Datasheet

Automotive Intelligent Power Device Single Channel 9 mΩ High Side Switch

BV1HB008EFJ-C

General Description

The BV1HB008EFJ-C single channel 9 mΩ Intelligent High Side Power Device integrates an Overcurrent load protection, a dual Temperature Shutdown mechanism which limits the internal thermal transients and reduces the mechanical stress of the IC, and a smart Active-Clamp circuit to dissipate the magnetic energy while switching off inductive loads and to protect internal circuits from overvoltage surges. Embedded Current Sense and Diagnostic features provide real time load current information and open or short circuit feedback in both on and off state. A 3 V and 5 V CMOS compatible input pin offers direct microcontroller connection without special interfaces or level shifters. These in conjunction with a wide input voltage range make the High Side IPD a high-performance component suitable for 12 V battery connected automotive applications.

Key Specifications

- Supply Nominal Voltage Range: 6 V to 28 V
- Low Operating Voltage (cranking): 4 V (Max)
- Overvoltage Protection: 41 V (Min)
- ON Resistance: 9 mΩ (Typ)
- Overcurrent Limit: 66 A (Typ)
- Sleep Current: 0.5 µA (Max)
- Operating Current: 3.5 mA (Typ)
- Junction Temperature Range (Tj): -40 °C to +150 °C

Package

	W (Typ) x D (Typ) x H (Max)
HTSOP-J8	4.9 mm x 6.0 mm x 1.0 mm

- Thermally Enhanced Thin Small-Outline 8 pin package with 1.27 mm Pin Pitch
- Exposed Pad for improved thermal performance

Features

- AEC-Q100 Qualified*(Note 1)*
- Short Circuit Load Protection
- Overcurrent Limitation
- Active Clamp and Overvoltage Protection
- Dual Temperature Shutdown
- Undervoltage Lock Out
- Integrated Current SENSE Circuit
- Loss of Ground Protection
- Reverse Battery Connection Protection
- Open Load and Short to Battery Diagnostics

(*Note 1)* Grade 1

Applications

- Driver for Resistive, Inductive and Capacitive Loads
- MOSFET, Relay and Fuse Replacement
- Intelligent Power Device for 12 V Automotive Applications

Typical Application Circuit

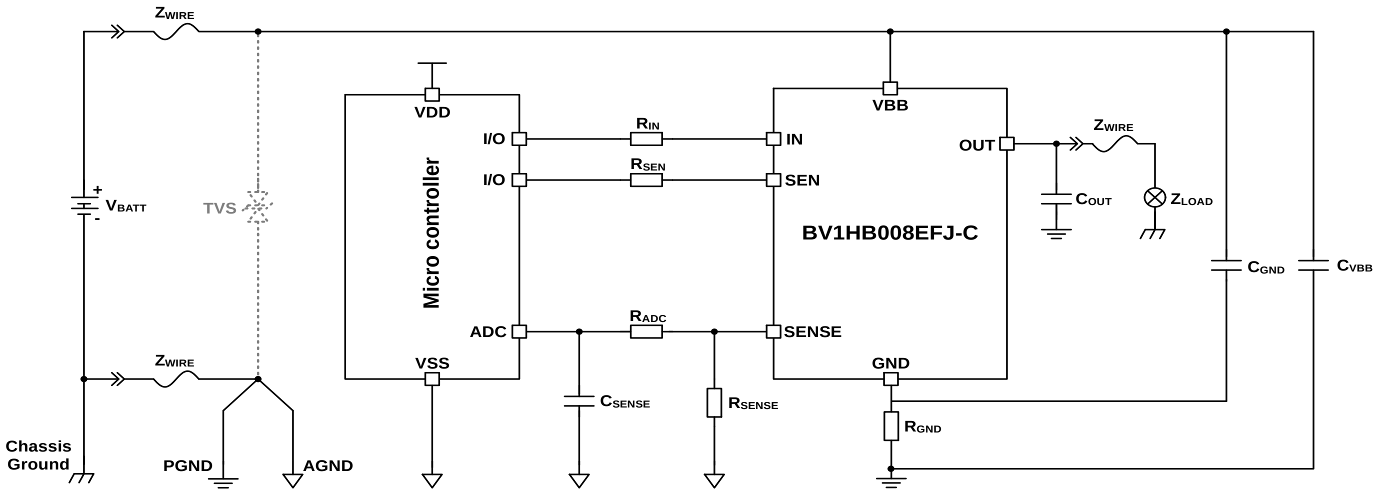

Figure 1. Typical Application Diagram

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

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Pin Configuration

HTSOP-J8
(Top View)

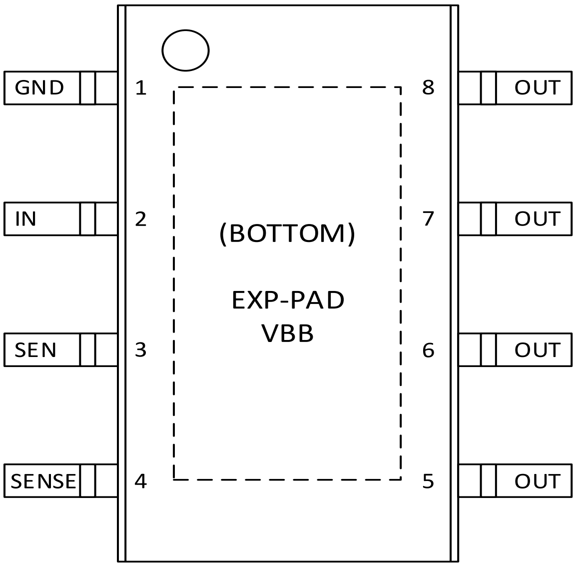


Figure 2. Pin Configuration

Pin Description

Pin No.	Pin Name	Function
1	GND	Device Ground pin
2	IN	Input Pin. Turns on the Switch. Active "High"
3	SEN	Current Sense and diagnostic enable. Active "High"
4	SENSE	Current Sense analog output pin
5 to 8	OUT	High Side Switch Power Output*(Note 1)*
EXP-PAD	VBB	Exposed-Pad. Power Supply Voltage Line Input

(Note 1) Output pins are internally shorted. Please connect the respective pins together on the PCB such as the metal traces can withstand the desired maximum current.

Definitions

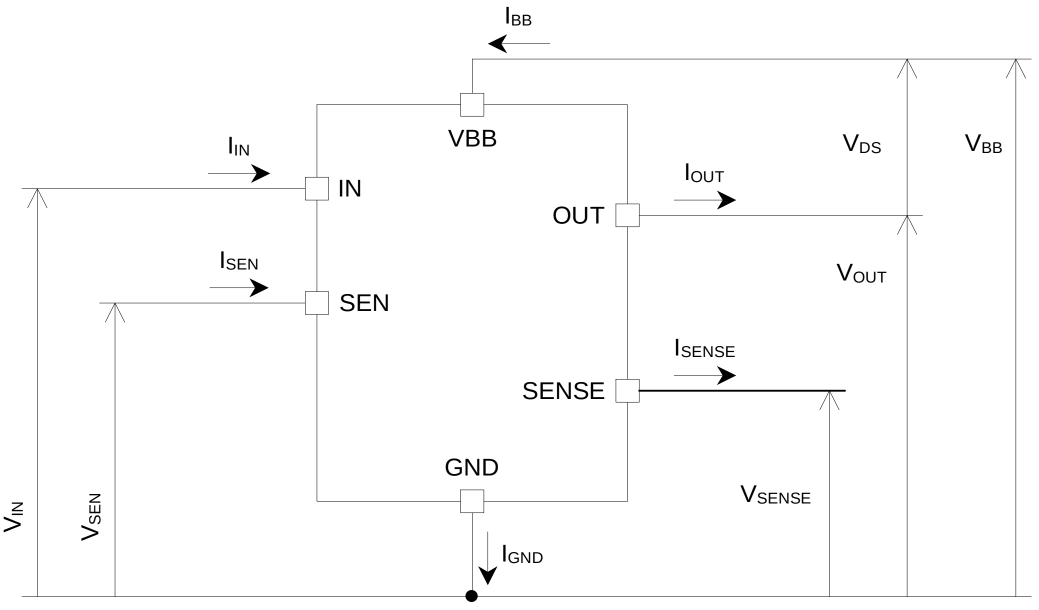


Figure 3. Voltage and Current Definitions

Absolute Maximum Ratings

Parameters	Symbol	Ratings	Unit	Conditions
[Power Supply / GND pin]				
DC Supply Voltage	V_{BB}	-0.3 to +36	V	
Supply Voltage at load dump	V_{BB_LD}	40	V	ISO16750-2, Ri = 2 Ω
Supply Voltage (Output to GND short) *(Note 4)*	V_{BB_SC}	-0.3 to +18	V	AEC-Q100-012
Supply Voltage (When battery is connected in reverse direction)	V_{BB_REV}	-16	V	less than 2 minutes, Tj = 25 °C, R_L > 4 Ω, R_{GND} connected
GND Pin Current	I_{GND}	-50 to +30	mA	less than 2 minutes, Tj = 25 °C
[Input Pin]				
Input Voltage	V_{IN}, V_{SEN}	-0.3 to +7	V	
Input Current	I_{IN}, I_{SEN}	-2 to +2	mA	
Input Current (When battery is connected in reverse direction)	I_{IN_REV}, I_{SEN_REV}	-5	mA	less than 2 minutes, Tj = 25 °C, R_{IN}, R_{SEN} ≥ 4.7 kΩ
[SENSE pin]				
SENSE Voltage	V_{SENSE_ON}	-0.3 to internal limitation *(Note 1)*	V	V_{SEN} = "high"
	V_{SENSE_OFF}	-0.3 to +7	V	V_{IN} = V_{SEN} = "low"
SENSE Current	I_{SENSE}	-20 to internal limitation *(Note 1)*	mA	R_{SENSE} = 1 kΩ
[OUT pin]				
Power Supply to Output Voltage	V_{DS}	-0.3 to internal limitation *(Note 2)*	V	
Maximum Output Current	I_{OUT}	internal limitation *(Note 3)*	A	Maximum V_{BB} = 28 V
Single Pulse Energy Rating *(Note 4)*	$E_{AS\_25°C}$	120	mJ	Tj = 25 °C, V_{BB} = 14 V, $I_{OUT(START)}$ = 8 A
	$E_{AS\_150°C}$	70	mJ	Tj = 150 °C, V_{BB} = 14 V, $I_{OUT(START)}$ = 8 A
[Temperature]				
Storage Temperature Range	Tstg	-55 to +150	°C	
Junction Temperature Range	Tj	-40 to +150	°C	
Maximum Junction Temperature	Tjmax	150	°C	
[ESD] *(Note 5)*				
Electrostatic-Discharge Capability Human Body Model - HBM	OUT pins	±2	KV	
	VBB,IN, SEN, SENSE pins	±2	KV	
Electrostatic-Discharge Capability Charged Device Model - CDM	All pins	±750	V	

(Note 1) Internal limitation by SENSE voltage clamp and current-limitation protection. Please see the "*Electrical Characteristics*" section for more details.
(Note 2) Internal limitation by output active-clamp overvoltage protection. Please see the "*Electrical Characteristics*" section for more details.
(Note 3) Internal limitation by output overcurrent protection. Please see the "*Electrical Characteristics*" section for more details.
(Note 4) Specified by design and/or statistical analysis of correlated parameters tested in production.
(Note 5) Measured as per EIA/JEDEC and AEC-Q100 Standard. HMB-Measured as per JESD22-A114D and AEC-Q100-002.
CDM-Measured as per JESD22-C101C and AEC-Q100-011.

***Caution 1**: Exposure to the absolute maximum ratings may cause permanent damage to the IC, may affect the device reliability and lifetime. Therefore, operation at or above the absolute maximum ratings is not recommended. The above-described values represent stress ratings and functional operation is not implied. In addition, no destructive conditions such as short or open can be assumed.*

***Caution 2**: If the IC is used in a manner that exceeds the maximum junction temperature the original characteristics of the IC will be degraded. If the junction temperature exceeds the maximum specified temperature, increase the board size, increase the area of copper foil for heat dissipation, or use a heat sink. Consider reducing the thermal resistance so that the maximum junction temperature is not exceeded.*

***Caution 3**: When an inductive load is turned off, the V_{OUT} voltage drops below ground level. An integrated active-clamp (overvoltage) protection limits the maximum V_{DS} across the power transistor and the inductive energy is dissipated internally. The energy can be calculated using the following simplified equation:*

Absolute Maximum Ratings – continued

$$E_L = V_{DSCLP} \times \left[\frac{V_{BB} - V_{DSCLP}}{R_L} \times \ln\left(1 - \frac{R_L \times I_{OUT(START)}}{V_{BB} - V_{DSCLP}}\right) + I_{OUT(START)}\right] \times \frac{L}{R_L}$$

Where:
L is the inductance value of the inductive load.
R_L is the resistance value of the load.
V_{BB} is the supply voltage.
V_{DSCLP} is the clamping voltage.
$I_{OUT(START)}$ is the current flowing through the inductive load at the instance the inductive load is turned off.

In simplified form, if R_L is neglected.

$$E_L = \frac{1}{2} \times L \times I_{OUT(START)}{}^2 \times \left(1 - \frac{V_{BB}}{V_{BB} - V_{DSCLP}}\right)$$

***Caution 4**: The maximum E_L energy the device can dissipate for a given $I_{OUT(START)}$ is limited by the maximum thermal transient the power transistor can handle, hence the maximum inductance L must be selected with respect to the maximum given $I_{OUT(START)}$.*

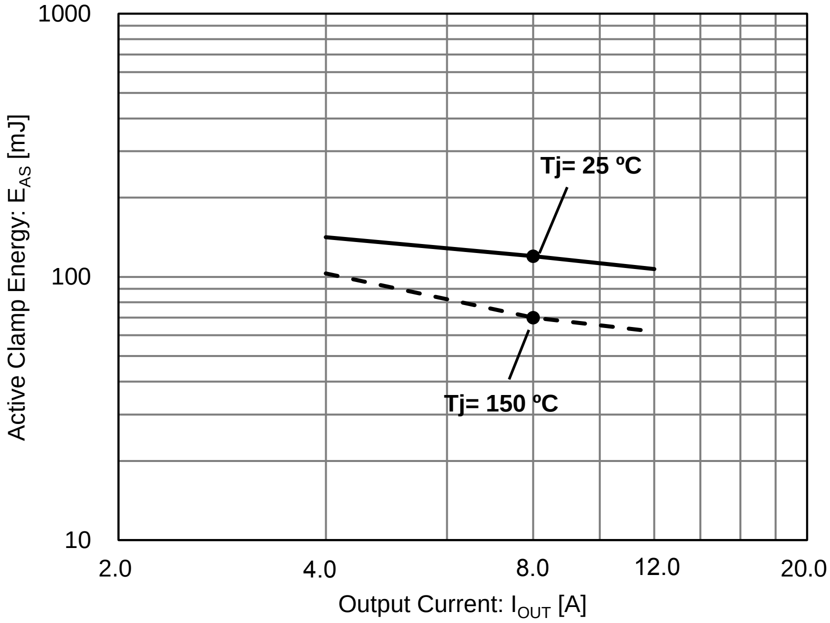


Figure 4. Active Clamp Energy vs Output Current

Recommended Operating Conditions

Parameters	Symbol	MIN	TYP	MAX	Unit
Supply Nominal Voltage Range (Note 1)	V_{BB}	6	14	28	V
Input Voltage	V_{IN}, V_{SEN}	0	-	5.5	V
Operating Junction Temperature	Tj	-40	+25	+150	°C
Input Frequency	f_{IN}	-	-	1	kHz

(Note 1) An extended supply operating voltage range from 4.0 V up to 28 V is possible after start-up; protections are operational. The device is functional up to 36 V and protections are active, however parameter deviations are possible. Please refer to the "*Electrical Characteristics*" section and the "*Features Description*" section.

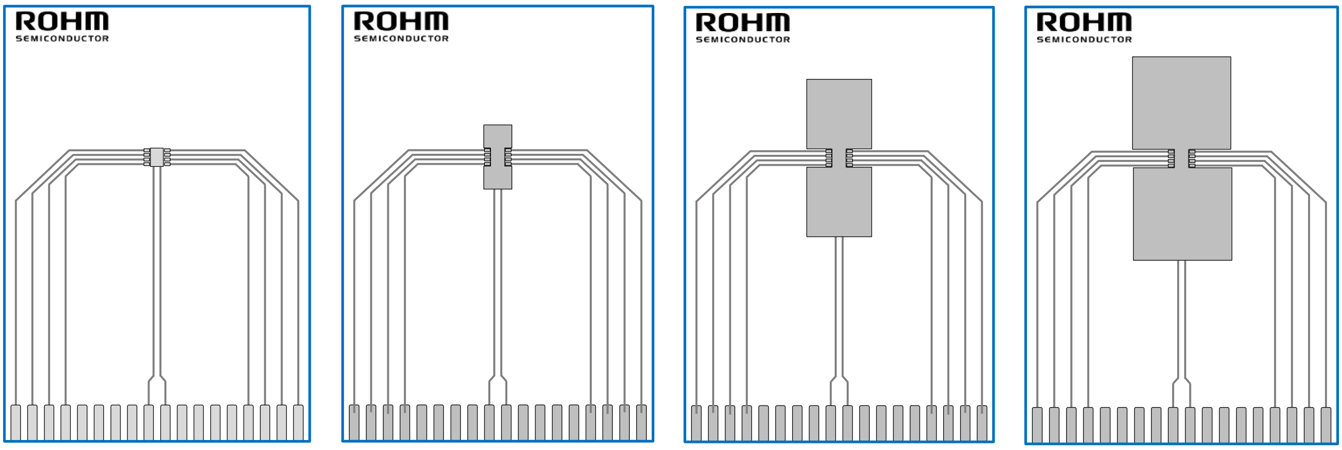
Thermal Resistance *(Note 1)*

Parameters	Symbol	TYP	Unit	Conditions	
HTSOP-J8					
Thermal Resistance between junction and ambient temperature	θ_{JA}	122.2	°C/W	1s	*(Note 2)*
		37.0	°C/W	2s	*(Note 3)*
		24.8	°C/W	2s2p	*(Note 4)*
Thermal characterization parameter between junction and top center of the outside surface of the component package	Ψ_{JT}	7	°C/W	1s	*(Note 2)*
		3	°C/W	2s	*(Note 3)*
		2	°C/W	2s2p	*(Note 4)*

(Note 1) Based on JESD51-2A(Still-Air). Specified by design.
(Note 2) Using a PCB board based on JESD51-3.
(Note 3) Using a PCB board based on JESD51-5.
(Note 4) Using a PCB board based on JESD51-5, 7.

