ROHM
SEMICONDUCTOR

Synchronous Boost DC/DC Converter (Vout = 5V, Io = 2A, 1ch)

BD1865GWL

Features

- Synchronous Boost DC/DC Converter
  Vout = 5V / Iomax = 2A
- Automatically PFM/PWM Transition.
- Efficiency: 90% @2A-5V (VIN=3.7V)
- Load Disconnect During Shutdown.
- Circuit Current: 66uA (Io=0mA, Typ).
- Adjustable Output Voltage: 4.9V – 5.2V
- Power Supply Voltage Range (Vo=5V, Ta=65°C):
  Iomax = 2.0A: 3.2V – 4.5V.
  Iomax = 1.8A: 3.0V – 3.2V.
  Iomax = 1.5A: 2.7V – 3.0V.
  Iomax = 1.33A: 2.5V – 2.7V.
- UVLO Detection: 2.1V (Max.).
- Switching Frequency: 2.5MHz.
- Thermal Shutdown.
- 16-pin WLCSP.
- Short Circuit Protection
- Over Output Voltage Protection

Applications

- Single-Cell Li-ion Battery-Powered Portable Products
- Tablet Terminal Device, Smartphone

Package

16-pin WL-CSP package: UCSP50L1C
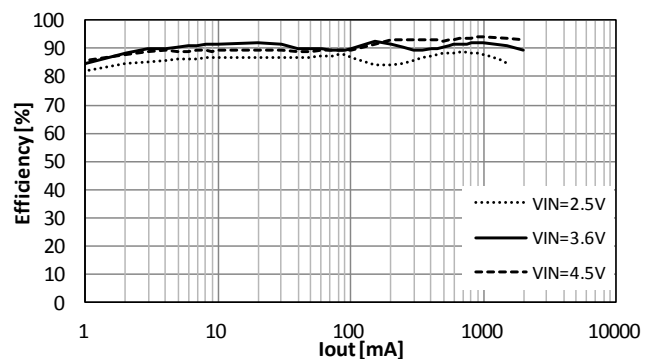W (Typ) x D (Typ) x H (Max): 1.6mm x 1.6mm x 0.57mm

General Description

The BD1865GWL devices provide a power supply solution for products powered by single-cell Li-ion battery. Output currents can go as high as 2A while discharge it down to 3.2V.

With the "MODE" pin, BD1865GWL provides mode selection of "PFM/PWM MODE" or "Mixing-PWM MODE". In "PFM/PWM MODE", the product switches automatically between PWM and PFM operation so that high efficiency is achievable over a wide range of load conditions. "Mixing-PWM MODE" can be prevented Audible Sound by switching noise at light loads.

Typical Application Efficiency
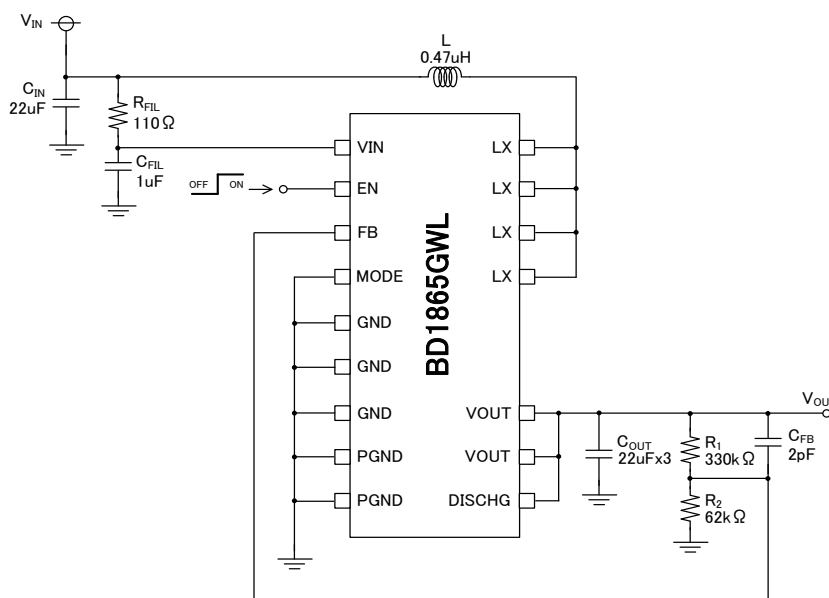
T=25°C, PFM/PWM mode

Typical Application Circuit

Figure. 1   Application Circuit (PFM/PWM mode)

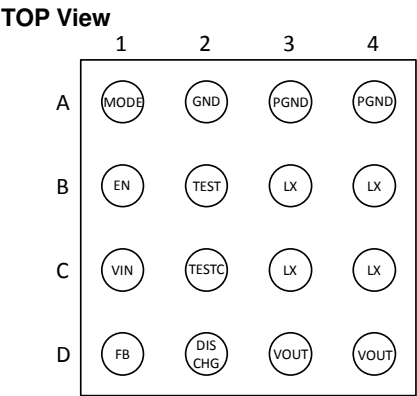○Product structure : Silicon monolithic integrated circuit   ○This product has no designed protection against radioactive rays

TSZ02201-0Q1Q0A900270-1-2
27. Jul. 2015   Rev. 002

Pin Configuration

TOP View

Figure. 2   Pin Configuration

Pin Description

Pin No.	Pin Name	I/O	Function

A1	MODE	I	Operation Mode Select Pin.
			  MODE=Low : PFM/PWM MODE
			  MODE=High: Mixing-PWM MODE [Note 1]

A2, B2, C2	GND	-	Analog Ground. This terminal is used as the ground reference of the internal circuit.
A3, A4	PGND	-	Power Ground.

B1	EN	I	Enable Pin.
			  EN=Low : Disable
			  EN=High : Enable

B3, B4, C3, C4	LX	I/O	Inductor Connection Terminal.
C1	VIN	I	Power Supply Input.
D1	FB	I	Output Feedback Pin.
D2	DISCHG	I	Discharge Pin. For PFM/PWM mode, this terminal can be used as VOUT discharge. For Mixing-PWM mode, this terminal should be shorted to MODE. [Note 1]
D3, D4	VOUT	O	Boost Converter Output.

(Note 1) Refer to "Application Information (P.10)" about MODE pin setting for Mixing-PWM mode. In addition, only during EN=L, the changing the operation mode is possible.
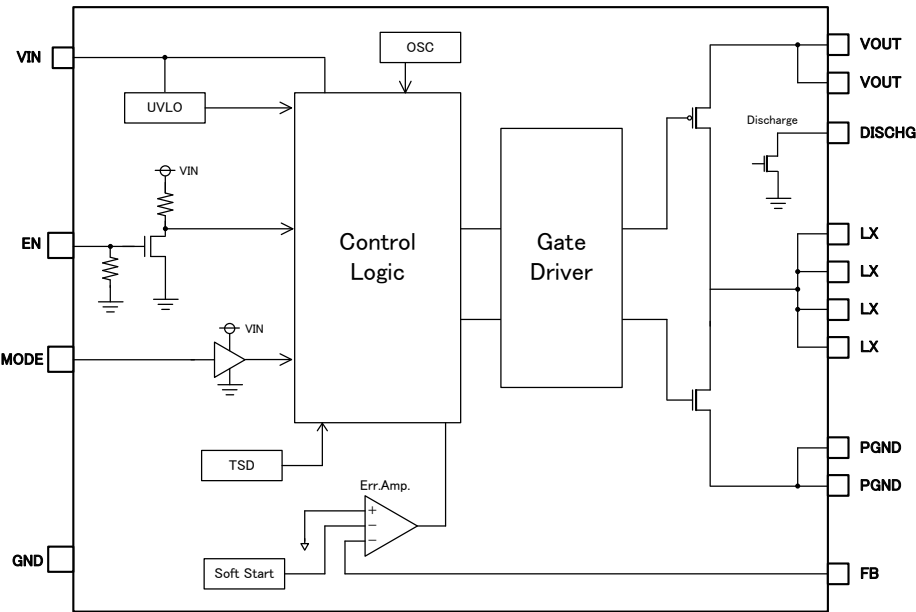
Block Diagram

