

NCV8403, NCV8403A

Self-Protected Low Side Driver with Temperature and Current Limit

42 V, 14 A, Single N-Channel, SOT-223

NCV8403/A is a three terminal 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)
- NCV Prefix for Automotive and Other Applications Requiring Unique Site and Control Change Requirements; AEC-Q100 Qualified and PPAP Capable
- These Devices are Pb-Free, Halogen Free/BFR Free and are RoHS Compliant

Typical Applications

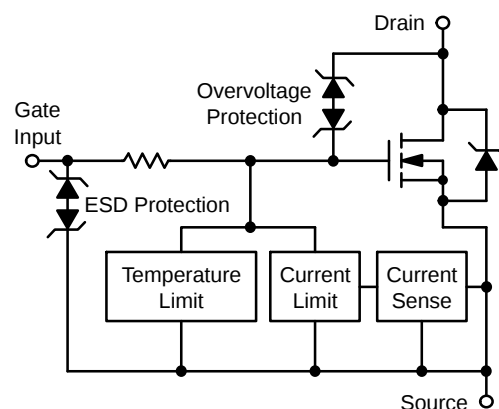
- Switch a Variety of Resistive, Inductive and Capacitive Loads
- Can Replace Electromechanical Relays and Discrete Circuits
- Automotive / Industrial



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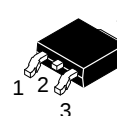
V_{DS} (Clamped)	$R_{DS(on)}$ TYP	I_D MAX (Limited)
42 V	53 mΩ @ 10 V	15 A



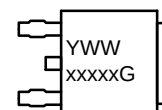
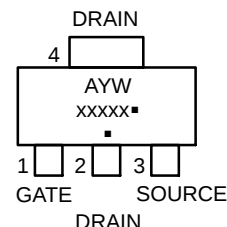
MARKING DIAGRAM



SOT-223
CASE 318E
STYLE 3



DPAK
CASE 369C



A = Assembly Location
Y = Year
W, WW = Work Week
xxxxx = V8403 or 8403A
G or ■ = Pb-Free Package

(Note: Microdot may be in either location)

ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 10 of this data sheet.

NCV8403, NCV8403A

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

Rating	Symbol	Value	Unit
Drain-to-Source Voltage Internally Clamped	V_{DSS}	42	Vdc
Gate-to-Source Voltage	V_{GS}	± 14	Vdc
Drain Current Continuous	I_D	Internally Limited	
Total Power Dissipation – SOT-223 Version @ $T_A = 25^\circ\text{C}$ (Note 1) @ $T_A = 25^\circ\text{C}$ (Note 2)	P_D	1.13 1.56	W
Total Power Dissipation – DPAK Version @ $T_A = 25^\circ\text{C}$ (Note 1) @ $T_A = 25^\circ\text{C}$ (Note 2)		1.32 2.5	
Thermal Resistance – SOT-223 Version Junction-to-Soldering Point Junction-to-Ambient (Note 1) Junction-to-Ambient (Note 2)	$R_{\theta JS}$ $R_{\theta JA}$ $R_{\theta JA}$	12 110 80	$^\circ\text{C/W}$
Thermal Resistance – DPAK Version Junction-to-Soldering Point Junction-to-Ambient (Note 1) Junction-to-Ambient (Note 2)	$R_{\theta JS}$ $R_{\theta JA}$ $R_{\theta JA}$	2.5 95 50	
Single Pulse Inductive Load Switching Energy ($V_{DD} = 25\text{ Vdc}$, $V_{GS} = 5.0\text{ V}$, $I_L = 2.8\text{ A}$, $L = 120\text{ mH}$, $R_G = 25\ \Omega$)	E_{AS}	470	mJ
Load Dump Voltage ($V_{GS} = 0$ and 10 V , $R_I = 2.0\ \Omega$, $R_L = 4.5\ \Omega$, $t_d = 400\text{ ms}$)	V_{LD}	55	V
Operating Junction Temperature	T_J	-40 to 150	$^\circ\text{C}$
Storage Temperature	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.

1. Surface mounted onto minimum pad size (0.412" square) FR4 PCB, 1 oz cu.
2. Mounted onto 1" square pad size (1.127" square) FR4 PCB, 1 oz cu.

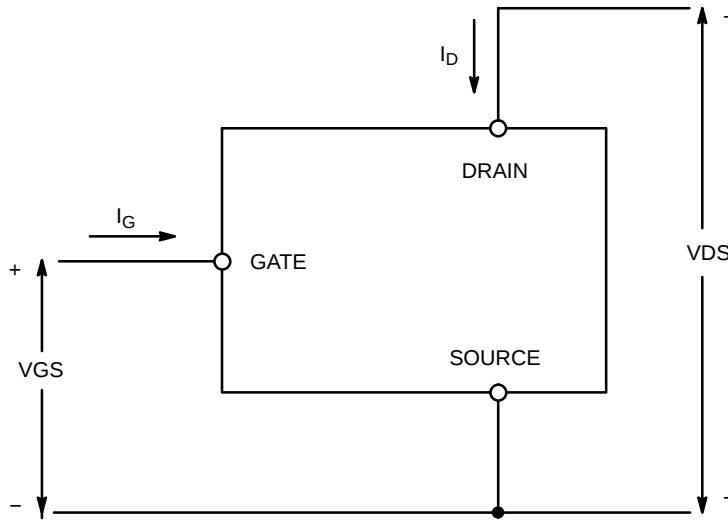


Figure 1. Voltage and Current Convention

NCV8403, NCV8403A

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

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Drain-to-Source Clamped Breakdown Voltage (V _{GS} = 0 Vdc, I _D = 250 μAdc) (V _{GS} = 0 Vdc, I _D = 250 μAdc, T _J = -40°C to 150°C) (Note 3)	V _{(BR)DSS}	42 40	46 45	51 51	Vdc Vdc
Zero Gate Voltage Drain Current (V _{DS} = 32 Vdc, V _{GS} = 0 Vdc) (V _{DS} = 32 Vdc, V _{GS} = 0 Vdc, T _J = 150°C) (Note 3)	I _{DSS}	- -	0.6 2.5	5.0 -	μAdc
Gate Input Current (V _{GS} = 5.0 Vdc, V _{DS} = 0 Vdc)	I _{GSS}	-	50	125	μAdc

