NCV8411

Self-Protected Low Side Driver with In-Rush Current Management

The NCV8411 is a three terminal protected Low−Side Smart Discrete FET. The protection features include Delta Thermal Shutdown, overcurrent, overtemperature, ESD and integrated Drain to Gate clamping for over voltage protection. The device also offers fault indication via the gate pin. This device is suitable for harsh automotive environments.

Features

- Short Circuit Protection with In−Rush Current Management
- Delta Thermal Shutdown
- Thermal Shutdown with Automatic Restart
- Over Voltage Protection
- Integrated Clamp for Over Voltage Protection and Inductive Switching
- ESD Protection
- dV/dt Robustness
- Analog Drive Capability (Logic Level Input)
- 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 and are RoHS Compliant

Typical Applications

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

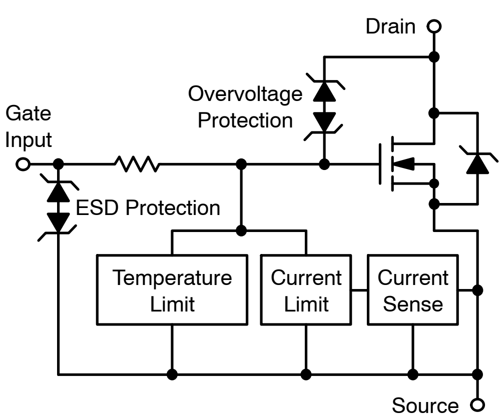

Figure 1. Block Diagram

ON Semiconductor®

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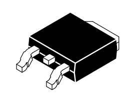
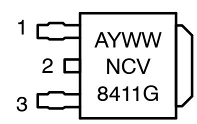
V_{DSS} (Clamped)	$R_{DS(ON)}$ TYP	I_D MAX (Limited)
42 V	23 mΩ @ 10 V	45 A



DPAK
CASE 369C
STYLE 2

MARKING DIAGRAM

1 = Gate
2 = Drain
3 = Source



A = Assembly Location
Y = Year
WW = Work Week
G = Pb−Free Package

ORDERING INFORMATION

Device	Package	Shipping†
NCV8411DTRKG	DPAK (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 Specification Brochure, BRD8011/D.

Table 1. MAXIMUM RATINGS

Rating	Symbol	Value (min)	Unit
Drain−to−Source Voltage Internally Clamped	V_{DSS}	42	V
Drain−to−Gate Voltage Internally Clamped	V_{DG}	42	V
Gate−to−Source Voltage	V_{GS}	±14	V
Drain Current − Continuous	I_D	Internally Limited	
Total Power Dissipation @ T_A = 25°C (Note 1) @ T_A = 25°C (Note 2)	P_D	 1.3 2.7	W
Thermal Resistance Junction−to−Case Junction−to−Ambient (Note 1) Junction−to−Ambient (Note 2)	 R_{thJC} R_{thJA} R_{thJA}	 0.65 95 45	°C/W
Single Pulse Inductive Load Switching Energy (Note 3) (L = 120 mH, $T_{J(start)}$ = 150°C)	E_{AS}	600	mJ
Load Dump Voltage (V_{GS} = 0 and 10 V, R_G = 2 Ω, R_L = 3 Ω) (Note 4)	U_S*	55	V
Operating Junction Temperature	T_J	−40 to 150	°C
Storage Temperature	$T_{storage}$	−55 to 150	°C

ESD CHARACTERISTICS (Note 3)

Electro−Static Discharge Capability Human Body Model (HBM)	ESD	4	kV

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. Mounted onto a 2″ square FR4 board (100 sq mm, 1 oz. Cu, steady state)
2. Mounted onto a 2″ square FR4 board (645 sq mm, 1 oz. Cu, steady state)
3. Not tested in production.
4. Load Dump Test B (with centralized load dump suppression) according to ISO16750−2 standard. Guaranteed by design. Not tested in production. Passed Class C according to ISO16750−1.

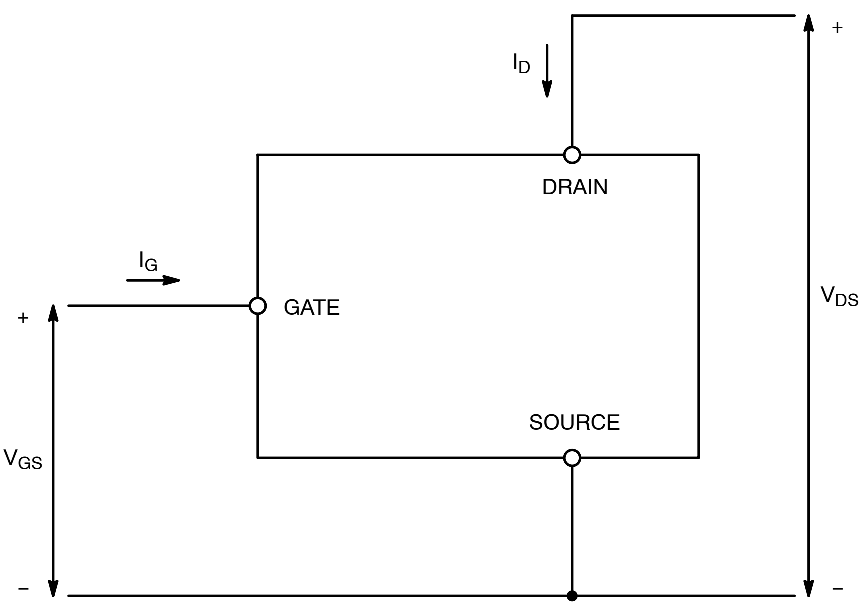


Figure 2. Voltage and Current Convention

Table 2. ELECTRICAL CHARACTERISTICS (T_J = 25°C unless otherwise noted)

