down function.

The thermal shut down works at 175°C or higher, and while holding the setting of EN control from the outside, the IC changes from its action condition into its non action condition. And at 175°C or below, the IC gets back to its normal action.



## ●Start control and brightness control

BD6061GUT/BD6063HFN/BD6071HFN/BD6072HFN can control the start conditions by its EN terminal, and power off at 0.4V or below, and power on at 1.4V or higher. And by changing the duty of power on and off by PWM control, the LED brightness can be adjusted.

Two techniques are available for the brightness adjustment. One is discrete time (PWM) adjustment, and the other is continuous time adjustment.

(1) PWM brightness adjustment is made by giving PWM signal to EN as shown in Fig.38.

The BD6061GUT/BD6063HFN/BD6071HFN/BD6072HFN power on/off is according to the PWM signal. By this method, LED current is controlled from 0 to the maximum current. The average LED current increases in proportion with the duty cycle of PWM signal. While in PWM off-cycle mode, the IC and LED both consume no currents, thus providing a high-efficiency operation. And please don't use duty less than 5% or more than 95% of current setting for the brightness adjustment because of the influence of turning on and off operating is large. The recommended PWM frequency is 100Hz ~ 300Hz.

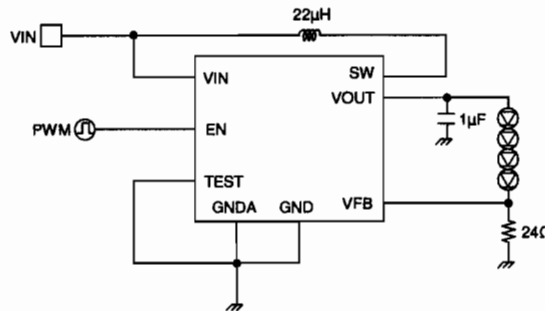


Fig.38 The brightness adjustment example of EN terminal by PWM (fPWM = 100 ~ 300Hz)

(2) The continuous time the brightness adjustment is made by giving DC control voltage to VFB pin of BD6061GUT/BD6063HFN/BD6071HFN/BD6072HFN via a series resistor as shown in Fig.39. LED luminance (current) changed by giving DC voltage to VFB directly. DC voltage is given from filtered one of DAC signal, or PWM signal shown in Fig.41. The advantage of this approach is that the PWM signal to be used to control the LED brightness can be set to a high frequency (1kHz or higher). And please don't use duty less than 5% or more than 95% of current setting for the brightness adjustment.

LED current (ILED) is approximated by the following equation.

$$I_{LED} = \left[ \frac{(V_{FB} - DAC)}{R1} \right] \cdot R2 + V_{FB} / R_{FB}$$

