System LED Drivers for Mobile Phones

# Charge Pump type for Flash

## BD7700GU

No.11041EAT19

## ●Description

BD7700GU is a maximum of 300mA LED flash (three-channel total) driver IC. Flash mode and torch mode are controllable by two external control signals. The flash mode timer ability for a maximum of 1s is carried, and management of flash lighting time is easy and safe.

## ●Features

1) Current regulation for LED
2) 3ch High side current Driver
3) Flash LED High side Current driver (Max 100mA@1ch)
4) Torch LED High side Current driver (Max 20mA@1ch)
5) Indicate LED High side Current driver (Max 1mA)
6) High efficiency up to 80%
7) 2port control Flash and Torch and Indicate mode
8) Charge pump step-up DC/DC converter (Max 300mA) Three charge pump mode (×1, ×1.5, ×2.0)
9) Automatically transition to each mode
10) Over-voltage protection / In rush current prevention (soft start) / Over current limiter
11) Under Voltage Lockout threshold / Thermal shutdown
12) Small and thin CSP package

## ●Applications

Flash and torch of camera for mobile phone

## ●Absolute Maximum Ratings (Ta=25℃)

| Parameter | Symbol | Ratings | Unit |
|---|---|---|---|
| Maximum applied voltage | VMAX | 7 | V |
| Input voltage | Vdin | GND-0.3 ~ VBAT+0.3 | V |
| Power dissipation | Pd | 1062.5 (Note1) | mW |
| Operating temperature range | Topr | -30 ~ +85 | ℃ |
| Storage temperature range | Tstg | -55 ~ +150 | ℃ |

(Note1) The measurement value, which was mounted on the PCB by ROHM.
Temperature deleting : 8.5mW/℃ from Ta>25℃

## ●Operating conditions (Ta=-30 ~ 85℃)

| Parameter | Symbol | Ratings | Unit |
|---|---|---|---|
| Battery Power Supply voltage | VBAT | 2.7 - 5.5 | V |

●Electrical Characteristics

(Unless otherwise noted, Ta = 25℃, VBAT=3.6V)

| Parameter | Symbol | Limits | | | Units | Condition |
|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | | |
| **Logic control terminal** | | | | | | |
| Low threshold voltage | VthL2 | - | - | 0.4 | V | CNT0 and CNT1 port |
| High threshold voltage | VthH2 | 1.2 | - | - | V | CNT0 and CNT1 port |
| High level Input current | IinH2 | - | 18.3 | 33 | μA | CNT0 or CNT1 = 5.5V |
| Low level Input current | IinL2 | -1 | 0 | - | μA | CNT0 or CNT1 = 0V |
| **DC/DC Converter** | | | | | | |
| Quiescent Current | Iq | - | 0.1 | 1.0 | μA | CNT0 and CNT1 = ‘0’ |
| Flash Current Accuracy | Iflash | -15 | 0 | 15 | % | 100mA |
| Torch Current Accuracy | Itorch | -15 | 0 | 15 | % | 20mA |
| Indicate Current Accuracy | Iind | -30 | 0 | 30 | % | 1mA,LED2 Terminal |
| Current Consumption 1 | Idd1 | - | 1.0 | 2.0 | mA | X1.0 mode, LED current = 0mA |
| Current Consumption 2 | Idd2 | - | 6.0 | 9.0 | mA | X1.5 mode, LED current = 0mA |
| Current Consumption 3 | Idd3 | - | 9.0 | 12.0 | mA | X2.0 mode, LED current = 0mA |
| ISET Voltage | Viset | 0.5 | 0.6 | 0.7 | V | |
| Switching frequency | Fsw | 1.0 | 1.25 | 1.5 | MHz | |
| Sat Voltage | Vsat | 150 | 250 | 350 | mV | VOUT-LED Voltage(VLED=3V) |
| Over voltage protection | Vovp | 5.5 | - | - | V | VOUT Limit |
| Under voltage lock-out | Vuvlo | 1.8 | 2.0 | 2.2 | V | UVLO Detect Voltage |
| Start up time | Tstart | - | - | 3 | ms | Stand by → Torch,Flash,Indicate |

