Power Management Switch ICs for PCs and Digital Consumer Products

1ch Small Package High Side Switch ICs for USB Devices and Memory Cards

BD2220G,BD2221G

No.11029EBT16

●Description

BD2220G and BD2221G are low on-resistance N-channel MOSFET high-side power switches, optimized for Universal Serial Bus (USB) applications. BD2220G and BD2221G are equipped with the function of over-current detection, thermal shutdown, under-voltage lockout and soft-start.

●Features

1) Low On-Resistance (Typ. 160mΩ) N-channel MOSFET Built-in
2) Over-Current Detection (Output off-latch operation)
3) Thermal Shutdown
4) Open-Drain Fault Flag Output
5) Under-Voltage Lockout
6) Soft-Start Circuit
7) Input Voltage Range: 2.7V ~ 5.5V
8) Control Input Logic
   Active-High : BD2220G
   Active-Low : BD2221G
9) Reverse Current Protection when Power Switch Off
10) SSOP5 Package

●Absolute Maximum Ratings (Ta=25℃)

Parameter	Symbol	Ratings	Unit
VIN supply voltage	V_{IN}	-0.3 ~ 6.0	V
EN(/EN) input voltage	$V_{EN(/EN)}$	-0.3 ~ 6.0	V
/OC voltage	$V_{/OC}$	-0.3 ~ 6.0	V
/OC sink current	$I_{/OC}$	5	mA
VOUT voltage	V_{OUT}	-0.3 ~ 6.0	V
Storage temperature	T_{STG}	-55 ~ 150	℃
Power dissipation	Pd	675 *1	mW

*1 Mounted on 70mm x 70mm x 1.6mm glass epoxy board. Reduce 5.4mW per 1°C above 25°C.
* This product is not designed for protection against radioactive rays.

●Operating Conditions

Parameter	Symbol	Ratings			Unit
		Min.	Typ.	Max.	
VIN operating voltage	V_{IN}	2.7	5.0	5.5	V
Operating temperature	T_{OPR}	-40	-	85	℃

●Electrical Characteristics (VIN= 5V, Ta= 25℃, unless otherwise specified.)

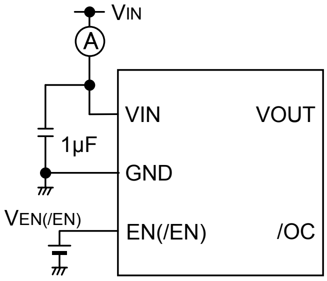
DC Characteristics

Parameter	Symbol	Limits			Unit	Conditions
		Min.	Typ.	Max.		
Operating current	IDD	-	110	160	μA	VEN = 5V (BD2220G) V/EN = 0V (BD2221G) VOUT = open
Standby current	ISTB	-	0.01	5	μA	VEN = 0V (BD2220G) V/EN = 5V (BD2221G) VOUT = open
EN(/EN) input voltage	VEN(/EN)	2.0	-	-	V	High input
	VEN(/EN)	-	-	0.8	V	Low input
EN(/EN) input leakage	IEN(/EN)	-1.0	0.01	1.0	μA	VEN(/EN) = 0V or 5V
On-resistance	RON	-	160	210	mΩ	IOUT = 50mA
Switch leak current	ILSW	-	-	1.0	μA	VEN(/EN) = 0V, VOUT = 0V
Reverse leak current	IREV	-	-	1.0	μA	VOUT = 5.5V, VIN = 0V
Over-current threshold	ITH	0.5	-	1.0	A	
Short circuit output current	ISC	0.35	-	-	A	VOUT = 0V, RMS
/OC output low voltage	V/OC	-	-	0.4	V	I/OC = 0.5mA
UVLO threshold	VTUVH	2.1	2.3	2.5	V	VIN increasing
	VTUVL	2.0	2.2	2.4	V	VIN decreasing

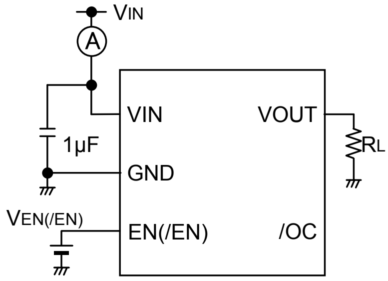
AC Characteristics

Parameter	Symbol	Limits			Unit	Conditions
		Min.	Typ.	Max.		
Output rise time	TON1	-	1	6	ms	RL = 20Ω
Output turn-on time	TON2	-	1.5	10	ms	RL = 20Ω
Output fall time	TOFF1	-	1	20	μs	RL = 20Ω
Output turn-off time	TOFF2	-	3	40	μs	RL = 20Ω
/OC delay time	T/OC	10	15	20	ms	

