

# N-Channel Logic Level Enhancement Mode Field Effect Transistor



ON Semiconductor®

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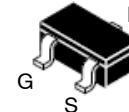
## NDS331N

### General Description

These N-Channel logic level enhancement mode power field effect transistors are produced using ON Semiconductor's proprietary, high cell density, DMOS technology. This very high density process is especially tailored to minimize on-state resistance. These devices are particularly suited for low voltage applications in notebook computers, portable phones, PCMCIA cards, and other battery powered circuits where fast switching, and low in-line power loss are needed in a very small outline surface mount package.

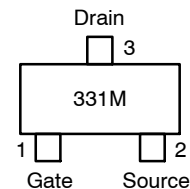
### Features

- 1.3 A, 20 V
  - ◆  $R_{DS(on)} = 0.21 \Omega @ V_{GS} = 2.7 V$
  - ◆  $R_{DS(on)} = 0.16 \Omega @ V_{GS} = 4.5 V$
- Industry Standard Outline SOT-23 Surface Mount Package Using Proprietary SUPERSOT™-3 Design for Superior Thermal and Electrical Capabilities
- High Density Cell Design for Extremely Low  $R_{DS(on)}$
- Exceptional On-Resistance and Maximum DC Current Capability
- This is a Pb-Free Device

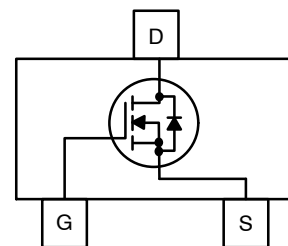


SOT-23/SUPERSOT-23, 3 LEAD, 1.4x2.9  
CASE 527AG

### MARKING DIAGRAM



M = Date Code



### ORDERING INFORMATION

Device	Package	Shipping†
NDS331N	SOT-23-3/ SUPERSOT-23 (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.

# NDS331N

## ABSOLUTE MAXIMUM RATINGS $T_A = 25^\circ\text{C}$ unless otherwise noted.

Symbol	Parameter	Ratings	Unit
$V_{DSS}$	Drain–Source Voltage	20	V
$V_{GSS}$	Gate–Source Voltage – Continuous	$\pm 8$	V
$I_D$	Maximum Drain Current – Continuous (Note 1a)	1.3	A
	Maximum Drain Current – Pulsed	10	
$P_D$	Maximum Power Dissipation (Note 1a)	0.5	W
	Maximum Power Dissipation (Note 1b)	0.46	
$T_J, T_{STG}$	Operating and Storage Temperature Range	$-55$ 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.

## THERMAL CHARACTERISTICS

Symbol	Parameter	Ratings	Unit
$R_{\theta JA}$	Thermal Resistance, Junction–to–Ambient (Note 1a)	250	$^\circ\text{C}/\text{W}$
$R_{\theta JC}$	Thermal Resistance, Junction–to–Case (Note 1)	75	$^\circ\text{C}/\text{W}$

1.  $R_{\theta JA}$  is the sum of the junction–to–case and case–to–ambient thermal resistance where the case thermal reference is defined as the solder mounting surface of the drain pins.  $R_{\theta JC}$  is guaranteed by design while  $R_{\theta CA}$  is determined by the user’s board design.

$$P_D(t) = \frac{T_J - T_A}{R_{\theta JA}(t)} = \frac{T_J - T_A}{R_{\theta JC} + R_{\theta CA}(t)} = I_D^2(t) \times R_{DS(on)@T_J}$$

Typical  $R_{\theta JA}$  using the board layouts shown below on 4.5”x5” FR-4 PCB in a still air environment:



- a)  $250^\circ\text{C}/\text{W}$  when mounted on a 0.02 in<sup>2</sup> pad of 2oz copper.



- b)  $270^\circ\text{C}/\text{W}$  when mounted on a 0.001 in<sup>2</sup> pad of 2oz copper.