Characteristic	Test Conditions	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Drain−to−Source Clamped Breakdown Voltage	V_{GS} = 0 V, I_D = 250 μA	$V_{(BR)DSS}$	42	46	50	V
	V_{GS} = 0 V, I_D = 250 μA, T_J = 150°C (Note 5)		42	44	50	
Zero Gate Voltage Drain Current	V_{DS} = 32 V, V_{GS} = 0 V	I_{DSS}	–	1.5	5	μA
	V_{DS} = 32 V, V_{GS} = 0 V, T_J = 150°C (Note 5)		–	5.5	–	
Gate Input Current	V_{GS} = 5 V, V_{DS} = 0 V	I_{GSS}	–	50	100	μA
ON CHARACTERISTICS						
Gate Threshold Voltage	V_{GS} = V_{DS}, I_D = 1.2 mA	$V_{GS(th)}$	1.0	1.8	2.5	V
Threshold Temperature Coefficient	V_{GS} = V_{DS}, I_D = 1.2 mA (Note 5)		–	5	–	mV/°C
Static Drain−to−Source On Resistance	V_{GS} = 10 V, I_D = 5 A, T_J = 25°C	$R_{DS(ON)}$	–	23	29	mΩ
	V_{GS} = 10 V, I_D = 5 A, T_J = 150°C (Note 5)		–	43	55	
	V_{GS} = 5 V, I_D = 5 A, T_J = 25°C		–	28	34	
	V_{GS} = 5 V, I_D = 5 A, T_J = 150°C (Note 5)		–	50	60	
Source Drain Forward On Voltage	I_S = 5 A, V_{GS} = 0 V	V_{SD}	–	0.8	1.1	V
SWITCHING CHARACTERISTICS (Note 5)						
Turn−On Time (10% V_{GS} to 90% I_D)	V_{GS} = 0 V to 5 V, V_{DS} = 12 V, I_D = 1 A	t_{ON}	–	29	50	μs
Turn−Off Time (90% V_{GS} to 10% I_D)		t_{OFF}	–	53	150	
Turn−On Time (10% V_{GS} to 90% I_D)	V_{GS} = 0 V to 10 V, V_{DS} = 12 V, I_D = 1 A	t_{ON}	–	14	25	
Turn−Off Time (90% V_{GS} to 10% I_D)		t_{OFF}	–	80	180	
Slew Rate On (80% V_{DS} to 50% V_{DS})	V_{GS} = 0 V to 10 V, V_{DD} = 12 V, R_L = 4.7 Ω	$-dV_{DS}/dt_{ON}$	–	1.52	2.5	V/μs
Slew Rate Off (50% V_{DS} to 80% V_{DS})		dV_{DS}/dt_{OFF}	–	0.71	0.85	
SELF PROTECTION CHARACTERISTICS						
Current Limit	V_{GS} = 5 V, V_{DS} = 10 V	I_{LIM}	29	33	40	A
	V_{GS} = 5 V, V_{DS} = 10 V, T_J = 150°C (Note 5)		27	31	37	
	V_{GS} = 10 V, V_{DS} = 10 V (Note 5)		23	34	46	
	V_{GS} = 10 V, V_{DS} = 10 V, T_J = 150°C (Note 5)		23	33	46	
Temperature Limit (Turn−Off)	V_{GS} = 5 V (Note 5)	$T_{LIM(OFF)}$	150	170	185	°C
Thermal Hysteresis		$\Delta T_{LIM(ON)}$	–	10	–	
Temperature Limit (Turn−Off)	V_{GS} = 10 V (Note 5)	$T_{LIM(OFF)}$	150	180	200	
Thermal Hysteresis		$\Delta T_{LIM(ON)}$	–	10	–	
GATE INPUT CHARACTERISTICS (Note 5)						
Device ON Gate Input Current – Normal Operation	V_{GS} = 5 V, V_{DS} = 10 V, I_D = 1 A	I_{GON}	–	50	100	μA
	V_{GS} = 10 V, V_{DS} = 10 V, I_D = 1 A		200	318	500	
Device ON Gate Input Current – Thermal Limit	V_{GS} = 5 V, V_{DS} = 10 V, I_D = 0 A	I_{GTL}	–	633	900	
	V_{GS} = 10 V, V_{DS} = 10 V, I_D = 0 A		–	1470	2000	
Device ON Gate Input Current – Current Limit	V_{GS} = 5 V, V_{DS} = 10 V	I_{GCL}	–	245	600	
	V_{GS} = 10 V, V_{DS} = 10 V		–	1121	1500	

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.

