Power Management Switch ICs for PCs and Digital Consumer Products

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

BD6538G

No.11029EBT14

●Description

BD6538G is single channel high side powers switch with low ON resistance Nch power MOSFET.
Rich safety functions such as Over current detection, Thermal shutdown (TSD), Under Voltage Lock Out(UVLO) and Soft start function which are required for the power supply port protection are integrated into 1chip.

●Feature

1) Single channel of low ON resistance (Typ = 150mΩ) Nch power MOSFET built in
2) 500mA Continuous current load
3) Active"High"Control Logic
4) Soft start function
5) Over current detection（Output Off-latch Operating）
6) Thermal shutdown
7) Open drain error flag output
8) Under voltage lockout
9) Power supply voltage range 2.7V~5.5V
10) Operating temperature range-40°C~85°C
11) SSOP5 Package

●Absolute maximum ratings

Parameter	Symbol	Ratings	Unit
Supply voltage	V_{IN}	-0.3 to 6.0	V
Enable voltage	V_{EN}	-0.3 to 6.0	V
/OC voltage	$V_{/OC}$	-0.3 to 6.0	V
/OC current	$I_{/OC}$	5	mA
OUT voltage	V_{OUT}	-0.3 to V_{IN} + 0.3	V
Storage temperature	T_{STG}	-55 to 150	°C
Power dissipation	PD	675 *1	mW

*1 1 Mounted on 70mm * 70mm * 1.6mm grass-epoxy PCB. Derating : 5.4mW / °C for operating above Ta=25°C.
* This product is not designed for protection against radioactive rays.

●Operating conditions

Parameter	Symbol	Ratings			Unit
		Min	Typ	Max	
Operating voltage	V_{IN}	2.7	-	5.5	V
Operating temperature	T_{OPR}	-40	-	85	°C
Continuous output current	I_{OUT}	0	-	0.5	A

