

Automotive IPD Series

1ch Low Side Switch IC BV1LB300FJ-C

Features

- Built-in overcurrent limiting circuit(OCP)
- Built-in thermal shutdown circuit(TSD)
- Built-in active clamp circuit
- Direct control enabled from CMOS logic IC, etc.
- On-state resistance R_{ON}=300mΩ(Typ) (when V_{IN}=5V, I_D=0.5A, Tj=25°C)
- Monolithic power management IC with the control block (CMOS) and power MOS FET mounted on a single chip
- AEC-Q100 Qualified ^(Note1)

(Note 1) Grade1

General Description

The BV1LB300FJ-C is an automotive 1ch low side switch IC, which has built-in overcurrent limiting circuit, thermal shutdown circuit, and overvoltage (active clamp) protection circuit.

Product Summary

On-state resistance (T _j =25°C, Typ)	300mΩ
Overcurrent limit (T _j =25°C, Typ)	2.7A
Output clamp voltage (Min)	42V
Active clamp energy ($T_j = 25^{\circ}C$)	150mJ

Package SOP-J8 W(Typ) x D(Typ) x H(Max) 4.90mm x 6.00mm x 1.65mm



Applications

1ch low side switch for driving resistive, Inductive load, Capacitive load

Block Diagram



Pin Configurations



Pin Descriptions

Pin No.	Symbol	Function
1	SOURCE	GND pin
2	SOURCE	GND pin
3	SOURCE	GND pin
4	IN	Input pin (Note 1)
5	DRAIN	Output pin
6	DRAIN	Output pin
7	DRAIN	Output pin
8	DRAIN	Output pin

(Note 1) Input pin is used to internally connect a pull-down resistor.

Definition



Figure 1. Definition

Absolute Maximum Ratings (T_j =25°C)

Parameter	Symbol	Ratings	Unit
Drain-Source voltage in output block	VDS	-0.3 to +42 (Note 1)	V
Input voltage	VIN	-0.3 to +7	V
Output current (DC)	ID	1.7 (Note 2)	А
Active clamp energy (Single pulse) T _{j(start)} = 25°C ^(Note 3)	Eas(25°C)	150	ml
Active clamp energy (Single pulse) T _{j(start)} = 150°C (Note 3) (Note 4)	Eas(150°C)	40	110
Operating temperature range	Tj	-40 to +150	°C
Storage temperature range	T _{stg}	-55 to +150	°C
Maximum junction temperature	T _{jmax}	150	°C

(Note 1) Please refer to P.16 "Operation Notes", when is used at less than -0.3V. (Note 2) Internally limited by the overcurrent limiting circuit.

(Note 3) Maximum Active clamp energy, using single non-repetitive pulse of 0.5A, V_{B} = 16V .

$$E_{AS} = \frac{1}{2} LI_{AR}^2 \cdot (1 - \frac{V_B}{V_B - V_{CL}})$$

(Note 4) Not 100% tested.

Thermal Characteristics (Note 1)

Parameter	Symbol	Ratings	Unit	Cond	itions
SOP-J8					
		143.7	°C / W	1s	(Note 2)
Thermal Resistance between channel and ambient temperature	θја	86.9	°C / W	2s	(Note 3)
		67.5	°C / W	2s2p	(Note 4)

 (Note 1)
 The thermal impedance is based on JESD51 - 2A (Still - Air) standard . It is used the chip of BV1LB300FJ-C

 (Note 2)
 JESD51 - 3 compliance FR4 114.3 mm × 76.2 mm × 1.57 mm
 1 layer (1s)

(top layer copper : Rohm recommend land pattern + measurement wiring, copper thickness 2oz)

(Note 3) JESD51 -5 compliance FR4 114.3 mm × 76.2 mm × 1.60 mm 2 layer (2s)

(top layer copper : Rohm recommend land pattern + measurement wiring, bottom layer copper area : 74.2 mm × 74.2 mm, Copper thickness (top and bottom layer) 2 oz)

(Note 4) JESD51 -5 / -7 compliance FR4 114.3 mm × 76.2 mm × 1.60 mm 4 layer (2s2p)

(top layer copper: Rohm recommend land pattern + measurement wiring / 2 layer, 3 layer, bottom layer copper area: 74.2 mm × 74.2 mm, Copper thickness (top and bottom layer / inner layer) 2 oz / 1oz)

PCB layout 1s (1 layer)



Footprint Only

Figure 2. PCB layout 1s (1 layer)

