Datasheet

Constant Current LED Driver with 64 Dimming Steps for up to 4 LEDs

BD1754HFN

●General Description

The multi-level brightness control LED works as a constant current driver in 64 steps, so that the driving current can be adjusted finely. BD1754HFN is best suited to turn on LEDs that require high-accuracy LED brightness control.

●Key Specification

- Operating power supply voltage range: 2.7V to 5.5V
- Quiescent Current: 0.1µA (Typ.)
- Operating temperature range: -30°C to +85°C

●Package W(Typ.) x D(Typ.) x H(Max.)

HSON8
2.90mm x 3.00mm x 0.60mm

Figure 1. HSON8

●Features

- Current regulation for LED up to 4 parallels
- Adjustable constant current 64 steps
- High accuracy and matching of each current channel (0.5% Typ.)
- Brightness control via a single-line digital control interface (Uni-Port Interface Control = UPIC)

●Applications

This driver can be used in various fields such as mobile phones, portable game machines and etc.

●Typical Application Circuit

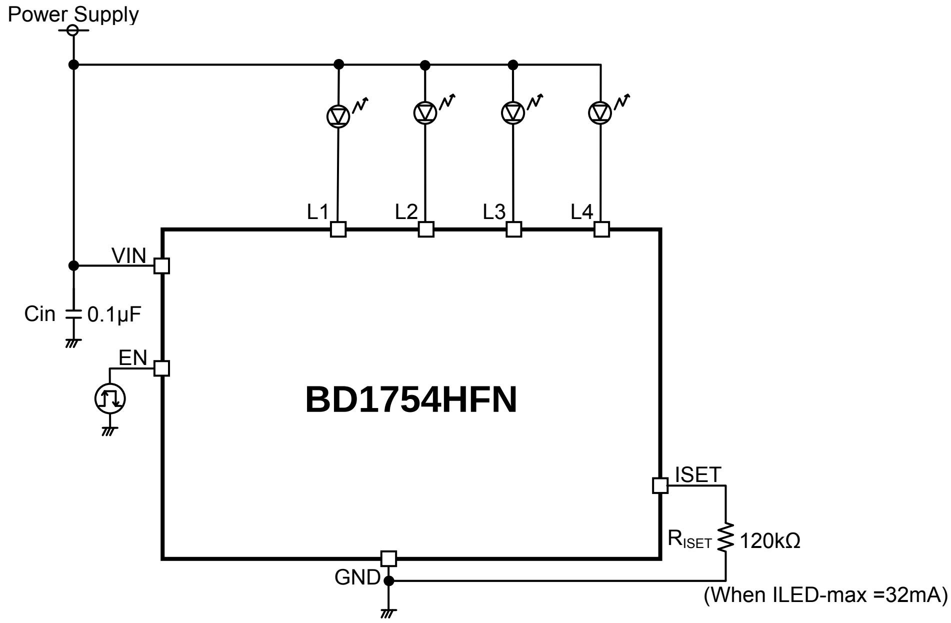


Figure 2. Application Circuit

○Product structure : Silicon monolithic integrated circuit ○This product is not designed protection against radioactive rays

●Absolute Maximum Ratings (Ta = 25°C)

Parameter	Symbol	Ratings	Unit
Terminal voltage	VMAX	7	V
Power dissipation	Pd	630 (*1)	mW
Operating temperature range	Topr	-30 to +85	°C
Storage temperature range	Tstg	-55 to +150	°C

(*1) This value is the measurement value when the driver is mounted on a glass epoxy board (70 mm x 70 mm x 1.6 mm).
When using the driver at Ta of 25°C or higher, the power is dissipated by approx. 5.04 mW/°C.

●Recommended Operating Ratings (Ta = -30°C to +85°C)

Parameter	Symbol	Limits			Unit	Condition
		Min.	Typ.	Max.		
Operating power supply voltage	VIN	2.7	3.6	5.5	V	
Driver pin voltage range	VDRV	0.2	-	VIN-1.4	V	When Current driver power on.

●Electrical Characteristics (Unless otherwise specified, Ta = 25°C and VIN = 3.6 V)

Parameter	Symbol	Limits			Unit	Condition
		Min.	Typ.	Max.		
Quiescent current	Iq	-	0.1	1	μA	EN=0V
Circuit current	IDD	-	1.2	2.0	mA	Except LED current
[Current driver]						
Maximum current	ILED-max	29.76	32.0	34.24	mA	R_{ISET} = 120kΩ
LED Current accuracy	ILED-diff	-	-	7.0	%	When current 16.5 mA setting R_{ISET} = 120kΩ
LED Current matching	ILED-match	-	0.5	3.0(*1)	%	When current 16.5 mA setting R_{ISET} = 120kΩ
[Logic controller]						
Low threshold voltage	VIL	-	-	0.4	V	
High threshold voltage	VIH	1.4	-	-	V	
‘H’ level input current	IIH	-	0	2	μA	EN=VIN
‘L’ level input current	IIL	-2	0	-	μA	EN=0V
EN ‘H’ time	THI	0.05	-	100	μs	
EN ‘L’ time	TLO	0.3	-	100	μs	
EN Off time-out	TOFF	1	-	-	ms	
VIN supply -> EN active time	TVINON	1	-	-	ms	
EN stand-by -> VIN Off time	TVINOFF	0	-	-	ms	

(*1) The following formula is used for calculation:
ILED-match = {(Imax - Imin) / (Imax + Imin)} x 100
Imax = Current value in a channel with the maximum current value among all channels
Imin = Current value in a channel with the minimum current value among all channels

●Pin Descriptions

No.	Pin Name	In/ Out	ESD Diode		Functions
			For Power	For GND	
1	EN	In	VIN	GND	LED enable and Brightness control signal
2	GND	-	VIN	-	Ground
3	ISET	Out	VIN	GND	Bias current
4	VIN	-	-	GND	Power supply voltage input
5	L1	In	-	GND	Current sink for LED 1
6	L2	In	-	GND	Current sink for LED 2
7	L3	In	-	GND	Current sink for LED 3
8	L4	In	-	GND	Current sink for LED 4
-	Thermal PAD	-	-	-	Heat radiation PAD of back side Connect to GND