5. Not tested in production.

TYPICAL PERFORMANCE CURVES

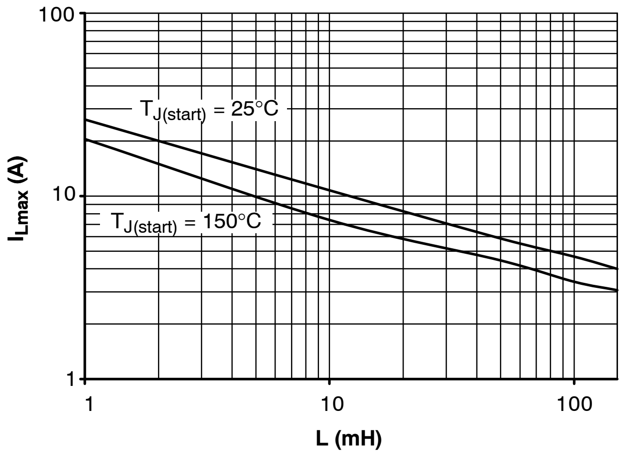


Figure 3. Single Pulse Maximum Switch-off Current vs. Load Inductance

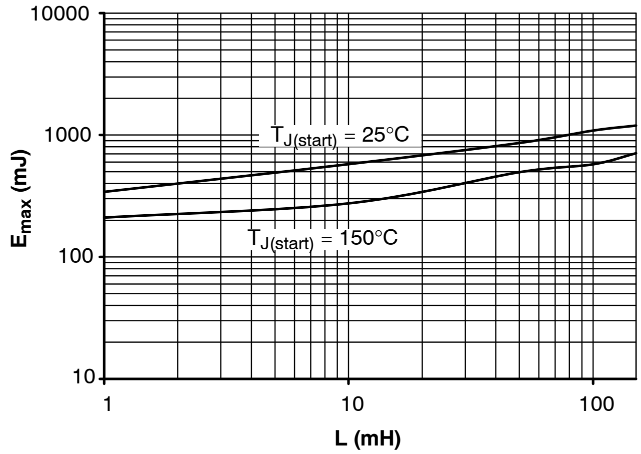


Figure 4. Single Pulse Maximum Switching Energy vs. Load Inductance

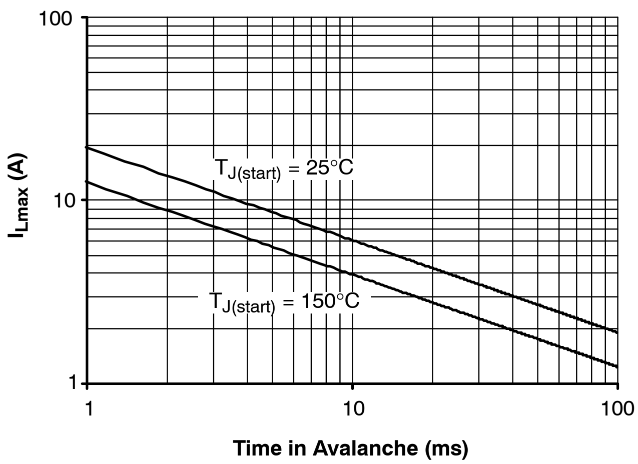


Figure 5. Single Pulse Maximum Inductive Switch-off Current vs. Time in Avalanche

