

Dual Self-Protected Low Side Driver with Temperature and Current Limit

NCV8406DD

NCV8406DD is a dual protected Low-Side Smart Discrete device. The protection features include overcurrent, overtemperature, ESD and integrated Drain-to-Gate clamping for overvoltage protection. This device offers protection and is suitable for harsh automotive environments.

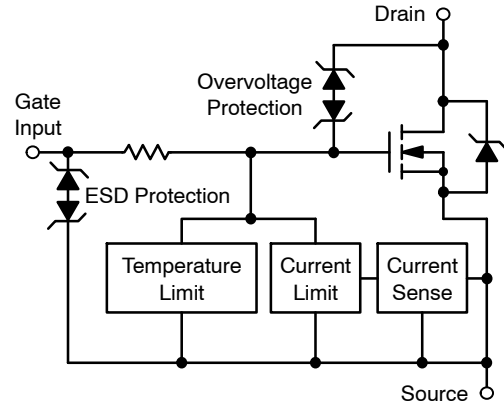
Features

- Short Circuit Protection
- Thermal Shutdown with Automatic Restart
- Over Voltage Protection
- Integrated Clamp for Inductive Switching
- ESD Protection
- dV/dt Robustness
- Analog Drive Capability (Logic Level Input)
- These Devices are Faster than the Rest of the NCV Devices
- NCV Prefix for Automotive and Other Applications Requiring Unique Site and Control Change Requirements; AEC-Q101 Qualified and PPAP Capable
- These Devices are Pb-Free, Halogen Free/BFR Free and are RoHS Compliant

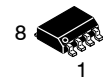
Typical Applications

- Switch a Variety of Resistive, Inductive and Capacitive Loads
- Can Replace Electromechanical Relays and Discrete Circuits
- Automotive / Industrial

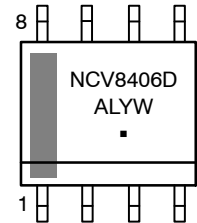
V _{DSS} (Clamped)	R _{DS(on)} TYP	I _D TYP (Limited)
65 V	210 mΩ	7.0 A



MARKING DIAGRAM

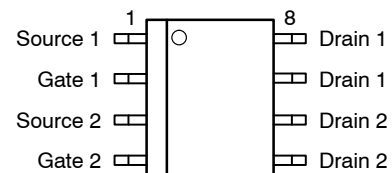


SO-8
CASE 751



NCV8406D = Specific Device Code
 A = Assembly Location
 L = Wafer Lot
 Y = Year
 W = Work Week
 ■ = Pb-Free Package

PIN ASSIGNMENT



ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 9 of this data sheet.

NCV8406DD

MAXIMUM RATINGS ($T_J = 25^\circ\text{C}$ unless otherwise noted)

Rating	Symbol	Value	Unit
Drain-to-Source Voltage Internally Clamped	V_{DSS}	60	Vdc
Gate-to-Source Voltage	V_{GS}	± 14	Vdc
Drain Current Continuous	I_D	Internally Limited	
Power Dissipation per Channel, both channels loaded equally @ $T_A = 25^\circ\text{C}$ (Note 1) @ $T_A = 25^\circ\text{C}$ (Note 2)	P_D	0.57 0.78	W
Total Power Dissipation, only one channel loaded @ $T_A = 25^\circ\text{C}$ (Note 1) @ $T_A = 25^\circ\text{C}$ (Note 2)	P_D	0.93 1.2	W
Thermal Resistance, both channels loaded equally Junction-to-Ambient (Note 1) Junction-to-Ambient (Note 2) Junction-to-Case (Soldering Point)	$R_{\theta JA}$ $R_{\theta JA}$ $R_{\theta JS}$	107.8 79.4 29	$^\circ\text{C/W}$
Thermal Resistance, only one channel loaded Junction-to-Ambient (Note 1) Junction-to-Ambient (Note 2) Junction-to-Case (Soldering Point)	$R_{\theta JA}$ $R_{\theta JA}$ $R_{\theta JS}$	133.6 103.8 29	$^\circ\text{C/W}$
Single Pulse Inductive Load Switching Energy (Starting $T_J = 25^\circ\text{C}$, $V_{DD} = 50\text{ Vdc}$, $V_{GS} = 5.0\text{ Vdc}$, $I_L = 2.1\text{ Apk}$, $L = 50\text{ mH}$, $R_G = 25\ \Omega$)	E_{AS}	110	mJ
Load Dump Voltage ($V_{GS} = 0$ and 10 V , $R_I = 2\ \Omega$, $R_L = 7\ \Omega$, $t_d = 400\text{ ms}$)	V_{LD}	75	V
Operating Junction Temperature Range	T_J	-40 to 150	$^\circ\text{C}$
Storage Temperature Range	T_{stg}	-55 to 150	$^\circ\text{C}$

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.

- Mounted onto a 80 x 80 x 1.6 mm single layer FR4 board (100 sq mm, 1 oz. Cu, steady state).
- Mounted onto a 80 x 80 x 1.6 mm single layer FR4 board (645 sq mm, 1 oz. Cu, steady state).

