3-Channel Charge Pump White LED Driver
with 16 Dimming Steps and 1-wire Serial Interface

BD82103GWL

●General Description

BD82103GWL is charge pump type 2 light or 3 light parallel LED driver for the portable instruments. This IC not only ensures efficient boost by automatically changing the boost rate but also works as a constant current driver in 16 steps, so that the driving current can be adjusted finely. This IC is best suited to turn on white LEDs that require high-accuracy LED brightness control.

●Features

- 2light or 3light parallel LED driver is mounted
- 16-step LED current adjust function
- Inter-LED relative current accuracy: 5% or less
- Driving control via a single-line digital control interface
- Automatic transition charge pump type DC/DC converter (×1,×1.5, x2)
- High efficiency achieved (Maximum over 93%)
- It transits for the most suitable power operating by the LED terminal process of the 3rd light when 2 light driving
- Various protection functions such as output voltage protection and thermal shutdown circuit are mounted.

●Key Specifications

- Operating power supply voltage range: 2.7V to 5.5V
- LED maximum current: 20mA (Typ.)
- Oscillator frequency: 0.85MHz(Typ.)
- Quiescent Current: 0.1μA (Typ.)
- Operating temperature range: -30℃ to +85℃

●Package

	W(Typ.) x D(Typ.) x H(Max.)
UCSP50L1	1.80mm x 1.40mm x 0.55mm

●Typical Application Circuit (3 Light)

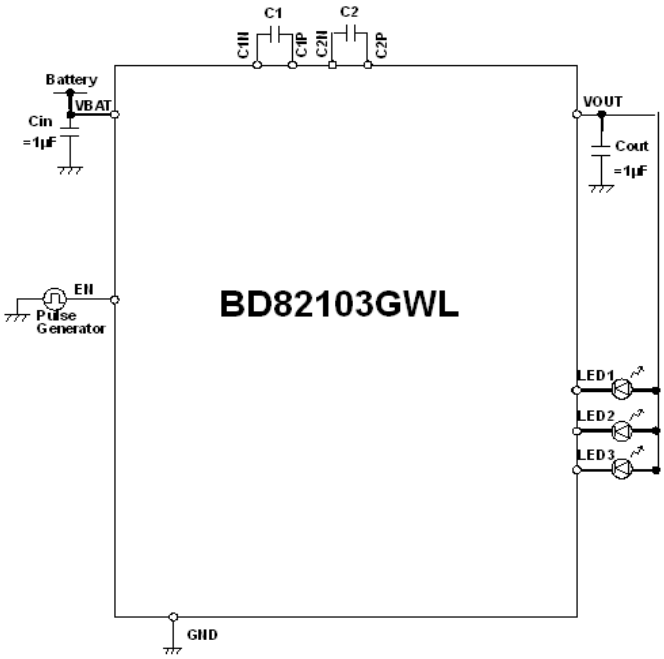


Figure 1. Typical Application Circuit

●Pin Configuration [Bottom View]

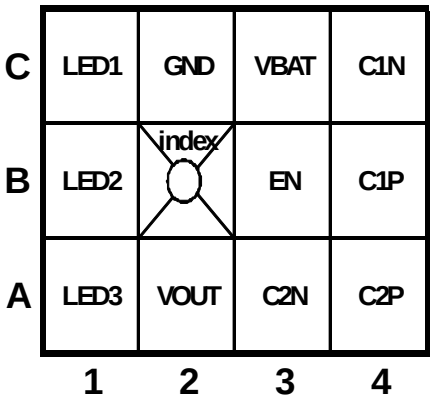


Figure 2. Pin Configuration

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

●**Absolute Maximum Ratings** (Ta=25℃)

Parameter	Symbol	Ratings	Unit
Terminal Voltage	VMAX	7	V
Input voltage (EN)	Vdin	GND-0.3 to VBAT+0.3	V
Power dissipation	Pd	730	mW
Operating temperature range	Topr	-30 to +85	℃
Storage temperature range	Tstg	-55 to +150	℃

Note 1) The measurement value which was mounted on the PCB by ROHM.
When a glass epoxy substrate (70mm × 70mm × 1.6mm) has been mounted, this loss will decrease 5.84mW/℃ if Ta is higher than or equal to 25℃.