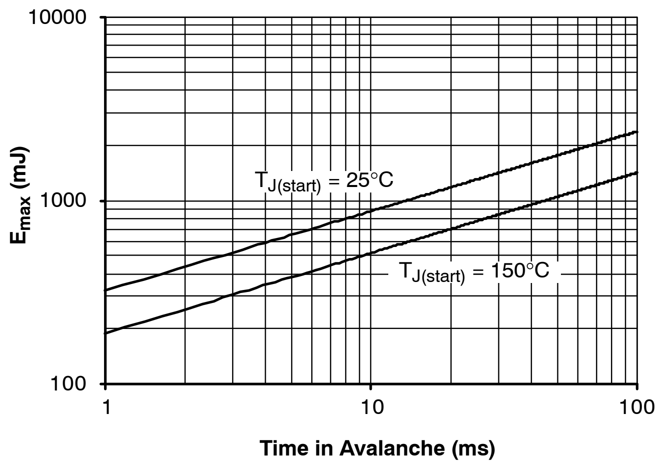


Figure 6. Single Pulse Maximum Inductive Switching Energy vs. Time in Avalanche

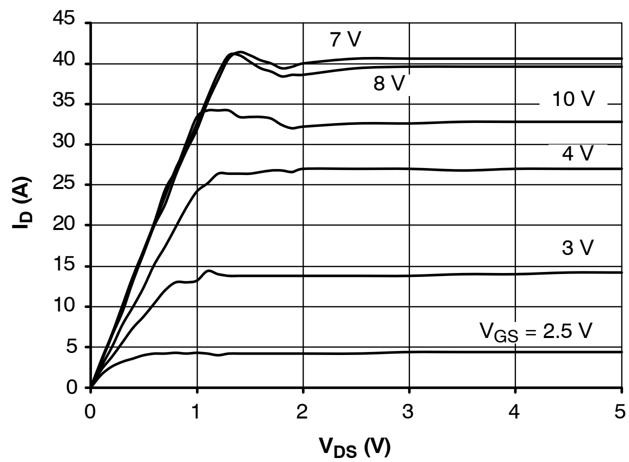


Figure 7. On-state Output Characteristics at 25°C

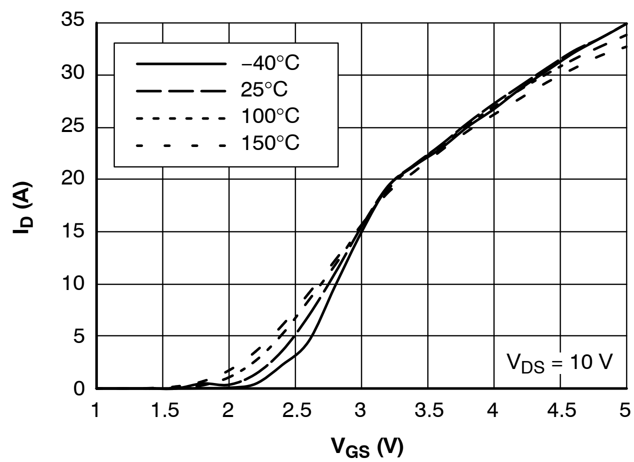


Figure 8. Transfer Characteristics

TYPICAL PERFORMANCE CURVES

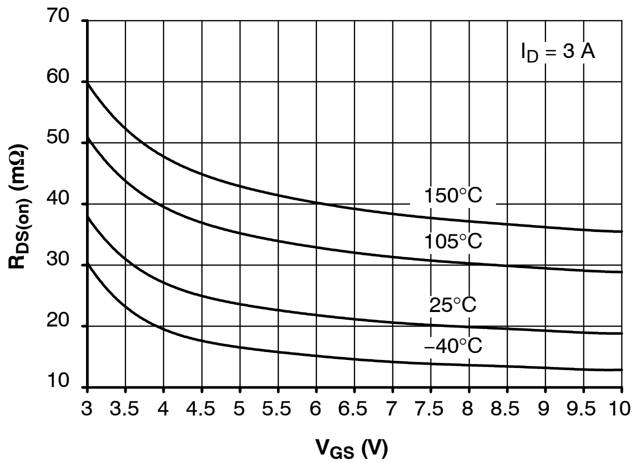


Figure 9. $R_{DS(on)}$ vs. Gate-Source Voltage

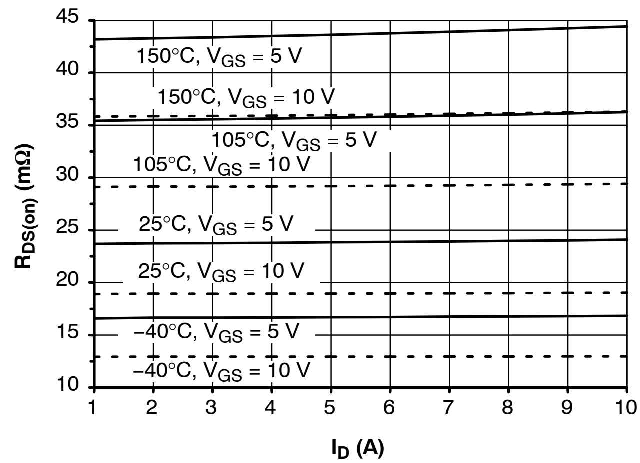


Figure 10. $R_{DS(on)}$ vs. Drain Current

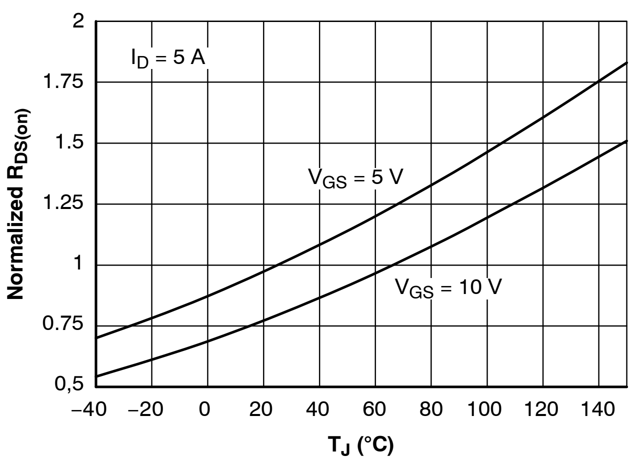


Figure 11. Normalized $R_{DS(on)}$ vs. Temperature

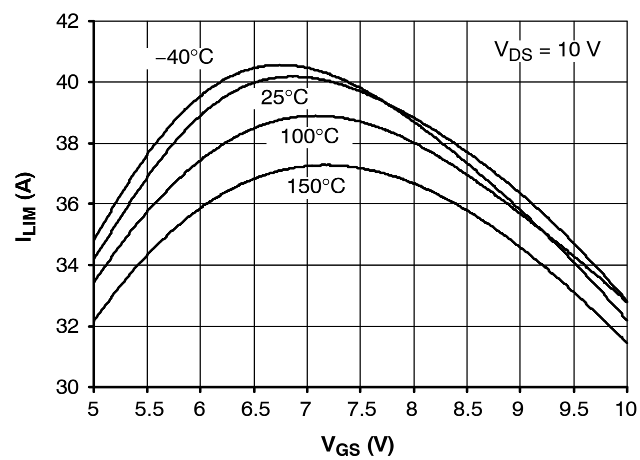


Figure 12. Current Limit vs. Gate-Source Voltage

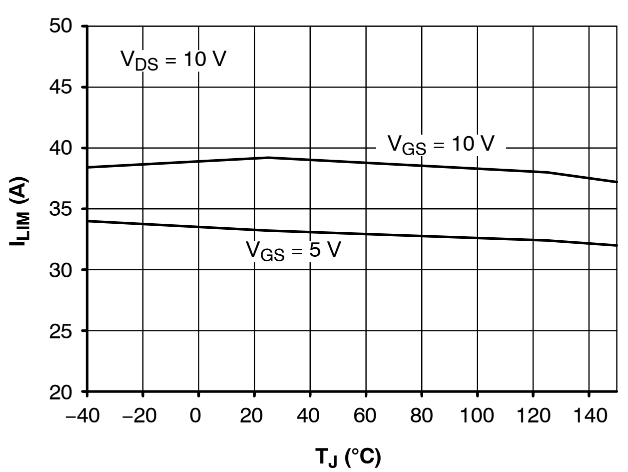


Figure 13. Current Limit vs. Junction Temperature