Figure. 3   Functional Block Diagram

Absolute Maximum Ratings (Ta = 25°C)

Parameter	Symbol	Rating	Unit
Power Dissipation (Note 2)	P_d	2.04	W
Operating Temperature Range	T_{opr}	-40 to +85	°C
Storage Temperature Range	T_{stg}	-55 to +125	°C
Maximum Applied Voltage: EN	V_{ENMAX}	-0.3 to 7.0	V
Maximum Applied Voltage: FB	V_{FBMAX}	-0.3 to 7.0	V
Maximum Applied Voltage: VOUT	V_{OUTMAX}	-0.3 to 7.0	V
Maximum Applied Voltage: DISCHG	V_{DISMAX}	-0.3 to 7.0	V
Maximum Applied Voltage: VIN	V_{INMAX}	-0.3 to 7.0	V
Maximum Applied Voltage: LX	V_{LXMAX}	-1.0 to 7.0 (DC) -3.2 to 8.0 (Pulse 10ns)	V
Maximum Applied Voltage: MODE	$V_{MODEMAX}$	-0.3 to 7.0	V
Maximum Applied Voltage: GND, PGND	V_{GNDMAX}	GND	V

(Note 2) This data is measured with ROHM evaluation board. (101.5 mm x 114.5 mm, 4-layer)
Caution: Operating the IC over the absolute maximum ratings may damage the IC. The damage can either be a short circuit between pins or an open circuit between pins and the internal circuitry. Therefore, it is important to consider circuit protection measures, such as adding a fuse, in case the IC is operated over the absolute maximum ratings.

Recommended Operating Condition (Ta= -40°C to +85°C)

Parameter	Symbol	Min	Typ	Max	Unit	Conditions
Supply Voltage	V_{IN}	2.5	3.6	4.5	V	

Electrical Characteristics (Unless otherwise specified V_{IN}=3.6V, Ta=25°C, V_{OUT}=5V)

Parameter	Symbol	Min	Typ	Max	Unit	Conditions
Shutdown Current (EN=0V)	Ist	-	0.1	1.0	µA	EN=0V,MODE=0V
Quiescent Current 1 no switching (PFM /PWM MODE)	ICC1	-	67	130	µA	EN=VIN,MODE=0V, FB=1V, Io=0mA (not include SW)
Quiescent Current 2 no switching (Mixing PWM MODE)	ICC2	-	300	600	µA	EN=VIN,MODE=VIN, FB=1V, Io=0mA (not include SW, Internal OSC ON)
Switching Frequency	Fsw	2.25	2.5	2.75	MHz	PWM operation
Feedback Voltage	V_{FB}	0.79	0.80	0.81	V	PWM operation
EN Input High	V_{IH_EN}	1.16	-	5.5	V	
EN Input Low	V_{IL_EN}	-0.3	-	0.3	V	
EN Pull-down Resistance	R_{PD_EN}	0.5	1	1.5	MΩ	
UVLO Detect Threshold	V_{UVLO}	2.00	2.05	2.10	V	VIN falling.
UVLO Release Threshold	$V_{UVLORLS}$	2.15	2.20	2.25	V	VIN rising.
Ramp up Time (Soft-Start)	t_{SS}	0.4	0.72	1.4	ms	10 – 95% Rise time. R_{load}=50ohm
NMOS ON Resistance	R_{ONN}	-	39	-	mΩ	
PMOS ON Resistance	R_{ONP}	-	48	-	mΩ	
Switch Current Limit	I_{OCP}	5.1	-	-	A	
Over Voltage Protection	V_{OVP}	-	-	6.5	V	
Discharge Resistance	R_{DISCHG}	2.5	5	10	Ω	
Output Capacitor (Note 3)	C_{OUT}	21	-	-	µF	

(Note 3) This value is the effective capacitance. It is required that the output capacitor value included the temperature and DC bias characteristics is higher than C_{OUT}(Min).

Typical Performance Curve (Unless otherwise specified V_{IN}=3.6V, V_{OUT}=5.058V, Ta=25℃)
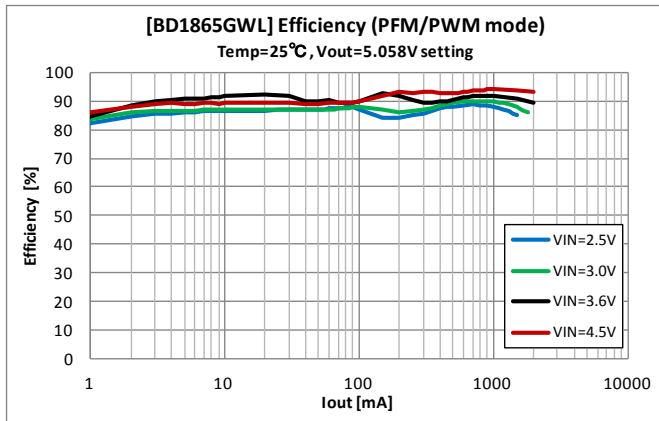

Figure. 4   Efficiency (PFM/PWM mode)
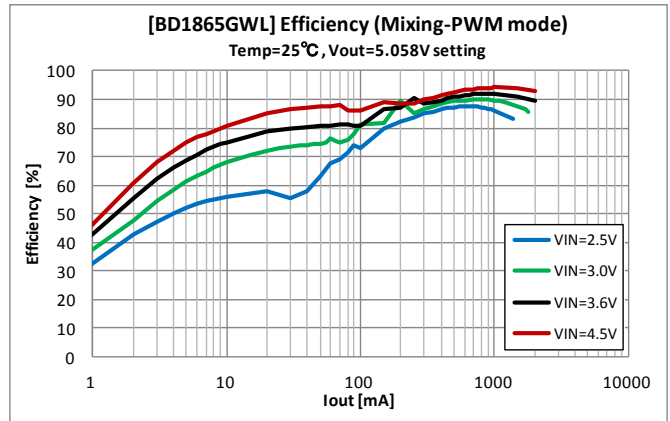

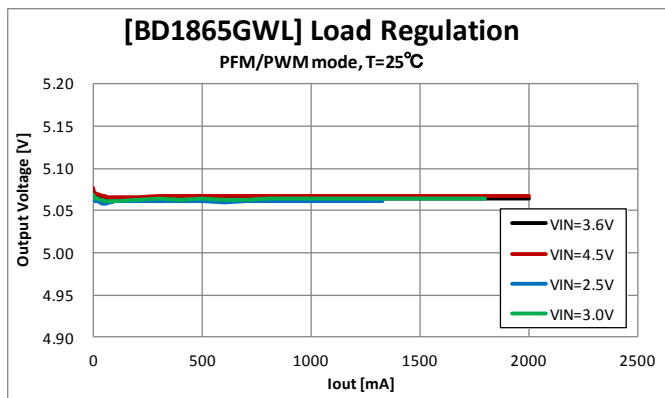Figure. 5   Efficiency (Mixing-PWM mode)

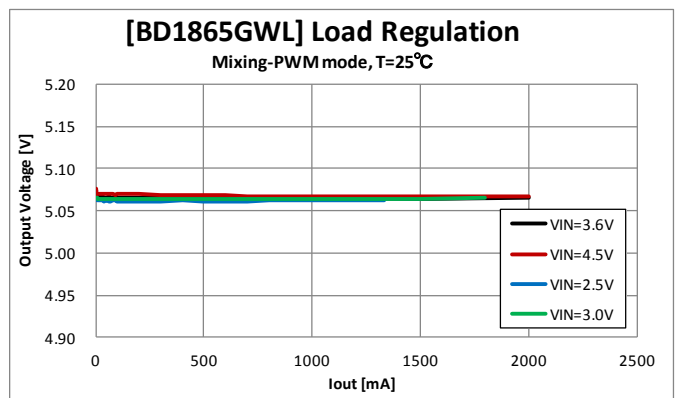Figure. 6   Load Regulation (PFM/PWM mode)

