NCV8402D

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

NCV8402D 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
- Overvoltage Protection
- Integrated Clamp for Inductive Switching
- ESD Protection
- dV/dt Robustness
- Analog Drive Capability (Logic Level Input)
- AEC−Q101 Qualified
- NCV Prefix for Automotive and Other Applications Requiring Site and Change Control
- 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

$V_{(BR)DSS}$ (Clamped)	$R_{DS(ON)}$ TYP	I_D MAX
42 V	165 mΩ @ 10 V	2.0 A*

*Max current limit value is dependent on input condition.


MARKING DIAGRAM

SO−8
CASE 751
STYLE 11
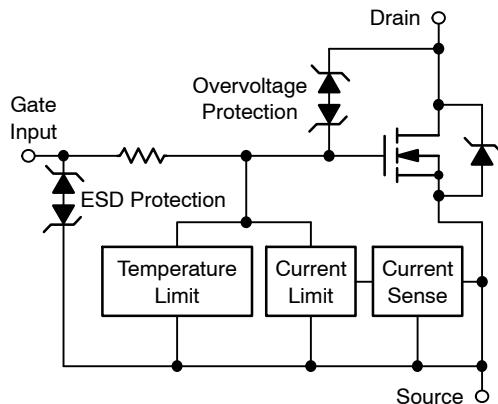
V8402D
ALYWX

V8402D = Specific Device Code
A = Assembly Location
L = Wafer Lot
Y = Year
W = Work Week
▪ = Pb−Free Package

PIN ASSIGNMENT

Source 1	Drain 1
Gate 1	Drain 1
Source 2	Drain 2
Gate 2	Drain 2
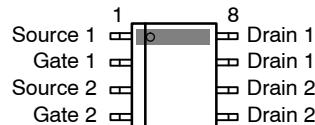
ORDERING INFORMATION

Device	Package	Shipping†
NCV8402DDR2G	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 Specification Brochure, BRD8011/D.

NCV8402D

MAXIMUM RATINGS (T_J = 25°C unless otherwise noted)

Rating		Symbol	Value	Unit
Drain−to−Source Voltage Internally Clamped		V_{DSS}	42	V
Drain−to−Gate Voltage Internally Clamped	(R_G = 1.0 MΩ)	V_{DGR}	42	V
Gate−to−Source Voltage		V_{GS}	± 14	V
Continuous Drain Current		I_D	Internally Limited	
Power Dissipation	@ T_A = 25°C (Note 1) @ T_A = 25°C (Note 2)	P_D	0.8 1.62	W
Thermal Resistance	Junction−to−Ambient Steady State (Note 1) Junction−to−Ambient Steady State (Note 2)	$R_{θJA}$ $R_{θJA}$	157 77	°C/W
Single Pulse Drain−to−Source Avalanche Energy (V_{DD} = 32 V, V_G = 5.0 V, I_{PK} = 1.0 A, L = 300 mH, $R_{G(ext)}$ = 25 Ω)		E_{AS}	150	mJ
Load Dump Voltage	(V_{GS} = 0 and 10 V, R_I = 2.0 Ω, R_L = 9.0 Ω, t_d = 400 ms)	V_{LD}	87	V
Operating Junction and Storage Temperature		T_J, T_{stg}	−55 to 150	°C

Stresses exceeding Maximum Ratings may damage the device. Maximum Ratings are stress ratings only. Functional operation above the Recommended Operating Conditions is not implied. Extended exposure to stresses above the Recommended Operating Conditions may affect device reliability.
1. Surface−mounted onto min pad FR4 PCB, (Cu area = 40 sq. mm, 1 oz.).
2. Surface−mounted onto 1″ sq. FR4 board (Cu area = 625 sq. mm, 2 oz.).
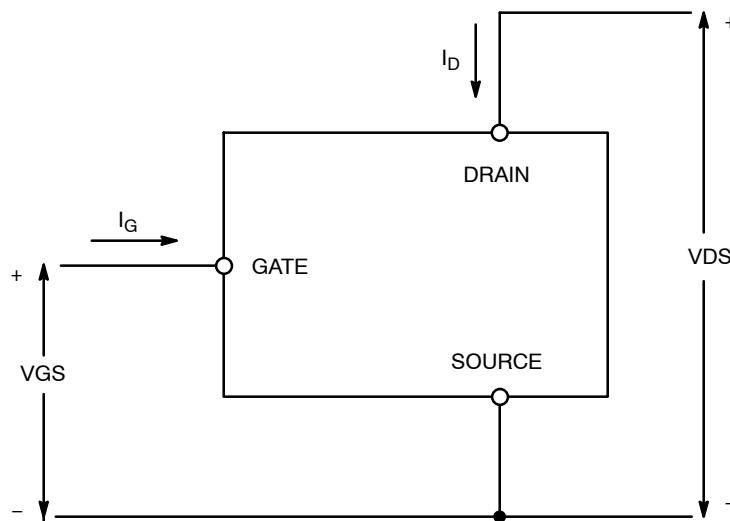
Figure 1. Voltage and Current Convention