●**Recommended Operating Rating** (Ta = -30 to 85 ℃)

Parameter	Symbol	Ratings	Unit
Operating power supply voltage	VBAT	2.7 to 5.5	V

●**Electrical Characteristics** (Unless otherwise noted, Ta = +25℃, VBAT=3.6V)

Parameter	Symbol	Limits			Unit	Condition
		Min.	Typ.	Max.		
Current Consumption						
Quiescent Current	I_q	-	0.1	1	μA	EN=0V
Current Consumption1	I_{dd1}	-	1.0	2.4	mA	x1.0 Mode, Except LED current
Current Consumption2	I_{dd2}	-	2.0	3.5	mA	x2.0 Mode, Except LED current
Charge Pump						
Oscillator frequency	f_{OSC}	0.56	0.85	1.14	MHz	
Current Source						
LED maximum current	$I_{LED-max}$	18	20	22	mA	VBAT≥3.0V
LED current accuracy	$I_{LED-diff}$	-	-	10.0	%	When LED current 10.0mA setting and LED terminal voltage 1.0V
LED current matching	$I_{LED-match}$	-	0.5	5.0	%	When LED current 10.0mA setting and LED terminal voltage 1.0V
LED control voltage	V_{LED}	-	0.15	0.25	V	minimum voltage at LED1 to LED3 pins
Logic control terminal						
Low threshold voltage	V_{IL}	-	-	0.4	V	EN
High threshold voltage	V_{IH}	1.4	-	-	V	EN
High level Input current	I_{IH}	-	0	1	μA	EN=VBAT
Low level Input current	I_{IL}	-1	0	-	μA	EN=0V
Minimum EN High time	T_{HI}	0.05	-	100	μs	Described in Figure 5
Minimum EN Low time	T_{LO}	0.3	-	100	μs	Described in Figure 5
EN Off Timeout	T_{OFF}	1	-	-	ms	Described in Figure 5
Latch time	T_{LAT}	1	-	-	ms	Described in Figure 5
Access available time	Tacc	1	-	-	ms	Described in Figure 5

●**Pin Descriptions**

Pin No.	Terminal No.	Pin name	In/Out	Type	Function
1	C3	VBAT	-	A	Power supply
2	B4	C1P	In/Out	A	Flying capacitor pin positive (+) side
3	C4	C1N	In/Out	B	Flying capacitor pin negative (-) side
4	A4	C2P	In/Out	A	Flying capacitor pin positive (+) side
5	A3	C2N	In/Out	B	Flying capacitor pin negative (-) side
6	A2	VOUT	Out	A	Charge pump output
7	B3	EN	In	C	ON/OFF and dimming control
8	C1	LED1	Out	A	LED current driver output 1
9	B1	LED2	Out	A	LED current driver output 2
10	A1	LED3	Out	A	LED current driver output 3
11	C2	GND	-	D	GND

