

# MOSFET - Power, Single N-Channel, Source-Down TDFN9

## 60 V, 1.5 mΩ, 235 A

### NTMFSS1D5N06CL

#### 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

- DC-DC Converters
- Power Load Switch
- Notebook Battery Management

#### 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 $R_{\theta JC}$	Steady State	$T_C = 25^\circ\text{C}$	$I_D$	237	A
		$T_C = 100^\circ\text{C}$		149	
Power Dissipation $R_{\theta JC}$	Steady State	$T_C = 25^\circ\text{C}$	$P_D$	144	W
		$T_C = 100^\circ\text{C}$		57	
Continuous Drain Current $R_{\theta JA}$ (Notes 1, 2)	Steady State	$T_A = 25^\circ\text{C}$	$I_D$	31	A
		$T_A = 100^\circ\text{C}$		19	
Power Dissipation $R_{\theta JA}$ (Notes 1, 2)	Steady State	$T_A = 25^\circ\text{C}$	$P_D$	2.5	W
		$T_A = 100^\circ\text{C}$		1	
Pulsed Drain Current	$T_A = 25^\circ\text{C}, t_p = 10 \mu\text{s}$	$I_{DM}$	1698	A	
Operating Junction and Storage Temperature Range		$T_J, T_{stg}$	-55 to +150	$^\circ\text{C}$	
Single Pulse Drain-to-Source Avalanche Energy ( $I_{L(pk)} = 75 \text{ A}$ )		$E_{AS}$	207	mJ	
Lead Temperature Soldering Reflow for Soldering Purposes (1/8" from case for 10 s)		$T_L$	260	$^\circ\text{C}$	

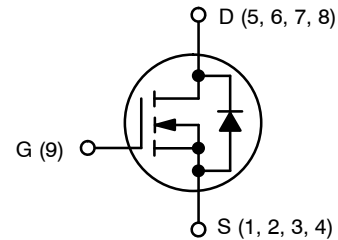
Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

#### THERMAL RESISTANCE MAXIMUM RATINGS

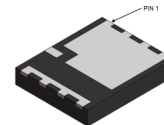
Parameter	Symbol	Value	Unit
Junction-to-Case - Steady State	$R_{\theta JC}$	0.86	$^\circ\text{C}/\text{W}$
Junction-to-Ambient - Steady State (Note 2)	$R_{\theta JA}$	50	

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

$V_{(BR)DSS}$	$R_{DS(ON)} \text{ MAX}$	$I_D \text{ MAX}$
60 V	1.5 mΩ @ 10 V	235 A
	2.3 mΩ @ 4.5 V	

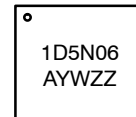


N-CHANNEL MOSFET



TDFN9 5x6  
CASE 520AE

#### MARKING DIAGRAM



1D5N06 = Specific Device Code  
A = Assembly Location  
Y = Year  
W = Work Week  
ZZ = Wafer Lot

#### ORDERING INFORMATION

Device	Package	Shipping†
NTMFSS1D5N06CL	TDFN9 (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 Specification Brochure, BRD8011/D.

# NTMFSS1D5N06CL

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

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
<b>OFF CHARACTERISTICS</b>						
Drain-to-Source Breakdown Voltage	$V_{(BR)DSS}$	$V_{GS} = 0\text{ V}, I_D = 250\ \mu\text{A}$	60			V
Drain-to-Source Breakdown Voltage Temperature Coefficient	$V_{(BR)DSS}/T_J$	$I_D = 250\ \mu\text{A}, \text{ref to } 25^\circ\text{C}$		23.2		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	$\mu\text{A}$
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	$V_{GS(TH)}$	$V_{GS} = V_{DS}, I_D = 250\ \mu\text{A}$	1.2		2.0	V
Threshold Temperature Coefficient	$V_{GS(TH)}/T_J$	$I_D = 250\ \mu\text{A}, \text{ref to } 25^\circ\text{C}$		-5.76		mV/ $^\circ\text{C}$
Drain-to-Source On Resistance	$R_{DS(on)}$	$V_{GS} = 10\text{ V}, I_D = 50\text{ A}$		1.05	1.5	m $\Omega$
		$V_{GS} = 4.5\text{ V}, I_D = 50\text{ A}$		1.42	2.3	
Forward Transconductance	$g_{FS}$	$V_{DS} = 15\text{ V}, I_D = 50\text{ A}$		151		S
Gate Resistance	$R_G$	$T_A = 25^\circ\text{C}$		1		$\Omega$

