

# NIF9N05CL, NIF9N05ACL

## Protected Power MOSFET

2.6 A, 52 V, N-Channel, Logic Level, Clamped MOSFET w/ ESD Protection in a SOT-223 Package



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### Benefits

- High Energy Capability for Inductive Loads
- Low Switching Noise Generation

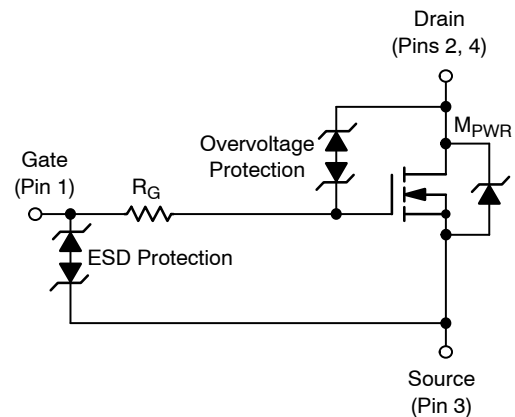
### Features

- Diode Clamp Between Gate and Source
- ESD Protection – HBM 5000 V
- Active Over-Voltage Gate to Drain Clamp
- Scalable to Lower or Higher  $R_{DS(on)}$
- Internal Series Gate Resistance
- Pb-Free Packages are Available

### Applications

- Automotive and Industrial Markets:  
Solenoid Drivers, Lamp Drivers, Small Motor Drivers

$V_{DSS}$ (Clamped)	$R_{DS(ON)}$ TYP	$I_D$ MAX
52 V	107 mΩ	2.6 A

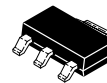


### MAXIMUM RATINGS ( $T_J = 25^\circ\text{C}$ unless otherwise noted)

Rating	Symbol	Value	Unit
Drain-to-Source Voltage Internally Clamped	$V_{DSS}$	52–59	V
Gate-to-Source Voltage – Continuous	$V_{GS}$	±15	V
Drain Current	$I_D$	2.6	A
– Continuous @ $T_A = 25^\circ\text{C}$			
– Single Pulse ( $t_p = 10 \mu\text{s}$ ) (Note 1)	$I_{DM}$	10	
Total Power Dissipation @ $T_A = 25^\circ\text{C}$ (Note 1)	$P_D$	1.69	W
Operating and Storage Temperature Range	$T_J, T_{stg}$	–55 to 150	$^\circ\text{C}$
Single Pulse Drain-to-Source Avalanche Energy ( $V_{DD} = 50 \text{ V}$ , $I_{D(pk)} = 1.17 \text{ A}$ , $V_{GS} = 10 \text{ V}$ , $L = 160 \text{ mH}$ , $R_G = 25 \Omega$ )	$E_{AS}$	110	mJ
Thermal Resistance, Junction-to-Ambient (Note 1)	$R_{\theta JA}$	74	$^\circ\text{C/W}$
Junction-to-Ambient (Note 2)	$R_{\theta JA}$	169	
Maximum Lead Temperature for Soldering Purposes, 1/8" from Case for 10 Seconds	$T_L$	260	$^\circ\text{C}$

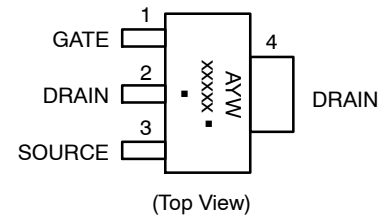
Stresses exceeding Maximum Ratings may damage the device. Maximum Ratings are stress ratings only. Functional operation above the Recommended Operating Conditions is not implied. Extended exposure to stresses above the Recommended Operating Conditions may affect device reliability.

1. When surface mounted to a FR4 board using 1" pad size, (Cu area 1.127 in<sup>2</sup>).
2. When surface mounted to a FR4 board using minimum recommended pad size, (Cu area 0.412 in<sup>2</sup>).



