

# MOSFET - Power, Single P-Channel

## -40 V, 9.5 mΩ, -64 A



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## NVTF59D6P04M8L

### Features

- Small Footprint (3.3 x 3.3 mm) for Compact Design
- Low  $R_{DS(on)}$  to Minimize Conduction Losses
- Low Capacitance to Minimize Driver Losses
- NVTF59D6P04M8L – Wettable Flanks Product
- AEC-Q101 Qualified and PPAP Capable
- These Devices are Pb-Free, Halogen Free/BFR-Free and are RoHS Compliant

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

Parameter	Symbol	Value	Unit	
Drain-to-Source Voltage	$V_{DSS}$	-40	V	
Gate-to-Source Voltage	$V_{GS}$	$\pm 20$	V	
Continuous Drain Current $R_{\theta JC}$ (Notes 1, 2, 4)	Steady State	$T_C = 25^\circ\text{C}$	-64	A
		$T_C = 100^\circ\text{C}$	-46	
Power Dissipation $R_{\theta JC}$ (Notes 1, 2)	Steady State	$T_C = 25^\circ\text{C}$	75	W
		$T_C = 100^\circ\text{C}$	38	
Continuous Drain Current $R_{\theta JA}$ (Notes 1, 3, 4)	Steady State	$T_A = 25^\circ\text{C}$	-13	A
		$T_A = 100^\circ\text{C}$	-9	
Power Dissipation $R_{\theta JA}$ (Notes 1, 3)	Steady State	$T_A = 25^\circ\text{C}$	3.2	W
		$T_A = 100^\circ\text{C}$	1.6	
Pulsed Drain Current	$T_A = 25^\circ\text{C}, t_p = 10 \mu\text{s}$	$I_{DM}$	311	A
Operating Junction and Storage Temperature Range	$T_J, T_{stg}$	-55 to +175	$^\circ\text{C}$	
Source Current (Body Diode)	$I_S$	-62	A	
Single Pulse Drain-to-Source Avalanche Energy ( $I_{L(pk)} = -8.5 \text{ A}$ )	$E_{AS}$	220	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.

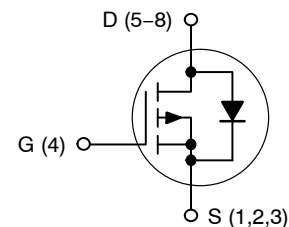
### THERMAL RESISTANCE MAXIMUM RATINGS (Note 1)

Parameter	Symbol	Value	Unit
Junction-to-Case – Steady State (Drain) (Notes 1, 2, 4)	$R_{\theta JC}$	2	$^\circ\text{C}/\text{W}$
Junction-to-Ambient – Steady State (Note 3)	$R_{\theta JA}$	47	

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. Assumes heat-sink sufficiently large to maintain constant case temperature independent of device power.
3. Surface-mounted on FR4 board using a 650 mm<sup>2</sup>, 2 oz. Cu pad.
4. Continuous DC current rating. Maximum current for pulses as long as 1 second is higher but is dependent on pulse duration and duty cycle.

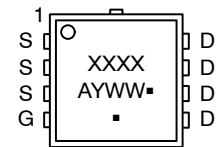
$V_{(BR)DSS}$	$R_{DS(on)}$ MAX	$I_D$ MAX
-40 V	9.5 mΩ @ -10 V	-64 A
	13.8 mΩ @ -4.5 V	

### P-Channel MOSFET



### MARKING DIAGRAM

  
WDFN8  
(μ8FL)  
CASE 511AB



XXXX = Specific Device Code  
A = Assembly Location  
Y = Year  
WW = Work Week  
▪ = Pb-Free Package

(Note: Microdot may be in either location)