●Electric characteristics

Unless otherwise specified V_{IN} = 5.0V, Ta = 25°C

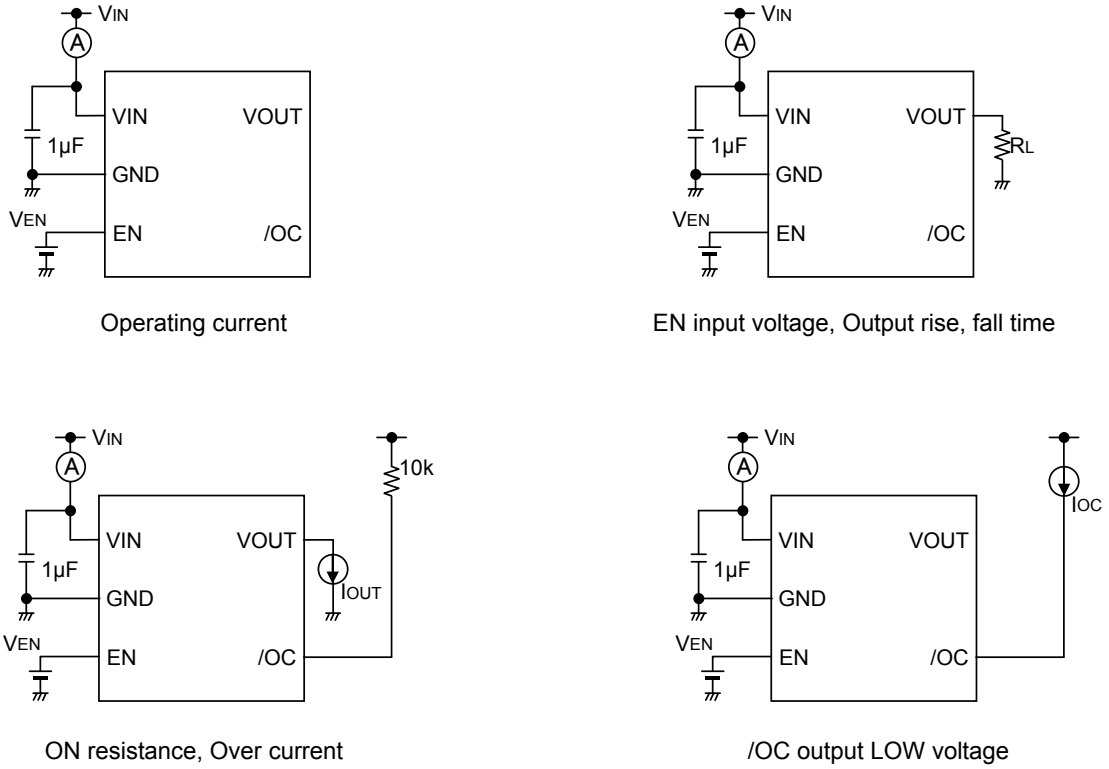
DC characteristics

Parameter	Symbol	Limits			unit	Condition
		Min.	Typ.	Max.		
Operating Current	I_{DD}	-	110	160	μA	V_{EN} = 5.0V, V_{OUT} = Open
Standby Current	I_{STB}	-	0.01	5	μA	V_{EN} = 0V, V_{OUT} = Open
EN input voltage	V_{EN}	2.0	-	-	V	High input
	V_{EN}	-	-	0.8	V	Low input
EN input current	I_{EN}	-1.0	0.01	1.0	μA	V_{EN} =0Vor5V
ON resistance	R_{ON}	-	150	200	mΩ	I_{OUT} = 50mA
Over current threshold	I_{TH}	0.5	-	1.0	A	-
Output current at short	I_{SC}	0.35	-	-	A	V_{OUT} = 0V (RMS)
/OC output lOW voltage	$V_{/OC}$	-	-	0.4	V	$I_{/OC}$ = 0.5mA
UVLO Threshold	V_{TUVH}	2.1	2.3	2.5	V	Increasing V_{IN}
	V_{TUVL}	2.0	2.2	2.4	V	Decreasing V_{IN}

AC characteristics

Parameter	Symbol	Limits			unit	Condition
		Min.	Typ.	Max.		
Output rise time	T_{ON1}	-	1	6	ms	R_L = 20Ω, Fig. 2 Ref.
Output rise delay time	T_{ON2}	-	1.5	10	ms	R_L = 20Ω, Fig. 2 Ref.
Output fall time	T_{OFF1}	-	1	20	μs	R_L = 20Ω, Fig. 2 Ref.
Output fall delay time	T_{OFF2}	-	3	40	μs	R_L = 20Ω, Fig. 2 Ref.
Blanking time	T_{BLANK}	10	15	20	ms	-