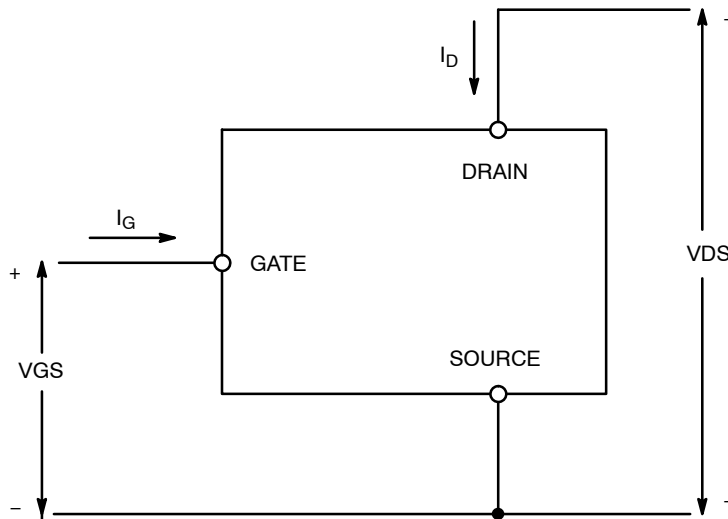


Figure 1. Voltage and Current Convention

NCV8406DD

MOSFET ELECTRICAL CHARACTERISTICS ($T_J = 25^\circ\text{C}$ unless otherwise noted)

Parameter	Test Condition	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Drain-to-Source Clamped Breakdown Voltage	$(V_{GS} = 0\text{ V}, I_D = 2\text{ mA})$	$V_{(BR)DSS}$	60	65	70	V
Zero Gate Voltage Drain Current	$(V_{DS} = 52\text{ V}, V_{GS} = 0\text{ V})$	I_{DSS}	–	22	100	μA
Gate Input Current	$(V_{GS} = 5.0\text{ V}, V_{DS} = 0\text{ V})$	I_{GSS}	–	30	100	μA

ON CHARACTERISTICS

Gate Threshold Voltage	$(V_{DS} = V_{GS}, I_D = 150\text{ }\mu\text{A})$ Threshold Temperature Coefficient	$V_{GS(th)}$	1.2 –	1.66 4.0	2.0 –	V –mV/ $^\circ\text{C}$
Static Drain-to-Source On-Resistance (Note 3)	$(V_{GS} = 10\text{ V}, I_D = 2.0\text{ A}, T_J @ 25^\circ\text{C})$	$R_{DS(on)}$	–	185	210	m Ω
Static Drain-to-Source On-Resistance (Note 3)	$(V_{GS} = 5.0\text{ V}, I_D = 2.0\text{ A}, T_J @ 25^\circ\text{C})$ $(V_{GS} = 5.0\text{ V}, I_D = 2.0\text{ A}, T_J @ 150^\circ\text{C})$	$R_{DS(on)}$	– –	210 445	240 520	m Ω
Source-Drain Forward On Voltage	$(I_S = 7.0\text{ A}, V_{GS} = 0\text{ V})$	V_{SD}	–	0.9	1.1	V

SWITCHING CHARACTERISTICS (Note 6)

Turn-on Delay Time	$R_L = 6.6\text{ }\Omega, V_{in} = 0\text{ to }10\text{ V},$ $V_{DD} = 13.8\text{ V}, I_D = 2.0\text{ A}, 10\% V_{in}\text{ to }10\% I_D$	$t_{d(on)}$	–	127	–	ns
Turn-on Rise Time	$R_L = 6.6\text{ }\Omega, V_{in} = 0\text{ to }10\text{ V},$ $V_{DD} = 13.8\text{ V}, I_D = 2.0\text{ A}, 10\% I_D\text{ to }90\% I_D$	t_{rise}	–	486	–	ns
Turn-off Delay Time	$R_L = 6.6\text{ }\Omega, V_{in} = 0\text{ to }10\text{ V},$ $V_{DD} = 13.8\text{ V}, I_D = 2.0\text{ A}, 90\% V_{in}\text{ to }90\% I_D$	$t_{d(off)}$	–	1600	–	ns
Turn-off Fall Time	$R_L = 6.6\text{ }\Omega, V_{in} = 0\text{ to }10\text{ V},$ $V_{DD} = 13.8\text{ V}, I_D = 2.0\text{ A}, 90\% I_D\text{ to }10\% I_D$	t_{fall}	–	692	–	ns
Slew Rate ON	$R_L = 6.6\text{ }\Omega, V_{in} = 0\text{ to }10\text{ V},$ $V_{DD} = 13.8\text{ V}, I_D = 2.0\text{ A}, 70\%\text{ to }50\% V_{DD}$	dV_{DS}/dT_{on}	–	79	–	V/ μs
Slew Rate OFF	$R_L = 6.6\text{ }\Omega, V_{in} = 0\text{ to }10\text{ V},$ $V_{DD} = 13.8\text{ V}, I_D = 2.0\text{ A}, 50\%\text{ to }70\% V_{DD}$	dV_{DS}/dT_{off}	–	27	–	V/ μs

SELF PROTECTION CHARACTERISTICS (Note 4)