Scale 1:1 on letter size paper

# NDS331N

## ELECTRICAL CHARACTERISTICS $T_A = 25^\circ\text{C}$ unless otherwise noted.

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
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### OFF CHARACTERISTICS

$BV_{DSS}$	Drain–Source Breakdown Voltage	$V_{GS} = 0\text{ V}, I_D = 250\ \mu\text{A}$	20	–	–	V
$I_{DSS}$	Zero Gate Voltage Drain Current	$V_{DS} = 16\text{ V}, V_{GS} = 0\text{ V}$	–	–	1	$\mu\text{A}$
		$V_{DS} = 16\text{ V}, V_{GS} = 0\text{ V}, T_J = 125^\circ\text{C}$	–	–	10	
$I_{GSSF}$	Gate–Body Leakage, Forward	$V_{GS} = 8\text{ V}, V_{DS} = 0\text{ V}$	–	–	100	nA
$I_{GSSR}$	Gate–Body Leakage, Reverse	$V_{GS} = -8\text{ V}, V_{DS} = 0\text{ V}$	–	–	-100	nA

### ON CHARACTERISTICS (Note 2)

$V_{GS(th)}$	Gate Threshold Voltage	$V_{DS} = V_{GS}, I_D = 250\ \mu\text{A}$	0.5	0.7	1	V
		$V_{DS} = V_{GS}, I_D = 250\ \mu\text{A}, T_J = 125^\circ\text{C}$	0.3	0.53	0.8	
$R_{DS(on)}$	Static Drain–Source On–Resistance	$V_{GS} = 2.7\text{ V}, I_D = 1.3\text{ A}$	–	0.15	0.21	$\Omega$
		$V_{GS} = 2.7\text{ V}, I_D = 1.3\text{ A}, T_J = 125^\circ\text{C}$	–	0.24	0.4	
		$V_{GS} = 4.5\text{ V}, I_D = 1.5\text{ A}$	–	0.11	0.16	
$I_{D(on)}$	On–State Drain Current	$V_{GS} = 2.7\text{ V}, V_{DS} = 5\text{ V}$	3	–	–	A
		$V_{GS} = 4.5\text{ V}, V_{DS} = 5\text{ V}$	4	–	–	
$g_{FS}$	Forward Transconductance	$V_{DS} = 5\text{ V}, I_D = 1.3\text{ A}$	–	3.5	–	S

### DYNAMIC CHARACTERISTICS

$C_{iss}$	Input Capacitance	$V_{DS} = 10\text{ V}, V_{GS} = 0\text{ V}, f = 1.0\text{ MHz}$	–	162	–	pF
$C_{oss}$	Output Capacitance		–	85	–	pF
$C_{rSS}$	Reverse Transfer Capacitance		–	28	–	pF

### SWITCHING CHARACTERISTICS (Note 2)

$t_{D(on)}$	Turn–On Delay Time	$V_{DD} = 5\text{ V}, I_D = 1\text{ A}, V_{GS} = 5\text{ V}, R_{GEN} = 6\ \Omega$	–	5	20	ns
$t_r$	Turn–On Rise Time		–	25	40	ns
$t_{D(off)}$	Turn–Off Delay Time		–	10	20	ns
$t_f$	Turn–Off Fall Time		–	5	20	ns
$Q_g$	Total Gate Charge	$V_{DS} = 5\text{ V}, I_D = 1.3\text{ A}, V_{GS} = 4.5\text{ V}$	–	3.5	5	nC
$Q_{gs}$	Gate–Source Charge		–	0.3	–	nC
$Q_{gd}$	Gate–Drain Charge		–	1	–	nC

### DRAIN–SOURCE DIODE CHARACTERISTICS AND MAXIMUM RATINGS

$I_S$	Maximum Continuous Drain–Source Diode Forward Current	–	–	0.42	A	
$I_{SM}$	Maximum Pulsed Drain–Source Diode Forward Current	–	–	10	A	
$V_{SD}$	Drain–Source Diode Forward Voltage	$V_{GS} = 0\text{ V}, I_S = 0.42\text{ A}$ (Note 2)	–	0.8	1.2	V

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.