***Caution**: The values presented here were measured/simulated under a specific set of conditions and should be regarded only as a guideline on how to estimate the thermal behavior of the application and should not be used as design parameters. A careful evaluation of the actual application values should be done to confirm the estimated results*

■ PCB Layout 1 Layer (1s)



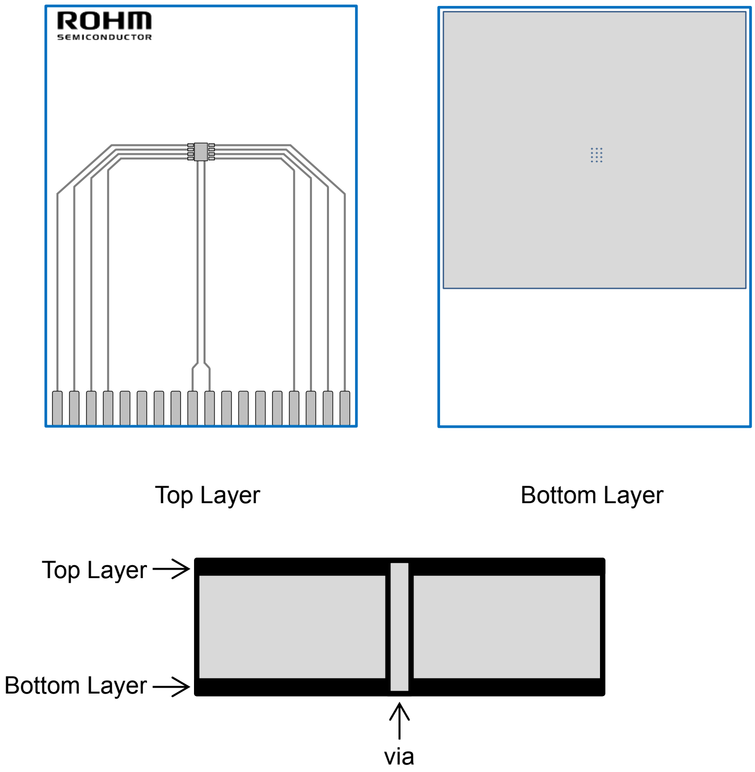
Footprint 100 mm² 600 mm² 1200 mm²

Figure 5. PCB Layout 1 Layer (1s)

Dimension	Value
Board Finish Thickness	1.57 mm
Board Dimension	76.2 mm x 114.3 mm
Board Material	FR4
Copper Thickness	0.070 mm (Cu: 2 oz)
Copper Foil Area	Footprint / 100 mm^2 / 600 mm^2 / 1200 mm^2

Thermal Resistance – continued

■ PCB Layout 2 Layers (2s)



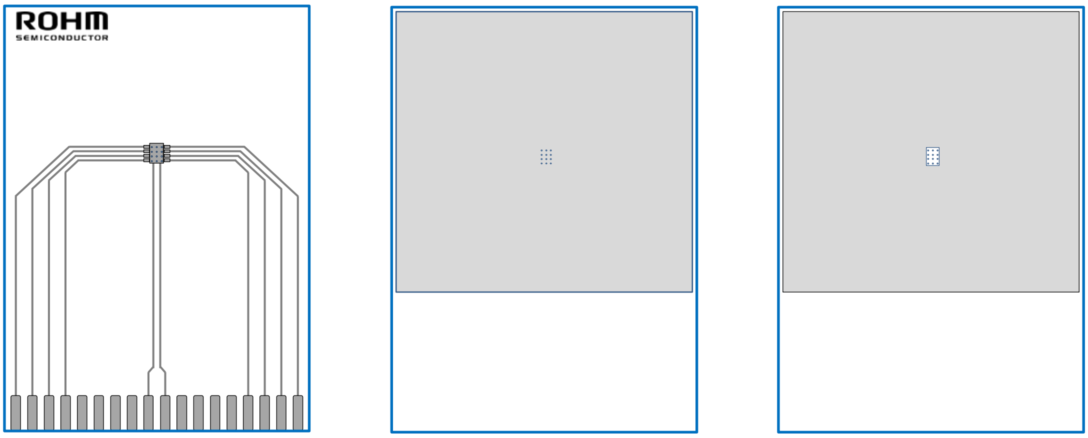
Cross Section

Figure 6. PCB Layout 2 Layers (2s)

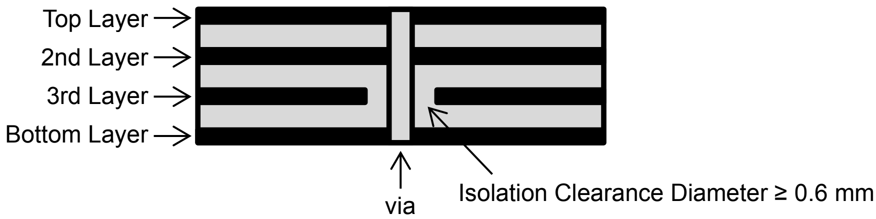
Dimension	Value
Board Finish Thickness	1.60 mm
Board Dimension	76.2 mm x 114.3 mm
Board Material	FR4
Copper Thickness (Top / Bottom Layers)	0.070 mm (Cu: 1 oz + plating)
Thermal Vias Separation / Diameter	1.2 mm / 0.3 mm

Thermal Resistance – continued

■ PCB Layout 4 Layers (2s2p)



Top Layer 2nd / Bottom Layer 3rd Layer



Cross Section

Figure 7. PCB Layout 4 Layers (2s2p)

Dimension	Value
Board Finish Thickness	1.60 mm
Board Dimension	76.2 mm x 114.3 mm
Board Material	FR4
Copper Thickness (Top / Bottom Layers)	0.070 mm (Cu: 1 oz + plating)
Copper Thickness (Inner Layers)	0.035 mm
Thermal Vias Separation / Diameter	1.2 mm / 0.3 mm

Thermal Resistance – continued

■ Thermal Resistance Graphs

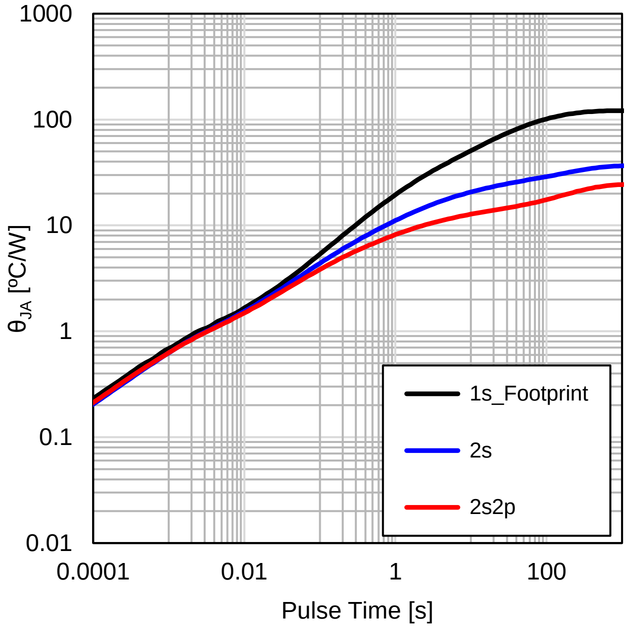


Figure 8. Transient Thermal Resistance

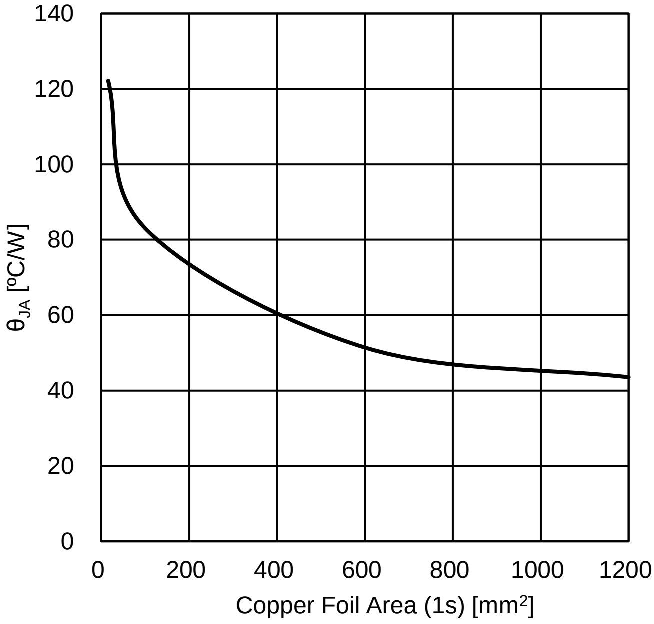


Figure 9. Thermal Resistance

Electrical Characteristics
(Unless otherwise specified V_{BB} = 6 V to 28 V, Tj = -40 °C to +150 °C)

Parameters	Symbol	Ratings MIN	Ratings TYP	Ratings MAX	Unit	Conditions
[Power Supply Section]						
Sleep Mode Current	I_{BBL1}	-	-	0.5	µA	V_{BB} = 18 V, V_{IN} = 0 V, V_{SEN} = 0 V, V_{OUT} = 0 V, Tj = 25 °C
	I_{BBL2} (Note 1)	-	-	1.0	µA	V_{BB} = 18 V, V_{IN} = 0 V, V_{SEN} = 0 V, V_{OUT} = 0 V, Tj = 85 °C
	I_{BBL3}	-	-	30	µA	V_{BB} = 18 V, V_{IN} = 0 V, V_{SEN} = 0 V, V_{OUT} = 0 V, Tj = 150 °C
Standby Mode Current (Diagnostic Function ON)	I_{GNDL}	-	1.0	2.0	mA	V_{BB} = 18 V, V_{IN} = 0 V, V_{SEN} = 5 V
Operating Mode Current	I_{GNDH}	-	3.5	6.0	mA	V_{BB} = 18 V, V_{IN} = 5 V
UVLO Threshold Voltage	V_{UVLOH}	4.7	5.1	5.5	V	V_{BB}: sweep-up, V_{IN} = 5 V, V_{OUT} reaches more than V_{BB} - 1 V
	V_{UVLOL}	3.0	3.5	4.0	V	V_{BB}: sweep-down, V_{IN} = 5 V, V_{OUT} reaches less than 1 V
UVLO Hysteresis Voltage	V_{UVHYS}	-	1.6	-	V	V_{UVHYS} = V_{UVLOH} - V_{UVLOL}
V_{BB} Overvoltage Protection	V_{BBCLP}	41	45	49	V	I_{BB} = 10 mA
[Input Section (IN / SEN pin)]						
High Level Input Voltage	V_{IH}	2.1	-	-	V	
Low Level Input Voltage	V_{IL}	-	-	0.9	V	
Input Hysteresis Voltage	V_{IHYS}	-	0.2	-	V	
High Level Input Current	I_{IH}	-	50	100	µA	V_{IN}, V_{SEN} = 5 V
Low Level Input Current	I_{IL}	-	5	10	µA	V_{IN}, V_{SEN} = 0.5 V
[Output Section]						
Output ON Resistance	R_{ON1}	-	9	12	mΩ	V_{BB} ≥ 8 V, Tj = 25 °C, I_{OUT} = 7 A
	R_{ON2}	-	-	22	mΩ	V_{BB} ≥ 8 V, Tj = 150 °C, I_{OUT} = 7 A
	R_{ON3}	-	-	20	mΩ	V_{BB} = 6 V, Tj = 25 °C, I_{OUT} = 7 A
Output ON Resistance in Reverse Battery Connection	$R_{ON(REV)}$	-	8	-	mΩ	V_{BB} = -14 V, Tj = 25 °C
Output Leakage Current	I_{OUTL1}	-	-	0.5	µA	V_{BB} = 18 V, V_{IN} = 0 V, V_{SEN} = 0 V, V_{OUT} = 0 V, Tj = 25 °C
	I_{OUTL2} (Note 1)	-	-	1.0	µA	V_{BB} = 18 V, V_{IN} = 0 V, V_{SEN} = 0 V, V_{OUT} = 0 V, Tj = 85 °C
	I_{OUTL3}	-	-	30	µA	V_{BB} = 18 V, V_{IN} = 0 V, V_{SEN} = 0 V, V_{OUT} = 0 V, Tj = 150 °C
V_{DS} Voltage at Light Load	V_{DSSL}	-	13	27	mV	V_{IN} = 5 V, I_{OUT} = 100 mA
Output Slew Rate when ON	SR_{ON}	-	0.25	0.70	V/µs	V_{BB} = 14 V, R_L = 2 Ω, Tj = 25 °C, V_{OUT} = 30 % to 70 % of V_{BB}
Output Slew Rate when OFF	$-SR_{OFF}$	-	0.25	0.70	V/µs	V_{BB} = 14 V, R_L = 2 Ω, Tj = 25 °C, V_{OUT} = 70 % to 30 % of V_{BB}
Output Propagation Time Delay when Turning ON	t_{OD_ON}	-	70	150	µs	V_{BB} = 14 V, R_L = 2 Ω, Tj = 25 °C, V_{OUT} rises at 20 % of V_{BB}
Output Propagation Time Delay when Turning OFF	t_{OD_OFF}	-	30	100	µs	V_{BB} = 14 V, R_L = 2 Ω, Tj = 25 °C, V_{OUT} drops at 80 % of V_{BB}
Switch ON Energy	E_{ON}	-	0.91	-	mJ	V_{BB} = 14 V, R_L = 2 Ω, Tj = 25 °C
Switch OFF Energy	E_{OFF}	-	0.91	-	mJ	V_{BB} = 14 V, R_L = 2 Ω, Tj = 25 °C
Reverse Current (Note 1)	I_{REVC}	-	-7	-	A	V_{IN} = 5 V, Tj = 25 °C
Body Diode Voltage	V_{DSDI}	-	0.5	0.9	V	I_{OUT} = -10 mA, Tj = 150 °C
V_{DS} Active Clamping Voltage	V_{DSCLP}	41	45	49	V	I_{OUT} = 30 mA

Electrical Characteristics – continued

(Unless otherwise specified V_{BB} = 6 V to 28 V, Tj = -40 °C to +150 °C)

Parameters	Symbol	Ratings			Unit	Conditions
		MIN	TYP	MAX		
[Output Protection Section]						
Overcurrent Detection Value *(Note 1) (Note 2)*	I_{OCD_14V}	46	66	90	A	V_{BB} = 14 V Tj = 25 °C
	I_{OCD_28V}	-	46	-	A	V_{BB} = 28 V Tj = 25 °C
	I_{OCD_14VH}	-	40	-	A	V_{BB} = 14 V Tj = 150 °C
	I_{OCD_TSD}	-	30	-	A	V_{BB} = 14 V , after TSD Detection
Hiccup Time	t_{OCOFF}	7	16	32	ms	
Temperature Shutdown Detection Threshold *(Note 1) (Note 2)*	T_{TSD}	150	175	200	°C	
Temperature Shutdown Detection Hysteresis *(Note 1)*	T_{TSDHYS}	-	15	-	°C	
Dynamic Temperature Protection Threshold *(Note 1) (Note 2)*	T_{DTj}	-	90	-	K	Differential temperature
[Diagnostic / SENSE Section]						
Output Pull Up Current	I_{OLD}	50	100	200	µA	V_{BB} = 14 V, V_{IN} = 0 V, V_{SEN} = 5 V, V_{OUT} = 5 V
Open Load at OFF V_{DS} Threshold	V_{DSOL}	1.5	2.5	3.5	V	V_{IN} = 0 V, V_{SEN} = 5 V
Output Pull Down Current	I_{OUTPD}	-	35	-	µA	V_{OUT} = 5 V
SENSE Leakage Current	I_{SENSEL}	-	-	0.5	µA	V_{IN} = 0 V, V_{SEN} = 0 V, V_{SENSE} = 0 V
	$I_{SENSELD}$	-	-	0.5	µA	V_{IN} = 0 V, V_{SEN} = 5 V, V_{SENSE} = 0 V, V_{OUT} = 0 V
Diagnostic Error Flag Current	I_{SENSEH}	10	20	50	mA	V_{BB} = 8 V, V_{SENSE} = 0 V
Diagnostic Error Flag Voltage	V_{SENSEH}	4.0	5.5	6.5	V	V_{BB} ≥ 8 V, R_{SENSE} = 1 kΩ
SENSE Output Delay Time when the Device Turns ON	t_{DS_ON}	-	100	250	µs	R_L = 2 Ω, V_{SEN} = V_{IN} = 0 to 5 V, R_{SENSE} = 1 kΩ
SENSE Output Delay Time when Diagnostic Turns ON	t_{DS_DON}	-	10	50	µs	R_L = 2 Ω, V_{IN} = 5 V, V_{SEN} = 0 V to 5 V, R_{SENSE} = 1 kΩ
SENSE Output Delay Time when Diagnostic Turns OFF	t_{DS_DOFF}	-	10	50	µs	R_L = 2 Ω, V_{IN} = 5 V, V_{SEN} = 5 V to 0 V, R_{SENSE} = 1 kΩ
SENSE Settling Time during Load Current Switching	$t_{DS\_CHG\_H}$	-	-	20	µs	V_{IN} = V_{SEN} = 5V, I_{OUT} = 5 A to 10 A, R_{SENSE} = 1 kΩ
	$t_{DS\_CHG\_L}$	-	0.6	2.0	ms	V_{IN} = V_{SEN} = 5 V, I_{OUT} = 5 A to 50 mA, R_{SENSE} = 1 kΩ
Open Load at OFF Detection Mask Time *(Note 1) (Note 2)*	t_{OLDMSK}	-	300	800	µs	V_{DS} = 0 V, V_{SEN} = 5 V, V_{IN} = 5 V to 0 V
Diagnostic Error Flag Release Delay Time *(Note 1) (Note 2)*	t_{ERRFD}	-	550	1200	µs	V_{IN} = 0 V, V_{SEN} = 5 V, V_{DS} = 0 V to 5 V
Current Sense Ratio 1	K_1	-45 %	5400	+45 %	-	V_{BB} = 14 V, I_{OUT} = 0.1 A, V_{IN} = V_{SEN} = 5 V
Current Sense Ratio 2	K_2	-30 %	5350	+30 %	-	V_{BB} = 14 V, I_{OUT} = 0.25 A, V_{IN} = V_{SEN} = 5 V
Current Sense Ratio 3	K_3	-25 %	5300	+25 %	-	V_{BB} = 14 V, I_{OUT} = 0.5 A, V_{IN} = V_{SEN} = 5 V
Current Sense Ratio 4	K_4	-22 %	5250	+22 %	-	V_{BB} = 14 V, I_{OUT} = 1 A, V_{IN} = V_{SEN} = 5 V
Current Sense Ratio 5	K_5	-16 %	5200	+16 %	-	V_{BB} = 14 V, I_{OUT} = 2 A, V_{IN} = V_{SEN} = 5 V
Current Sense Ratio 6	K_6	-12 %	5200	+12 %	-	V_{BB} = 14 V, I_{OUT} = 4 A, V_{IN} = V_{SEN} = 5 V
Current Sense Ratio 7	K_7	-8 %	5200	+8 %	-	V_{BB} = 14 V, I_{OUT} = 10 A, V_{IN} = V_{SEN} = 5 V
Current Sense Ratio 8	K_8	-8 %	5200	+8 %	-	V_{BB} = 14 V, I_{OUT} = 15 A, V_{IN} = V_{SEN} = 5 V
Current Sense Derating *(Note 1)*	ΔK_1	-30	-	+30	%	K_1 vs K_2, Tj = 25 °C
	ΔK_2	-5	-	+5	%	K_4 vs K_5, Tj = 25 °C
Output Load Open Detection ON	I_{OUT_ONOLD}	29.7	54.0	78.3	mA	I_{SENSE} = 10 µA = (54 mA / 5400)

(Note 1) Specified by design and/or statistical analysis of correlated parameters tested in production.
(Note 2) Functional test only.