Figure. 7   Load Regulation (Mixing-PWM mode)
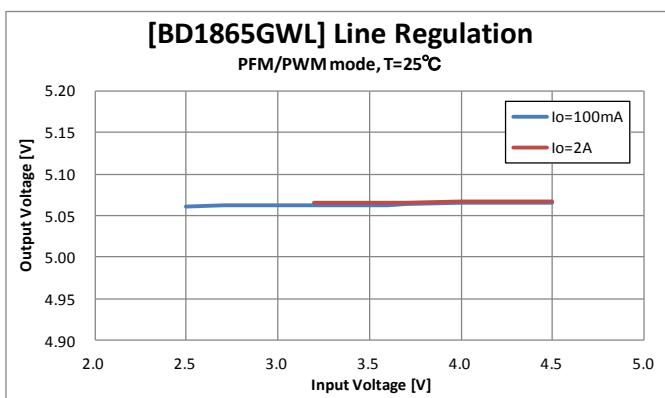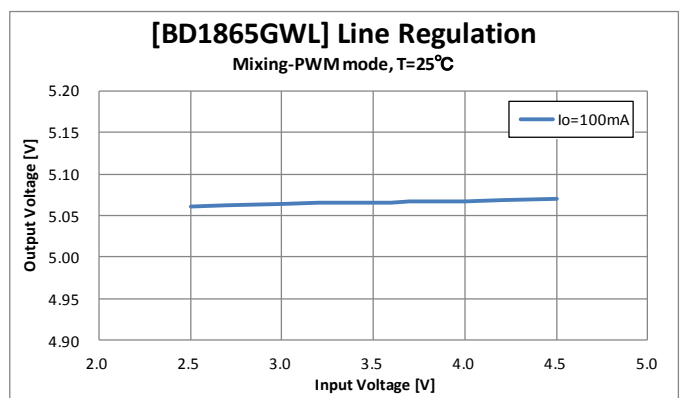

Figure. 8   Line Regulation (PFM/PWM mode)

Figure. 9   Line Regulation (Mixing-PWM mode)

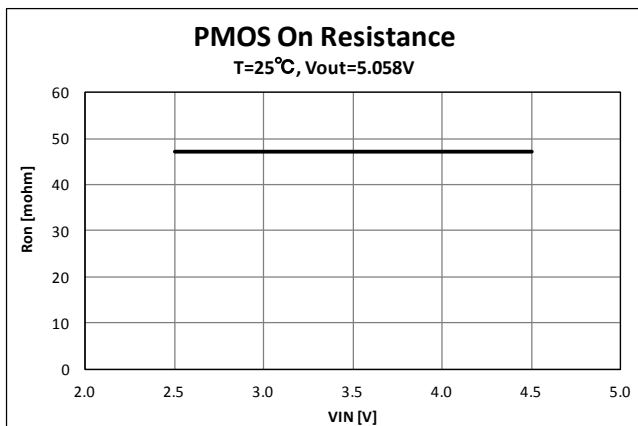**Typical Performance Curve (Cont'd)** (Unless otherwise specified V_{IN}=3.6V, V_{OUT}=5.058V, Ta=25℃)

Figure. 10   PMOS ON Resistance
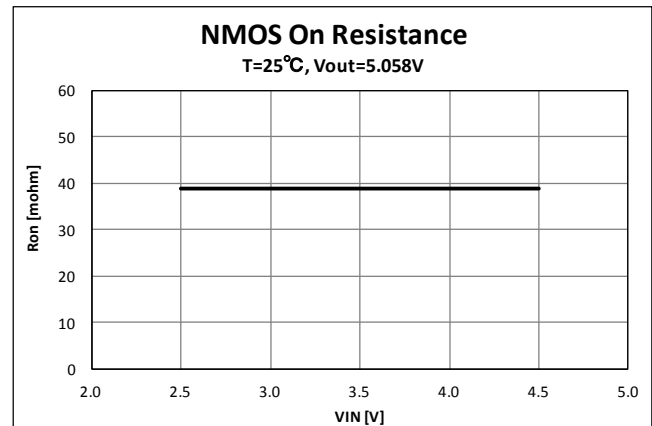

Figure. 11   NMOS ON Resistance
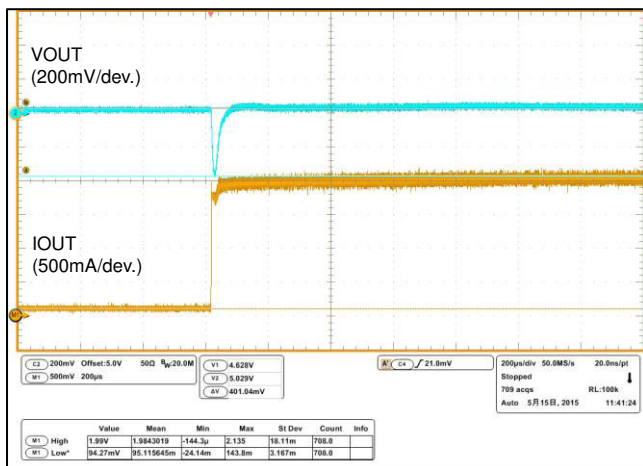
Figure.   12   Transient Response (PFM/PWM mode)
Io=100mA to 2A (t_{RISE}=250ns)
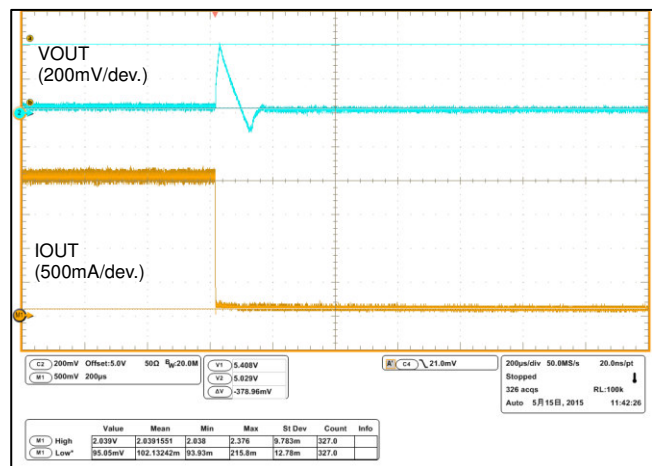
Figure.   13   Transient Response (PFM/PWM mode)
Io=2A to 100mA (t_{FALL}=250ns)
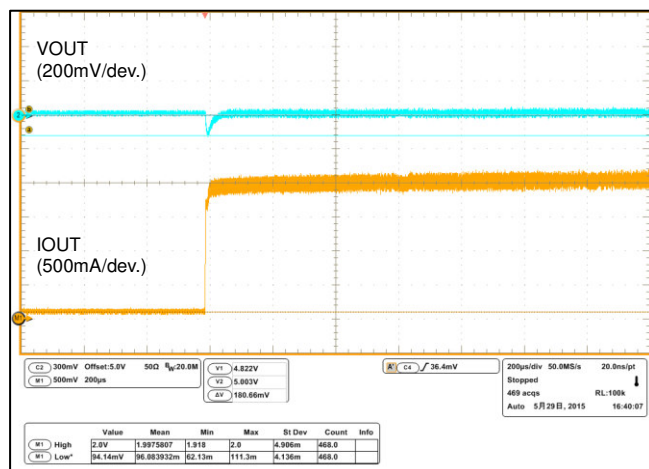
Figure.   14   Transient Response (Mixing-PWM mode)
Io = 100mA to 2A (t_{RISE}=250ns)
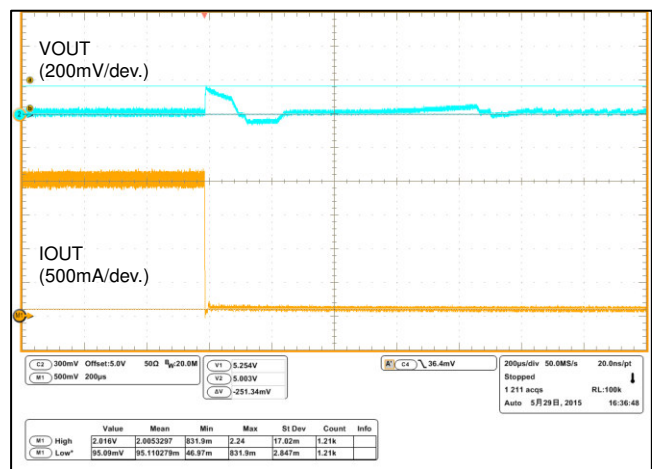
Figure.   15   Transient Response   (Mixing-PWM mode)
Io =2A to 100mA (t_{FALL}=250ns)