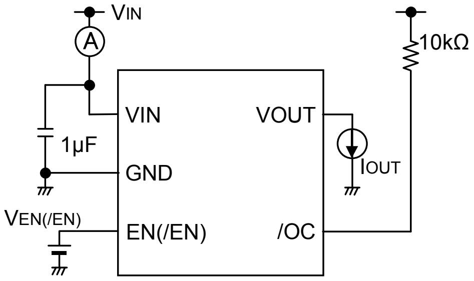
●Measurement Circuit



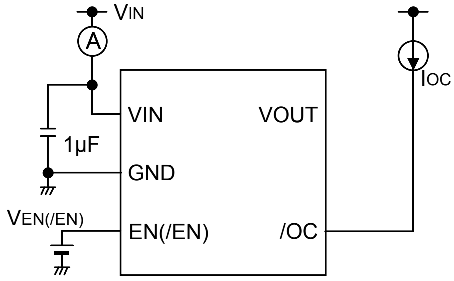
Operating current



EN,/EN Input voltage, Output rise/fall time



On-resistance, Over-current detection



/OC Output low voltage

Fig.1 Measurement circuit

●Timing Diagram

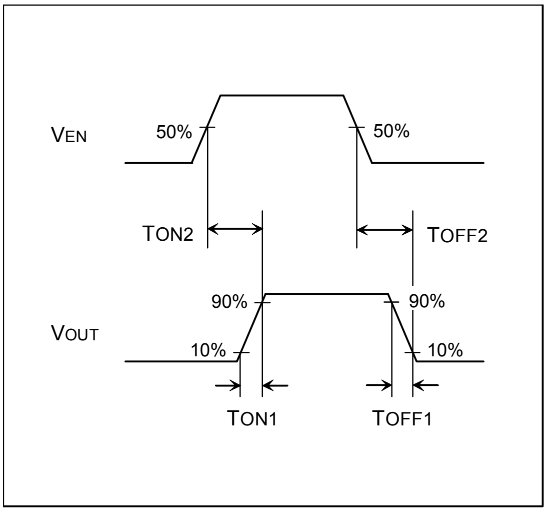


Fig.2 Output rise/fall time
(BD2220G)

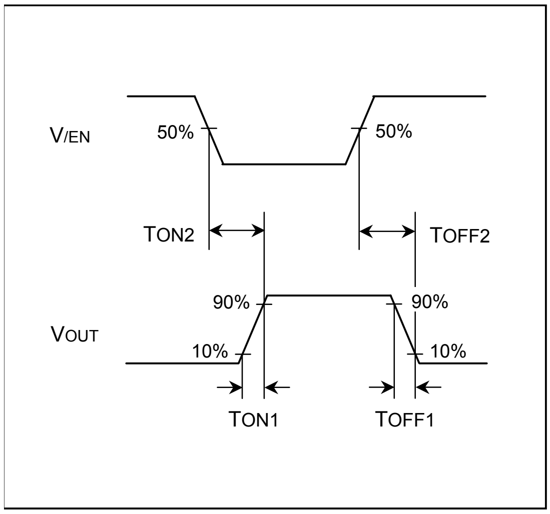


Fig.3 Output rise/fall time
(BD2221G)