●**Pin ESD Type**

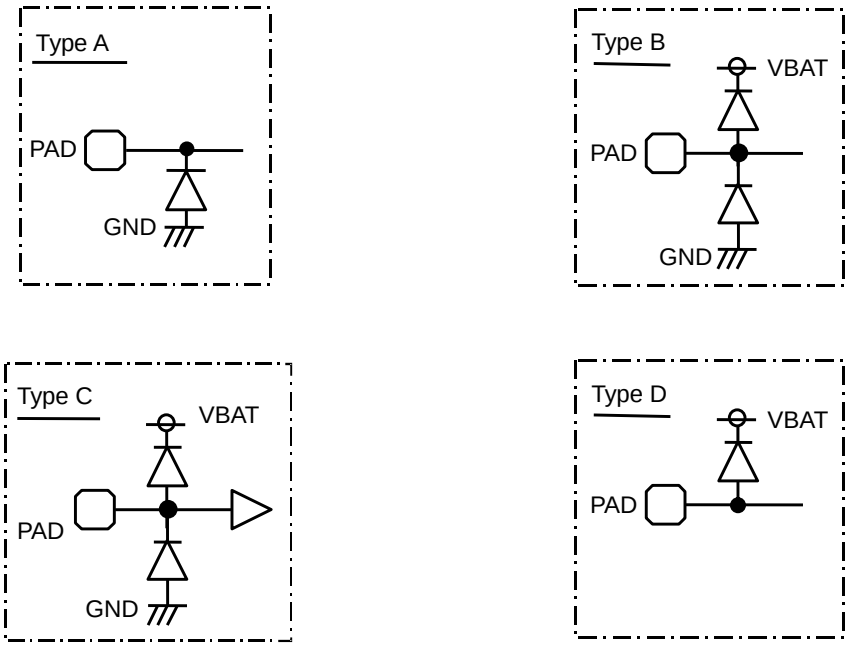
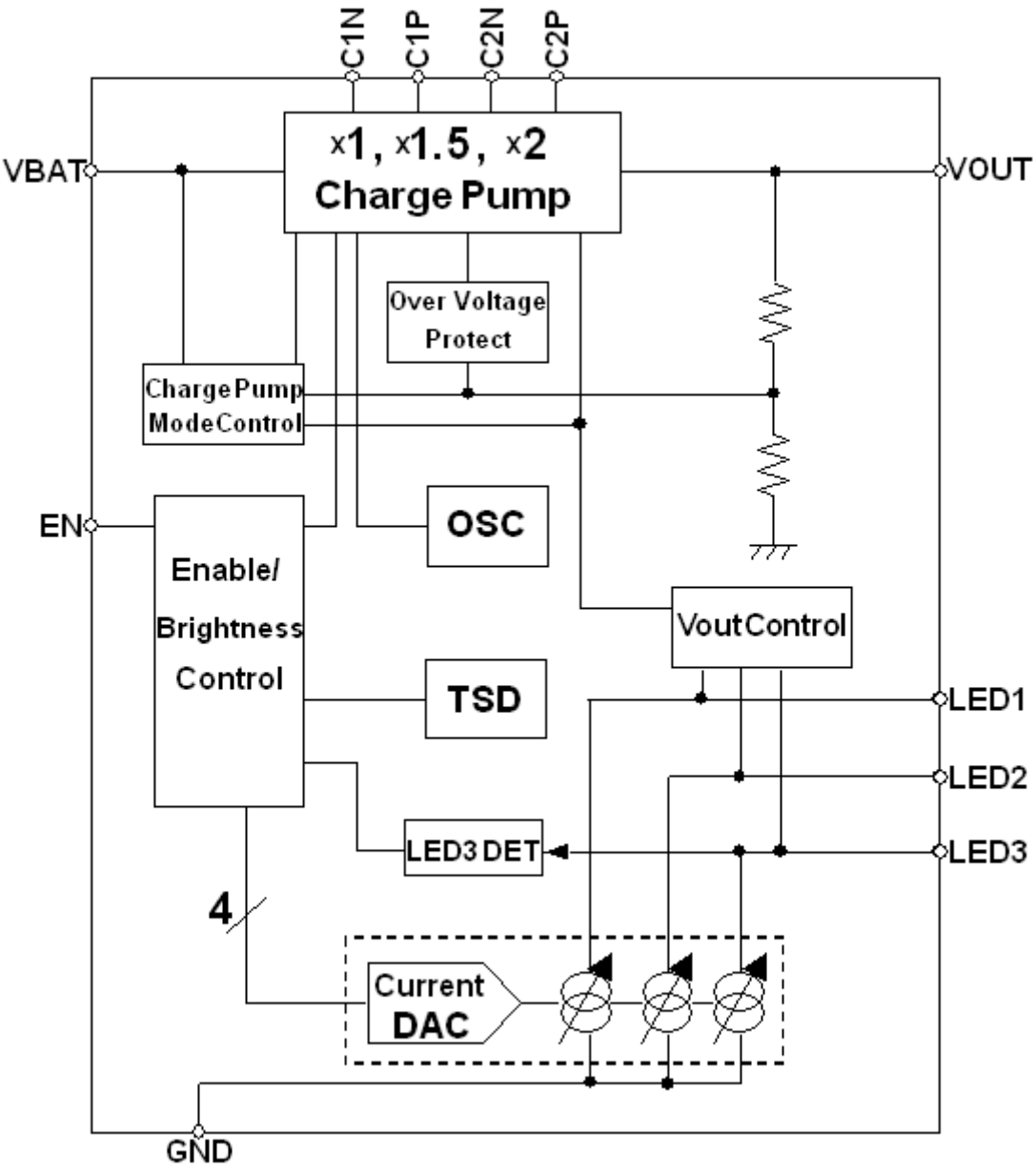