●Package Outline

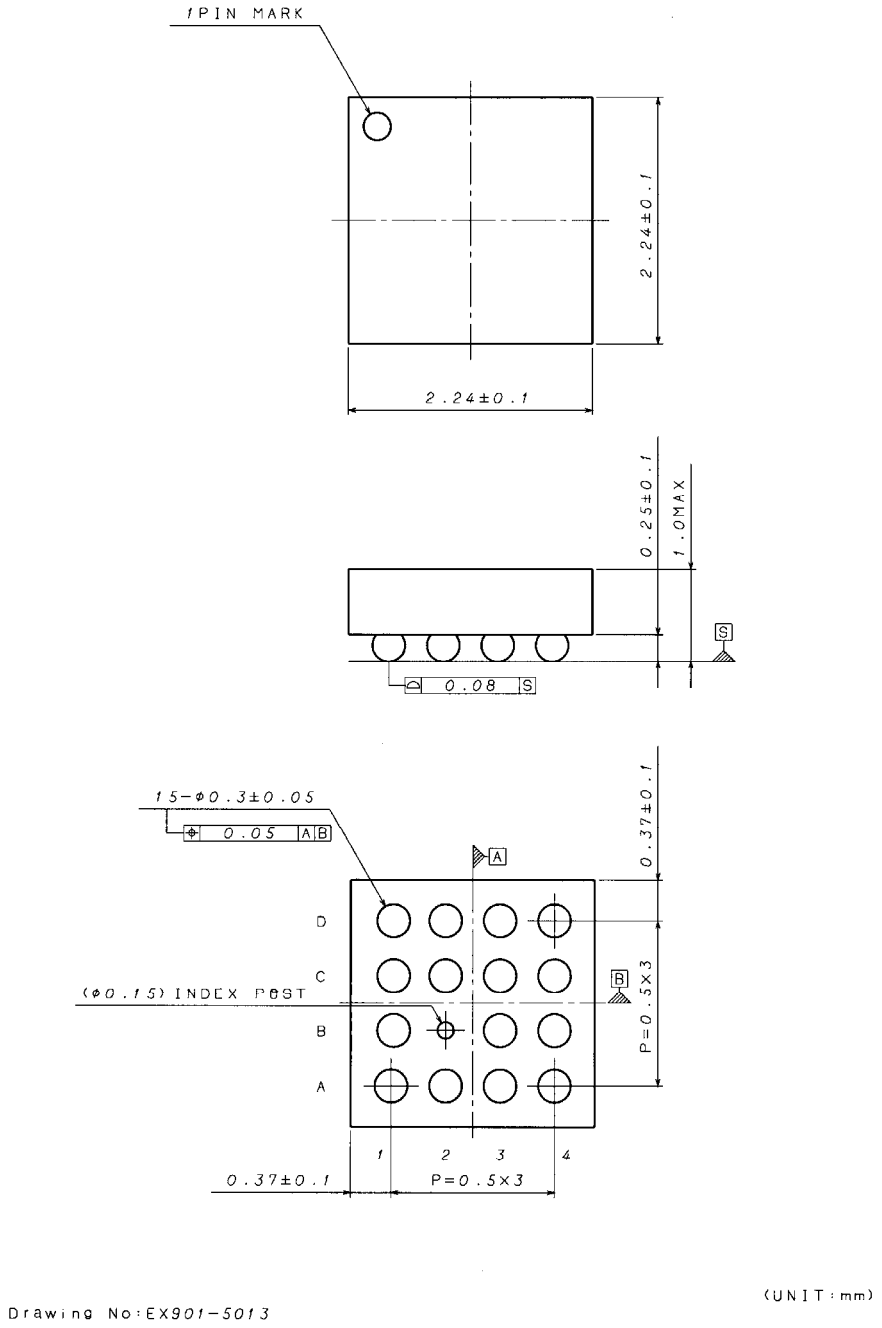



Fig.1. Package outline

## ●Block Diagram

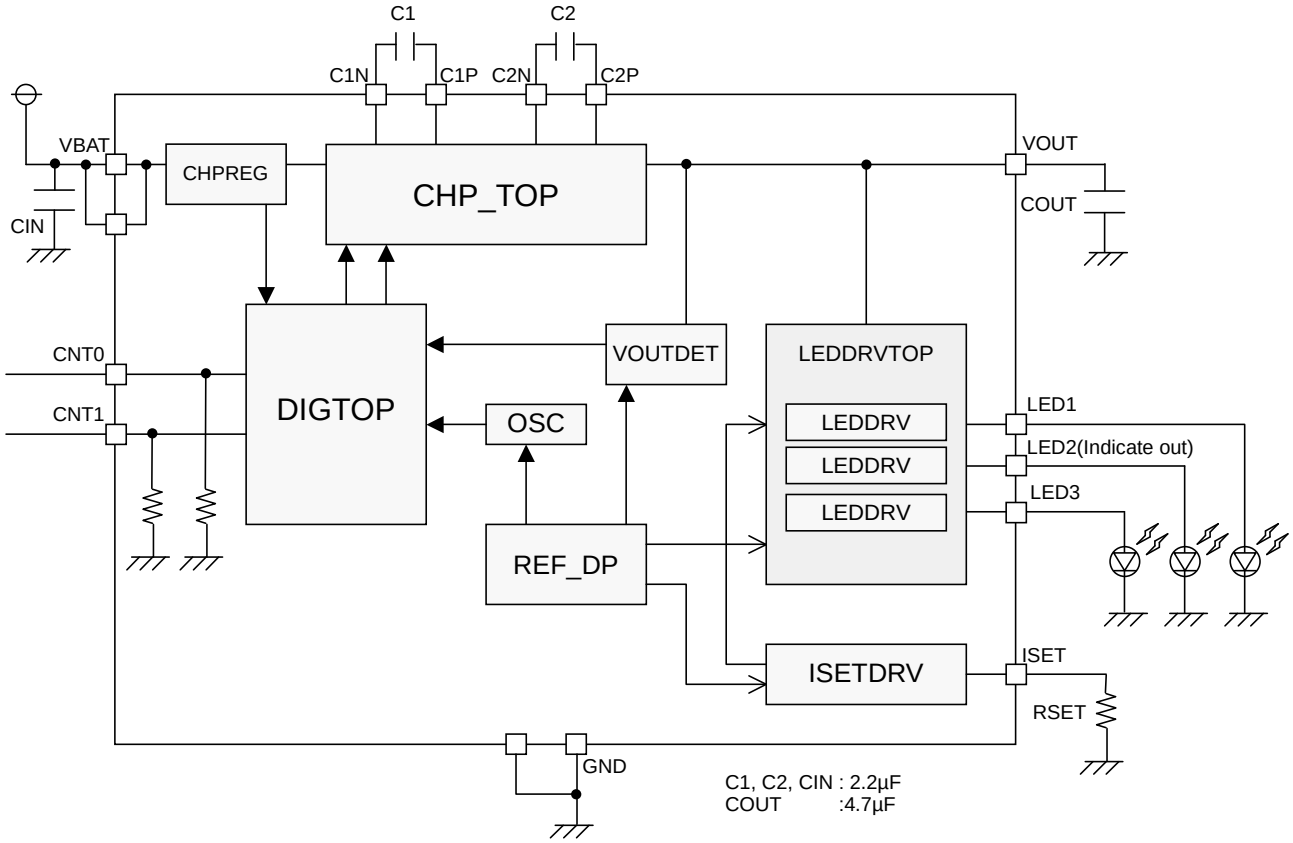



Fig-2. Block Diagram

## ●Pin Location

Bottom View

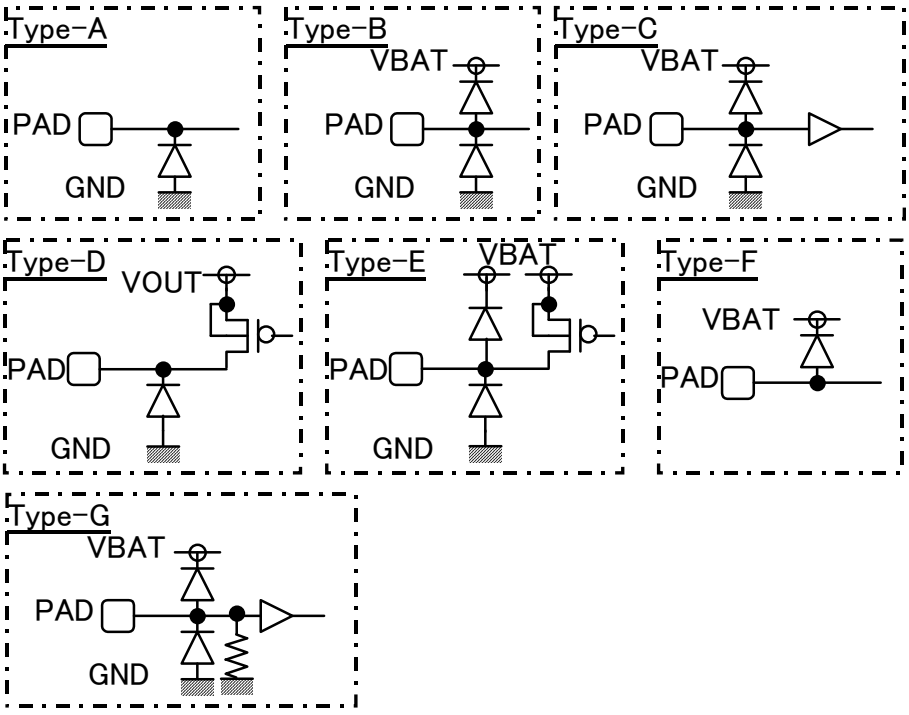
| | | | | |
|---|---|---|---|---|
| D | C1N | C2N | C2P | C1P |
| C | GND | CNT0 | CNT1 | VBAT |
| B | ISET | | LED3 | VOUT |
| A | GND | VBAT | LED2 | LED1 |
| | 1 | 2 | 3 | 4 |

Fig-3. Pin Location

●Terminals

| No. | Pin Name | In/ Out | Type | ESD Diode | | Functions |
|---|---|---|---|---|---|---|
| | | | | for Power | for GND | |
| C4 | VBAT | - | A | - | GND | Battery power supply pin |
| A2 | VBAT | - | A | - | GND | Battery power supply pin |