NCV8402D

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

Parameter	Test Condition	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Drain–to–Source Breakdown Voltage (Note 3)	V_{GS} = 0 V, I_D = 10 mA, T_J = 25°C	$V_{(BR)DSS}$	42	46	55	V
	V_{GS} = 0 V, I_D = 10 mA, T_J = 150°C (Note 5)		40	45	55	
Zero Gate Voltage Drain Current	V_{GS} = 0 V, V_{DS} = 32 V, T_J = 25°C	I_{DSS}		0.25	4.0	μA
	V_{GS} = 0 V, V_{DS} = 32 V, T_J = 150°C (Note 5)			1.1	20	
Gate Input Current	V_{DS} = 0 V, V_{GS} = 5.0 V	I_{GSSF}		50	100	μA
ON CHARACTERISTICS (Note 3)						
Gate Threshold Voltage	V_{GS} = V_{DS}, I_D = 150 μA	$V_{GS(th)}$	1.3	1.8	2.2	V
Gate Threshold Temperature Coefficient		$V_{GS(th)}/T_J$		4.0	6.0	–mV/°C
Static Drain–to–Source On–Resistance	V_{GS} = 10 V, I_D = 1.7 A, T_J = 25°C	$R_{DS(on)}$		165	200	mΩ
	V_{GS} = 10 V, I_D = 1.7 A, T_J = 150°C (Note 5)			305	400	
	V_{GS} = 5.0 V, I_D = 1.7 A, T_J = 25°C			195	230	
	V_{GS} = 5.0 V, I_D = 1.7 A, T_J = 150°C (Note 5)			360	460	
	V_{GS} = 5.0 V, I_D = 0.5 A, T_J = 25°C			190	230	
	V_{GS} = 5.0 V, I_D = 0.5 A, T_J = 150°C (Note 5)			350	460	
Source–Drain Forward On Voltage	V_{GS} = 0 V, I_S = 7.0 A	V_{SD}		1.0		V
SWITCHING CHARACTERISTICS (Note 5)						
Turn–ON Time (10% V_{IN} to 90% I_D)	V_{GS} = 10 V, V_{DD} = 12 V I_D = 2.5 A, R_L = 4.7 Ω	t_{ON}		25		μs
Turn–OFF Time (90% V_{IN} to 10% I_D)		t_{OFF}		120		
Slew–Rate ON (70% V_{DS} to 50% V_{DS})	V_{GS} = 10 V, V_{DD} = 12 V, R_L = 4.7 Ω	$-dV_{DS}/dt_{ON}$		0.8		V/μs
Slew–Rate OFF (50% V_{DS} to 70% V_{DS})		dV_{DS}/dt_{OFF}		0.3		
SELF PROTECTION CHARACTERISTICS (T_J = 25°C unless otherwise noted) (Note 4)						
Current Limit	V_{DS} = 10 V, V_{GS} = 5.0 V, T_J = 25°C	I_{LIM}	3.7	4.3	5.0	A
	V_{DS} = 10 V, V_{GS} = 5.0 V, T_J = 150°C (Note 5)		2.3	3.0	3.7	
	V_{DS} = 10 V, V_{GS} = 10 V, T_J = 25°C		4.2	4.8	5.4	
	V_{DS} = 10 V, V_{GS} = 10 V, T_J = 150°C (Note 5)		2.7	3.6	4.5	
Temperature Limit (Turn–off)	V_{GS} = 5.0 V (Note 5)	$T_{LIM(off)}$	150	175	200	°C
Thermal Hysteresis	V_{GS} = 5.0 V	$\Delta T_{LIM(on)}$		15		
Temperature Limit (Turn–off)	V_{GS} = 10 V (Note 5)	$T_{LIM(off)}$	150	165	185	
Thermal Hysteresis	V_{GS} = 10 V	$\Delta T_{LIM(on)}$		15		
GATE INPUT CHARACTERISTICS (Note 5)						
Device ON Gate Input Current	V_{GS} = 5 V I_D = 1.0 A	I_{GON}		50		μA
	V_{GS} = 10 V I_D = 1.0 A			400		
Current Limit Gate Input Current	V_{GS} = 5 V, V_{DS} = 10 V	I_{GCL}		0.05		mA
	V_{GS} = 10 V, V_{DS} = 10 V			0.4		
Thermal Limit Fault Gate Input Current	V_{GS} = 5 V, V_{DS} = 10 V	I_{GTL}		0.15		mA
	V_{GS} = 10 V, V_{DS} = 10 V			0.7		
ESD ELECTRICAL CHARACTERISTICS (T_J = 25°C unless otherwise noted) (Note 5)						
Electro–Static Discharge Capability	Human Body Model (HBM)	ESD	4000			V
	Machine Model (MM)		400			

3. Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2%.
4. Fault conditions are viewed as beyond the normal operating range of the part.
5. Not subject to production testing.

