NCV8402, NCV8402A

Self-Protected Low Side Driver with Temperature and Current Limit

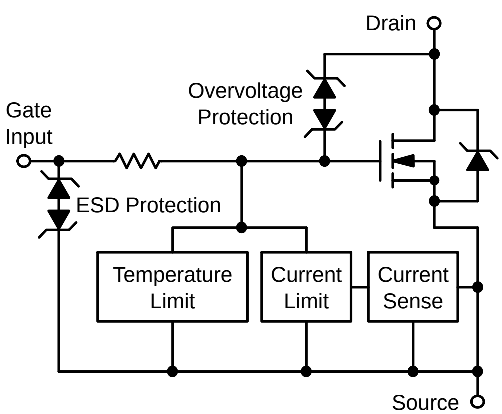
NCV8402/A is a three terminal protected Low−Side Smart Discrete device. The protection features include overcurrent, overtemperature, ESD and integrated Drain−to−Gate clamping for overvoltage protection. This device offers protection and is suitable for harsh automotive environments.

Features

- Short−Circuit Protection
- Thermal Shutdown with Automatic Restart
- Overvoltage Protection
- Integrated Clamp for Inductive Switching
- ESD Protection
- NCV8402AMNWT1G − Wettable Flanks Product
- 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 and are RoHS Compliant

Typical Applications

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



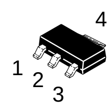
ON Semiconductor®

www.onsemi.com

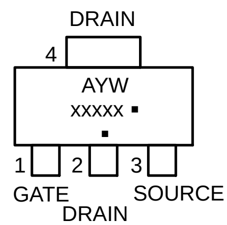
$V_{(BR)DSS}$ (Clamped)	$R_{DS(ON)}$ TYP	I_D MAX
42 V	165 mΩ @ 10 V	2.0 A*

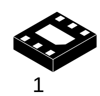
*Max current limit value is dependent on input condition.

MARKING DIAGRAMS

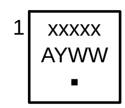


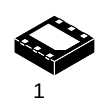
SOT−223
CASE 318E
STYLE 3



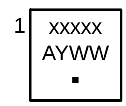


DFN6
CASE 506AX





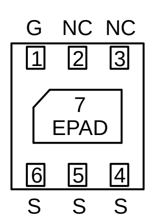
DFN6 (WF)
CASE 506DK



A = Assembly Location
Y = Year
W or WW = Work Week
XXXXX = V8402 or 8402A
▪ = Pb−Free Package

(Note: Microdot may be in either location)

DFN6 PACKAGE PIN DESCRIPTION



Pin #	Symbol	Description
1	G	Gate Input
2	NC	No Connect
3	NC	No Connect
4	S*	Source
5	S*	Source
6	S*	Source
7	EPAD	Drain

*Pins 4, 5, 6 are internally shorted together. It is recommended to short these pins externally.

ORDERING INFORMATION

See detailed ordering and shipping information on page 11 of this data sheet.

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	
Total Power Dissipation − SOT−223 Version	@ T_A = 25°C (Note 1) @ T_A = 25°C (Note 2) @ T_S = 25°C)	P_D	1.1 1.7 8.9	W
Total Power Dissipation − DFN Version	@ T_A = 25°C (Note 1) @ T_A = 25°C (Note 2) @ T_S = 25°C)	P_D	0.76 1.7 8.9	W
Maximum Continuous Drain Current − SOT−223 Version	@ T_A = 25°C (Note 1) @ T_A = 25°C (Note 2) @ T_S = 25°C)	I_D	2.37 2.98 6.75	A
Maximum Continuous Drain Current − DFN Version	@ T_A = 25°C (Note 1) @ T_A = 25°C (Note 2) @ T_S = 25°C)	I_D	1.98 3.02 6.75	A
Thermal Resistance	SOT223 Junction−to−Ambient Steady State (Note 1) SOT223 Junction−to−Ambient Steady State (Note 2) SOT223 Junction−to−Soldering Point Steady State DFN Junction−to−Ambient Steady State (Note 1) DFN Junction−to−Ambient Steady State (Note 2) DFN Junction−to−Soldering Point Steady State	$R_{\theta JA}$ $R_{\theta JA}$ $R_{\theta JS}$ $R_{\theta JA}$ $R_{\theta JA}$ $R_{\theta JS}$	114 72 14 163 70 14	°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}	55	V
Operating Junction Temperature		T_J	−40 to 150	°C
Storage Temperature		T_{stg}	−55 to 150	°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 min pad FR4 PCB, (2 oz. Cu, 0.06″ thick).
2. Surface−mounted onto 2″ sq. FR4 board (1″ sq., 1 oz. Cu, 0.06″ thick).