SOT-223  
CASE 318E  
STYLE 3

### MARKING DIAGRAM



- A = Assembly Location
- Y = Year
- W = Work Week
- xxxxx = F9N05 or 9N05A
- = 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 5 of this data sheet.

# NIF9N05CL, NIF9N05ACL

## MOSFET ELECTRICAL CHARACTERISTICS ( $T_J = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
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### OFF CHARACTERISTICS

Drain-to-Source Breakdown Voltage (Note 3) $(V_{GS} = 0\text{ V}, I_D = 1.0\text{ mA}, T_J = 25^\circ\text{C})$ $(V_{GS} = 0\text{ V}, I_D = 1.0\text{ mA}, T_J = -40^\circ\text{C to } 125^\circ\text{C})$ Temperature Coefficient (Negative)	$V_{(BR)DSS}$	52 50.8	55 54 -9.3	59 59.5	V V $\text{mV}/^\circ\text{C}$
Zero Gate Voltage Drain Current $(V_{DS} = 40\text{ V}, V_{GS} = 0\text{ V})$ $(V_{DS} = 40\text{ V}, V_{GS} = 0\text{ V}, T_J = 125^\circ\text{C})$	$I_{DSS}$			10 25	$\mu\text{A}$
Gate-Body Leakage Current $(V_{GS} = \pm 8\text{ V}, V_{DS} = 0\text{ V})$ $(V_{GS} = \pm 14\text{ V}, V_{DS} = 0\text{ V})$	$I_{GSS}$		$\pm 22$	$\pm 10$	$\mu\text{A}$

### ON CHARACTERISTICS (Note 3)

Gate Threshold Voltage (Note 3) $(V_{DS} = V_{GS}, I_D = 100\ \mu\text{A})$ Threshold Temperature Coefficient (Negative)	$V_{GS(th)}$	1.3	1.75 -4.1	2.5	V $\text{mV}/^\circ\text{C}$
Static Drain-to-Source On-Resistance (Note 3) $(V_{GS} = 3.5\text{ V}, I_D = 0.6\text{ A})$ $(V_{GS} = 4.0\text{ V}, I_D = 1.5\text{ A})$ $(V_{GS} = 10\text{ V}, I_D = 2.6\text{ A})$	$R_{DS(on)}$		190 165 107	380 200 125	$\text{m}\Omega$
Forward Transconductance (Note 3) ( $V_{DS} = 15\text{ V}, I_D = 2.6\text{ A}$ )	$g_{FS}$		3.8		Mhos

### DYNAMIC CHARACTERISTICS

Input Capacitance	$V_{DS} = 35\text{ V}, V_{GS} = 0\text{ V},$ $f = 10\text{ kHz}$	$C_{iss}$		155	250	$\mu\text{F}$
Output Capacitance		$C_{oss}$		60	100	
Transfer Capacitance		$C_{rss}$		25	40	
Input Capacitance	$V_{DS} = 25\text{ V}, V_{GS} = 0\text{ V},$ $f = 10\text{ kHz}$	$C_{iss}$		170		$\mu\text{F}$
Output Capacitance		$C_{oss}$		70		
Transfer Capacitance		$C_{rss}$		30		

3. Pulse Test: Pulse Width  $\leq 300\ \mu\text{s}$ , Duty Cycle  $\leq 2\%$ .
4. Switching characteristics are independent of operating junction temperatures.