●Reference Data

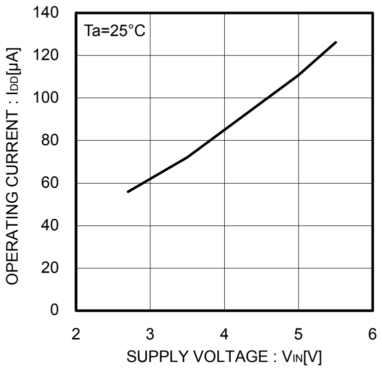


Fig.4 Operating current
EN,/EN enable

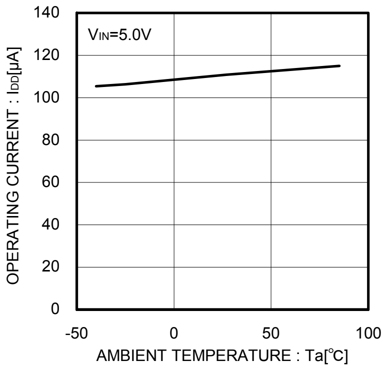


Fig.5 Operating current
EN,/EN enable

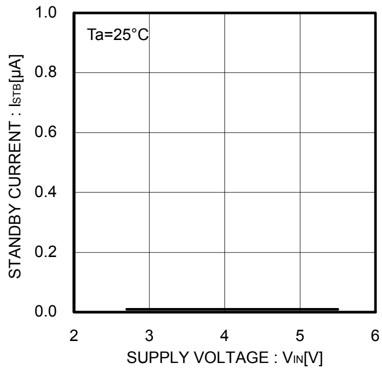


Fig.6 Standby current
EN,/EN disable

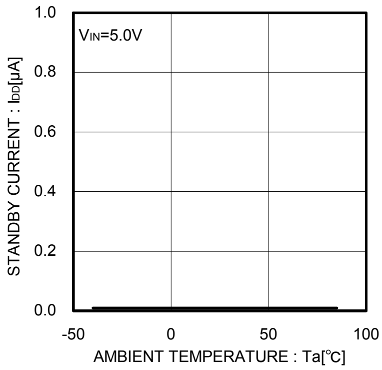


Fig.7 Standby current
EN,/EN disable

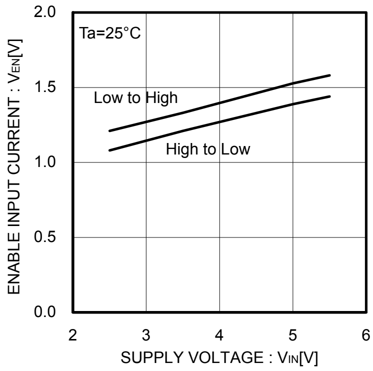


Fig.8 EN,/EN input voltage

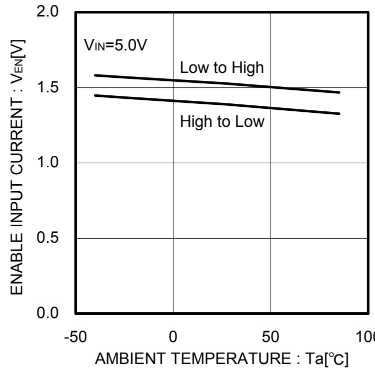


Fig.9 EN,/EN input voltage

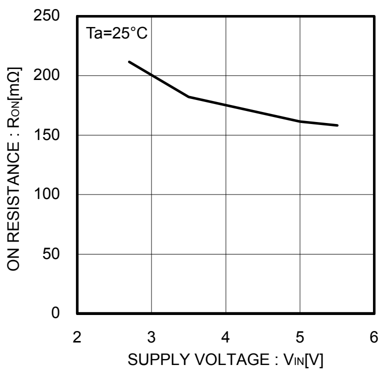


Fig.10 On-resistance

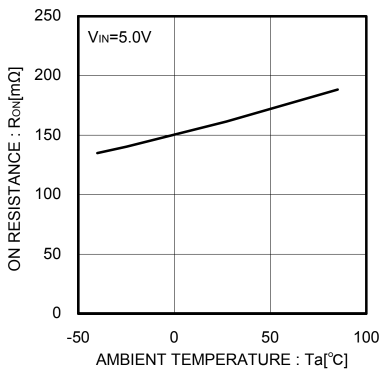


Fig.11 On-resistance

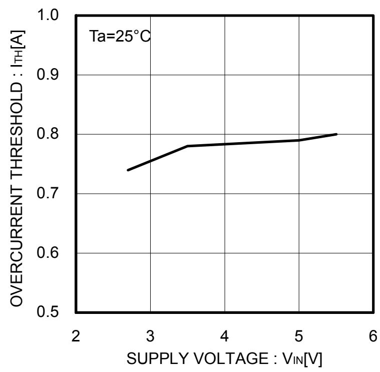


Fig.12 Over-current threshold

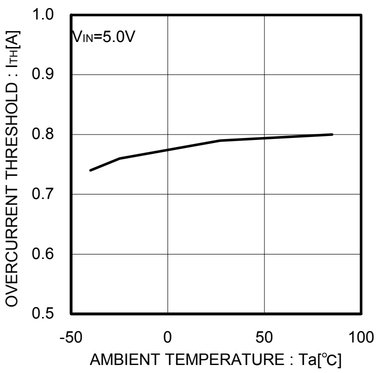


Fig.13 Over-current threshold

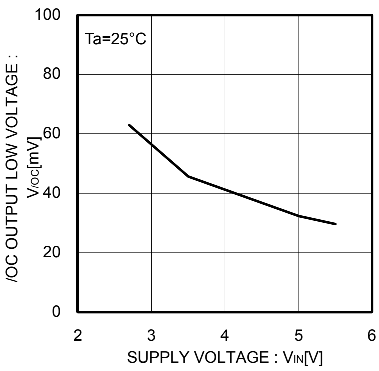


Fig.14 /OC output low voltage

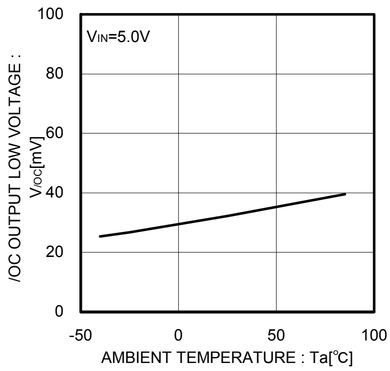


