

# NCV459

## 4 A Single Load Switch for Low Voltage Rail

The NCV459 is a power load switch with very low Ron NMOSFET controlled by external logic pin, allowing optimization of battery life, and portable device autonomy.

Indeed, thanks to a best in class current consumption optimization with NMOS structure, leakage currents are drastically decreased. Offering optimized leakages isolation on the ICs connected on the battery.

Output discharge path is proposed to eliminate residual voltages on the external components connected on output pin.

Proposed in wide input voltage range from 0.75 V to 5.5 V, and a very small DFNW8 3x3 mm, 0.65 pitch package.

### Features

- 0.75 V – 5.5 V Operating Range
- 23 mΩ N–MOSFET
- Vbias Rail Input
- DC Current up to 4 A
- Output Auto–Discharge Option
- Active High EN Pin
- DFNW8, 3 x 3 mm, 0.65 pitch

### Typical Applications

- ADAS System
- Camera Module
- Power Management



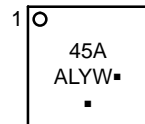
**ON Semiconductor®**

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### MARKING DIAGRAM



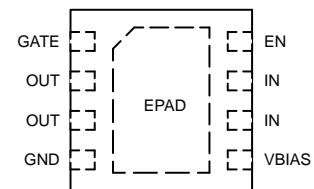
**DFNW8  
CASE 507AB**



45A = Specific Device Code  
 A = Assembly Location  
 L = Wafer Lot  
 Y = Year  
 W = Work Week  
 ■ = Pb–Free Package

(Note: Microdot may be in either location)

### PINOUT DIAGRAM



(Top View)

### ORDERING INFORMATION

See detailed ordering and shipping information on page 10 of this data sheet.

