

# NTMFS23D9N06HL

## Power MOSFET

60 V, 23.9 mΩ, 23 A, Single N-Channel

### Features

- Small Footprint (5x6 mm) for Compact Design
- Low  $R_{DS(on)}$  to Minimize Conduction Losses
- Low  $Q_G$  and Capacitance to Minimize Driver Losses
- These Devices are Pb-Free, Halogen-Free / BFR Free and are RoHS Compliant

### Typical Applications

- Printer Head Drive
- Motor Drive

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

Parameter			Symbol	Value	Unit
Drain-to-Source Voltage			$V_{DSS}$	60	V
Gate-to-Source Voltage			$V_{GS}$	$\pm 20$	V
Continuous Drain Current $R_{\theta JC}$ (Note 2)	Steady State	$T_C = 25^{\circ}\text{C}$	$I_D$	23	A
Power Dissipation $R_{\theta JC}$ (Note 2)		$T_C = 25^{\circ}\text{C}$	$P_D$	28.8	W
Continuous Drain Current $R_{\theta JA}$ (Notes 1, 2)	Steady State	$T_A = 25^{\circ}\text{C}$	$I_D$	8.1	A
Power Dissipation $R_{\theta JA}$ (Notes 1, 2)		$T_A = 25^{\circ}\text{C}$	$P_D$	3.5	W
Pulsed Drain Current	$T_A = 25^{\circ}\text{C}$ , $t_p = 10\text{ }\mu\text{s}$		$I_{DM}$	100	A
Operating Junction and Storage Temperature			$T_J$ , $T_{stg}$	-55 to +175	$^{\circ}\text{C}$
Source Current (Body Diode)			$I_S$	24	A
Single Pulse Drain-to-Source Avalanche Energy ( $I_{L(pk)} = 1.1\text{ A}$ )			$E_{AS}$	65	mJ
Lead Temperature for Soldering Purposes (1/8" from case for 10 s)			$T_L$	260	$^{\circ}\text{C}$

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 RESISTANCE MAXIMUM RATINGS

Parameter	Symbol	Value	Unit
Junction-to-Case – Steady State (Note 2)	$R_{\theta JC}$	5.3	$^\circ\text{C}/\text{W}$
Junction-to-Ambient – Steady State (Note 2)	$R_{\theta JA}$	43	

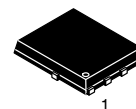
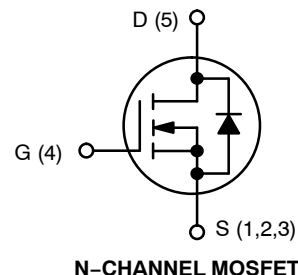
1. Surface-mounted on FR4 board using a 1 in<sup>2</sup> pad size, 1 oz. Cu pad.
2. The entire application environment impacts the thermal resistance values shown, they are not constants and are only valid for the particular conditions noted.



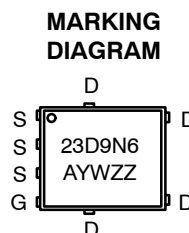
ON Semiconductor®

[www.onsemi.com](http://www.onsemi.com)

$V_{(BR)DSS}$	$R_{DS(ON)} \text{ MAX}$	$I_D \text{ MAX}$
60 V	23.9 mΩ @ 10 V	23 A
	35.3 mΩ @ 4.5 V	



DFN5  
(SO-8FL)  
CASE 488AA  
STYLE 1



23D9N6 = Specific Device Code  
A = Assembly Location  
Y = Year  
W = Work Week  
ZZ = Lot Traceability

### ORDERING INFORMATION

See detailed ordering, marking and shipping information on page 5 of this data sheet.