2. Pulse Test: Pulse Width  $\leq 300\ \mu\text{s}$ , Duty Cycle  $\leq 2.0\%$ .

TYPICAL ELECTRICAL CHARACTERISTICS

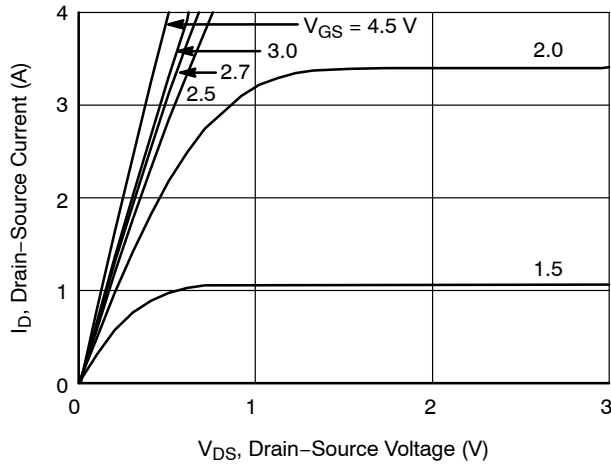


Figure 1. On-Region Characteristics

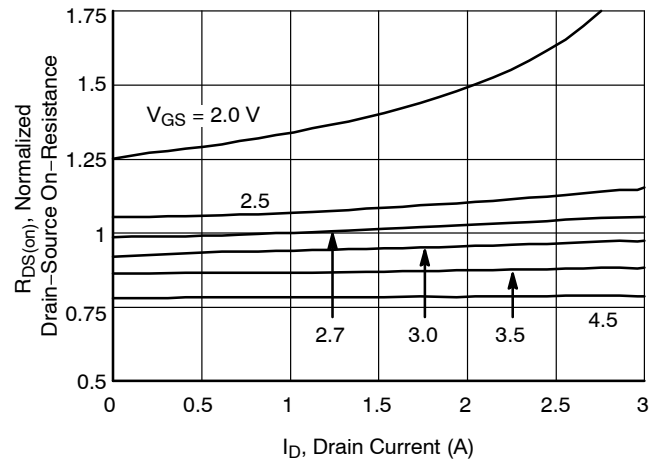


Figure 2. On-Resistance Variation with Drain Current and Gate Voltage

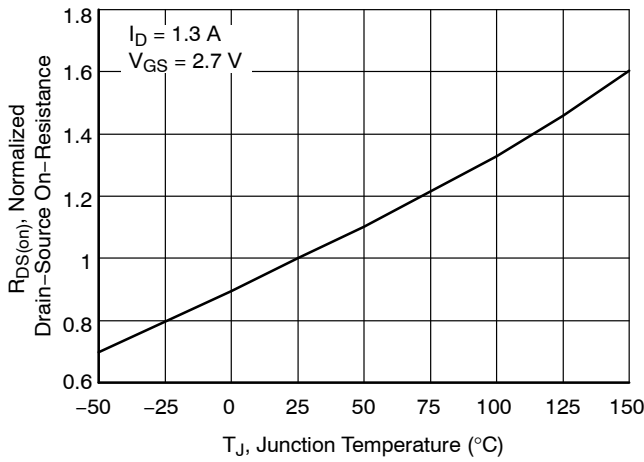


Figure 3. On-Resistance Variation with Temperature

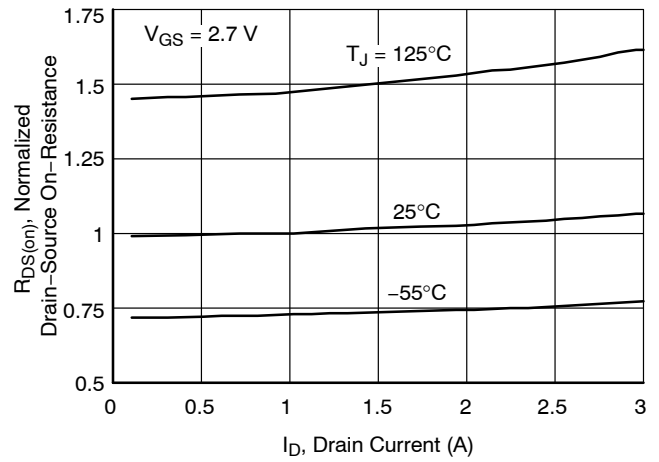


Figure 4. On-Resistance Variation with Drain Current and Temperature

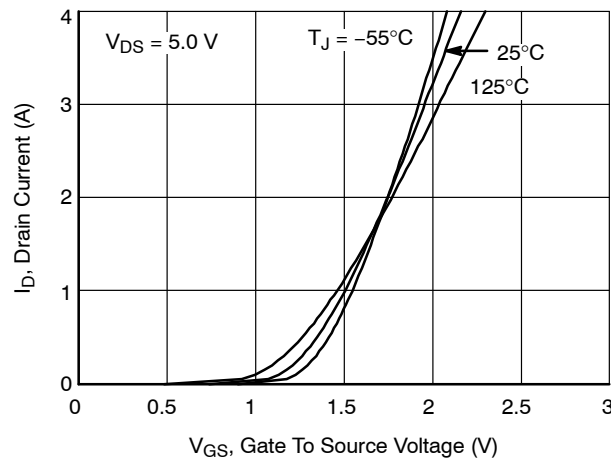


Figure 5. Transfer Characteristics

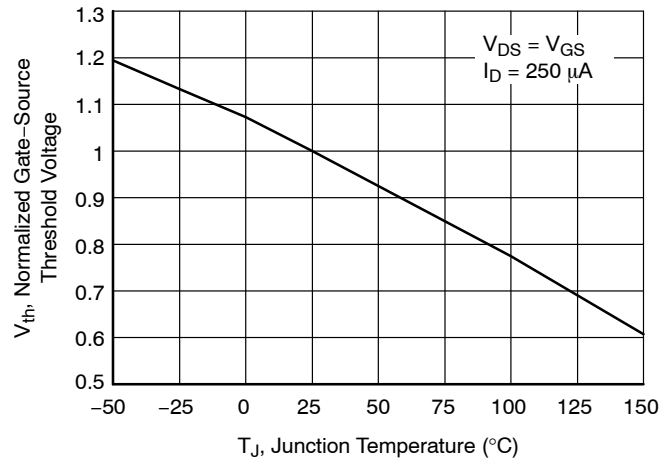


Figure 6. Gate Threshold Variation with Temperature

TYPICAL ELECTRICAL CHARACTERISTICS (continued)