Typical Performance Curves
(Unless otherwise specified V_{BB} = 14 V, Tj = 25 °C)

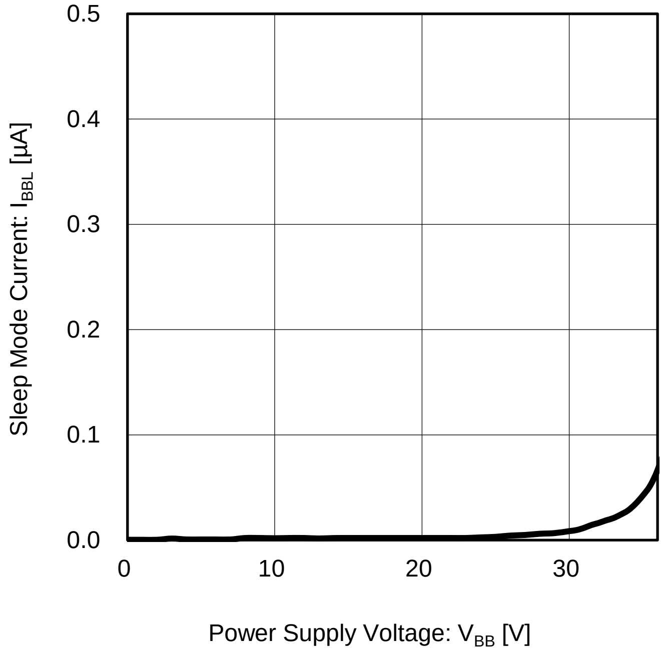


Figure 10. Sleep Mode Current vs Power Supply Voltage

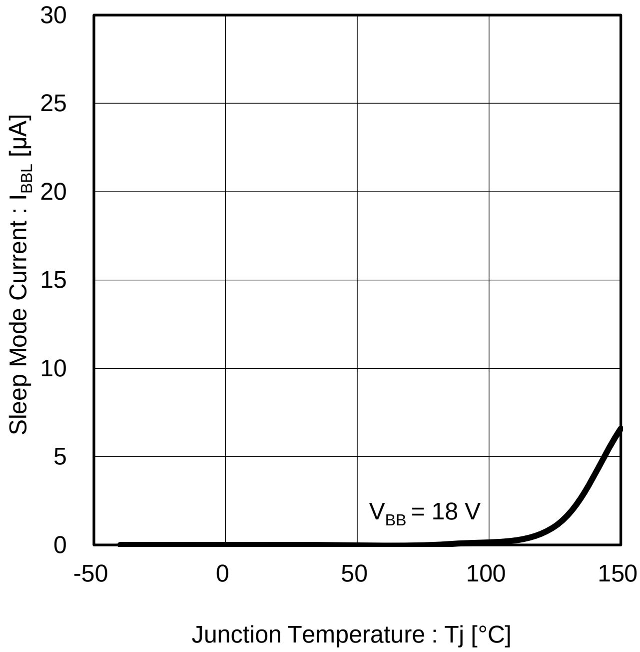


Figure 11. Sleep Mode Current vs Junction Temperature

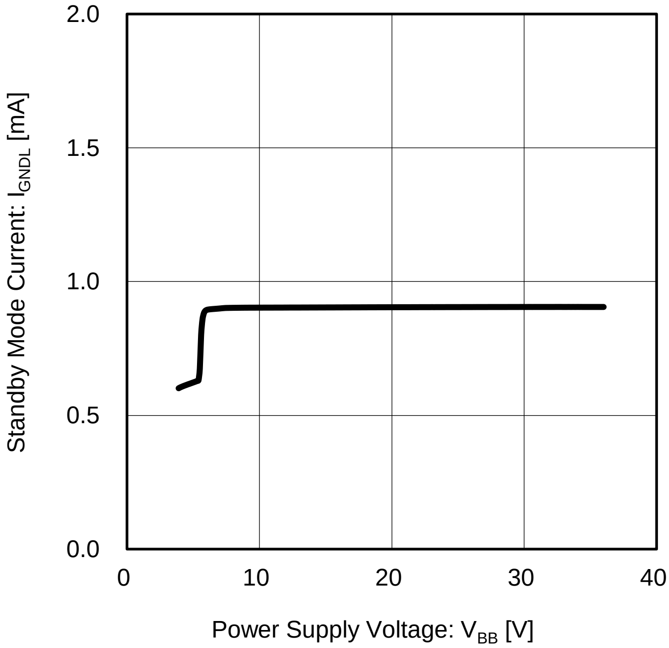


Figure 12. Standby Mode Current vs Power Supply Voltage

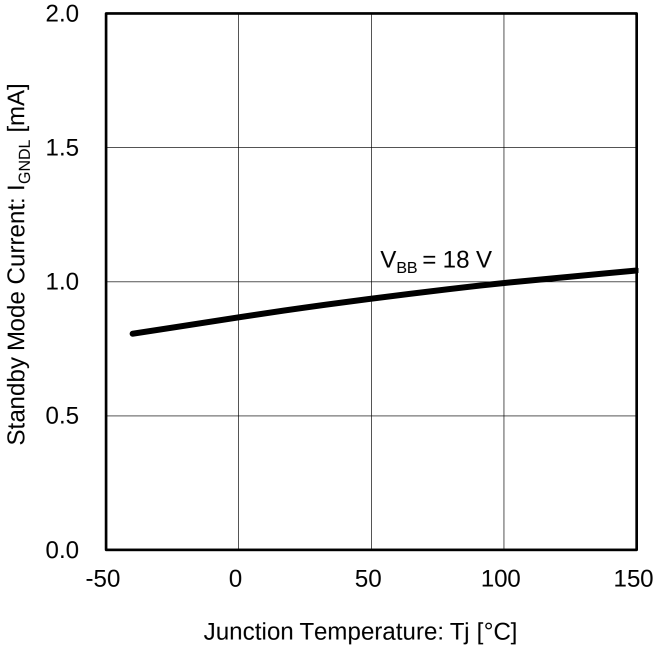


Figure 13. Standby Mode Current vs Junction Temperature

Typical Performance Curves – continued
(Unless otherwise specified V_{BB} = 14 V, Tj = 25 °C)

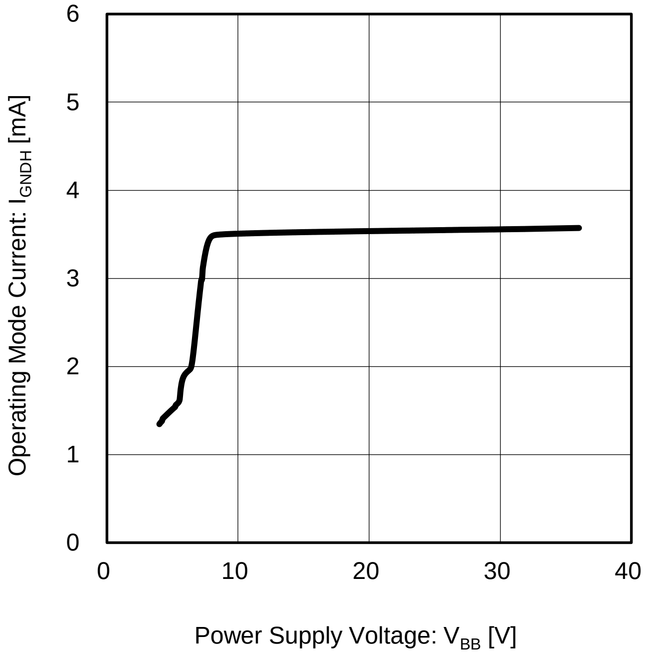


Figure 14. Operating Mode Current vs Power Supply Voltage

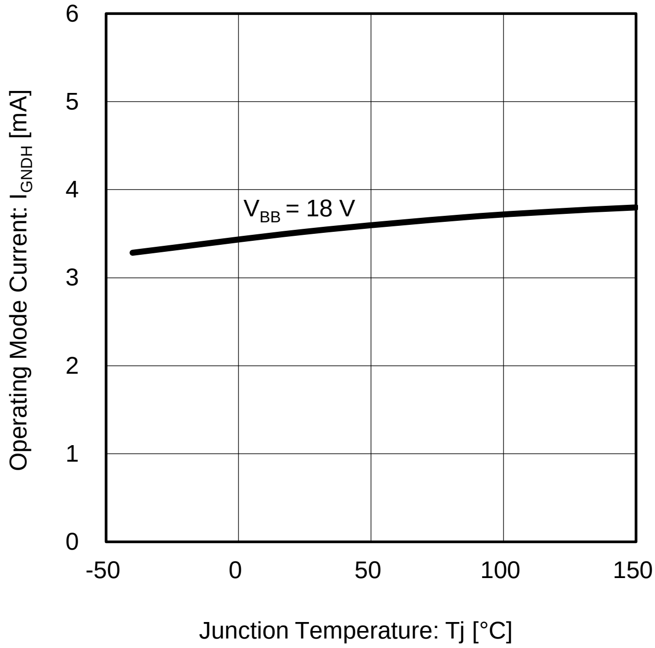


Figure 15. Operating Mode Current vs Junction Temperature

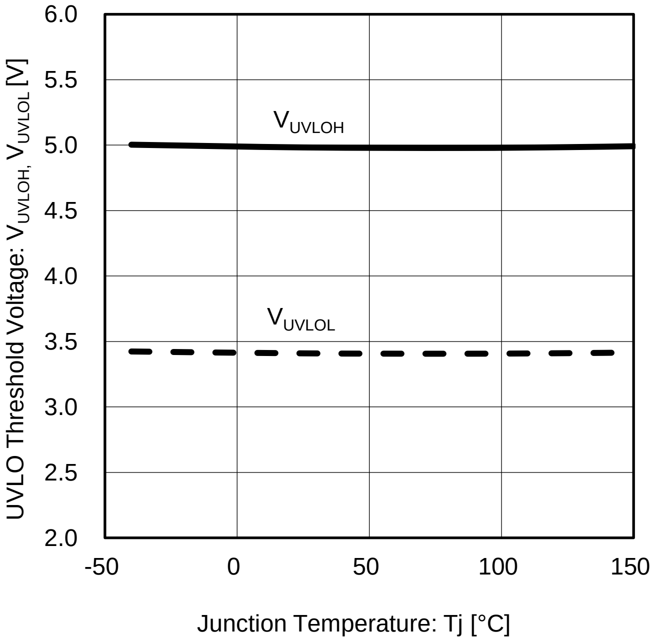


Figure 16. UVLO Threshold Voltage vs Junction Temperature

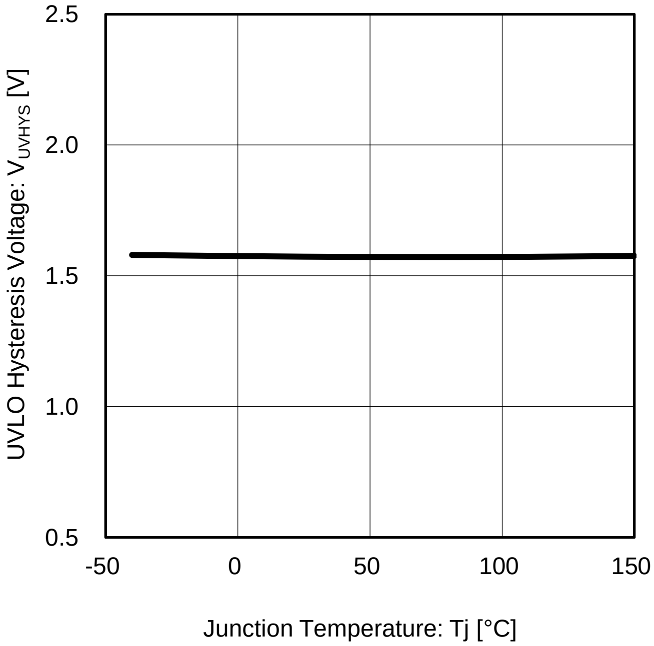


Figure 17. UVLO Hysteresis Voltage vs Junction Temperature

Typical Performance Curves – continued
(Unless otherwise specified V_{BB} = 14 V, Tj = 25 °C)

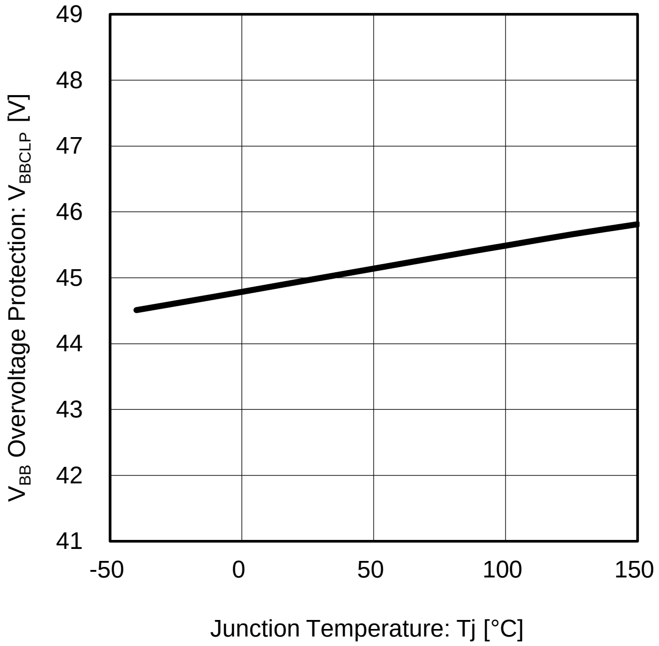


Figure 18. V_{BB} Overvoltage Protection vs Junction Temperature

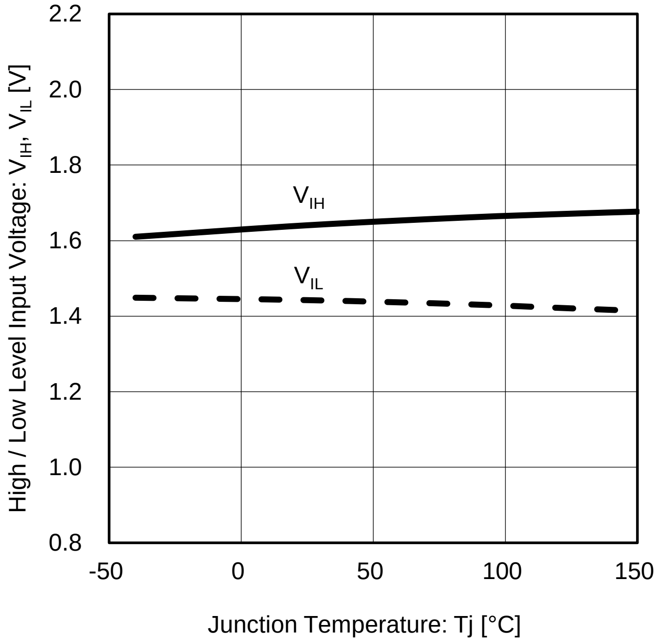


Figure 19. High / Low Level Input Voltage vs Junction Temperature

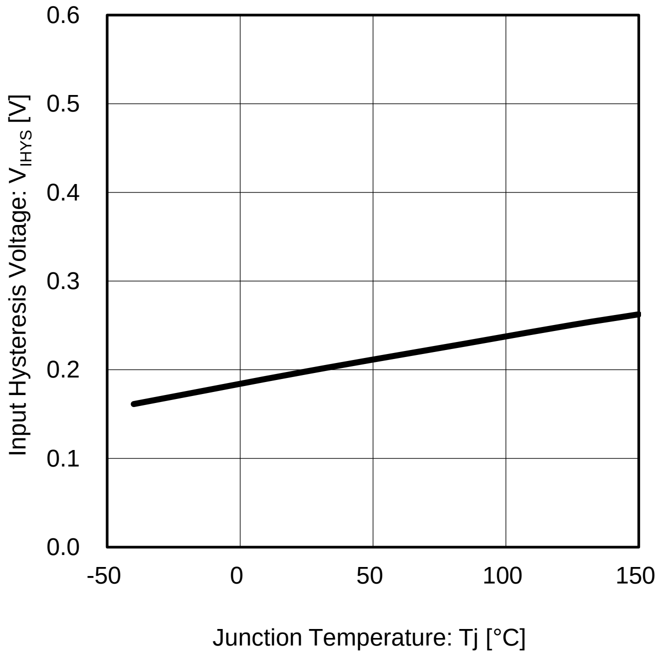


Figure 20. Input Hysteresis Voltage vs Junction Temperature

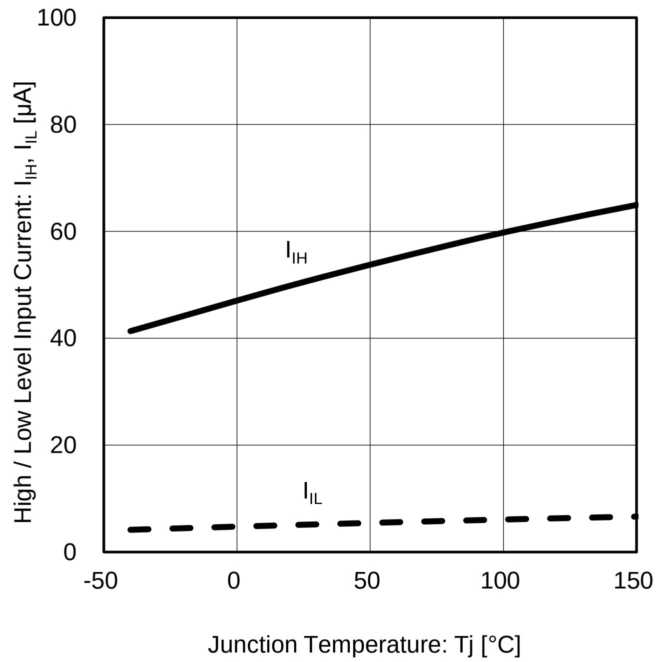


Figure 21. High / Low Level Input Current vs Junction Temperature

Typical Performance Curves – continued
(Unless otherwise specified V_{BB} = 14 V, Tj = 25 °C)

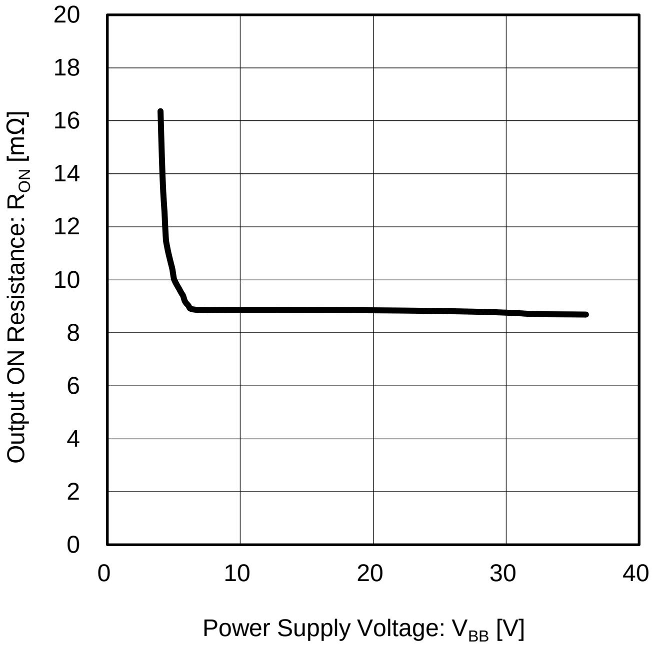


Figure 22. Output ON Resistance vs Power Supply Voltage

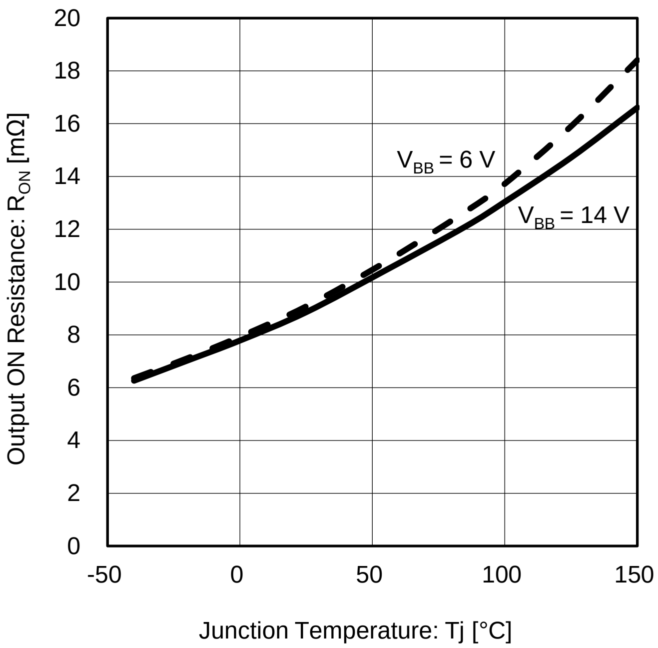


Figure 23. Output ON Resistance vs Junction Temperature

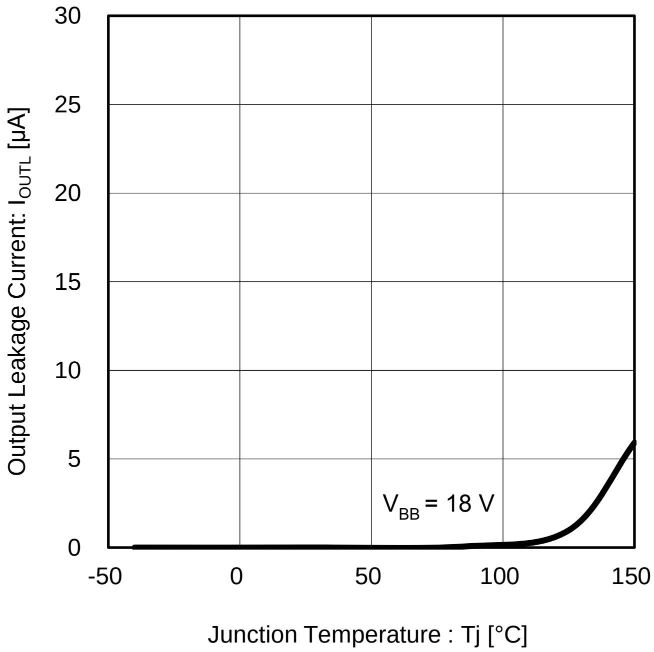


Figure 24. Output Leakage Current vs Junction Temperature

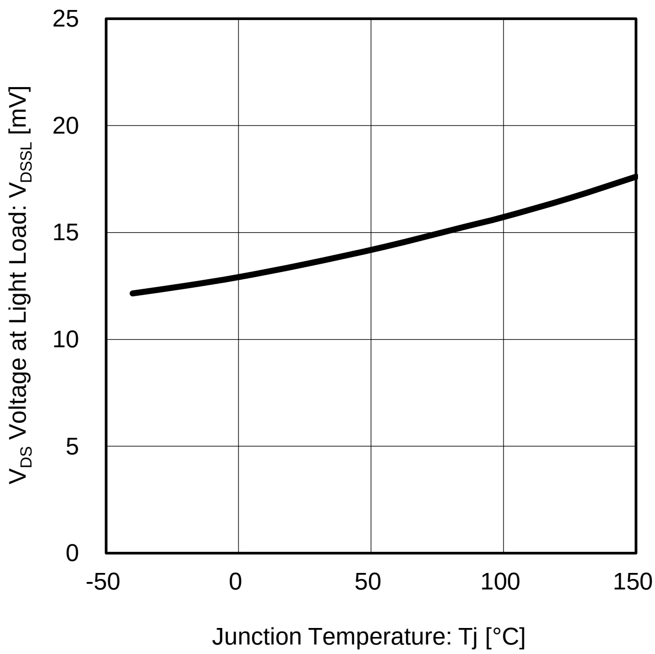


Figure 25. V_{DS} Voltage at Light Load vs Junction Temperature

Typical Performance Curves – continued

(Unless otherwise specified V_{BB} = 14 V, Tj = 25 °C)