### ORDERING INFORMATION

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

# NVTFS9D6P04M8L

## ELECTRICAL CHARACTERISTICS (T<sub>J</sub> = 25°C unless otherwise noted)

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

Drain-to-Source Breakdown Voltage	V <sub>(BR)DSS</sub>	V <sub>GS</sub> = 0 V, I <sub>D</sub> = -250 μA	-40			V	
Drain-to-Source Breakdown Voltage Temperature Coefficient	V <sub>(BR)DSS</sub> /T <sub>J</sub>			21		mV/°C	
Zero Gate Voltage Drain Current	I <sub>DSS</sub>	V <sub>GS</sub> = 0 V, V <sub>DS</sub> = -40 V	T <sub>J</sub> = 25°C			-1.0	μA
			T <sub>J</sub> = 125°C				
Gate-to-Source Leakage Current	I <sub>GSS</sub>	V <sub>DS</sub> = 0 V, V <sub>GS</sub> = ±20 V				±100	nA

### ON CHARACTERISTICS (Note 5)

Gate Threshold Voltage	V <sub>GS(TH)</sub>	V <sub>GS</sub> = V <sub>DS</sub> , I <sub>D</sub> = -580 μA	-1.0		-2.4	V
Negative Threshold Temperature Coefficient	V <sub>GS(TH)</sub> /T <sub>J</sub>			-5		mV/°C
Drain-to-Source On Resistance	R <sub>DS(on)</sub>	V <sub>GS</sub> = -10 V, I <sub>D</sub> = -20 A		7.5	9.5	mΩ
		V <sub>GS</sub> = -4.5 V, I <sub>D</sub> = -10 A		10.7	13.8	
Forward Transconductance	g <sub>FS</sub>	V <sub>DS</sub> = -1.5 V, I <sub>D</sub> = -15 A		46		S

### CHARGES AND CAPACITANCES

Input Capacitance	C <sub>iss</sub>	V <sub>GS</sub> = 0 V, f = 1.0 MHz, V <sub>DS</sub> = -20 V		2312		pF
Output Capacitance	C <sub>oss</sub>			923		
Reverse Transfer Capacitance	C <sub>rss</sub>			31		
Total Gate Charge	Q <sub>G(TOT)</sub>	V <sub>DS</sub> = -20 V, I <sub>D</sub> = -20 A	V <sub>GS</sub> = -4.5 V	16.2		nC
			V <sub>GS</sub> = -10 V	34.6		
Threshold Gate Charge	Q <sub>G(TH)</sub>	V <sub>GS</sub> = -10 V, V <sub>DS</sub> = -20 V, I <sub>D</sub> = -20 A		3.8		nC
Gate-to-Source Charge	Q <sub>GS</sub>			6.9		
Gate-to-Drain Charge	Q <sub>GD</sub>			4.1		
Plateau Voltage	V <sub>GP</sub>			2.9		

### SWITCHING CHARACTERISTICS, V<sub>GS</sub> = -4.5 V (Note 6)

Turn-On Delay Time	t <sub>d(on)</sub>	V <sub>GS</sub> = -4.5 V, V <sub>DS</sub> = -20 V, I <sub>D</sub> = -20 A, R <sub>G</sub> = 2.5 Ω		12.6		ns
Rise Time	t <sub>r</sub>			91.5		
Turn-Off Delay Time	t <sub>d(off)</sub>			74.6		
Fall Time	t <sub>f</sub>			49.3		

### DRAIN-SOURCE DIODE CHARACTERISTICS

Forward Diode Voltage	V <sub>SD</sub>	V <sub>GS</sub> = 0 V, I <sub>S</sub> = -20 A	T <sub>J</sub> = 25°C		-0.86	-1.25	V
			T <sub>J</sub> = 125°C		-0.74		
Reverse Recovery Time	t <sub>RR</sub>	V <sub>GS</sub> = 0 V, dI <sub>S</sub> /dt = 100 A/μs, I <sub>S</sub> = -20 A		38.8		ns	
Charge Time	t <sub>a</sub>			18.4			
Discharge Time	t <sub>b</sub>			20.4			
Reverse Recovery Charge	Q <sub>RR</sub>			19.7			nC

5. Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2%.