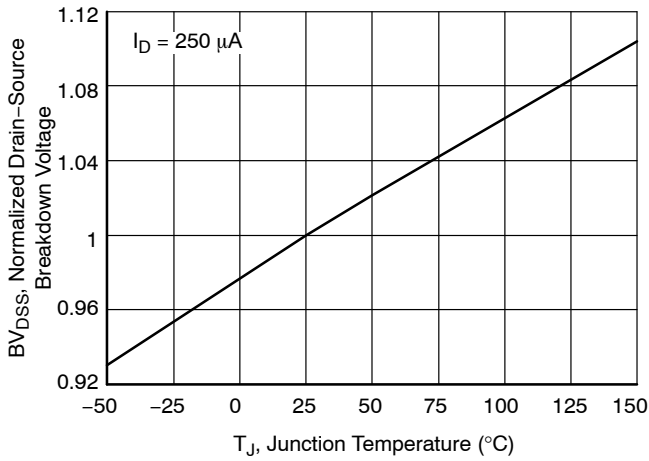


Figure 7. Breakdown Voltage Variation with Temperature

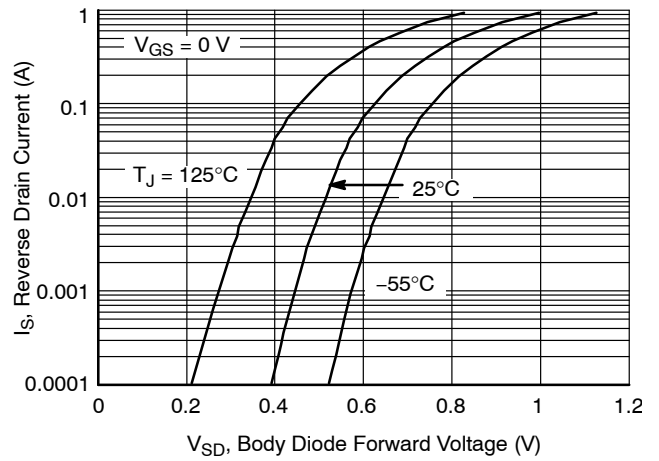


Figure 8. Body Diode Forward Voltage Variation with Source Current and Temperature