## CHARGES & CAPACITANCES

Input Capacitance	$C_{ISS}$	$V_{GS} = 0\text{ V}, f = 1\text{ MHz}, V_{DS} = 30\text{ V}$		7526		pF
Output Capacitance	$C_{OSS}$			3462		
Reverse Capacitance	$C_{RSS}$			42		
Total Gate Charge	$Q_{G(TOT)}$	$V_{GS} = 10\text{ V}, V_{DS} = 30\text{ V}, I_D = 50\text{ A}$		102.6		nC
Total Gate Charge	$Q_{G(TOT)}$	$V_{GS} = 4.5\text{ V}, V_{DS} = 30\text{ V}, I_D = 50\text{ A}$		46.1		
Gate-to-Drain Charge	$Q_{GD}$			8.4		
Gate-to-Source Charge	$Q_{GS}$			21		
Plateau Voltage	$V_{GP}$			2.9		

## SWITCHING CHARACTERISTICS (Note 3)

Turn-On Delay Time	$t_{d(ON)}$	$V_{GS} = 4.5\text{ V}, V_{DD} = 30\text{ V}, I_D = 50\text{ A}, R_G = 1.0\ \Omega$		16		ns
Rise Time	$t_r$			7.1		
Turn-Off Delay Time	$t_{d(OFF)}$			41.3		
Fall Time	$t_f$			5.4		

## SOURCE-TO-DRAIN DIODE CHARACTERISTICS

Forward Diode Voltage	$V_{SD}$	$V_{GS} = 0\text{ V}, I_S = 50\text{ A}$	$T_J = 25^\circ\text{C}$		0.78	1.2	V
			$T_J = 125^\circ\text{C}$		0.66		
Reverse Recovery Time	$t_{RR}$	$V_{GS} = 0\text{ V}, di/dt = 100\text{ A}/\mu\text{s}, I_S = 50\text{ A}$		83		ns	
Charge Time	$t_a$			39.9			
Discharge Time	$t_b$			43.2			
Reverse Recovery Charge	$Q_{RR}$			142			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. Switching characteristics are independent of operating junction temperatures.