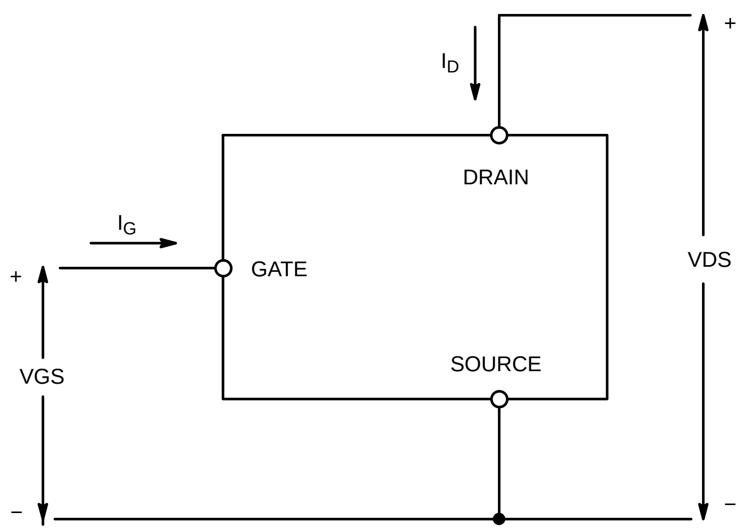


Figure 1. Voltage and Current Convention

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
Zero Gate Voltage Drain Current	V_{GS} = 0 V, V_{DS} = 32 V, T_J = 150°C (Note 5)	I_{DSS}		1.1	20	μA
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		−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 Delay 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	$td_{(on)}$		25	30	μs
Turn−On Rise Time (10% I_D to 90% I_D)		t_{rise}		120	200	μs
Turn−Off Delay Time (90% V_{IN} to 10% I_D)		$td_{(off)}$		20	25	μs
Turn−Off Fall Time (90% I_D to 10% I_D)		t_{fall}		50	70	μs
Slew−Rate ON (70% to 50% V_{DD})		$-dV_{DS}/dt_{ON}$		0.8	1.2	V/μs
Slew−Rate OFF (50% to 70% V_{DD})		dV_{DS}/dt_{OFF}		0.3	0.5	V/μs
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		

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.

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

Parameter	Test Condition	Symbol	Min	Typ	Max	Unit
GATE INPUT CHARACTERISTICS (Note 5)						
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.

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.