TYPICAL PERFORMANCE CURVES
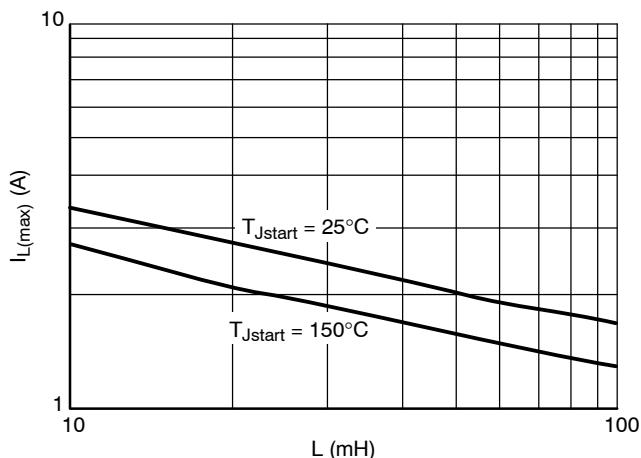
**Figure 2. Single Pulse Maximum Switch−off
Current vs. Load Inductance**
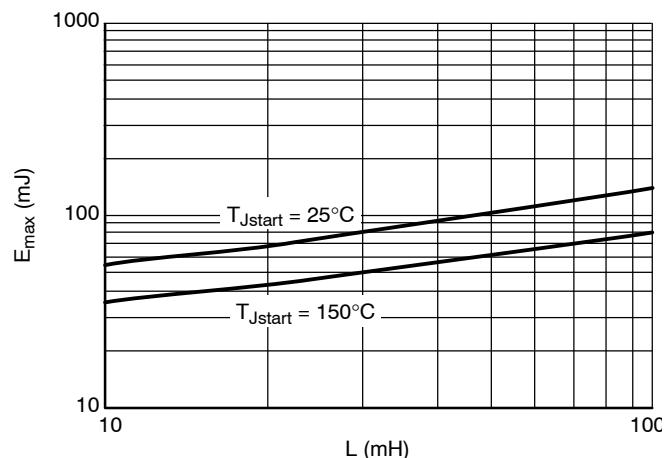
**Figure 3. Single Pulse Maximum Switching
Energy vs. Load Inductance**
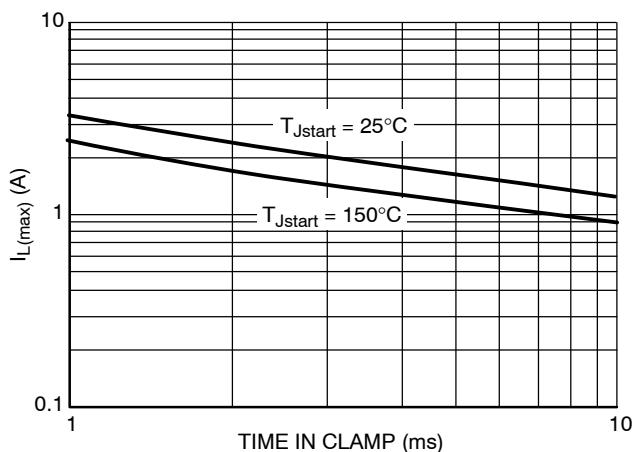
**Figure 4. Single Pulse Maximum Inductive
Switch−off Current vs. Time in Clamp**
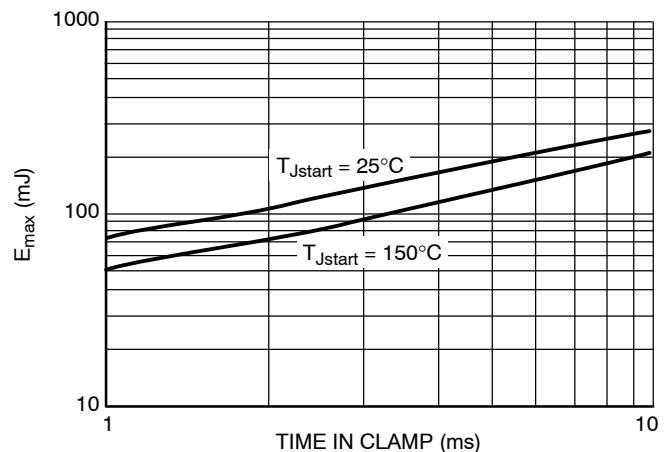
**Figure 5. Single Pulse Maximum Inductive
Switching Energy vs. Time in Clamp**
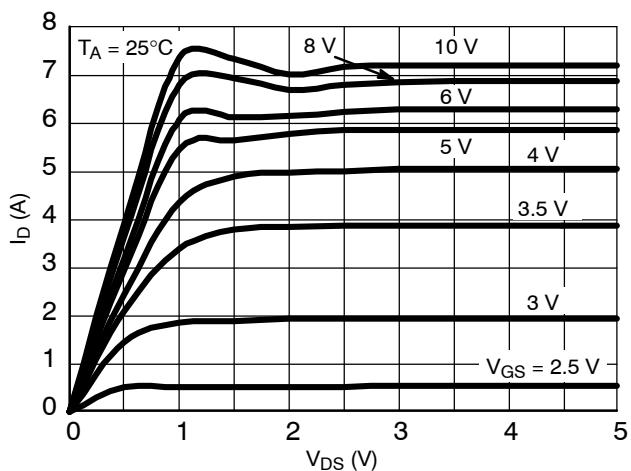
**Figure 6. On−state Output Characteristics**
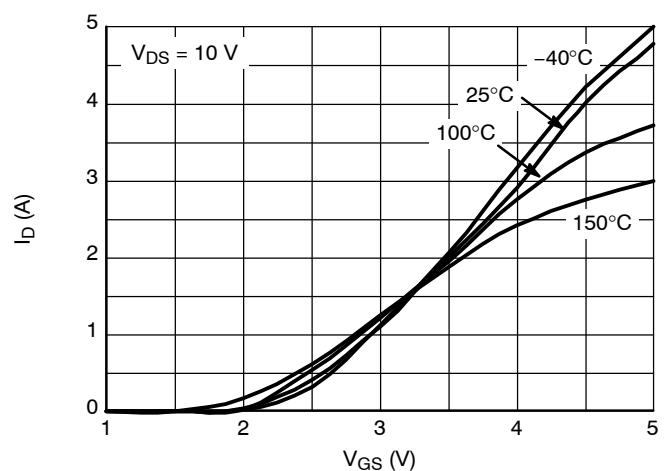