| C2 | CNT0 | In | G | VBAT | GND | LED control input ‘1’: On, ‘0’: Off |
| C3 | CNT1 | In | G | VBAT | GND | LED control input ‘1’: On, ‘0’: Off |
| B4 | VOUT | Out | A | - | GND | Output Voltage |
| A4 | LED1 | Out | D | - | GND | Current drive out for Torch,Flash |
| A3 | LED2 | Out | D | - | GND | Current drive out for Torch,Flash,Indicate |
| B3 | LED3 | Out | D | - | GND | Current drive out for Torch,Flash |
| B1 | ISET | In | B | VBAT | GND | Resistor connection for LED current setting |
| D4 | C1P | In/Out | B | VBAT | GND | Positive terminal of transfer capacitor 1 |
| D1 | C1N | In/Out | A | - | GND | Negative terminal of transfer capacitor 1 |
| D3 | C2P | In/Out | B | VBAT | GND | Positive terminal of transfer capacitor 2 |
| D2 | C2N | In/Out | A | - | GND | Negative terminal of transfer capacitor 2 |
| C1 | GND | - | F | VBAT | - | Ground pin |
| A1 | GND | - | F | VBAT | - | Ground pin |

Total : 15 Pin



## ●Functional Description

### 1. "FLASH" and "TORCH" and "Indicate" pin control

"FLASH" and "TORCH" select

"FLASH" and "TORCH" is selected by "CNT0" and "CNT1" pin.
Status is as bellows.

| CNT1 | CNT0 | Status |
|---|---|---|
| 0 | 0 | All LED OFF |
| 0 | 1 | Indicate |
| 1 | 0 | TORCH |
| 1 | 1 | FLASH |

"FLASH" control

"FLASH" status turns "High", Flash LED Current is occurred, and "FLASH" status turns "Low", Flash LED Current is OFF.
"FLASH" status is set by CNT0 pin = "1" and CNT1 pin = "1".
Flash term is maximum 1s by internal timer.