ON CHARACTERISTICS

Gate Threshold Voltage (V _{DS} = V _{GS} , I _D = 1.2 mAdc) Threshold Temperature Coefficient (Negative)	V _{GS(th)}	1.0 -	1.7 5.0	2.2 -	Vdc mV/°C
Static Drain-to-Source On-Resistance (Note 4) (V _{GS} = 10 Vdc, I _D = 3.0 Adc, T _J @ 25°C) (V _{GS} = 10 Vdc, I _D = 3.0 Adc, T _J @ 150°C) (Note 3)	R _{DS(on)}	- -	53 95	68 123	mΩ
Static Drain-to-Source On-Resistance (Note 4) (V _{GS} = 5.0 Vdc, I _D = 3.0 Adc, T _J @ 25°C) (V _{GS} = 5.0 Vdc, I _D = 3.0 Adc, T _J @ 150°C) (Note 3)	R _{DS(on)}	- -	63 105	76 135	mΩ
Source-Drain Forward On Voltage (I _S = 7.0 A, V _{GS} = 0 V)	V _{SD}	-	0.95	1.1	V

SWITCHING CHARACTERISTICS (Note 3)

Turn-ON Time (10% V _{IN} to 90% I _D)	V _{IN} = 0 V to 5 V, V _{DD} = 25 V I _D = 1.0 A, Ext R _G = 2.5 Ω	t _{ON}	44		μs
Turn-OFF Time (90% V _{IN} to 10% I _D)		t _{OFF}	84		
Turn-ON Time (10% V _{IN} to 90% I _D)	V _{IN} = 0 V to 10 V, V _{DD} = 25 V, I _D = 1.0 A, Ext R _G = 2.5 Ω	t _{ON}	15		μs
Turn-OFF Time (90% V _{IN} to 10% I _D)		t _{OFF}	116		
Slew-Rate ON (20% V _{DS} to 50% V _{DS})	V _{in} = 0 to 10 V, V _{DD} = 12 V, R _L = 4.7 Ω	-dV _{DS} /dt _{ON}	2.43		V/μs
Slew-Rate OFF (80% V _{DS} to 50% V _{DS})		dV _{DS} /dt _{OFF}	0.83		

SELF PROTECTION CHARACTERISTICS (T_J = 25°C unless otherwise noted) (Note 5)

Current Limit	V _{GS} = 5.0 V, V _{DS} = 10 V V _{GS} = 5.0 V, T _J = 150°C (Note 3)	I _{LIM}	10 5.0	15 10	20 15	Adc
Current Limit	V _{GS} = 10 V, V _{DS} = 10 V V _{GS} = 10 V, T _J = 150°C (Note 3)	I _{LIM}	12 8.0	17 13	22 18	Adc
Temperature Limit (Turn-off)	V _{GS} = 5.0 Vdc (Note 3)	T _{LIM(off)}	150	175	200	°C
Thermal Hysteresis	V _{GS} = 5.0 Vdc	ΔT _{LIM(on)}	-	15	-	°C
Temperature Limit (Turn-off)	V _{GS} = 10 Vdc (Note 3)	T _{LIM(off)}	150	165	185	°C
Thermal Hysteresis	V _{GS} = 10 Vdc	ΔT _{LIM(on)}	-	15	-	°C

GATE INPUT CHARACTERISTICS (Note 3)

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}	0.1		mA
	V _{GS} = 10 V, V _{DS} = 10 V		0.6		
Thermal Limit Fault Gate Input Current	V _{GS} = 5 V, V _{DS} = 10 V	I _{GTL}	0.45		mA
	V _{GS} = 10 V, V _{DS} = 10 V		1.5		

ESD ELECTRICAL CHARACTERISTICS (T_J = 25°C unless otherwise noted) (Note 3)

Electro-Static Discharge Capability	Human Body Model (HBM)	ESD	4000	-	-	V
Electro-Static Discharge Capability	Machine Model (MM)	ESD	400	-	-	V