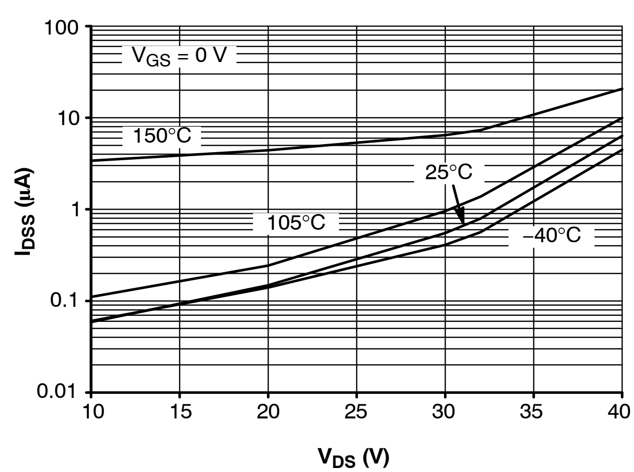


Figure 14. Drain-to-Source Leakage Current

TYPICAL PERFORMANCE CURVES

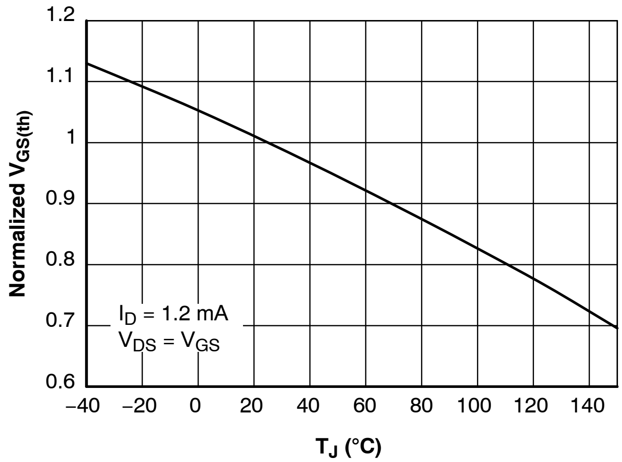


Figure 15. Normalized Threshold Voltage vs. Temperature

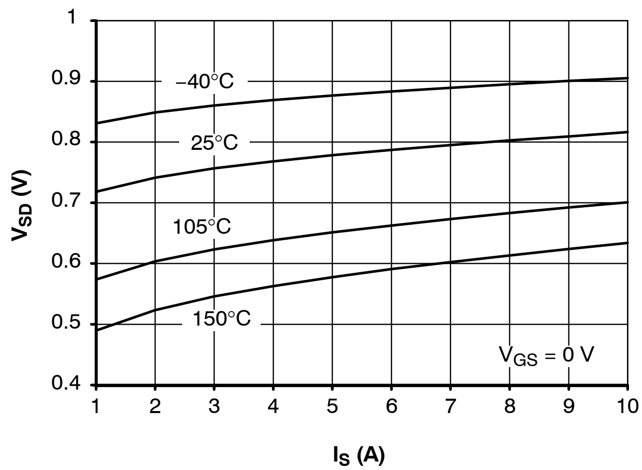


Figure 16. Source-Drain Diode Forward Characteristics

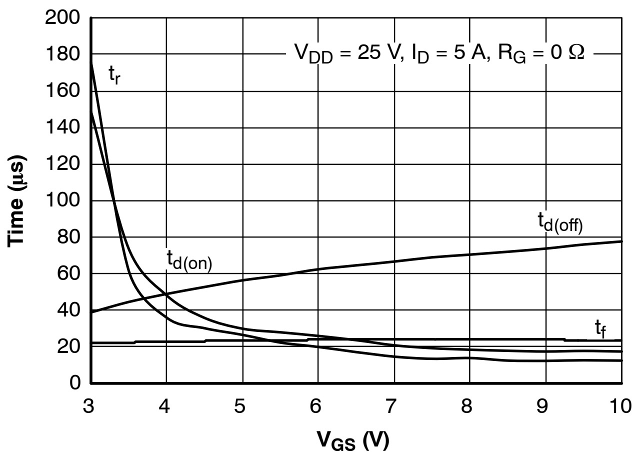


Figure 17. Resistive Load Switching Time vs. Gate-Source Voltage

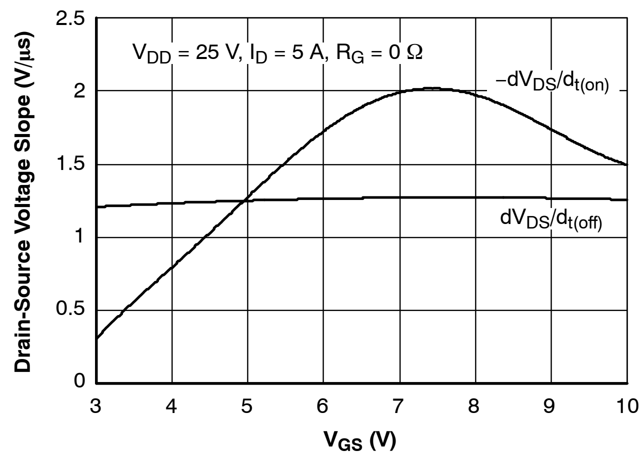


Figure 18. Resistive Load Switching Drain-Source Voltage Slope vs. Gate-Source Voltage

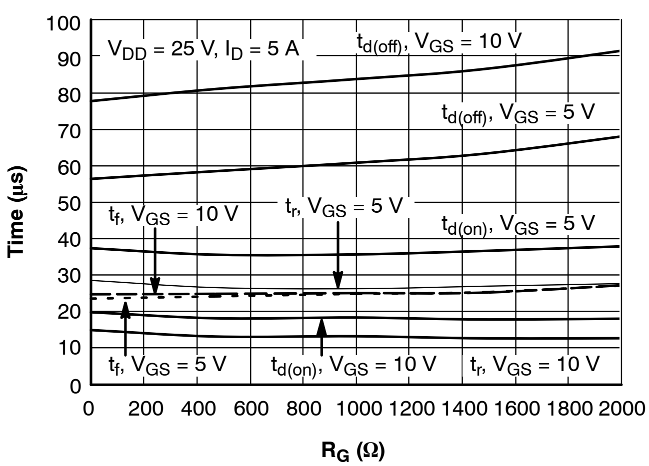


Figure 19. Resistive Load Switching Time vs. Gate Resistance

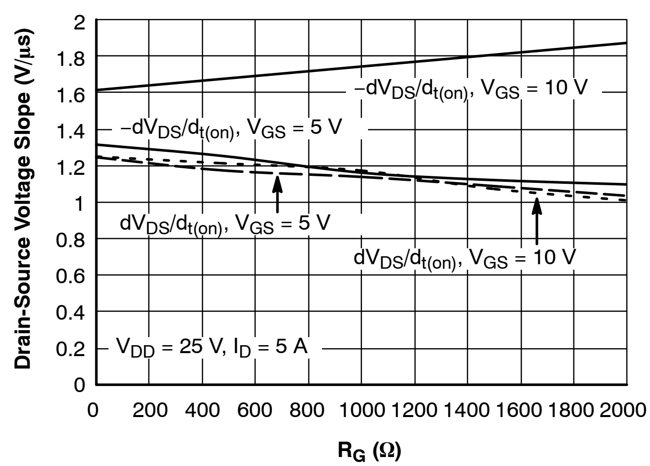


Figure 20. Drain-Source Voltage Slope during Turn On and Turn Off vs. Gate Resistance