Fig.15 /OC output low voltage

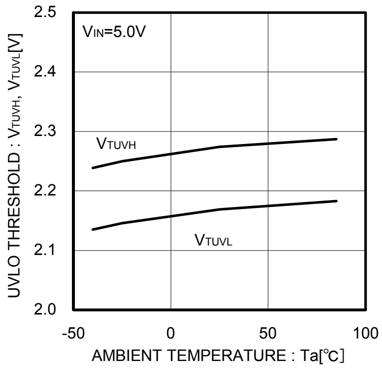


Fig.16 UVLO threshold

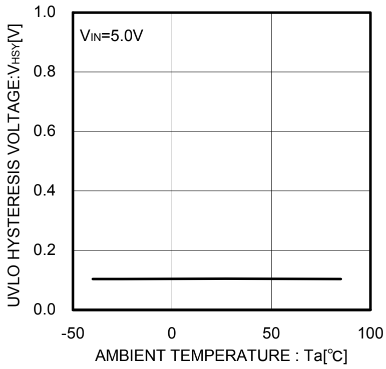


Fig.17 UVLO hysteresis voltage

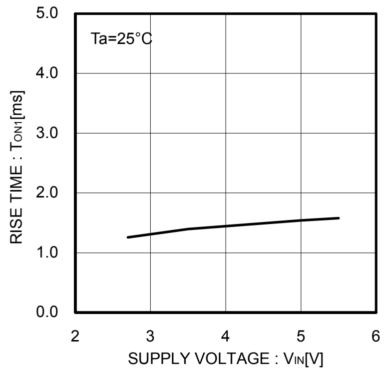


Fig.18 Output rise time

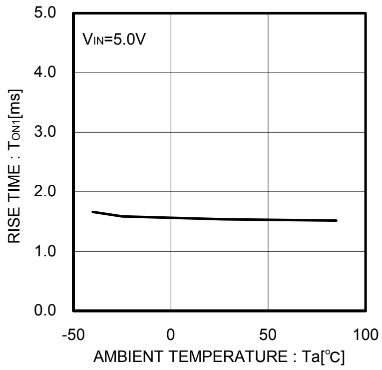


Fig.19 Output rise time

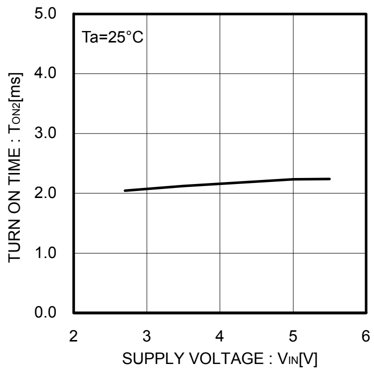


Fig.20 Output turn-on time

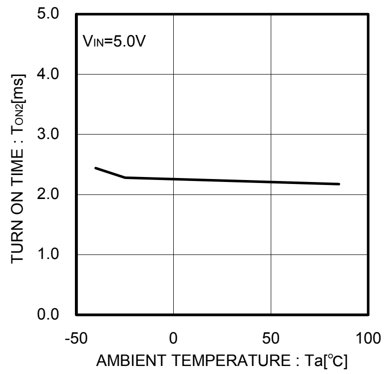


Fig.21 Output turn-on time

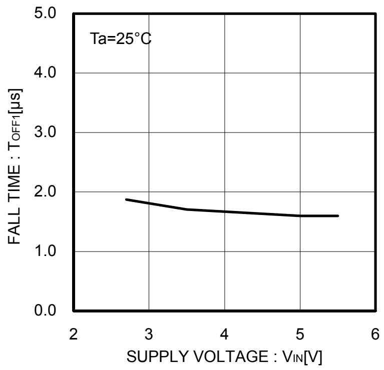


Fig.22 Output fall time

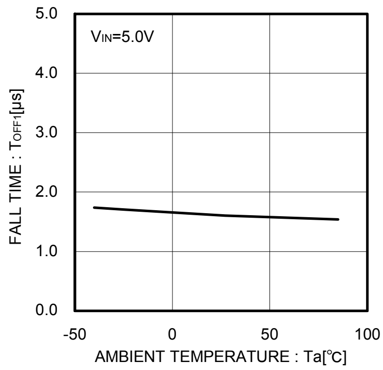


Fig.23 Output fall time

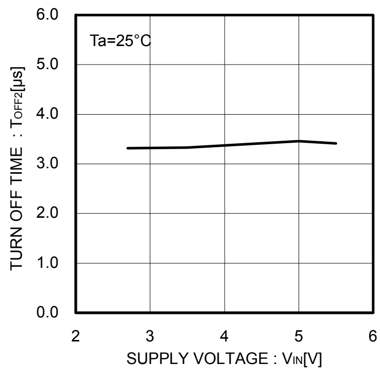


Fig.24 Output turn-off time

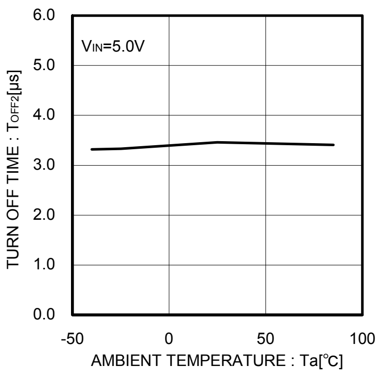


Fig.25 Output turn-off time

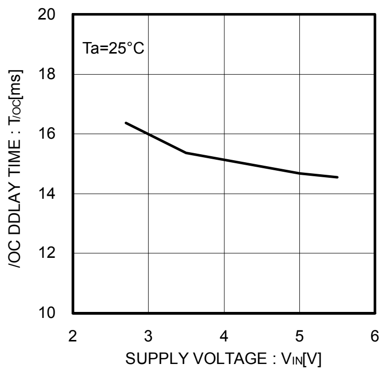


Fig.26 /OC delay time

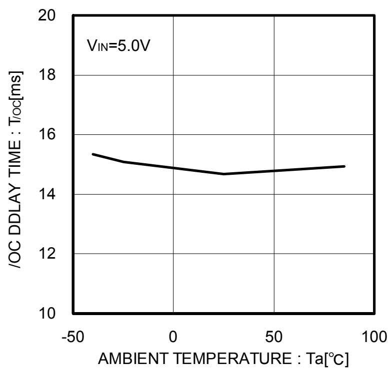


Fig.27 /OC delay time

●Waveform Data (BD2220G)