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TSZ22111 • 15 • 001

5/17

TSZ02201-0Q1Q0A900270-1-2
27. Jul. 2015   Rev.002

Typical Performance Curve (Cont'd) (Unless otherwise specified V_{IN}=3.6V, V_{OUT}=5.058V, Ta=25℃)
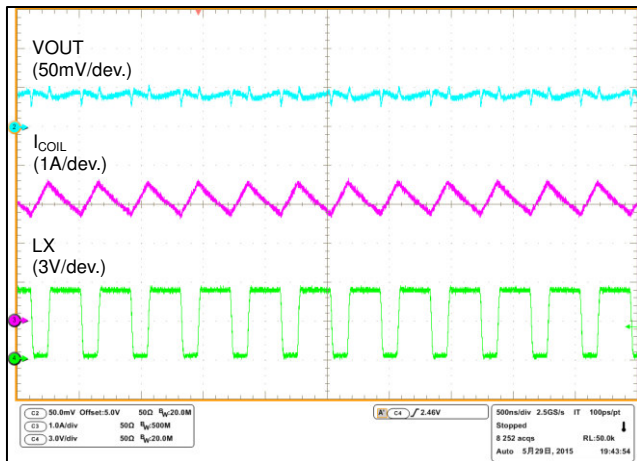
Figure. 16   Operation Waveform (PWM)
Io = 2A

Figure. 17   Operation Waveform (PFM)
Io = 1mA

Figure. 18   Operation Waveform (Mixing-PWM)
Io = 1mA

Figure. 19   Reversed Current from VOUT to VIN
(EN = L)

Figure. 20   Start-up Waveform (Soft-Start) Io = 0A

Figure. 21   Shutdown Waveform   Io = 0A

Detailed Description

1.) Start-up (SOFT START)

After being enabled, BD1865GWL starts the Soft Start operation. First, high side switch MOS is turned on and the output voltage 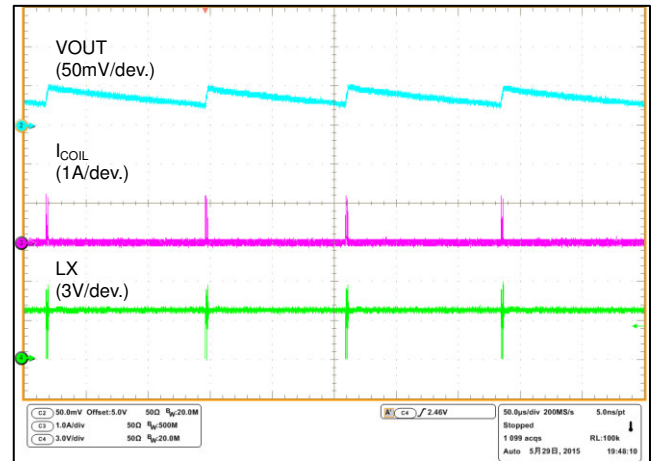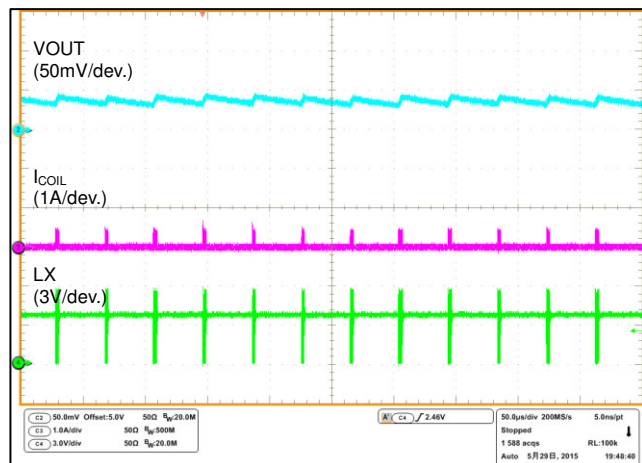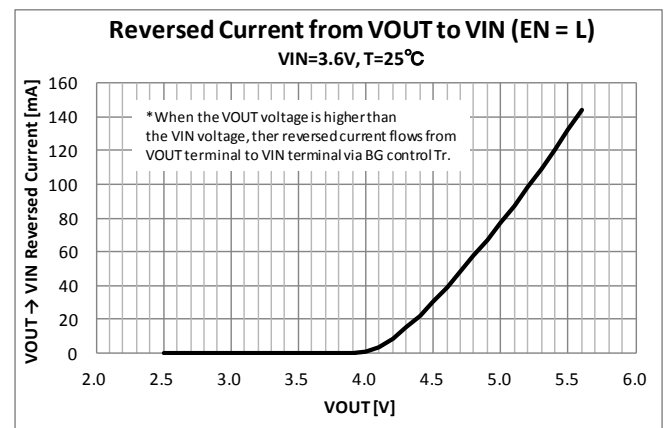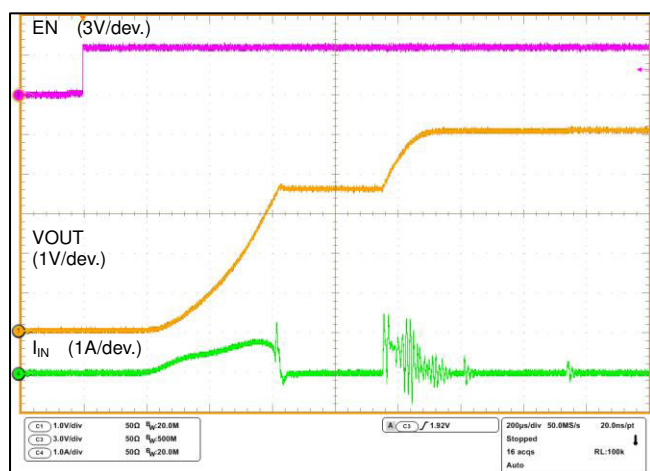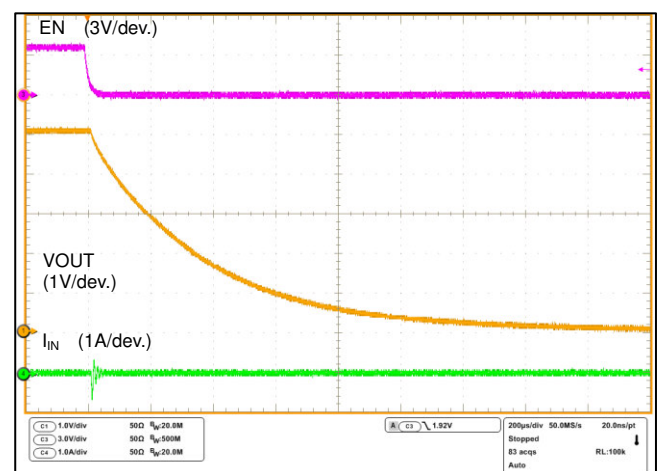VOUT is lifted to the input voltage VIN level, applying restriction to current. (Current Restriction Operation) For this operation, up to around 1A external load is allowed. Then, the device starts switching operation and VOUT is risen up to setting voltage adjusting the output slew rate by DAC for Soft Start. (Soft Start Operation) This soft start operation is reset by EN, UVLO, TSD and SCP.