TYPICAL PERFORMANCE CURVES

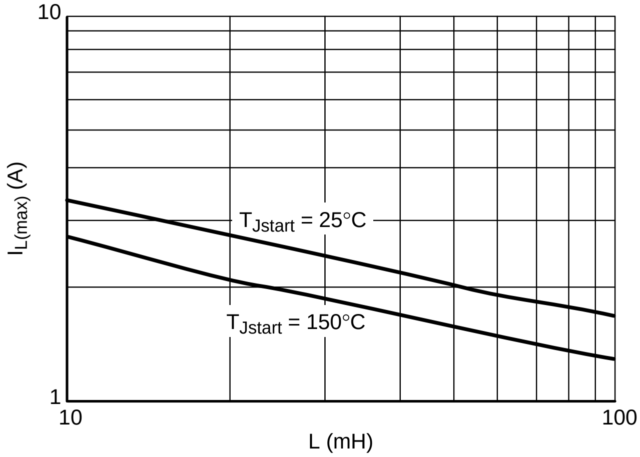


Figure 2. Single Pulse Maximum Switch−off Current vs. Load Inductance

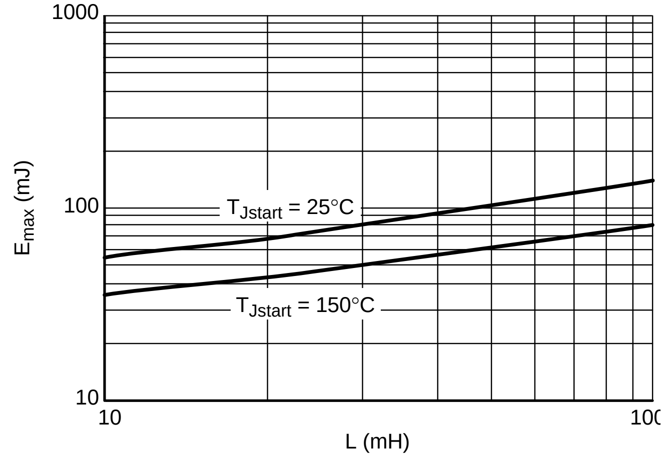


Figure 3. Single Pulse Maximum Switching Energy vs. Load Inductance

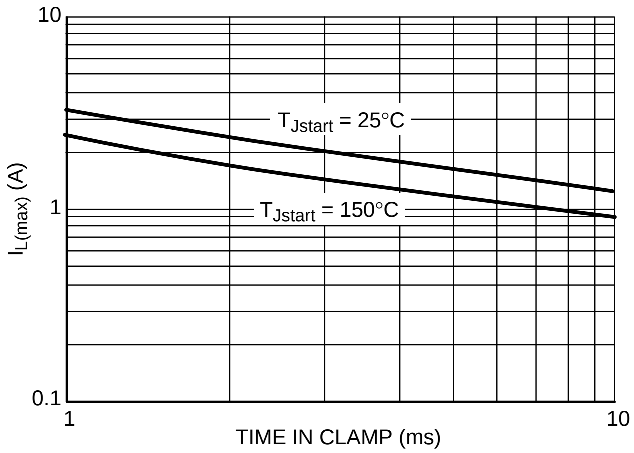


Figure 4. Single Pulse Maximum Inductive Switch−off Current vs. Time in Clamp

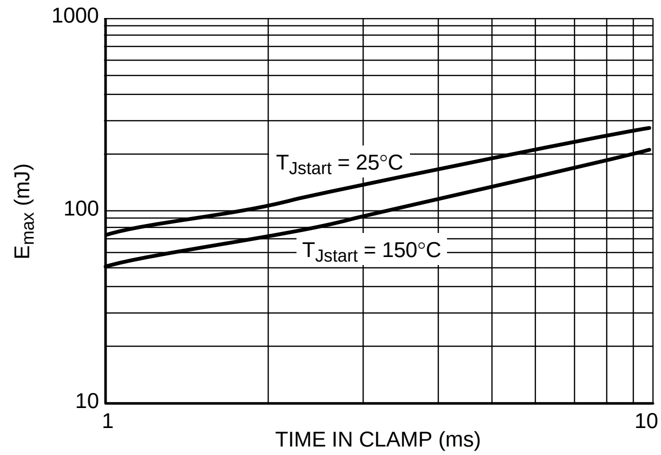


Figure 5. Single Pulse Maximum Inductive Switching Energy vs. Time in Clamp

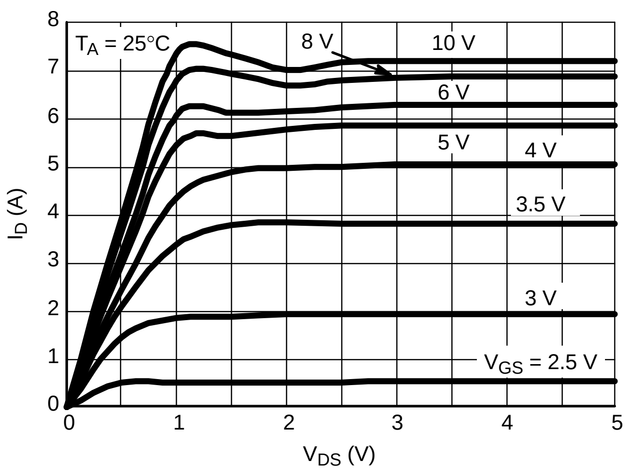


Figure 6. On−state Output Characteristics

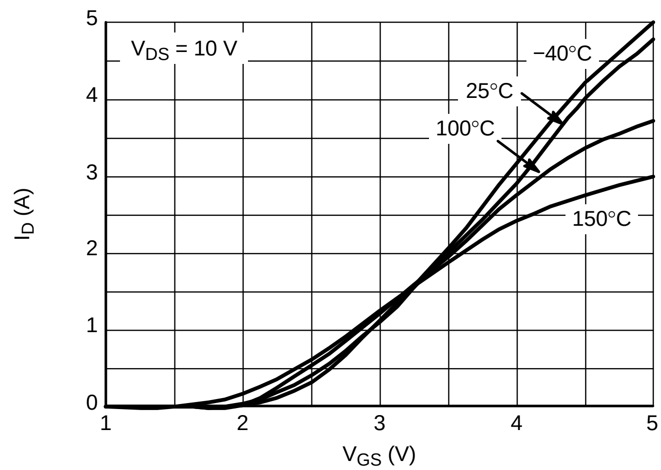


Figure 7. Transfer Characteristics

TYPICAL PERFORMANCE CURVES

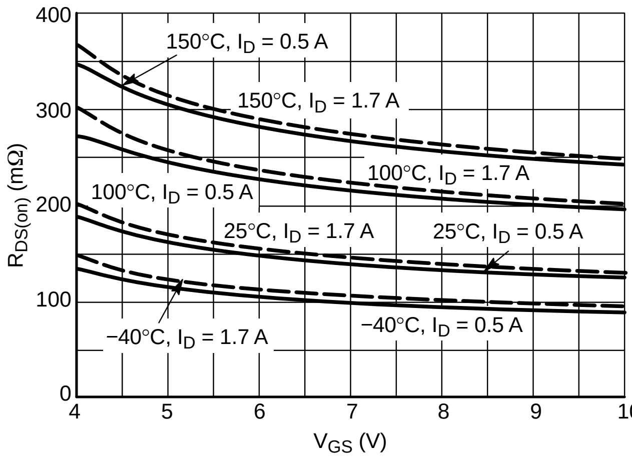


Figure 8. $R_{DS(on)}$ vs. Gate−Source Voltage

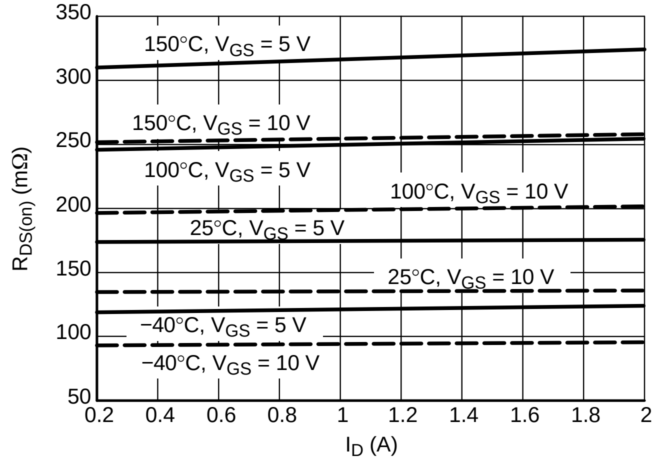


Figure 9. $R_{DS(on)}$ vs. Drain Current