●Block Diagram

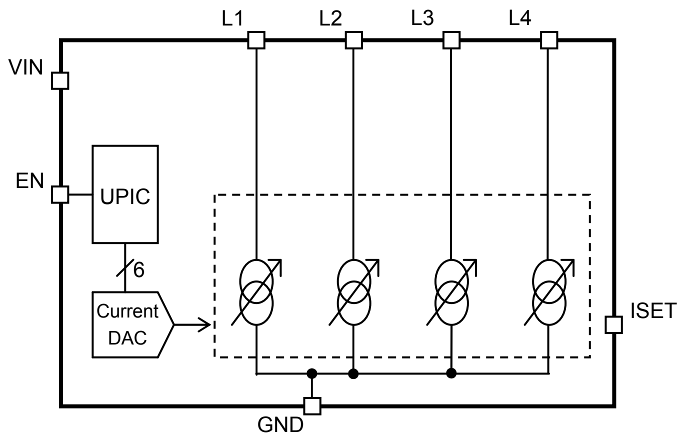


Figure 3. Block Diagram

●**Typical Performance Curves**

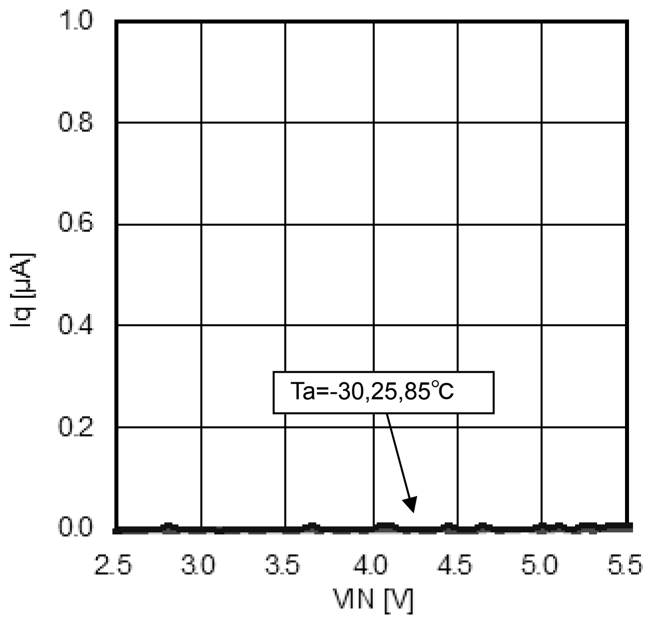


Figure 4. Quiescent Current

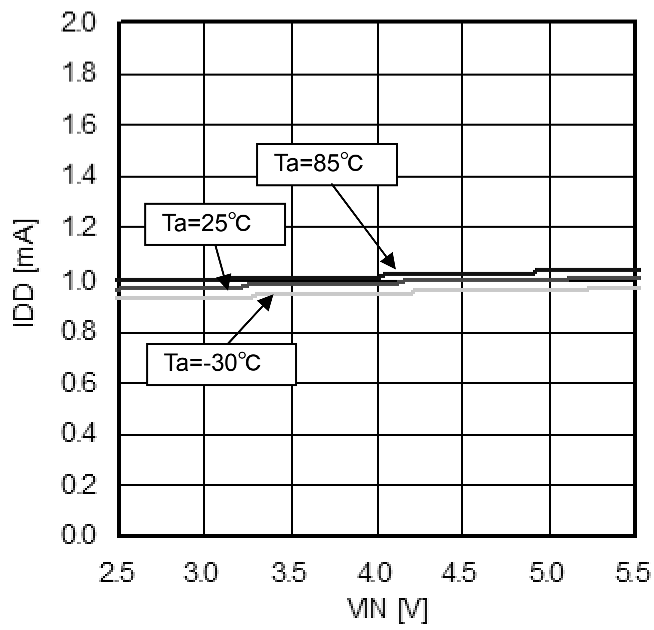


Figure 5. Circuit current

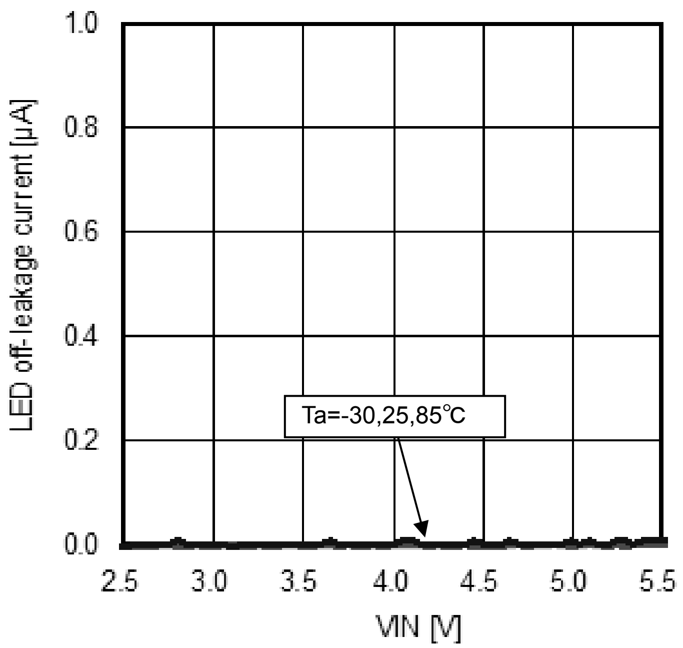


Figure 6. LED off-leakage current

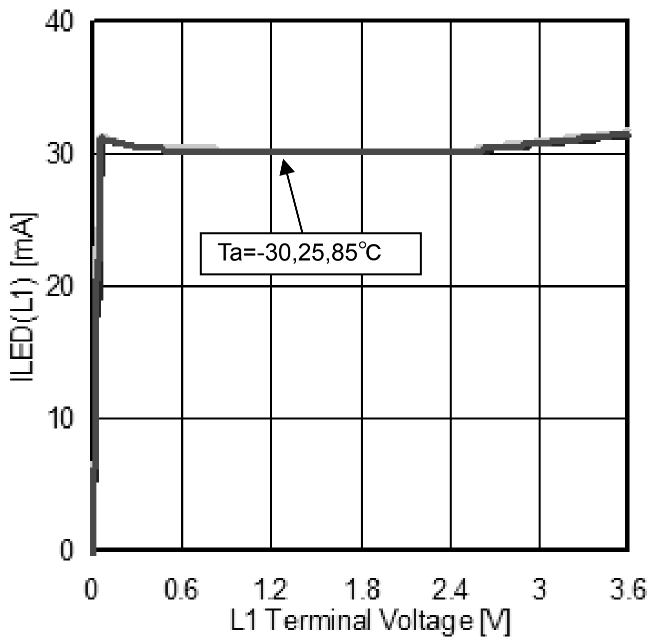


Figure 7. LED output current vs. LED pin voltage
(VIN = 3.6 V, at 32 mA of LED current)