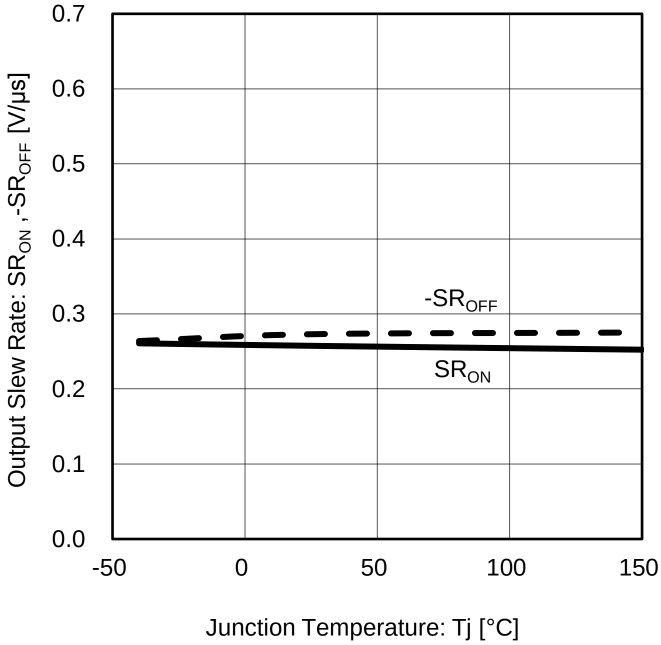


Figure 26. Output Slew Rate vs Junction Temperature

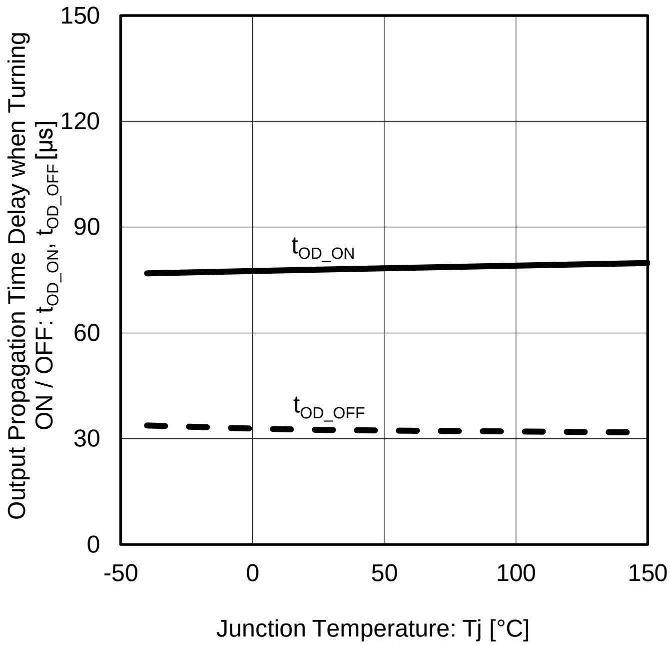


Figure 27. Output Propagation Time Delay when Turning ON / OFF vs Junction Temperature

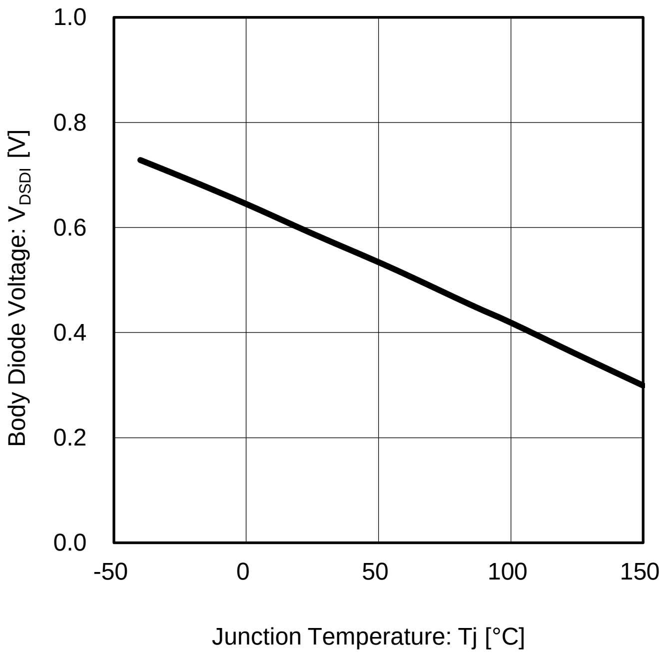


Figure 28. Body Diode Voltage vs Junction Temperature

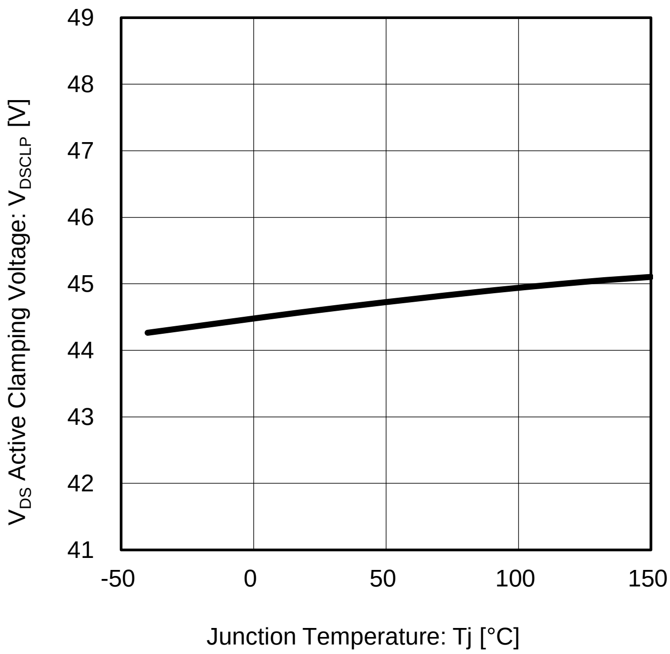


Figure 29. V_{DS} Active Clamping Voltage vs Junction Temperature

Typical Performance Curves – continued
(Unless otherwise specified V_{BB} = 14 V, Tj = 25 °C)

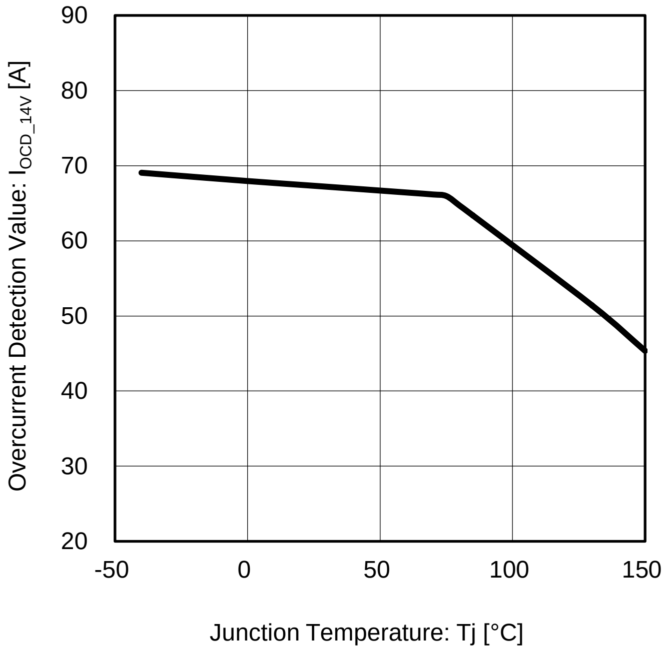


Figure 30. Overcurrent Detection Value vs Junction Temperature

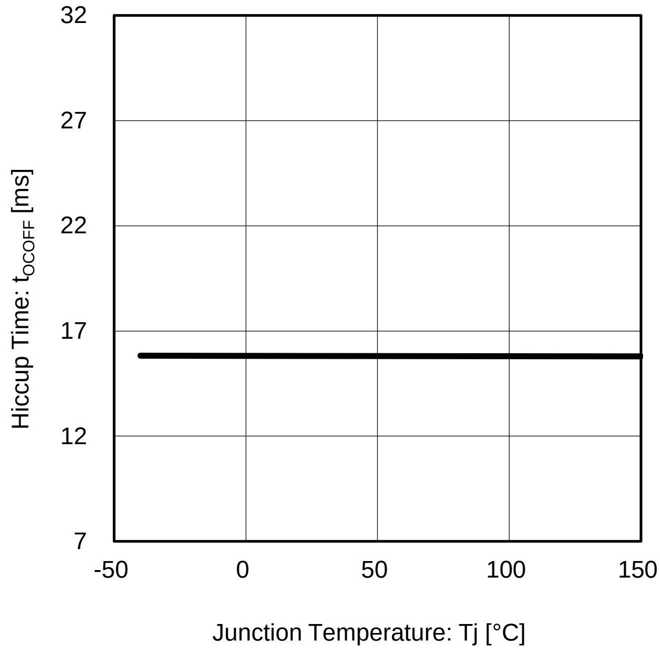


Figure 31. Hiccup Time vs Junction Temperature

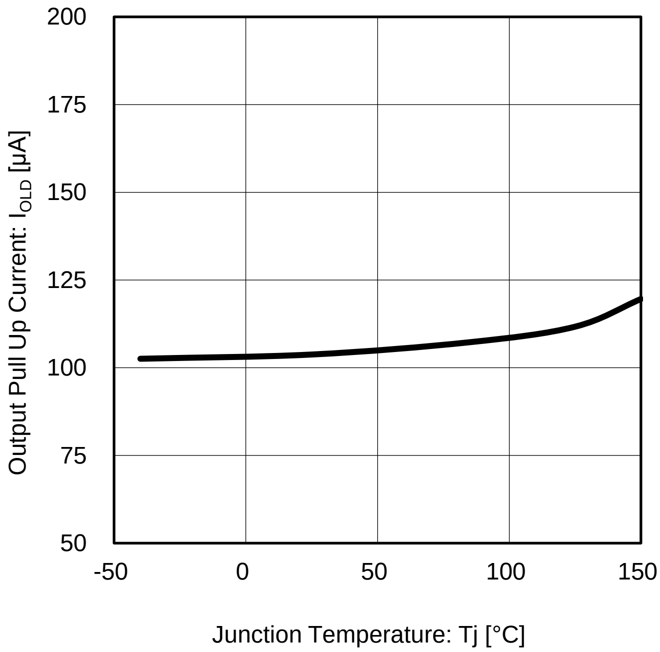


Figure 32. Output Pull Up Current vs Junction Temperature

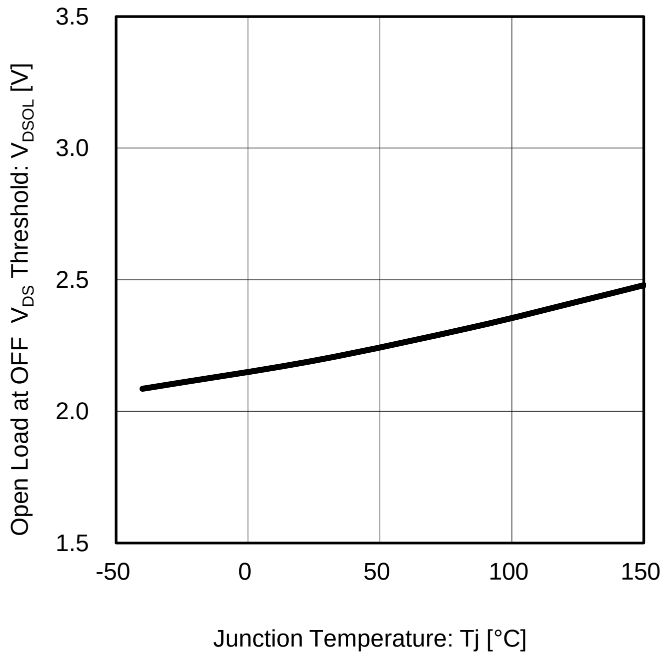


Figure 33. Open Load at OFF V_{DS} Threshold vs Junction Temperature

Typical Performance Curves – continued
(Unless otherwise specified V_{BB} = 14 V, Tj = 25 °C)

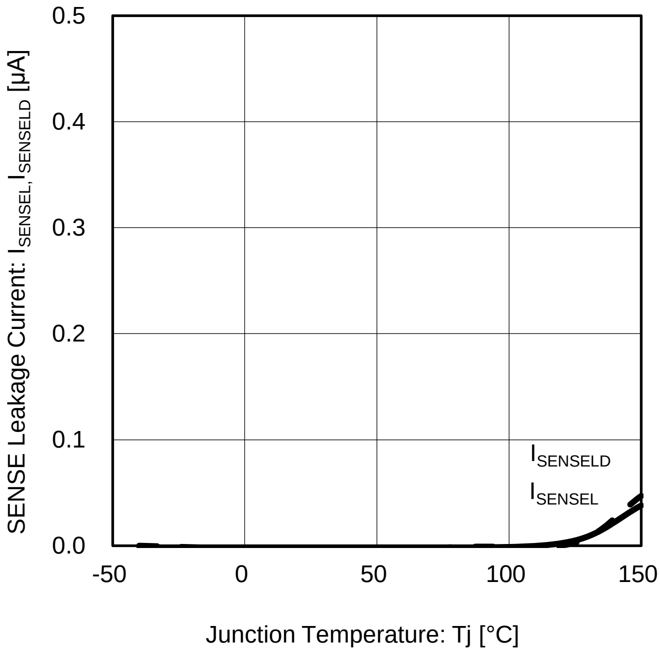


Figure 34. SENSE Leakage Current vs Junction Temperature

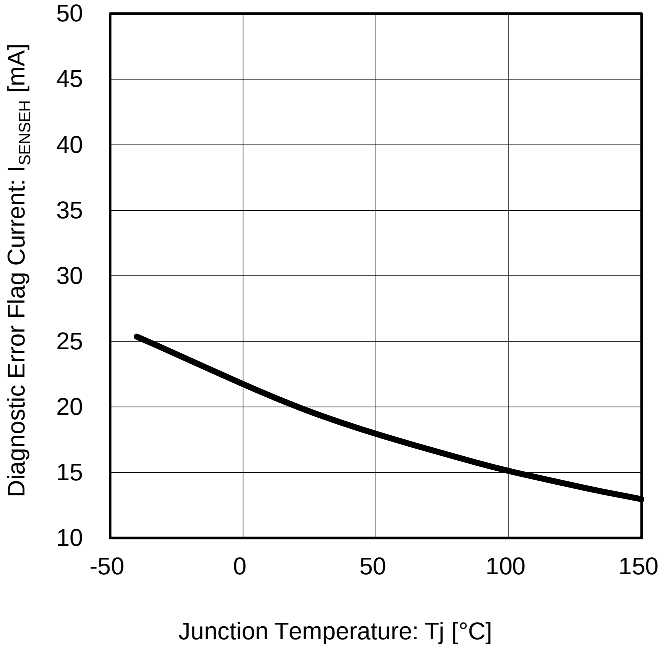


Figure 35. Diagnostic Error Flag Current vs Junction Temperature

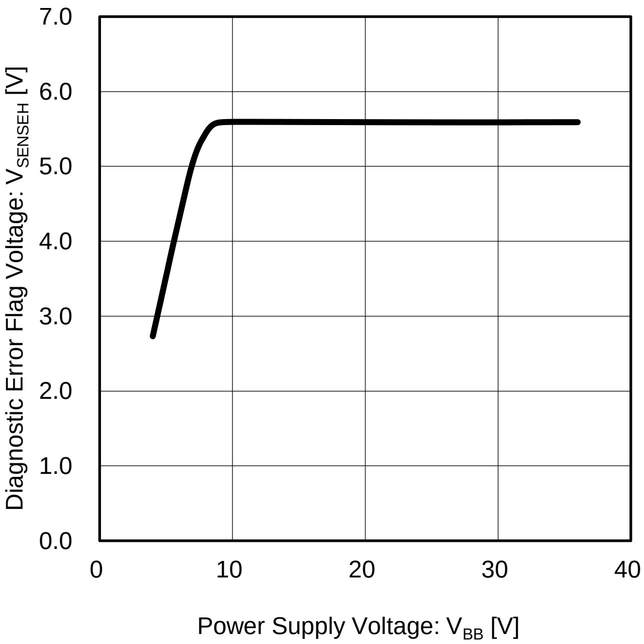


Figure 36. Diagnostic Error Flag Voltage vs Power Supply Voltage

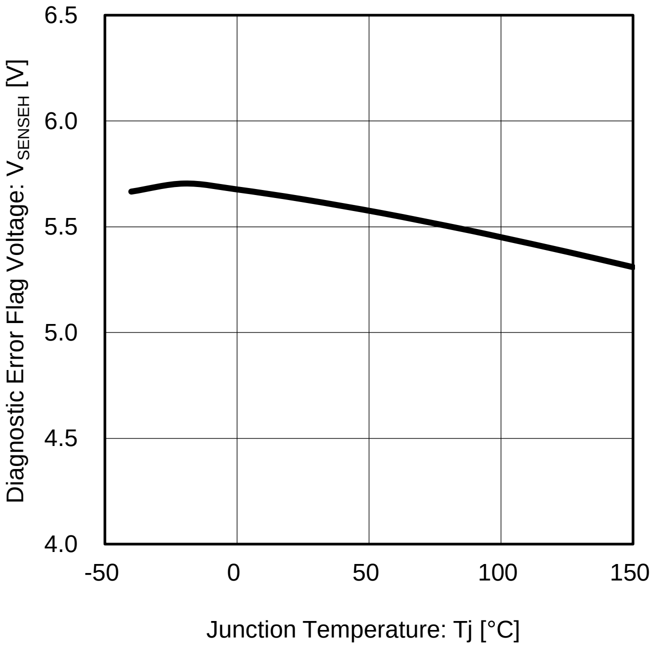


Figure 37. Diagnostic Error Flag Voltage vs Junction Temperature

Typical Performance Curves – continued
(Unless otherwise specified V_{BB} = 14 V, Tj = 25 °C)