Figure 7. Transfer Characteristics

TYPICAL PERFORMANCE CURVES
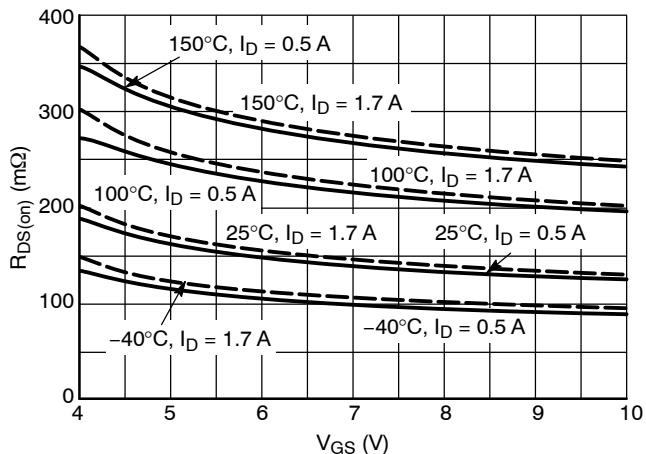
Figure 8. R$_{DS(on)}$ vs. Gate−Source Voltage
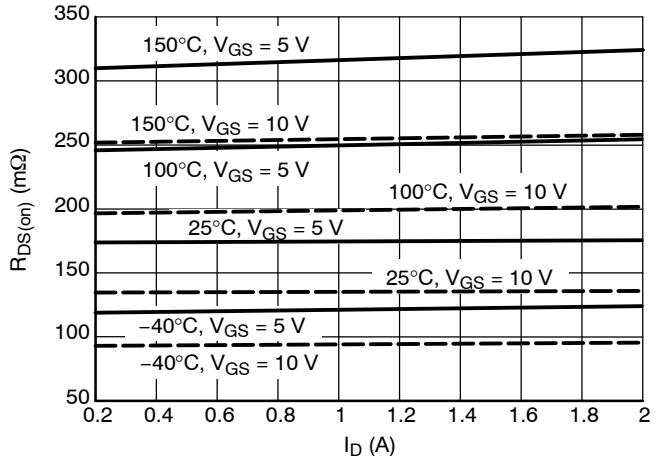
Figure 9. R$_{DS(on)}$ vs. Drain Current
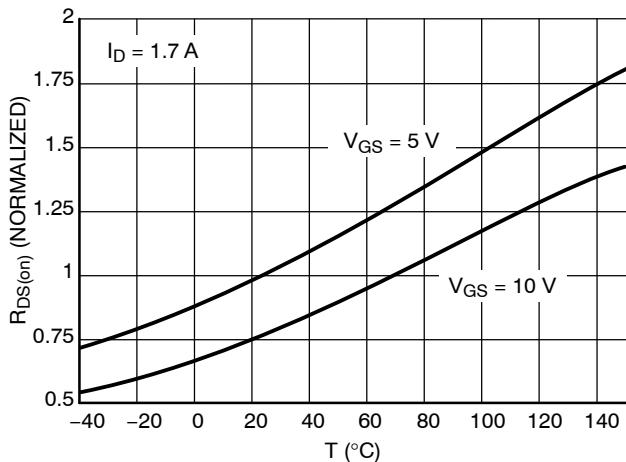
Figure 10. Normalized R$_{DS(on)}$ vs. Temperature
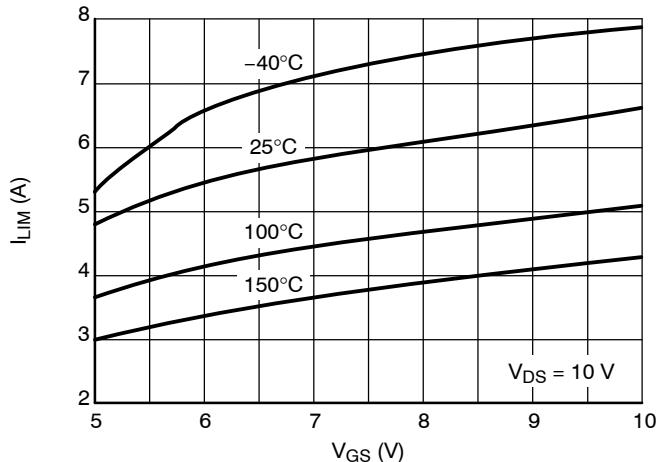
Figure 11. Current Limit vs. Gate−Source Voltage
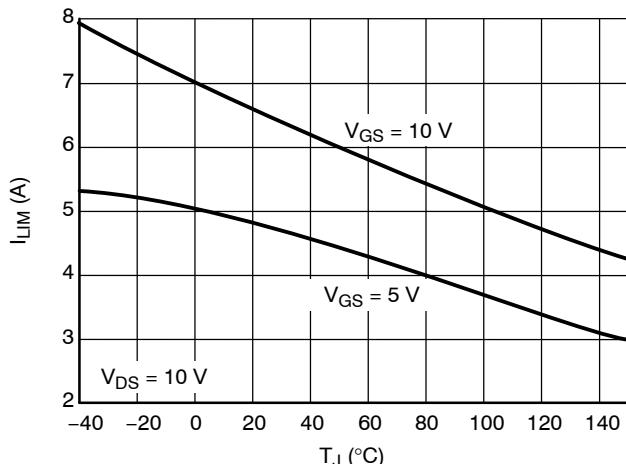
Figure 12. Current Limit vs. Junction Temperature
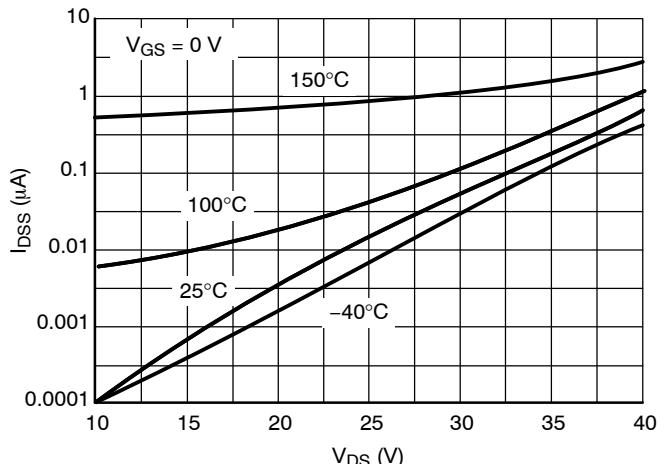
Figure 13. Drain−to−Source Leakage Current