Current Limit	$V_{DS} = 10\text{ V}, V_{GS} = 5.0\text{ V}, T_J = 25^\circ\text{C}$ (Notes 5, 7) $V_{DS} = 10\text{ V}, V_{GS} = 5.0\text{ V}, T_J = 150^\circ\text{C}$ (Notes 5, 6, 7) $V_{DS} = 10\text{ V}, V_{GS} = 10\text{ V}, T_J = 25^\circ\text{C}$ (Notes 5, 7)	I_{LIM}	5.0 3.5 6.5	7.0 4.5 8.5	9.5 6.0 10.5	A
Temperature Limit (Turn-off)	$V_{GS} = 5.0\text{ V}$ (Notes 6, 7)	$T_{LIM(off)}$	150	180	200	$^\circ\text{C}$
Thermal Hysteresis	$V_{GS} = 5.0\text{ V}$	$\Delta T_{LIM(on)}$	–	10	–	$^\circ\text{C}$
Temperature Limit (Turn-off)	$V_{GS} = 10\text{ V}$ (Notes 6, 7)	$T_{LIM(off)}$	150	180	200	$^\circ\text{C}$
Thermal Hysteresis	$V_{GS} = 10\text{ V}$	$\Delta T_{LIM(on)}$	–	20	–	$^\circ\text{C}$
Input Current during Thermal Fault	$V_{DS} = 0\text{ V}, V_{GS} = 5.0\text{ V}, T_J = T_J > T_{(fault)}$ (Note 6) $V_{DS} = 0\text{ V}, V_{GS} = 10\text{ V}, T_J = T_J > T_{(fault)}$ (Note 6)	$I_{g(fault)}$	– –	5.9 12.3	–	mA

ESD ELECTRICAL CHARACTERISTICS

Electro-Static Discharge Capability Human Body Model (HBM) Machine Model (MM)	ESD	6000 500	– –	– –	V
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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.

3. Pulse Test: Pulse Width $\leq 300\text{ }\mu\text{s}$, Duty Cycle $\leq 2\%$.
4. Fault conditions are viewed as beyond the normal operating range of the part.
5. Current limit measured at $380\text{ }\mu\text{s}$ after gate pulse.
6. Not subject to production test.
7. Refer to Application Note AND8202/D for dependence of protection features on gate voltage.