●Measurement circuit



Operating current

EN input voltage, Output rise, fall time

ON resistance, Over current

/OC output LOW voltage

Fig.1 Measurement circuit

●Timing diagram

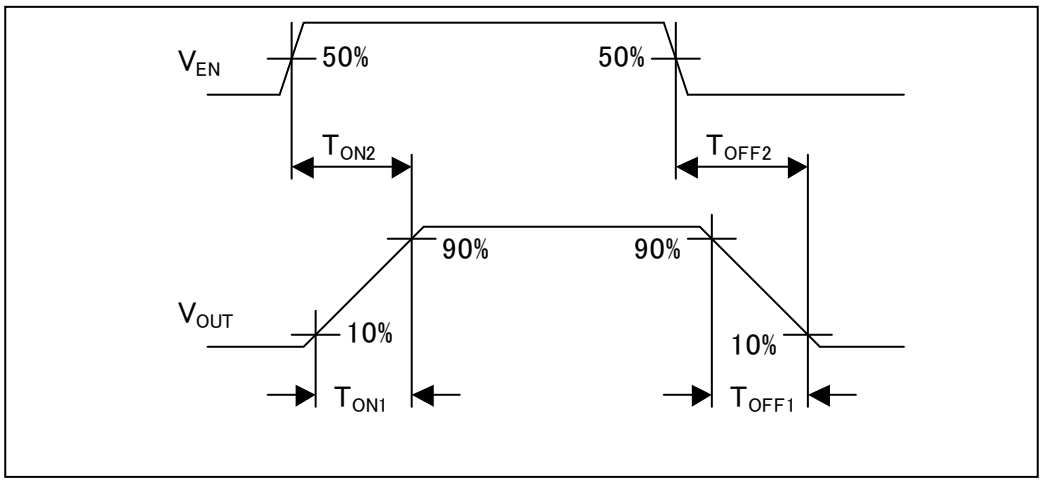


Fig.2 Timing chart at output rise / fall time

●Reference data

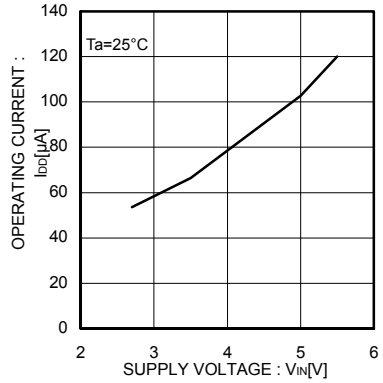


Fig.3 Operating current
EN Enable

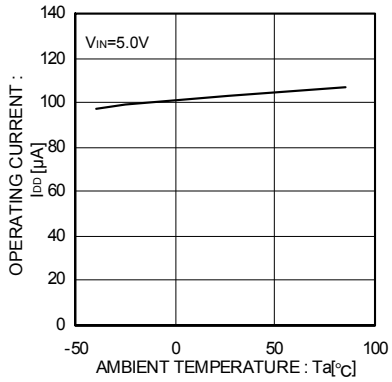


Fig.4 Operating current
EN Enable

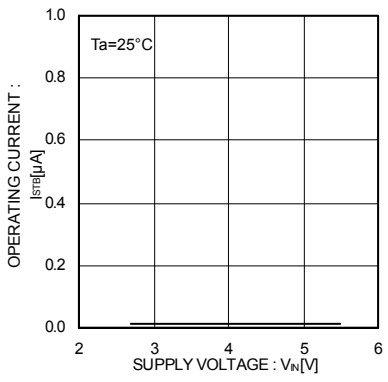


Fig.5 Operating current
EN Disable

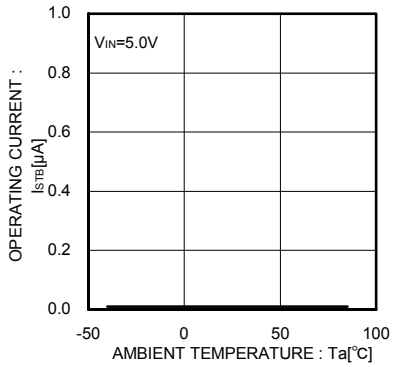


Fig.6 Operating current
EN Disable

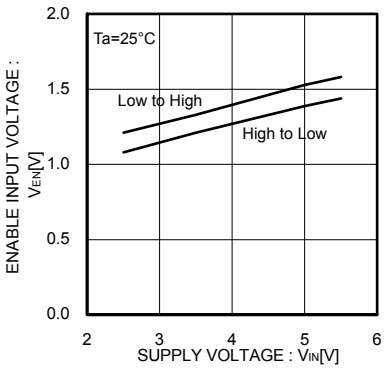


Fig.7 EN input voltage

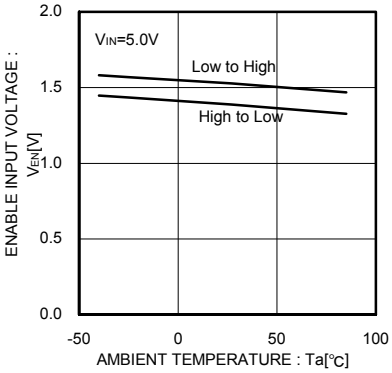


Fig.8 EN input voltage

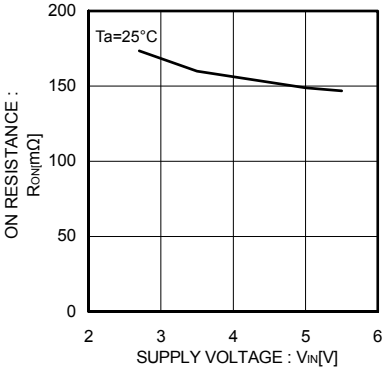


Fig.9 ON resistance

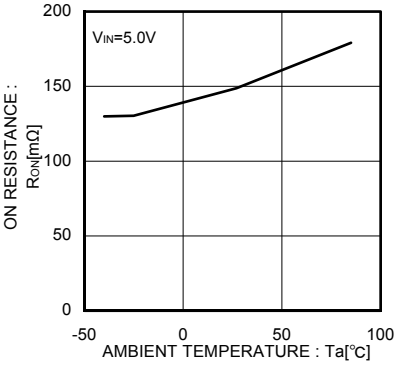


Fig.10 ON resistance

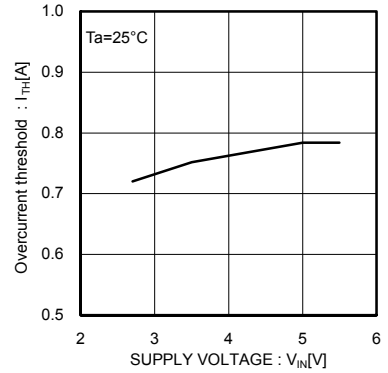


Fig.11 Over current detection

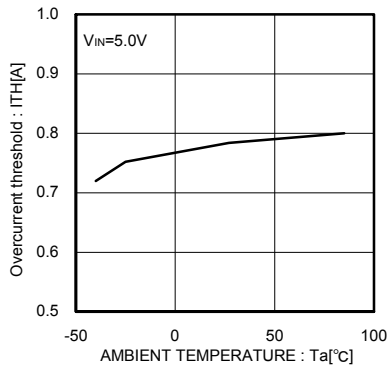


Fig.12 Over current detection

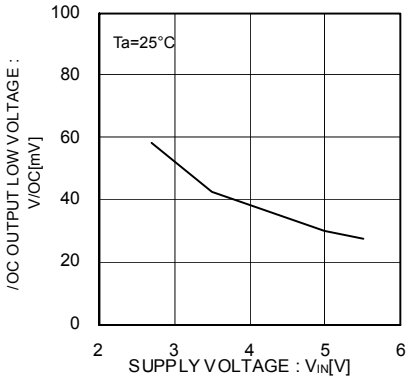


Fig.13 /OC output LOW voltage

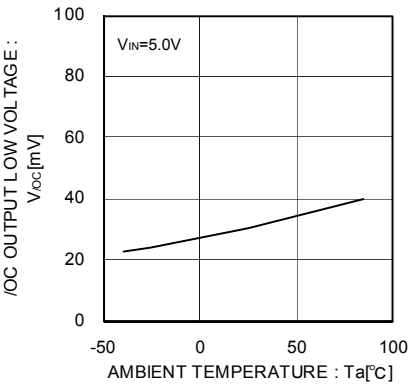


Fig.14 /OC output LOW voltage

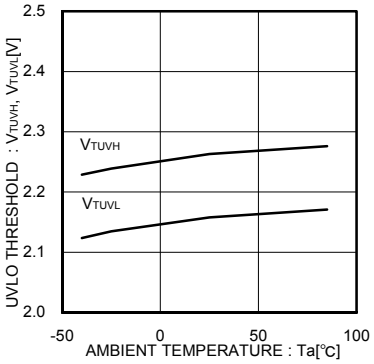


Fig.15 UVLO Threshold

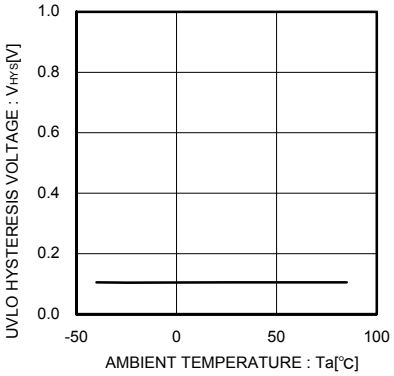