# NIF9N05CL, NIF9N05ACL

## MOSFET ELECTRICAL CHARACTERISTICS ( $T_J = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit	
<b>SWITCHING CHARACTERISTICS (Note 4)</b>						
Turn-On Delay Time	$V_{GS} = 4.5\text{ V}, V_{DD} = 40\text{ V}, I_D = 2.6\text{ A}, R_D = 15.4\ \Omega$	$t_{d(on)}$		275	465	ns
Rise Time		$t_r$		1418	2400	
Turn-Off Delay Time		$t_{d(off)}$		780	1320	
Fall Time		$t_f$		1120	1900	
Turn-On Delay Time	$V_{GS} = 4.5\text{ V}, V_{DD} = 40\text{ V}, I_D = 1.0\text{ A}, R_D = 40\ \Omega$	$t_{d(on)}$		242		ns
Rise Time		$t_r$		1165		
Turn-Off Delay Time		$t_{d(off)}$		906		
Fall Time		$t_f$		1273		
Turn-On Delay Time	$V_{GS} = 10\text{ V}, V_{DD} = 15\text{ V}, I_D = 2.6\text{ A}, R_D = 5.8\ \Omega$	$t_{d(on)}$		107		ns
Rise Time		$t_r$		290		
Turn-Off Delay Time		$t_{d(off)}$		1540		
Fall Time		$t_f$		1000		
Gate Charge	$V_{GS} = 4.5\text{ V}, V_{DS} = 40\text{ V}, I_D = 2.6\text{ A (Note 3)}$	$Q_T$		4.5	7.0	nC
		$Q_1$		0.9		
		$Q_2$		2.6		
Gate Charge	$V_{GS} = 4.5\text{ V}, V_{DS} = 15\text{ V}, I_D = 1.5\text{ A (Note 3)}$	$Q_T$		3.9		nC
		$Q_1$		1.0		
		$Q_2$		1.7		

## SOURCE-DRAIN DIODE CHARACTERISTICS

Forward On-Voltage	$I_S = 2.6\text{ A}, V_{GS} = 0\text{ V (Note 3)}$ $I_S = 2.6\text{ A}, V_{GS} = 0\text{ V}, T_J = 125^\circ\text{C}$	$V_{SD}$		0.81 0.66	1.5	V
Reverse Recovery Time	$I_S = 1.5\text{ A}, V_{GS} = 0\text{ V}, di_S/dt = 100\text{ A}/\mu\text{s (Note 3)}$	$t_{rr}$		730		ns
		$t_a$		200		
		$t_b$		530		
Reverse Recovery Stored Charge		$Q_{RR}$		6.3		$\mu\text{C}$

## ESD CHARACTERISTICS

Electro-Static Discharge Capability	Human Body Model (HBM)	ESD	5000			V
	Machine Model (MM)		500			