Dimension	Value
Board finish thickness	1.57 mm ± 10%
Board dimension	76.2 mm x 114.3 mm
Board material	FR4
Copper thickness (Top layer)	0.070mm (Cu:2oz)

PCB layout 2s (2layer)







Top Layer



Dimension	Value	
Board finish thickness	1.60 mm ± 10%	
Board dimension	76.2 mm x 114.3 mm	
Board material	FR4	
Copper thickness (Top/Bottom layers)	0.070mm (Cu + Plating)	

PCB layout 2s2p (4layer)



Top Layer

2nd/3rd/Bottom Layer

Figure 4. PCB layout 2s2p (4 layer)

Dimension	Value	
Board finish thickness	1.60 mm ± 10%	
Board dimension	76.2 mm x 114.3 mm	
Board material	FR4	
Copper thickness (Top/Bottom layers)	0.070mm (Cu + Plating)	
Copper thickness (Inner layers)	0.035mm	



■ Over Thermal Resistance (Single Pulse)



Electrical Characteristics (Unless otherwise specified, $-40^{\circ}C \le T_j \le +150^{\circ}C$ and $V_{IN}=3.0V$ to 5.5V)

Parameter	Symbol	Limit		Lloit	Conditions	
Falameter	Symbol	Min	Тур	Max	Onit	Conditions
Output Clamp Voltage	V _{CL}	42	48	54	V	V_{IN} =0V, I_D =1mA
On-state Resistance1 (at 25 °C)	R _{ON1}	-	300	380	mΩ	V _{IN} =5V, I _D =0.5A,T _j =25°C
On-state Resistance1 (at 150 °C)	R _{ON2}	-	520	640	mΩ	V _{IN} =5V, I _D =0.5A,T _j =150°C
On-state Resistance2 (at 25 °C)	Rons	-	400	500	mΩ	V _{IN} =3V, I _D =0.5A, T _j =25°C
On-state Resistance2 (at 150 °C)	Ron4	-	680	840	mΩ	V _{IN} =3V, I _D =0.5A,T _j =150°C
Leak Current (at 25 °C)	V _{IL1}	-	0	4	μΑ	V _{IN} =0V, V _{DS} =18V,T _j =25°C
Leak Current (at 150 °C)	VIL2	-	1.5	20	μA	V _{IN} =0V, V _{DS} =18V,T _j =150°C
Turn-ON Time	ton	-	25	50	μs	V_{IN} =0V/5V, R _L =15 Ω , V _B =12V, T _j =25°C
Turn-OFF Time	tOFF	-	25	50	μs	$V_{IN}=0V/5V, R_L=15\Omega, V_B=12V, T_j=25^{\circ}C$
Slew Rate ON	SRON	-	1.0	2.0	V/µs	V _{IN} =0V/5V, R _L =15Ω, V _B =12V, T _j =25°C
Slew Rate OFF	SROFF	-	2.0	4.0	V/µs	V _{IN} =0V/5V, R _L =15Ω, V _B =12V, T _j =25°C
Input Threshold Voltage	VTH	1.1	-	2.7	V	I _D =1mA
High-level Input Current1 (in normal operation)	I _{INH1}	-	150	300	μA	V _{IN} =5V
High-level Input Current2 (in abnormal operation)	I _{INH2}	-	250	450	μA	V _{IN} =5V
Low-level Input Current	I _{INL}	-10	0	10	μA	V _{IN} =0V
Overcurrent Detection Current	IOCP	1.7	2.7	3.7	А	V _{IN} =5V, T _j =25°C
TSD Detection Temperature (Note 1)	T _{jd}	150	175	-	°C	V _{IN} =5V
TSD Release Temperature (Note 1)	Tjr	130	-	-	°C	V _{IN} =5V
TSD Hysteresis (Note 1)	⊿T _{jd}	-	15	-	°C	V _{IN} =5V

(Note 1) Not 100% tested.

Measuring Circuit



Figure 6. Output Clamp Voltage Measuring Circuit



Figure 7. On-state Resistance Measuring Circuit



I/O Pin Truth Table

Operating Status	Input Signal	Output Level	Output Status
Normal	Н	L	ON
Normai	L	Н	OFF
Overeurrent	Н	Н	Current limiting
Overcurrent	L	Н	OFF
Over Termenerature	Н	Н	OFF
Over temperature	L	Н	OFF

Typical Performance Curves (Unless otherwise specified, Tj=25°C, VIN=5.0V)



Figure 9. Output Clamp Voltage vs. Junction Temperature





Typical Performance Curves (Unless otherwise specified, Tj=25°C, VIN=5.0V) - continued