# NTMFS23D9N06HL

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

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

Drain-to-Source Breakdown Voltage	$V_{(BR)DSS}$	$V_{GS} = 0\text{ V}, I_D = 250\text{ }\mu\text{A}$	60			V
Drain-to-Source Breakdown Voltage Temperature Coefficient	$V_{(BR)DSS}/T_J$	$I_D = 250\text{ }\mu\text{A}$ , ref to $25^\circ\text{C}$		45.3		mV/ $^\circ\text{C}$
Zero Gate Voltage Drain Current	$I_{DSS}$	$V_{GS} = 0\text{ V}, V_{DS} = 60\text{ V}$	$T_J = 25^\circ\text{C}$		10	$\mu\text{A}$
			$T_J = 125^\circ\text{C}$		125	
Gate-to-Source Leakage Current	$I_{GSS}$	$V_{DS} = 0\text{ V}, V_{GS} = 20\text{ V}$			100	nA

### ON CHARACTERISTICS (Note 3)

Gate Threshold Voltage	$V_{GS(TH)}$	$V_{GS} = V_{DS}, I_D = 20\text{ }\mu\text{A}$	1.2		2.2	V
Threshold Temperature Coefficient	$V_{GS(TH)}/T_J$	$I_D = 20\text{ }\mu\text{A}$ , ref to $25^\circ\text{C}$		-4.5		mV/ $^\circ\text{C}$
Drain-to-Source On Resistance	$R_{DS(on)}$	$V_{GS} = 10\text{ V}, I_D = 10\text{ A}$		20	23.9	m $\Omega$
		$V_{GS} = 4.5\text{ V}, I_D = 10\text{ A}$		27	35.3	
Gate Resistance	$R_G$	$T_A = 25^\circ\text{C}$		1.5		$\Omega$

### CHARGES, CAPACITANCES & GATE RESISTANCE

Input Capacitance	$C_{ISS}$	$V_{GS} = 0\text{ V}, f = 1\text{ MHz}, V_{DS} = 30\text{ V}$		340		pF
Output Capacitance	$C_{OSS}$			64		
Reverse Transfer Capacitance	$C_{RSS}$			3.80		
Total Gate Charge	$Q_{G(TOT)}$	$V_{GS} = 10\text{ V}, V_{DS} = 30\text{ V}; I_D = 10\text{ A}$		6.0		nC
Total Gate Charge	$Q_{G(TOT)}$	$V_{GS} = 4.5\text{ V}, V_{DS} = 30\text{ V}; I_D = 10\text{ A}$		2.75		
Threshold Gate Charge	$Q_{G(TH)}$			0.75		
Gate-to-Source Charge	$Q_{GS}$			1.40		
Gate-to-Drain Charge	$Q_{GD}$			0.60		

### SWITCHING CHARACTERISTICS (Note 4)

Turn-On Delay Time	$t_{d(ON)}$	$V_{GS} = 4.5\text{ V}, V_{DS} = 30\text{ V}, I_D = 10\text{ A}, R_G = 2.5\text{ }\Omega$		7.0		ns
Rise Time	$t_r$			28		
Turn-Off Delay Time	$t_{d(OFF)}$			12		
Fall Time	$t_f$			22		

### DRAIN-SOURCE DIODE CHARACTERISTICS

Forward Diode Voltage	$V_{SD}$	$V_{GS} = 0\text{ V}, I_S = 10\text{ A}$	$T_J = 25^\circ\text{C}$		0.9	1.2	V
			$T_J = 125^\circ\text{C}$		0.8		
Reverse Recovery Time	$t_{RR}$	$V_{GS} = 0\text{ V}, dI_S/dt = 100\text{ A}/\mu\text{s}, I_S = 10\text{ A}$			18		ns
Charge Time	$t_a$				12		
Discharge Time	$t_b$				6.0		
Reverse Recovery Charge	$Q_{RR}$				8.0		nC

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.