6. Switching characteristics are independent of operating junction temperatures.

# NVTFS9D6P04M8L

## TYPICAL CHARACTERISTICS

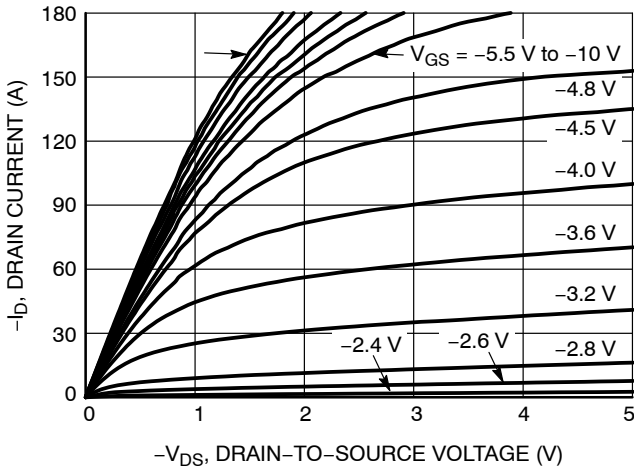


Figure 1. On-Region Characteristics

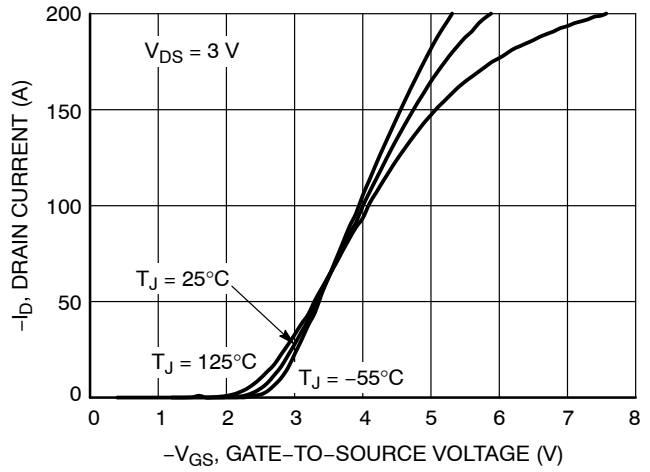


Figure 2. Transfer Characteristics

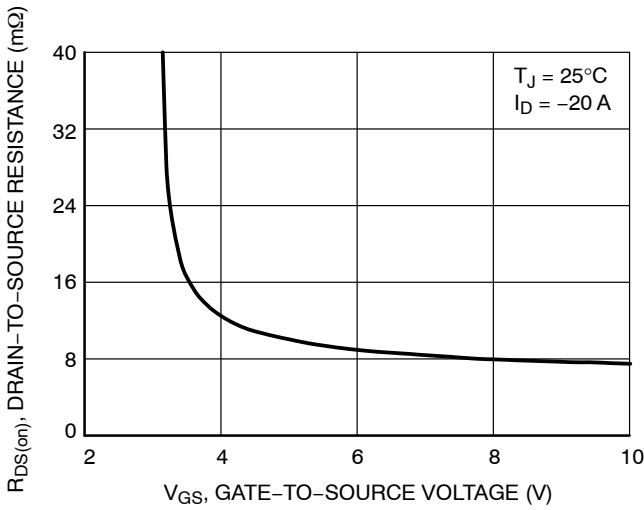