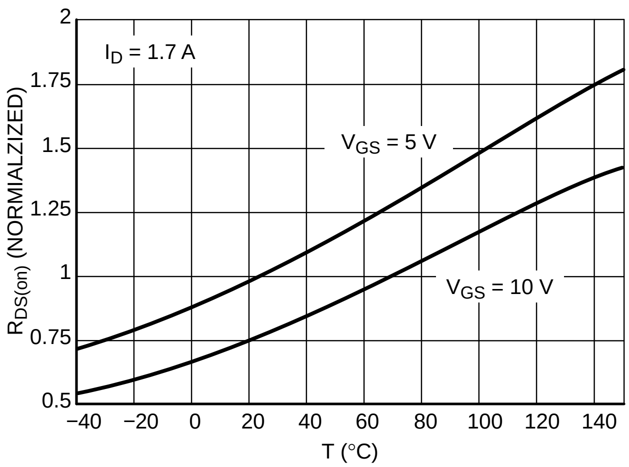


Figure 10. Normalized $R_{DS(on)}$ vs. Temperature

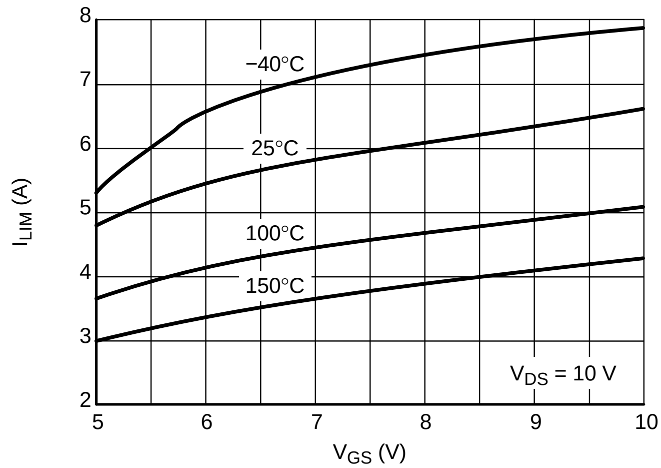


Figure 11. Current Limit vs. Gate−Source Voltage

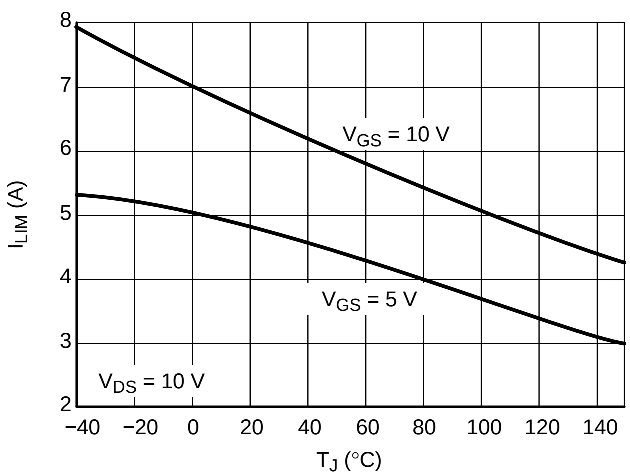


Figure 12. Current Limit vs. Junction Temperature

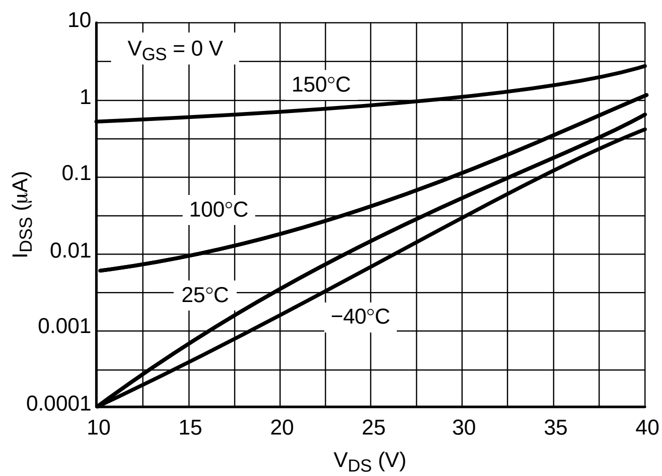


Figure 13. Drain−to−Source Leakage Current

TYPICAL PERFORMANCE CURVES

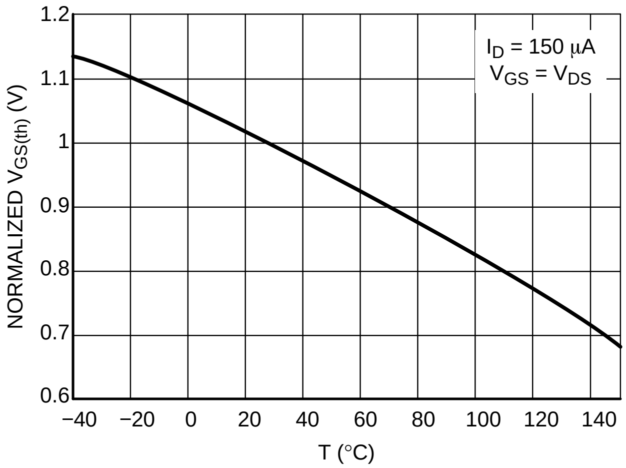


Figure 14. Normalized Threshold Voltage vs. Temperature

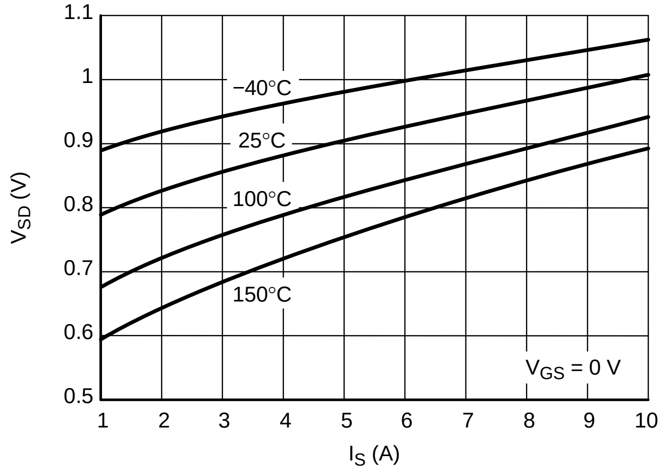


Figure 15. Source−Drain Diode Forward Characteristics

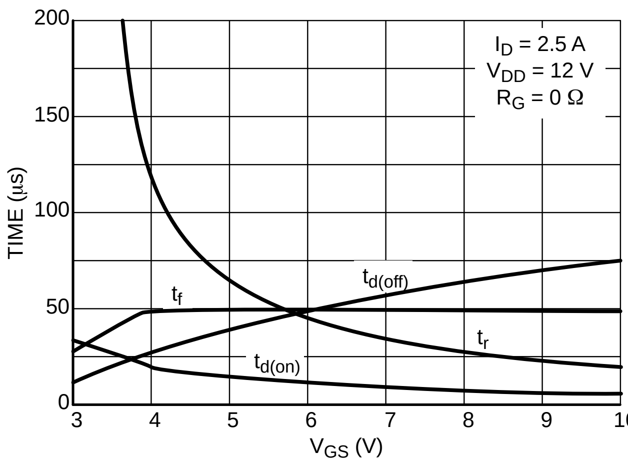


Figure 16. Resistive Load Switching Time vs. Gate−Source Voltage

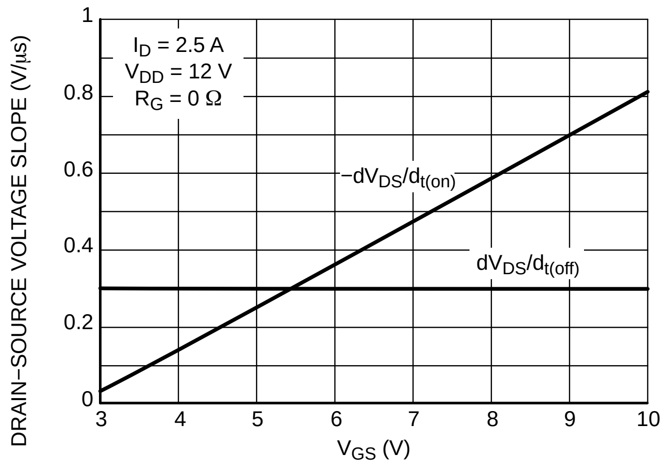


Figure 17. Resistive Load Switching Drain−Source Voltage Slope vs. Gate−Source Voltage