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

4. Switching characteristics are independent of operating junction temperatures.

# NIF9N05CL, NIF9N05ACL

## TYPICAL PERFORMANCE CURVES

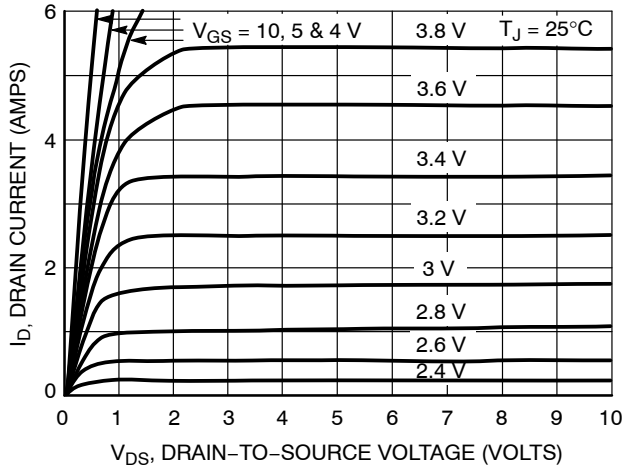


Figure 1. On-Region Characteristics

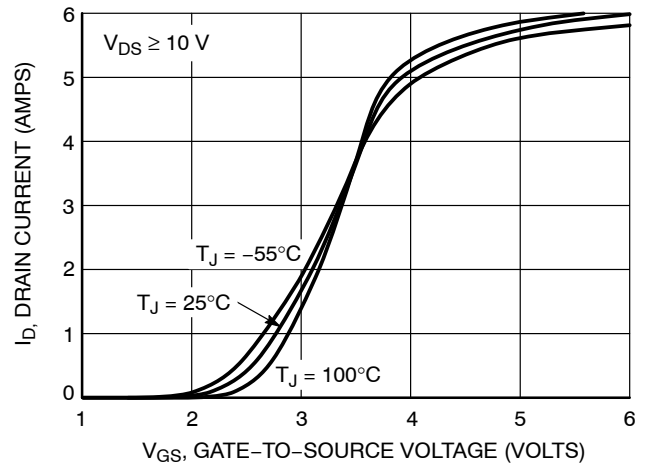


Figure 2. Transfer Characteristics

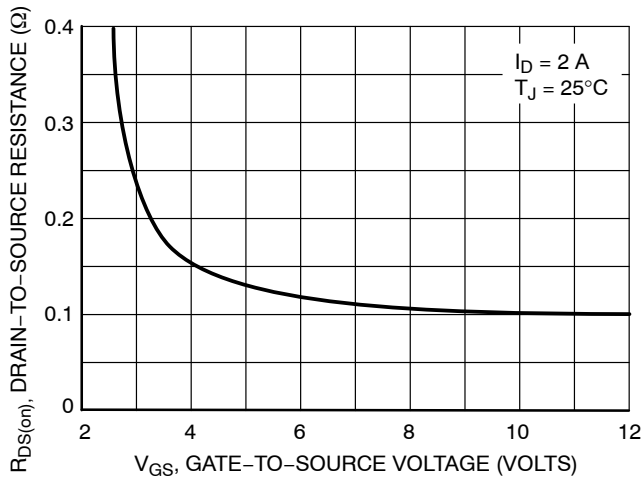


Figure 3. On-Resistance vs. Gate-to-Source Voltage

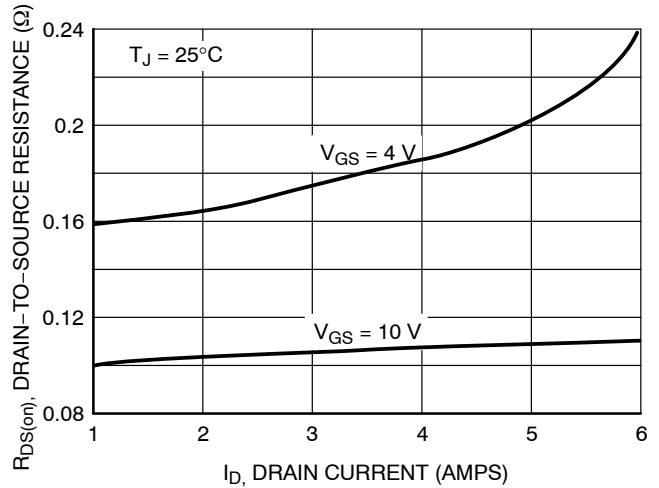


Figure 4. On-Resistance vs. Drain Current and Gate Voltage