3. Pulse Test: pulse width  $\leq 300\text{ }\mu\text{s}$ , duty cycle  $\leq 2\%$ .

4. Switching characteristics are independent of operating junction temperatures.

TYPICAL CHARACTERISTICS

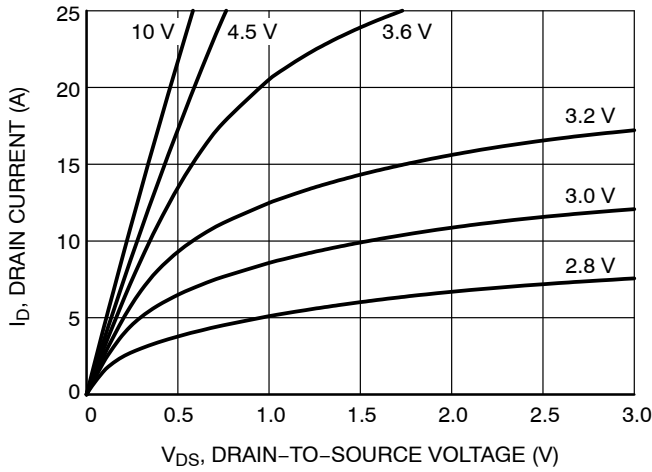


Figure 1. On-Region Characteristics

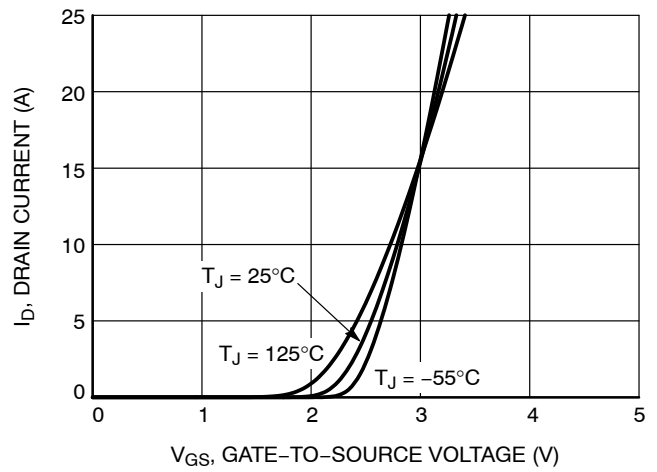


Figure 2. Transfer Characteristics

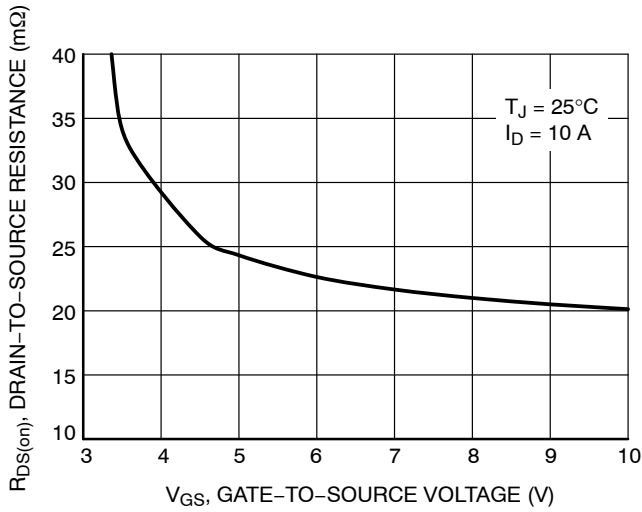