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

TYPICAL PERFORMANCE CURVES

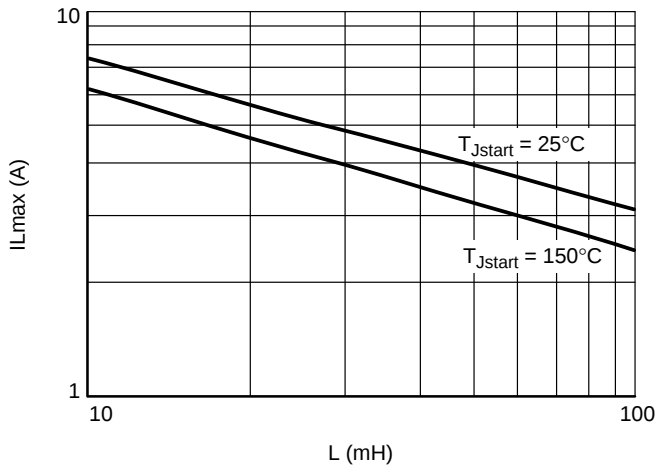


Figure 2. Single Pulse Maximum Switch-off Current vs. Load Inductance

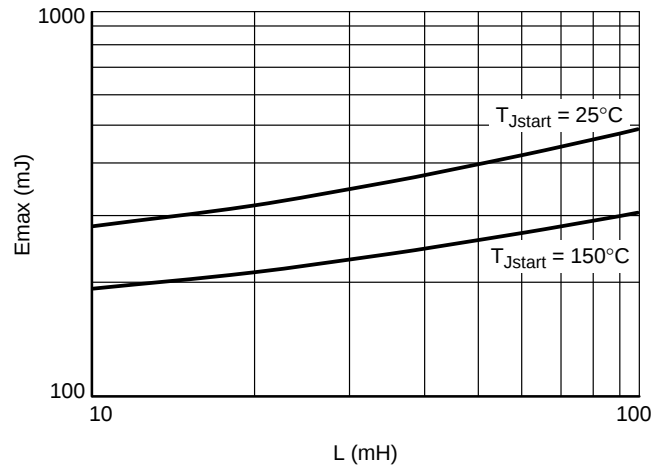


Figure 3. Single-Pulse Maximum Switching Energy vs. Load Inductance

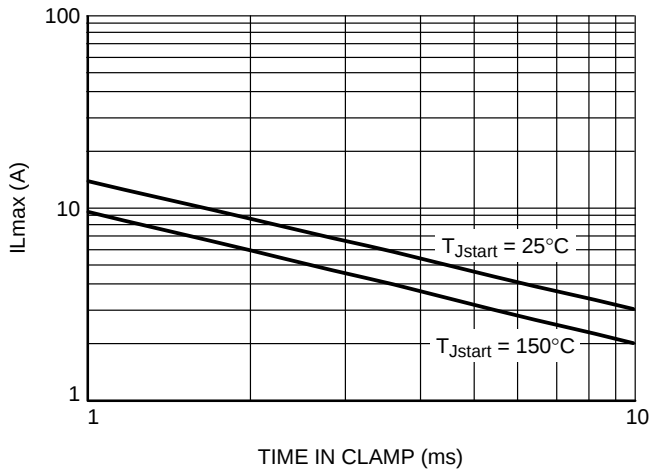


Figure 4. Single Pulse Maximum Inductive Switch-off Current vs. Time in Clamp

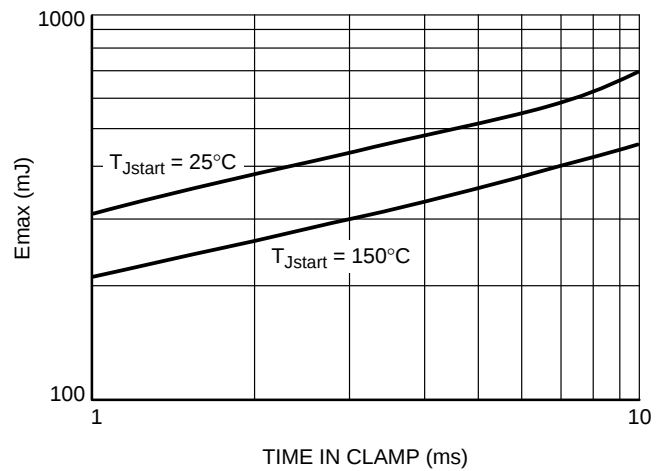


Figure 5. Single-Pulse Maximum Inductive Switching Energy vs. Time in Clamp

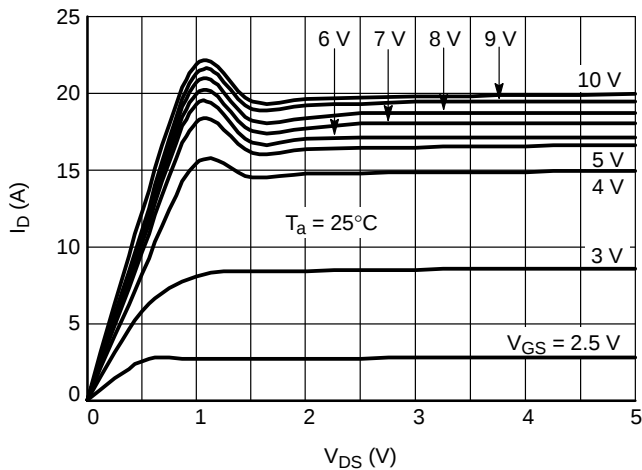


Figure 6. On-state Output Characteristics

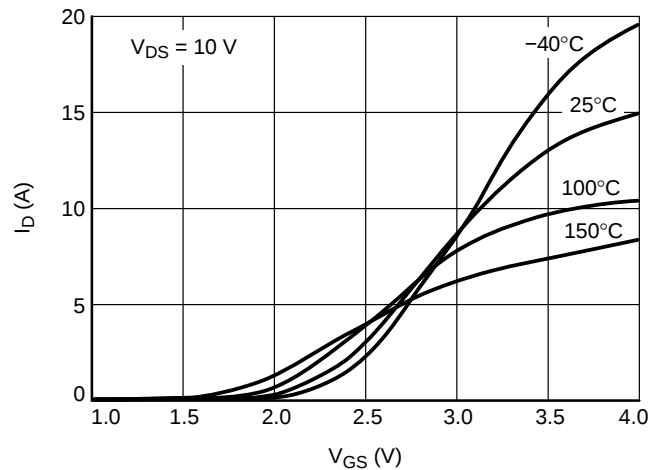