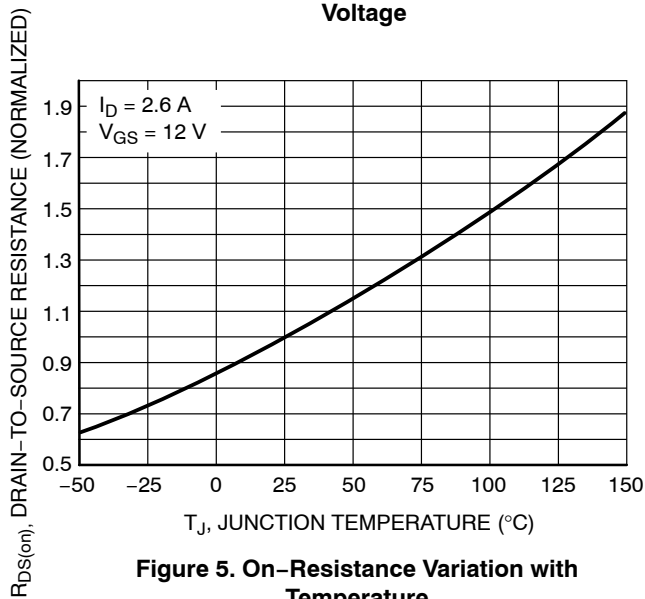


Figure 5. On-Resistance Variation with Temperature

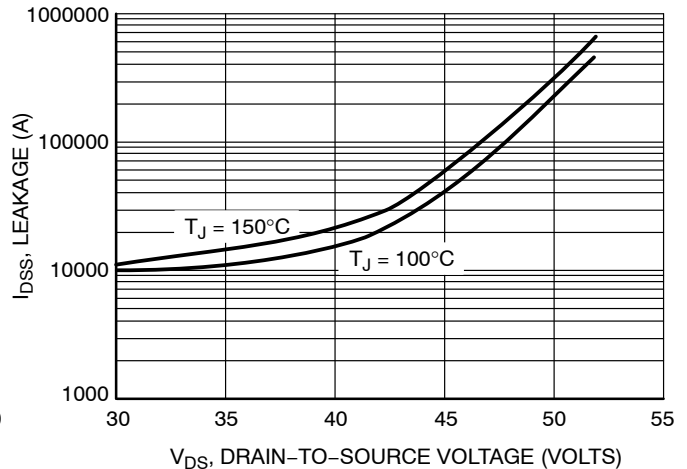


Figure 6. Drain-to-Source Leakage Current vs. Voltage

# NIF9N05CL, NIF9N05ACL

## TYPICAL PERFORMANCE CURVES

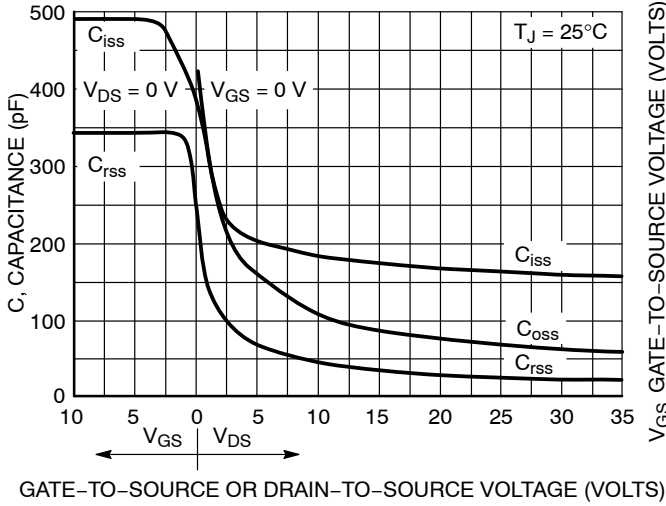


Figure 7. Capacitance Variation

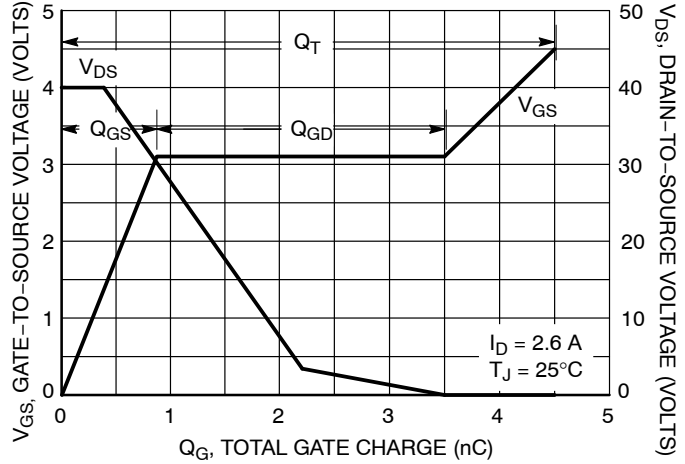


Figure 8. Gate-to-Source Voltage vs. Total Gate Charge

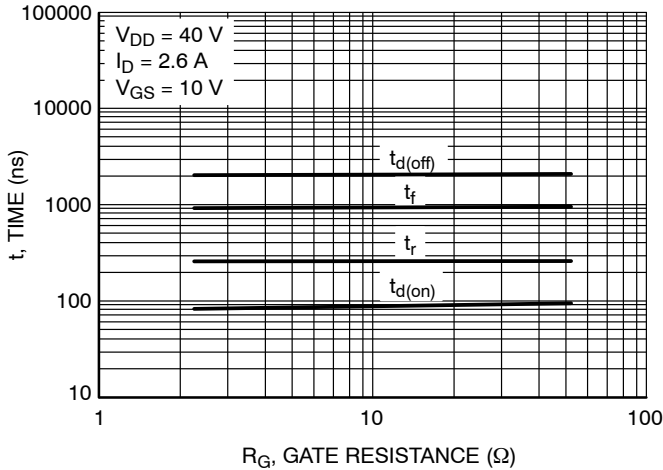


Figure 9. Resistance Switching Time Variation vs. Gate Resistance

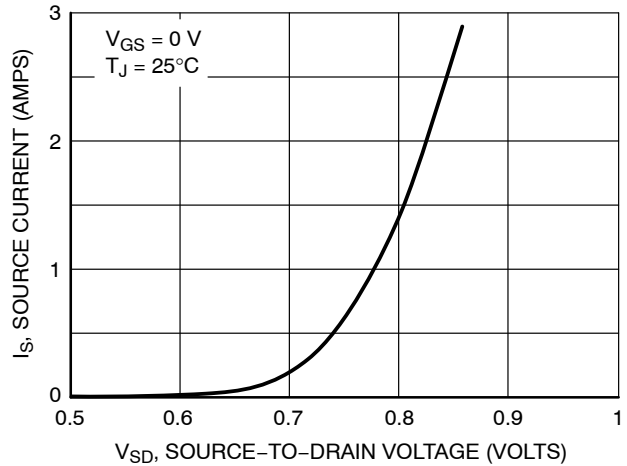