Figure 3. On-Resistance vs. Gate-to-Source Voltage

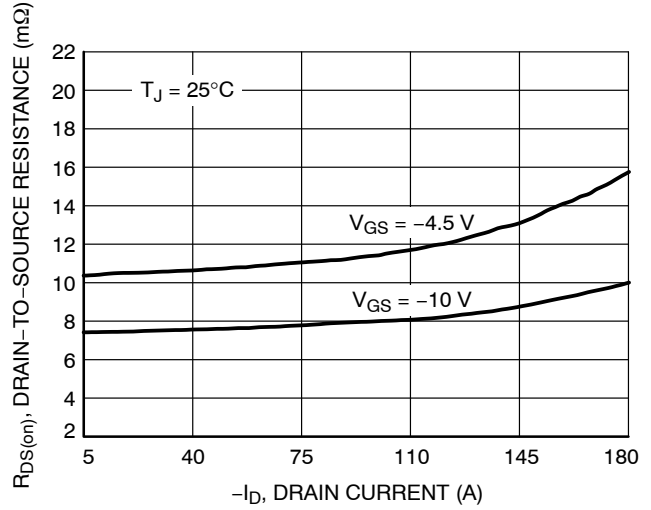


Figure 4. On-Resistance vs. Drain Current and Gate Voltage

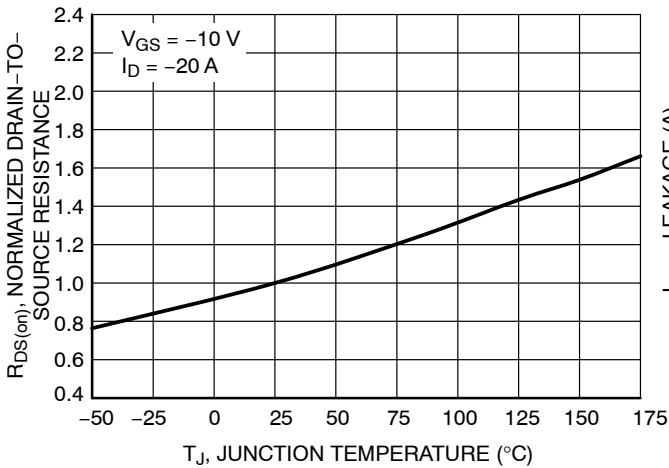


Figure 5. On-Resistance Variation with Temperature

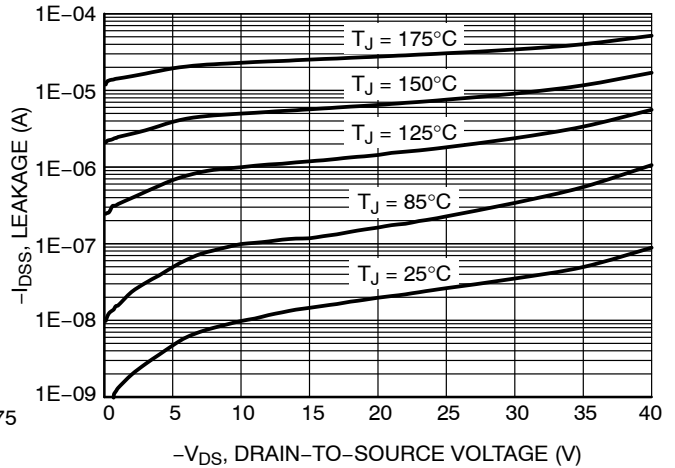
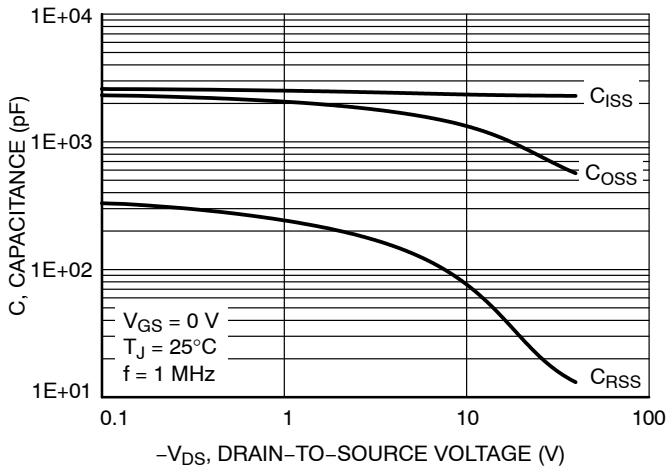