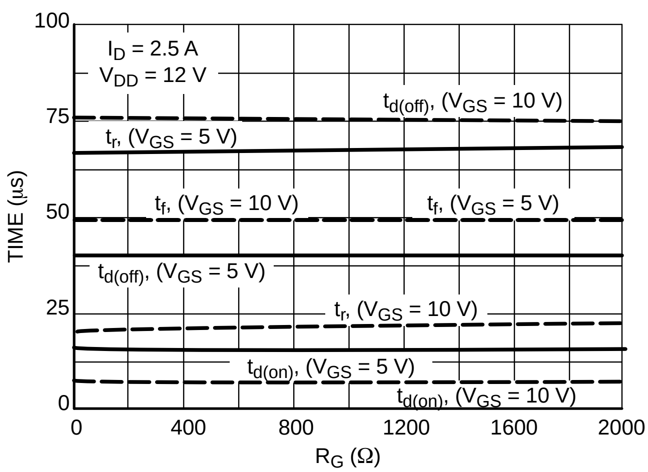


Figure 18. Resistive Load Switching Time vs. Gate Resistance

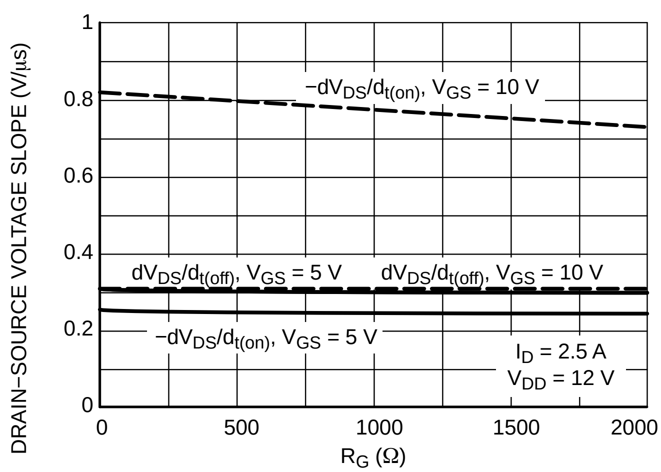


Figure 19. Drain−Source Voltage Slope during Turn On and Turn Off vs. Gate Resistance