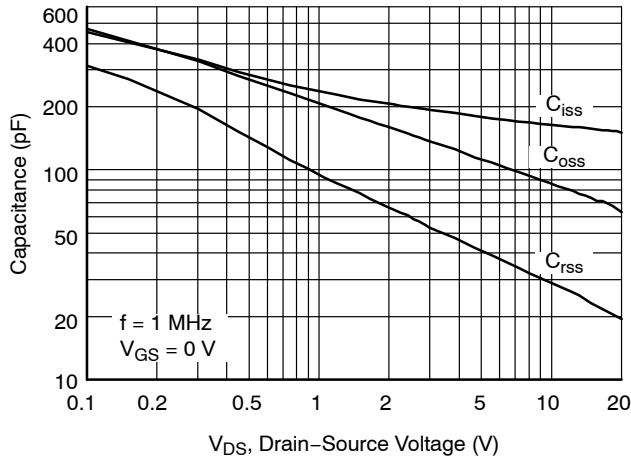


Figure 9. Capacitance Characteristics

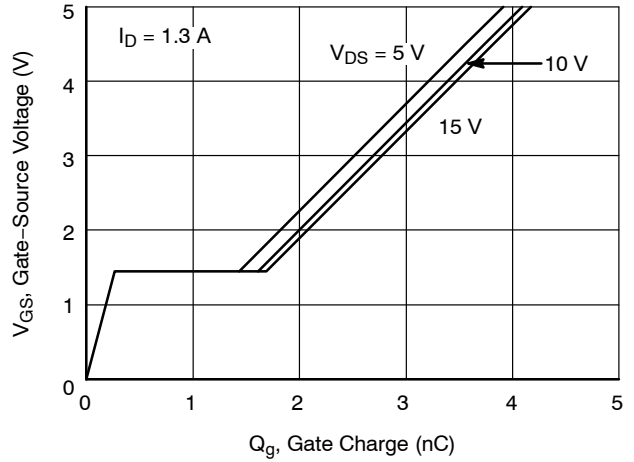


Figure 10. Gate Charge Characteristics

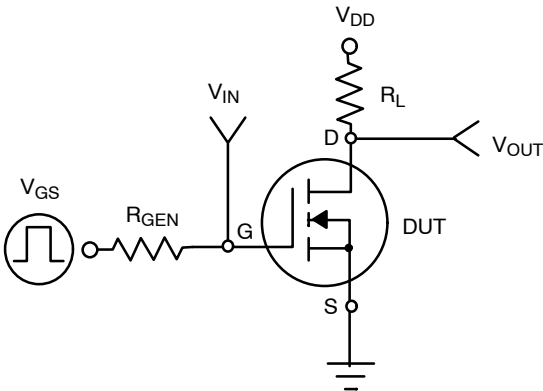


Figure 11. Switching Test Circuit

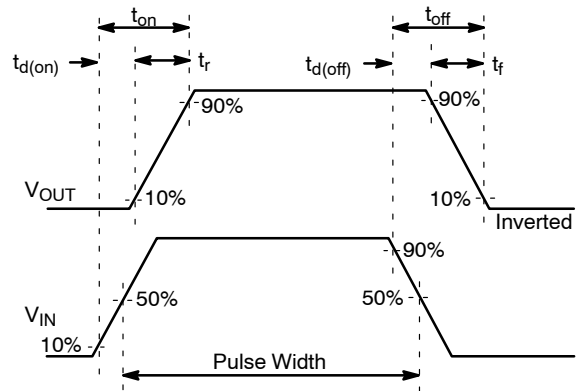


Figure 12. Switching Waveforms

TYPICAL ELECTRICAL CHARACTERISTICS (continued)