Figure 7. Transfer Characteristics

TYPICAL PERFORMANCE CURVES

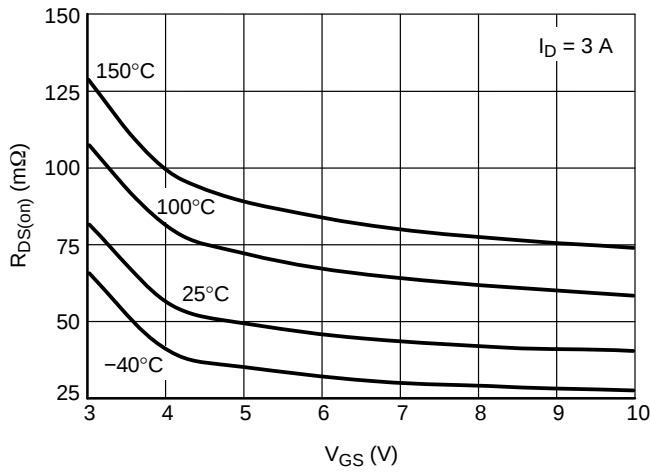


Figure 8. $R_{DS(on)}$ vs. Gate-Source Voltage

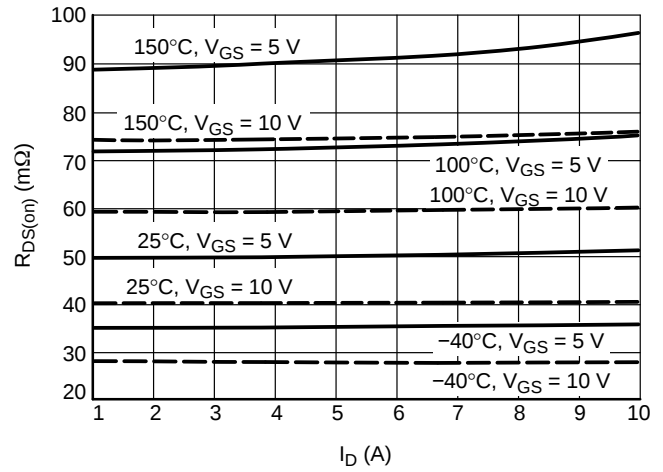


Figure 9. $R_{DS(on)}$ vs. Drain Current

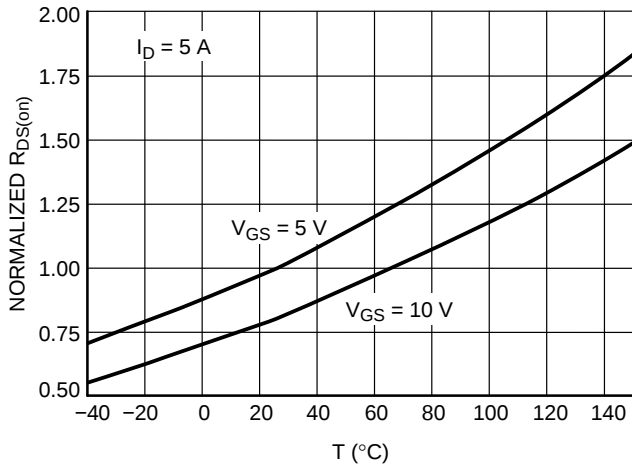


Figure 10. Normalized $R_{DS(on)}$ vs. Temperature

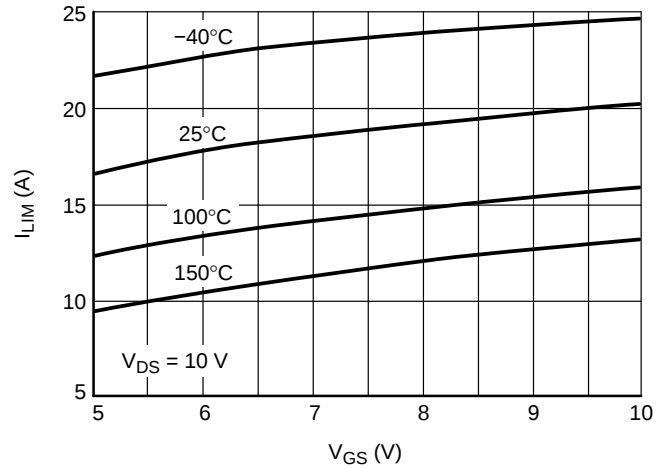


Figure 11. Current Limit vs. Gate-Source Voltage

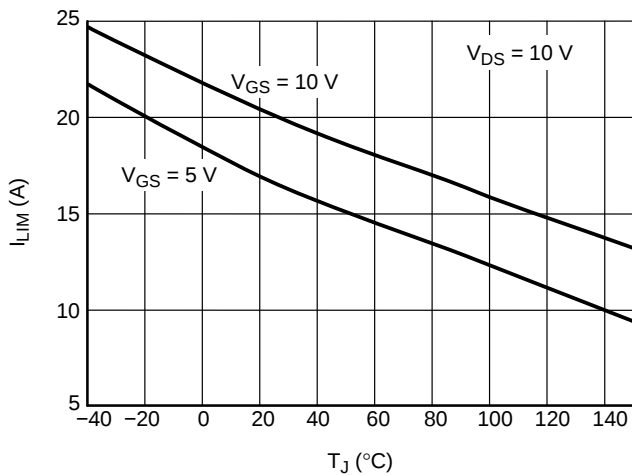


Figure 12. Current Limit vs. Junction Temperature

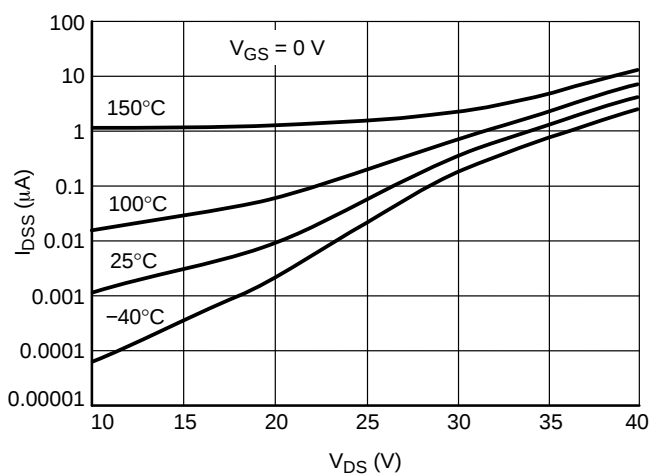


Figure 13. Drain-to-Source Leakage Current

TYPICAL PERFORMANCE CURVES