(Input Voltage Characteristics)

Typical Performance Curves (Unless otherwise specified, Tj=25°C, VIN=5.0V) - continued





Figure 19. Overcurrent Detection Current Characteristics (Temperature Characteristics)

Timing Chart







Figure 21. Inductive Load Operation

Figure 22. Switching Time



Marking Diagram



Datasheet

Physical Dimension, Tape and Reel Information



Operational Notes

1. Grounding Interconnection Pattern

When a small-signal ground and a high-current ground are used, it is recommended to isolate the high-current grounding interconnection pattern and the small-signal grounding interconnection pattern and establish a single ground at the reference point of a set so that voltage changes due to the resistance and high current of patterned interconnects will not cause any changes in the small-signal ground voltage. Pay careful attention to prevent changes in the interconnection pattern of ground for external components.

The ground lines must be as short and thick as possible to reduce line impedance.

2. Thermal Design

Use a thermal design that allows for a sufficient margin by taking into account thermal resistance in actual operating conditions.

3. Absolute Maximum Ratings

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.

4. Inspections on Set Board

If a capacitor is connected to a low-impedance pin in order to conduct inspections of the IC on a set board, stress may apply to the IC. To avoid that, be sure to discharge the capacitor in each process. In addition, to connect or disconnect the IC to or from a jig in the testing process, be sure to turn OFF the power supply prior to connecting the IC, and disconnect it from the jig only after turning OFF the power supply. Furthermore, in order to protect the IC from static electricity, establish a ground for the IC assembly process and pay utmost attention to transport and store the IC.

5. 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.

6. 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.

7. Thermal Shutdown Circuit

IC has a built-in thermal shutdown circuit as an overheat-protection measure. The circuit is designed to turn OFF output when the temperature of the IC chip exceeds 175°C (Typ) and return the IC to the normal operation when the temperature falls below 160°C (Typ).

The thermal shutdown circuit is a circuit absolutely intended to protect the IC from thermal runaway, not intended to protect or guarantee the IC. Consequently, do not operate the IC based on the subsequent continuous use or operation of the circuit.

8. Overcurrent Limiting Circuit

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.

9. Overvoltage (Active Clamp) Protection Function

IC has a built-in overvoltage protection function in order for the IC to absorb counter-electromotive force energy generated when inductive load is turned OFF. Since the input voltage is clamped at 0V. When the active clamp circuit is activated, the thermal shutdown circuit is disabled. Design a thermal solution so that the chip temperature will definitely come to less than 150°C.

10. Counter-electromotive Force

Fully ensure that the counter-electromotive force presents no problems in the operation or the IC.

11. Reverse Connection of Power Supply

The reverse connection of the power supply connector may cause this IC to break down. In order to avoid the reverse connection breakdown, mount an external diode between the power supply and the power supply pin of the IC, or take other protection measures.

Operational Notes – continued

12. Negative Current of Output

When supply a negative current from DRAIN terminal in the state that supplied the voltage to IN terminal. The current pass from IN terminal to DRAIN terminal through a parasitic transistor and voltage of IN terminal descend as shown in figure.23 and figure.24.

As shown in figure.23 power MOS is turned on, set the DRAIN terminal is more than -0.3V. Because a negative current may be passed to DRAIN terminal from a power supply of the connection of the IN terminal (MCU, and so on).

As shown in figure 24 power MOS is turned off, add a restriction resistance higher than 330 Ω to IN terminal. Because a negative current may be passed to DRAIN terminal from GND of the connection of the IN terminal.

The restriction resistance value, set up in consideration of the voltage descent caused by the IN terminal current.



Figure 23. Negative current pass (when power MOS is turned on)



Figure 24. Negative current pass (when power MOS is turned off)

Revision History

Date	Revision	Changes
25.Aug.2016	001	New Release
31.Jan.2017	002	 P.4 "Thermal Characteristics" "Top/Bottom layers" modify to "Top layer". P.7 "Electrical Characteristics" Modify max value of "On-state Resistance2 (at 25 °C)" P.7 "Electrical Characteristics" "Tj" modify to "Tj" P9-11 "Typical Performance Curves" "Tj" modify to "Tj" "VIN" modify to "VIN" P.11 "Figure 18,19" "Overcurrent Protection" modify to "Overcurrent Detection" P.15 Revised expression on the information of Thermal Design. P.15 Add "Counter-electromotive Force"

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(Note1) Medical Equipment Classification of the Specific Applications	
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JAPAN	USA	EU	CHINA
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