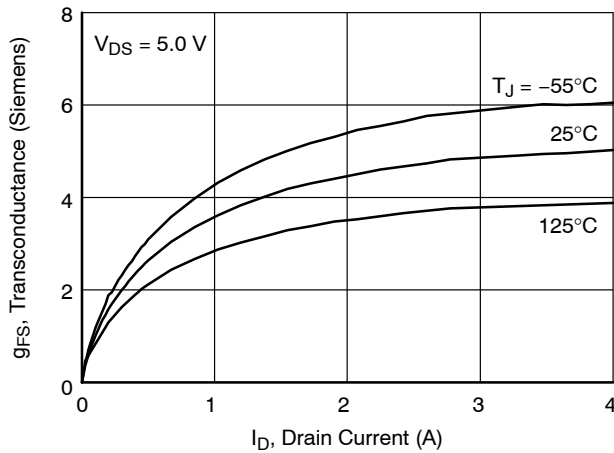


Figure 13. Transconductance Variation with Drain Current and Temperature

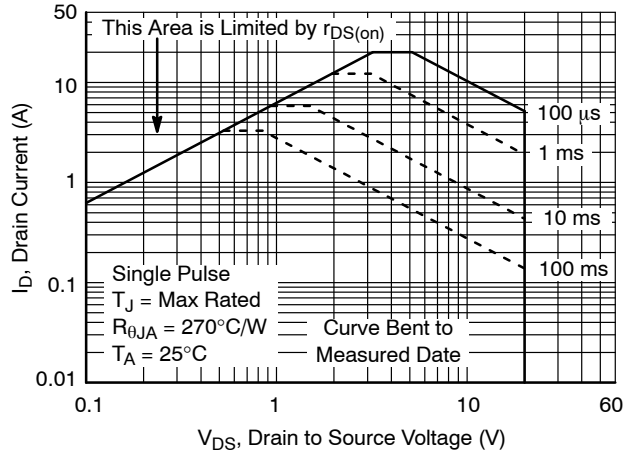


Figure 14. Maximum Safe Operating Area

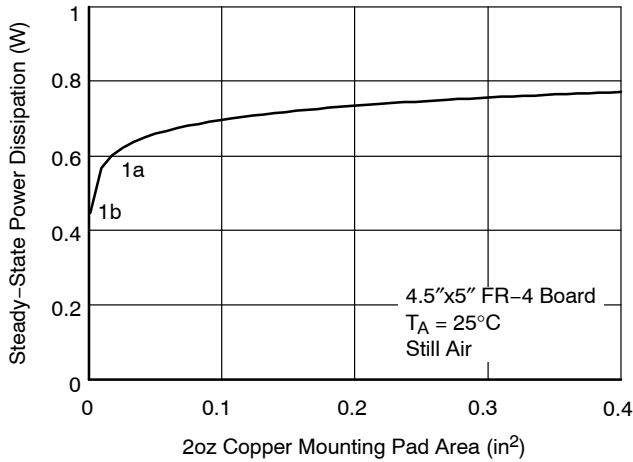


Figure 15. SUPERSOT-3 Maximum Steady-State Power Dissipation versus Copper Mounting Pad Area