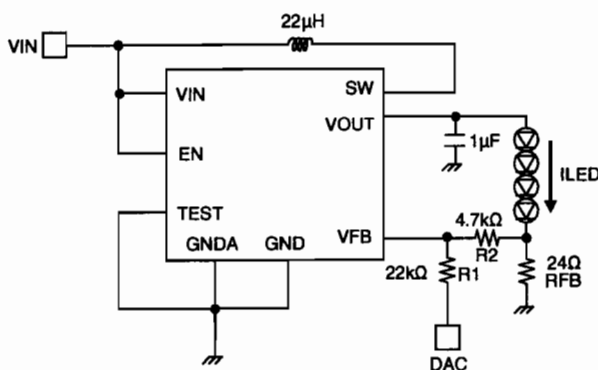


Fig.39 The brightness adjustment example by DAC

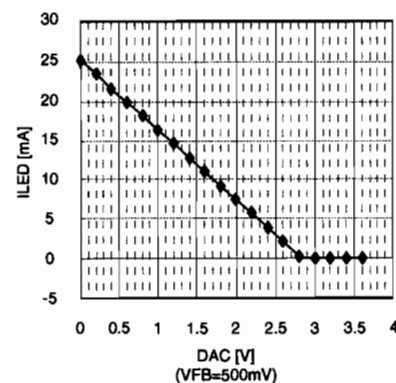


Fig.40 DAC adjustment

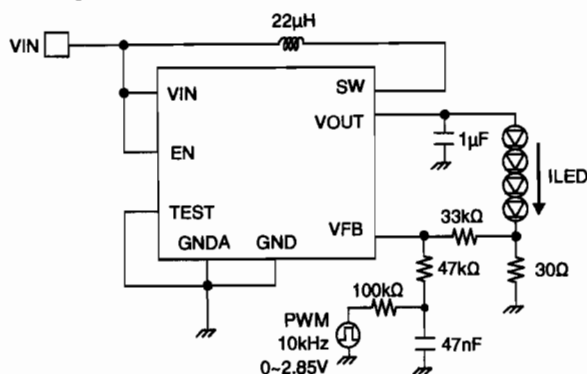


Fig.41 The brightness adjustment example of VFB terminal by PWM (fPWM = 10kHz)

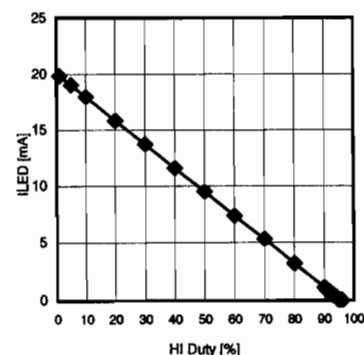


Fig.42 VFB PWM Control

2-2) The brightness adjustment of below is done in adjusting of R2 ON time by R1 and Duty cycle of PWM.  
The minimum value of the LED current is decided by  $V_{FB} / R_1$  at the PWM 0%, the maximum value of the LED current is decided by  $V_{FB} / R_2$  at the PWM 100%.  
 $I_{LED}$  is given as shown below.

$$I_{LED} = V_{FB} / R_1 + V_{FB} / R_2 \times \text{HI Duty}$$

Standard PWM frequency is 100Hz~1kHz. And please don't use duty less than 5% or more than 95% of current setting for the brightness adjustment.

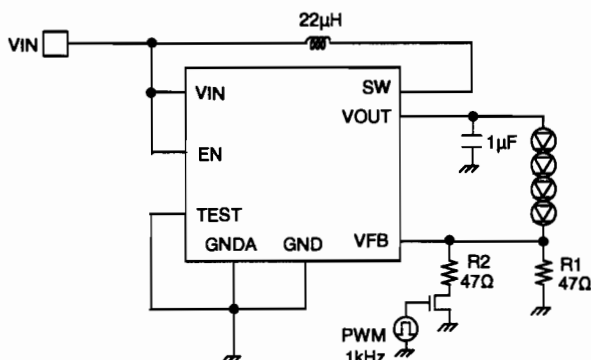


Fig.43 The brightness adjustment example of VFB terminal by PWM  
( $f_{PWM}=100\sim 1\text{kHz}$ )

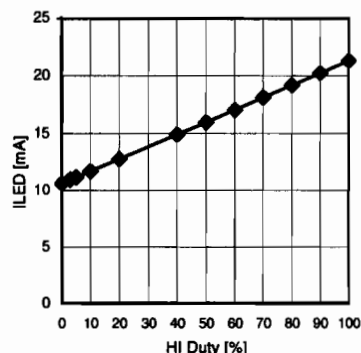


Fig.44 VFB PWM Control

#### ●Setting range of LED current

LED current is determined by the voltage of VFB and the resistor connected to VFB terminal.