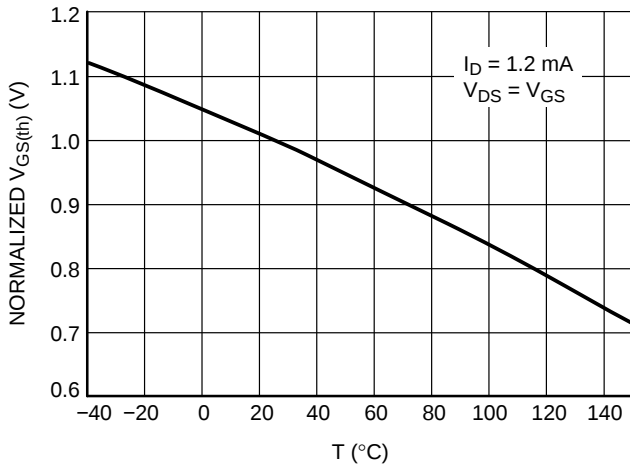


Figure 14. Normalized Threshold Voltage vs. Temperature

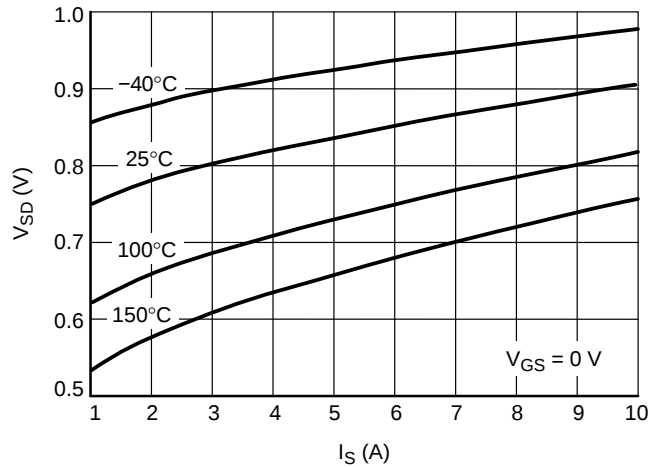


Figure 15. Source-Drain Diode Forward Characteristics

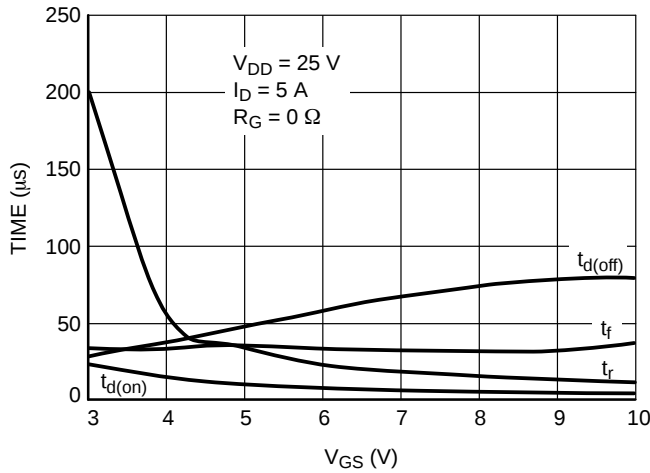


Figure 16. Resistive Load Switching Time vs. Gate-Source Voltage

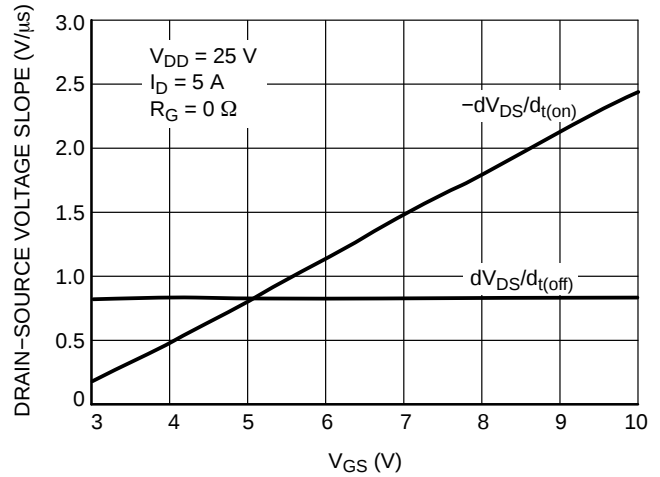


Figure 17. Resistive Load Switching Drain-Source Voltage Slope vs. Gate-Source Voltage

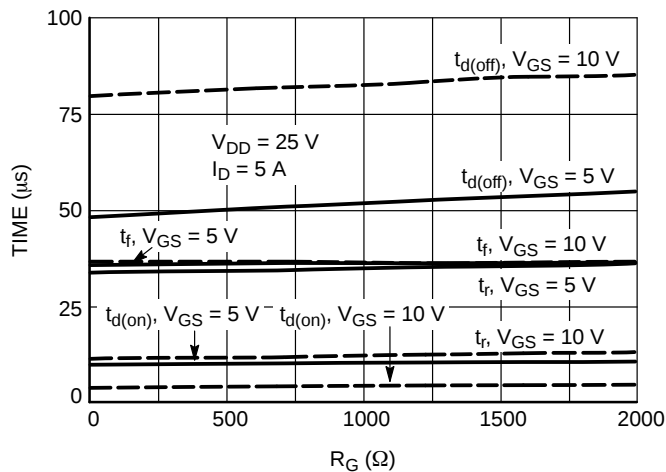


Figure 18. Resistive Load Switching Time vs. Gate Resistance

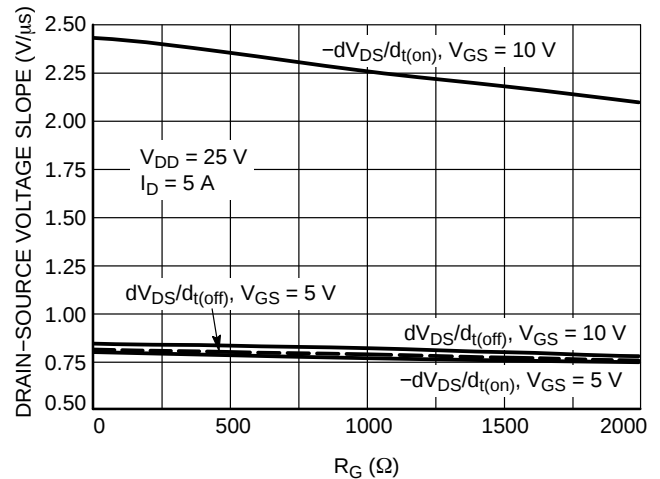


Figure 19. Drain-Source Voltage Slope during Turn On and Turn Off vs. Gate Resistance