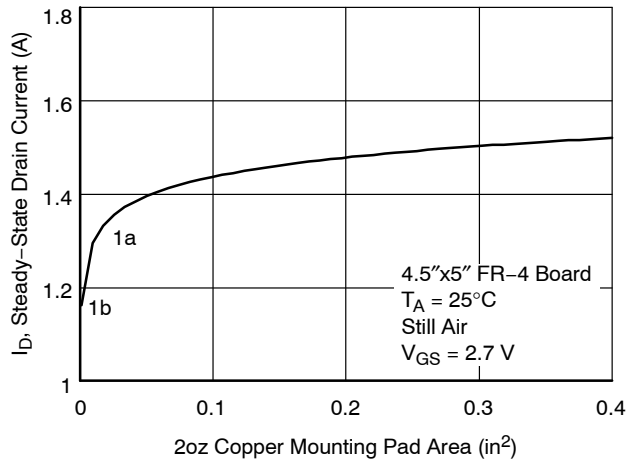


Figure 16. Maximum Steady-State Drain Current versus Copper Mounting Pad Area

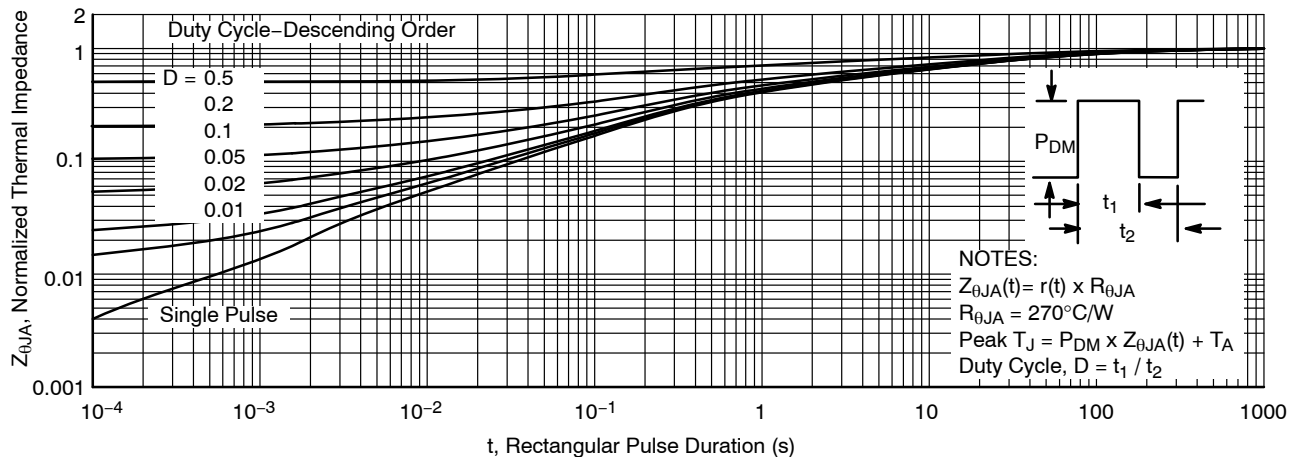


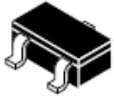
Figure 17. Transient Thermal Response Curve

NOTE: Thermal characterization performed using the conditions described in Note 1b. Response will change depending on the circuit board design.