Attention is necessary to change input rush current and start-up time by the output capacitor.
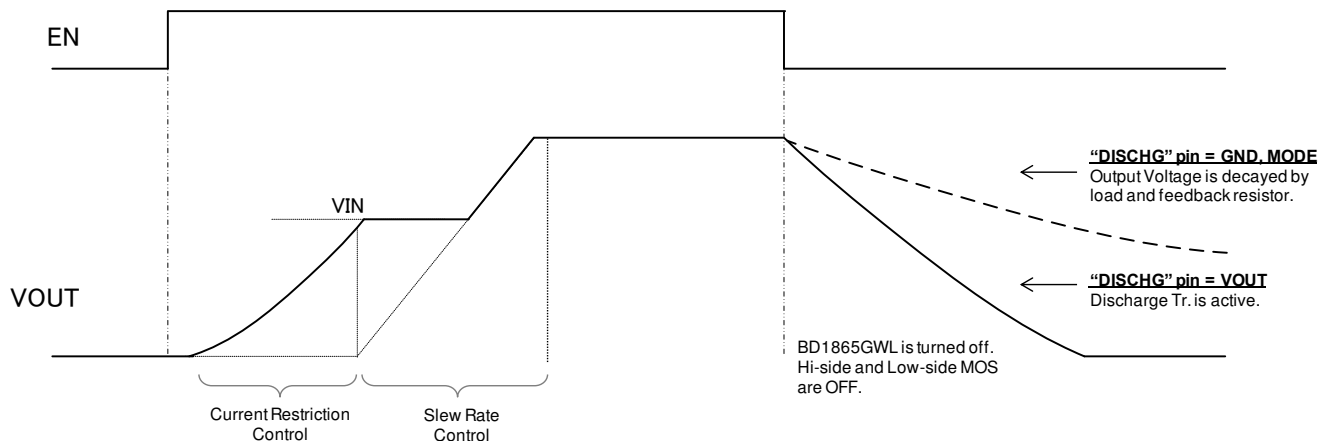

Figure. 23   Start-up (Soft Start) and Shutdown Operation

2.) Discharge for Output Terminal (For PFM/PWM mode)

In PFM/PWM mode, the discharge function is selectable as described below.
- DISCHG terminal is shorted to VOUT; the discharge Tr. in the device is active. VOUT terminal is always discharged when DC/DC converter is in standby state.
- DISCHG terminal is shorted to GND; the discharge Tr. in the device is inactive. VOUT terminal voltage is decayed by load and feedback resistor when DC/DC converter is turned off.

In Mixing-PWM mode, DISCHG terminal is shorted to MODE terminal.

3.) Under Voltage Lock Out (UVLO)

UVLO prevents malfunction of the internal circuit at the time of rising or dropping to a lower value of power supply voltage. If the VIN voltage becomes lower than 2.05V(Typ), the DC/DC converter is turned off. In order to cancel UVLO of VIN, it is necessary to set VIN more than 2.2V(Typ).

4.) Output Overvoltage Protection (OVP)

BD1865GWL turns off the switching operation when the VOUT voltage becomes over V_{OVP}. At that time, the VOUT terminal is not discharge (in the case that DISCHG terminal is shorted to VOUT). If the VOUT voltage becomes less than V_{OVP}, movement returns it.

5.) Over Current Protection (OCP)

BD1865GWL has the function to limit the switching current.

OCP detector is active during low side MOS is in ON state.

When the heavy load is connected such that the peak of switching current Ipeak is above OCP threshold, OCP function becomes active. ON-time of low side MOS is limited so that Ipeak does not exceed OCP threshold, and VOUT voltage decreases.

6.) Short Circuit Protect (SCP)

BD1865GWL has Automatic reboot type Short Current Protect function.

SCP is detected when the VOUT voltage becomes lower than VIN x 0.924(Typ). At that moment, the switching operation is turned off and VOUT terminal is discharged (in the case that DISCHG terminal is shorted to VOUT).

Then, the device starts the Soft Start operation for reboot without distinction of the value of the load resistance. If the VOUT terminal is shorted to GND or the heavy load exceeding the specification value, the device keeps Current restriction state.

Detailed Description (Cont'd)

VOUT terminal is
shorted to ground

VOUT （5V）

SCP detect
BD1865GWL turns off
switching operation.

VIN x 0.924

VOUT decrease by OCP.

Automatic Reboot
(Soft Start)

VIN

VOUT （5V）

Slew rate
control

0V

Current
restriction
control

Time interval (usec order)

Once DC/DC converter operation is turned off and
VOUT terminal is discharged.
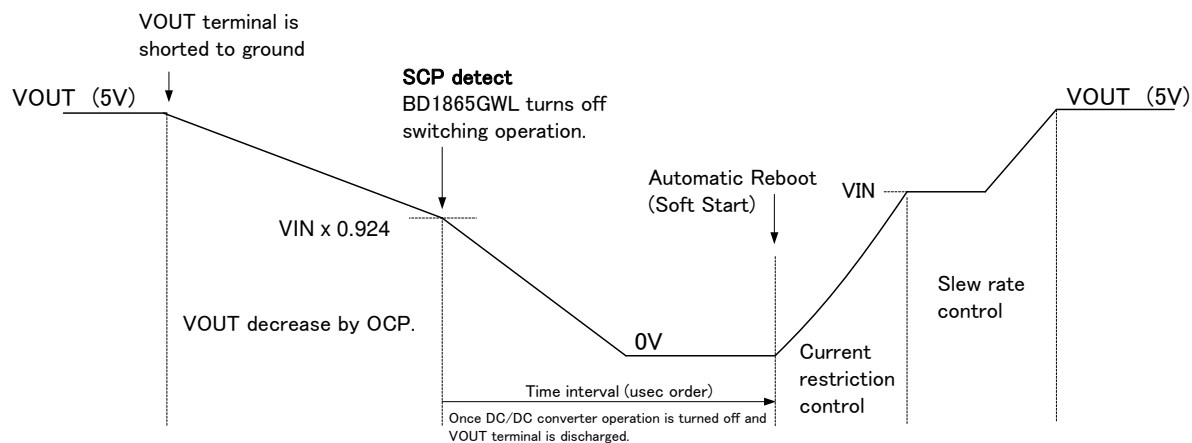
Figure. 24   Output Voltage in SCP Operation

7.) Thermal Shutdown (TSD)

BD1865GWL turns off the switching operation when the device temperature exceeds the threshold value for the device protection. After the device temperature falls below the threshold value, the device starts the Soft Start operation.

8.) Mixing PWM mode

Mixing-PWM mode is possible to be High Efficiency and Audible Sound Human defection at light load using Mixing PWM controller. Mixing PWM controller is mixing frequency of 25kHz and 2.5MHz. Therefore, this can prevent the sound rumbles such as capacitor because a noise does not occur in audible range.