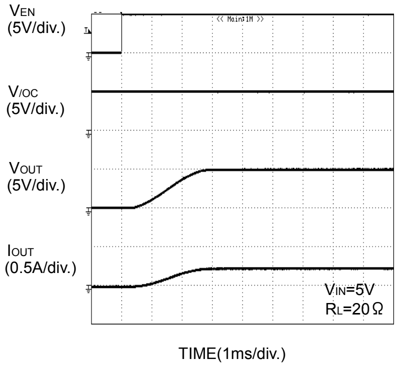


Fig.28 Output rise characteristic

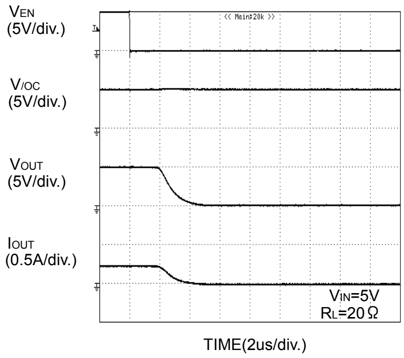


Fig.29 Output fall characteristic

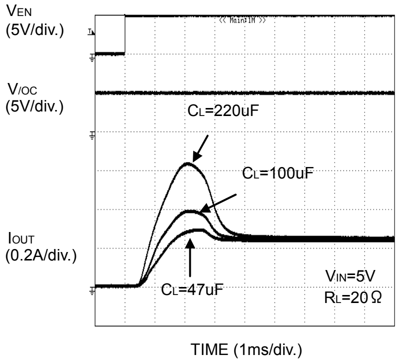


Fig.30 Inrush current response

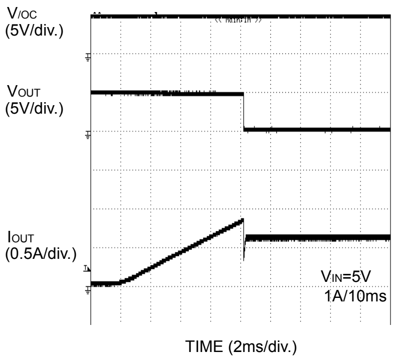


Fig.31 Over-current response ramped load

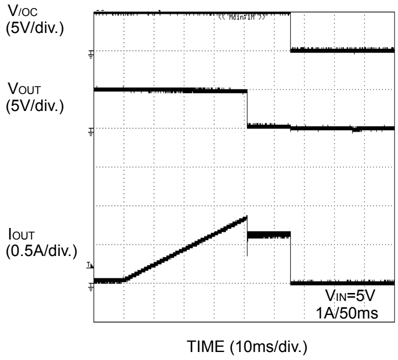


Fig.32 Over-current response ramped load

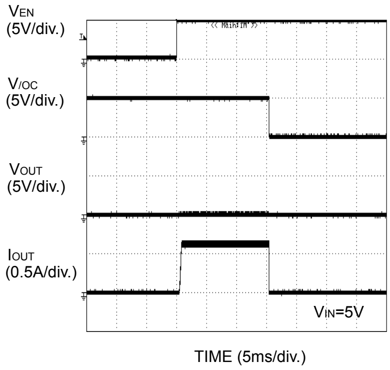


Fig.33 Over-current response enable to short-circuit

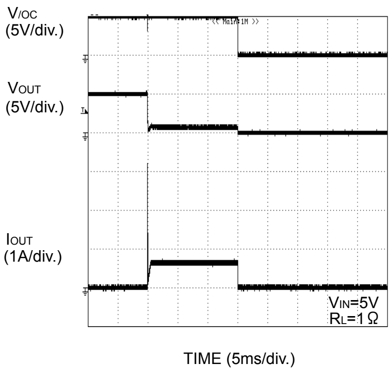


Fig.34 Over-current response 1Ω load connected at EN

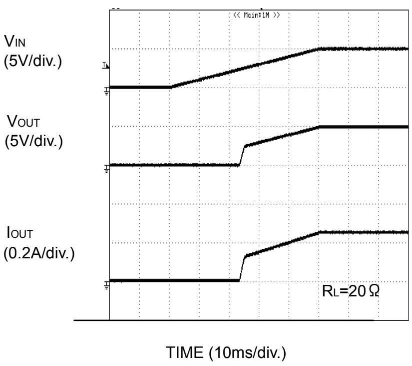


Fig.35 UVLO response increasing V_{IN}

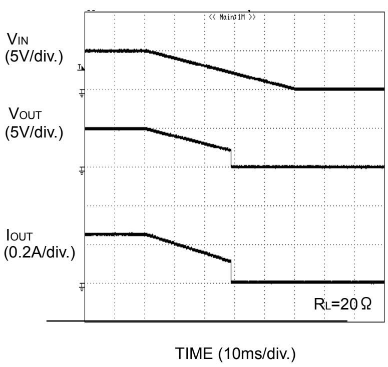


Fig.36 UVLO response decreasing V_{IN}

●Block Diagram

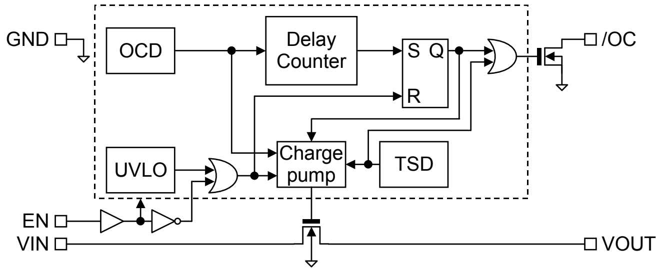


Fig.37 Block diagram

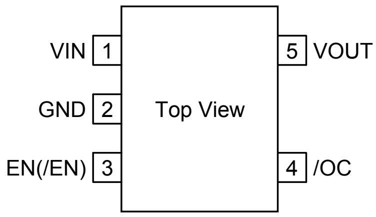
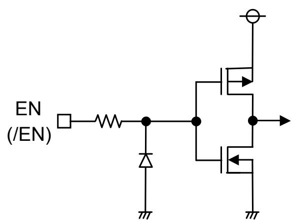
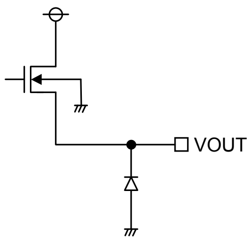
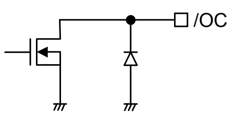


Fig.38 Pin configuration

●Pin Description

Pin No.	Symbol	I/O	Function
1	VIN	-	Switch input and the supply voltage for the IC.
2	GND	-	Ground.
3	EN, /EN	I	Enable input. EN: High level input turns on the switch. (BD2220G) /EN: Low level input turns on the switch. (BD2221G)
4	/OC	O	Over-current notification terminal. Low level output during over-current or over-temperature condition. Open-drain fault flag output.
5	VOUT	O	Switch output.

●I/O Circuit

Symbol	Pin No.	Equivalent circuit
EN (/EN)	3	
VOUT	5	
/OC	4	

●Functional Description

1. Switch Operation

VIN terminal and VOUT terminal are connected to the drain and the source of switch MOSFET respectively. And the VIN terminal is used also as power source input to internal control circuit.

When the switch is turned on from EN,/EN control input, VIN terminal and VOUT terminal are connected by a 160mΩ(Typ.) switch. In on status, the switch is bidirectional. Therefore, when the potential of VOUT terminal is higher than that of VIN terminal, current flows from VOUT terminal to VIN terminal.