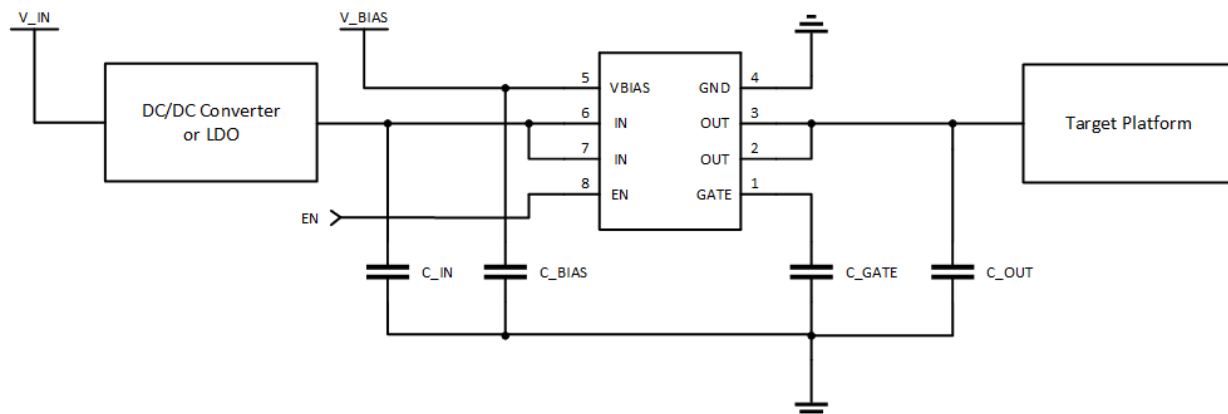


Figure 1. Typical Application Schematic

# NCV459

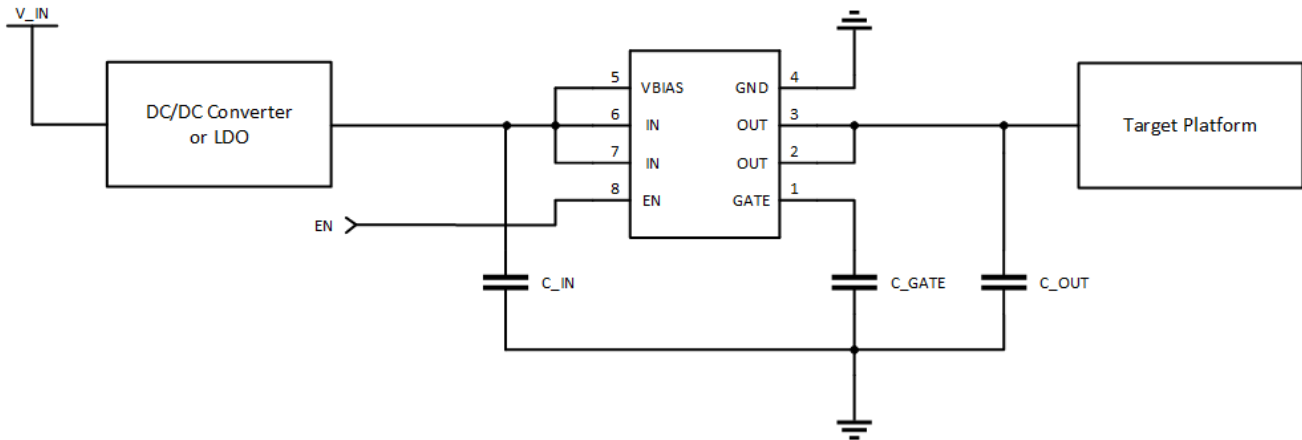


Figure 2. Application Schematic with Vbias Connected to IN

## PIN FUNCTION DESCRIPTION

Pin Name	Pin Number	Type	Description
GATE	1	INPUT	OUT pin slew rate control ( $t_{rise}$ ).
OUT	2, 3	POWER	Load-switch output pin.
GND	4	POWER	Ground connection.
VBIAS	5	POWER	External supply voltage input.
IN	6, 7	POWER	Load-switch input pin.
EN	8	INPUT	Enable input, logic high turns on power switch.
EPAD	9	POWER	Exposed pad, connect to ground potential.