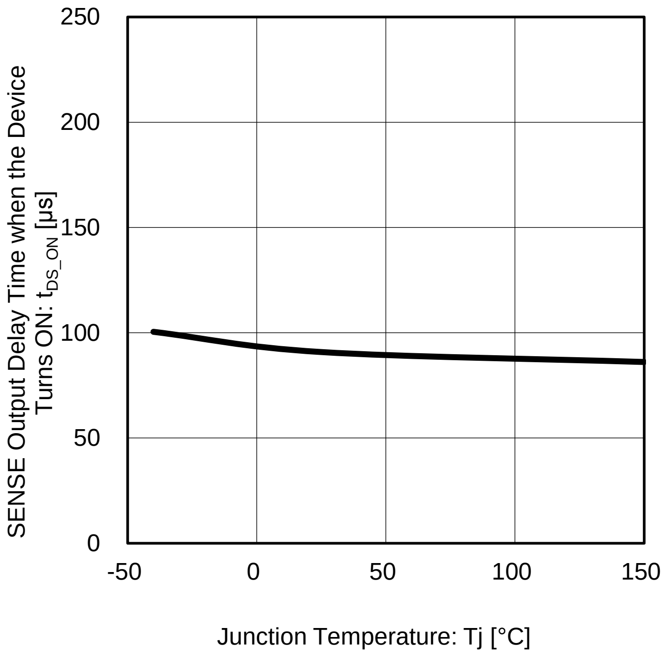


Figure 38. SENSE Output Delay Time when the Device Turns ON vs Junction Temperature

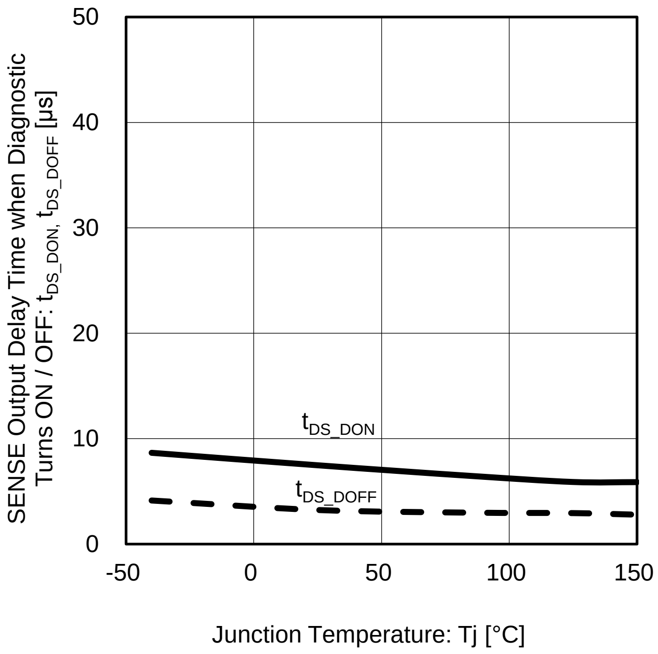


Figure 39. SENSE Output Delay Time when Diagnostic Turns ON / OFF vs Junction Temperature

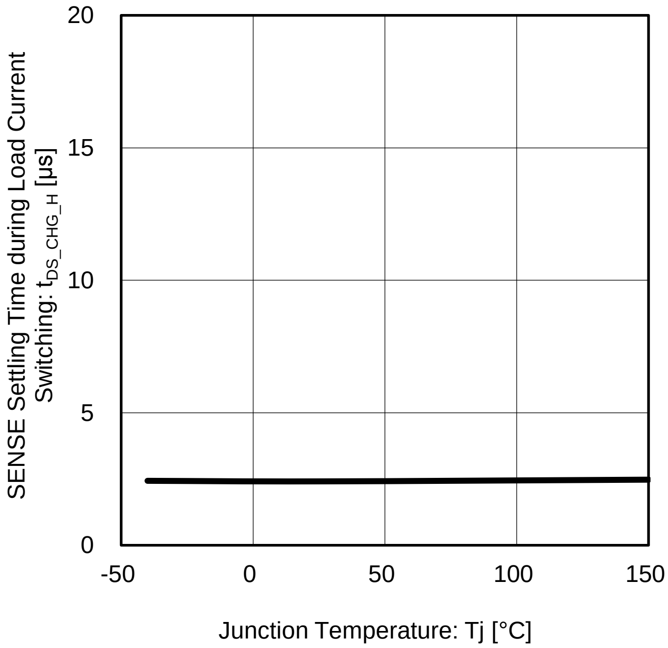


Figure 40. SENSE Settling Time during Load Current Switching vs Junction Temperature

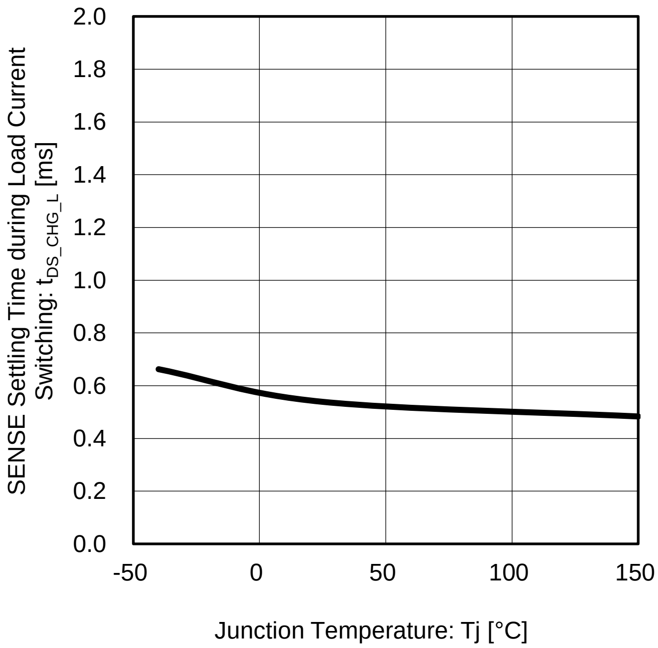


Figure 41. SENSE Settling Time during Load Current Switching vs Junction Temperature

Typical Performance Curves – continued
(Unless otherwise specified V_{BB} = 14 V, Tj = 25 °C)

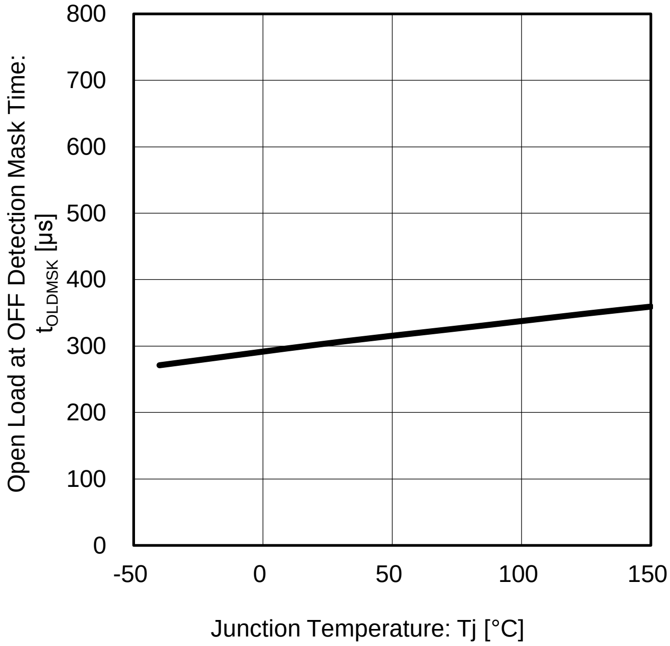


Figure 42. Open Load at OFF Detection Mask Time vs Junction Temperature

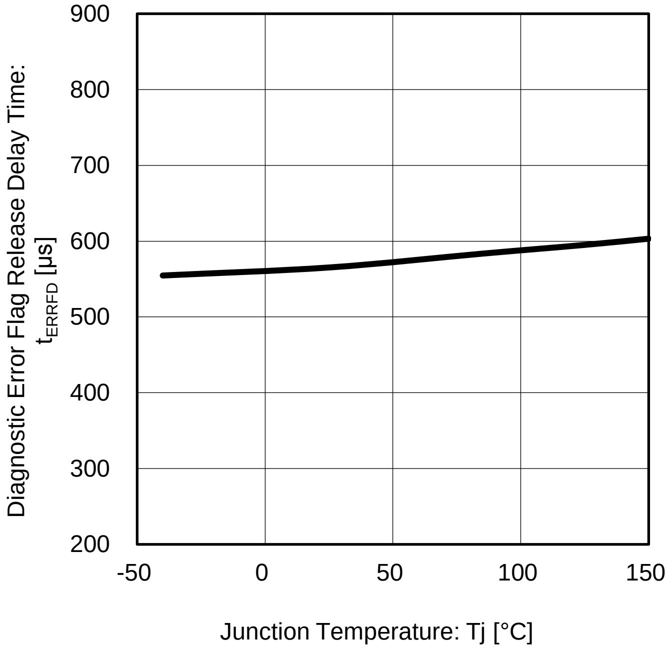


Figure 43. Diagnostic Error Flag Release Delay Time vs Junction Temperature

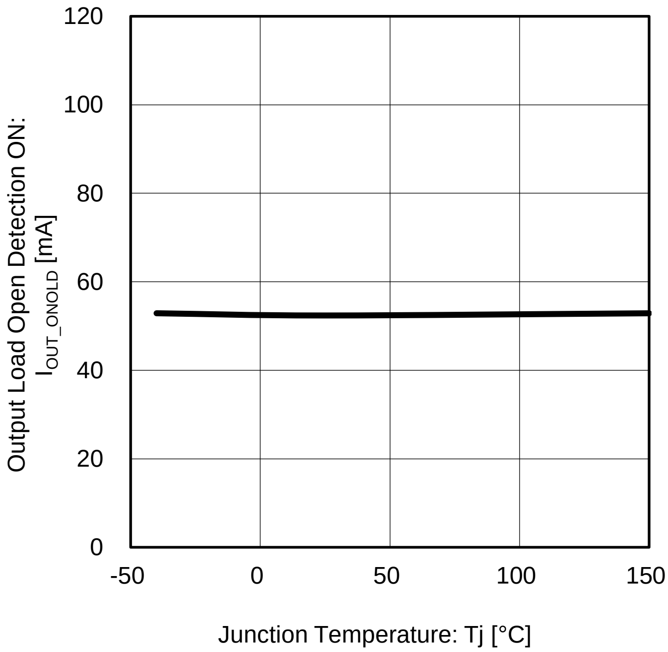


Figure 44. Output Load Open Detection ON vs Junction Temperature

Measurement Circuit Diagram

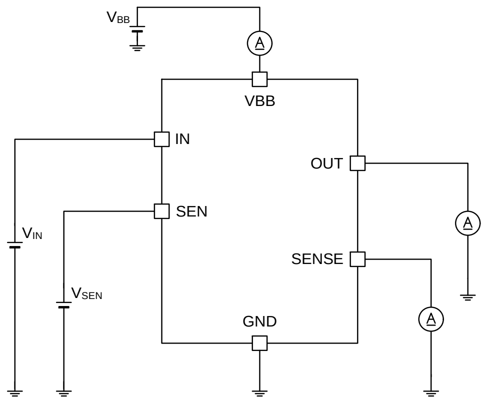


Figure 45. Sleep Mode Current
OUT Leakage Current
SENSE Leakage Current

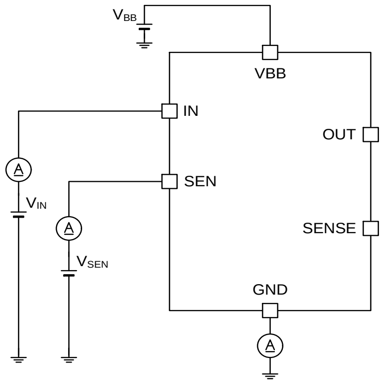


Figure 46. Standby Mode Current
Operating Mode Current

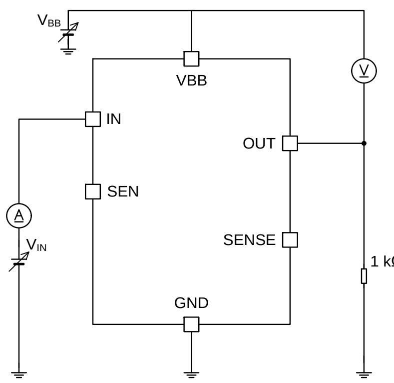


Figure 47. UVLO Threshold / Hysteresis Voltage
High / Low Level Input Voltage (IN)
Input Hysteresis Voltage (IN)
High / Low Level Input Current (IN)

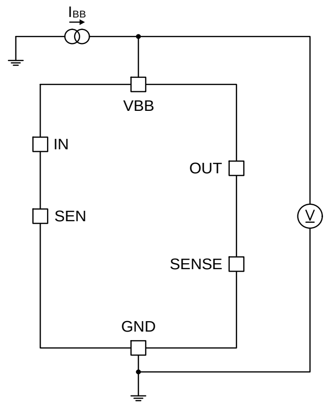


Figure 48. V_{BB} Overvoltage Protection

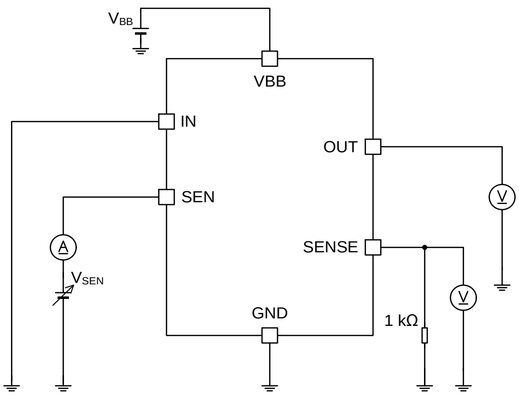


Figure 49. High / Low Level Input Voltage (SEN)
Input Hysteresis Voltage (SEN)
High / Low Level Input Current (SEN)

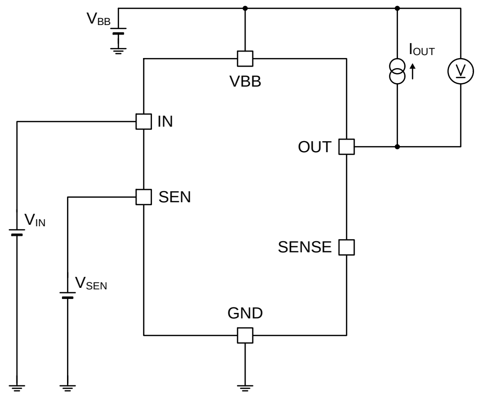


Figure 50. Output ON Resistance
V_{DS} Voltage at Light Load
Body Diode Voltage
V_{DS} Active Clamping Voltage

Measurement Circuit Diagram – continued

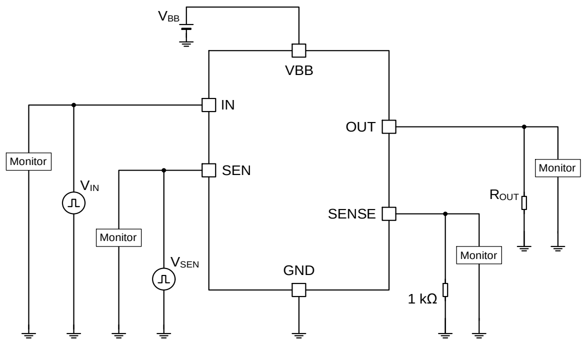


Figure 51. Output Slew Rate when ON / OFF
Output Propagation Delay Time when Turning ON / OFF
SENSE Output Delay Time when the Device Turns ON
SENSE Output Delay Time when Diagnostic Turns ON / OFF

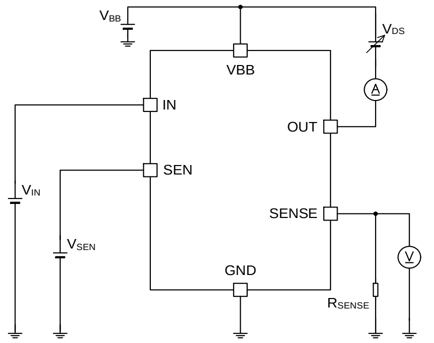


Figure 52. Open Load at OFF V_{DS} Threshold
Output Pull Up Current
Diagnostic Error Flag Voltage

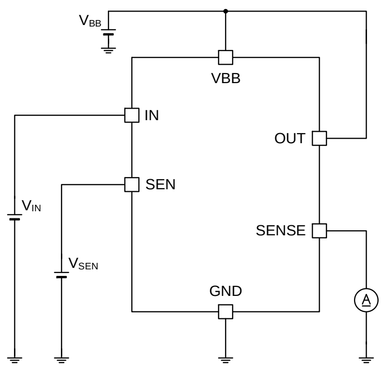


Figure 53. SENSE Leak Current
Diagnostic Error Flag Current

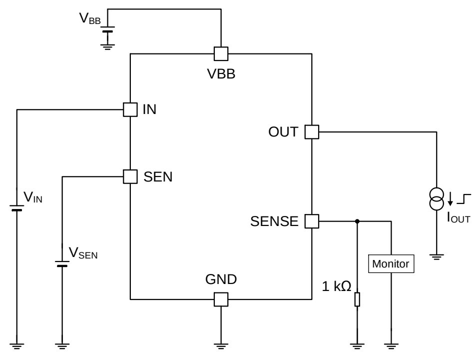


Figure 54. SENSE Settling Time During Load Current Switching

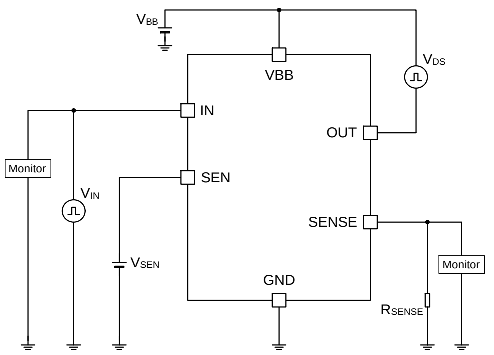


Figure 55. Open Load at OFF Detection Mask Time
Diagnostic Error Flag Release Delay Time