Figure 10. Diode Forward Voltage vs. Current

### ORDERING INFORMATION

Device	Package	Shipping†
NIF9N05CLT1	SOT-223	1000 / Tape & Reel
NIF9N05CLT1G	SOT-223 (Pb-Free)	
NIF9N05ACL1G		
NIF9N05CLT3	SOT-223	4000 / Tape & Reel
NIF9N05CLT3G	SOT-223 (Pb-Free)	
NIF9N05ACL3G		

†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.

# MECHANICAL CASE OUTLINE

## PACKAGE DIMENSIONS

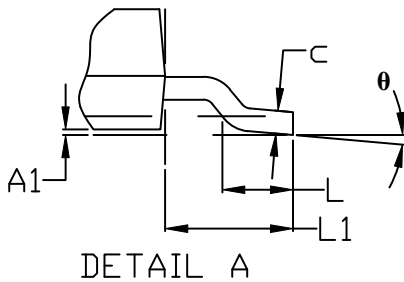
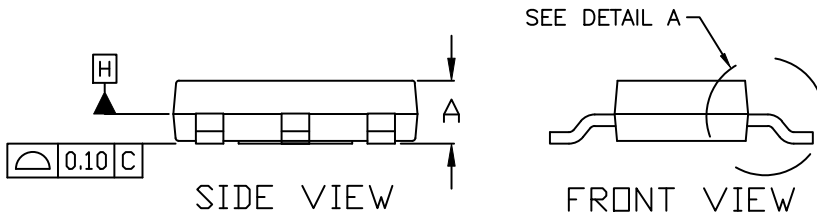
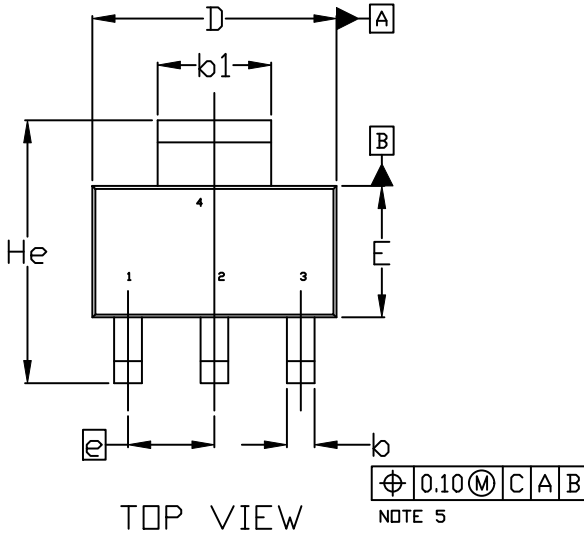
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SCALE 1:1