Since a parasitic diode between the drain and the source of switch MOSFET is canceled, in the off status, it is possible to prevent current from flowing reversely from VOUT to VIN.

2. Thermal Shutdown Circuit (TSD)

If over current would continue, the temperature of the IC would increase drastically. If the junction temperature were beyond 170°C(Typ.) in the condition of over current detection, thermal shutdown circuit operates and makes power switch turn off and outputs fault flag (/OC). Then, when the junction temperature decreases lower than 150°C(Typ.), power switch is turned on and fault flag (/OC) is cancelled. Unless the fact of the increasing chips temperature is removed or the output of power switch is turned off, this operation repeats.
The thermal shutdown circuit operates when the switch is on (EN,/EN signal is active).

3. Over Current Detection (OCD)

The over current detection circuit limits current (I_{SC}) and outputs fault flag (/OC) when current flowing in each switch MOSFET exceeds a specified value. There are three types of response against over current. The over current detection circuit works when the switch is on (EN,/EN signal is active).

3-1. When the switch is turned on while the output is in shortcircuit status
When the switch is turned on while the output is in shortcircuit status or so, the switch gets in current limit status soon.

3-2. When the output shortcircuits while the switch is on
When the output shortcircuits or large capacity is connected while the switch is on, very large current flows until the over current limit circuit reacts. When the current detection, limit circuit works, current limitation is carried out.

3-3. When the output current increases gradually
When the output current increases gradually, current limitation does not work until the output current exceeds the over current detection value. When it exceeds the detection value, current limitation is carried out.