●**Typical Performance Curves - continued**

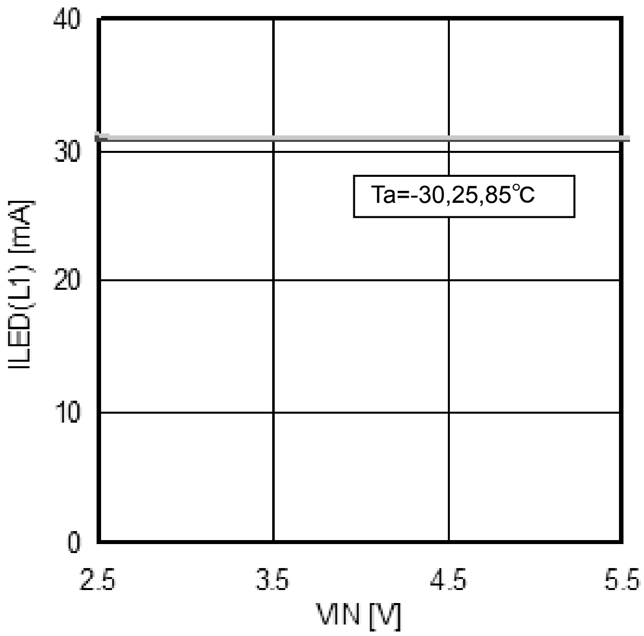


Figure 8. LED output current vs. VIN
(at 32 mA of LED current)

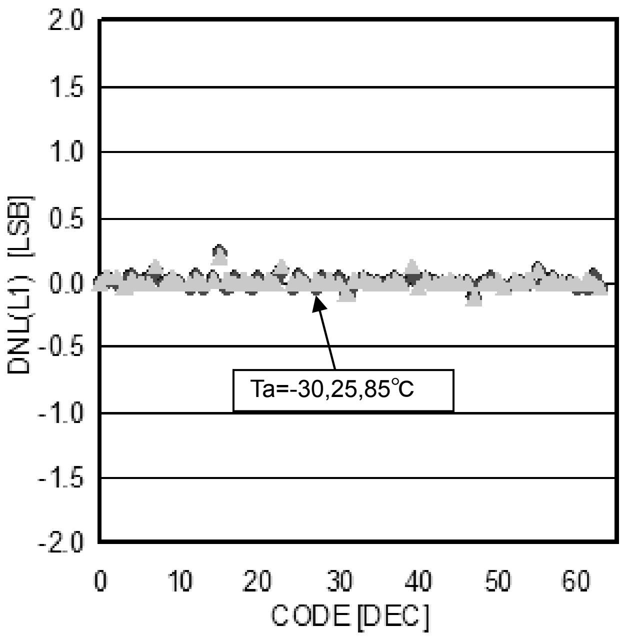


Figure 9. LED current characteristics
(VIN = 3.6 V, differential linearity error)

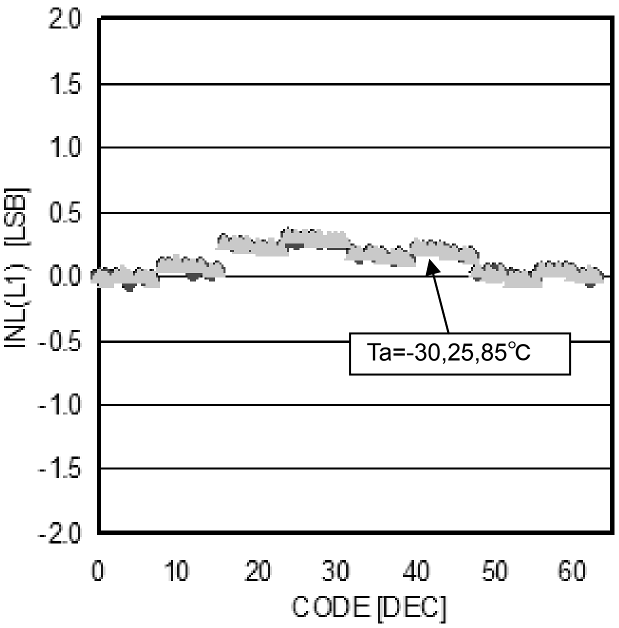


Figure 10. LED current characteristics
(VIN = 3.6 V, integral linearity error)

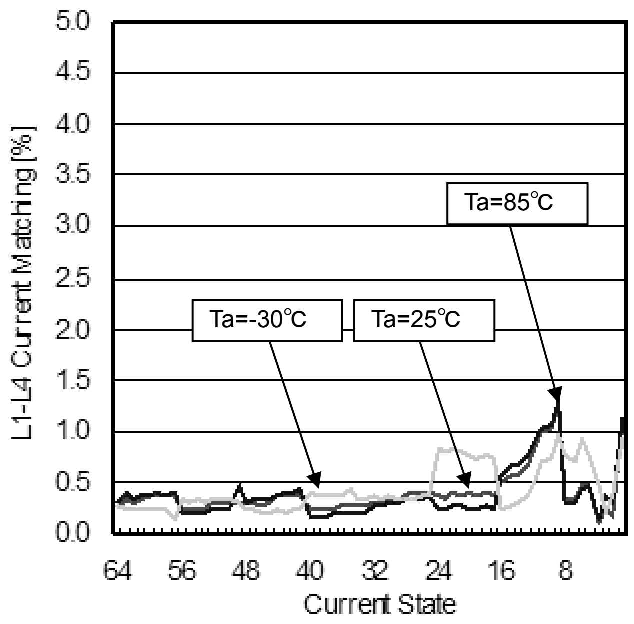


Figure 11. LED current relative accuracy
(VIN = 3.6 V)

●**Typical Performance Curves - continued**

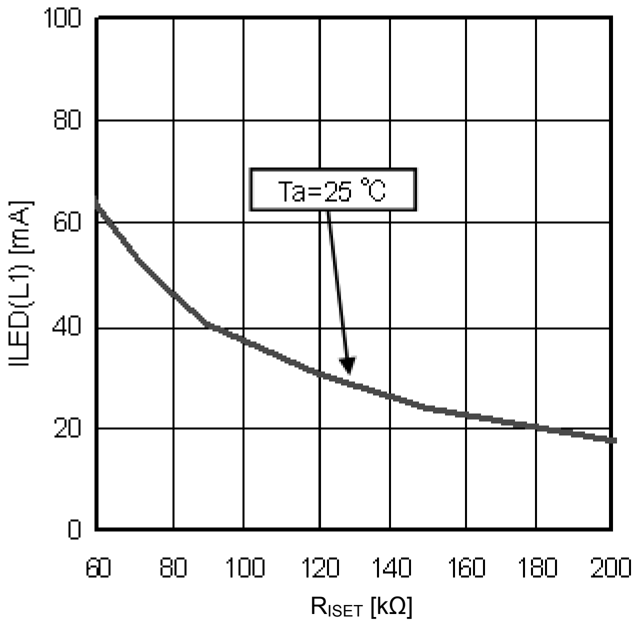


Figure 12. LED current vs. R_{ISET}
(VIN = 3.6 V, at the maximum current setting)

●**Description of Operations**

(1) UPIC (= Uni-Port Interface Control) interface

BD1754HFN has a single-line digital control interface (UPIC) that can control the power ON/OFF and LED current value through the EN pin. The LED current decreases by one step depending on the number of rising edges. After the number of rising edge is reached to the minimum output current (64 rising edges), the next rising edge changes the output current to the maximum value at startup time. To maintain any output current, the EN pin must be kept at 'H' level. To power off, the EN pin must be kept at 'L' level for more than 1ms.