NCV8403, NCV8403A

TYPICAL PERFORMANCE CURVES

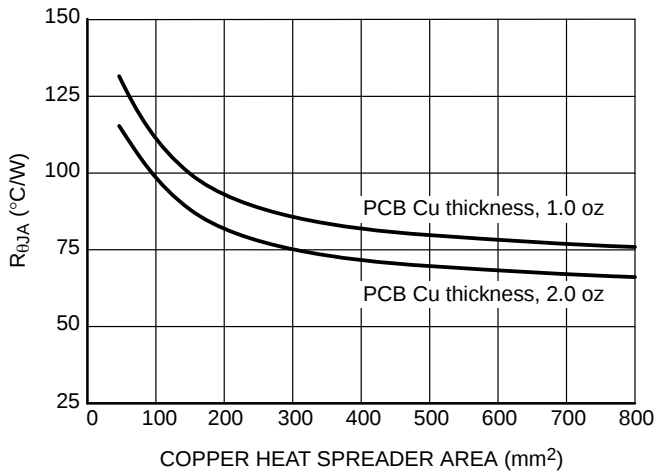


Figure 20. $R_{\theta JA}$ vs. Copper Area – SOT-223

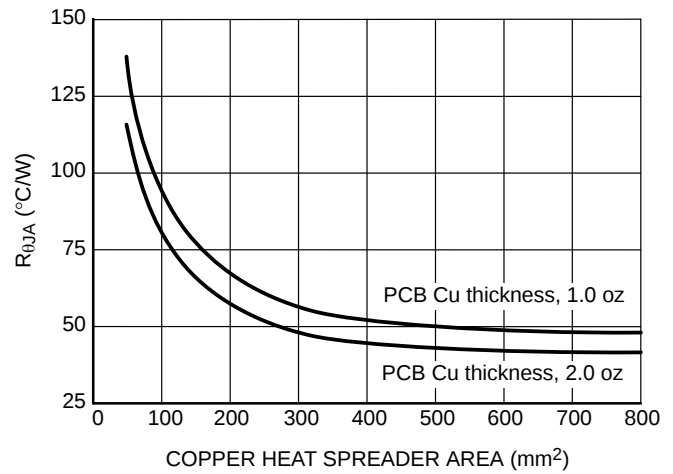


Figure 21. $R_{\theta JA}$ vs. Copper Area – DPAK

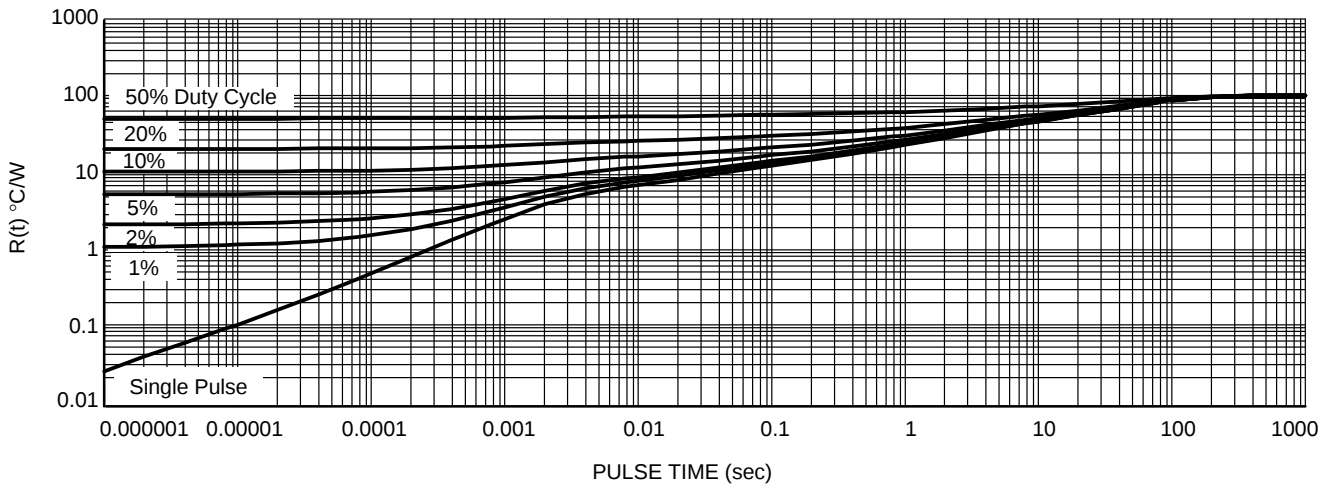


Figure 22. Transient Thermal Resistance – SOT-223 Version

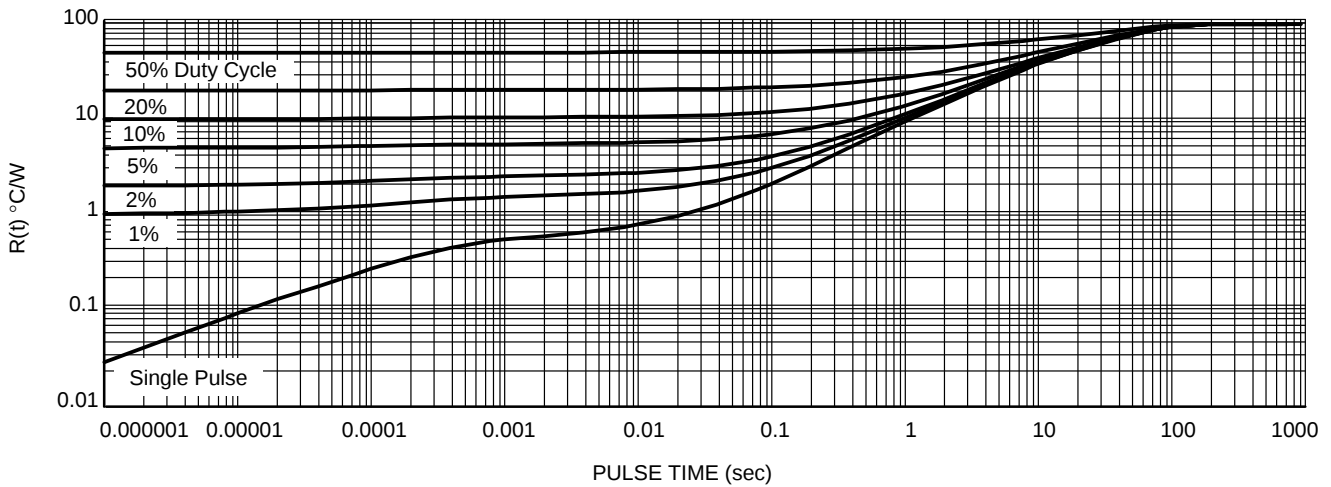


Figure 23. Transient Thermal Resistance – DPAK Version

NCV8403, NCV8403A

TEST CIRCUITS AND WAVEFORMS

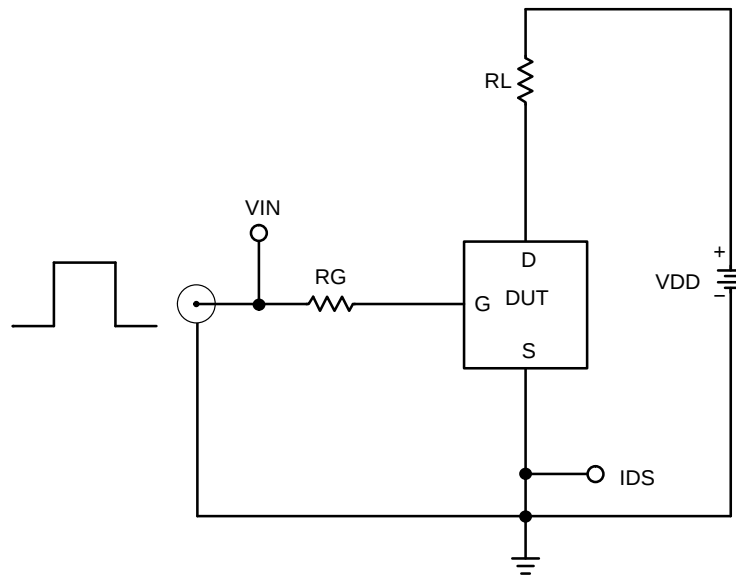


Figure 24. Resistive Load Switching Test Circuit

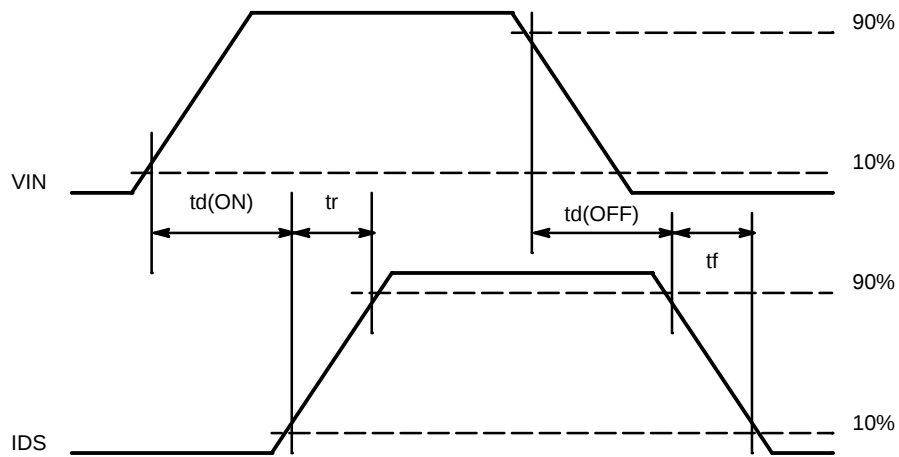


Figure 25. Resistive Load Switching Waveforms