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TSZ22111 • 15 • 001

8/17

TSZ02201-0Q1Q0A900270-1-2
27. Jul. 2015   Rev.002

Reference Application Circuit
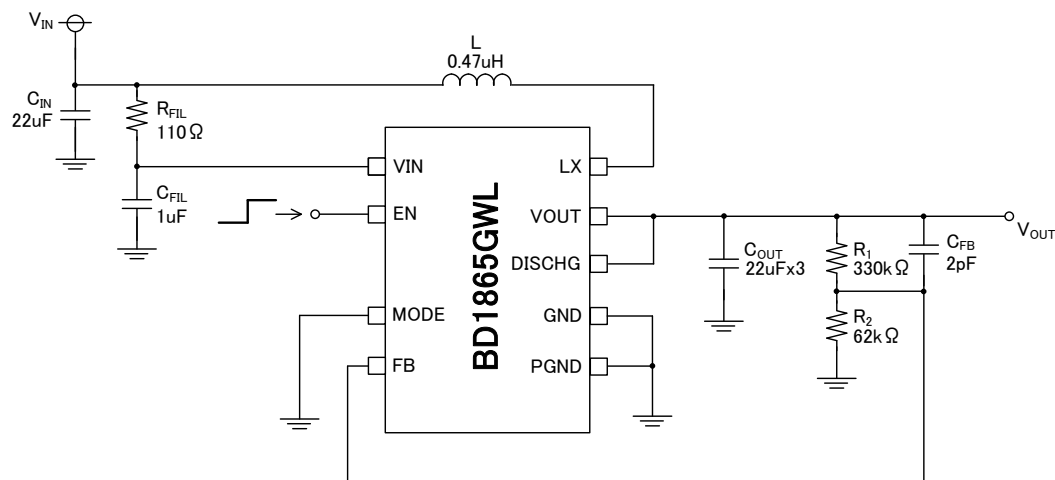
Figure. 25   (PFM/PWM mode) Typical Application Circuit
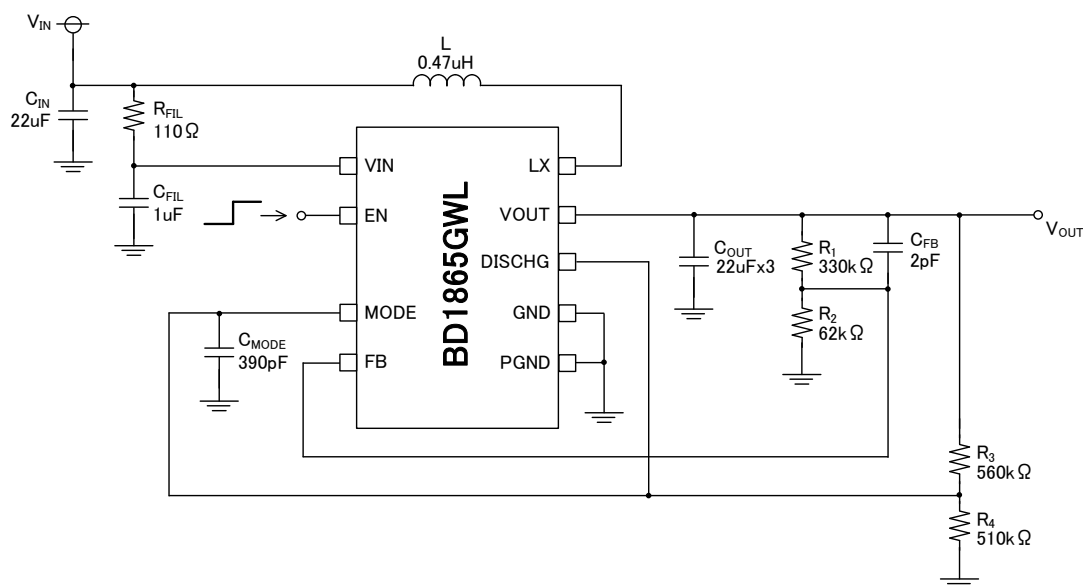
Figure. 26   (Mixing-PWM mode) Typical Application Circuit

Reference BOM List

VOUT = 5.058V setting.

Name	Type	Value	Area (mm)	Height(Max) (mm)	Rated Voltage	Parts Number	Manufacturer
C_{IN}	Capacitor	22uF	2012	0.95	10V	GRM219R61A226MEA0D	MURATA
C_{OUT}	Capacitor	22uF x 3	2012	1.45	10V	LMK212BBJ226MG-T	TAIYO YUDEN
C_{FB}	Capacitor	2pF	0603	0.33	50V	UMK063CK020CT	TAIYO YUDEN
L	Inductor	0.47uH	3225	1.2	-	PIFE32251B-R47MS-88	CYNTEC
R_1	Resistor	330kΩ	1005	0.40	-	MCR01MZPD3303	ROHM
R_2	Resistor	62kΩ	1005	0.40	-	MCR01MZPD6202	ROHM
R_{FIL}	Resistor	110Ω	1608	0.55	-	MCR03MZPJ110	ROHM
C_{FIL}	Capacitor	1uF	1005	0.55	16V	EMK105BJ105KV	TAIYO YUDEN
R_3*	Resistor	560kΩ	1005	0.40	-	MCR01MZPD5603	ROHM
R_4*	Resistor	510kΩ	1005	0.40	-	MCR01MZPD5103	ROHM
C_{MODE}*	Capacitor	390pF	1005	0.55	50V	UMK105CH391JV-F	TAIYO YUDEN

*Only for Mixing-PWM mode.

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9/17

TSZ02201-0Q1Q0A900270-1-2
27. Jul. 2015   Rev.002

Application Information

1.) Output Voltage Setting

BD1865GWL controls FB terminal become to 0.8V (Typ). The output voltage is adjustable from 4.9V ~ 5.2V by changing R_1 and R_2.

The output voltage VOUT is calculated by Equation 1. The sum of R_1 and R_2 should be set up more than 100kΩ.

$$V_{out} = V_{FB} \cdot \left(\frac{R_1 + R_2}{R_2} \right) = 0.8 \cdot \left(\frac{R_1 + R_2}{R_2} \right)$$
(1)

2.) MODE pin setting for Mixing-PWM mode

For Mixing-PWM mode, it is required to supply the voltage that divided VOUT to MODE terminal as shown in Fig.24. R_3, R_4 and C_{MODE} should be selected as satisfying Equation 2 and Equation 3.
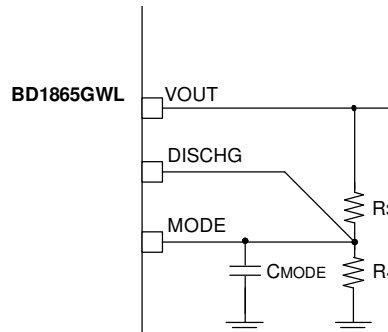
Figure.   28   Voltage Dividing Circuit for MODE Terminal (Mixing-PWM mode)

$$0.467 < \left(\frac{R_4}{R_3 + R_4} \right) < 0.480$$
(2)

$$550\mu s < 2\pi \cdot (R_3 // R_4) \cdot C_{MODE} < 1ms$$
(3)

Reference Board Layout
(PFM/PWM mode)

TOP View
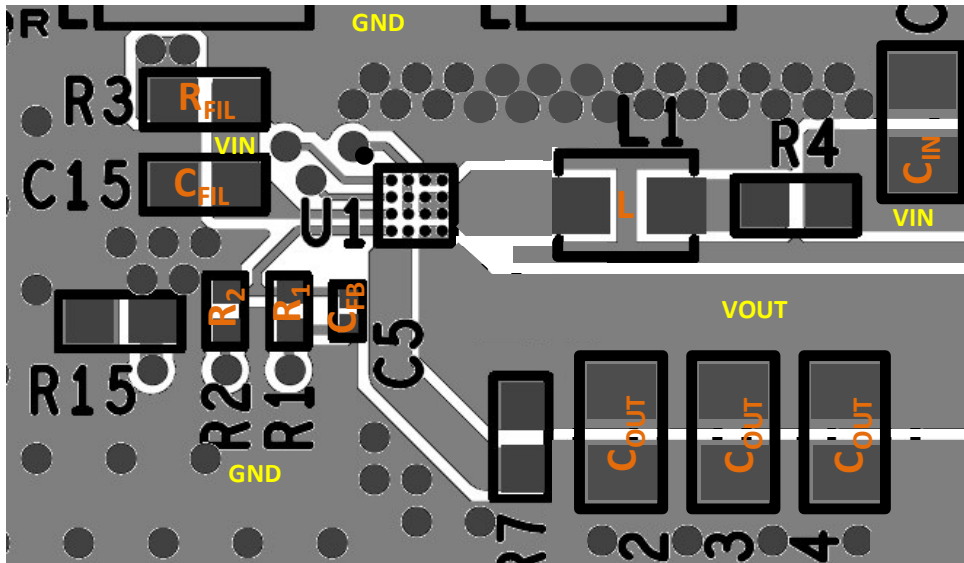
Figure.   29   Reference Board Layout (TOP Layer)

Pin Equivalence Circuit

Pin. No	Pin Name	Pin equivalence circuit
B1	EN	
A1	MODE	
C1 A3 A4 A2	VIN PGND GND	

Pin. No	Pin Name	Pin equivalence circuit
D1	FB	
D2	DIS CHG	
D3 D4 B2 B3 C2 C3	VOUT LX	

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11/17

TSZ02201-0Q1Q0A900270-1-2
27. Jul. 2015   Rev.002

Thermal Derating Curve

In the heat design, please operate it in the following condition.
(Please consider the margin etc. because the following temperature is a guarantee temperature.)