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## BLOCK DIAGRAMS

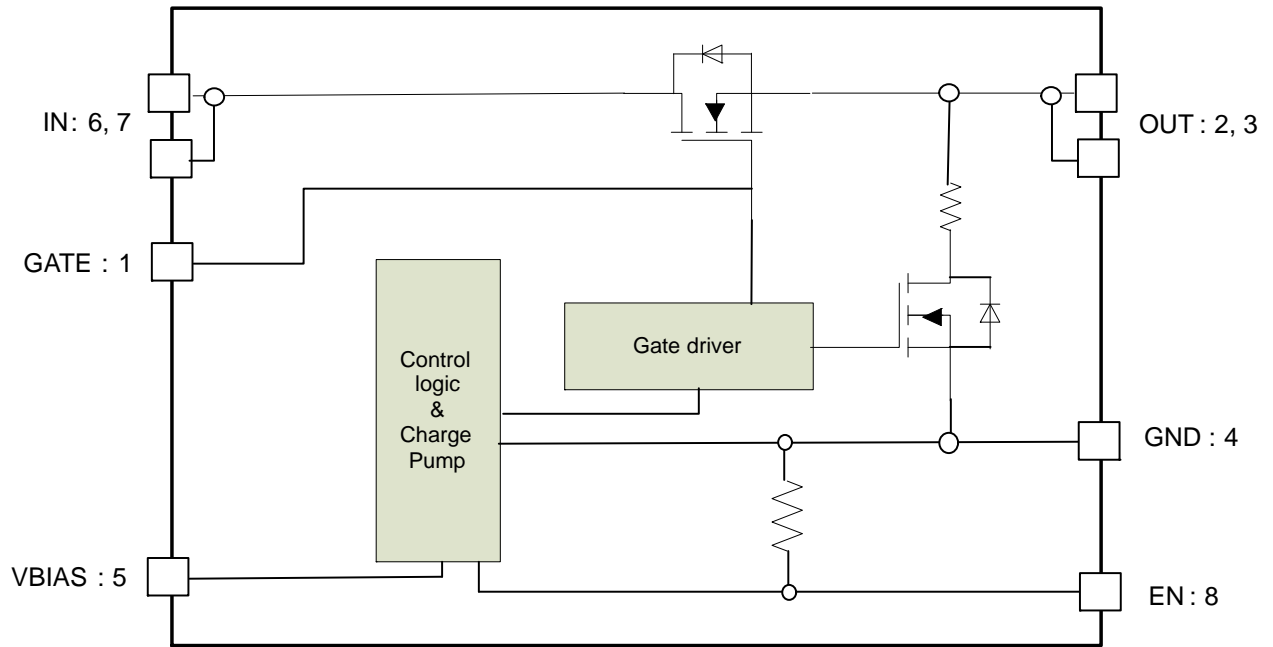


Figure 3. NCV459 Block Diagram

**MAXIMUM RATINGS**

Rating	Symbol	Value	Unit
IN, OUT, EN, VBIAS, GATE Pins: (Note 1)	$V_{EN}, V_{IN}, V_{OUT}, V_{BIAS}, V_{GATE}$	-0.3 to +6.5	V
From IN to OUT Pins: Input/Output (Note 1)	$V_{IN}, V_{OUT}$	0 to + 6.5	V
Human Body Model (HBM) ESD Rating are (Note 2)	ESD HBM	2000	V
Maximum Junction Temperature	$T_J$	-40 to + 125	°C
Storage Temperature Range	$T_{STG}$	-40 to + 150	°C
Moisture Sensitivity (Note 3)	MSL	Level 1	

Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

1. According to JEDEC standard JESD22-A108.
2. This device series contains ESD protection and passes the following tests:  
Human Body Model (HBM) ±2.0 kV per JEDEC standard:  
JESD22-A114 for all pins.
3. Moisture Sensitivity Level (MSL): 1 per IPC/JEDEC standard: J-STD-020.

**OPERATING CONDITIONS**

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$V_{IN}$	Operational Power Supply		0.75		5.5	V
$V_{EN}$	Enable Voltage		0		5.5	V
$V_{BIAS}$	Bias voltage ( $V_{BIAS} \geq$ best of $V_{IN}, V_{OUT}$ )		1.2		5.5	V
$T_A$	Ambient Temperature Range		-40	25	+105	°C
$C_{IN}$	Decoupling input capacitor		100			nF
$C_{OUT}$	Decoupling output capacitor		100			nF
$R_{\theta JA}$	Thermal Resistance Junction to Air	DFNW8 (Note 4)		106		°C/W
$I_{OUT}$	DC current			4	4.5	A
	AC current 1 ms @ 217 Hz				5	A
	AC current 100 μs spike				15	A
$P_D$	Power Dissipation Rating (Note 5)			0.18		W

Functional operation above the stresses listed in the Recommended Operating Ranges is not implied. Extended exposure to stresses beyond the Recommended Operating Ranges limits may affect device reliability.

4. Value based on 1s0p board with copper 650 mm<sup>2</sup> (or 1 in<sup>2</sup>) of 1 oz thickness and FR4 PCB substrate
5. The maximum power dissipation (PD) is given by the following formula:

$$P_D = \frac{T_{JMAX} - T_A}{R_{\theta JA}}$$

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**ELECTRICAL CHARACTERISTICS** Min & Max Limits apply for  $T_J$  between  $-40^{\circ}\text{C}$  to  $+125^{\circ}\text{C}$  for  $V_{IN}$  between 0.75 V and 5.5 V, and  $V_{BIAS}$  between 1.2 V and 5.5 V (Unless otherwise noted). Typical values are referenced to  $T_A = +25^{\circ}\text{C}$ ,  $V_{IN} = 3.3\text{ V}$  and  $V_{BIAS} = 5\text{ V}$  (Unless otherwise noted).

Symbol	Parameter	Conditions	Min	Typ	Max	Unit	
<b>POWER SWITCH</b>							
$R_{DS(on)}$	Static drain-source on-state resistance for each rail	$V_{IN} = V_{BIAS} = 5.5\text{ V}$	$I_{OUT} = 200\text{ mA}$ , $T_A = 25^{\circ}\text{C}$		23	60	m $\Omega$
			$T_J = 125^{\circ}\text{C}$			80	
		$V_{IN} = V_{BIAS} = 3.3\text{ V}$	$I_{OUT} = 200\text{ mA}$ , $T_A = 25^{\circ}\text{C}$		23	60	
			$T_J = 125^{\circ}\text{C}$			80	
		$V_{IN} = V_{BIAS} = 1.8\text{ V}$	$I_{OUT} = 200\text{ mA}$ , $T_A = 25^{\circ}\text{C}$		23	60	
			$T_J = 125^{\circ}\text{C}$			80	
		$V_{IN} = V_{BIAS} = 1.5\text{ V}$	$I_{OUT} = 200\text{ mA}$ , $T_A = 25^{\circ}\text{C}$		23	60	
			$T_J = 125^{\circ}\text{C}$			80	
$V_{IN} = V_{BIAS} = 1.2\text{ V}$	$I_{OUT} = 200\text{ mA}$ , $T_A = 25^{\circ}\text{C}$		24	60			
	$T_J = 125^{\circ}\text{C}$			80			
		$V_{IN} = 1.0\text{ V}$ $V_{BIAS} = 1.2\text{ V}$	$I_{OUT} = 200\text{ mA}$ , $T_A = 25^{\circ}\text{C}$		24	60	
			$T_J = 125^{\circ}\text{C}$			80	
		$V_{IN} = 0.8\text{ V}$ $V_{BIAS} = 1.2\text{ V}$	$I_{OUT} = 200\text{ mA}$ , $T_A = 25^{\circ}\text{C}$		24	60	
			$T_J = 125^{\circ}\text{C}$			80	
$R_{DIS}$	Output discharge path		EN = low		230	300	$\Omega$