Figure 3. Pin ESD Type

●**Block Diagram**



Pin number 11pin
Figure 4. Block Diagram

●Function Description

(1) LED driver

・Register access control protocol

LED current is controlled by only EN terminal. It is possible to access the register inside of this chip by using the protocol below. LED driver ON/OFF, selecting the mode is operated by accessing the registers with using this protocol.

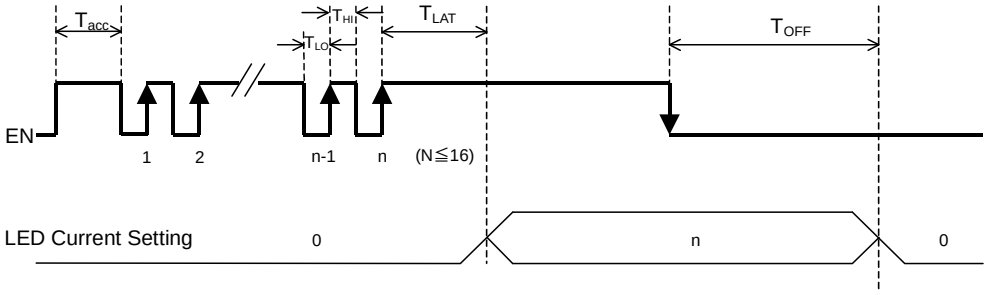


Figure 5. Register access protocol

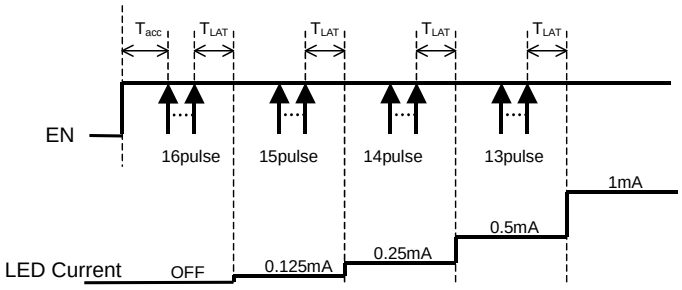


Figure 6. Slope control example

(Note)

・In the case of N > 16, BD82103GWL selects the mode of N = 16.

・LED current is changed by the pulse of EN pin.
Be careful to noise of EN signal.

・Reset BD82103GWL when the set is unusual. (Keep EN=L over Toff time.)

・LED current level

The interface records rising edges of the EN pin and decodes them into 16 different indicated in following table.

Data	Output current [mA]	Data	Output current [mA]
1	20.0	9	5.0
2	17.0	10	4.0
3	14.0	11	3.0
4	12.0	12	2.0
5	10.0	13	1.0
6	8.5	14	0.5
7	7.0	15	0.25
8	6.0	16	0.125

(2) Charge pump

a) Description of operations

Pin voltage comparison takes place at VOUT control section, and then VOUT generation takes place so that the LED cathode voltage with the highest Vf is set to 0.2V. A boost rate is changed automatically to a proper one at the Charge Pump Mode Control section so that operation can take place at possible low boost rate. In addition, if the output voltage falls below 1.5V, this IC is reset for short-circuit at output.

b) Soft start function

BD82103GWL have a soft start function that prevents the rush current.