# NTMFSS1D5N06CL

## TYPICAL CHARACTERISTICS

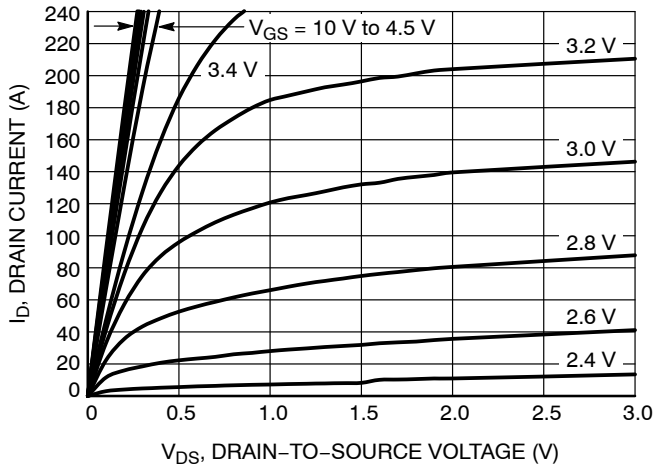


Figure 1. On-Region Characteristics

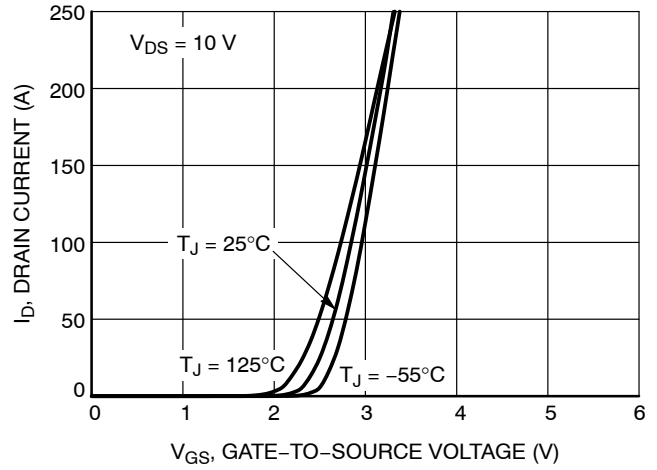


Figure 2. Transfer Characteristics

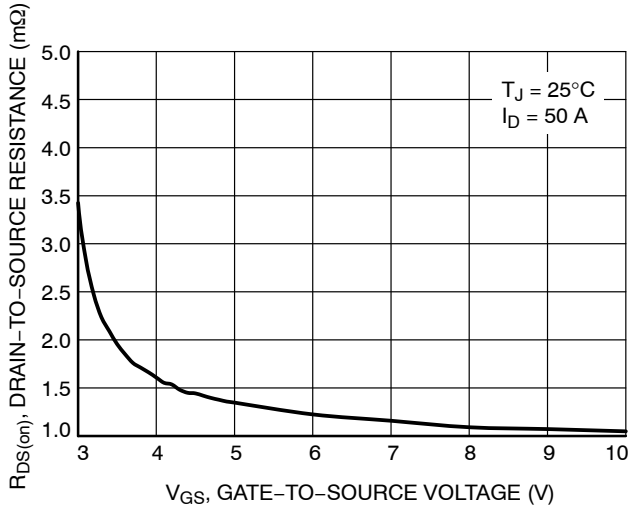


Figure 3. On-Resistance vs. Gate-to-Source Voltage

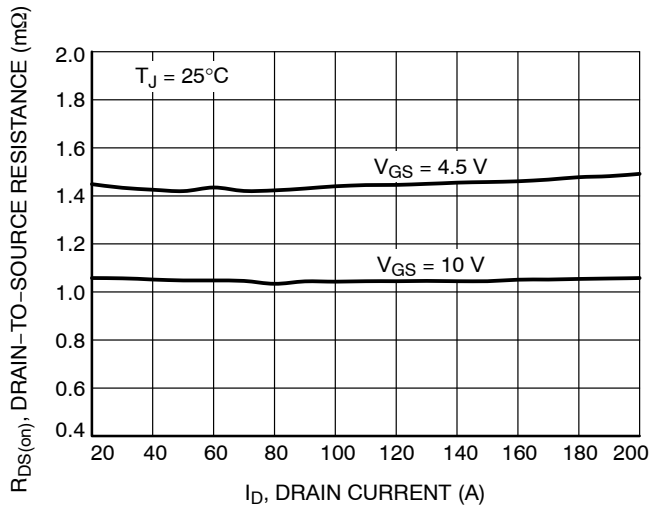


Figure 4. On-Resistance vs. Drain Current and Gate Voltage

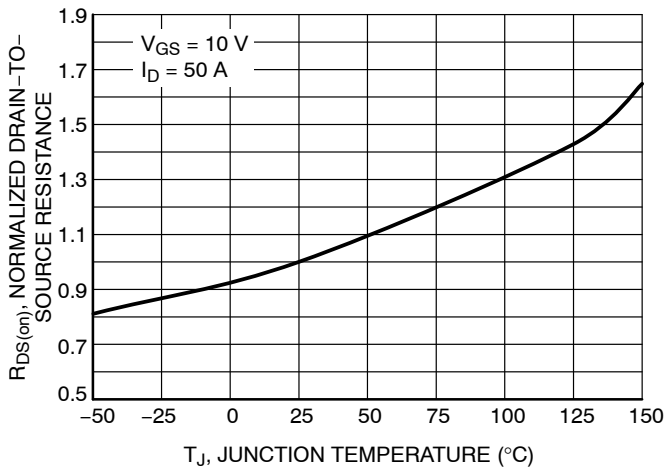