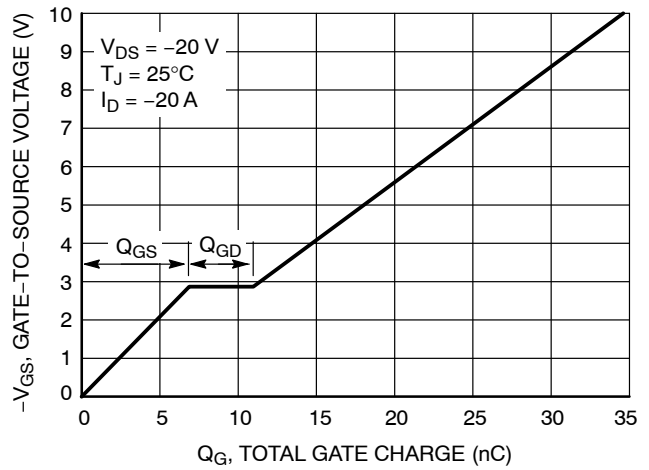
Figure 6. Drain-to-Source Leakage Current vs. Voltage

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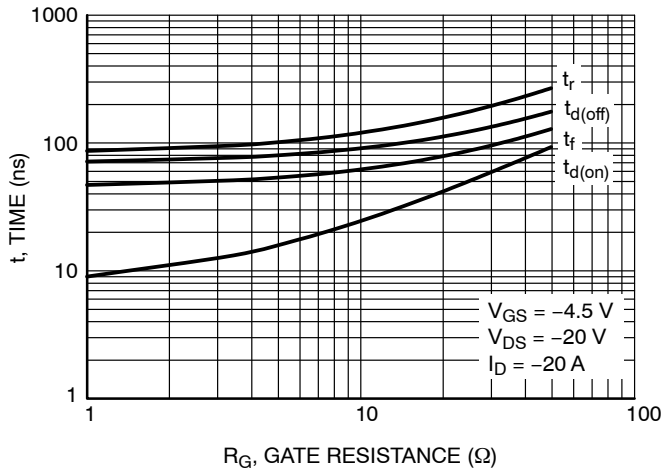
## TYPICAL CHARACTERISTICS



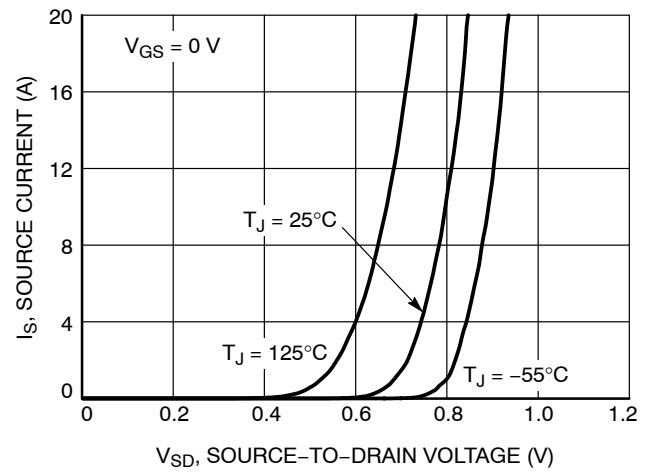
**Figure 7. Capacitance Variation**



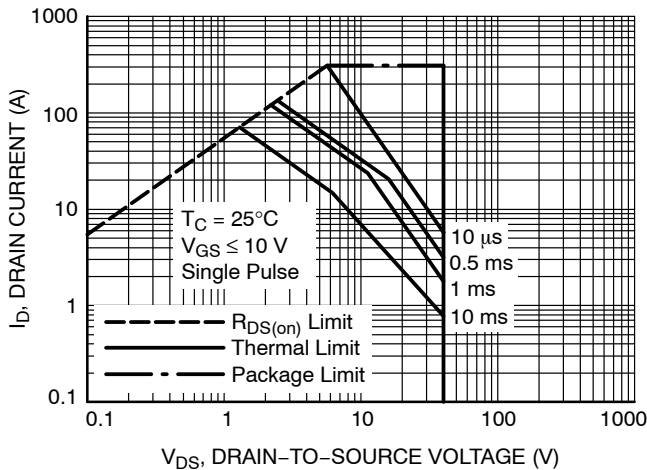
**Figure 8. Gate-to-Source vs. Total Charge**