Fig.16 UVLO hysteresis voltage

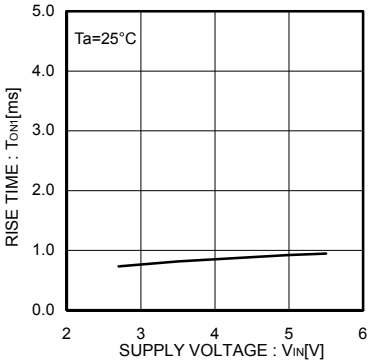


Fig.17 Output rise time

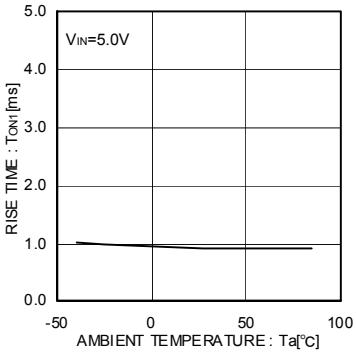


Fig.18 Output rise time

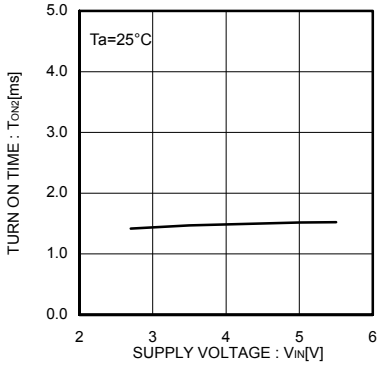


Fig.19 Output turn on time

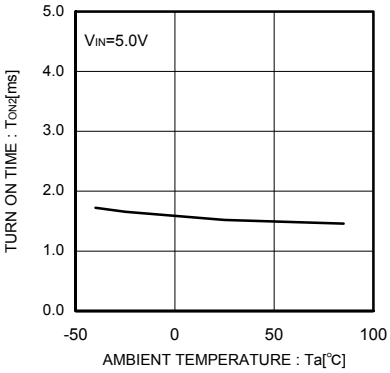


Fig.20 Output turn on time

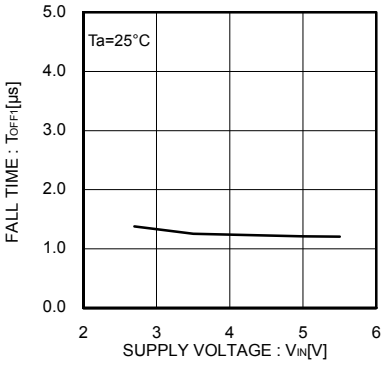


Fig.21 Output fall time

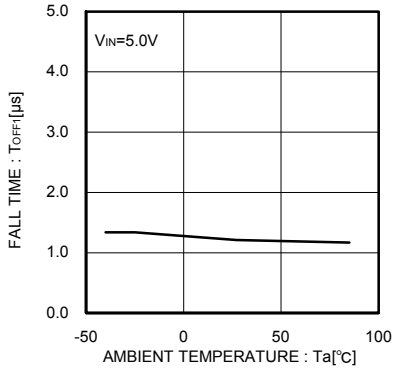


Fig.22 Output fall time

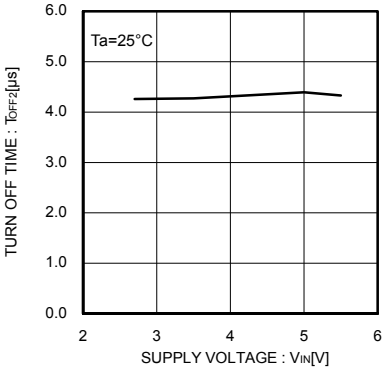


Fig.23 Output turn off time

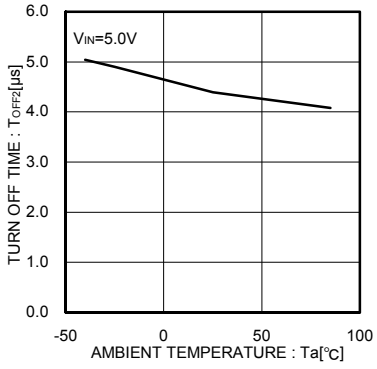


Fig.24 Output turn off time

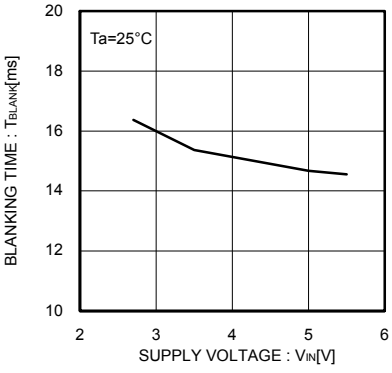


Fig.25 Blanking time

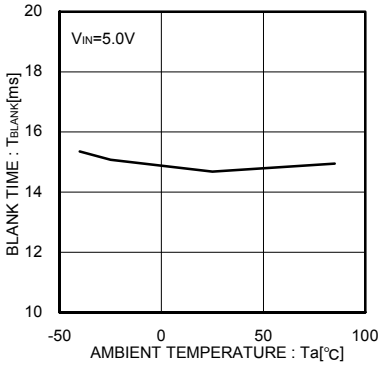


Fig.26 Blanking time

●Waveform data

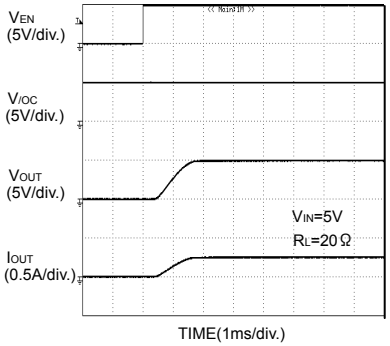


Fig.27 Output rise characteristic

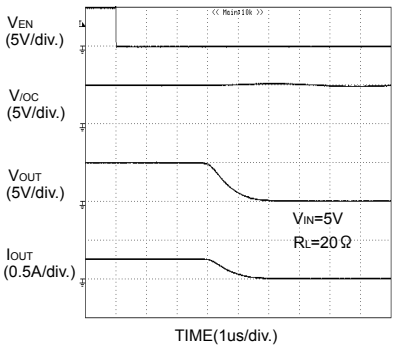


Fig.28 Output fall characteristic

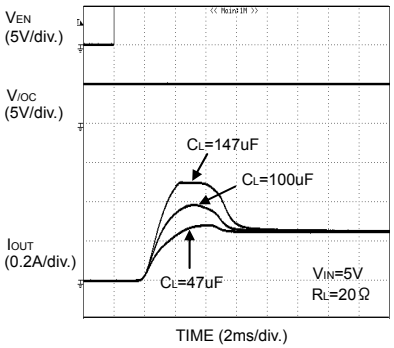


Fig29. Inrush current respone

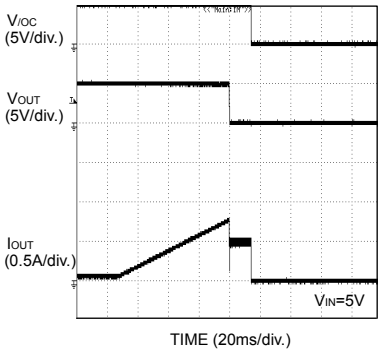


Fig.30 Over current response
Ramped load

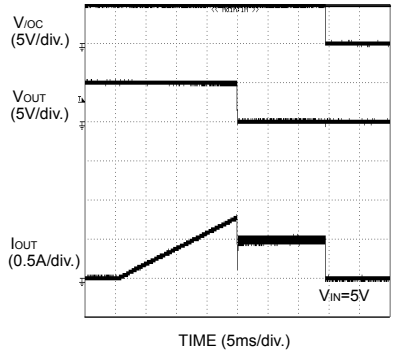


Fig.31 Over current response
Ramped load

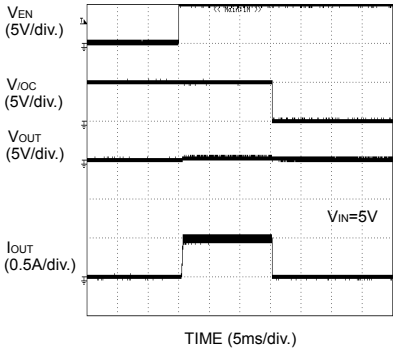


Fig.32 Over current response
Enable to short circuit

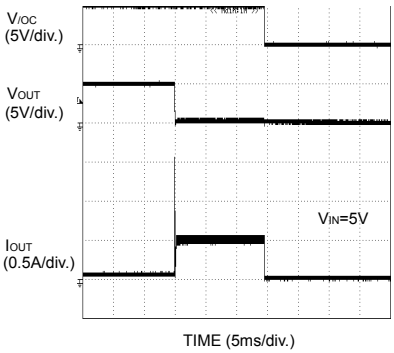