     1. Surrounding temperature Ta must be 85℃ or less.
     2. Loss of IC must be permissible loss Pd or less.

The allowable dissipation (Pd) characteristics are described below.
  *This data is measured with ROHM Evaluation board.
   (FR-4 / 4-layer / Size: 101.5mm x 114.5mm x 1.6mm / Copper Thickness: 2oz Outer, 1oz Inner)

Figure. 30   Thermal Derating Curve

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12/17

TSZ02201-0Q1Q0A900270-1-2
27. Jul. 2015   Rev.002

Operational Notes

1.) Reverse Connection of Power Supply
   Connecting the power supply in reverse polarity can damage the IC. Take precautions against reverse polarity when connecting the power supply, such as mounting an external diode between the power supply and the IC's power supply pins.

2.) Power Supply Lines
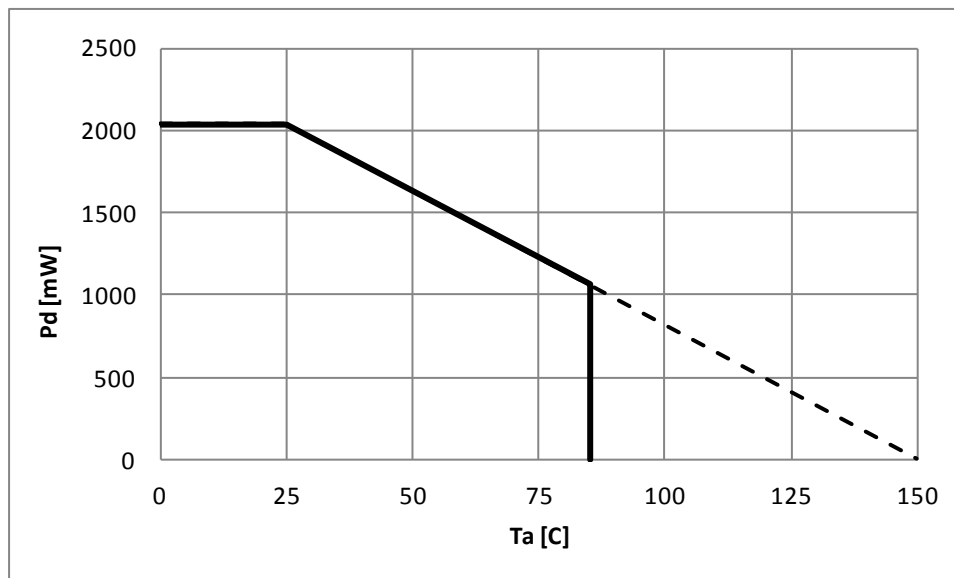   Design the PCB layout pattern to provide low impedance supply lines. Furthermore, connect a capacitor to ground at all power supply pins. Consider the effect of temperature and aging on the capacitance value when using electrolytic capacitors.

3.) Ground Voltage
   Ensure that no pins are at a voltage below that of the ground pin at any time, even during transient condition. However, pins that drive inductive loads (e.g. motor driver outputs, DC-DC converter outputs) may inevitably go below ground due to back EMF or electromotive force. In such cases, the user should make sure that such voltages going below ground will not cause the IC and the system to malfunction by examining carefully all relevant factors and conditions such as motor characteristics, supply voltage, operating frequency and PCB wiring to name a few.

4.) Ground Wiring Pattern
   When using both small-signal and large-current ground traces, the two ground traces should be routed separately but connected to a single ground at the reference point of the application board to avoid fluctuations in the small-signal ground caused by large currents. Also ensure that the ground traces of external components do not cause variations on the ground voltage. The ground lines must be as short and thick as possible to reduce line impedance.

5.) Thermal Consideration
   Should by any chance the power dissipation rating be exceeded the rise in temperature of the chip may result in deterioration of the properties of the chip. In case of exceeding this absolute maximum rating, increase the board size and copper area to prevent exceeding the Pd rating.

6.) Recommended Operating Conditions
   These conditions represent a range within which the expected characteristics of the IC can be approximately obtained. The electrical characteristics are guaranteed under the conditions of each parameter.

7.) Inrush Current
   When power is first supplied to the IC, it is possible that the internal logic may be unstable and inrush current may flow instantaneously due to the internal powering sequence and delays, especially if the IC has more than one power supply. Therefore, give special consideration to power coupling capacitance, power wiring, width of ground wiring, and routing of connections.

8.) Operation Under Strong Electromagnetic Field
   Operating the IC in the presence of a strong electromagnetic field may cause the IC to malfunction.

9.) Testing on Application Boards
   When testing the IC on an application board, connecting a capacitor directly to a low-impedance output pin may subject the IC to stress. Always discharge capacitors completely after each process or step. The IC's power supply should always be turned off completely before connecting or removing it from the test setup during the inspection process. To prevent damage from static discharge, ground the IC during assembly and use similar precautions during transport and storage.

10.) Inter-pin Short and Mounting Errors
   Ensure that the direction and position are correct when mounting the IC on the PCB. Incorrect mounting may result in damaging the IC. Avoid nearby pins being shorted to each other especially to ground, power supply and output pin. Inter-pin shorts could be due to many reasons such as metal particles, water droplets (in very humid environment) and unintentional solder bridge deposited in between pins during assembly to name a few.

11.) Unused Input Pins
   Input pins of an IC are often connected to the gate of a MOS transistor. The gate has extremely high impedance and extremely low capacitance. If left unconnected, the electric field from the outside can easily charge it. The small charge acquired in this way is enough to produce a significant effect on the conduction through the transistor and cause unexpected operation of the IC. So unless otherwise specified, unused input pins should be connected to the power supply or ground line.

12.) Regarding the Input Pin of the IC
   This monolithic IC contains P+ isolation and P substrate layers between adjacent elements in order to keep them isolated. P-N junctions are formed at the intersection of the P layers with the N layers of other elements, creating a parasitic diode or transistor. For example (refer to figure below):

   When GND > Pin A and GND > Pin B, the P-N junction operates as a parasitic diode.
   When GND > Pin B, the P-N junction operates as a parasitic transistor.

Operational Notes (Cont'd)

Parasitic diodes inevitably occur in the structure of the IC. The operation of parasitic diodes can result in mutual interference among circuits, operational faults, or physical damage. Therefore, conditions that cause these diodes to operate, such as applying a voltage lower than the GND voltage to an input pin (and thus to the P substrate) should be avoided.
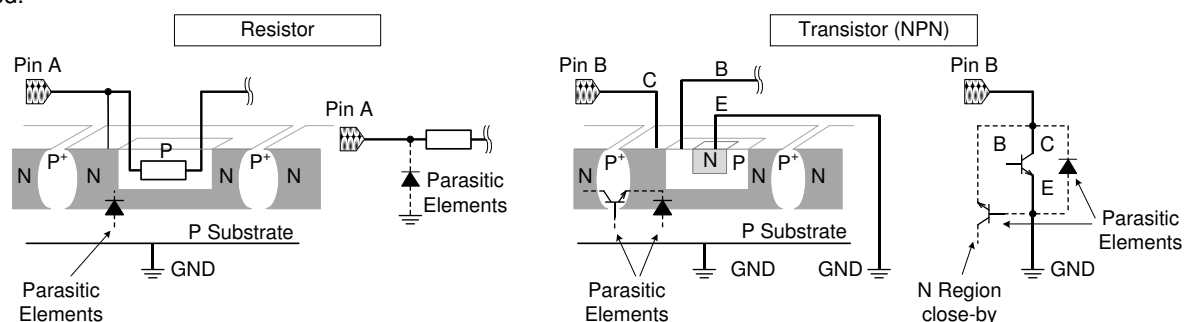

Figure xx. Example of monolithic IC structure

13.) Ceramic Capacitor

When using a ceramic capacitor, determine the dielectric constant considering the change of capacitance with temperature and the decrease in nominal capacitance due to DC bias and others.

14.) Area of Safe Operation (ASO)

Operate the IC such that the output voltage, output current, and power dissipation are all within the Area of Safe Operation (ASO).

15.) Thermal Shutdown Circuit(TSD)

This IC has a built-in thermal shutdown circuit that prevents heat damage to the IC. Normal operation should always be within the IC's power dissipation rating. If however the rating is exceeded for a continued period, the junction temperature (Tj) will rise which will activate the TSD circuit that will turn OFF all output pins. When the Tj falls below the TSD threshold, the circuits are automatically restored to normal operation.