TYPICAL PERFORMANCE CURVES

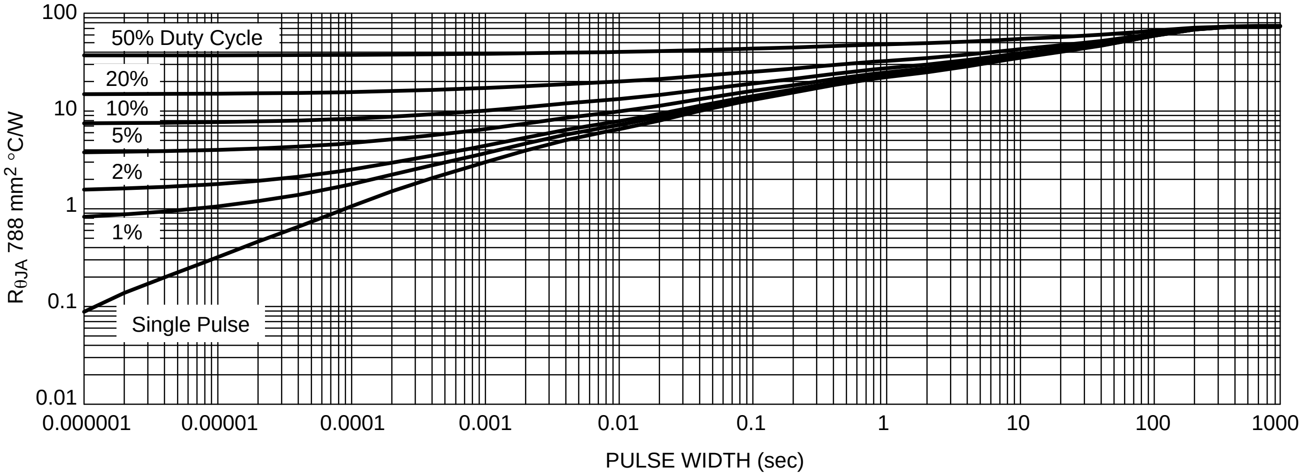


Figure 20. Transient Thermal Resistance − SOT−223 Package

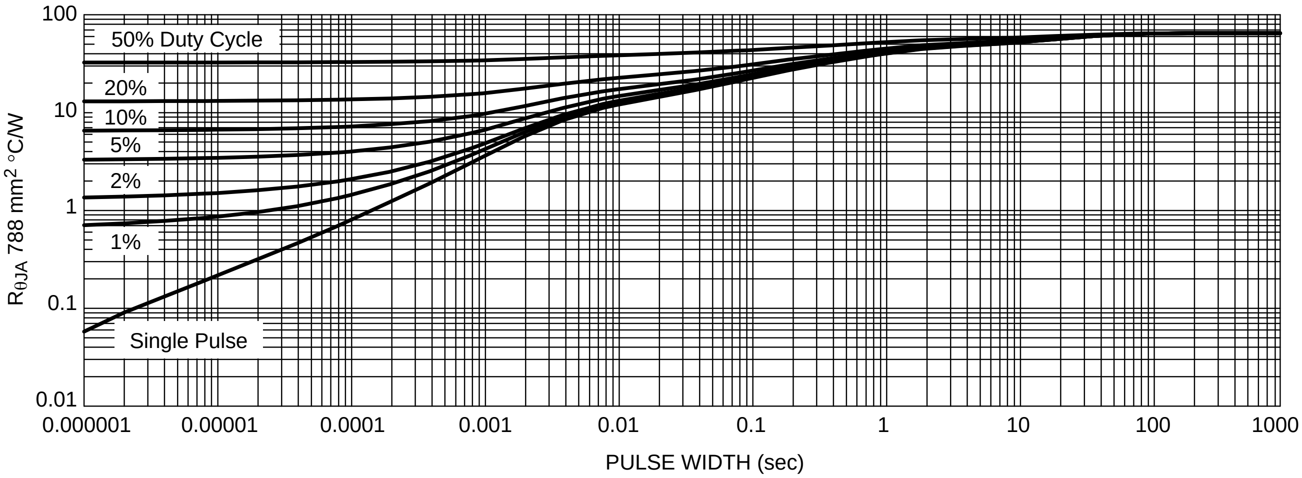


Figure 21. Transient Thermal Resistance − DFN Package

TEST CIRCUITS AND WAVEFORMS

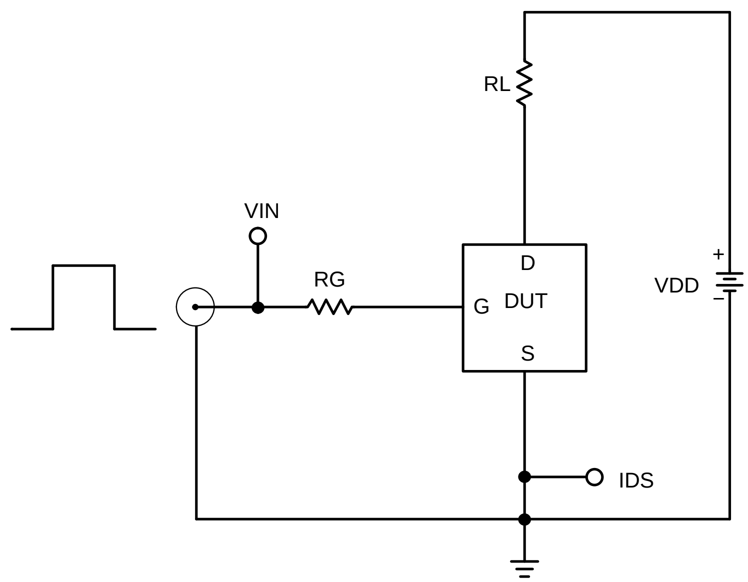


Figure 22. Resistive Load Switching Test Circuit

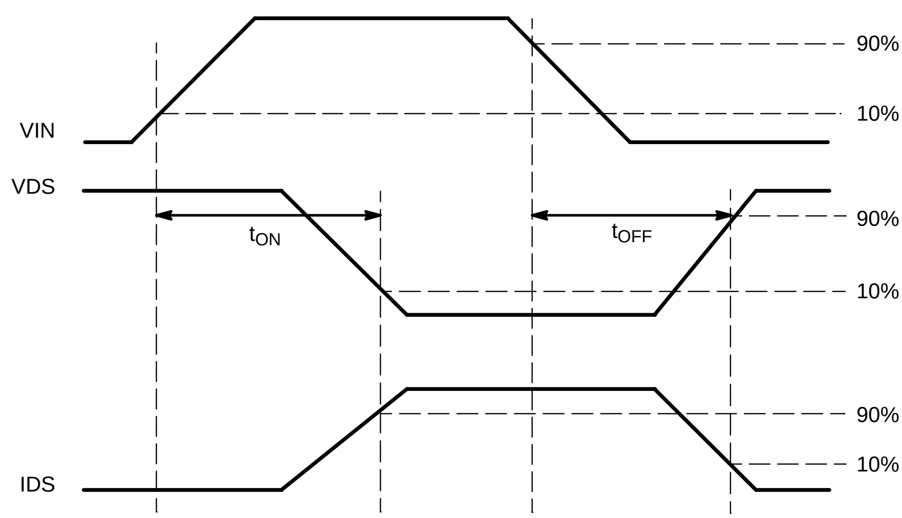


Figure 23. Resistive Load Switching Waveforms

TEST CIRCUITS AND WAVEFORMS

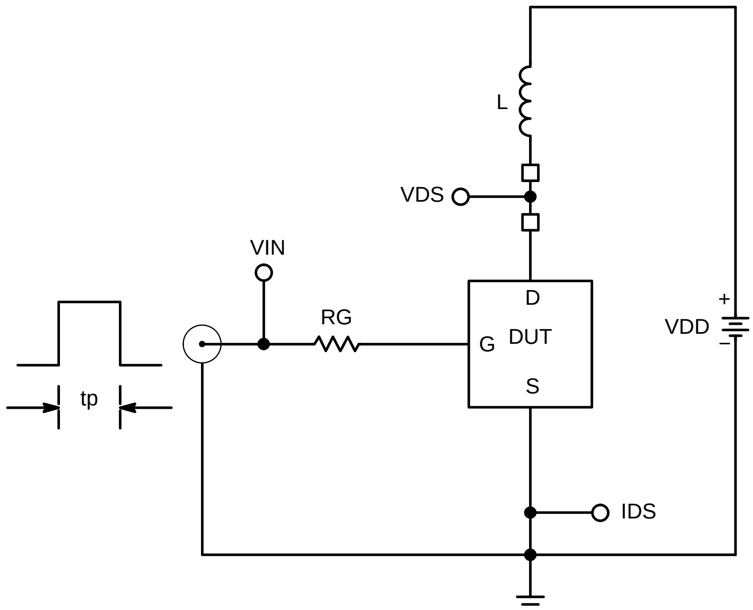


Figure 24. Inductive Load Switching Test Circuit

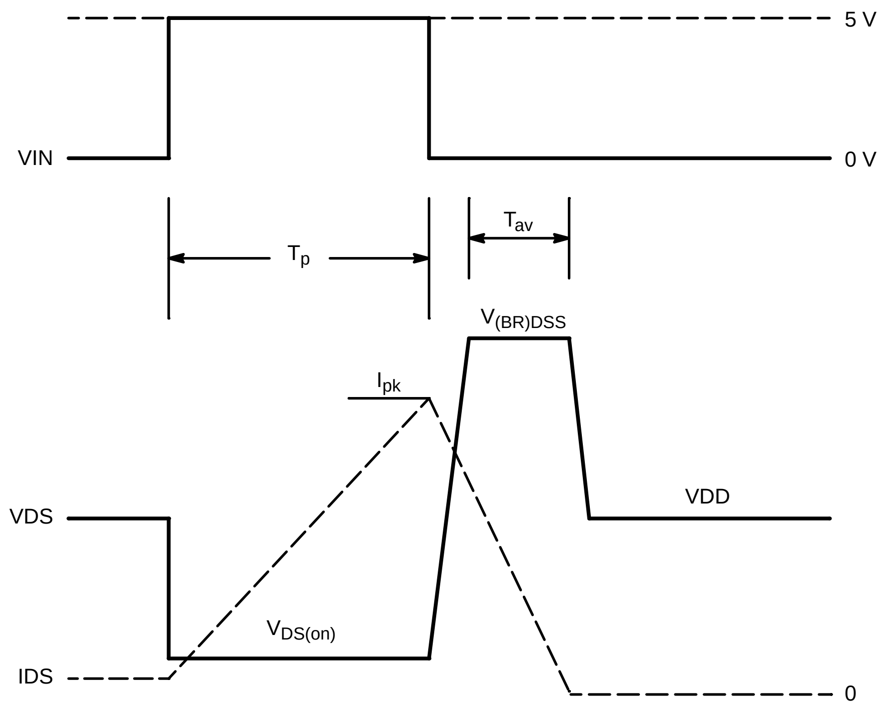


Figure 25. Inductive Load Switching Waveforms

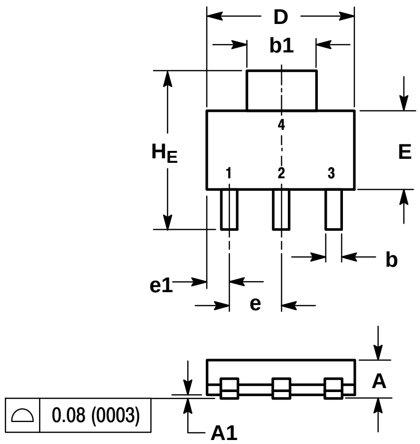
Table 1. ORDERING INFORMATION