Fig.33 Over current response
Output shortcircuit at Enable

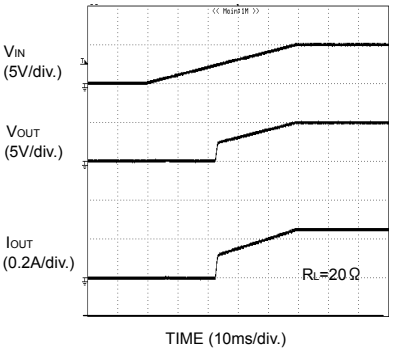


Fig.34 UVLO response
V_{IN} Increasing

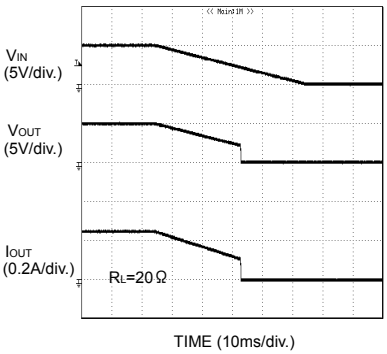


Fig.35 UVLO response
V_{IN} Decreasing

●Block diagram

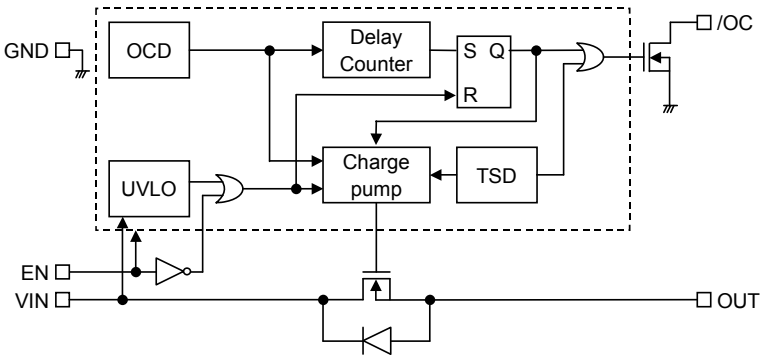


Fig.36 Block diagram

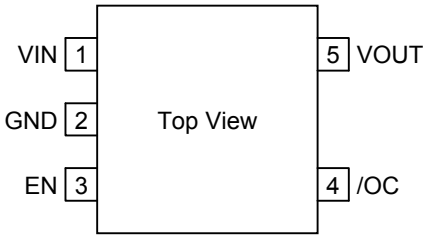


Fig.37 Pin Configuration

●Pin description

Pin No.	symbol	I/O	Pin function
1	VIN	-	Power supply input. Input terminal to switch and power supply input terminal of the internal circuit.
2	GND	-	Ground.
3	EN	I	Enable input. Power switch on at High level.
4	/OC	O	Over current output. Low level at over current detection. Open drain output.
5	VOUT	O	Switch output.

●Terminal circuit

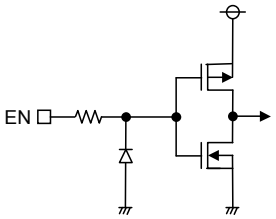
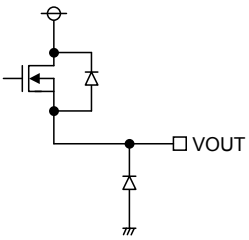
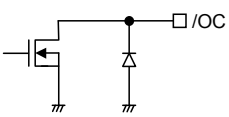
symbol	Pin No.	Equivalent circuit
EN	3	
VOUT	5	
/OC	4	

Fig.38 Terminal circuit

●Operations Explanation

1.Overcurrent protection（OCD）

The overcurrent detection circuit limits the current and outputs an error flag (/OC) when the current flowing in switch MOSFET exceeds overcurrent threshold (I_{TH}).

The timer is reset when the state of the overcurrent is terminated before passing of T_{BLANK}. After a state of overcurrent is passed at blanking time, the switch is shut down and the overcurrent signal (/OC) changes to Low level.

The latch is reset through it input Low to EN or detects UVLO. Normal operation is returned by EN signal is set to High or UVLO is off. (Fig. 4, Fig. 5).

The over current limit circuit works when EN signal is enable.

2. Thermal shutdown circuit（TSD）

Thermal shutdown circuit turns off the switch and outputs an error flag (/OC) when the junction temperature exceeds 150°C (typ.). Therefore, when the junction temperature goes down to 150°C (typ), the switch output and an error flag (/OC) are recovered automatically. This operating is repeated until cause of junction temperature increase is removed or EN signal is set Disable. Thermal shutdown circuit works when EN signal is enable.

3. Under voltage lockout （UVLO）

UVLO keeps the switch-off state at MOSFET until VIN exceeds 2.3V (Typ.). If VIN drops under 2.2V (Typ.) while the switch is turning on, then UVLO shuts off the power switch.

Under voltage lockout works when EN signal is enable.

4. Overcurrent signal output

Overcurrent signal output（/OC）is N-MOS open drain output. At detection of overcurrent, thermal shutdown, output is Low level.