$I_{LED}$  is given as shown below.

$$I_{LED} = V_{FB} / R_{FB}$$

The current in the standard application is as shown below.

$$V_{FB} = 0.5\text{V}, R_{FB} = 24\Omega$$

$$I_{LED} = 20.8\text{mA}$$

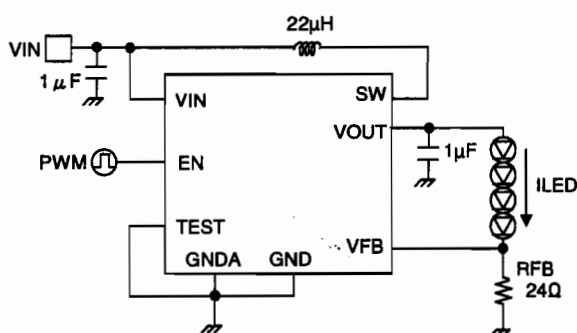


Fig.45 Standard application

The shaded portion in the figure below is the setting range of LED current to become the standard. Depending on coils and white LEDs to be used, however, some ICs may not be used at desired currents. Consequently, for the proper setting of LED current, thoroughly check it for the suitability under use conditions including applicable power supply voltage and temperature.

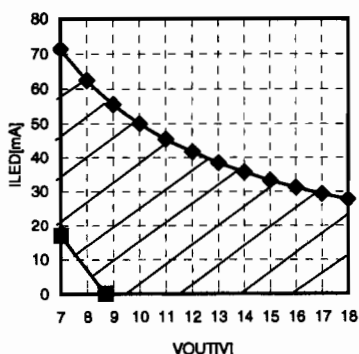


Fig.46 Setting range of LED current  
BD6061GUT/BD6063HFN/BD6072HFN

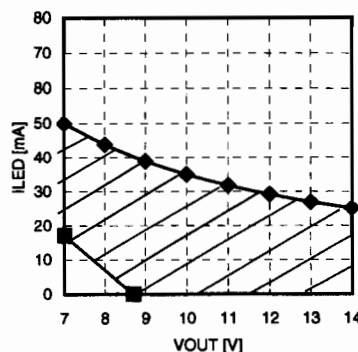


Fig.47 Setting range of LED current  
BD6071HFN

●Selection of external parts

Recommended external parts are as shown below.

When to use other parts than these, select the following equivalent parts.

• Coil

| Value | Tolerance | Manufacturer | Product number   | Size             |                    |        | DCR<br>(Ω) |
|-------|-----------|--------------|------------------|------------------|--------------------|--------|------------|
|       |           |              |                  | Vertical<br>size | Horizontal<br>size | Height |            |
| 22μH  | ±10%      | MURATA       | LQH32CN220K53    | 2.5              | 3.2                | 1.55   | 0.71       |
| 22μH  | ±20%      | TDK          | VLF3012AT220MR33 | 2.6              | 2.8                | 1.2    | 0.66       |
| 22μH  | ±20%      | Coil Craft   | DO1608           | 4.45             | 6.6                | 2.92   | 0.37       |
| 22μH  | ±20%      | TDK          | VLF3010AT220MR33 | 2.6              | 2.8                | 1.0    | 1.30       |

Please refer to the reference data of p.4 ~ 5 for the change in the efficiency when the coil is changed.

• Capacitor

| Value    | Manufacturer | Product number    | Size          |                 |        | Temperature range |
|----------|--------------|-------------------|---------------|-----------------|--------|-------------------|
|          |              |                   | Vertical size | Horizontal size | Height |                   |
| 【 CIN 】  |              |                   |               |                 |        |                   |
| 1μF      | MURATA       | GRM188B10J105KA01 | 1.6           | 0.8             | 0.8    | −25deg ~ +85deg   |
| 【 COUT 】 |              |                   |               |                 |        |                   |
| 1μF      | MURATA       | GRM188B10J105KA75 | 1.6           | 0.8             | 0.8    | −25deg ~ +85deg   |

• Resistor

| Value               | Tolerance | Manufacturer | Product number | Size          |                 |        |
|---------------------|-----------|--------------|----------------|---------------|-----------------|--------|
|                     |           |              |                | Vertical size | Horizontal size | Height |
| 【 R <sub>FB</sub> 】 |           |              |                |               |                 |        |
| 24Ω                 | ±1%       | ROHM         | MCR006YZPF24R0 | 0.6           | 0.3             | 0.23   |

The coil is the part that is most influential to efficiency. Select the coil whose direct current resistor (DCR) and current - inductance characteristic is excellent. The BD6061GUT /BD6063HFN/BD6071HFN/BD6072HFN are designed for the inductance value of 22μH. Do not use other inductance value. Select a capacitor of ceramic type with excellent frequency and temperature characteristics. Further, select Capacitor to be used for CIN/COUT with small direct current resistance, and pay sufficient attention to the layout pattern shown in the next page.