### TIMINGS (Note 6)

$T_R$	Output rise time From 10% to 90% of $V_{OUT}$	$V_{IN} = 5\text{ V}$ $C_{LOAD} = 1\ \mu\text{F}$ , $R_{LOAD} = 25\ \Omega$	No cap on GATE pin		0.26		ms	
			Gate capacitor = 1 nF		1.5			
			Gate capacitor = 10 nF		15			
$T_{en}$	Enable time From En $V_{ih}$ to 10% of $V_{OUT}$		Without Cgate		10		$\mu\text{s}$	
			With 1 nF on Gate		60		$\mu\text{s}$	
$T_F$	Fall Time. From 90% to 10% of $V_{OUT}$				50		$\mu\text{s}$	
$T_{dis}$	Disable time				From EN to 90% Vout	75		$\mu\text{s}$
$T_R$	Output rise time From 10% to 90% of $V_{OUT}$		$V_{IN} = 3.3\text{ V}$ $C_{LOAD} = 1\ \mu\text{F}$ , $R_{LOAD} = 25\ \Omega$	No cap on GATE pin		0.25	0.5	ms
				Gate capacitor = 1 nF		1		
		Gate capacitor = 10 nF			10			
$T_{en}$	Enable time From En $V_{ih}$ to 10% of $V_{OUT}$	Without Cgate			20	50	$\mu\text{s}$	
		With 1 nF on Gate			114		$\mu\text{s}$	
$T_F$	Output fall time From 90% to 10% of $V_{OUT}$				60	120	$\mu\text{s}$	
$T_R$	Output rise time From 10% to 90% of $V_{OUT}$	$V_{IN} = 1.8\text{ V}$ $C_{LOAD} = 1\ \mu\text{F}$ , $R_{LOAD} = 25\ \Omega$		No cap on GATE pin		0.12		ms
				Gate capacitor = 1 nF		0.6		
				Gate capacitor = 10 nF		5.5		
$T_{en}$	Enable time From En $V_{ih}$ to 10% of $V_{OUT}$		Without Cgate		15		$\mu\text{s}$	
			With 1 nF on Gate		85		$\mu\text{s}$	
$T_F$	Output fall time From 90% to 10% of $V_{OUT}$				35		$\mu\text{s}$	

Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

6. Parameters are guaranteed for  $C_{LOAD}$  and  $R_{LOAD}$  connected to the OUT pin with respect to the ground

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**ELECTRICAL CHARACTERISTICS** Min & Max Limits apply for  $T_J$  between  $-40^{\circ}\text{C}$  to  $+125^{\circ}\text{C}$  for  $V_{IN}$  between 0.75 V and 5.5 V, and  $V_{BIAS}$  between 1.2 V and 5.5 V (Unless otherwise noted). Typical values are referenced to  $T_A = +25^{\circ}\text{C}$ ,  $V_{IN} = 3.3\text{ V}$  and  $V_{BIAS} = 5\text{ V}$  (Unless otherwise noted).