Note that the TSD circuit operates in a situation that exceeds the absolute maximum ratings and therefore, under no circumstances, should the TSD circuit be used in a set design or for any purpose other than protecting the IC from heat damage.

16.) Over Current Protection Circuit (OCP)

This IC incorporates an integrated overcurrent protection circuit that is activated when the load is shorted. This protection circuit is effective in preventing damage due to sudden and unexpected incidents. However, the IC should not be used in applications characterized by continuous operation or transitioning of the protection circuit.

17.) Disturbance light

In a device where a portion of silicon is exposed to light such as in a WL-CSP, IC characteristics may be affected due to photoelectric effect. For this reason, it is recommended to come up with countermeasures that will prevent the chip from being exposed to light.

Ordering Information

| B | D | 1 | 8 | 6 | 5 | G | W | L | - | E | 2 |

Part No.

Package
GWL : UCSP50L1C

Packaging and forming specification
E2: Embossed tape and reel

Footprint Dimensions (Optimize footprint dimensions to the board design and soldering condition)

Symbol	Reference Value
e	0.40
b3	Φ0.20
SD	0.20
SE	0.20

(Unit: mm)

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TSZ22111 • 15 • 001
15/17
TSZ02201-0Q1Q0A900270-1-2
27. Jul. 2015   Rev.002
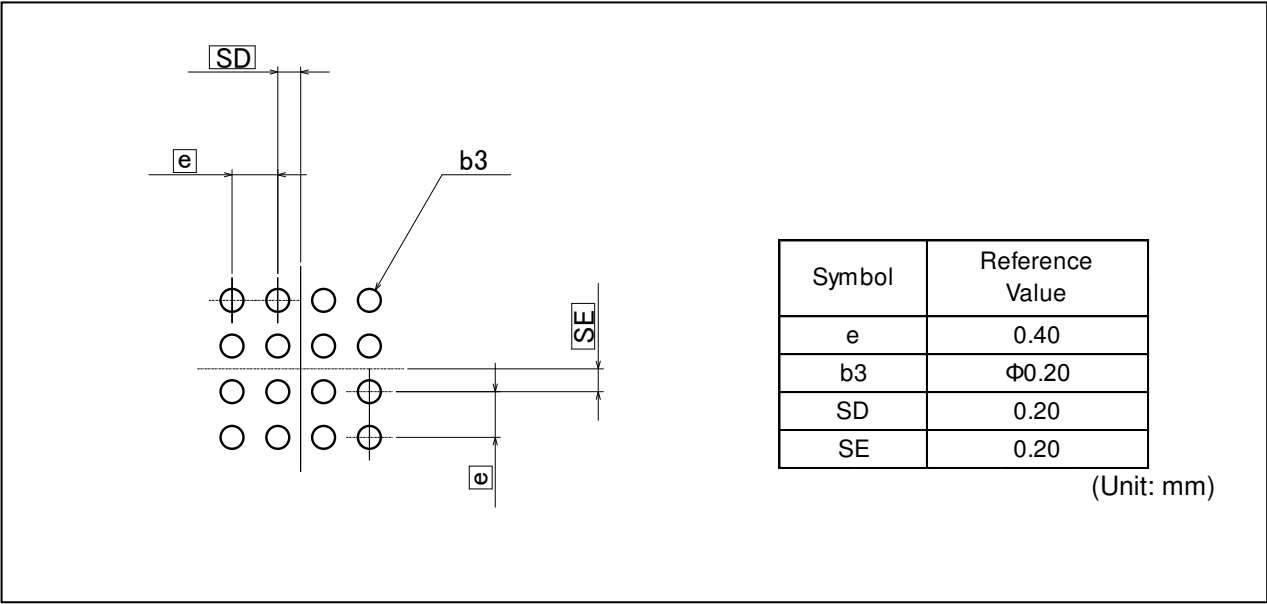
Physical Dimension Tape and Reel Information

Package Name	UCSP50L1C (BD1865GWL)

1PIN MARK   Lot No.

1865

1.6±0.05

1.6±0.05

0.1±0.05
0.57MAX

⌓ 0.06 S

16−φ 0.20±0.05

⊕ 0.05 A B

0.2±0.05

P=0.4×3

0.2±0.05   P=0.4×3

(Unit: mm)
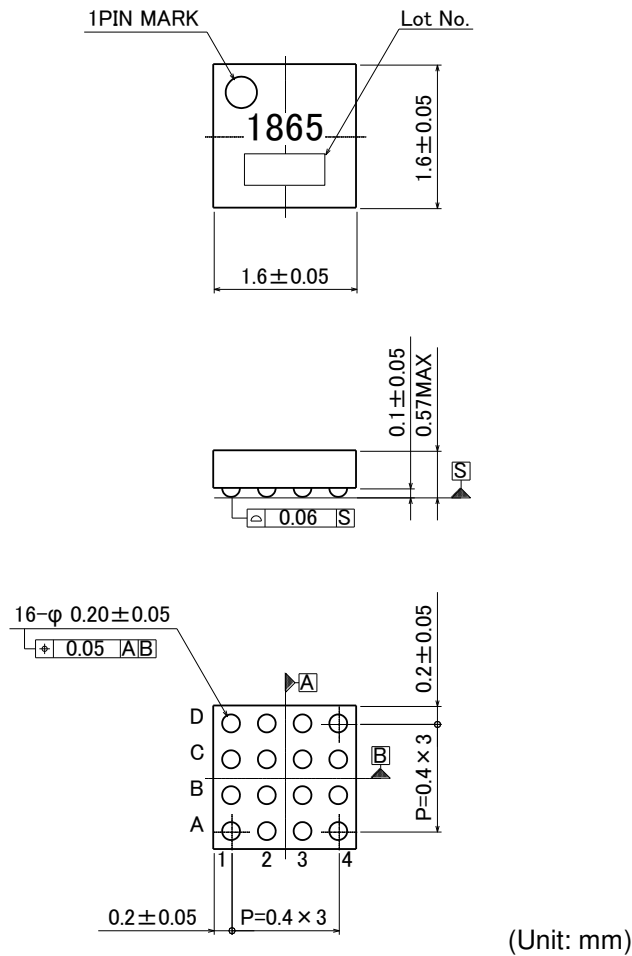
< Tape and Reel Information >

Tape	Embossed carrier tape
Quantity	3,000pcs/Reel
Direction of feed	E2
	The direction is the pin 1 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

1234   1234   1234   1234   1234   1234

Reel   1pin   Direction of feed

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16/17

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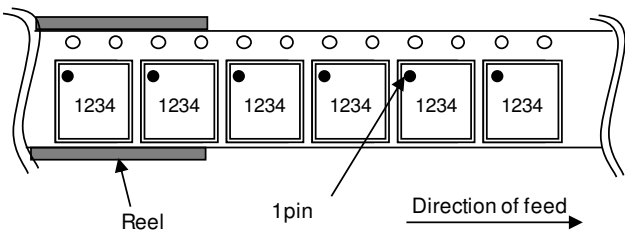
27. Jul. 2015   **Rev.002**

Revision History

Revision	Date	Changes
Rev.001	15.Jun.2015	New Release.
Rev.002	27.Jul.2015	P.2 Add the note for "MODE" terminal to "Note 1".
		P.3 Add the measurement condition (board size) of Pd to "Note 2".
		P.7 3.) UVLO Add "(Typ)" to UVLO threshold value.
		P.7 5.) OCP Change the description about OCP function.
		P.7 6.) SCP Add "(Typ)" to SCP threshold value.
		P.8 8.)Mixing PWM mode Delete a part of description.
		P.10 1.) Output Voltage Setting Add the description about the value of R1 and R2.
		P.15 Revise the package name from "UCSP50L1" to "UCSP50L1C".

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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 [Note 1], 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.

    (Note1) Medical Equipment Classification of the Specific Applications

JAPAN	USA	EU	CHINA
CLASSⅢ	CLASSⅢ	CLASSⅡb	CLASSⅢ
CLASSⅣ		CLASSⅢ	

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    [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 on a surface-mount products, the flow soldering method must be used on a through hole mount products. If the flow soldering method is preferred on a surface-mount products, 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.

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