TYPICAL PERFORMANCE CURVES
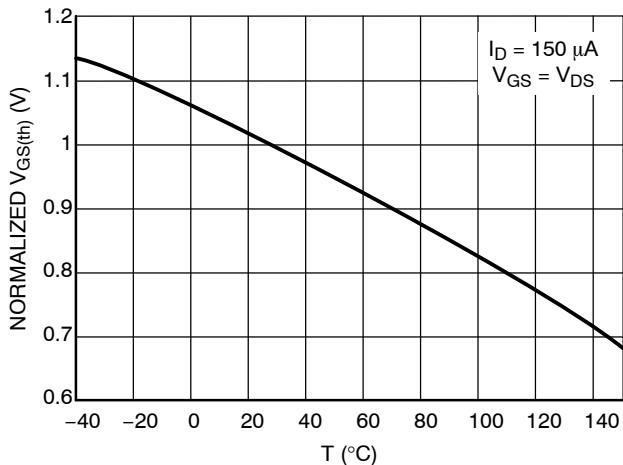
**Figure 14. Normalized Threshold Voltage vs. Temperature**
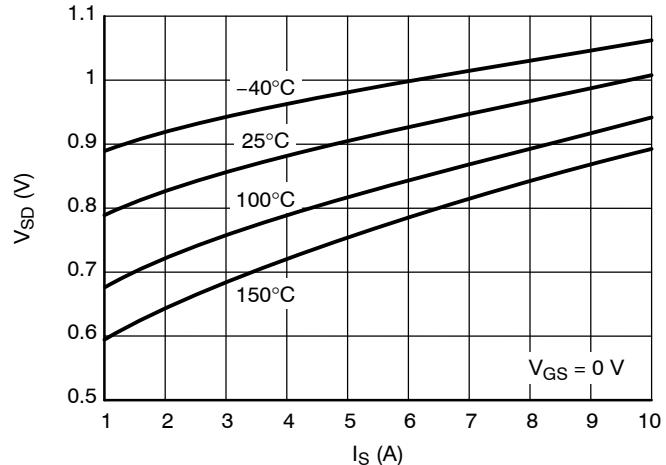
Figure 15. Source−Drain Diode Forward Characteristics
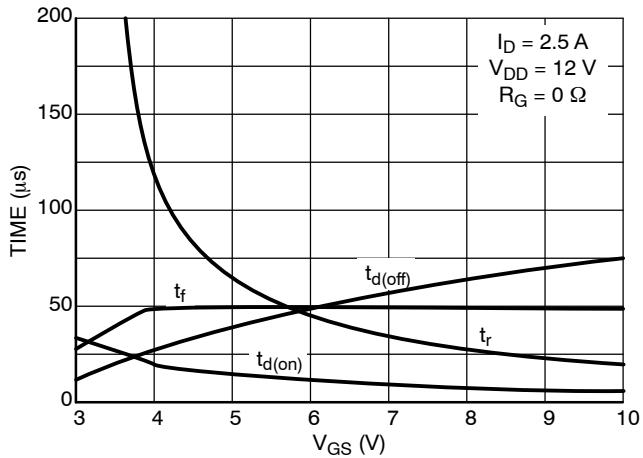
Figure 16. Resistive Load Switching Time vs. Gate−Source Voltage
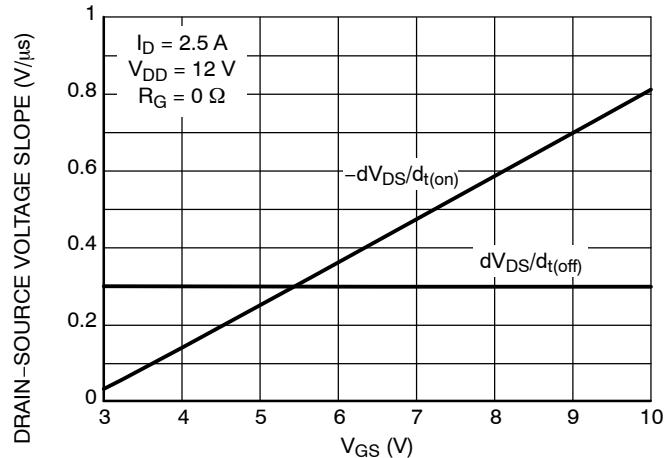
**Figure 17. Resistive Load Switching Drain−Source Voltage Slope vs. Gate−Source Voltage**
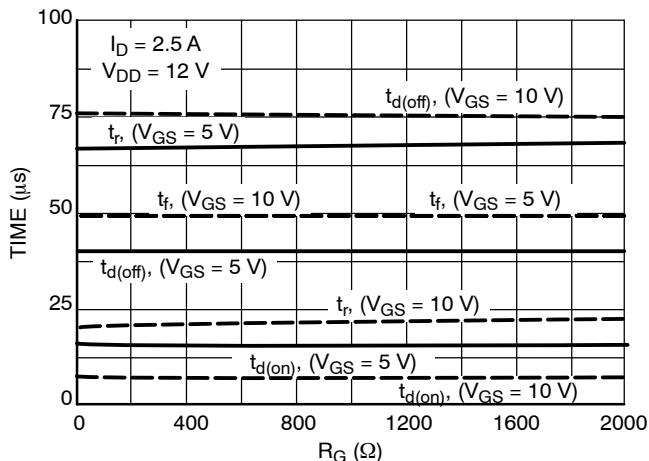
**Figure 18. Resistive Load Switching Time vs. Gate Resistance**
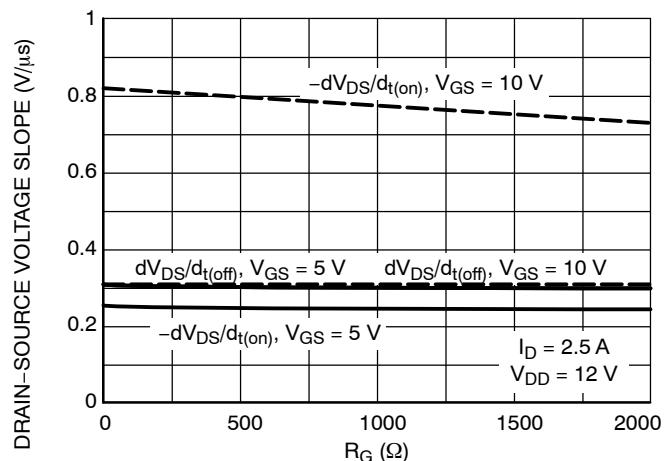
Figure 19. Drain−Source Voltage Slope during Turn On and Turn Off vs. Gate Resistance