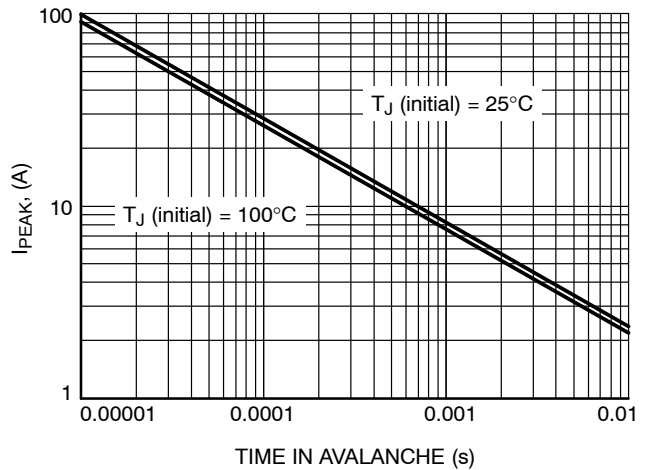
**Figure 9. Resistive Switching Time Variation vs. Gate Resistance**



**Figure 10. Diode Forward Voltage vs. Current**



**Figure 11. Maximum Rated Forward Biased Safe Operating Area**



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

# NVTFS9D6P04M8L

## TYPICAL CHARACTERISTICS

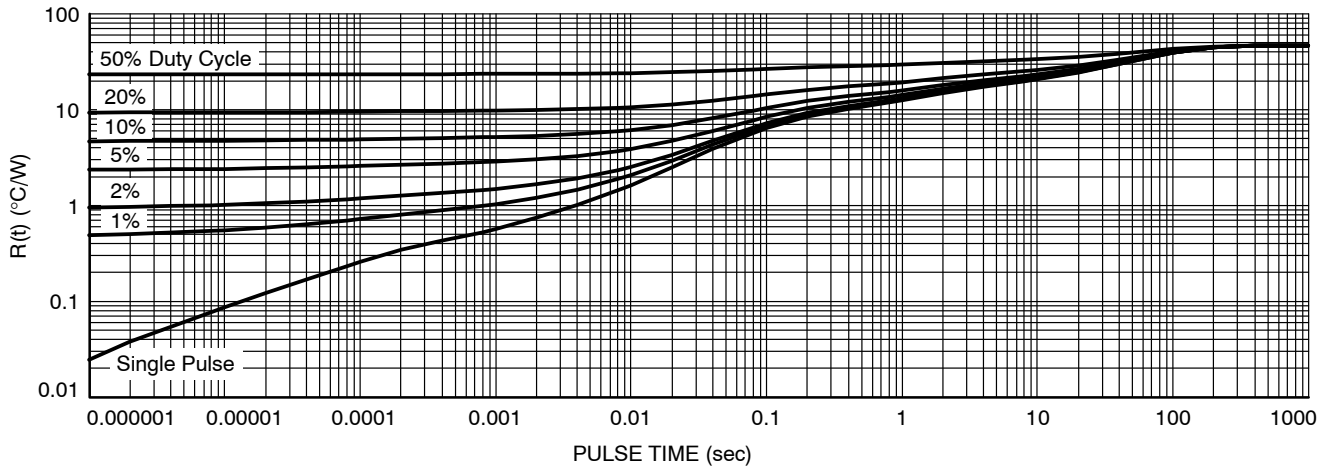


Figure 13. Thermal Characteristics

### DEVICE ORDERING INFORMATION

Device	Marking	Package	Shipping <sup>†</sup>
NVTFS9D6P04M8LTAG	9D6M	WDFN8 (Pb-Free)	1500 / Tape & Reel
NVTFWS9D6P04M8LTAG	9D6W	WDFN8 (Pb-Free, Wettable Flank)	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.