## ●Layout

In order to make the most of the performance of this IC, its layout pattern is very important. Characteristics such as efficiency and ripple and the likes change greatly with layout patterns, which please note carefully.

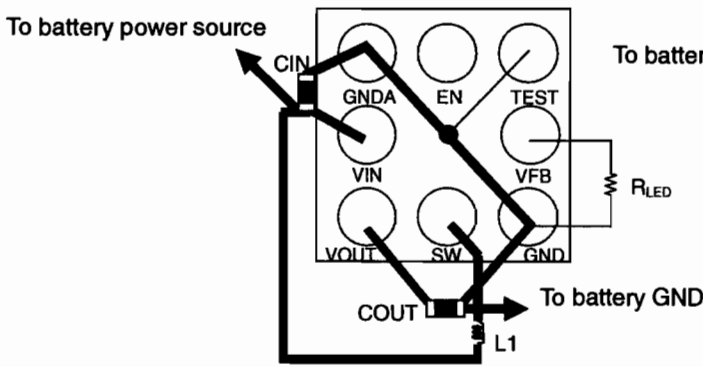


Fig.48 BD6061GUT

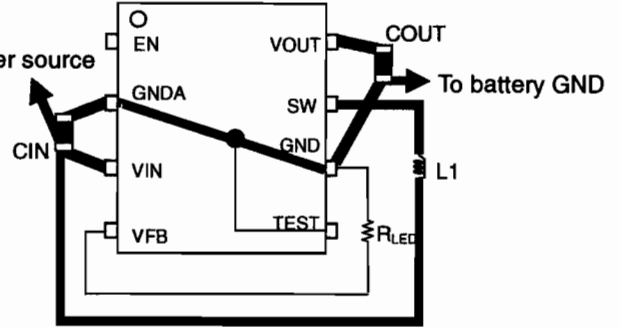


Fig.49 BD6063HFN

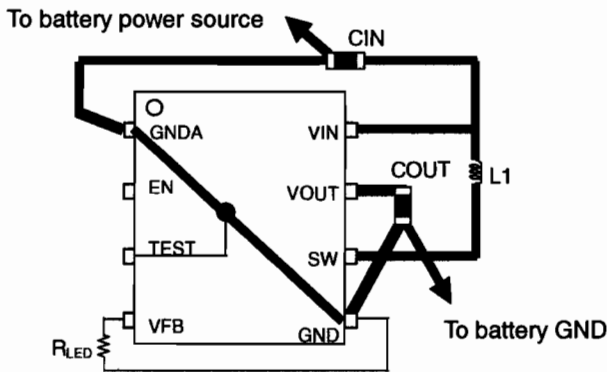
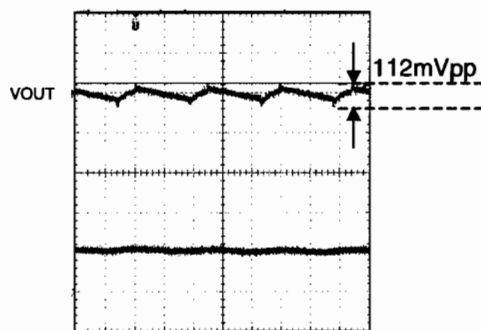


Fig.50 BD6071HFN/BD6072HFN

Connect the input bypass capacitor CIN nearest to between VIN and GNDA pin, as shown in the upper diagram. Thereby, the input voltage ripple of the IC can be reduced. And, connect the output capacitor COUT nearest to between VOUT and GND pin. Thereby, the output voltage ripple of the IC can be reduced. Connect the current setting RLED nearest to FB pin. Connect the GND connection side of RLED directly to GND pin. Connect the GNDA pin directly to GND pin. When those pins are not connected directly near the chip, influence is given to the performance of BD6061GUT/BD6063HFN/BD6071HFN/BD6072HFN, and may limit the current drive performance. As for the wire to the inductor, make its resistance component small so as to reduce electric power consumption and increase the entire efficiency. And keep the pins that are subject to the influence like FB pin away from the wire to SW.