●Over current shutdown operating

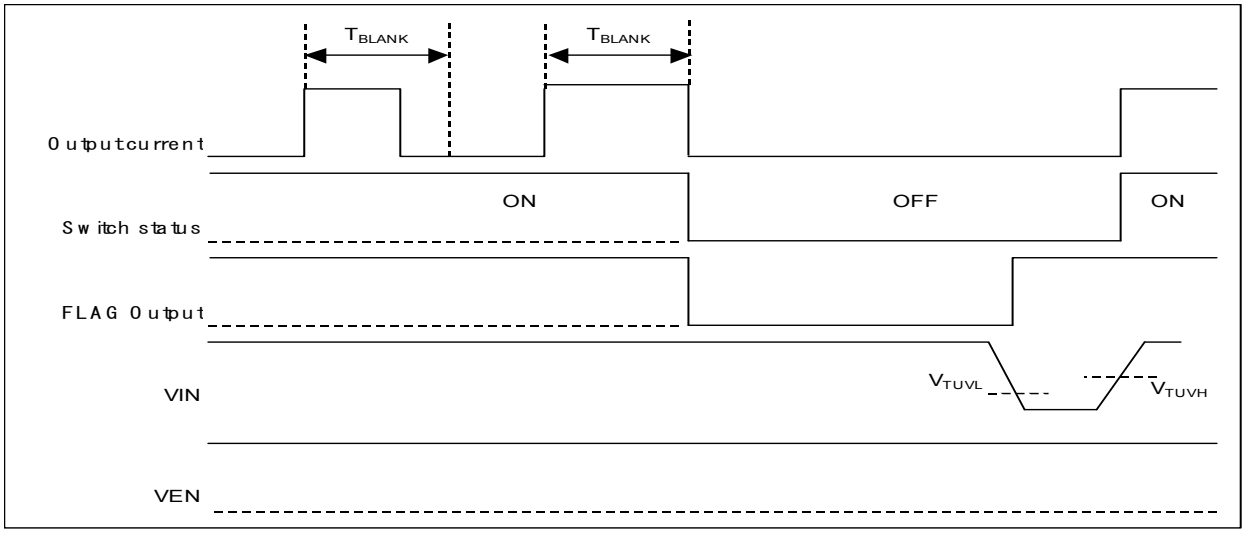


Fig.39 Overcurrent shutdown operation（Reset at toggle of EN）

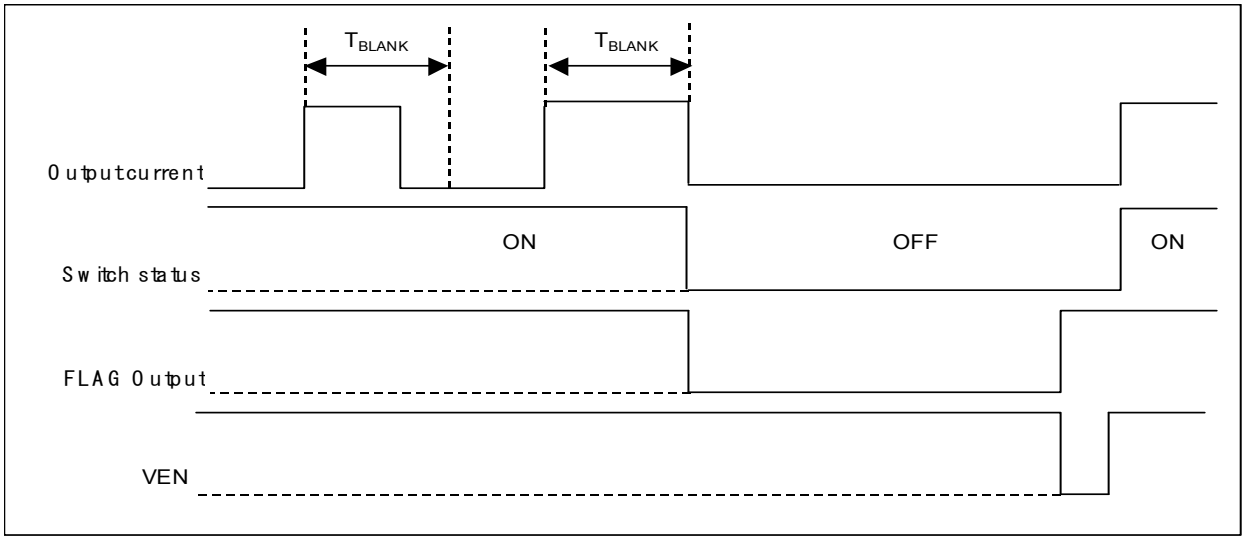


Fig.40 Overcurrent shutdown operation (Reset at reclosing of power supply VIN)