Figure 5. On-Resistance Variation with Temperature

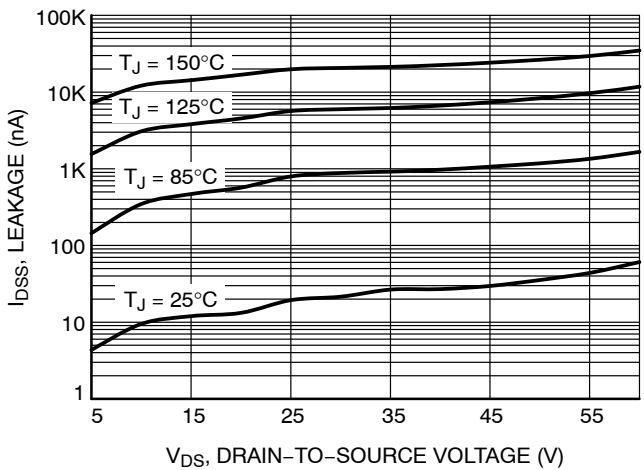


Figure 6. Drain-to-Source Leakage Current vs. Voltage

# NTMFSS1D5N06CL

## TYPICAL CHARACTERISTICS

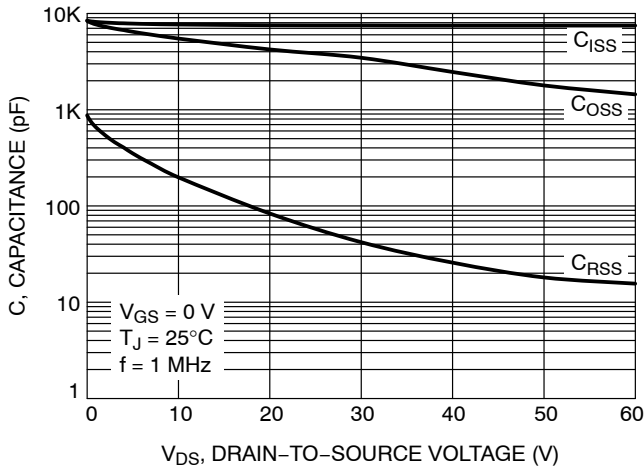


Figure 7. Capacitance Variation

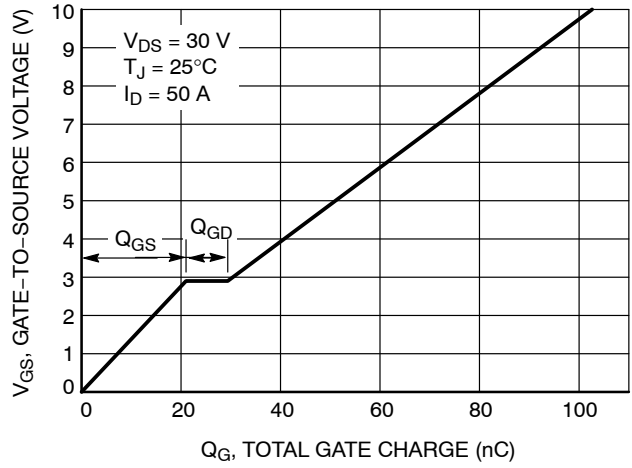


Figure 8. Gate-to-Source vs. Total Charge

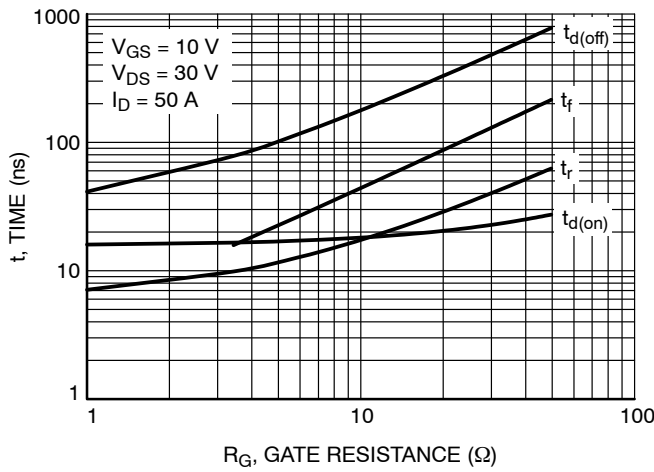