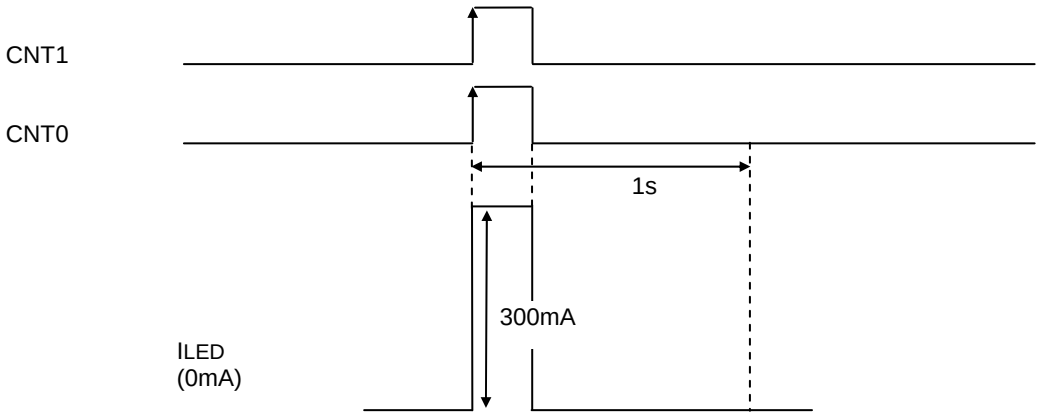



Fig-4. FLASH control and LED Current

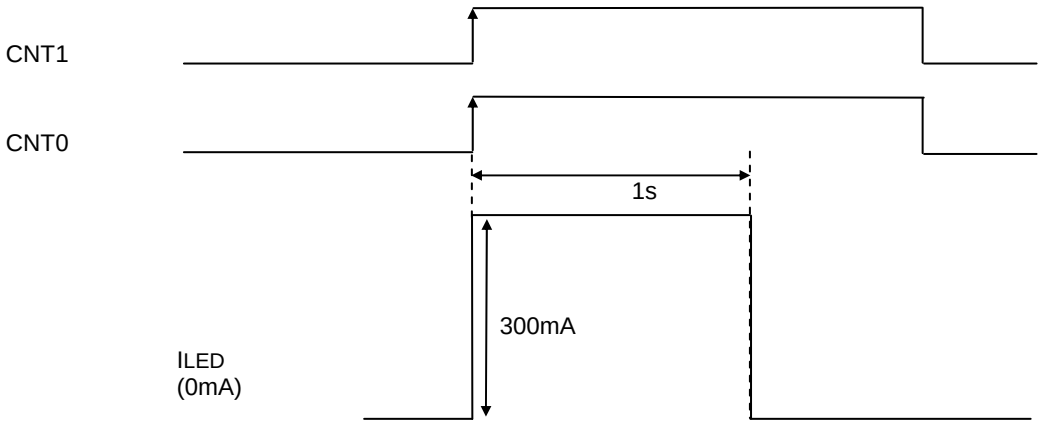



Fig-5. FLASH control and LED Current (with Timer Limit)

"TORCH" control

"TORCH" status turns "High", LED Current is occurred at 60mA(Torch Mode, 3 channel total), and "TORCH" status turns "Low", LED Current is OFF.

"TORCH" status is set by CNT0 pin = "0" and CNT1 pin = "1".

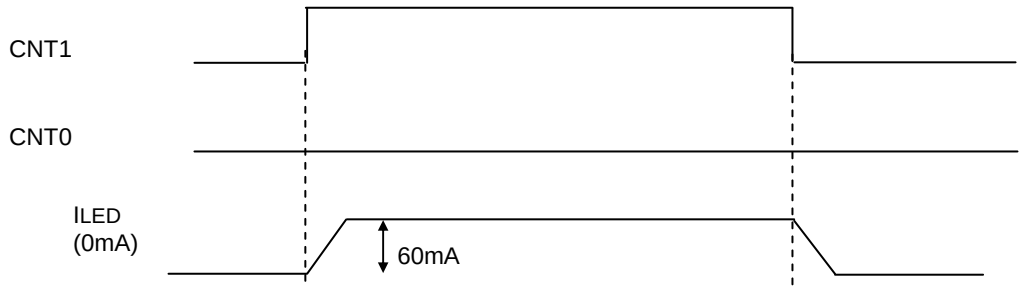



Fig-6. TORCH control and LED Current

"Indicate" control

"Indicate" status turns "High", LED2 Current is occurred at 1 mA.LED1 and LED3 Current is occurred at 0mA.Indicate" status turns "Low", LED Current is OFF.