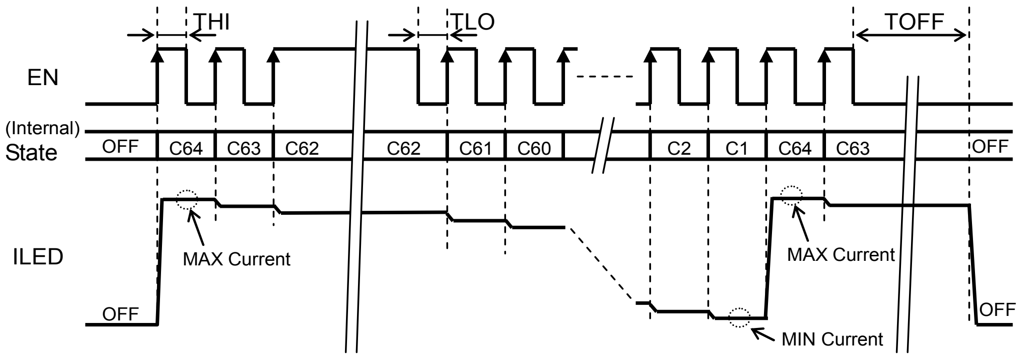


Figure 13. Brightness Control Method

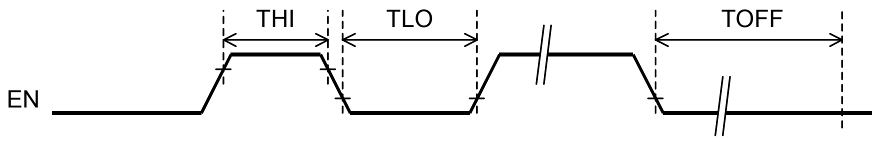


Figure 14. UPIC Interface

By following sequence, UPIC can control current driver for MAX current and OFF state only.

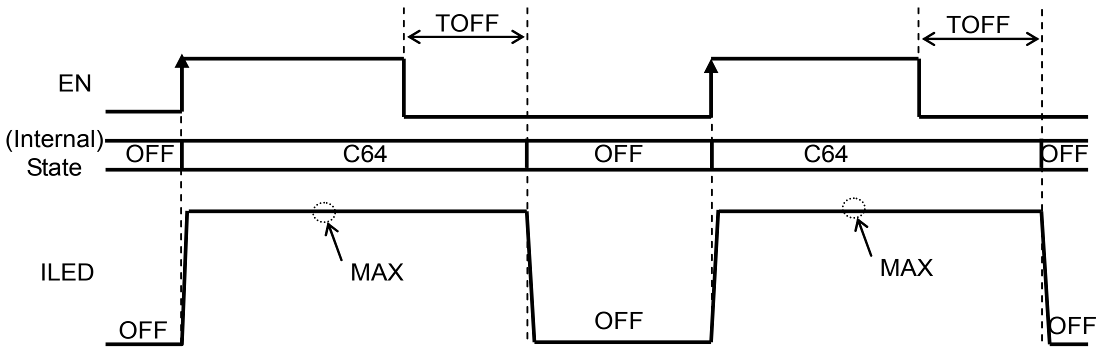


Figure 15. UPIC Interface usage for MAX current or OFF only

(2) Current Driver

The MAX Current is determined by the ISET resistance and the following formula.

$$ILED\text{-}max\ [mA] = 6.4 \times 600\ [mV] / R_{ISET}\ [k\Omega]$$

The LED current state can be changed by the EN control signal. When the state is C*n*, the output current (ILED) can be obtained from the following formula (where, n indicates a state number).

$$ILED\ [mA] = ILED\text{-}max \times n / 64$$

The following table is the example of LED current, when ISET resistance is 120 [kΩ].

R_{ISET} : 120[kΩ]

State	Output current [mA]	State	Output current [mA]	State	Output current [mA]	State	Output current [mA]
C64	32.0	C48	24.0	C32	16.0	C16	8.0
C63	31.5	C47	23.5	C31	15.5	C15	7.5
C62	31.0	C46	23.0	C30	15.0	C14	7.0
C61	30.5	C45	22.5	C29	14.5	C13	6.5
C60	30.0	C44	22.0	C28	14.0	C12	6.0
C59	29.5	C43	21.5	C27	13.5	C11	5.5
C58	29.0	C42	21.0	C26	13.0	C10	5.0
C57	28.5	C41	20.5	C25	12.5	C9	4.5
C56	28.0	C40	20.0	C24	12.0	C8	4.0
C55	27.5	C39	19.5	C23	11.5	C7	3.5
C54	27.0	C38	19.0	C22	11.0	C6	3.0
C53	26.5	C37	18.5	C21	10.5	C5	2.5
C52	26.0	C36	18.0	C20	10.0	C4	2.0
C51	25.5	C35	17.5	C19	9.5	C3	1.5
C50	25.0	C34	17.0	C18	9.0	C2	1.0
C49	24.5	C33	16.5	C17	8.5	C1	0.5

When the state is C64 (the maximum value), the output current value can be changed on the ISET resistance value as below.

State : C64

ISET resistance value (kΩ)	Output current per channel (mA)	Total output current of the four channels (mA)
240	16.0	64.0
120	32.0	128.0
90	42.7	170.8
60	64.0	256.0