Figure 3. On-Resistance vs. Gate-to-Source Voltage

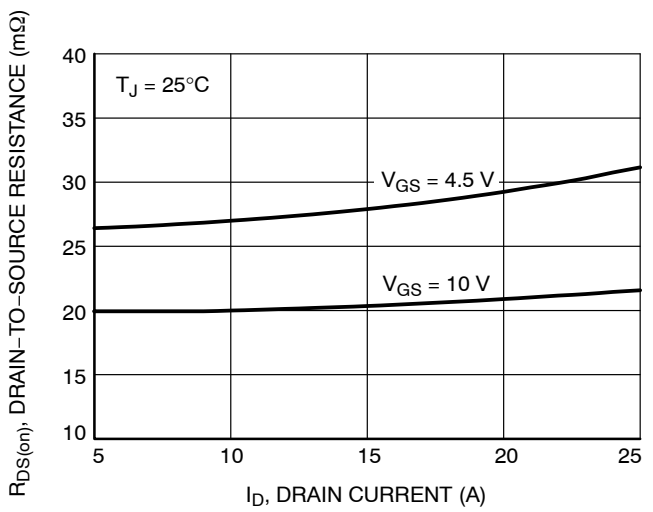


Figure 4. On-Resistance vs. Drain Current and Gate Voltage

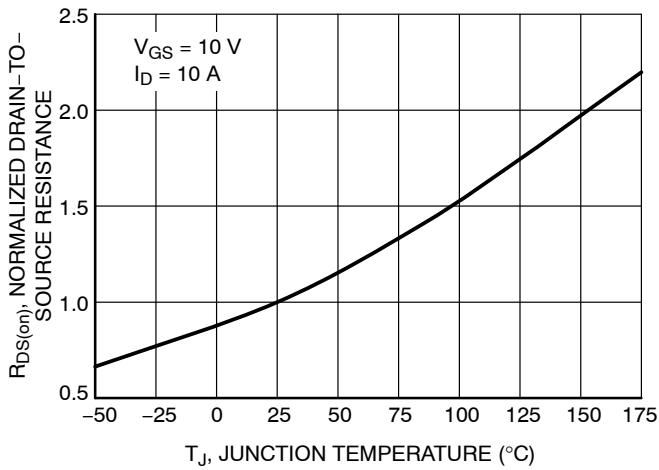


Figure 5. On-Resistance Variation with Temperature

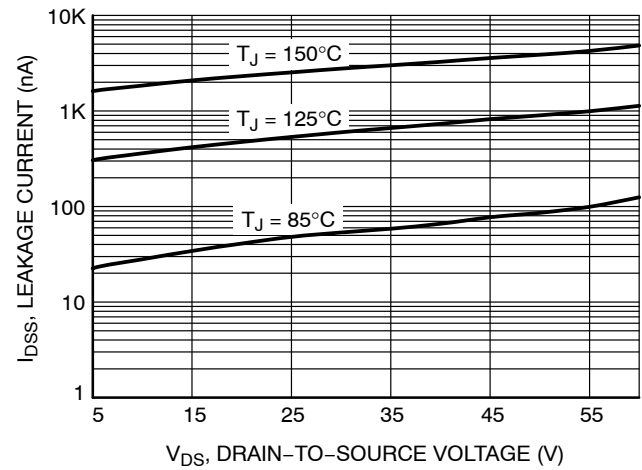


Figure 6. Drain-to-Source Leakage Current vs. Voltage

TYPICAL CHARACTERISTICS

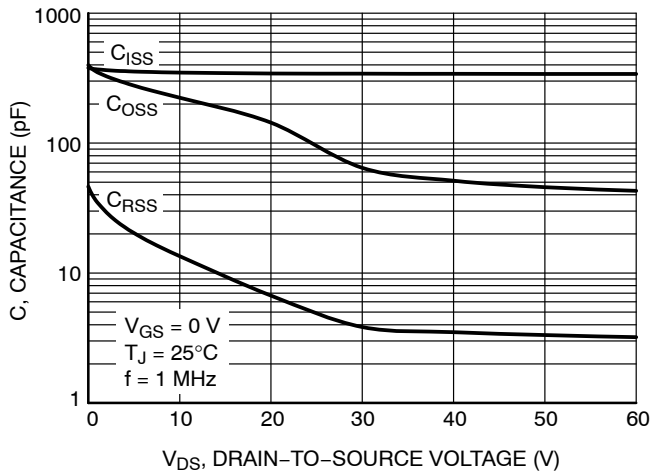


Figure 7. Capacitance Variation