Figure 9. Resistive Switching Time Variation vs. Gate Resistance

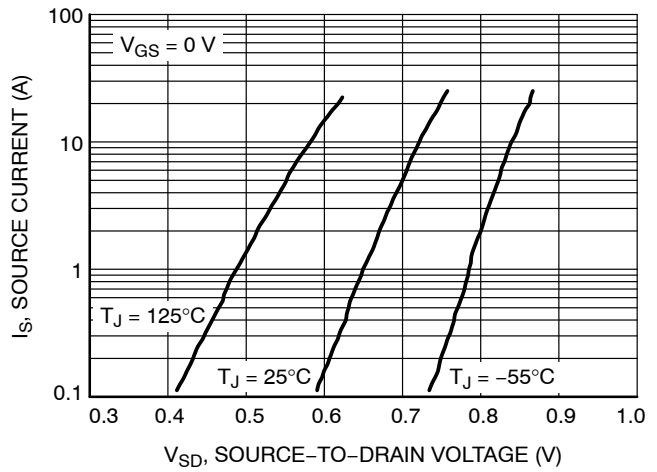


Figure 10. Diode Forward Voltage vs. Current

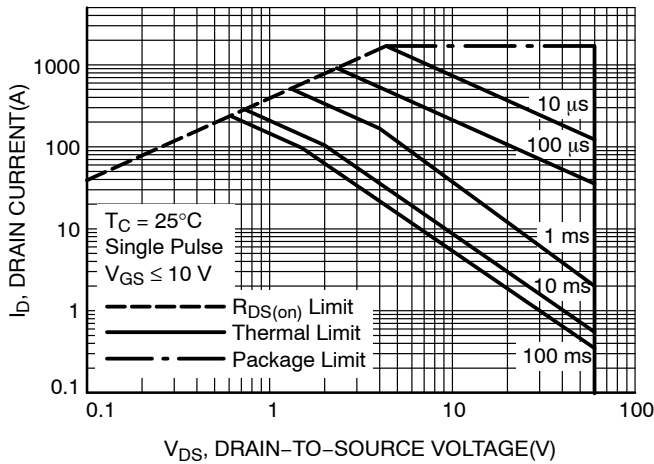


Figure 11. Safe Operating Area

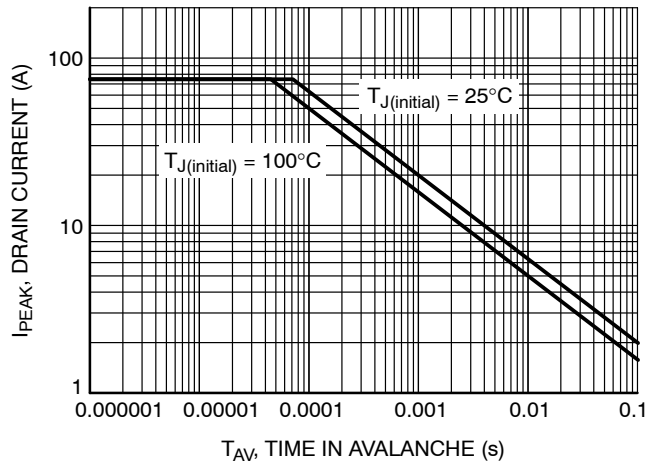


Figure 12.  $I_{PEAK}$  vs. Time in Avalanche

# NTMFSS1D5N06CL

## TYPICAL CHARACTERISTICS

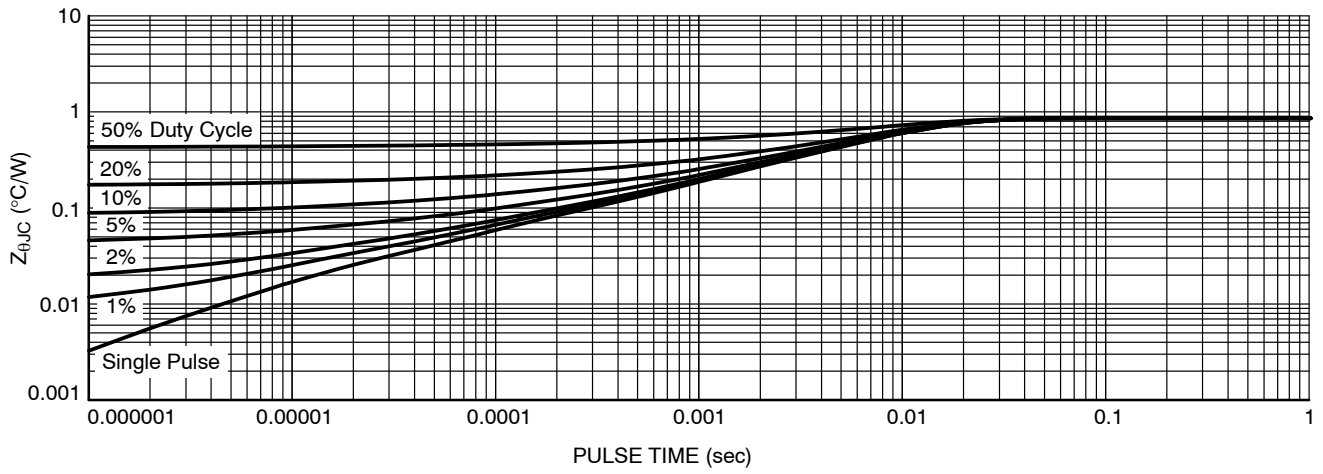
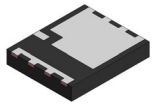