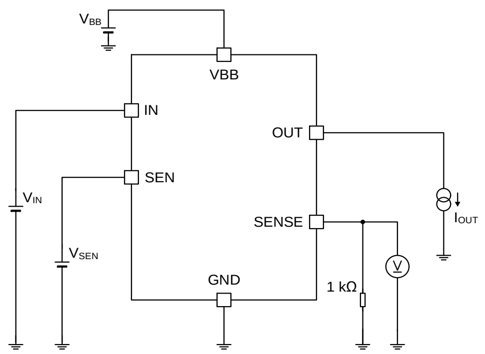


Figure 56. Current Sense Ratio

Block Diagram

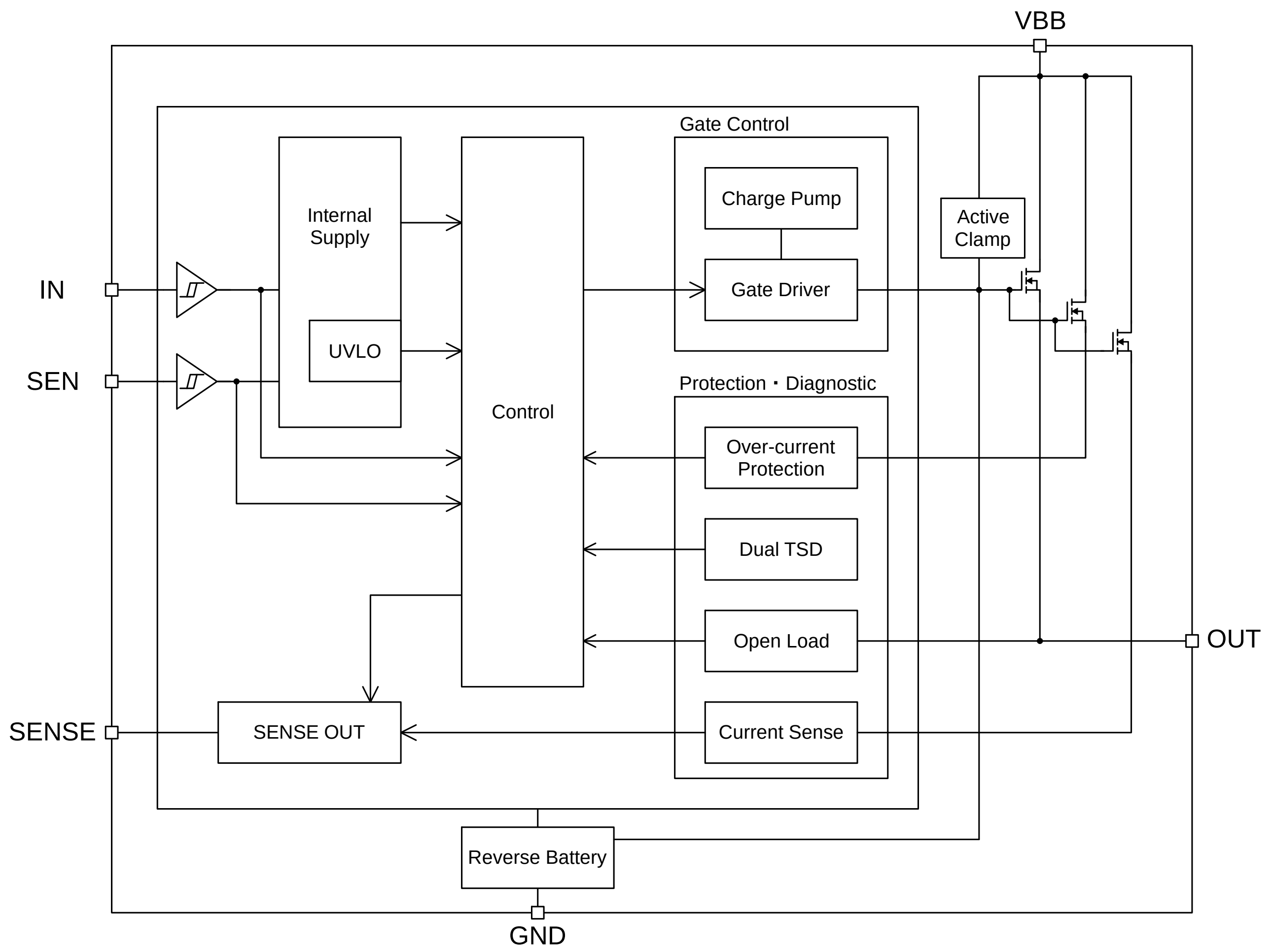


Figure 57. Block Diagram

Features Description

Input Pins

The input circuitry is compatible with 3.3 V and 5 V microcontrollers. The IN and SEN pins must be connected to the microcontroller via 4.7 kΩ resistors. In case not used, the pins shall be connected to ground via resistors; 4.7 kΩ or more is recommended.

The input circuitry reacts to voltage thresholds and avoids undefined states by use of internal hysteresis. Setting the IN pin voltage above 2.1 V the High Side Power Switch output turns on. The device is in Operating mode. Setting the SEN pin voltage above 2.1 V the diagnostic functions are activated. Setting the IN pin voltage below 0.9 V the output is turned off. Setting the SEN pin voltage below 0.9 V the diagnostic functions are deactivated.

With IN and SEN input pins “low” the device enters Sleep mode; all internal circuits are switched off to prevent current consumption from the power supply, output is turned off and no protection is active. In case the IN pin is de-asserted i.e., IN is “low” and the SEN pin is kept “high” then the device enters in a Standby mode with diagnostic functions activated. In this scenario the current consumption is reduced, but not stopped.

In case the connection is interrupted, the input pins are pulled down internally; only in case all input pins are low the Sleep mode is activated. The internal pull-down is implemented with a resistance. Furthermore, internal de-bounce filters make sure the circuits are not activated or deactivated by high frequency noise or other voltage spikes at the pins.

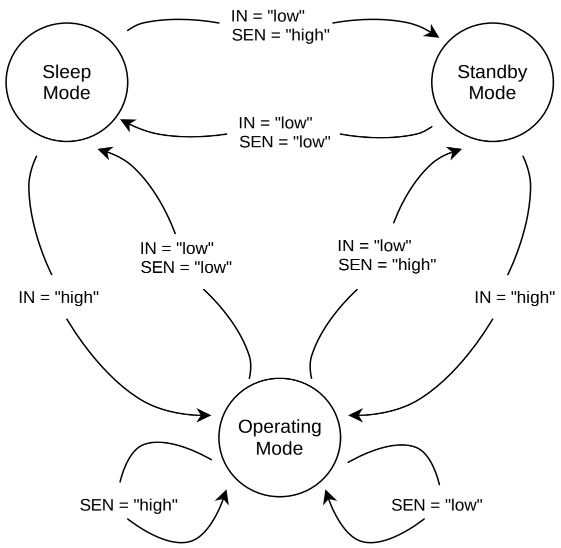


Figure 58. State Diagram

Internal Supply and Under Voltage Lock Out (UVLO)

The Power Supply Line Input V_{BB} is used to energize and supply internal circuitry and generate internal volage references. The Intelligent High Side Power Device is designed to operate down to very low battery cranking voltages. However, as with any battery powered device it still needs a certain minimum voltage to operate. An under voltage protection circuit with hysteresis makes sure the device does nothing until the supply voltage is high enough and a predictable behavior can be maintained. The UVLO circuit prevents an undefined output state and/or unintended diagnostic functions turn on when the V_{BB} voltage is below the specified threshold.

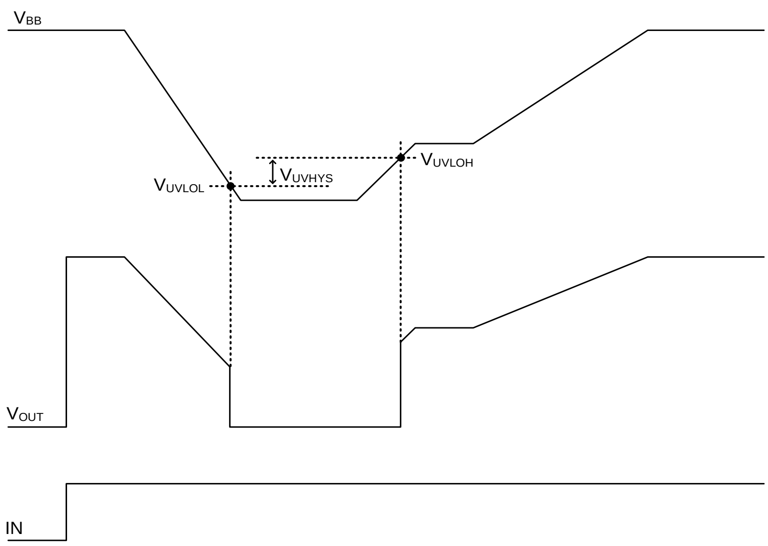


Figure 59. UVLO Functionality

Features Description – continued

Control Circuitry

The device integrates logic circuits that control the operation of the Intelligent High Side Power Switch. Based on the state of the protection circuits and given inputs the control logic performs state transitions and produces outputs as such.

Gate Control Circuitry

The device integrates a gate driving circuit that acts as interface between the control logic and the N-channel power transistor. A charge pump acts as internal supply allowing to turn on the MOSFET and drive it in the deep triode operation region. The integrated charge pump operates at a fixed frequency improving the EMI performance of the IC. Moreover, the switching behavior of the power transistor is regulated via the gate-driver hence the on and off switching times and slew rates are current-controlled to further improve the EMC.

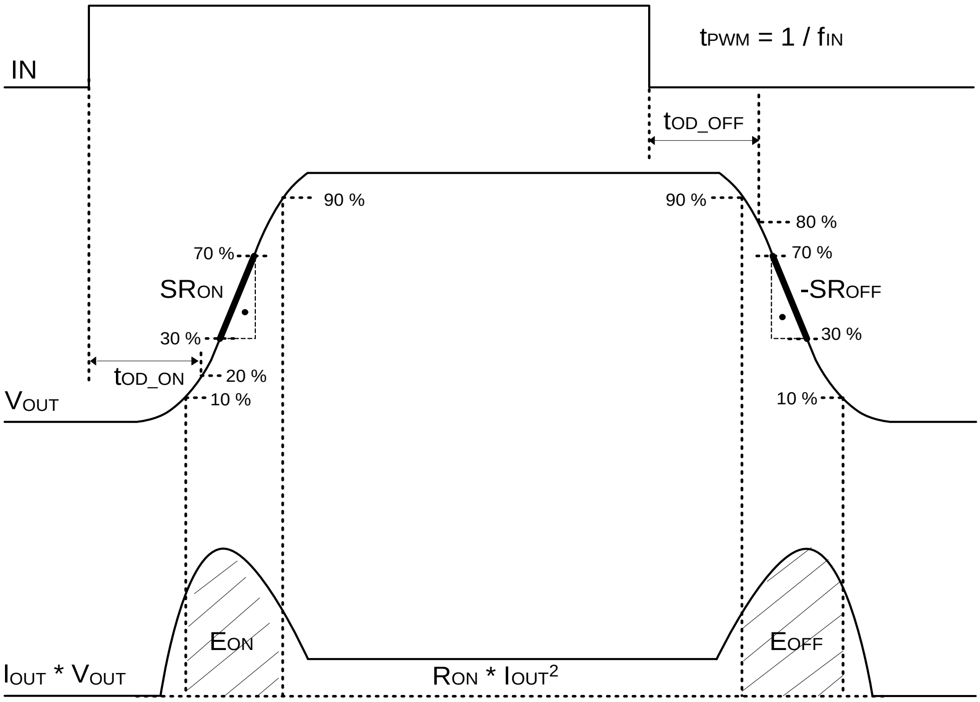


Figure 60. Switching Resistive Loads

Active Clamp Protection

An intelligent integrated active clamp protection limits the maximum V_{DS} across the power transistor when switching inductive loads at the output pin and the inductive energy is dissipated internally. Moreover, a VBB to GND internal clamp circuit protects the internal circuits from overvoltage surges.

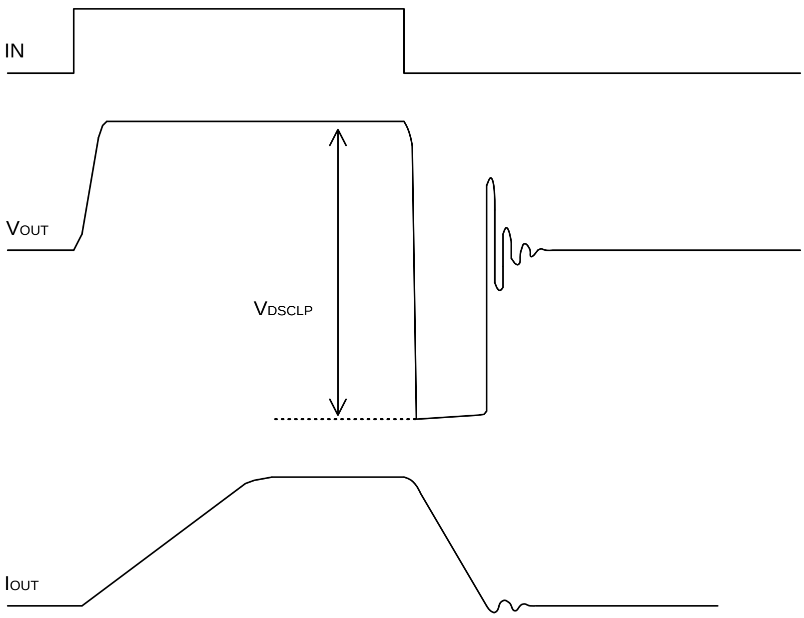


Figure 61. Switching Inductive Loads

Features Description – continued

Loss of Ground Protection

When the module's ground becomes open, the outputs switch off. However, it is recommended to add resistors connected between the input pins and the microcontroller. Furthermore, it is recommended to keep all the digital inputs pulled either all high or all low to avoid creating parasitic ground paths that could prevent the outputs from switching off. If the GND pin is open when an inductive load is driven, the active clamp protection safeguards the IC.

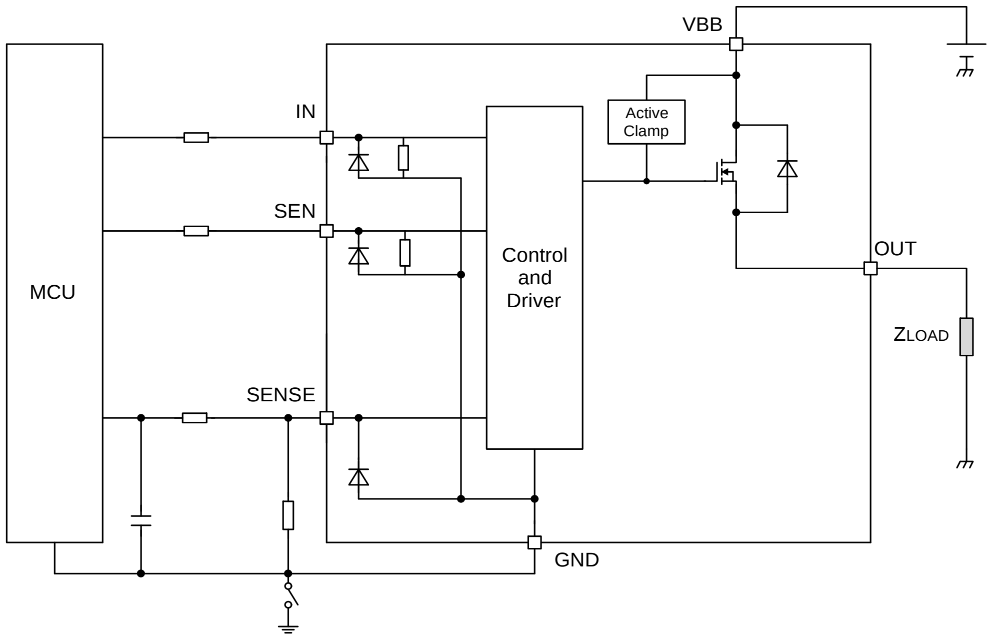


Figure 62. Loss of Ground Protection Diagram

Load Dump and Overvoltage Protection

The integrated VBB to GND overvoltage protection will safeguard the internal circuits from overvoltage transients. In order for the overvoltage protection to work a ground resistance R_{GND} is necessary. However, a ground shift needs to be considered versus the microcontroller ground when looking at the input voltage threshold levels while in normal operation. Furthermore, the active clamp protection limits the maximum V_{DS} across the power transistor. Moreover, in case the V_{BB} voltage exceeds the V_{BBCLP} level the input pins can start to conduct as well, hence input resistors are mandatory as per the above explanations.

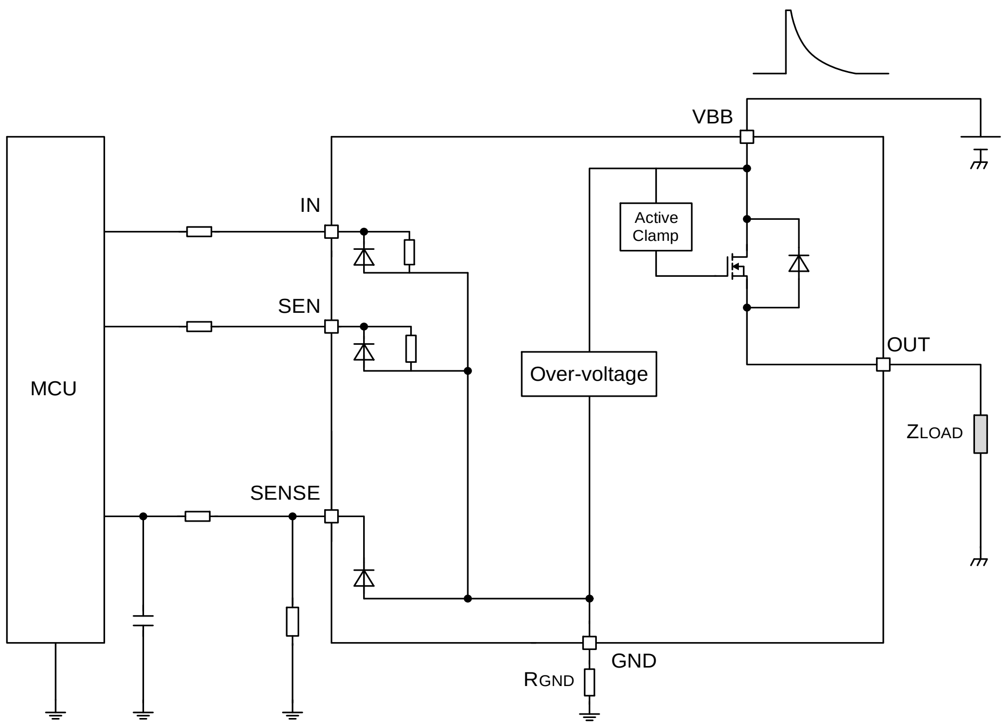


Figure 63. Load Dump Protection Diagram

Features Description – continued

Loss of Battery Protection

When the connection to the battery becomes open the device can dissipate the energy of the wire harness for inductivities up to 10 μH without degrading its robustness. The integrated VBB to GND overvoltage protection will act as a freewheeling path and the active clamp at the output will close the path for the current to flow safeguarding the IC. In applications where the nominal load currents are exceeded, and more load inductivity is expected, an external load freewheeling diode is necessary and/or a transient voltage suppressor must be present on the battery line.

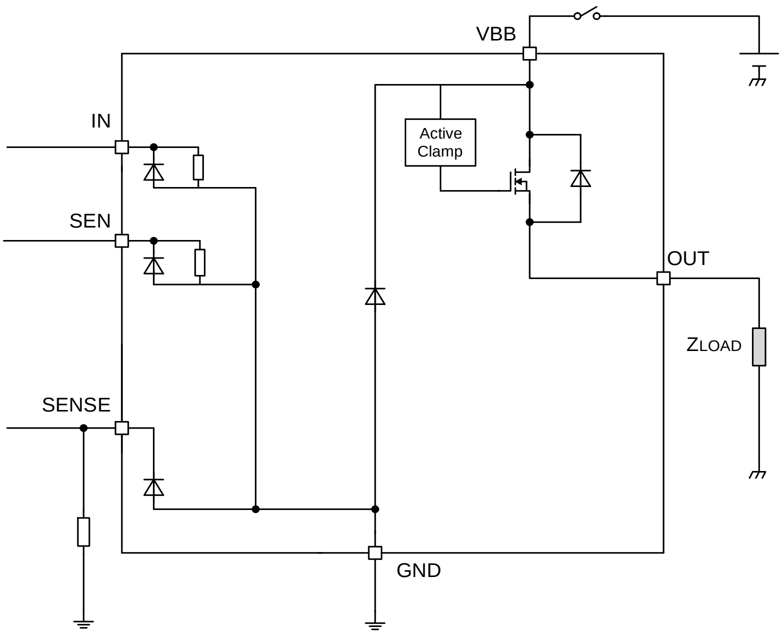


Figure 64. Loss of Battery Diagram

Reverse Battery Protection

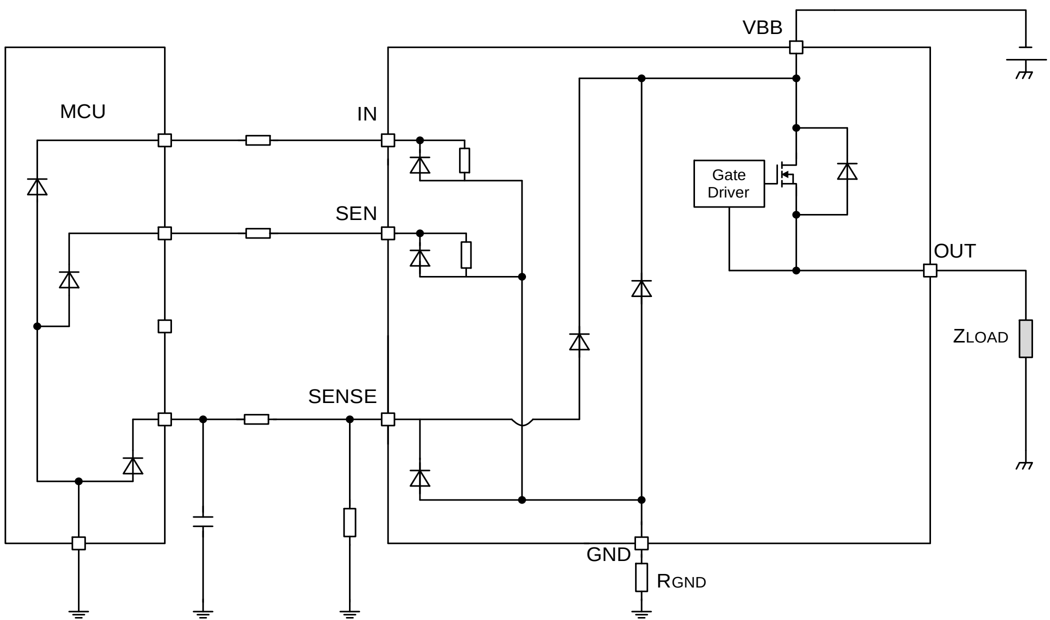


Figure 65. Reverse Battery Diagram

To limit the current through the input pins and the SENSE pin in case of reverse battery connection and negative or positive ISO transients on the battery line, the device's interface pins must be protected with resistors connected between the micro controller and the IC.