TYPICAL PERFORMANCE CURVES

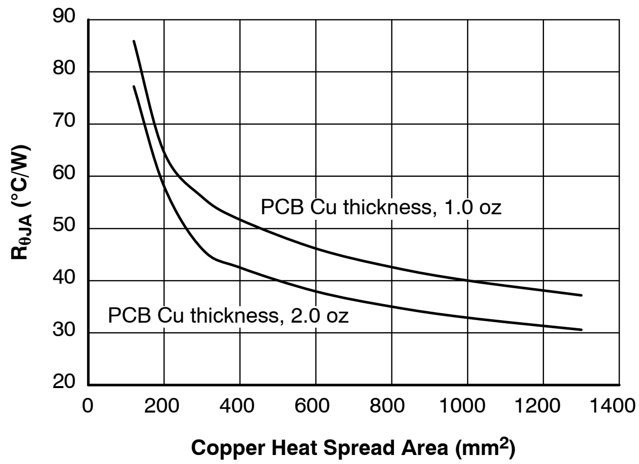


Figure 21. $R_{\theta JA}$ vs. Copper Area

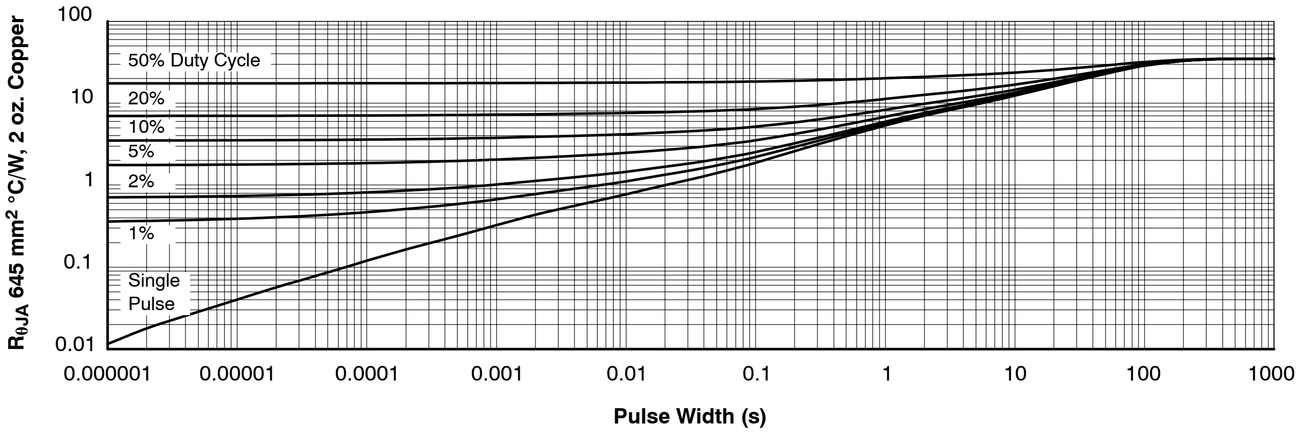


Figure 22. Transient Thermal Resistance

APPLICATION INFORMATION

Circuit Protection Features

The NCV8411 has three main protections. Current Limit, Thermal Shutdown and Delta Thermal Shutdown. These protections establish robustness of the NCV8411.

Current Limit and Short Circuit Protection

The NCV8411 has current sense element. In the event that the drain current reaches designed current limit level, integrated Current Limit protection establishes its constant level.

Delta Thermal Shutdown

Delta Thermal Shutdown (DTSD) Protection increases higher reliability of the NCV8411. DTSD consist of two independent temperature sensors – cold and hot sensors. The NCV8411 establishes a slow junction temperature rise by sensing the difference between the hot and cold sensors. ON/OFF output cycling is designed with hysteresis that results in a controlled saw tooth temperature profile (Figure 23). The die temperature slowly rises (DTSD) until the absolute temperature shutdown (TSD) is reached around 175°C.

Thermal Shutdown with Automatic Restart

Internal Thermal Shutdown (TSD) circuitry is provided to protect the NCV8411 in the event that the maximum junction temperature is exceeded. When activated at typically 175°C, the NCV8411 turns off. This feature is provided to prevent failures from accidental overheating.