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
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## TIMINGS (Note 6)

$T_R$	Output rise time From 10% to 90% of $V_{OUT}$	$V_{IN} = 1\text{ V}$ $C_{LOAD} = 1\ \mu\text{F}$ , $R_{LOAD} = 25\ \Omega$	No cap on GATE pin		0.01	ms
			Gate capacitor = 1 nF		1	
			Gate capacitor = 10 nF		13	
$T_{en}$	Enable time From En $V_{ih}$ to 10% of $V_{OUT}$	$V_{IN} = 1\text{ V}$ $C_{LOAD} = 1\ \mu\text{F}$ , $R_{LOAD} = 25\ \Omega$	Without Cgate		10	$\mu\text{s}$
			With 1 nF on Gate		0.4	ms
$T_F$	Output fall time			20		$\mu\text{s}$

## Logic

$V_{IH}$	High-level input voltage		0.9			V
$V_{IL}$	Low-level input voltage				0.4	V
$R_{EN}$	Pull down resistor		3		7	$\text{M}\Omega$

## QUIESCENT CURRENT

$I_{VBIAS}$	$V_{BIAS}$ Quiescent current	$V_{BIAS} = 3.3\text{ V}$ , EN = high		1.3	5	$\mu\text{A}$
$I_{INQ}$	IN Quiescent current	EN = high		0.01	0.3	$\mu\text{A}$
$I_{STBIN}$	Standby current IN	EN = low, IN standby current, $V_{IN} = 3.3\text{ V}$ , with discharge path, $T_A = -40^{\circ}\text{C}$ to $85^{\circ}\text{C}$		0.01	0.5	$\mu\text{A}$
$I_{STDVbias}$	Standby current $V_{BIAS}$	$V_{BIAS} = 3.3\text{ V}$ EN = low, $T_A = -40^{\circ}\text{C}$ to $85^{\circ}\text{C}$		0.4	1.5	$\mu\text{A}$

Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

6. Parameters are guaranteed for  $C_{LOAD}$  and  $R_{LOAD}$  connected to the OUT pin with respect to the ground

## TIMINGS

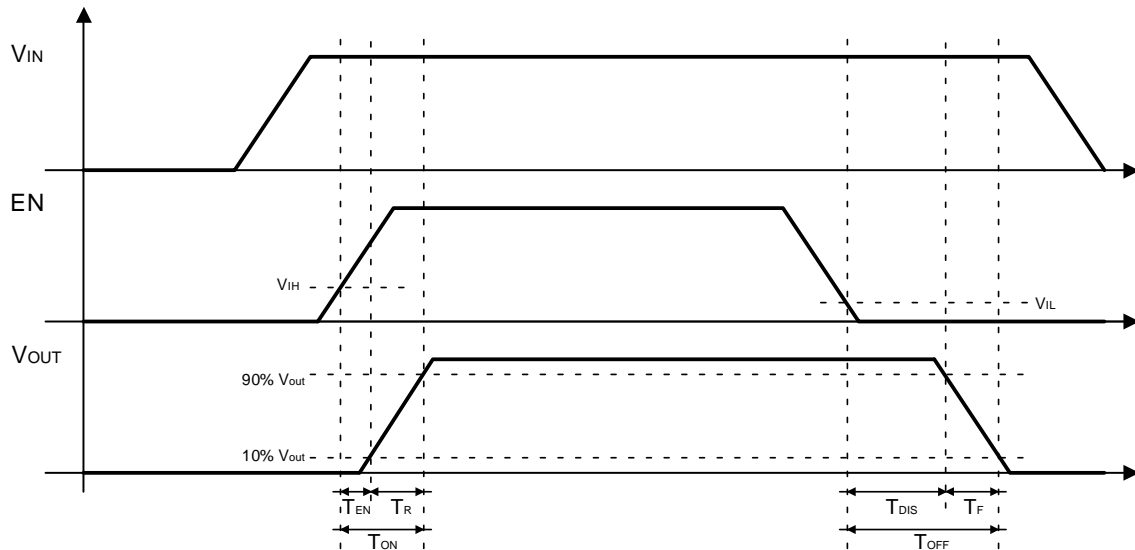


Figure 4. Enable, Rise and Fall Time

TYPICAL CHARACTERISTICS

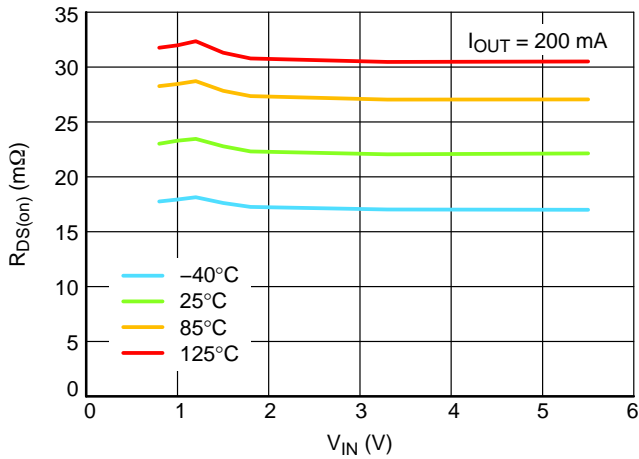


Figure 5.  $R_{DS(on)}$  vs.  $V_{IN}$ , Multi Junction Temperature

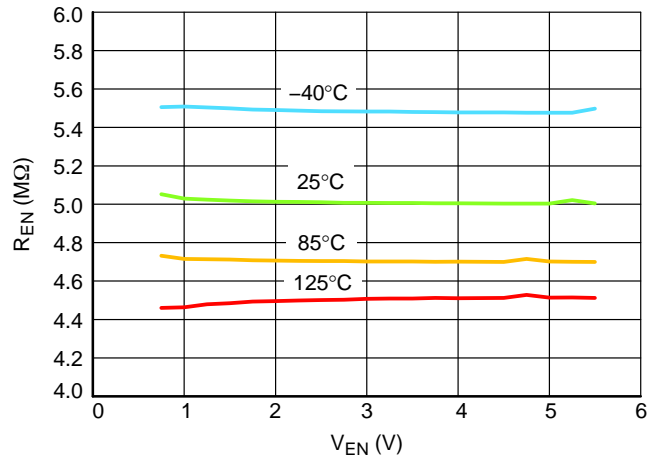


Figure 6. Pull Down Resistor vs.  $V_{EN}$ , Multi Junction Temperature

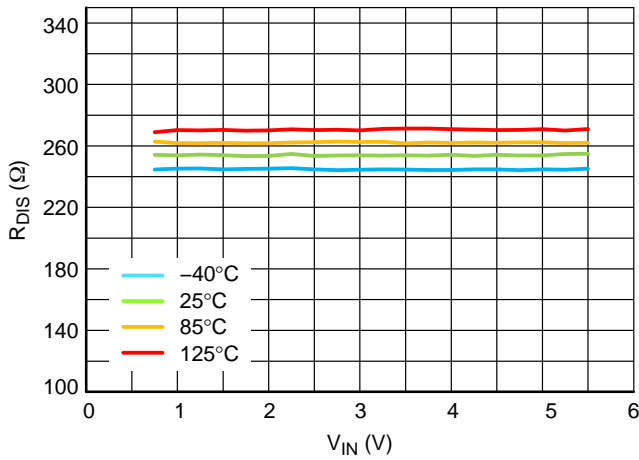


Figure 7. Output Discharge Resistor vs.  $V_{IN}$ , Multi Junction Temperature