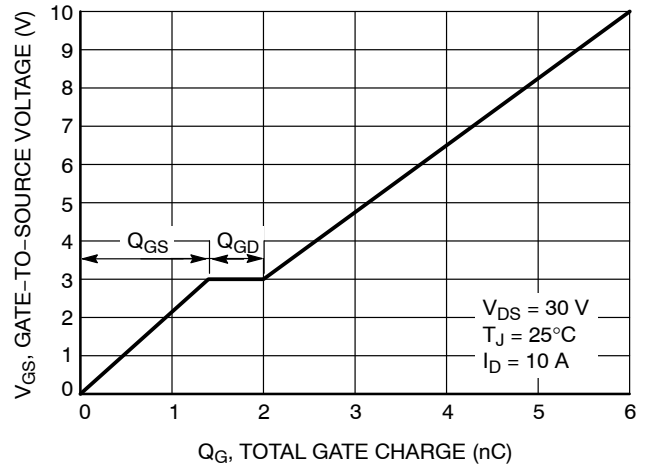


Figure 8. Gate-to-Source Voltage vs. Total Charge

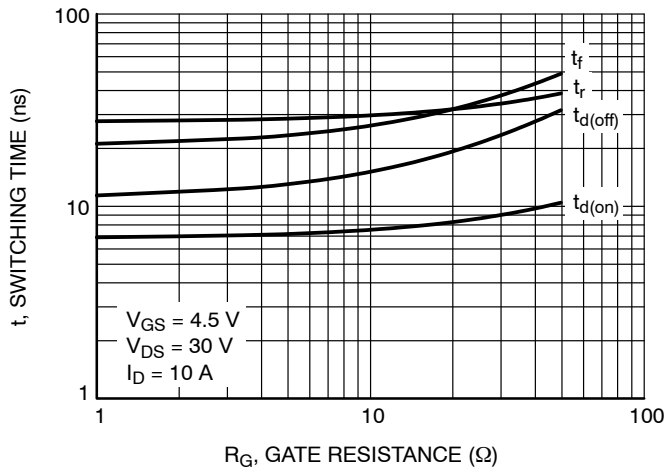


Figure 9. Resistive Switching Time Variation vs. Gate Resistance

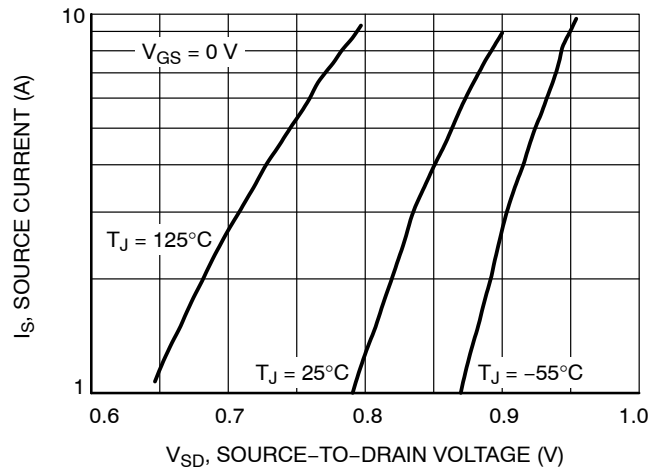


Figure 10. Diode Forward Voltage vs. Current

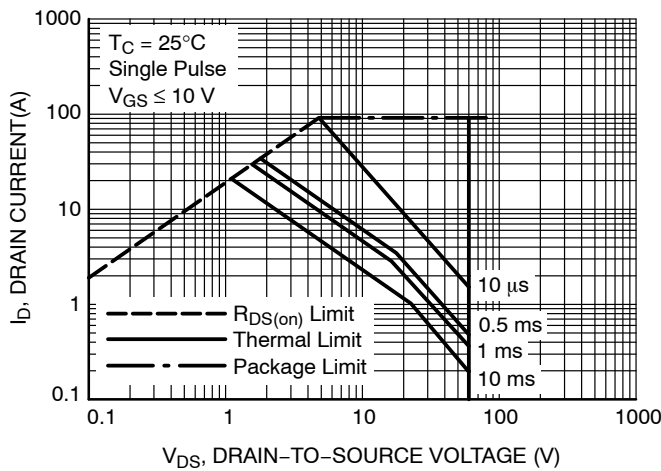


Figure 11. Maximum Rated Forward Biased Safe Operating Area