●Typical application circuit

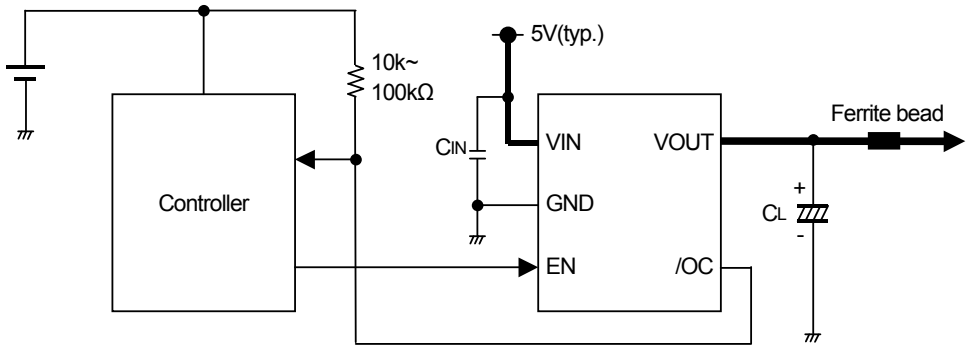


Fig.41 Typical application circuit

●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 by IN terminal and GND terminal of IC. 1uF 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.

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●Power dissipation character

(SSOP5 package)

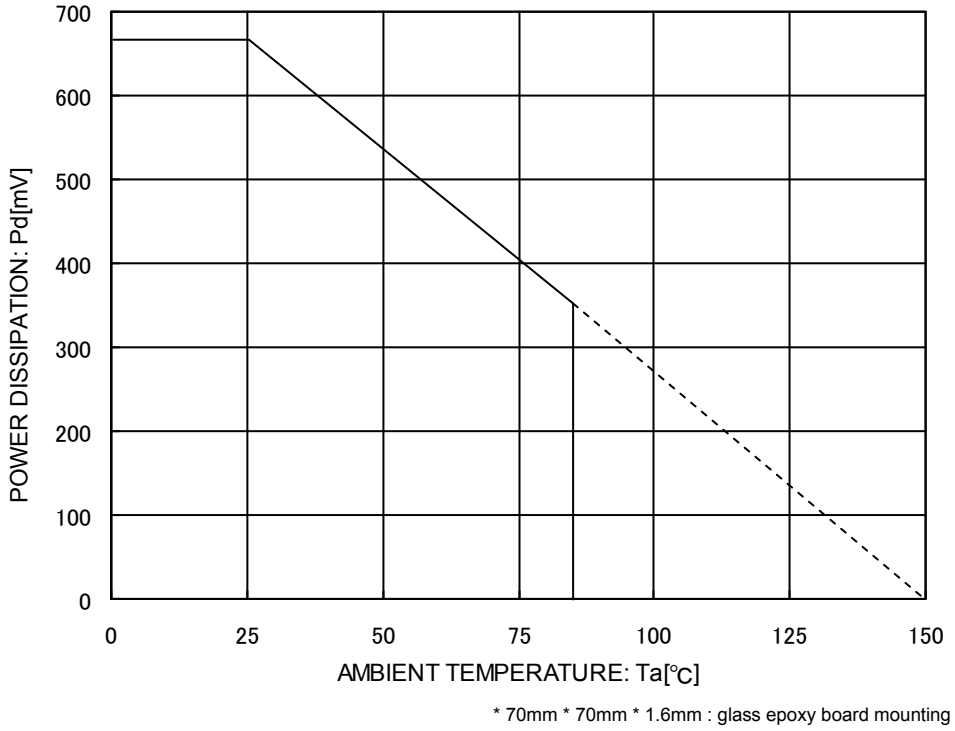


Fig.42 Power dissipation curve (Pd-Ta Curve)

●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, which is aimed at isolating the LSI from thermal runaway as much as possible, is not aimed at the protection or guarantee of the LSI. Therefore, do not continuously use the LSI with this circuit operating or use the LSI assuming its operation.

(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	6	5	3	8	G	-	T	R

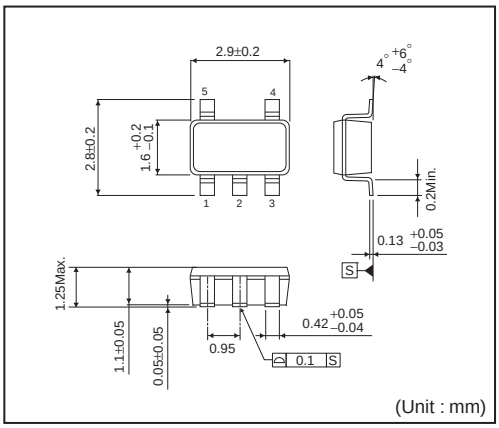
Part No.

Part No.
6538

Package
G: SSOP5

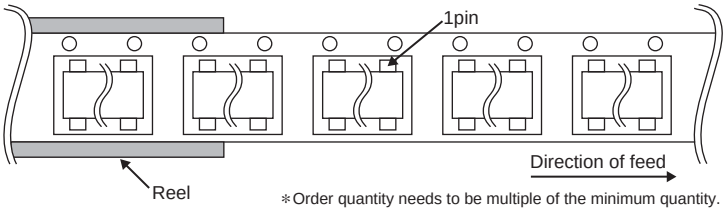
Packaging and forming specification
TR: Embossed tape and reel
(SSOP5)

SSOP5



<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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