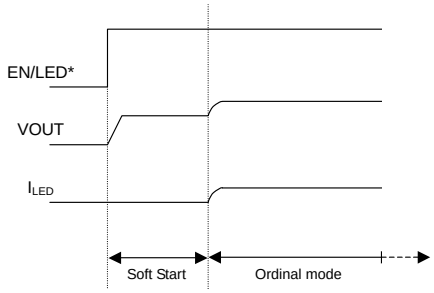


Figure 7. Soft Start

c) Automatic boost rate change

The boost rate automatically switches to the best mode.

*** (×1 mode → ×1.5 mode) or (×1.5 mode → ×2 mode)**

If a battery voltage drop occurs BD82103GWL cannot maintain the LED constant current, and then mode transition begins.

*** (×1.5 mode → ×1 mode) or (×2 mode → ×1.5 mode)**

If a battery voltage rise occurs, VOUT and VBAT detection are activated, and then mode transition begins.

(3) UVLO (Under Voltage Lock Out)

If the input voltage falls below 2.2V, BD82103GWL is shut down to prevent malfunction due to ultra-low voltage.

(4) OVP (Over Voltage Protection)

This circuit protects this IC against damage when the C/P output voltage (VOUT) rises extremely for some external factors.

(5) Thermal shutdown (TSD)

To protect this IC against thermal damage or heat-driven uncontrolled operations, this circuit turns off the output if the chip temperature rises over 175℃. In addition, it turns on the output if the temperature returns to the normal temperature.

(6) Power sequence

EN signal must be released after VBAT voltage enough rise up.

Prohibit the VBAT rise up during EN="H".