●Application Circuit Examples

(1) Circuit example when the power supply is separated

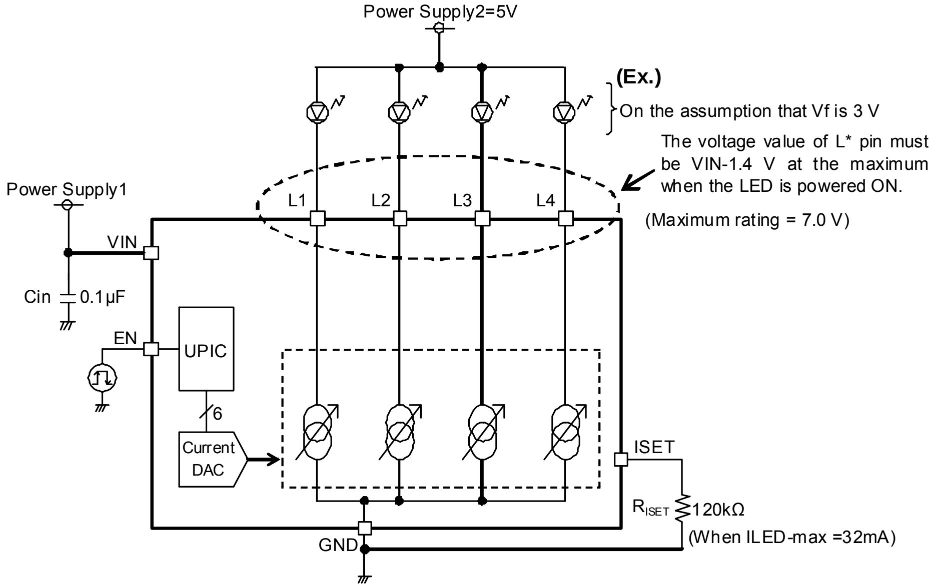


Figure 16. Circuit example when the power supply is separated

This figure shows a circuit example when the power supply for VIN and for LEDs is separated. Apply a voltage of Vf (threshold voltage value of a white LED) or higher to the LED. In this case, please note that when the LED is powered ON, the voltage value of L* pin (each pin of L1 to L4) must be VIN-1.4 V at the maximum. If a voltage of higher than VIN-1.4 V is applied to L* pin, a desired current value cannot be obtained. Also, please pay attention to the voltage application procedure at start-up. Be sure to power the current driver ON using the UPIC after applying power supply voltages to the VIN and the LED-anode pins. If the current driver is powered ON prior to applying power supply voltages to the LED, a rush current occurs in the LED. Determine the resistance value with which the LED current value is maximized and then connect such resistor between the ISET and the GND pins. The power ON/OFF and the brightness of the LEDs are controlled through the EN pin in accordance with the UPIC format.

(2) Circuit example when using only two LEDs

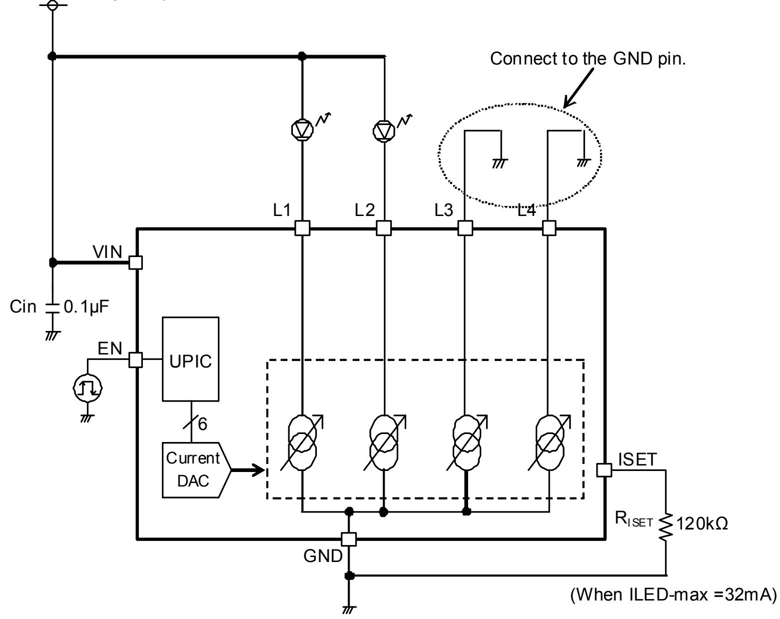


Figure 17. Circuit Example when using only two LEDs

This figure shows a circuit example when none of L3 and L4 LEDs are used. Connect both of the unused L3 and L4 pins to the GND pin. Likewise, it is possible to make the L1 and/or the L2 pins unused, which allows the back lights to be used with the one or three LED(s) turned on. In all cases, connect the unused L* pin to the GND pin. Determine the resistance value with which the LED current value is maximized and then connect such resistor between the ISET and the GND pins. The power ON/OFF and the brightness of the LEDs are controlled through the EN pin in accordance with the UPIC format.

(3) Circuit example when the EN pin is powered on at all times

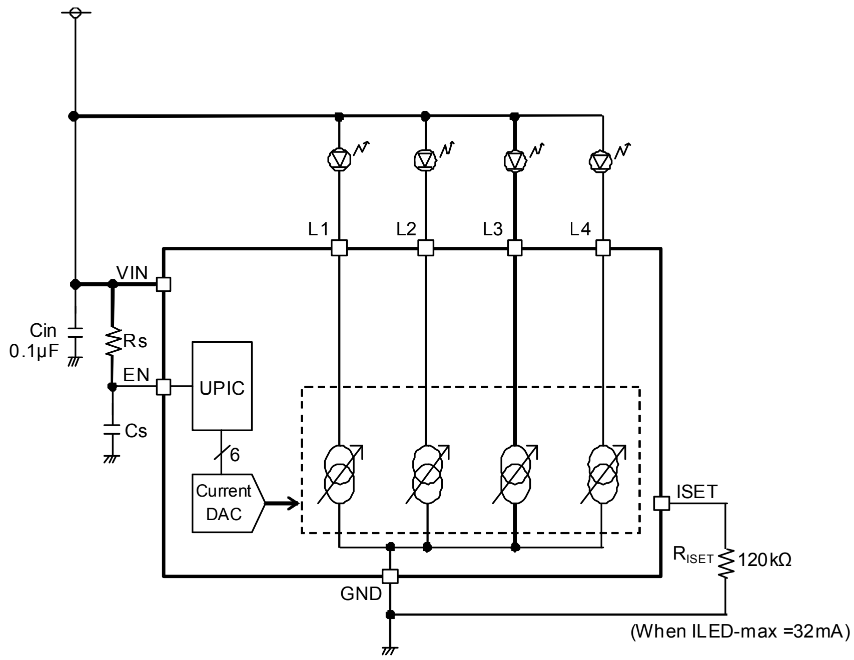


Figure 18. Circuit example when the EN pin is powered on at all times

This figure shows a circuit example when the EN pin is powered on at all times. To prevent a rush current from occurring in the driver, it is necessary to apply voltages to the VIN pin and the LEDs prior to powering the current driver ON. Mount an RC filter between the VIN and the EN pins to delay the EN pin rising against the power-supply voltage rising. Determine the resistance value with which the LED current value is maximized and then connect such resistor between the ISET and the GND pins.