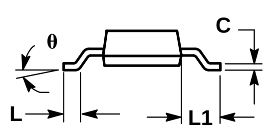
Device	Package	Shipping†
NCV8402STT1G	SOT−223 (Pb−Free)	1000 / Tape & Reel
NCV8402ASTT1G		
NCV8402STT3G	SOT−223 (Pb−Free)	4000 / Tape & Reel
NCV8402ASTT3G		
NCV8402AMNT2G	DFN6 (Pb−Free)	2000 / Tape & Reel
NCV8402AMNWT1G	DFN6 (Pb−Free, Wettable Flank)	3000 / Tape & Reel

†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.

PACKAGE DIMENSIONS

SOT−223 (TO−261)
CASE 318E−04
ISSUE N



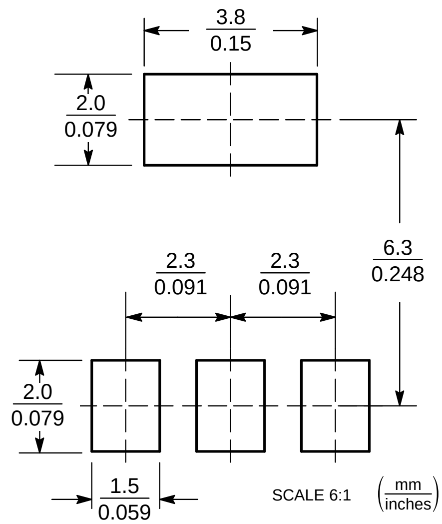


NOTES:
1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: INCH.

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
H_E	6.70	7.00	7.30	0.264	0.276	0.287
θ	0°	−	10°	0°	−	10°

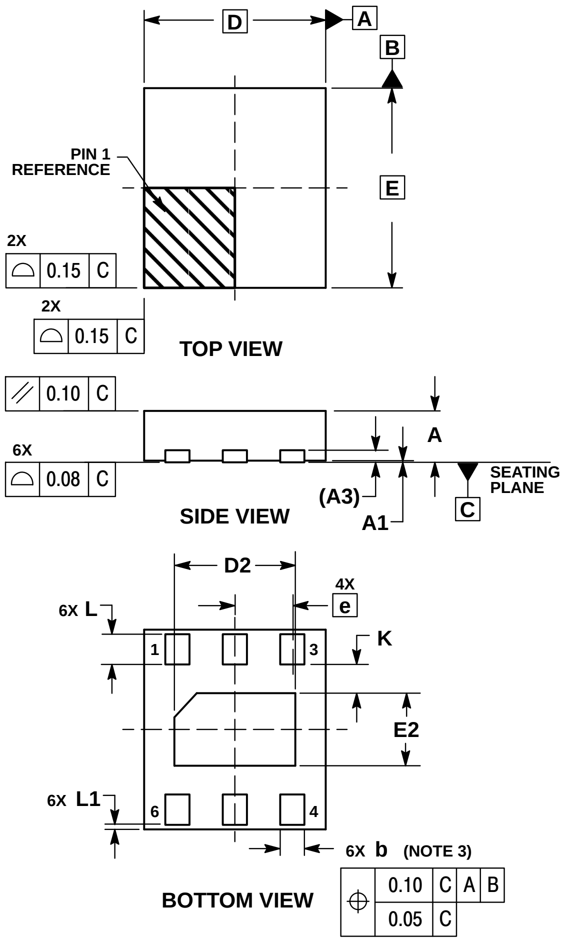
STYLE 3:
PIN 1. GATE
2. DRAIN
3. SOURCE
4. DRAIN