# MECHANICAL CASE OUTLINE

## PACKAGE DIMENSIONS

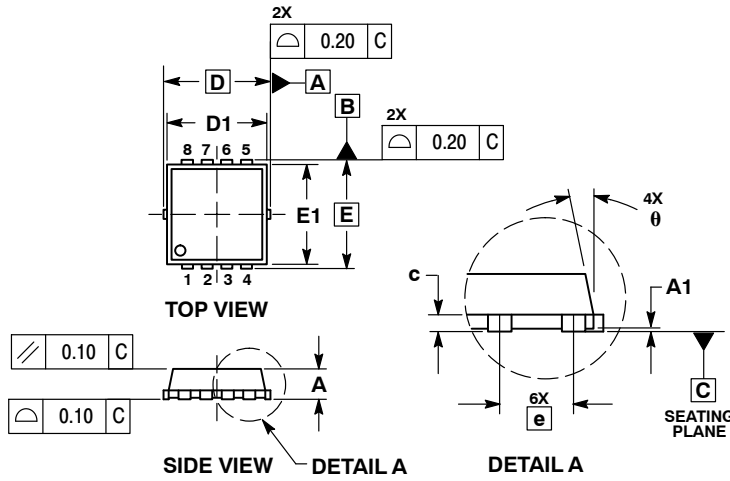
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SCALE 2:1

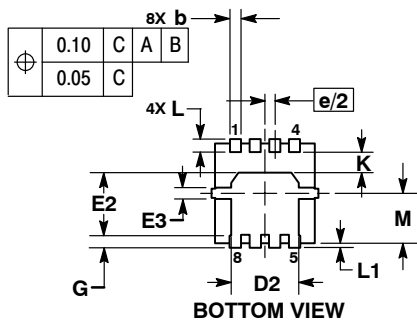
### WDFN8 3.3x3.3, 0.65P CASE 511AB ISSUE D

DATE 23 APR 2012



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

DIM	MILLIMETERS			INCHES		
	MIN	NOM	MAX	MIN	NOM	MAX
A	0.70	0.75	0.80	0.028	0.030	0.031
A1	0.00	---	0.05	0.000	---	0.002
b	0.23	0.30	0.40	0.009	0.012	0.016
c	0.15	0.20	0.25	0.006	0.008	0.010
D	3.30 BSC			0.130 BSC		
D1	2.95	3.05	3.15	0.116	0.120	0.124
D2	1.98	2.11	2.24	0.078	0.083	0.088
E	3.30 BSC			0.130 BSC		
E1	2.95	3.05	3.15	0.116	0.120	0.124
E2	1.47	1.60	1.73	0.058	0.063	0.068
E3	0.23	0.30	0.40	0.009	0.012	0.016
e	0.65 BSC			0.026 BSC		
G	0.30	0.41	0.51	0.012	0.016	0.020
K	0.65	0.80	0.95	0.026	0.032	0.037
L	0.30	0.43	0.56	0.012	0.017	0.022
L1	0.06	0.13	0.20	0.002	0.005	0.008
M	1.40	1.50	1.60	0.055	0.059	0.063
θ	0°	---	12°	0°	---	12°

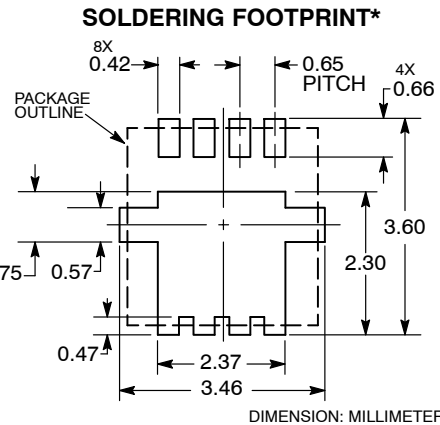


#### GENERIC MARKING DIAGRAM\*



- XXXXX = Specific Device Code
- A = Assembly Location
- Y = Year
- WW = Work Week
- = Pb-Free Package

\*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.



\*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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