TYPICAL PERFORMANCE CURVES

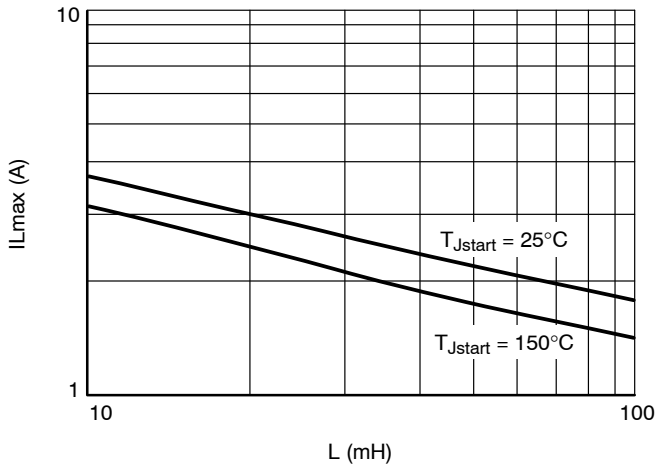


Figure 2. Single Pulse Maximum Switch-off Current vs. Load Inductance

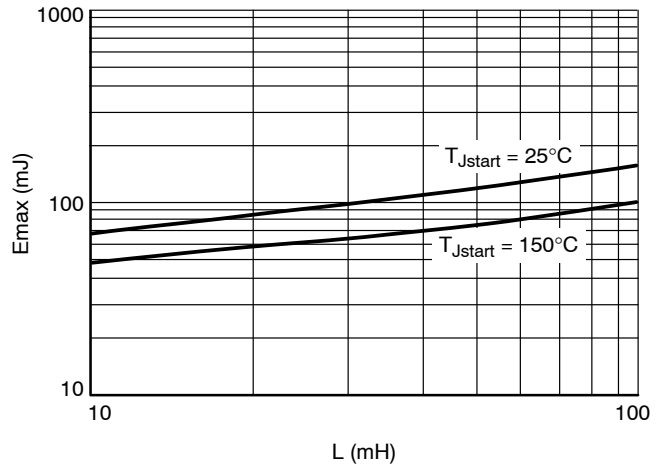


Figure 3. Single-Pulse Maximum Switching Energy vs. Load Inductance

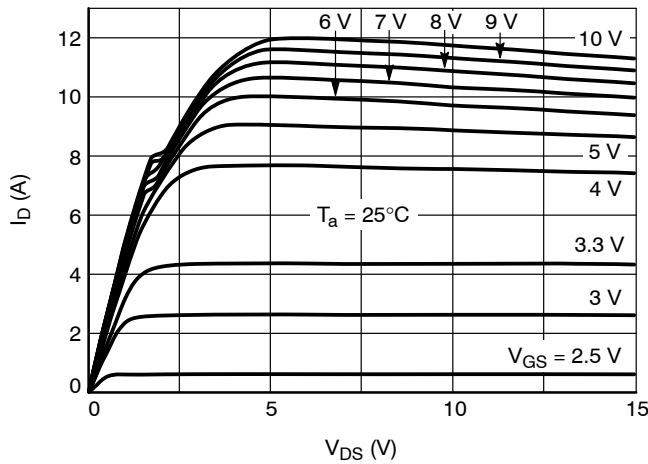


Figure 4. On-state Output Characteristics

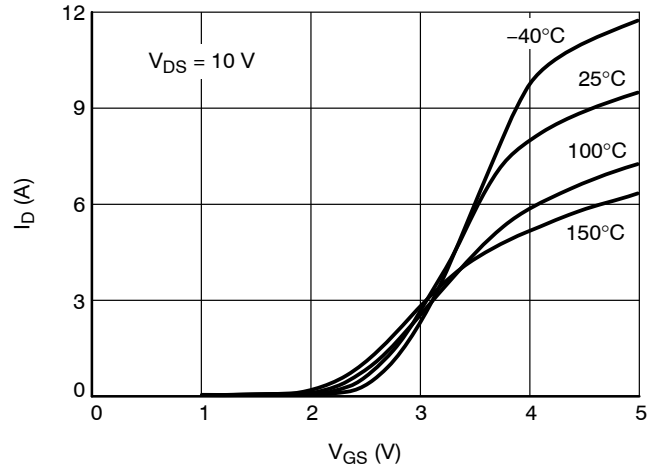


Figure 5. Transfer Characteristics

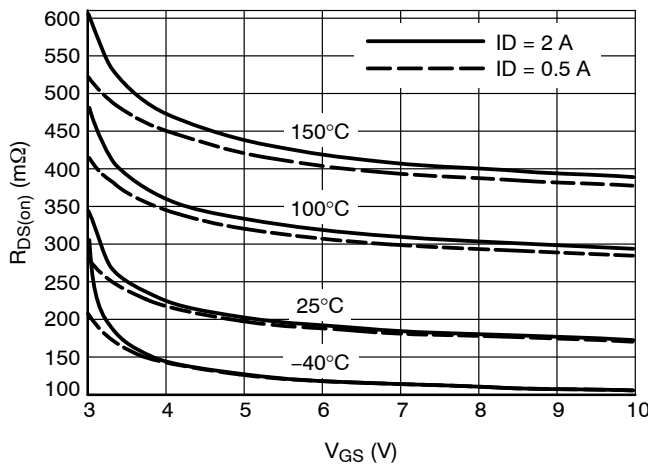


Figure 6. $R_{DS(on)}$ vs. Gate-Source Voltage