# NDS331N

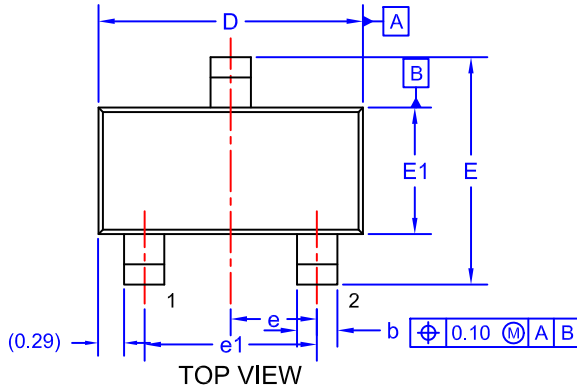
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# MECHANICAL CASE OUTLINE PACKAGE DIMENSIONS



SOT-23/SUPERSOT™ -23, 3 LEAD, 1.4x2.9  
CASE 527AG  
ISSUE A

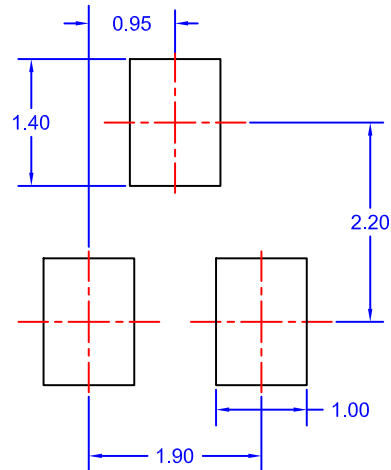
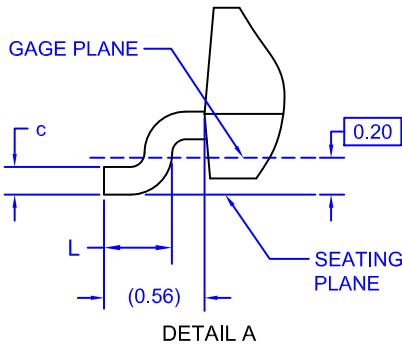
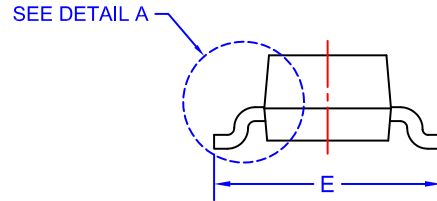
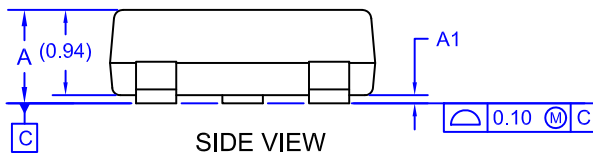
DATE 09 DEC 2019



NOTES: UNLESS OTHERWISE SPECIFIED

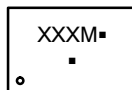
1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 2009.
2. ALL DIMENSIONS ARE IN MILLIMETERS.
3. DIMENSIONS ARE EXCLUSIVE OF BURRS, MOLD FLASH AND TIE BAR EXTRUSIONS.

DIM	MIN.	NOM.	MAX.
A	0.85	0.95	1.12
A1	0.00	0.05	0.10
b	0.370	0.435	0.508
c	0.085	0.150	0.180
D	2.80	2.92	3.04
E	2.31	2.51	2.71
E1	1.20	1.40	1.52
e	0.95 BSC		
e1	1.90 BSC		
L	0.33	0.38	0.43



\*FOR ADDITIONAL INFORMATION ON OUR Pb-FREE STRATEGY AND SOLDERING DETAILS, PLEASE DOWNLOAD THE ON SEMICONDUCTOR SOLDERING AND MOUNTING TECHNIQUES REFERENCE MANUAL, SOLDERRM/D.

### GENERIC MARKING DIAGRAM\*



- XXX = Specific Device Code
- M = Month Code
- = Pb-Free Package

(Note: Microdot may be in either location)

\*This information is generic. Please refer to device data sheet for actual part marking. Pb-Free indicator, "G" or microdot "▪", may or may not be present. Some products may not follow the Generic Marking.

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