The layout pattern in consideration of these is shown in the next page.



(VBAT=3.6V, Ta=25 °C, VOUT=14V, 20mA Load)

Fig.51 Output noise

●Recommended layout pattern

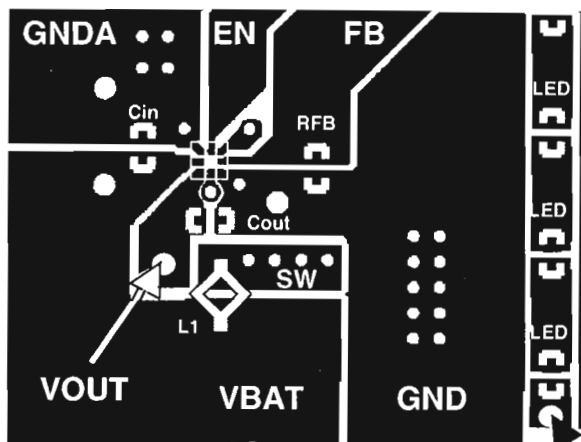


Fig.52 BD6061GUT Frontal surface (TOP VIEW)

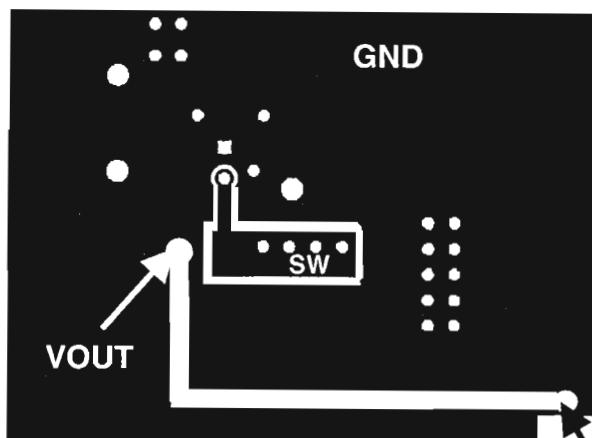


Fig.53 BD6061GUT Rear surface (TOP VIEW)

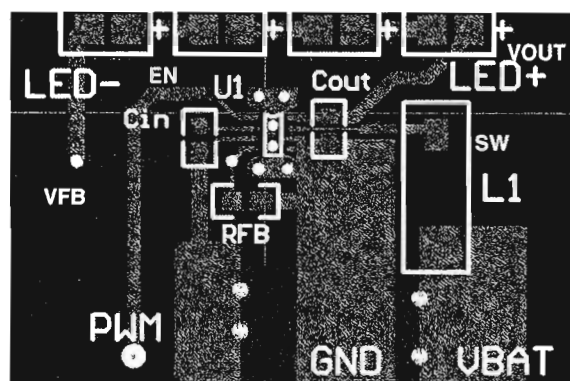


Fig.54 BD6063HFN Frontal surface (TOP VIEW)

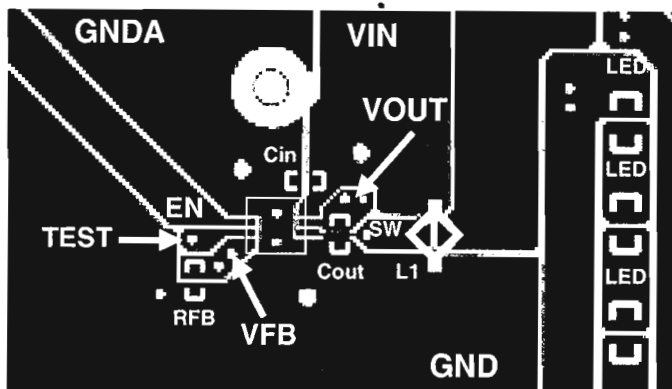


Fig.55 BD6071HFN/BD6072HFN Frontal surface (TOP VIEW)

●Attention point of board layout

In board pattern design, the wiring of power supply line should be low Impedance, and put the bypass capacitor if necessary. Especially the wiring impedance must be lower around the DC/DC converter.