SOLDERING FOOTPRINT



PACKAGE DIMENSIONS

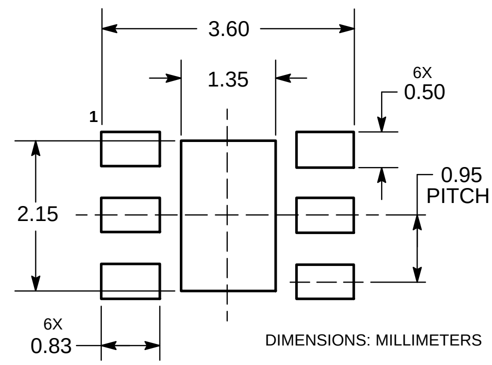
DFN6 3x3.3, 0.95 PITCH
CASE 506AX
ISSUE O



NOTES:
1. DIMENSIONS AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: MILLIMETERS.
3. DIMENSION b APPLIES TO PLATED TERMINAL AND IS MEASURED BETWEEN 0.25 AND 0.30 mm FROM TERMINAL.
4. COPLANARITY APPLIES TO THE EXPOSED PAD AS WELL AS THE TERMINALS.

	MILLIMETERS		
DIM	MIN	NOM	MAX
A	0.80	---	0.90
A1	0.00	---	0.05
A3	0.20 REF		
b	0.30	---	0.40
D	3.00 BSC		
D2	1.90	---	2.10
E	3.30 BSC		
E2	1.10	---	1.30
e	0.95 BSC		
K	0.20	---	---
L	0.40	---	0.60
L1	0.00	---	0.15

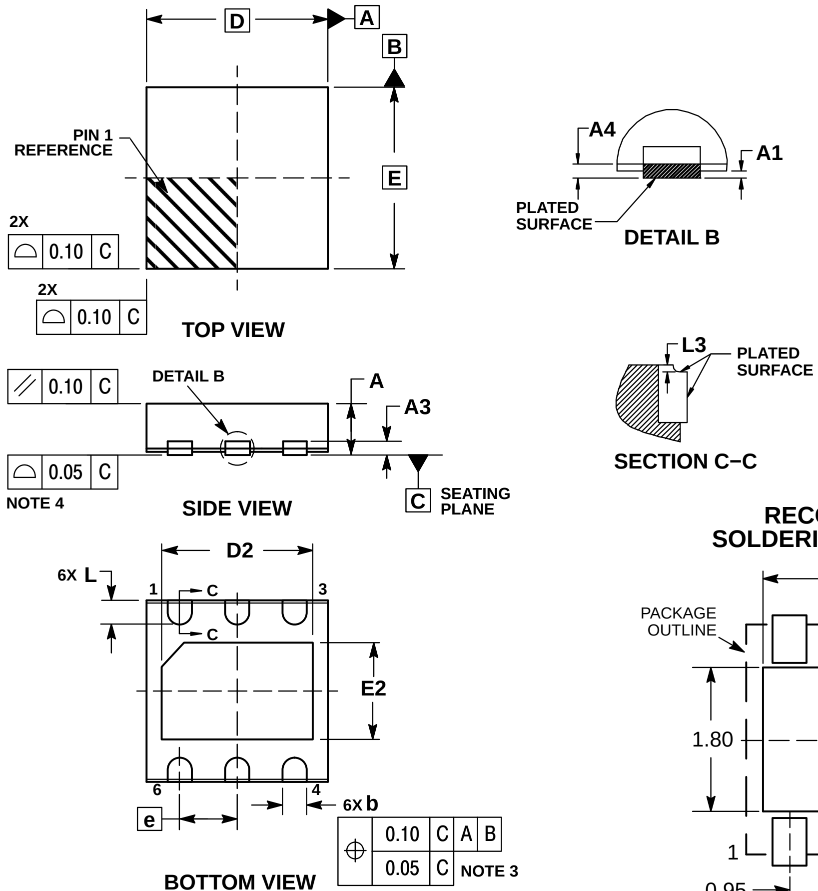
SOLDERING FOOTPRINT*



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

PACKAGE DIMENSIONS

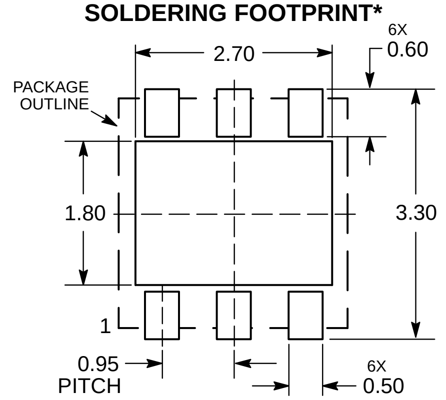
DFN6 3x3, 0.95P
CASE 506DK
ISSUE O



NOTES:
1. DIMENSIONS AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: MILLIMETERS.
3. DIMESNION b APPLIES TO PLATED TERMINAL AND IS MEASURED BETWEEN 0.15 AND 0.20 MM FROM THE TERMINAL TIP.
4. COPLANARITY APPLIES TO THE EXPOSED PAD AS WELL AS THE TERMINALS.

	MILLIMETERS	
DIM	MIN	MAX
A	0.75	0.95
A1	0.00	0.05
A3	0.20 REF	
A4	0.05	0.15
b	0.35	0.45
D	3.00 BSC	
D2	2.40	2.60
E	3.00 BSC	
E2	1.50	1.70
e	0.95 BSC	
L	0.30	0.50
L3	0.00	0.10

RECOMMENDED SOLDERING FOOTPRINT*



DIMENSIONS: MILLIMETERS

*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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