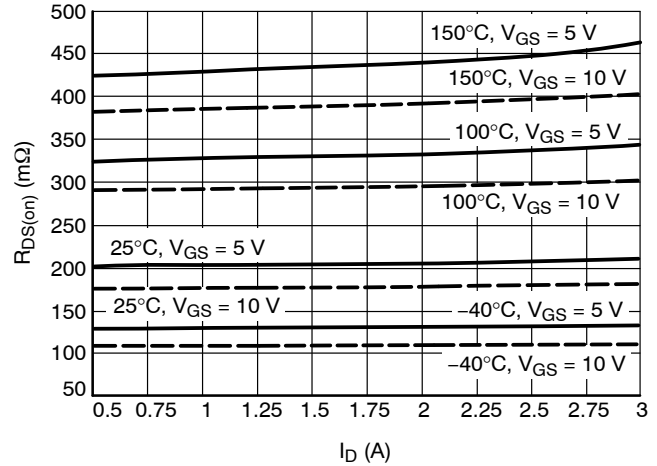


Figure 7. $R_{DS(on)}$ vs. Drain Current

TYPICAL PERFORMANCE CURVES

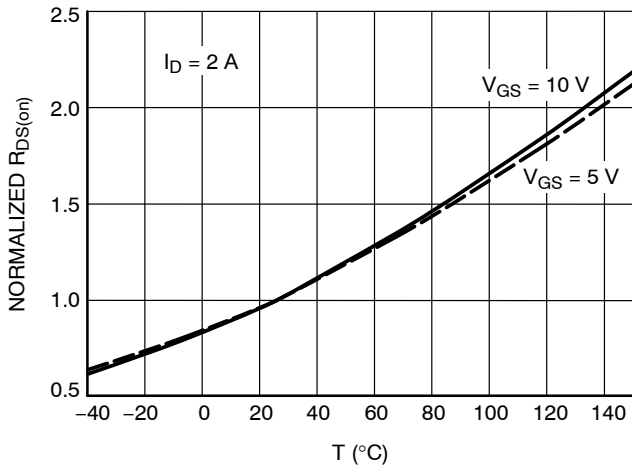


Figure 8. Normalized $R_{DS(on)}$ vs. Temperature

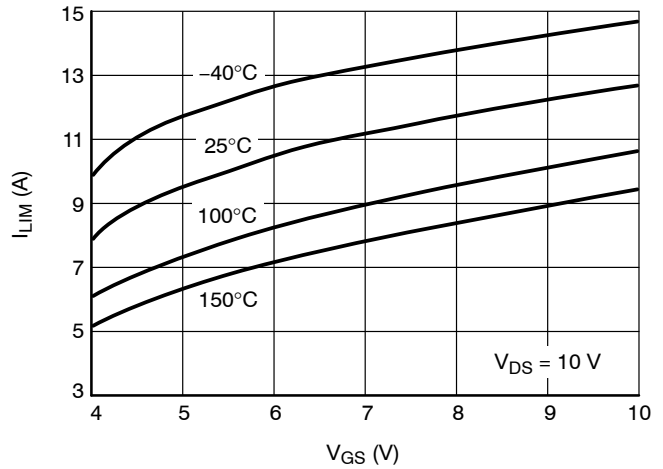


Figure 9. Current Limit vs. Gate-Source Voltage

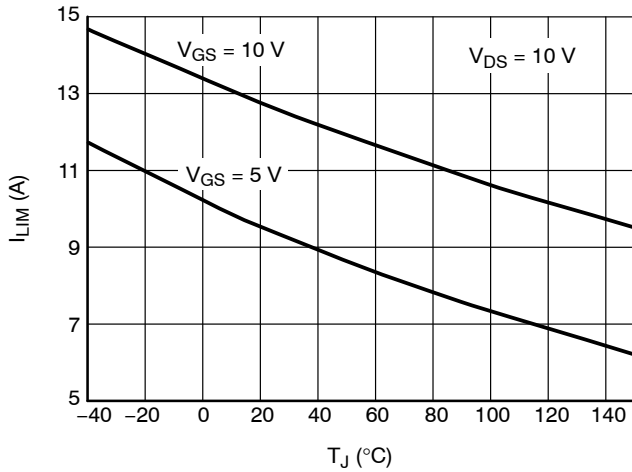


Figure 10. Current Limit vs. Junction Temperature

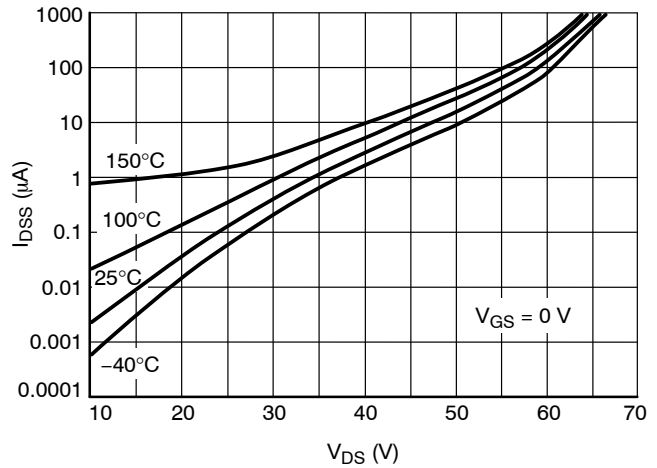


Figure 11. Drain-to-Source Leakage Current

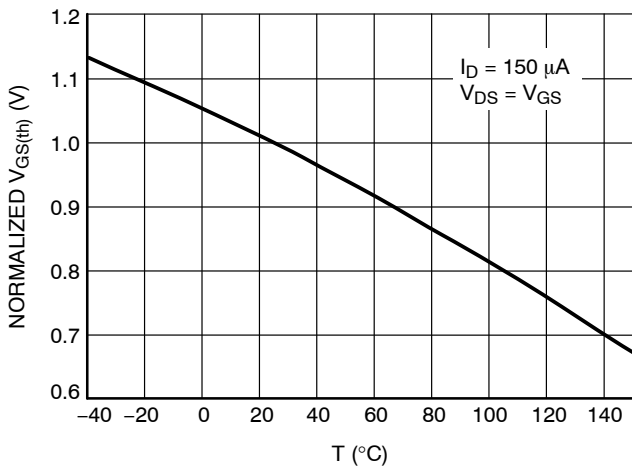