(4) Circuit example when performing a PWM brightness control

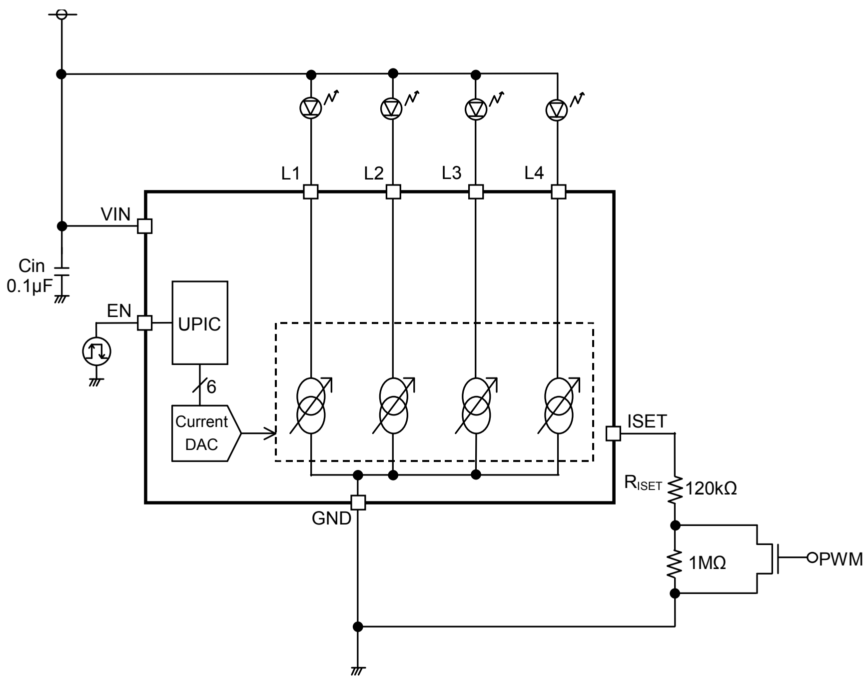


Figure 19. Circuit example when performing a PWM brightness control

This figure shows a circuit example when performing a PWM brightness control. Through switching the ISET resistance value by the PWM input signal, the LED current is outputted under a PWM mode. The EN signal is controlled by an applied voltage level. In the circuit example shown above, the LED current value is changed to 3.43 mA in 0 % of the PWM duty cycle, 17.72 mA in 50 % of that and 32 mA in 100 % of that.

(5) Circuit example when driving a large current with only one LED powered on.

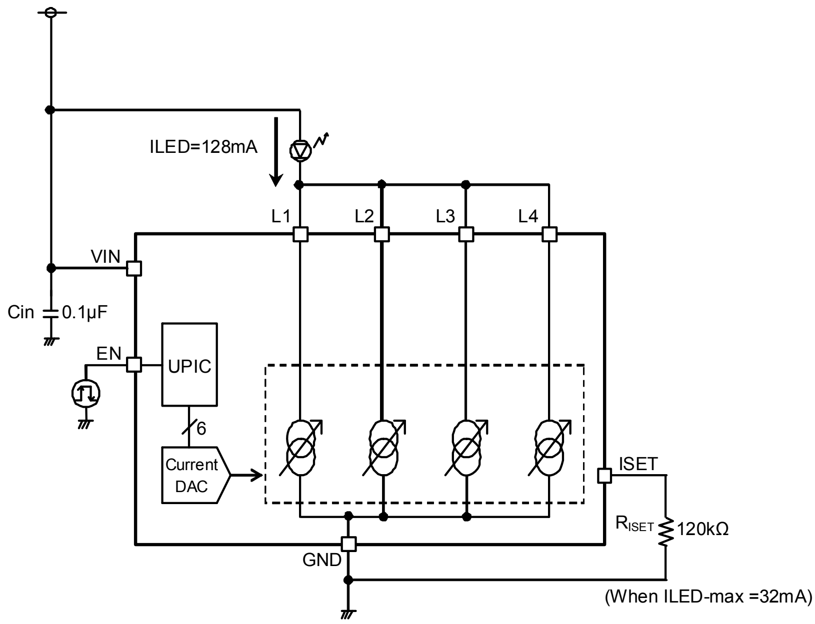


Figure 20. Circuit example when driving a large current with only one LED powered on.

This figure shows a circuit example when driving a large current through all of four channels with only one LED powered on. By shorting out all the LED driver pins, in the example of using 120 kΩ R_{ISET}, a current up to 128 mA (32 mA x 4) can be driven. In this example, the brightness can be adjusted in 64 gradations with 2 mA step (0.5 mA step/channel x 4 channels). For higher current values, using 60 kΩ R_{ISET} allows a current up to 256 mA to be driven into one of the LEDs. The power ON/OFF and the brightness of the LEDs are controlled through the EN pin in accordance with the UPIC format.

(6) Circuit example when making the eight LEDs available by connecting the two BD1754HFN drivers

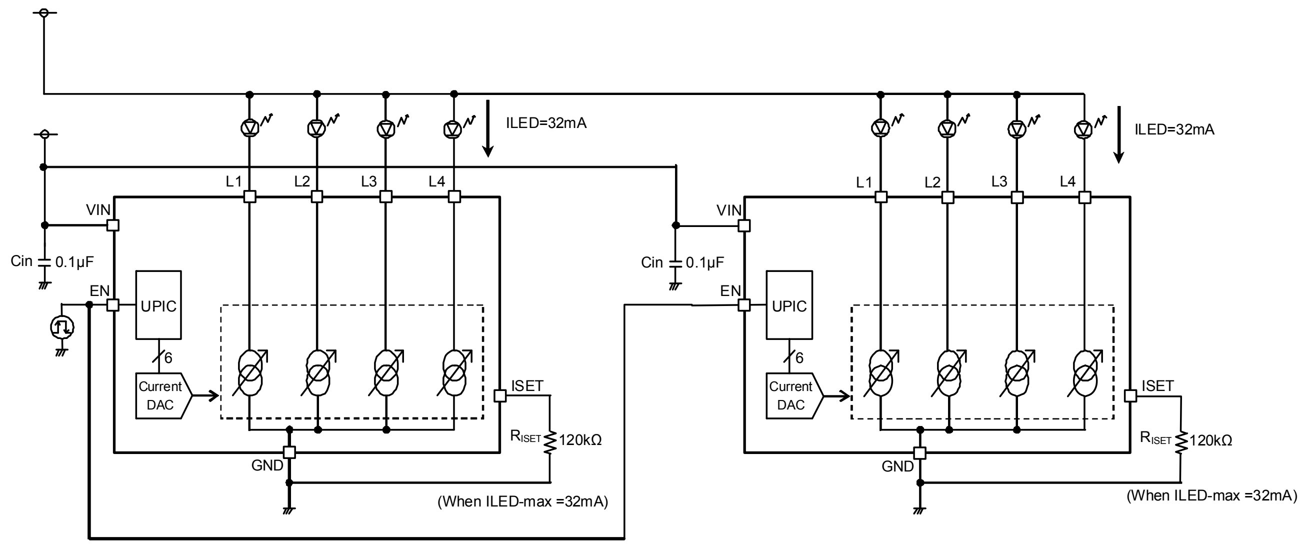


Figure 21. Circuit example when making the eight LEDs available by connecting the two BD1754HFN drivers

This figure shows a circuit example when making eight LEDs available by connecting two BD1754HFN drivers. By connecting the control signals to the EN pins in parallel, the eight LED channels can be controlled concurrently. This parallel connection scheme can increase the number of the LED channels further as necessary (such as twelve, sixteen, or more). Determine the resistance value with which the LED current value is maximized and then connect such resistor between the ISET and the GND pins. The power ON/OFF and the brightness of the LEDs are controlled through the EN pin in accordance with the UPIC format.