NCV8403, NCV8403A

TEST CIRCUITS AND WAVEFORMS

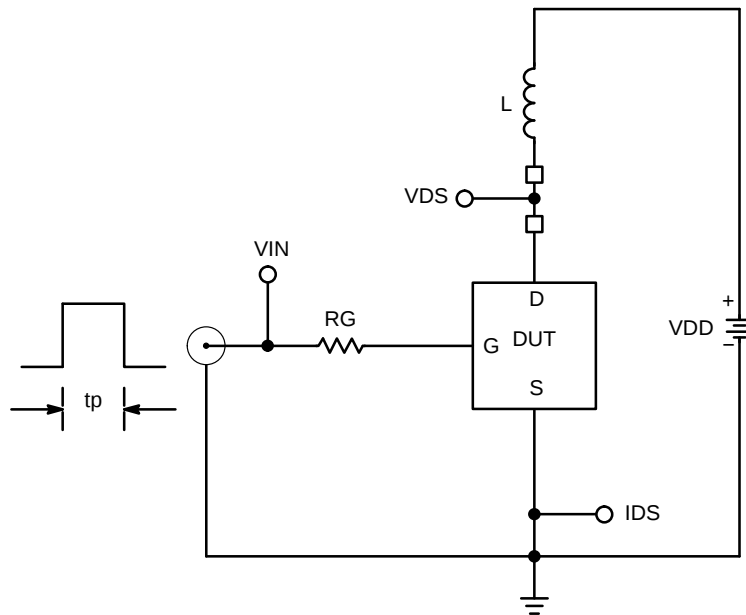


Figure 26. Inductive Load Switching Test Circuit

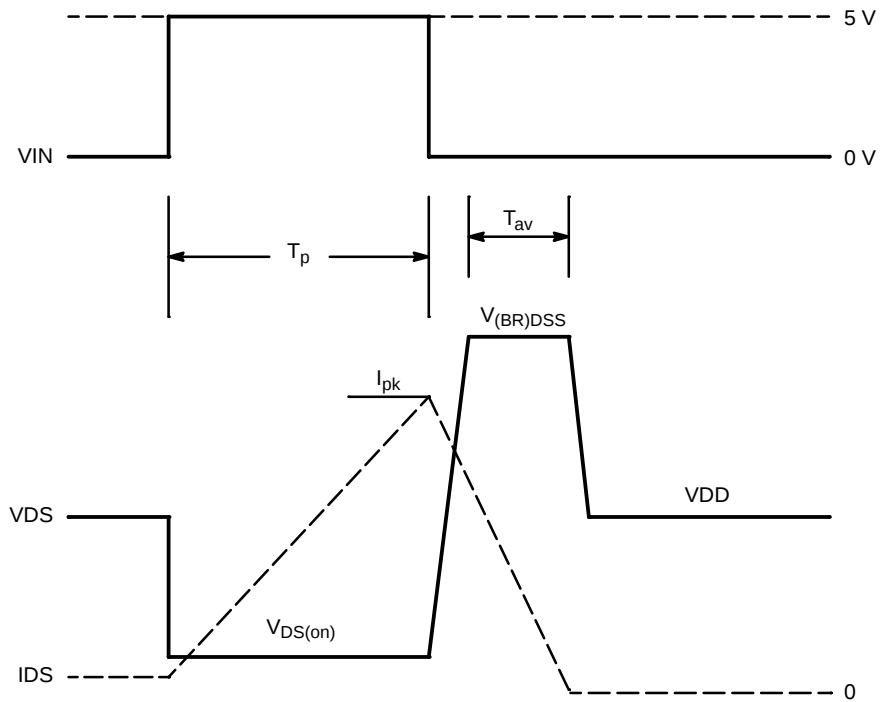


Figure 27. Inductive Load Switching Waveforms

NCV8403, NCV8403A

ORDERING INFORMATION

Device	Package	Shipping†
NCV8403STT1G	SOT-223 (Pb-Free)	1000 / Tape & Reel
NCV8403STT3G	SOT-223 (Pb-Free)	4000 / Tape & Reel
NCV8403DTRKG	DPAK (Pb-Free)	2500 / Tape & Reel
NCV8403ASTT1G	SOT-223 (Pb-Free)	1000 / Tape & Reel
NCV8403ASTT3G	SOT-223 (Pb-Free)	4000 / Tape & Reel
NCV8403ADTRKG	DPAK (Pb-Free)	2500 / Tape & Reel
NCV8403AMNT2G (In Development)	DFN6 (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.