Figure 12. Normalized Threshold Voltage vs. Temperature

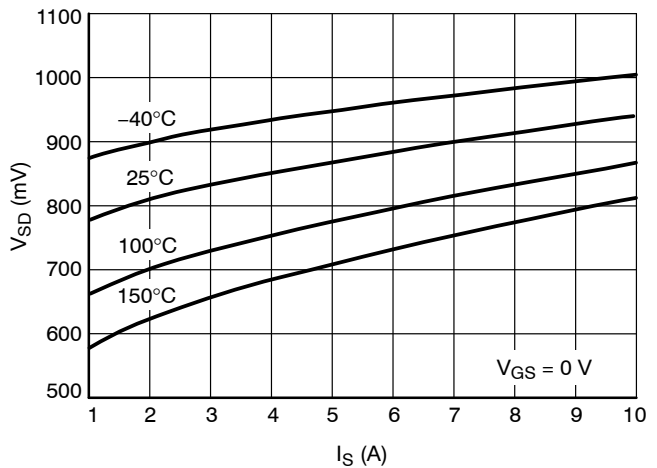


Figure 13. Source-Drain Diode Forward Characteristics

TYPICAL PERFORMANCE CURVES

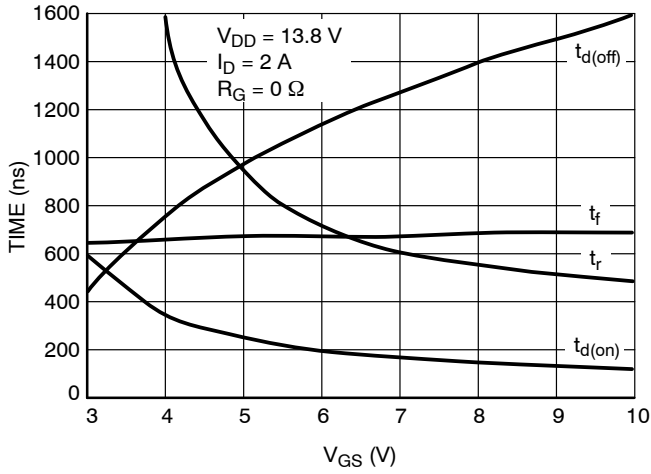


Figure 14. Resistive Load Switching Time vs. Gate-Source Voltage

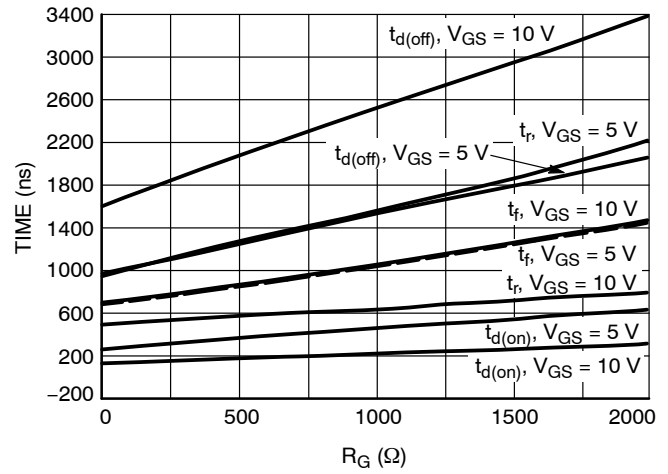


Figure 15. Resistive Load Switching Time vs. Gate Resistance

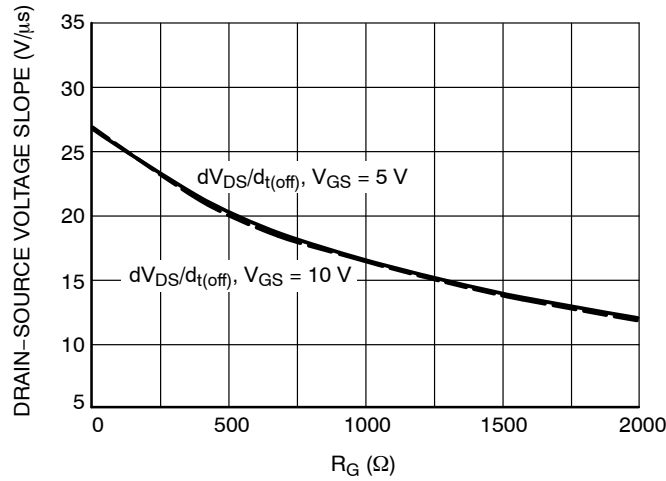


Figure 16. Drain-Source Voltage Slope during Turn On and Turn Off vs. Gate Resistance