4. Under Voltage Lockout (UVLO)

UVLO circuit prevents the switch from turning on until the VIN exceeds 2.3V(Typ.). If the VIN drops below 2.2V(Typ.) while the switch turns on, then UVLO shuts off the power switch. UVLO has hysteresis of a 100mV(Typ).
Under voltage lockout circuit works when the switch is on (EN,/EN signal is active).

5. Fault Flag (/OC) Output

Fault flag output is N-MOS open drain output. At detection of over current, thermal shutdown, low level is output.

Over current detection has delay filter. This delay filter prevents instantaneous current detection such as inrush current at switch on, hot plug from being informed to outside.

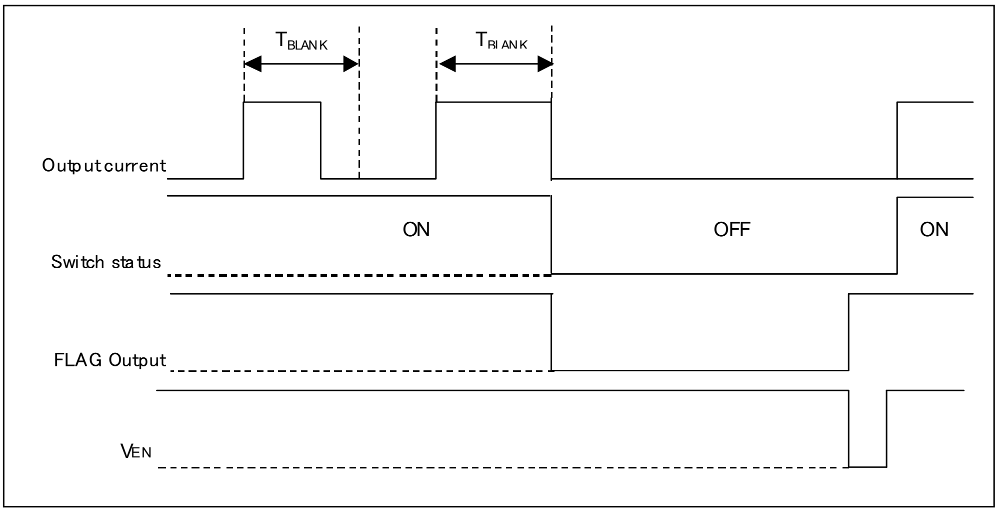


Fig.39 Over-current shutdown operation(reset at toggle of EN）(BD2220G)

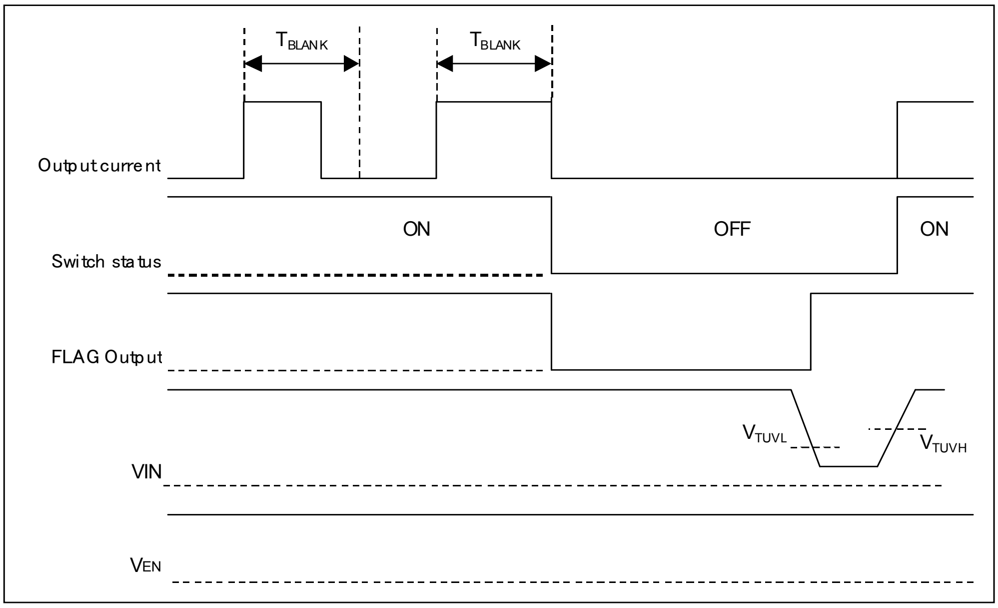


Fig.40 Over-current shutdown operation (reset at re-closing of power supply VIN) (BD2220G)