SOT-223 (TO-261)  
CASE 318E-04  
ISSUE R

DATE 02 OCT 2018



NOTES:

1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: MILLIMETERS
3. DIMENSIONS D & E DO NOT INCLUDE MOLD FLASH, PROTRUSIONS OR GATE BURRS. MOLD FLASH, PROTRUSIONS OR GATE BURRS SHALL NOT EXCEED 0.200MM PER SIDE.
4. DATUMS A AND B ARE DETERMINED AT DATUM H.
5. A1 IS DEFINED AS THE VERTICAL DISTANCE FROM THE SEATING PLANE TO THE LOWEST POINT OF THE PACKAGE BODY.
6. POSITIONAL TOLERANCE APPLIES TO DIMENSIONS b AND b1.

MILLIMETERS			
DIM	MIN.	NOM.	MAX.
A	1.50	1.63	1.75
A1	0.02	0.06	0.10
b	0.60	0.75	0.89
b1	2.90	3.06	3.20
c	0.24	0.29	0.35
D	6.30	6.50	6.70
E	3.30	3.50	3.70
e	2.30 BSC		
L	0.20	---	---
L1	1.50	1.75	2.00
He	6.70	7.00	7.30
θ	0°	---	10°



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**SOT-223 (TO-261)**  
**CASE 318E-04**  
**ISSUE R**

DATE 02 OCT 2018

- |  |   |   |   |   |
|--|---|---|---|---|
| <b>STYLE 1:</b><br>PIN 1. BASE<br>2. COLLECTOR<br>3. EMITTER<br>4. COLLECTOR | <b>STYLE 2:</b><br>PIN 1. ANODE<br>2. CATHODE<br>3. NC<br>4. CATHODE        | <b>STYLE 3:</b><br>PIN 1. GATE<br>2. DRAIN<br>3. SOURCE<br>4. DRAIN           | <b>STYLE 4:</b><br>PIN 1. SOURCE<br>2. DRAIN<br>3. GATE<br>4. DRAIN   | <b>STYLE 5:</b><br>PIN 1. DRAIN<br>2. GATE<br>3. SOURCE<br>4. GATE    |
| <b>STYLE 6:</b><br>PIN 1. RETURN<br>2. INPUT<br>3. OUTPUT<br>4. INPUT        | <b>STYLE 7:</b><br>PIN 1. ANODE 1<br>2. CATHODE<br>3. ANODE 2<br>4. CATHODE | <b>STYLE 8:</b><br>CANCELLED  | <b>STYLE 9:</b><br>PIN 1. INPUT<br>2. GROUND<br>3. LOGIC<br>4. GROUND | <b>STYLE 10:</b><br>PIN 1. CATHODE<br>2. ANODE<br>3. GATE<br>4. ANODE |
| <b>STYLE 11:</b><br>PIN 1. MT 1<br>2. MT 2<br>3. GATE<br>4. MT 2             | <b>STYLE 12:</b><br>PIN 1. INPUT<br>2. OUTPUT<br>3. NC<br>4. OUTPUT         | <b>STYLE 13:</b><br>PIN 1. GATE<br>2. COLLECTOR<br>3. EMITTER<br>4. COLLECTOR |   |   |

**GENERIC  
 MARKING DIAGRAM\***



- A = Assembly Location
- Y = Year
- W = Work Week
- XXXXX = Specific Device 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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