TYPICAL PERFORMANCE CURVES

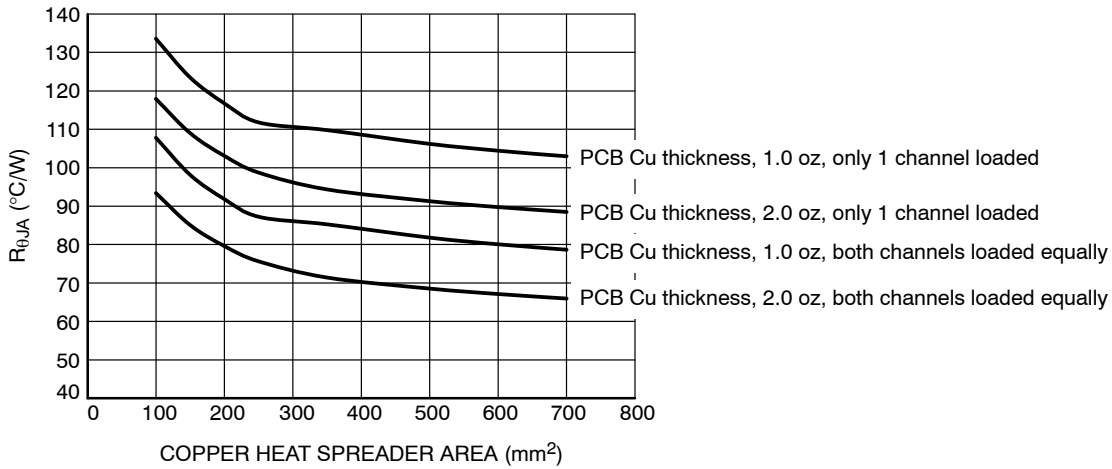


Figure 17. R_{θJA} vs. Copper Area

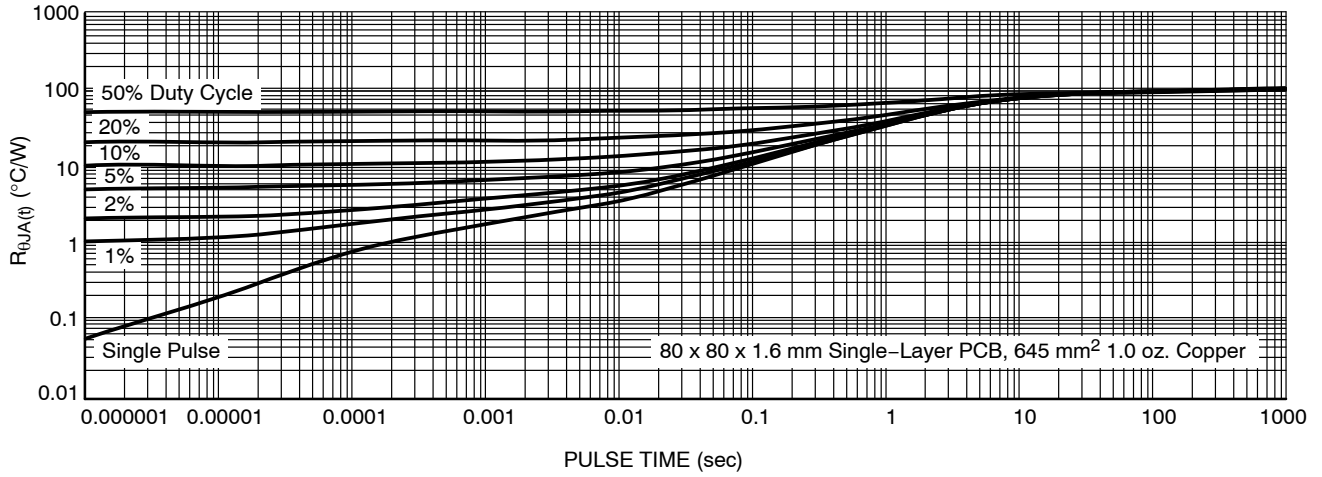


Figure 18. Transient Thermal Resistance, Only 1 Channel Loaded

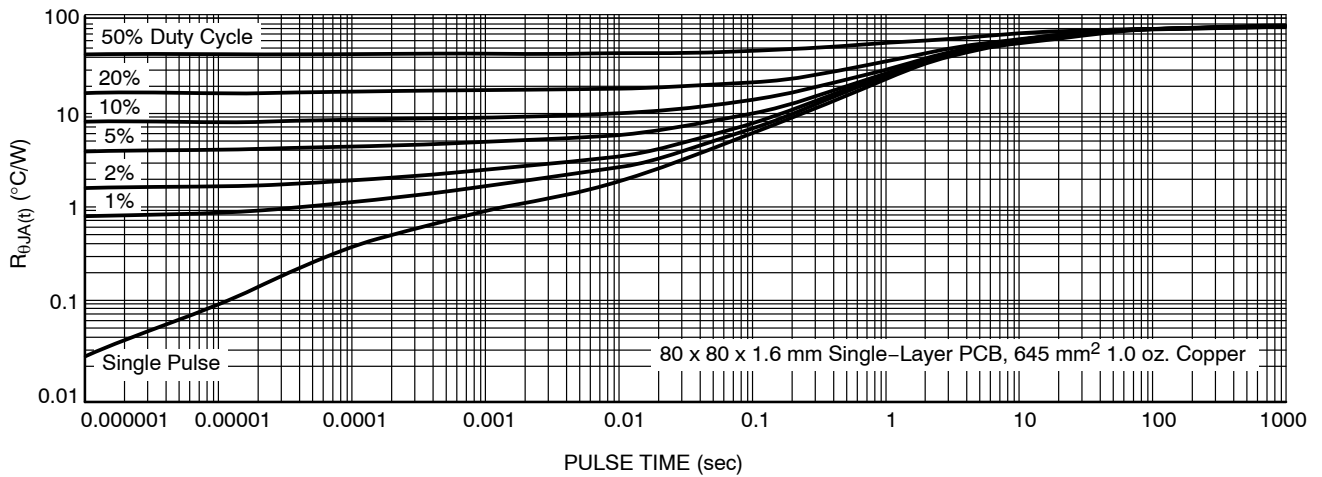


Figure 19. Transient Thermal Resistance, 2 Channels Loaded

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TEST CIRCUITS AND WAVEFORMS



Figure 20. Resistive Load Switching Test Circuit

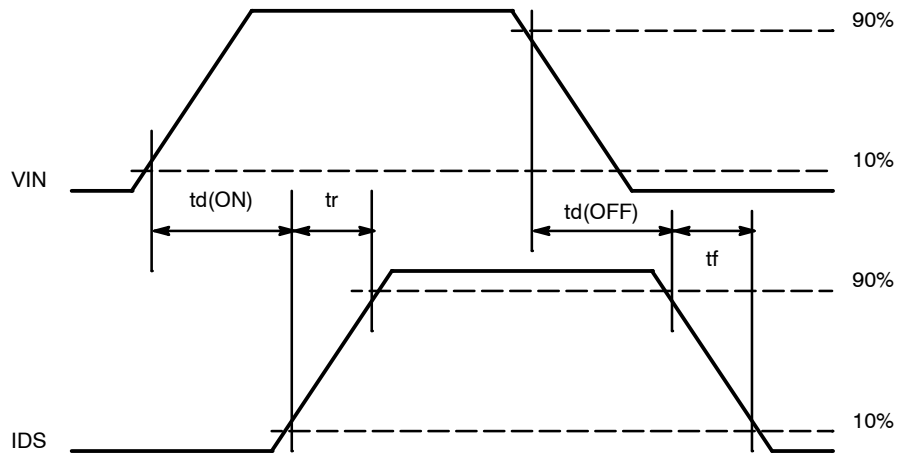


Figure 21. Resistive Load Switching Waveforms

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TEST CIRCUITS AND WAVEFORMS

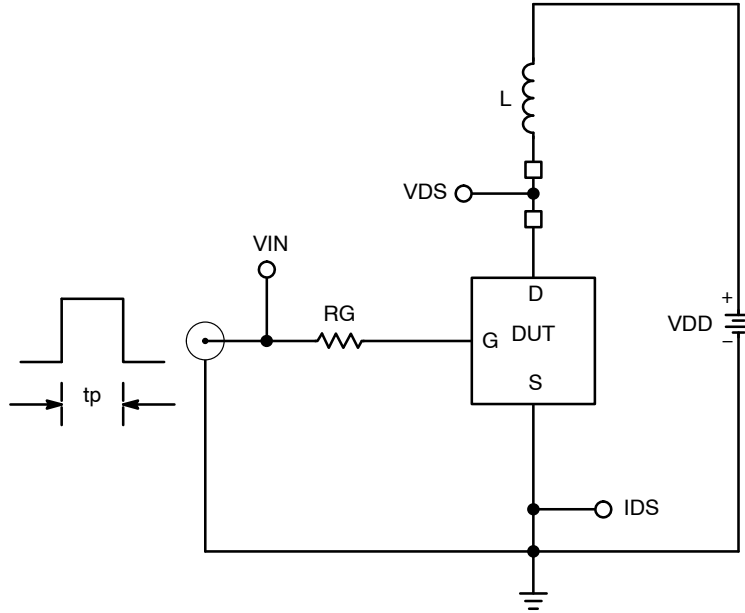


Figure 22. Inductive Load Switching Test Circuit

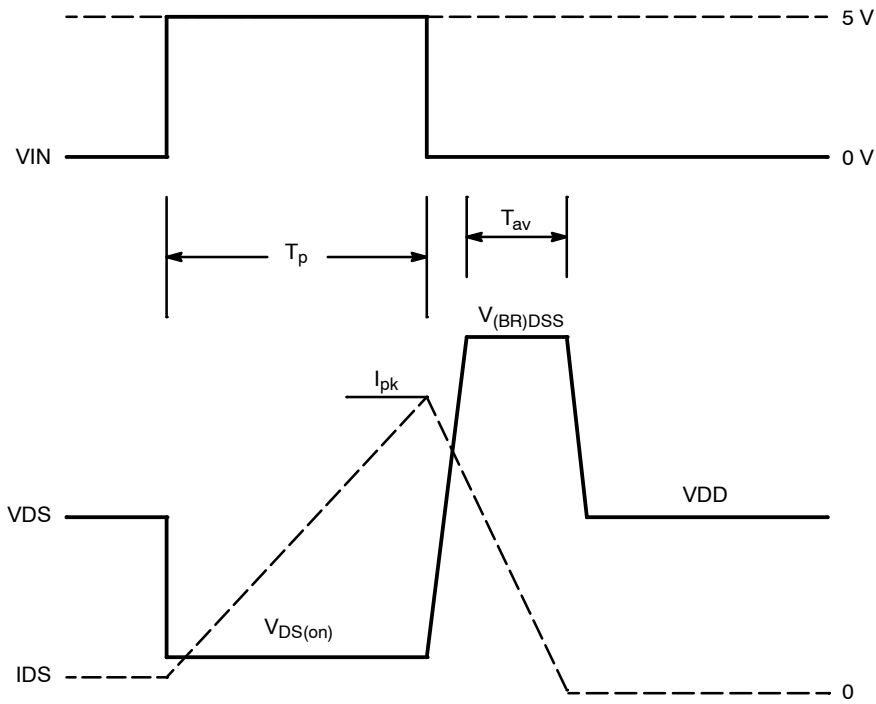


Figure 23. Inductive Load Switching Waveforms

ORDERING INFORMATION

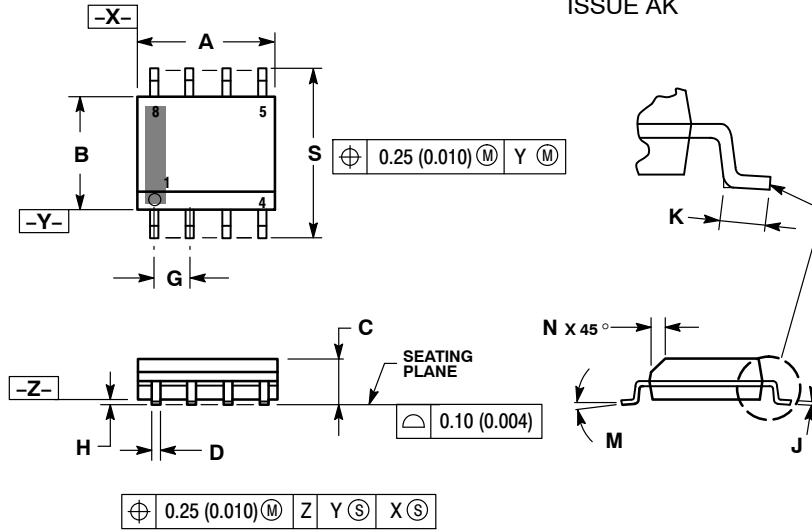
Device	Package	Shipping [†]
NCV8406DD1CR2G	SOIC-8 (Pb-Free)	2500 / Tape & Reel

[†]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.

NCV8406DD