A ground resistor safeguards the IC during load dump or over voltage. However, a ground shift needs to be considered versus the micro controller ground when looking at the input voltage threshold levels due to the chip's current consumption in normal operation. Resistor power dissipation needs to be considered during reverse battery conditions.

Features Description – continued

During reverse battery the device allows the load current to flow through the power MOSFET turned on; the current must be limited by the resistance of the load. However, in case the load is inductive, special care must be taken to ensure safe operation. A reverse polarity diode on the battery line would be a possible solution.

A compromise between the above options must be found depending on the specific application requirements and the targeted loads.

Dual Temperature Shutdown Protection

A dual temperature shutdown (Dual TSD) mechanism limits the internal thermal transients and reduces the mechanical stress of the IC increasing its cyclic short-circuit robustness. The device integrates an absolute and dynamic overtemperature protection circuit. When the chip's junction temperature rises above either the T_{DTj} or the T_{TSD} threshold, the output turns off. A thermal hysteresis restart mechanism is implemented. When the chip's temperature falls below a predefined threshold, the output automatically restarts, and operation is resumed accordingly. Moreover, the TSD circuits safeguard the IC in case of overload operation (high inrush current) with the output current below the I_{OCD} thresholds i.e., before the overcurrent protection activates. When the TSD protection is triggered, the SENSE pin acts as an error flag and signals the fault to the microcontroller. The voltage at the SENSE pin is forced to be V_{SENSEH}.

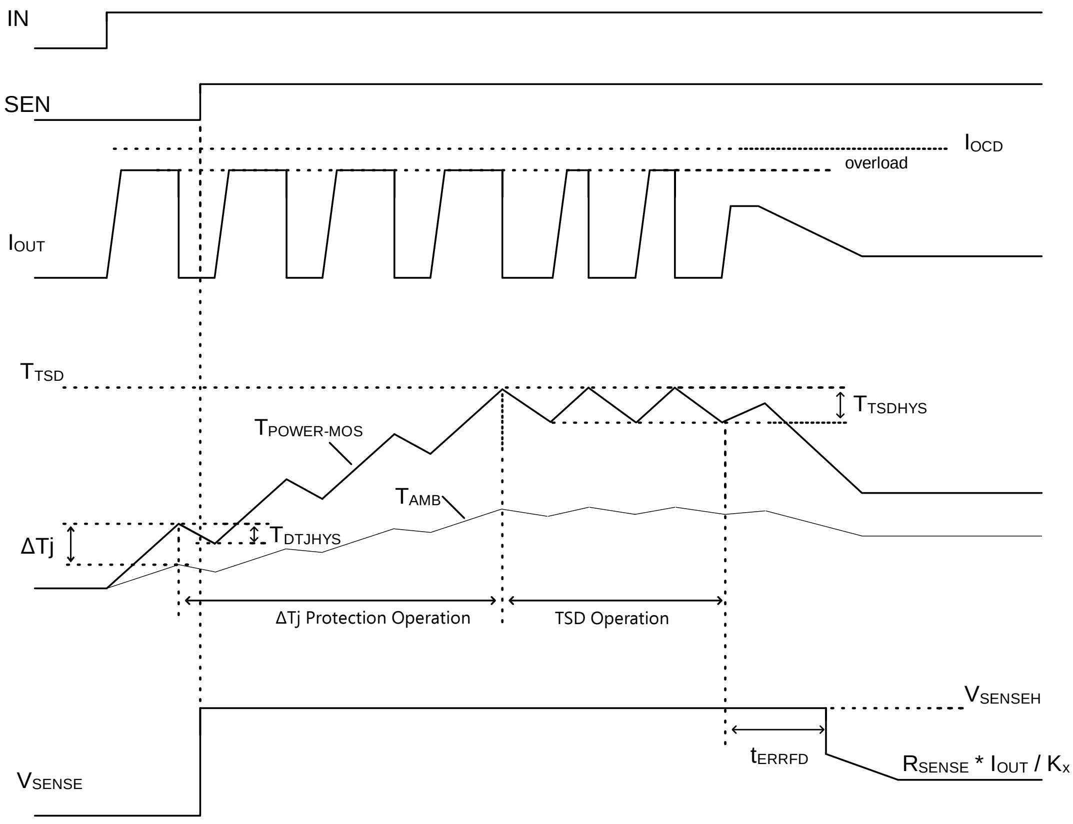


Figure 66. Overtemperature Protection

Features Description – continued

Over Current Protection

The IC has a built-in overcurrent protection feature. If an excessive current flows at the output of the High Side Power Switch, a current limitation aims to protect the IC and peripheral components. Given that a fault is present (short-circuit to ground), or high inrush current at start-up occurs, then the output current is limited to safe operating levels. Moreover, the output current limit is designed to have V_{BB} voltage dependency in favor of an increased robustness of the device. When the load current is above the I_{OCD} threshold the SENSE pin acts as an error flag and signals the fault to the microcontroller. The voltage at the SENSE pin is forced to be V_{SENSEH}. Furthermore, the overtemperature - dual temperature shutdown (TSD) protection - circuits complement the overcurrent protection. In case the overtemperature protection is triggered during current limitation the power MOSFET is turned off, a restart happens when the chip has cooled down sufficiently.
If overtemperature is detected, over protection is detected, the overcurrent detection limit is halved, and shifts to intermittent operation. This halving of the overcurrent detection limit continues until IN = 'L'.

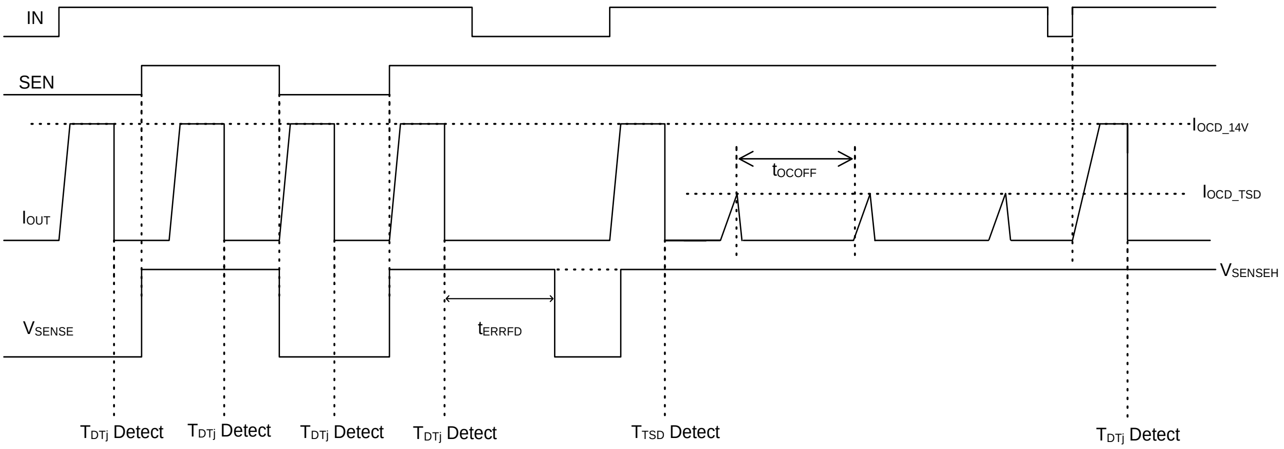


Figure 67. Overcurrent Protection and Temperature Protection Timing Chart

Reverse Current Protection

The IC allows reverse current to flow through the power MOSFET when the V_{OUT} voltage level is higher than V_{BB}. Furthermore, as long as the current is maintained within the nominal range and the package's thermal limitations are not exceeded the IC can maintain its operating state.

Features Description – continued

Diagnostic / SENSE Functions

Diagnosis / SENSE Output(Note 1)

Mode	IN	SEN	SENSE	OUT
Normal Operation	Low	High	Hi-Z	Low
Open Load	Low	High	Hi-Z	< V_{BB} - V_{DSOL}
	Low	High	V_{SENSEH}	≥ V_{BB} - V_{DSOL}
Short to Battery	Low	High	V_{SENSEH}	High
Thermal Shutdown	Low	High	Hi-Z	Low
Short to Ground	Low	High	Hi-Z	Low
Reverse Current	Low	High	V_{SENSEH}	High
Normal Operation	High	High	I_{OUT} / K_x	High
Open Load	High	High	I_{OUT_ONOLD} / K_x	High
Short to Battery	High	High	< I_{OUT} / K_x	High
Thermal Shutdown	High	High	V_{SENSEH}	Low
Short to Ground	High	High	V_{SENSEH}	Low
Reverse Current	High	High	Hi-Z	High
All modes	-	Low	Hi-Z	-

(Note 1) All values in the above table are Typ values and SENSE is considered Hi-Z looking into the pin i.e., R_{SENSE} is ignored.

The current sense and diagnostic functions are enabled by setting the voltage V_{SEN} = High. The operation is as per the above table. However, an external resistor R_{SENSE} must be connected between SENSE and GND pins. The simplified implementation is described in the below diagram.

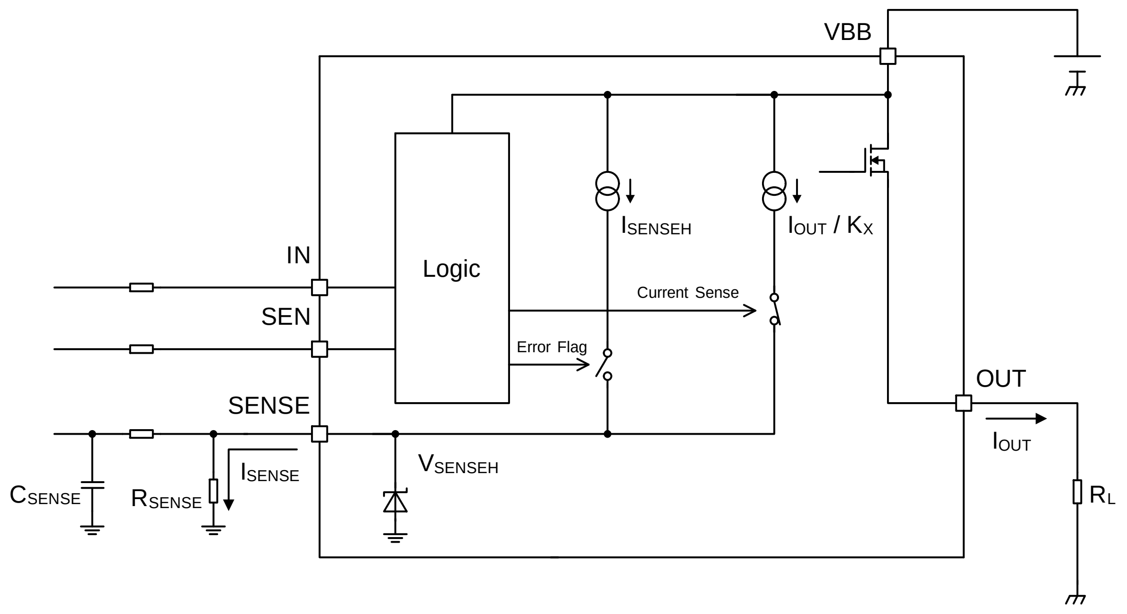


Figure 68. Diagnostic Output Block Diagram

Features Description – continued

Current Sense

When the diagnostic is enabled, and the high side power switch is turned on, a current proportional to the load current is flowing through the SENSE pin. The current I_{SENSE} becomes equal to I_{OUT} / K_x, (K_x: Current sense ratio). An external resistor R_{SENSE} is recommended, hence for example the voltage at the SENSE pin is equal to:

$$V_{SENSE} = \frac{R_{SENSE} \times I_{OUT}}{K_X}$$

Current Sense Ratio Accuracy

The below diagram shows the load current sense ration dependency vs. the output current through the power MOSFET. The accuracy of the current sense ratio depends on the load current, technological process, voltage and temperature. A higher-precision current sense ratio could be obtained with additional calibration on the application side. The device allows derating at a specific point (ΔK_x, Tj = 25 °C). Moreover, to reduce signal ripple at the microcontroller side, it is recommended to insert an external RC filter between the SENSE pin and the ADC input pin.

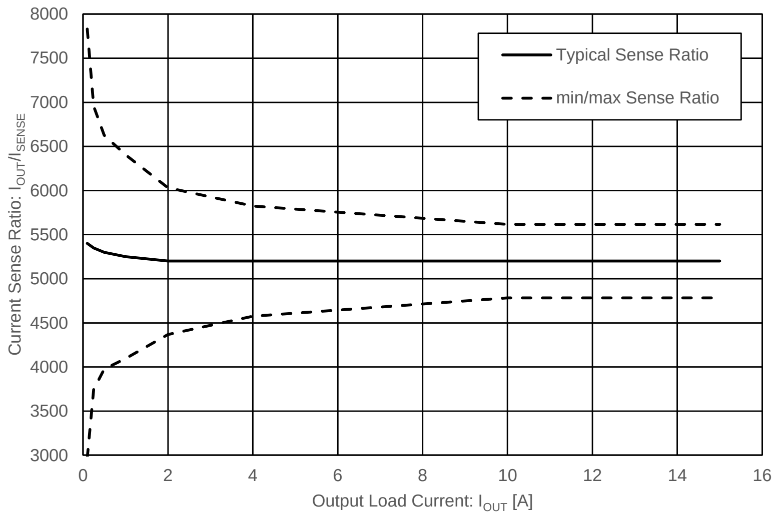


Figure 69. Current Sense Ratio vs Output Load Current

Furthermore, an open load at ON condition can be recognized via the sense ratio if the load current falls below a certain threshold. This is given by the I_{OUT_ONOLD} parameter.

Open Load Detection

Open load at off can be detected by connecting an external resistance R_{OLD} between power supply VBB and OUT.

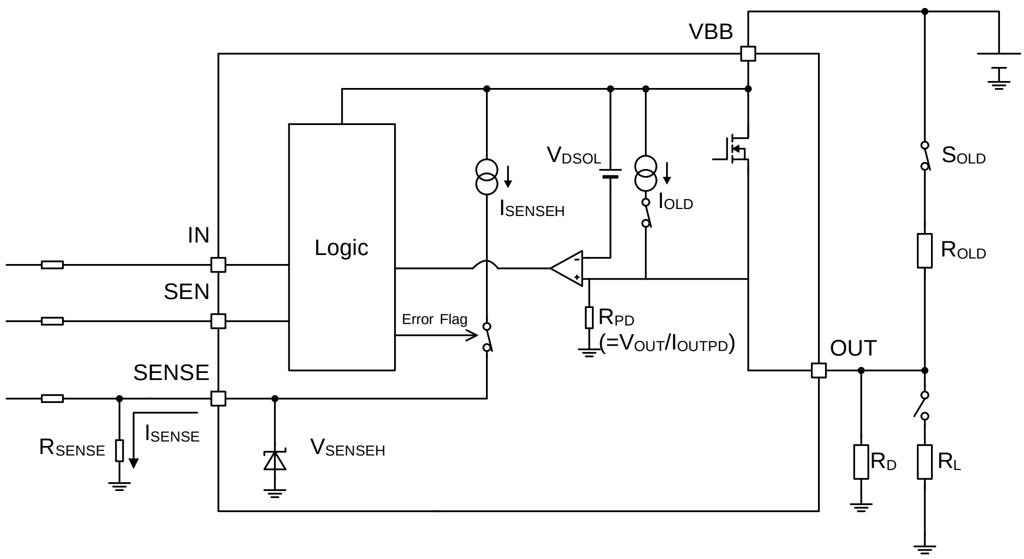


Figure 70. Open Load Detection Block Diagram

Features Description – continued

When the output load is disconnected, input pin IN is low and SEN is high, and open load will be flagged at the SENSE pin by the V_{SENSEH} voltage if the load is missing or the output is shorted to the VBB battery line. To reduce the standby current of the system, an open load switch S_{OLD} is recommended. R_D represents the minimum parasitic resistance at the output pin. In case R_D is not considered the device integrates a R_{PD} resistance.

The value of external resistance R_{OLD} is decided based on the minimum power supply voltage (V_{BB}), parasitic resistance R_{PD} and open detection threshold V_{DSOL}. The equation for calculating the R_{OLD} value is shown below.

$$R_{OLD} < \frac{R_D \times R_{PD}}{R_D + R_{PD}} \times \left(\frac{V_{DSOL}}{V_{BB(min)} - V_{DSOL}} \right)$$

Moreover, in case a high ohmic open load can be considered, an integrated 100 µA I_{OLD} pull up current could help detect an open load at off without the need for any external components.

Open Load Masking Time

The IC diagnoses open load detection after the mask time t_{OLDMSK} after the IN pin is de-asserted to allow for the output voltage to drop while in normal operation (load connected).