"Indicate" status is set by CNT0 pin = "1" and CNT1 pin = "0".

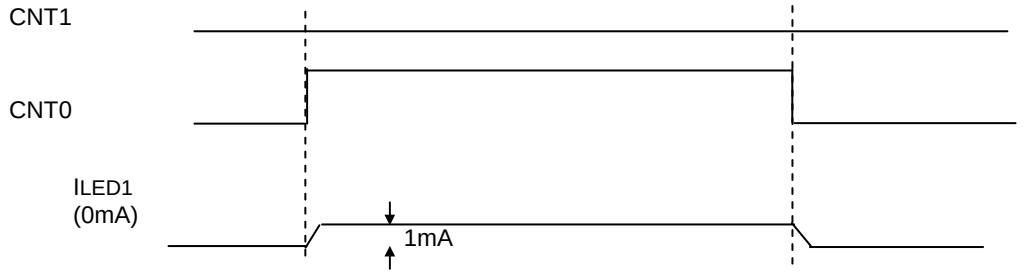



Fig-7. Indicate LED control and Indicate LED Current

## 2. LED Current control by "Rset"

The setting of Rset controls LED current, and following equation shows the LED current(@1ch).

ILED = 1200 / Rset (Flash)

ILED = 240 / Rset (Torch)

ILED = 12 / Rset (Indicate)

Then, follows Table shows the LED current(@1ch) for some Rset settings.(Typical)

| Rset | 120kΩ | 62kΩ | 30kΩ | 20kΩ | 15kΩ | 12kΩ |
|---|---|---|---|---|---|---|
| ILED(FLASH) | 10mA | 20mA | 40mA | 60mA | 80mA | 100mA |
| ILED(TORCH) | 2mA | 4mA | 8mA | 12mA | 16mA | 20mA |
| ILED(Indicate) | 0.1mA | 0.2mA | 0.4mA | 0.6mA | 0.8mA | 1mA |

Ratio of Flash and Torch current deviates from 5:1 by RSET value in light-load of LED current.

3. Charge pump mode transition

The charge pump mode is automatically and optimally changed.

(From x1 mode to x1.5 mode)
(From x1.5 mode to x2.0 mode)

Power supply voltage goes down and this IC can't keep constant LED current, then the mode transition will start.

(From x1.5 mode to x1 mode)
(From x2.0 mode to x1.5 mode)

Power supply voltage goes up and the detection of VOUT and VBAT is worked, then the mode transition will start.

4. Over voltage and current protection

This IC has VOUT over voltage and current protection for VOUT.
Even if LED pins are open, VOUT voltage is kept below limit voltage.
Even if VOUT pin is short to GND, current limiter works and restrains VBAT current.

5. UVLO function

This IC is shut down when VBAT is under Vuvlo voltage.
This IC automatically return initial operation when VBAT is up to Vuvlo voltage, and IC will return to normal operation.

6. Thermal shutdown function

This IC has a thermal shut down function.
It works above 175℃, and under the situation, IC will change the status from active to inactive.
To become under 175℃, IC will return to normal operation.

●Selection of external parts

Recommended external parts are as shown below.
When to use other parts than these, select the following equivalent parts.

・Capacitor

| Value | Manufacturer | Product number | Size | | | Temp. Chara. | Rated Voltage |
|---|---|---|---|---|---|---|---|
| | | | Vertical size | Horizontal size | Height | | |
| 【 CIN 】 | | | | | | | |
| 2.2μF | MURATA | GRM155B30J225ME | 1.0 | 0.5 | 0.5 | B | 6.3V |
| 【 COUT 】 | | | | | | | |
| 4.7μF | MURATA | GRM188B31A475KE15D | 1.6 | 0.8 | 0.8 | B | 10V |
| 【 C1, C2 】 | | | | | | | |
| 2.2μF | MURATA | GRM155B30J225ME | 1.0 | 0.5 | 0.5 | B | 6.3V |

[LED specification]