●Typical Application Circuit

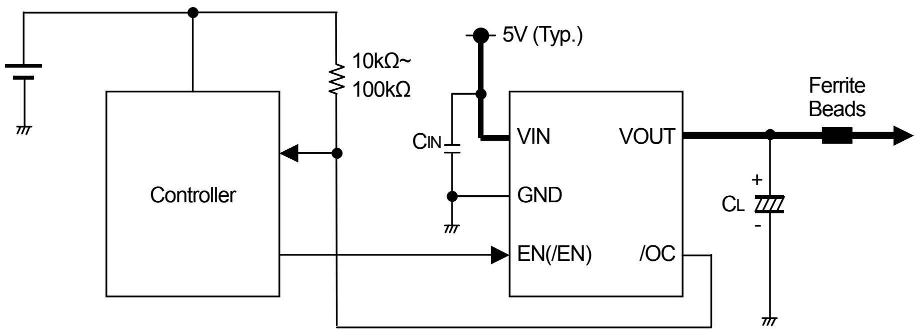


Fig.41 Typical application circuit

●Application Information

When excessive current flows owing to output shortcircuit or so, ringing occurs by inductance of power source line to IC, and may cause bad influences upon IC actions. In order to avoid this case, connect a bypath capacitor C_{IN} by VIN terminal and GND terminal of IC. 1μF or higher is recommended.

Pull up /OC output by resistance 10kΩ ~ 100kΩ.

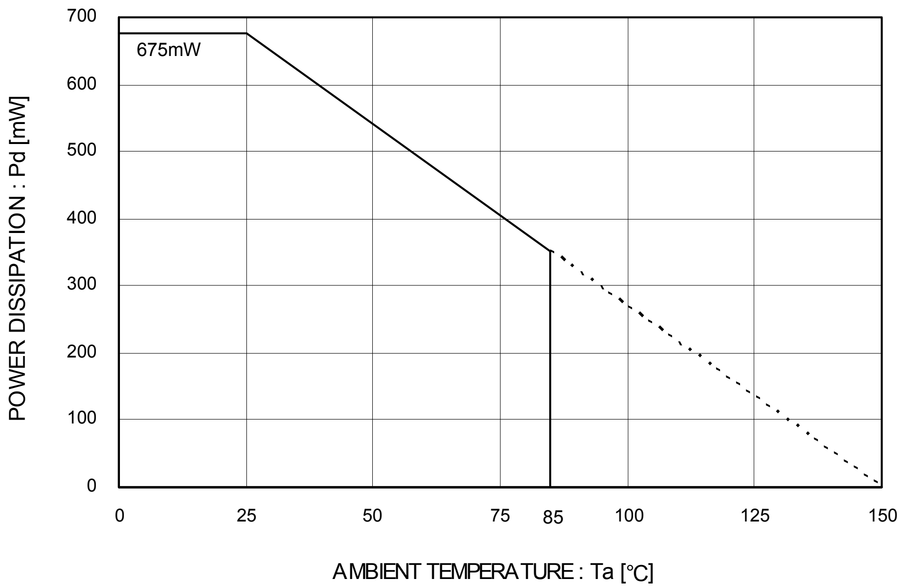
Set up value which satisfies the application as C_L and Ferrite Beads.

This system connection diagram doesn't guarantee operating as the application.

The external circuit constant and so on is changed and it uses, in which there are adequate margins by taking into account external parts or dispersion of IC including not only static characteristics but also transient characteristics.

●Power Dissipation Characteristic

(SSOP5 package)



* 70mm x 70mm x 1.6mm Glass Epoxy Board

Fig.42 Power dissipation curve (Pd-Ta curve)

●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 to cause fluctuations in the GND wiring pattern of external parts as well.

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

(12) Thermal shutdown circuit (TSD)
When junction temperatures become detected temperatures or higher, the thermal shutdown circuit operates and turns a switch OFF. The thermal shutdown circuit is aimed at isolating the LSI from thermal runaway as much as possible. Do not continuously use the LSI with this circuit operating or use the LSI assuming its operation.

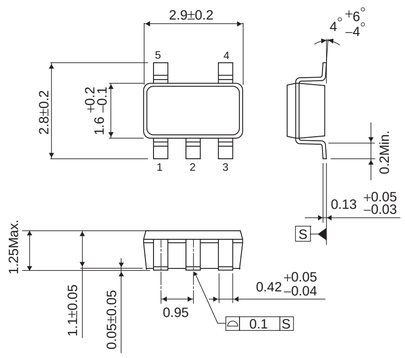
(13) Thermal design
Perform thermal design in which there are adequate margins by taking into account the power dissipation (Pd) in actual states of use.

● Ordering part number

B	D		2	2	2	0		G	-	T	R

- Part No.: BD
- Part No.: 2220, 2221
- Package: G: SSOP5
- Packaging and forming specification: TR: Embossed tape and reel

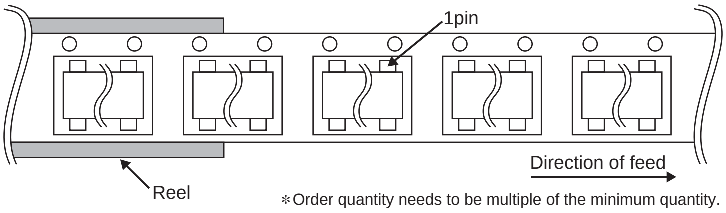
SSOP5



(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.

Notes

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