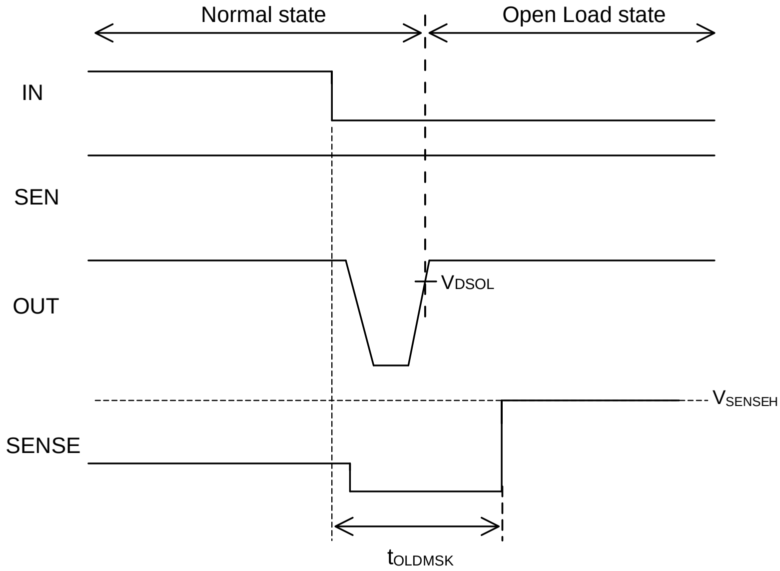


Figure 71. Open Load Mask Timing Chart

Diagnostic Timings

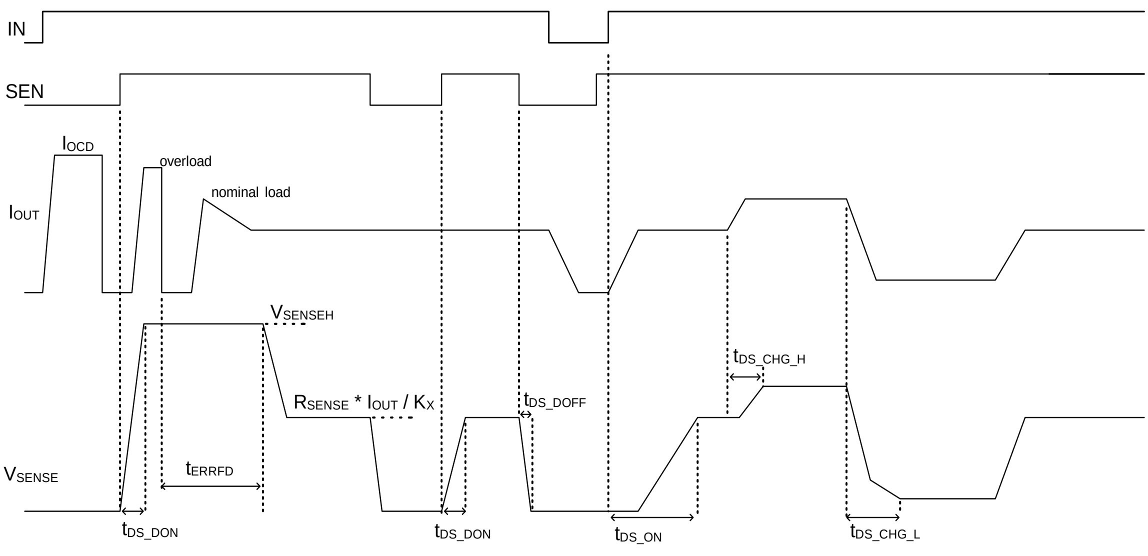


Figure 72. Diagnostics Timing Diagram

Application Circuit Example

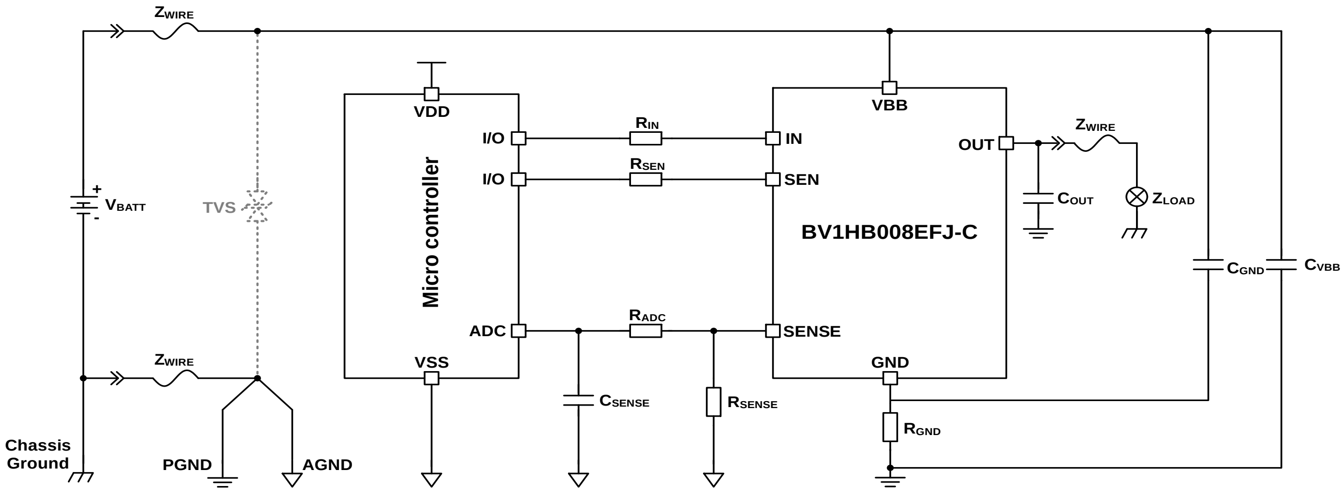


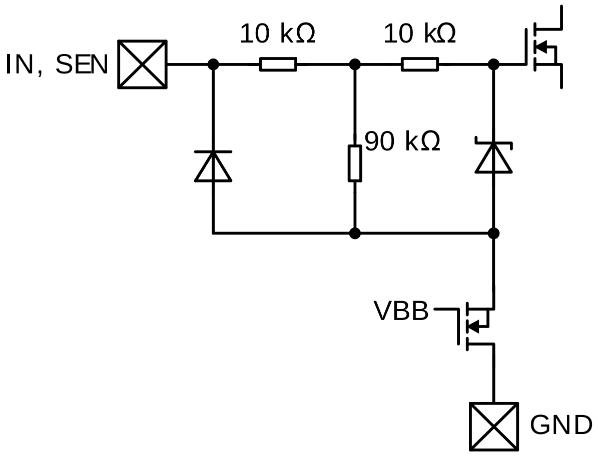
Figure 73. Application Schematic

Recommended External Components Example

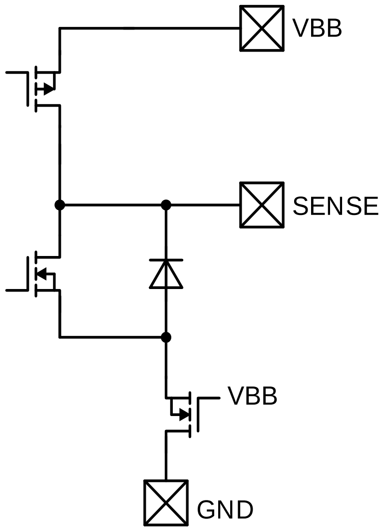
Item	Symbol	Standard Value	Unit
Input Pin Resistance	R_{IN}	4.7	kΩ
Diagnostic Input Pin Resistance	R_{SEN}	4.7	kΩ
Microcontroller SENSE Pin Resistance	R_{ADC}	4.7	kΩ
SENSE Pin Resistance	R_{SENSE}	1	kΩ
SENSE Filter Capacitance	C_{SENSE}	100	pF
Output EMC Capacitance	C_{OUT}	10	nF
Battery Line Filter Capacitance	C_{VBB}	100	nF
Buffer Capacitance	C_{GND}	47	nF
Chip Ground Protection Impedance Network	R_{GND}	47	Ω
Transient Voltage Suppressor Diode	TVS	36	V

I/O Equivalence Circuits

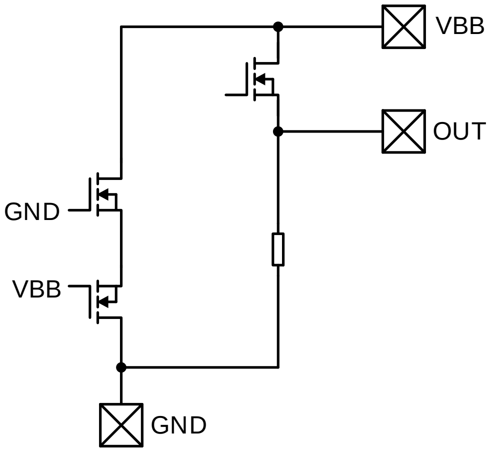
IN, SEN



SENSE



VBB, OUT



Operational Notes

1. **Recommended Operating Conditions**
   The IC is designed to operate in 12 V automotive board net applications. The functions and operation of the IC are guaranteed within the range specified by the recommended operating conditions. The characteristic values are guaranteed only under the conditions specified by the electrical characteristics. The IC can withstand transient voltages beyond the recommended operating conditions; however, parameter deviations are possible when used outside of the supply nominal voltage range. Exposure to the absolute maximum ratings may cause permanent damage to the IC.

2. **Inrush Current**
   When a load is being activated by the IC inrush currents may flow. The IC is designed to drive high inrush current loads; however, careful consideration must be completed when pairing the IC with the load. In case special recommendations are not available in the Datasheet the minimum overcurrent protection level of the IC should be higher than the maximum expected inrush current for proper load driving.

3. **Testing on Application Boards**
   When testing the IC on an application board, it is recommended to always discharge capacitors completely after each evaluation 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.

4. **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.

5. **Ceramic Capacitor**
   When using a ceramic capacitor, determine a capacitance value considering the change of capacitance with temperature and the decrease in nominal capacitance due to DC bias and others.

6. **Thermal Shutdown Function (TSD)**
   This IC has a built-in thermal shutdown function that prevents heat damage to the IC. Normal operation should always be within the IC's maximum junction temperature rating. If however the rating is exceeded for a continued period, the junction temperature (Tj) will rise which will activate the TSD function that will turn OFF power output pins. When the Tj falls below the TSD threshold, the circuits are automatically restored to normal operation.
   Note that the TSD function operates in a situation that exceeds the absolute maximum ratings and therefore, under no circumstances, should the TSD function be used in a set design or for any purpose other than protecting the IC from heat damage.

7. **Over Current Protection Function (OCP)**
   This IC integrates an overcurrent limitation protection function that is activated when the load is shorted towards ground. This protection function is effective in preventing damage due to sudden and unexpected fault events. However, the IC should not be used in applications characterized by continuous operation of the protection function.

8. **Active Clamp Operation**
   The IC integrates the active clamp function to internally absorb the reverse energy E_L which is generated when the inductive load is turned off. When the active clamp operates, the thermal shutdown function does not work. Decide a load so that the reverse energy E_L is active clamp energy (Single Pulse) E_{AS} (refer to Figure 4. Active Clamp Energy vs Output Current) or under when inductive load is used.

9. **Same Pin Connection**
   Connect all OUT pins to same line.

10. **Reverse Battery Connection**
    Connecting the power supply i.e., the battery with a reversed polarity can damage the IC. Precautions must be taken against reverse polarity when connecting the power supply, such as mounting an external diode between the battery feed and the IC's power supply, blocking all current paths. Alternatively, inserting a blocking diode or resistance in series with the IC's GND pin will prevent or limit the current from flowing into the control circuits of the high side switch respectively. However, current thorough the body diode of the integrated power FET must be limited by the resistive component of the load. The current through the Digital inputs and SENSE pins must be limited too with protection resistors.

Operational Note – continued

11. Power Supply and PCB Layout

Design the PCB layout in order to provide sufficient cooling to the IC. Connect the exposed pad with sufficient thermal vias to power supply copper plane to dissipate as much as possible thermal energy to the environment. Furthermore, connect as close as possible to the IC a capacitor between power supply and ground pins. Minimize the input capacitance of the digital input pins by placing the protection resistors as close as possible to the IC. Place the ground network as close as possible to the IC. Place the sense pin resistance as close as possible to the IC and the R-C filtering network close to the microcontroller. Place the output capacitors as close as possible to the IC. Short all output pins of the respective channel on the PCB to ensure equal current distribution. It is usually recommended to use a PCB with an internal copper layer as a power supply plane and another internal copper layer as a ground plane for thermal and EMC considerations respectively.

12. Ground Shift and 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. The IC is robust against small ground shift, however, ensure that the ground traces of external components do not cause big variations on the ground voltage. The ground lines must be as short and thick as possible to reduce line impedance. Big ground shifts could cause additional switching losses and electromagnetic emissions.

13. Reverse Current

A capacitive or inductive type of load can cause the output of the IC to rise above the input power supply level. The IC is designed to accept reverse current and normal operation is maintained as long as the reverse current is below the specified levels. Therefore, give special consideration to the maximum amount of reverse current that can flow through the device.

14. Undervoltage or Loss of Battery

The IC is designed to automatically switch off in case of loss of battery/power supply or undervoltage events. The IC will restart once the battery exceeds the specified operation threshold. In case the load is inductive a resistor on the ground network is recommended if loss of battery is foreseen at the same time in the application.

15. Loss of Ground

The IC cannot operate without the appropriate ground connection; nonetheless, the IC will automatically switch off in case of loss of ground. However, careful consideration of the external state of the inputs must be considered in order to avoid creating parasitic paths to another ground in the application via the external circuitry.

16. Load Dump and Overvoltage Protection

The IC is designed with integrated overvoltage protection to safeguard its internal circuits. For the overvoltage protection to work a ground resistance R_{GND} is necessary. Furthermore, input pins' protection resistors are mandatory. In case of Load dump external TVS protection diodes must be connected to safeguard the system.

17. Open Load or Short to Battery

An open load event is not considered dangerous to the IC; moreover, the IC can detect such failure and signal the fault to the microcontroller. In case a short to battery is present the load is turned on independent of the state of the IC. The device can be used to detect such a failure and signal the fault to the microcontroller.

18. Internally Not Connected (N.C.) Pins

Pins that are specified as internally not connected have no physical connection to the IC. For mechanical reasons it is recommended to solder them on the PCB. Electrically they can remain not connected in the circuit or may be connected to different signals especially when using high current outputs.

Ordering Information

B V 1 H B 0 0 8 E F J - CE 2

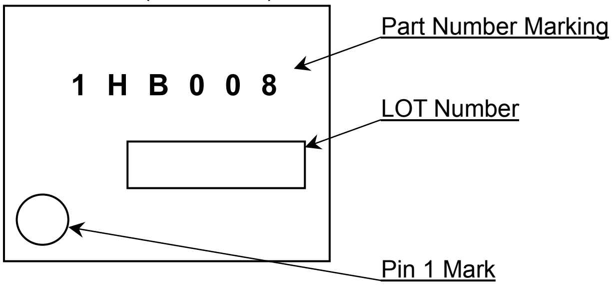
V1: 1ch
H: High-side switch

Package
EFJ: HTSOP-J8

Product rank
C: Automotive rank product
Packaging and forming specification
E2: Embossed tape and reel

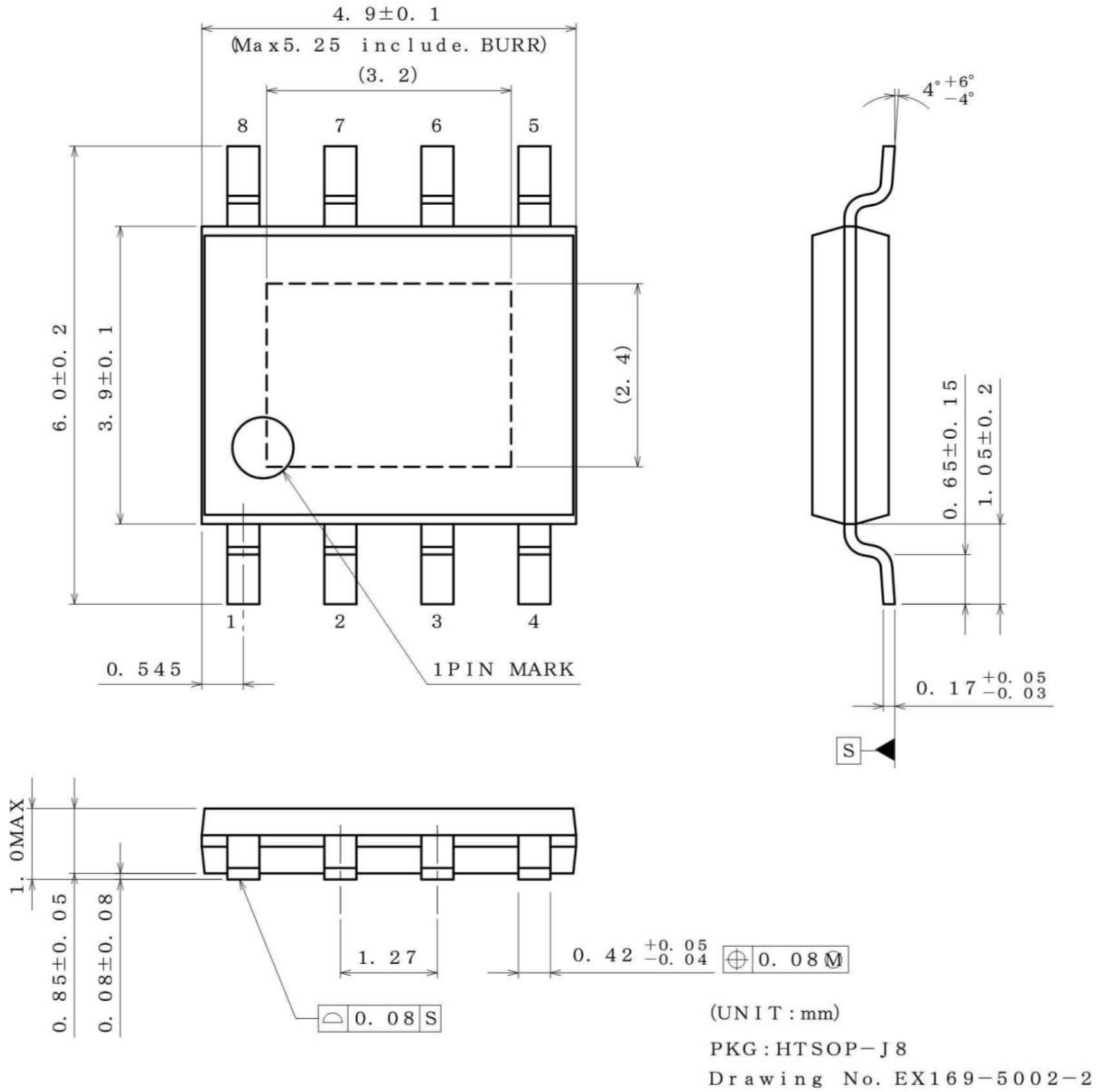
Marking Diagram

HTSOP-J8 (TOP VIEW)



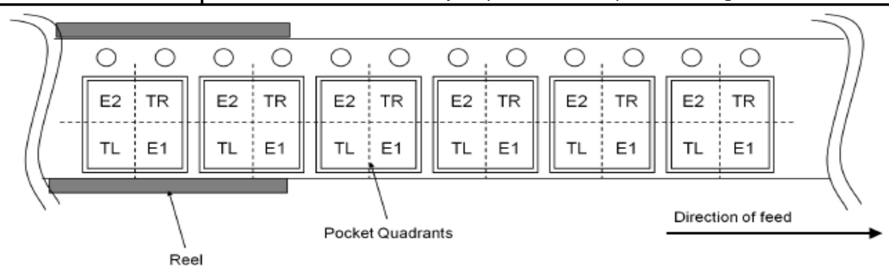
Physical Dimension and Packaging Information

Package Name	HTSOP-J8



< Tape and Reel Information >

Tape	Embossed carrier tape
Quantity	2500pcs
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



Revision History

Date	Ver.	Contents
21.Jan.2025	001	New Release

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1. If you intend to use our Products in devices requiring extremely high reliability (such as medical equipment (Note 1), aircraft/spacecraft, nuclear power controllers, 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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   [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 (Exclude cases where no-clean type fluxes is used. However, recommend sufficiently about the residue.); 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 depending on ambient temperature. When used in sealed area, confirm that it is the use in the range that does not exceed the maximum junction 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

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This Product is electrostatic sensitive product, which may be damaged due to electrostatic discharge. Please take proper caution in your manufacturing process and storage so that voltage exceeding the Products maximum rating will not be applied to Products. Please take special care under dry condition (e.g. Grounding of human body / equipment / solder iron, isolation from charged objects, setting of Ionizer, friction prevention and temperature / humidity control).

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 Cl_2, H_2S, NH_3, SO_2, and NO_2
   [b] the temperature or humidity exceeds those recommended by ROHM
   [c] the Products are exposed to direct sunshine or condensation
   [d] the Products are exposed to high Electrostatic

2. Even under ROHM recommended storage condition, solderability of products out of recommended storage time period may be degraded. It is strongly recommended to confirm solderability before using Products of which storage time is exceeding the recommended storage time period.

3. Store / transport cartons in the correct direction, which is indicated on a carton with a symbol. Otherwise bent leads may occur due to excessive stress applied when dropping of a carton.

4. Use Products within the specified time after opening a humidity barrier bag. Baking is required before using Products of which storage time is exceeding the recommended storage time period.

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