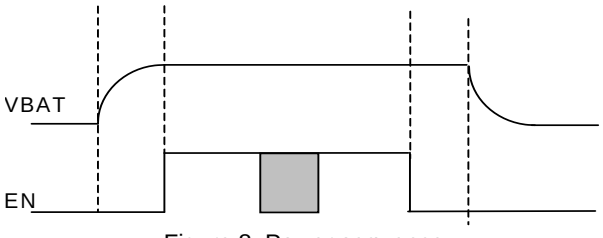


Figure 8. Power sequence

●**Application Circuit Example (3 light)**

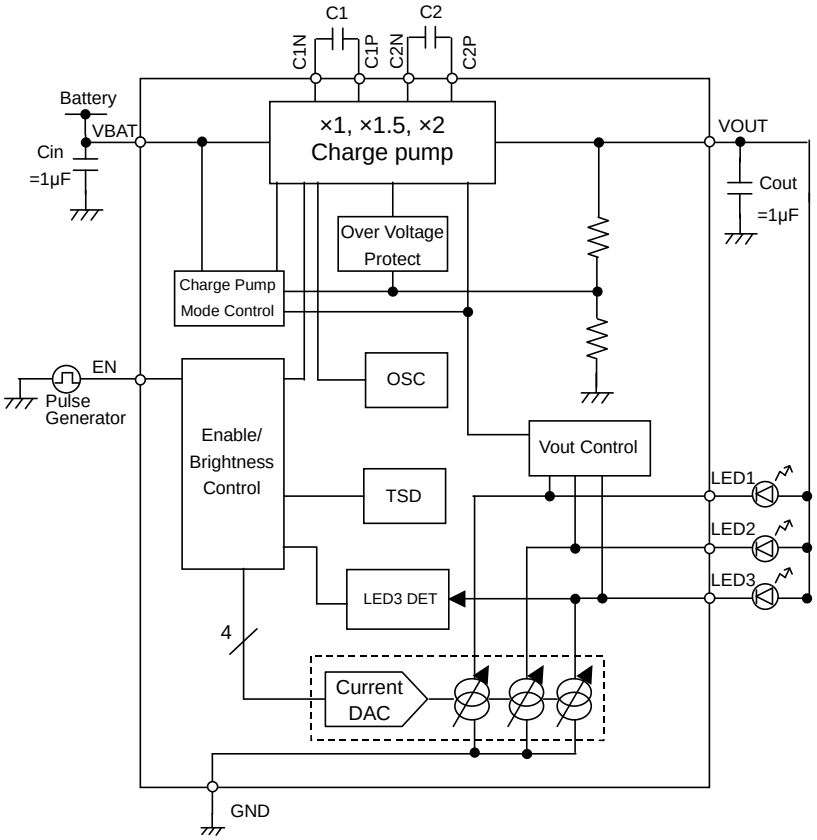


Figure 9. Application Circuit Example 1

●**Application Circuit Example (2 light)**

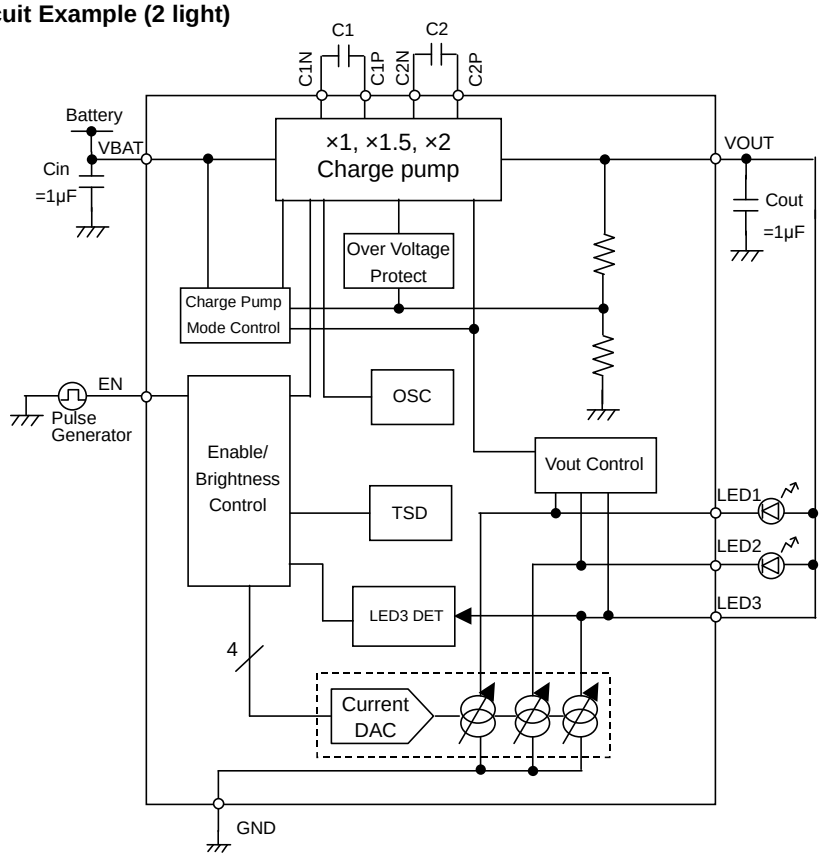


Figure 10. Application Circuit Example 2

●**Operational Notes**

(1) Absolute Maximum Ratings
An excess in the absolute maximum ratings, such as supply voltage, temperature range of operating conditions, etc., can break down 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) Power Supply and Ground Line
Design PCB pattern to provide low impedance for the wiring between the power supply and the ground lines. Pay attention to the interference by common impedance of layout pattern when there are plural power supplies and ground lines. Especially, when there are ground pattern for small signal and ground pattern for large current included the external circuits, please separate each ground pattern. Furthermore, for all power supply pins to ICs, mount a capacitor between the power supply and the ground pin. At the same time, in order to use a 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.

(3) Ground Voltage
Make setting of the potential of the ground pin so that it will be maintained at the minimum in any operating state. Furthermore, check to be sure no pins are at a potential lower than the ground voltage including an actual electric transient.

(4) Short Circuit between Pins 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 pins or between the pin and the power supply or the ground pin, the ICs can break down.

(5) Operation in Strong Electromagnetic Field
Be noted that using ICs in the strong electromagnetic field can malfunction them.

(6) Input Pins
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 pin. Therefore, pay thorough attention not to handle the input pins, such as to apply to the input pins a voltage lower than the ground respectively, so that any parasitic element will operate. Furthermore, do not apply a voltage to the input pins when no power supply voltage is applied to the IC. In addition, even if the power supply voltage is applied, apply to the input pins a voltage lower than the power supply voltage or within the guaranteed value of electrical characteristics.

(7) 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.