TYPICAL PERFORMANCE CURVES
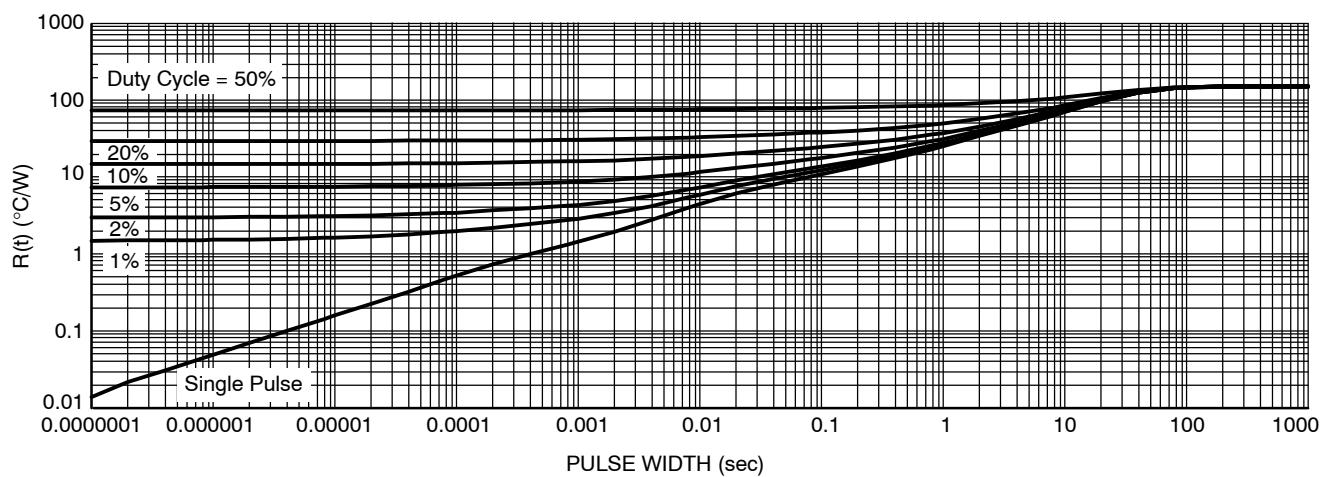
Figure 20. Transient Thermal Resistance