TEST CIRCUITS AND WAVEFORMS

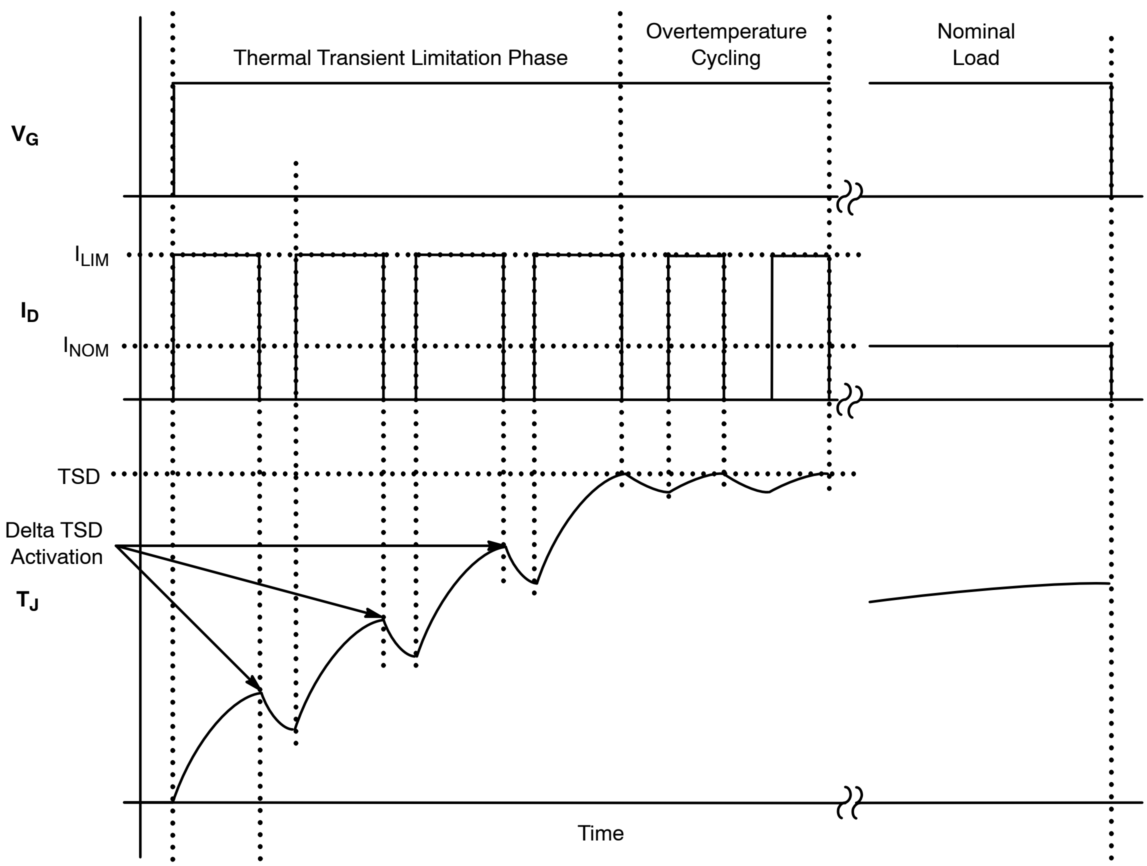


Figure 23. Overload Protection Behavior

TEST CIRCUITS AND WAVEFORMS

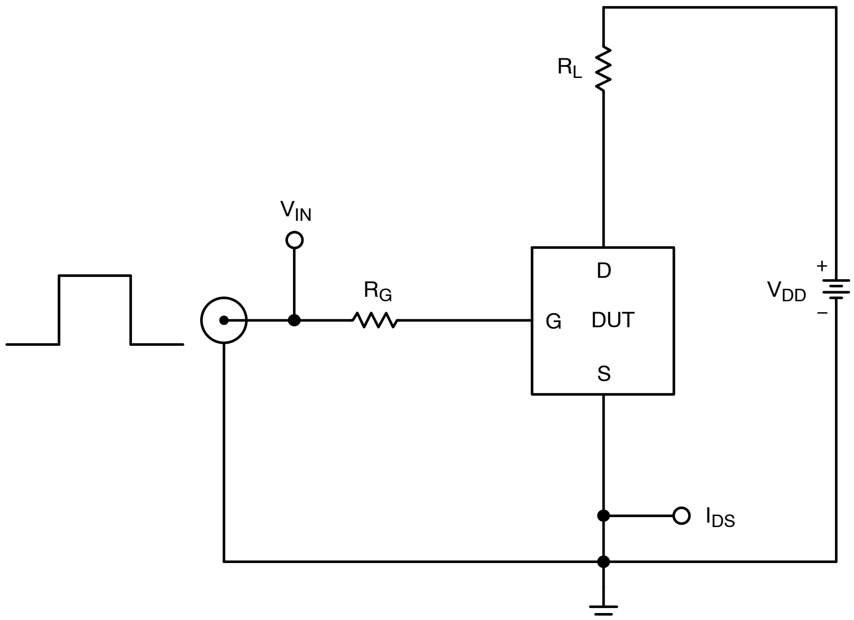


Figure 24. Resistive Load Switching Test Circuit

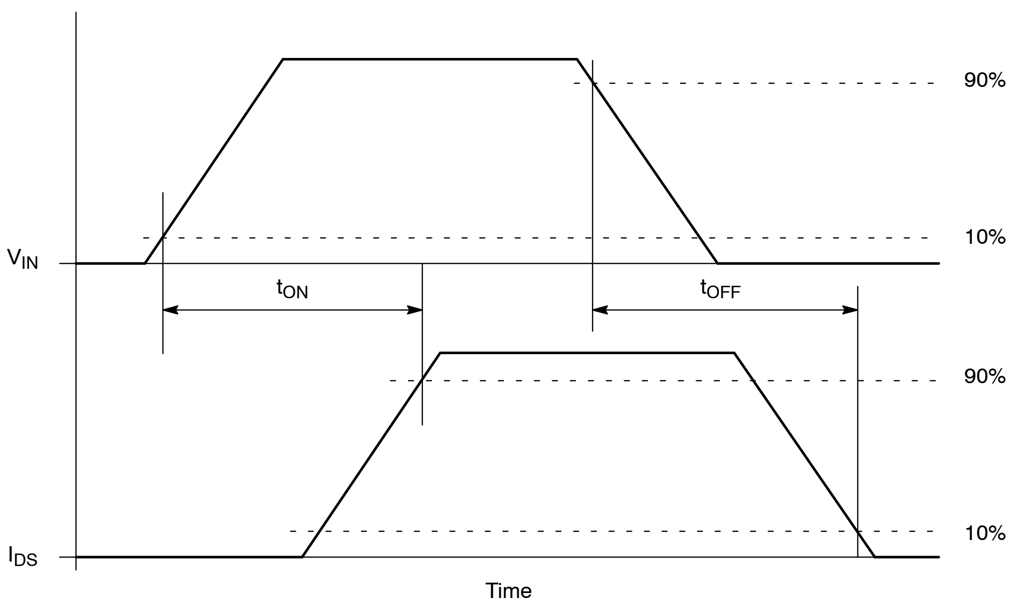


Figure 25. Resistive Load Switching Waveforms

TEST CIRCUITS AND WAVEFORMS

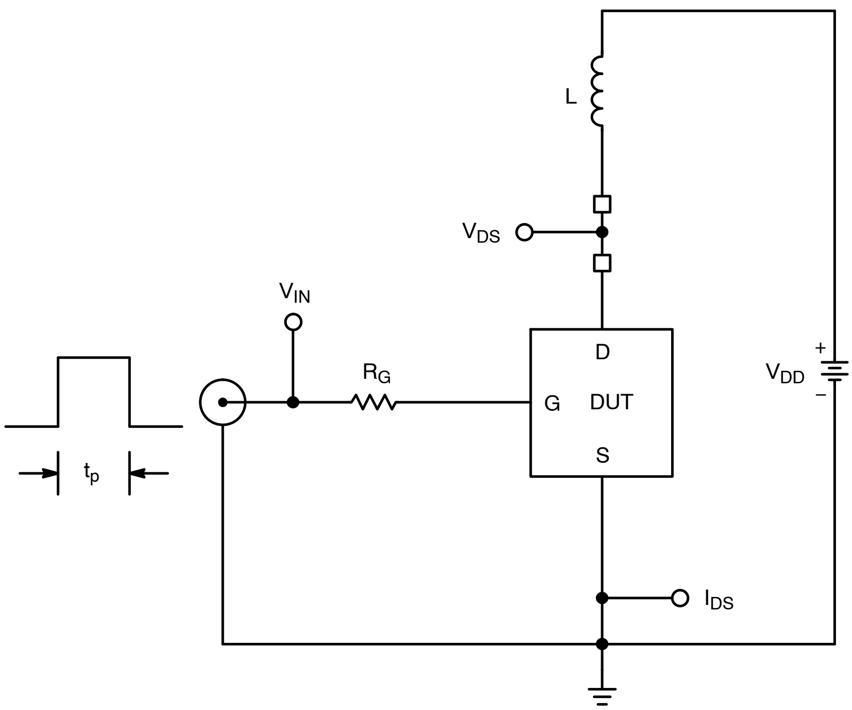


Figure 26. Inductive Load Switching Test Circuit

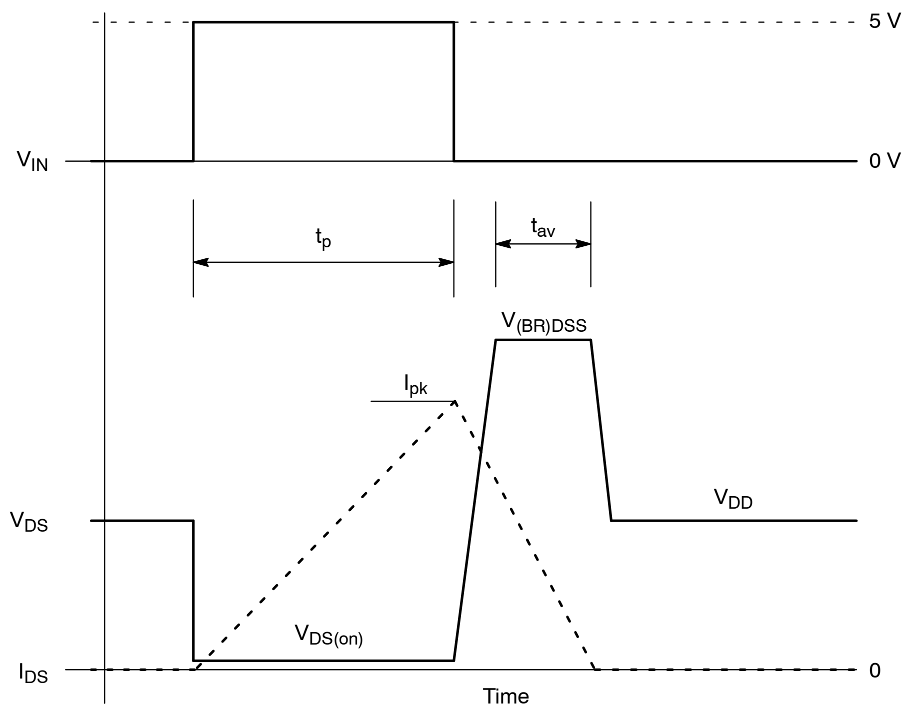
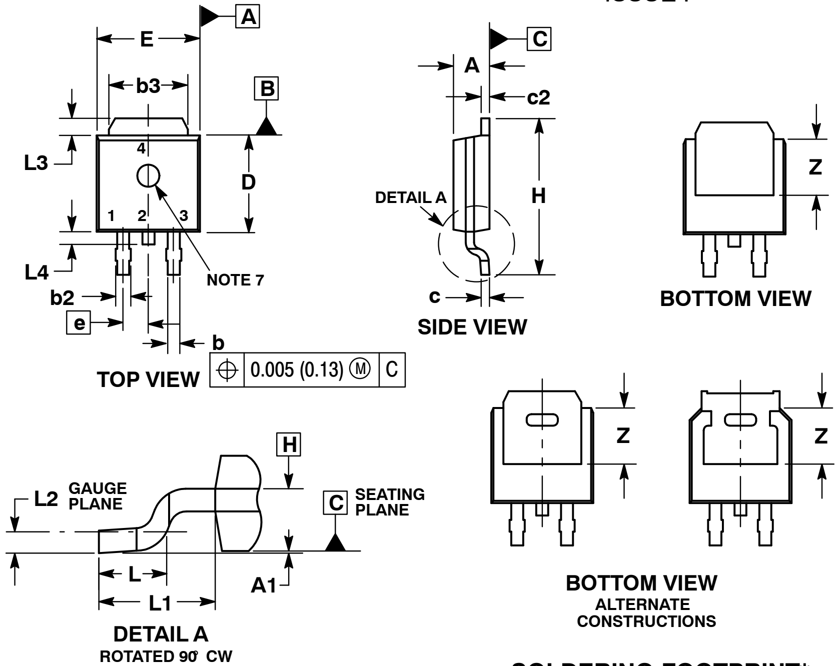


Figure 27. Inductive Load Switching Waveform

PACKAGE DIMENSIONS

DPAK
CASE 369C
ISSUE F

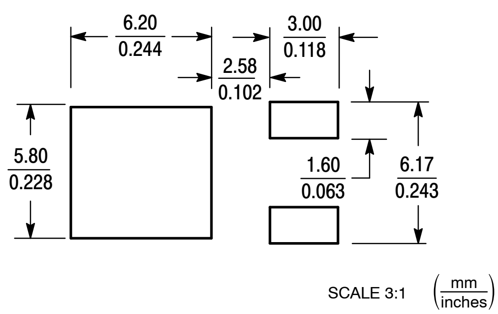


NOTES:
1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: INCHES.
3. THERMAL PAD CONTOUR OPTIONAL WITHIN DIMENSIONS b3, L3 and Z.
4. DIMENSIONS D AND E DO NOT INCLUDE MOLD FLASH, PROTRUSIONS, OR BURRS. MOLD FLASH, PROTRUSIONS, OR GATE BURRS SHALL NOT EXCEED 0.006 INCHES PER SIDE.