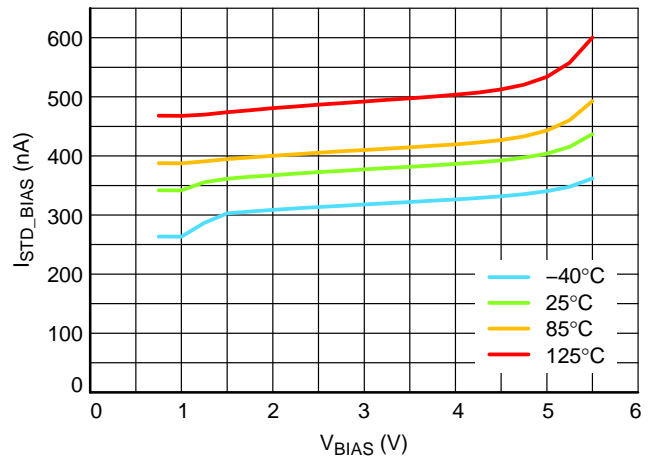


Figure 8. BIAS Standby Current vs.  $V_{BIAS}$ , Multi Junction Temperature

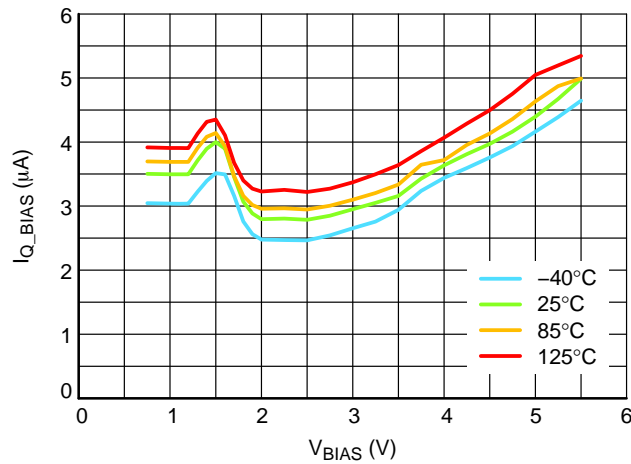


Figure 9. BIAS Quiescent Current vs.  $V_{BIAS}$ , Multi Junction Temperature

TYPICAL CHARACTERISTICS

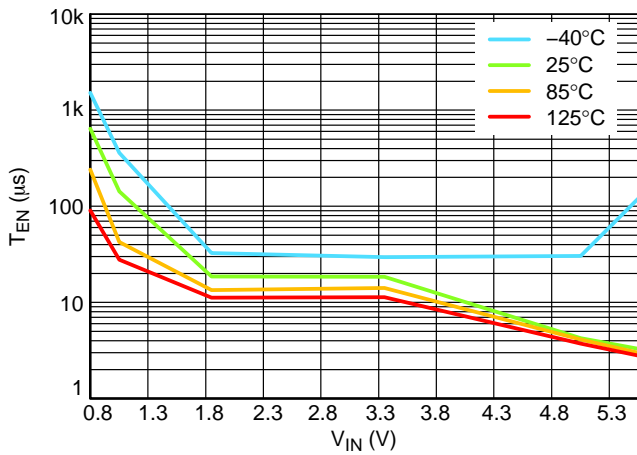


Figure 10. Enable Time vs.  $V_{IN}$ , Multi Junction Temperature (without Cgate)

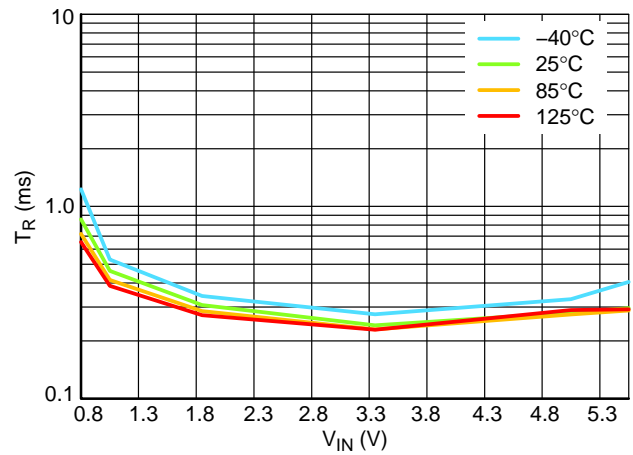


Figure 11. Rise Time vs.  $V_{IN}$ , Multi Junction Temperature (without Cgate)

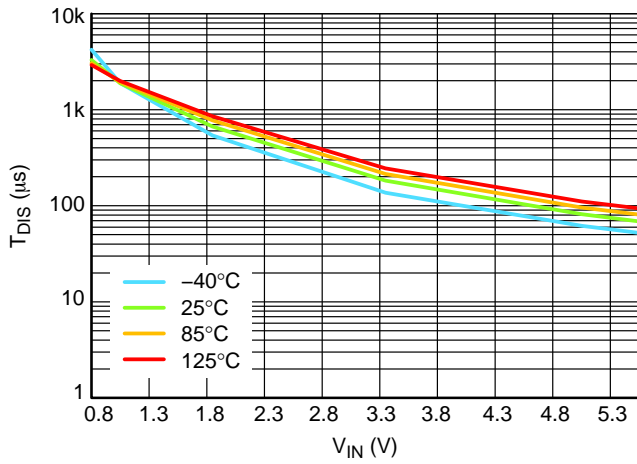


Figure 12. Disable Time vs.  $V_{IN}$ , Multi Junction Temperature,  $V_{BIAS}$  and  $V_{IN}$  Tied Together