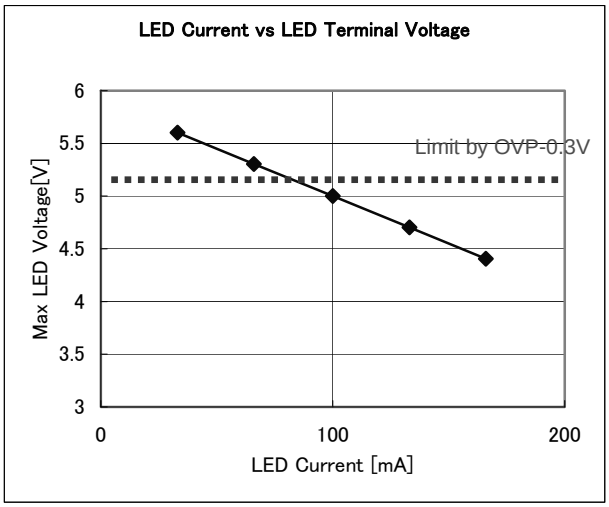
This IC targets to drive high power LED. Available VF(Forward voltage) range of LED is as follows.

| | Typ | Max |
|---|---|---|
| VF | 3.4V | 5V |

at 100mA/1ch , Ta=25℃

Note) LED VF range has Temperature characteristics. It is necessary tochoice suitable LED characteristics at LED Current setting.

Available LED terminal Voltage range is changed by LED current.




Ron(x2.0)=1.76Ω

## ●Notes for 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 tocause 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) Not connecting input terminals
In terms of extremely high impedance of CMOS gate, to open the input terminals causes unstable state. Unstable state occurs from the inside gate voltage of p-channel or n-channel transistor into active. As a result, power supply current may increase. And unstable state can also cause unexpected operation of IC. So unless otherwise specified, input terminals not being used should be connected to the power supply or GND line.

(13) Thermal shutdown circuit (TSD)
When junction temperatures become setting temperature 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.

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

## ●Ordering part number

| B | D | 7 | 7 | 0 | 0 | G | U | - | E | 2 |
|---|---|---|---|---|---|---|---|---|---|---|

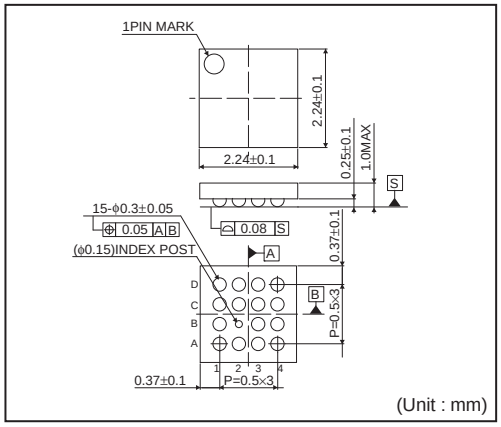
Part No.

Part No.
7700

Package
GU : VCSP85H2

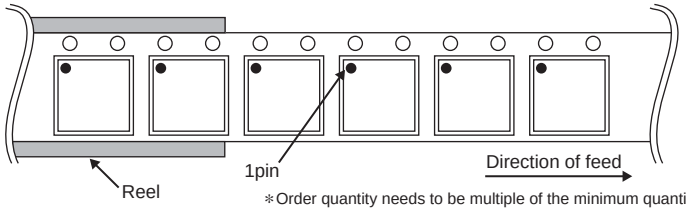
Packaging and forming specification
E2: Embossed tape and reel

**VCSP85H2 (BD7700GU)**




<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 ) |




∗Order quantity needs to be multiple of the minimum quantity.

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

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   [e] Use of our Products in proximity to heat-producing components, plastic cords, or other flammable items
   [f] Sealing or coating our Products with resin or other coating materials
   [g] Use of our Products without cleaning residue of flux (even if you use no-clean type fluxes, cleaning residue of flux is recommended); or Washing our Products by using water or water-soluble cleaning agents for cleaning residue after soldering
   [h] Use of the Products in places subject to dew condensation

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

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

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

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

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

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

## Precaution for Mounting / Circuit board design

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

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

For details, please refer to ROHM Mounting specification

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### Precaution for Electrostatic

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

### Precaution for Storage / Transportation

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

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

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

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

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