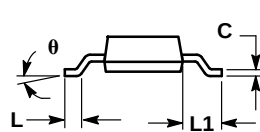
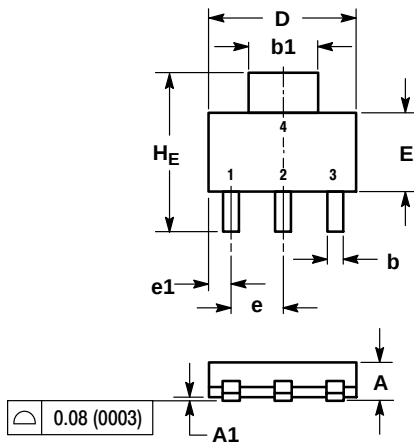
NCV8403, NCV8403A

PACKAGE DIMENSIONS

SOT-223 (TO-261)

CASE 318E-04

ISSUE N



NOTES:

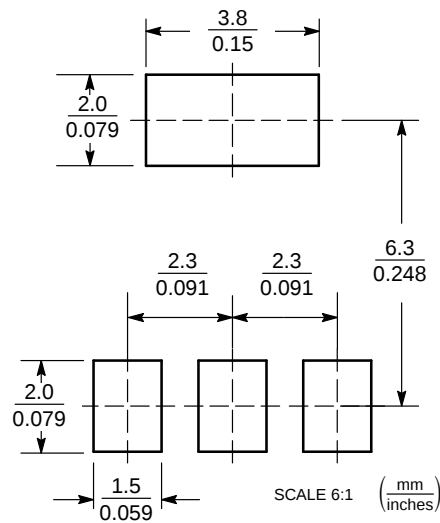
1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: INCH.

DIM	MILLIMETERS			INCHES		
	MIN	NOM	MAX	MIN	NOM	MAX
A	1.50	1.63	1.75	0.060	0.064	0.068
A1	0.02	0.06	0.10	0.001	0.002	0.004
b	0.60	0.75	0.89	0.024	0.030	0.035
b1	2.90	3.06	3.20	0.115	0.121	0.126
c	0.24	0.29	0.35	0.009	0.012	0.014
D	6.30	6.50	6.70	0.249	0.256	0.263
E	3.30	3.50	3.70	0.130	0.138	0.145
e	2.20	2.30	2.40	0.087	0.091	0.094
e1	0.85	0.94	1.05	0.033	0.037	0.041
L	0.20	---	---	0.008	---	---
L1	1.50	1.75	2.00	0.060	0.069	0.078
HE	6.70	7.00	7.30	0.264	0.276	0.287
θ	0°	---	10°	0°	---	10°

STYLE 3:

- PIN 1. GATE
2. DRAIN
3. SOURCE
4. DRAIN

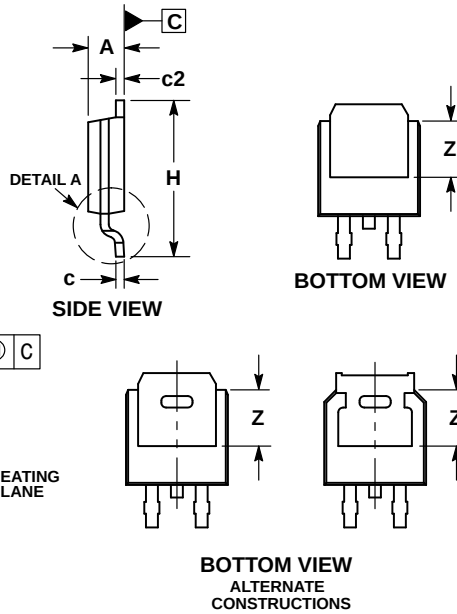
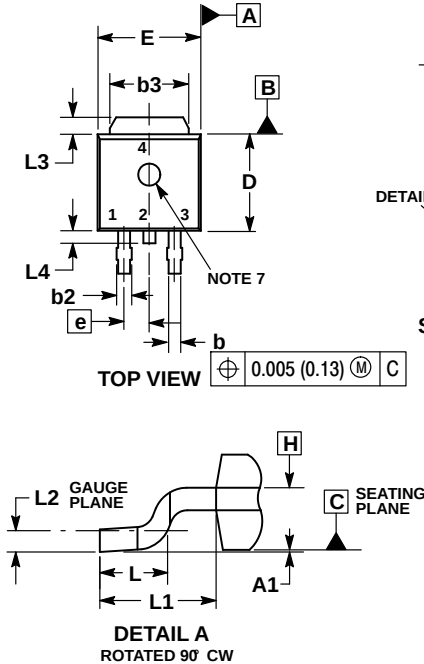
SOLDERING FOOTPRINT



NCV8403, NCV8403A

PACKAGE DIMENSIONS

DPAK (SINGLE GAUGE) CASE 369C ISSUE F

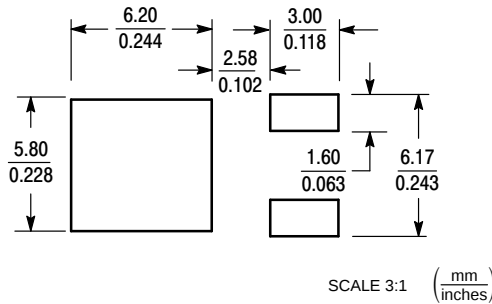


NOTES:

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	---

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.

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