5. DIMENSIONS D AND E ARE DETERMINED AT THE OUTERMOST EXTREMES OF THE PLASTIC BODY.
6. DATUMS A AND B ARE DETERMINED AT DATUM PLANE H.
7. OPTIONAL MOLD FEATURE.

	INCHES		MILLIMETERS	
DIM	**MIN**	**MAX**	**MIN**	**MAX**
A	0.086	0.094	2.18	2.38
A1	0.000	0.005	0.00	0.13
b	0.025	0.035	0.63	0.89
b2	0.028	0.045	0.72	1.14
b3	0.180	0.215	4.57	5.46
c	0.018	0.024	0.46	0.61
c2	0.018	0.024	0.46	0.61
D	0.235	0.245	5.97	6.22
E	0.250	0.265	6.35	6.73
e	0.090 BSC		2.29 BSC	
H	0.370	0.410	9.40	10.41
L	0.055	0.070	1.40	1.78
L1	0.114 REF		2.90 REF	
L2	0.020 BSC		0.51 BSC	
L3	0.035	0.050	0.89	1.27
L4	---	0.040	---	1.01
Z	0.155	---	3.93	---

STYLE 2:
PIN 1. GATE
2. DRAIN
3. SOURCE
4. DRAIN

SOLDERING FOOTPRINT*



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

PUBLICATION ORDERING INFORMATION

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Fax: 303−675−2176 or 800−344−3867 Toll Free USA/Canada
Email: orderlit@onsemi.com

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