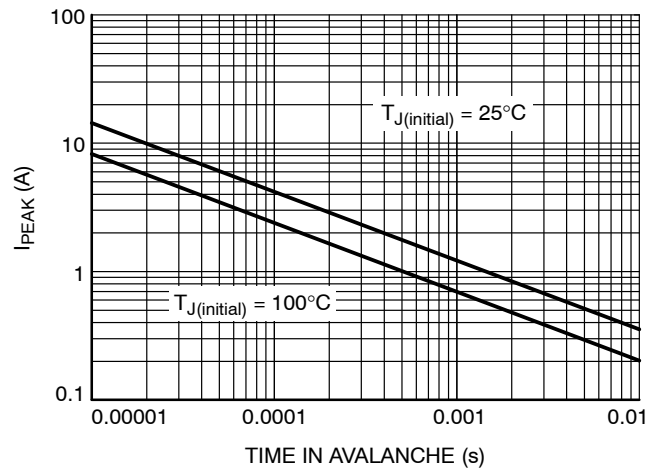


Figure 12.  $I_{PEAK}$  vs. Time in Avalanche

# NTMFS23D9N06HL

## TYPICAL CHARACTERISTICS

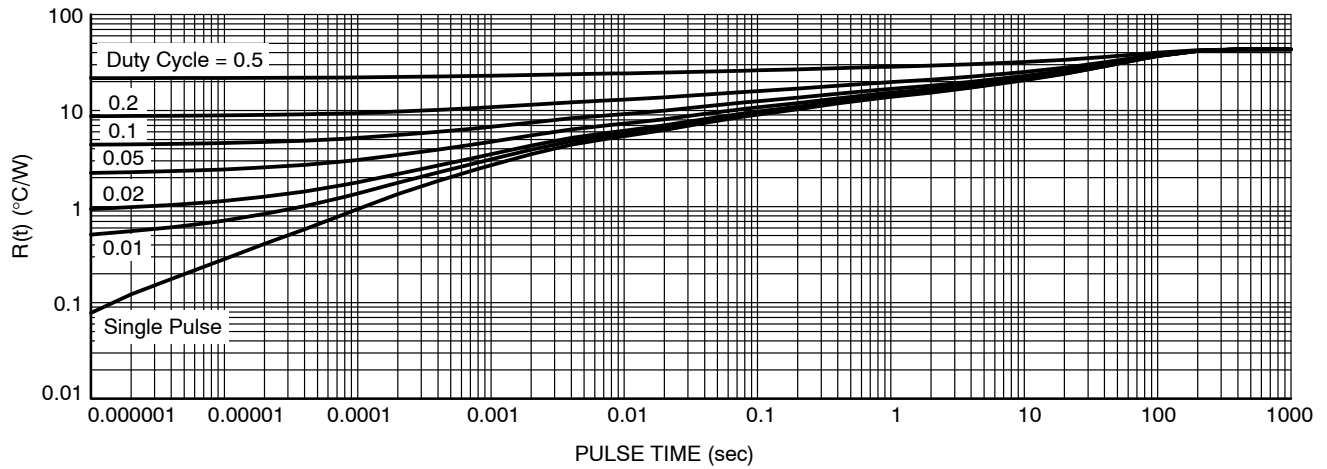


Figure 13. Thermal Characteristics

### DEVICE ORDERING INFORMATION

Device	Marking	Package	Shipping <sup>†</sup>
NTMFS23D9N06HLT1G	23D9N6	DFN5 (Pb-Free)	1500 / Tape & Reel

<sup>†</sup>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.