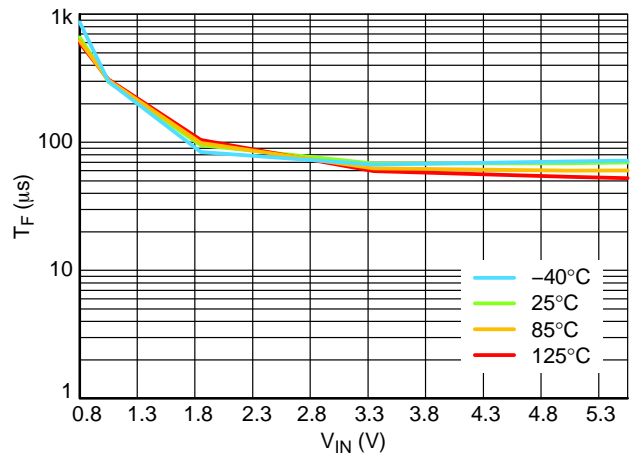


Figure 13. Fall Time vs.  $V_{IN}$ , Multi Junction Temperature,  $V_{BIAS}$  and  $V_{IN}$  Tied Together  $R_{load} 25 \Omega$

## FUNCTIONAL DESCRIPTION

### Overview

The NCV459 are high side N channel MOSFET power distribution switch designed to isolate ICs connected on the LDO or DCDC supplies in order to save energy. The part can be used with a wide range of supply from 0.75 V to 5.5 V.

### Enable Input

Enable pin is an active high. The path is opened when EN pin is tied low (disable), forcing NMOS switch off.

The IN/OUT path is activated with a minimum of  $V_{BIAS}$  min,  $V_{in}$  min and EN forced to high level.

### Auto Discharge

NMOS FET is placed between the output pin and GND, in order to discharge the application capacitor connected on OUT pin.

The auto-discharge is activated when EN pin is set to low level (disable state).

The discharge path ( Pull down NMOS) stays activated as long as EN pin is set at low level.

In order to limit the current across the internal discharge Nmosfet, the typical value is set at  $R_{DIS}$  value.

### Vbias Rail

The core of the IC is supplied thanks to Vbias supply rail (common +5 V, 3.3 V, 1.8 V, 1.2 V). Indeed, no current

consumption is used on IN pin, allowing to improve power saving of the rail that must be isolated by the power switch.

If Vbias rail is not available or used, Vbias pin and  $V_{in}$  pin can be connected together as close as possible the DUT. A minimum of 1.2 V is necessary to control the IC. It is recommended to connect external capacitor 10  $\mu$ F due to better EMC immunity.

### Output rise time – Gate control

The NMOS is control with internal charge pump and driver. A minimum gate slew rate is internally set to avoid huge inrush current when EN is set from low to high. The default gate slew rate depends on  $V_{in}$  level. The higher  $V_{in}$  level, the longer rise time.

In addition, an external capacitor can be connected between Gate pin and GND in order to slow down the gate rising. See electrical table for more details.

### Cin and Cout Capacitors

100 nF external capacitors must be connected as close as possible the DUT for noise immunity and better stability. In case of input hot plug (input voltage connected with fast slew rate – few  $\mu$ s – it's strongly recommended to avoid big capacitor connected on the input. That allows to avoid input over voltage transients.

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## APPLICATION INFORMATION

### Power Dissipation

Main contributor in term of junction temperature is the power dissipation of the power MOSFET. Assuming this, the power dissipation and the junction temperature in normal mode can be calculated with the following equations:

$$P_D = R_{DS(on)} \times (I_{OUT})^2 \quad (\text{eq. 1})$$

$P_D$	= Power dissipation (W)
$R_{DS(on)}$	= Power MOSFET on resistance ( $\Omega$ )
$I_{OUT}$	= Output current (A)
$T_J = P_D \times R_{\theta JA} + T_A$	(eq. 2)
$T_J$	= Junction temperature ( $^{\circ}\text{C}$ )
$R_{\theta JA}$	= Package thermal resistance ( $^{\circ}\text{C}/\text{W}$ )
$T_A$	= Ambient temperature ( $^{\circ}\text{C}$ )

### ORDERING INFORMATION

Device	Marking	Option	Package	Shipping†
NCV459NMWBTBG	45A	Auto Discharge 230 $\Omega$	DFNW8 3 x 3 mm (Pb-Free)	3000 / Tape & Reel

†For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.



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