Figure 13. Thermal Characteristics

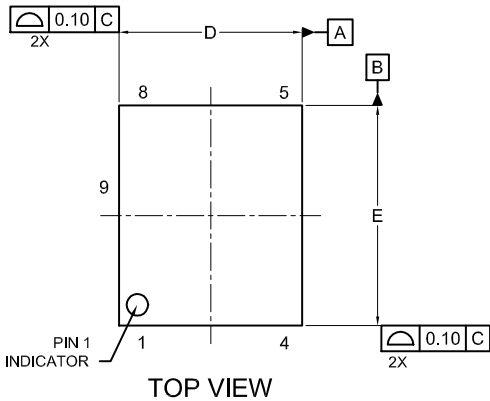
# MECHANICAL CASE OUTLINE

## PACKAGE DIMENSIONS

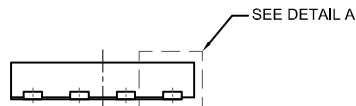


**TDFN9 5x6, 1.27P**  
**CASE 520AE**  
**ISSUE B**

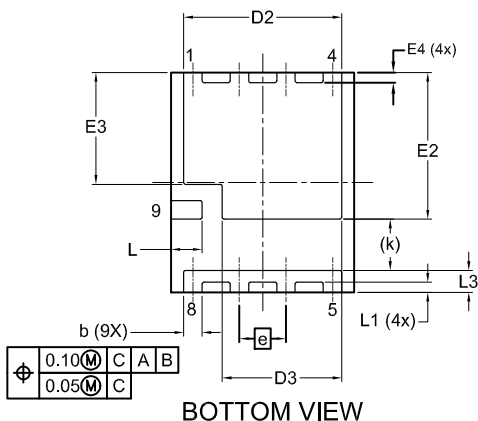
DATE 24 NOV 2022



TOP VIEW



FRONT VIEW

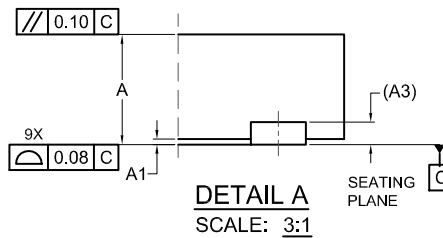


BOTTOM VIEW

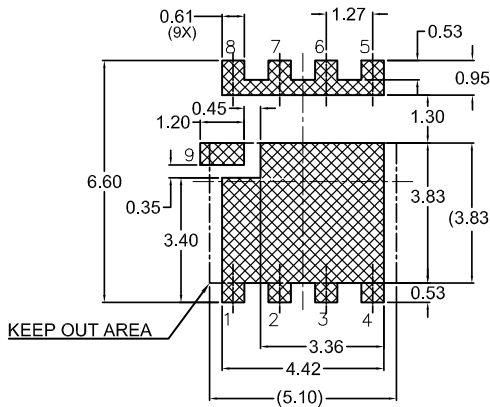
**NOTES:**

1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 2009.
2. CONTROLLING DIMENSION: MILLIMETERS
3. COPLANARITY APPLIES TO THE EXPOSED PADS AS WELL AS THE TERMINALS.
4. DIMENSIONS D1, D2, E1 AND E2 DO NOT INCLUDE MOLD FLASH.
5. SEATING PLANE IS DEFINED BY THE TERMINALS. "A1" IS DEFINED AS THE DISTANCE FROM THE SEATING PLANE TO THE LOWEST POINT ON THE PACKAGE BODY.

DIM	MILLIMETERS		
	MIN	NOM	MAX
A	0.95	1.00	1.05
A1	0.00	0.02	0.05
A3	0.20 REF		
b	0.45	0.50	0.55
D	4.90	5.00	5.10
D2	4.10	4.30	4.50
D3	3.16	3.26	3.36
E	5.90	6.00	6.10
E2	3.90	4.00	4.10
E3	2.95	3.05	3.15
E4	0.18	0.28	0.38
e	1.27 BSC		
k	1.40 REF		
L	0.75	0.85	0.95
L1	0.18	0.28	0.38
L3	0.50	0.60	0.70



DETAIL A  
 SCALE: 3:1



LAND PATTERN RECOMMENDATION

\*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\***



XXXX = Specific Device Code  
 A = Assembly Location  
 WL = Wafer Lot  
 Y = Year Code  
 WW = Work Week Code

\*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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