# NTMFS23D9N06HL

## PACKAGE DIMENSIONS

DFN5 5x6, 1.27P  
(SO-8FL)  
CASE 488AA  
ISSUE N

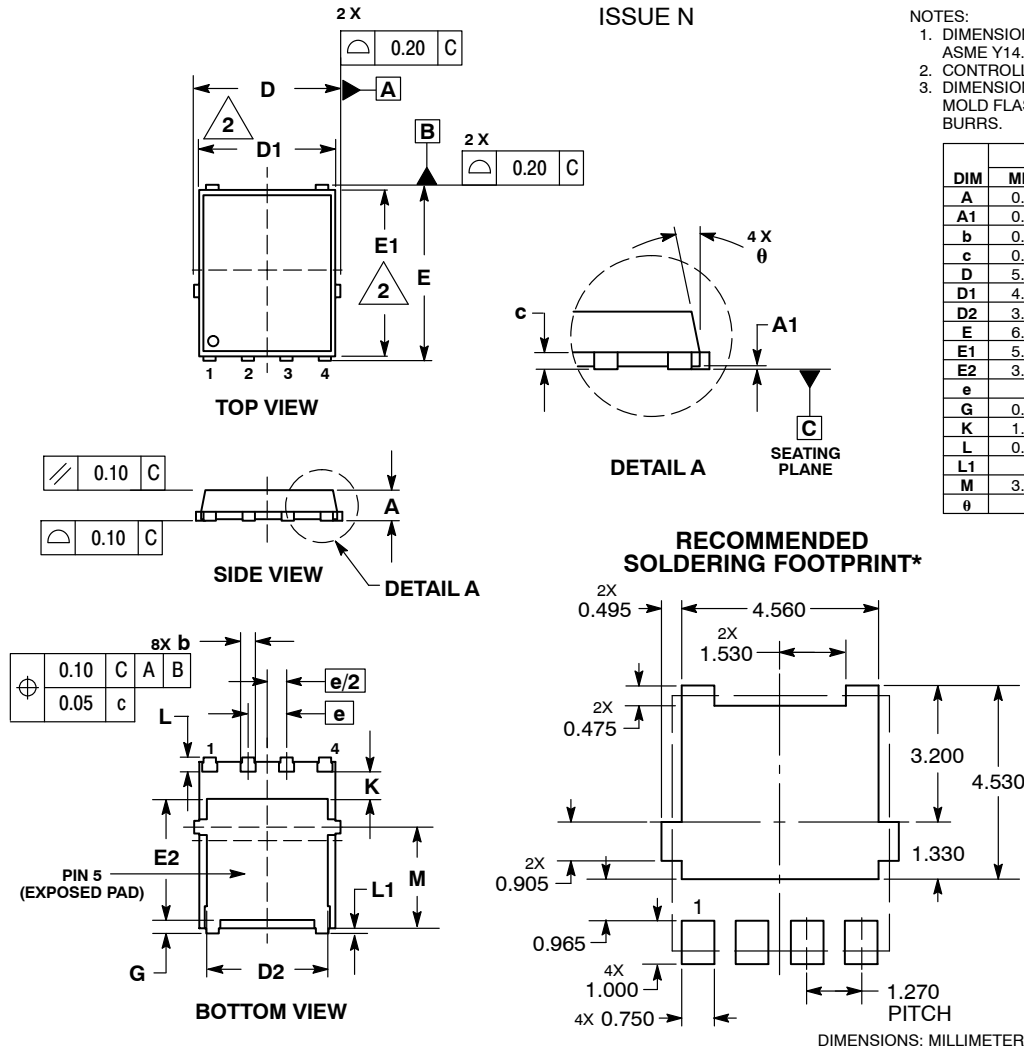
### NOTES:

1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: MILLIMETER.
3. DIMENSION D1 AND E1 DO NOT INCLUDE MOLD FLASH PROTRUSIONS OR GATE BURRS.

DIM	MILLIMETERS		
	MIN	NOM	MAX
A	0.90	1.00	1.10
A1	0.00	---	0.05
b	0.33	0.41	0.51
c	0.23	0.28	0.33
D	5.00	5.15	5.30
D1	4.70	4.90	5.10
D2	3.80	4.00	4.20
E	6.00	6.15	6.30
E1	5.70	5.90	6.10
E2	3.45	3.65	3.85
e	1.27 BSC		
G	0.51	0.575	0.71
K	1.20	1.35	1.50
L	0.51	0.575	0.71
L1	0.125 REF		
M	3.00	3.40	3.80
θ	0°	---	12°

### STYLE 1:

- PIN 1. SOURCE
- SOURCE
- SOURCE
- GATE
- DRAIN



\*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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