(7) Circuit example when connecting the two LEDs to each of the channels in series

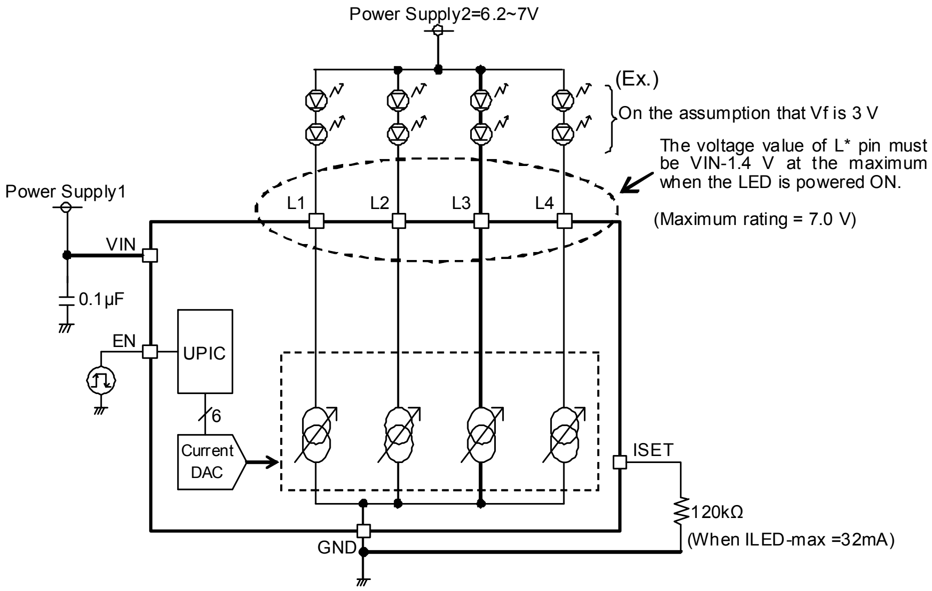


Figure 22. Circuit example when connecting the two LEDs to each of the channels in series

This figure shows a circuit example when making 8 (2 x 4) LEDs available by connecting two LEDs to each of the channels in series. In this example, when Vf is set to approx. 3 V in order to ensure the voltage to L1 through L4 pins, it is necessary to apply a voltage of 6.2 V (3 V x 2 LED's in series + 0.2 V of the minimum voltage value of the driver pin) or higher to the LED anode pin as its power supply voltage. Pay attention that the voltage should not exceed the 7.0-V maximum rating of the L1 through L4 pins. Determine the resistance value with which the LED current value is maximized and then connect such resistor between the ISET and the GND pins. The power ON/OFF and the brightness of the LEDs are controlled through the EN pin in accordance with the UPIC format.

●Selection of Components Externally Connected

<Capacitor>

Symbol	Recommended value	Recommended component	Manufacturer
Cin	0.1μF	GRM188B31H104KA92B	MURATA

<Resistor>

Symbol	Recommended value	Recommended component	Manufacturer
R_{ISET}	120kΩ	MCR10PZHZF1203	ROHM

●Recommended PCB Layout

Design PCB pattern to provide low impedance for the wiring to the power supply line.
Also, provide a bypass capacitor if needed.

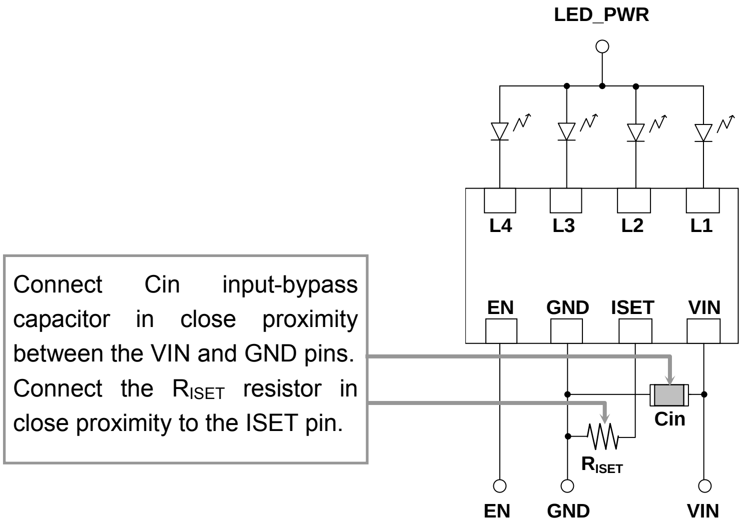


Figure 23. Layout image of the application components (Top View)

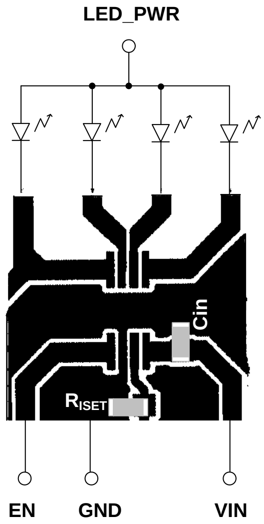


Figure 24. Surface (Top View)

<Heat radiation PAD of back side>

PAD is used for improving the efficiency of IC heat radiation. Solder PAD to GND pin.
Moreover, connect ground plane (GND) of board using via as shown in the patterns of next page.
The efficiency of heat radiation improves according to the area of ground plane (GND).

●Operational Notes

(1) Absolute Maximum Ratings
An excess in the absolute maximum ratings, such as applied voltage, temperature range of operating conditions, 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) Recommended 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. The voltage and temperature characteristics are also shown under the conditions in respect of electrical ones.

(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. 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 that 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 that no terminal is operated 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 cause a malfunction.