# NCV8402D

TEST CIRCUITS AND WAVEFORMS
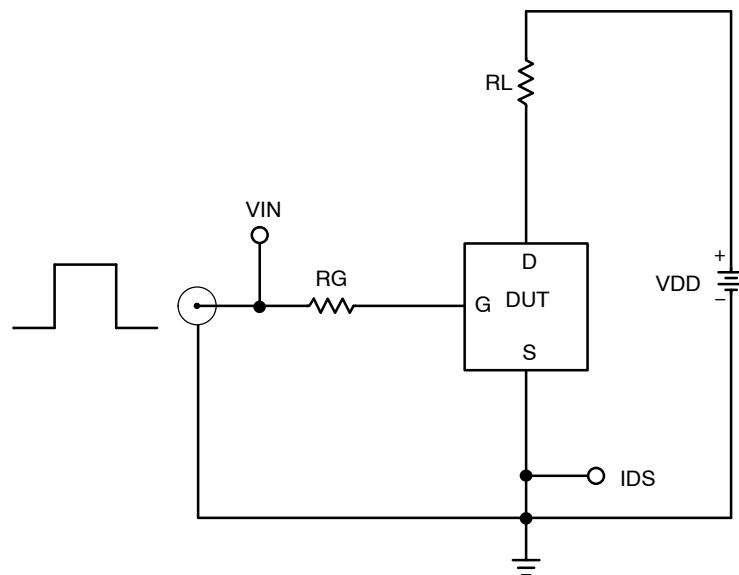

Figure 21. Resistive Load Switching Test Circuit
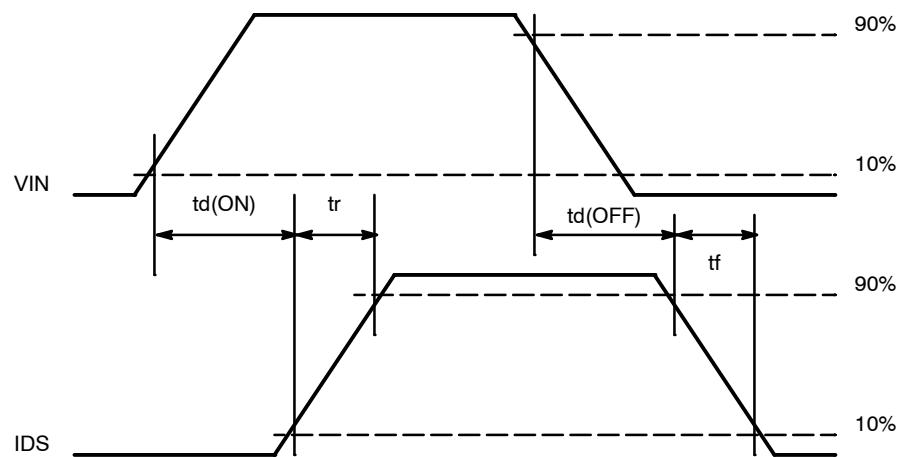
Figure 22. Resistive Load Switching Waveforms