PACKAGE DIMENSIONS

SOIC-8 NB
CASE 751-07
ISSUE AK

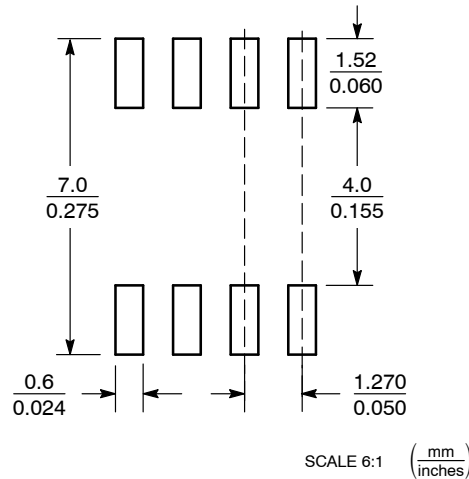


NOTES:

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER.
3. DIMENSION A AND B DO NOT INCLUDE MOLD PROTRUSION.
4. MAXIMUM MOLD PROTRUSION 0.15 (0.006) PER SIDE.
5. DIMENSION D DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.127 (0.005) TOTAL IN EXCESS OF THE D DIMENSION AT MAXIMUM MATERIAL CONDITION.
6. 751-01 THRU 751-06 ARE OBSOLETE. NEW STANDARD IS 751-07.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	4.80	5.00	0.189	0.197
B	3.80	4.00	0.150	0.157
C	1.35	1.75	0.053	0.069
D	0.33	0.51	0.013	0.020
G	1.27 BSC		0.050 BSC	
H	0.10	0.25	0.004	0.010
J	0.19	0.25	0.007	0.010
K	0.40	1.27	0.016	0.050
M	0°	8°	0°	8°
N	0.25	0.50	0.010	0.020
S	5.80	6.20	0.228	0.244

SOLDERING FOOTPRINT*



*For additional information on our Pb-Free strategy and soldering details, please download the **onsemi** Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

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