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

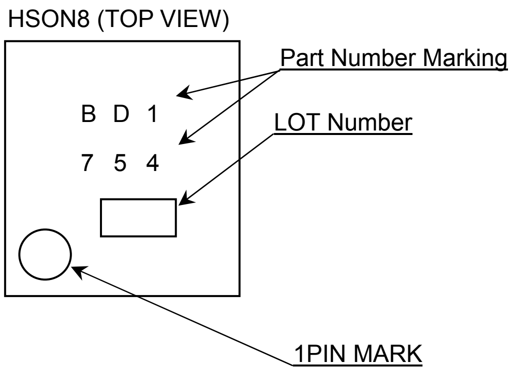
Status of this document
The Japanese version of this document is formal specification. A customer may use this translation version only for a reference to help reading the formal version.
If there are any differences in translation version of this document formal version takes priority.

●Ordering Information

B D 1 7 5 4 H F N - T R

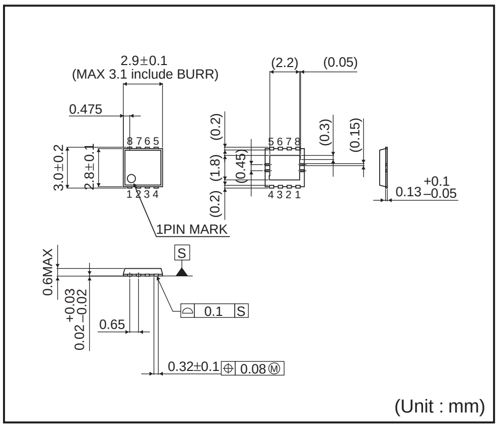
Part Number	Package	Packaging and forming specification
BD1754	HFN: HSON8	TR: Embossed tape and reel

●Marking Diagram



●Physical Dimension Tape and Reel Information

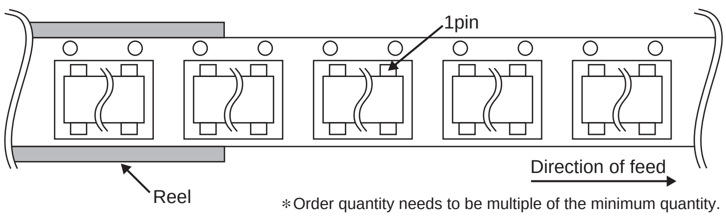
HSON8



(Unit : mm)

<Tape and Reel information>

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



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

●**Revision History**

Date	Revision	Changes
09.Nov.2012	001	New Release

Notice

●General Precaution

1) Before you use our Products, you are requested to carefully read this document and fully understand its contents. ROHM shall not be in any way responsible or liable for failure, malfunction or accident arising from the use of any ROHM's Products against warning, caution or note contained in this document.

2) All information contained in this document is current as of the issuing date and subject to change without any prior notice. Before purchasing or using ROHM's Products, please confirm the latest information with a ROHM sales representative.

●Precaution on using ROHM Products

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

2) ROHM designs and manufactures its Products subject to strict quality control system. However, semiconductor products can fail or malfunction at a certain rate. Please be sure to implement, at your own responsibilities, adequate safety measures including but not limited to fail-safe design against the physical injury, damage to any property, which a failure or malfunction of our Products may cause. The following are examples of safety measures:
   [a] Installation of protection circuits or other protective devices to improve system safety
   [b] Installation of redundant circuits to reduce the impact of single or multiple circuit failure

3) Our Products are designed and manufactured for use under standard conditions and not under any special or extraordinary environments or conditions, as exemplified below. Accordingly, ROHM shall not be in any way responsible or liable for any damages, expenses or losses arising from the use of any ROHM's Products under any special or extraordinary environments or conditions. If you intend to use our Products under any special or extraordinary environments or conditions (as exemplified below), your independent verification and confirmation of product performance, reliability, etc, prior to use, must be necessary:
   [a] Use of our Products in any types of liquid, including water, oils, chemicals, and organic solvents
   [b] Use of our Products outdoors or in places where the Products are exposed to direct sunlight or dust
   [c] Use of our Products in places where the Products are exposed to sea wind or corrosive gases, including Cl_2, H_2S, NH_3, SO_2, and NO_2
   [d] Use of our Products in places where the Products are exposed to static electricity or electromagnetic waves
   [e] Use of our Products in proximity to heat-producing components, plastic cords, or other flammable items
   [f] Sealing or coating our Products with resin or other coating materials
   [g] Use of our Products without cleaning residue of flux (even if you use no-clean type fluxes, cleaning residue of flux is recommended); or Washing our Products by using water or water-soluble cleaning agents for cleaning residue after soldering
   [h] Use of the Products in places subject to dew condensation

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

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

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

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

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

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

●Precaution for Mounting / Circuit board design

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

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

For details, please refer to ROHM Mounting specification

●Precautions Regarding Application Examples and External Circuits

1) If change is made to the constant of an external circuit, please allow a sufficient margin considering variations of the characteristics of the Products and external components, including transient characteristics, as well as static characteristics.

2) You agree that application notes, reference designs, and associated data and information contained in this document are presented only as guidance for Products use. Therefore, in case you use such information, you are solely responsible for it and you must exercise your own independent verification and judgment in the use of such information contained in this document. ROHM shall not be in any way responsible or liable for any damages, expenses or losses incurred by you or third parties arising from the use of such information.

●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.

●Precaution for Product Label

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

●Precaution for Disposition

When disposing Products please dispose them properly using an authorized industry waste company.

●Precaution for Foreign Exchange and Foreign Trade act

Since our Products might fall under controlled goods prescribed by the applicable foreign exchange and foreign trade act, please consult with ROHM representative in case of export.

●Precaution Regarding Intellectual Property Rights

1) All information and data including but not limited to application example contained in this document is for reference only. ROHM does not warrant that foregoing information or data will not infringe any intellectual property rights or any other rights of any third party regarding such information or data. ROHM shall not be in any way responsible or liable for infringement of any intellectual property rights or other damages arising from use of such information or data.:

2) No license, expressly or implied, is granted hereby under any intellectual property rights or other rights of ROHM or any third parties with respect to the information contained in this document.

●Other Precaution

1) The information contained in this document is provided on an “as is” basis and ROHM does not warrant that all information contained in this document is accurate and/or error-free. ROHM shall not be in any way responsible or liable for any damages, expenses or losses incurred by you or third parties resulting from inaccuracy or errors of or concerning such information.

2) This document may not be reprinted or reproduced, in whole or in part, without prior written consent of ROHM.

3) The Products may not be disassembled, converted, modified, reproduced or otherwise changed without prior written consent of ROHM.

4) In no event shall you use in any way whatsoever the Products and the related technical information contained in the Products or this document for any military purposes, including but not limited to, the development of mass-destruction weapons.

5) The proper names of companies or products described in this document are trademarks or registered trademarks of ROHM, its affiliated companies or third parties.