TEST CIRCUITS AND WAVEFORMS
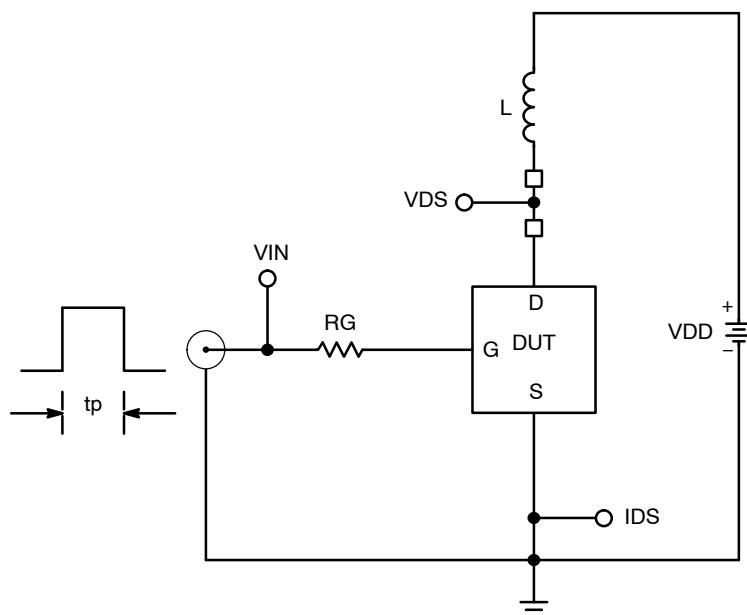
**Figure 23. Inductive Load Switching Test Circuit**
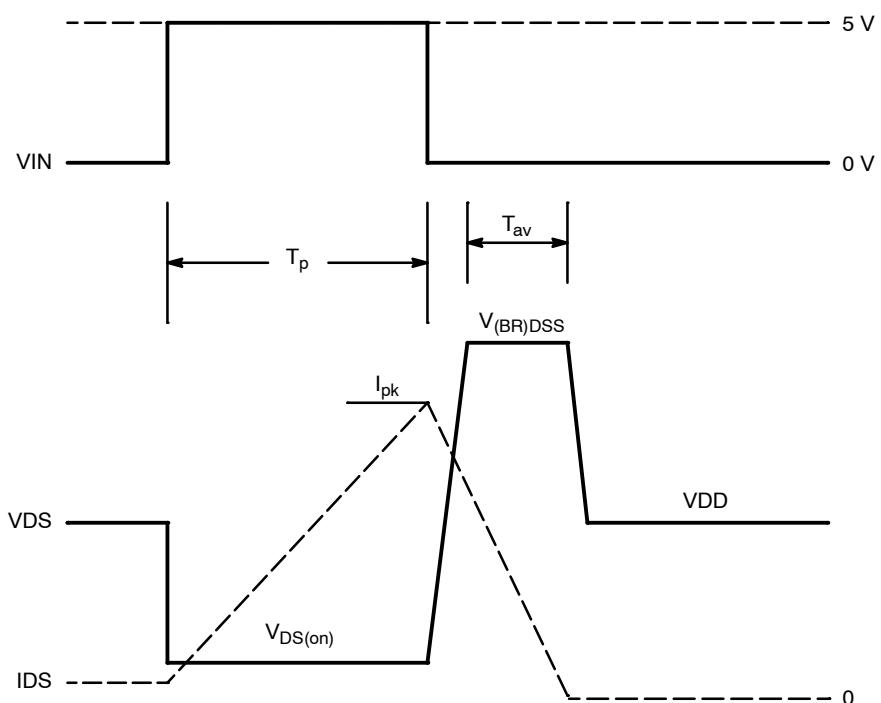
Figure 24. Inductive Load Switching Waveforms

PACKAGE DIMENSIONS

SOIC−8
CASE 751−07
ISSUE AJ
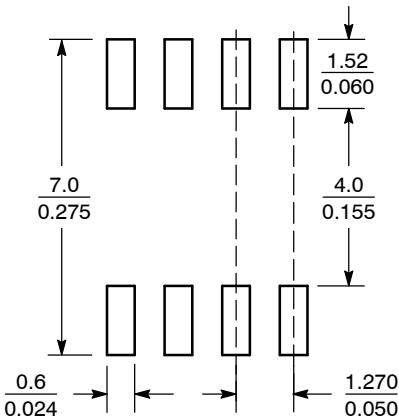
NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER.
3. DIMENSION A AND B DO NOT INCLUDE MOLD PROTRUSION.
4. MAXIMUM MOLD PROTRUSION 0.15 (0.006) PER SIDE.
5. DIMENSION D DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.127 (0.005) 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

STYLE 11:
PIN 1. SOURCE 1
2. GATE 1
3. SOURCE 2
4. GATE 2
5. DRAIN 2
6. DRAIN 2
7. DRAIN 1
8. DRAIN 1

SOLDERING FOOTPRINT*

SCALE 6:1 $\left(\frac{mm}{inches}\right)$

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