●About heat loss

In heat design, operate the DC/DC converter in the following condition.

(The following temperature is a guarantee temperature, so consider the margin.)

1. Periphery temperature  $T_a$  must be less than  $85^{\circ}\text{C}$ .
2. The loss of IC must be less than dissipation  $P_d$ .

●Cautions on use

( 1 ) Absolute Maximum Ratings

An excess in the absolute maximum ratings, such as supply voltage, temperature range of operating conditions, 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 ) Operating conditions

These conditions represent a range within which characteristics can be provided approximately as expected. The electrical characteristics are guaranteed under the conditions of each parameter.

( 3 ) Reverse connection of power supply connector

The reverse connection of power supply connector can break down ICs. Take protective measures against the breakdown due to the reverse connection, such as mounting an external diode between the power supply and the IC's power supply terminal.

( 4 ) Power supply line

Design PCB pattern to provide low impedance for the wiring between the power supply and the GND lines. In this regard, for the digital block power supply and the analog block power supply, even though these power supplies has the same level of potential, separate the power supply pattern for the digital block from that for the analog block, thus suppressing the diffraction of digital noises to the analog block power supply resulting from impedance common to the wiring patterns. For the GND line, give consideration to design the patterns in a similar manner.

Furthermore, for all power supply terminals to ICs, mount a capacitor between the power supply and the GND terminal. At the same time, in order to use an electrolytic capacitor, thoroughly check to be sure the characteristics of the capacitor to be used present no problem including the occurrence of capacity dropout at a low temperature, thus determining the constant.

( 5 ) 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.

( 6 ) 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.

( 7 ) Operation in strong electromagnetic field

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

( 8 ) 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.

( 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 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.

( 10 ) Ground wiring pattern

If small-signal GND and large-current GND are provided, It will be recommended to separate the large-current GND pattern from the small-signal GND pattern and establish a single ground at the reference point of the set PCB so that resistance to the wiring pattern and voltage fluctuations due to a large current will cause no fluctuations in voltages of the small-signal GND. Pay attention not to cause fluctuations in the GND wiring pattern of external parts as well.

( 11 ) External capacitor

In order to use a ceramic capacitor as the external capacitor, determine the constant with consideration given to a degradation in the nominal capacitance due to DC bias and changes in the capacitance due to temperature, etc.

( 12 ) Thermal shutdown circuit (TSD)

When junction temperatures become 175°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.