(8) Thermal Shutdown Circuit (TSD)
This IC builds in a thermal shutdown (TSD) circuit. When junction temperatures become detection temperature or higher, the thermal shutdown circuit operates and turns a switch OFF. The thermal shutdown circuit, which is aimed at isolating the IC from thermal runaway as much as possible, is not aimed at the protection or guarantee of the IC. Therefore, do not continuously use the IC with this circuit operating or use the IC assuming its operation.

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

(10) LDO
Use each output of LDO by the independence. Don't use under the condition that each output is short-circuited because it has the possibility that an operation becomes unstable.

(11) About the Rush Current
For ICs with more than one power supply, it is possible that rush current may flow instantaneously due to the internal powering sequence and delays. Therefore, give special consideration to power coupling capacitance, power wiring, width of ground wiring, and routing of wiring.

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	8	2	1	0	3	G	W	L	-	E 2

Part Number

Package
GWL: UCSP50L1

Packaging and forming specification
E2: Embossed tape and reel

●Marking Diagram

UCSP50L1 (BD82103GWL)

(TOP VIEW)

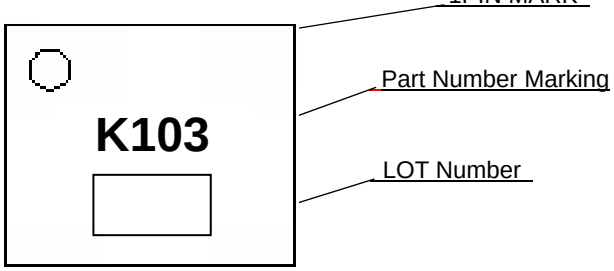
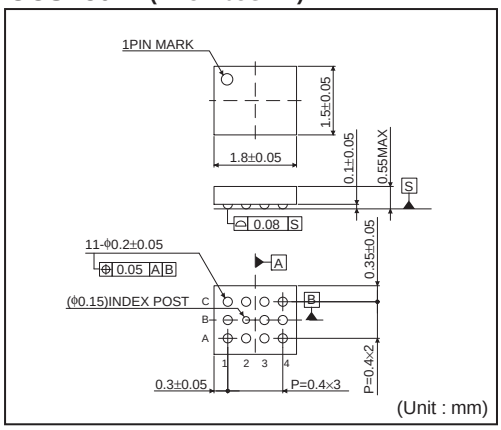


Figure 11. Marking Diagram

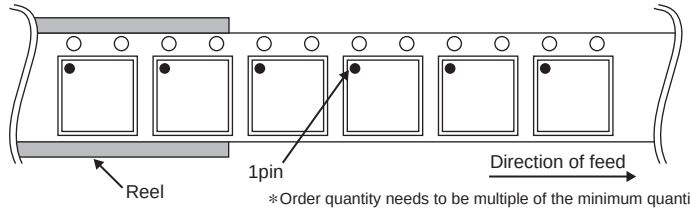
●Physical Dimension Tape and Reel Information

UCSP50L1 (BD82103GWL)



<Tape and Reel information>

Tape	Embossed carrier tape
Quantity	3000pcs
Direction of feed	E2 (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.

Figure 12. UCSP50L1 (BD82103GWL)

●**Revision History**

Date	Revision	Changes
16.Oct.2012	001	New Release

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   [b] Installation of redundant circuits to reduce the impact of single or multiple circuit failure

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   [c] Use of our Products in places where the Products are exposed to sea wind or corrosive gases, including Cl_2, H_2S, NH_3, SO_2, and NO_2
   [d] Use of our Products in places where the Products are exposed to static electricity or electromagnetic waves
   [e] Use of our Products in proximity to heat-producing components, plastic cords, or other flammable items
   [f] Sealing or coating our Products with resin or other coating materials
   [g] Use of our Products without cleaning residue of flux (even if you use no-clean type fluxes, cleaning residue of flux is recommended); or Washing our Products by using water or water-soluble cleaning agents for cleaning residue after soldering
   [h] Use of the Products in places subject to dew condensation

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

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

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

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

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

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

●Precaution for Mounting / Circuit board design

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

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

For details, please refer to ROHM Mounting specification

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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).

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   [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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