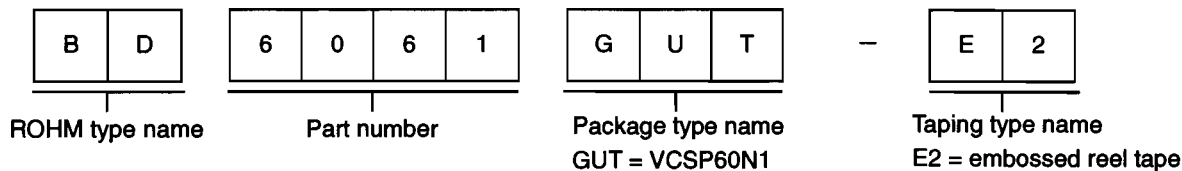
( 13 ) Thermal design

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

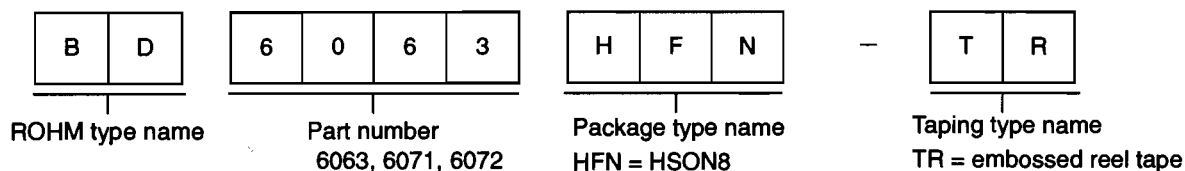
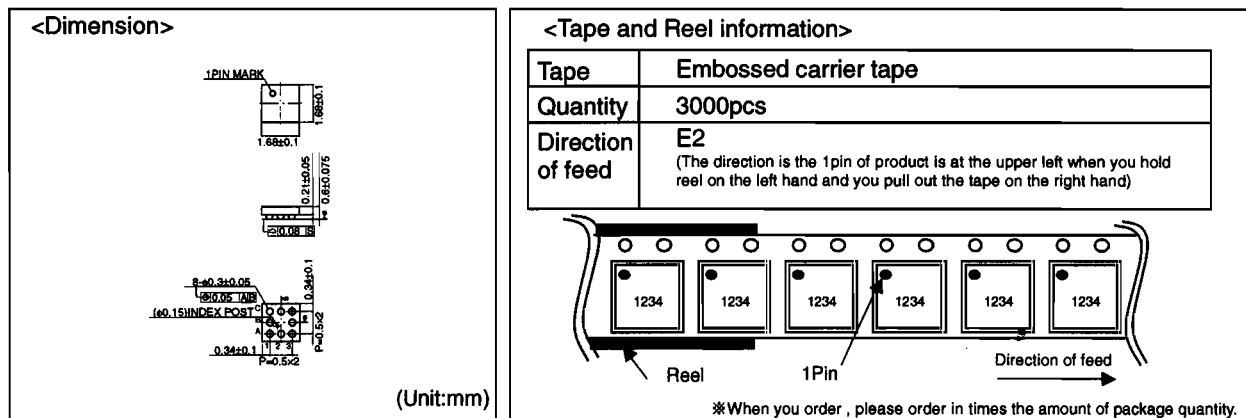
( 14 ) Selection of coil

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

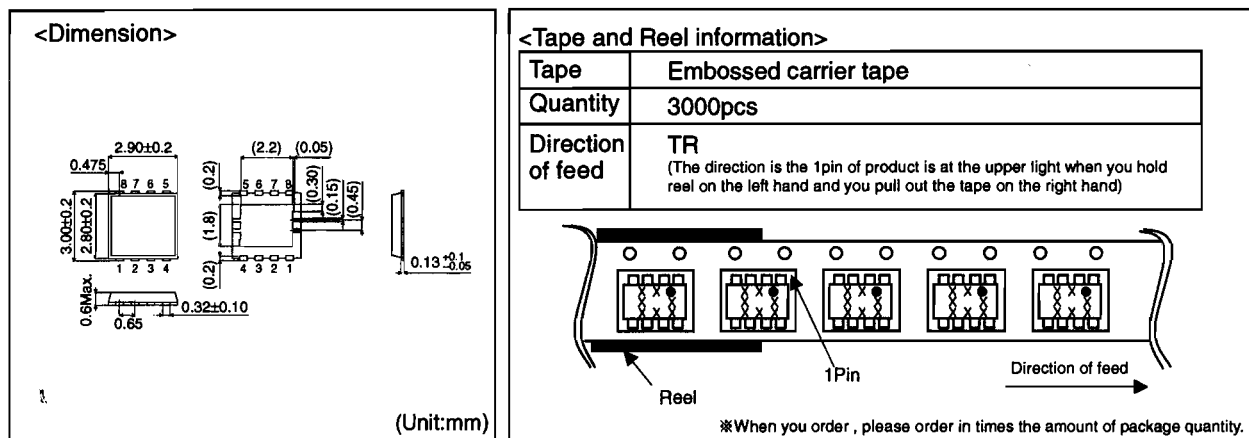
●Order type name selection



## VCSP60N1



## HSON8



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