

# RF Power Field Effect Transistors

## N-Channel Enhancement-Mode Lateral MOSFETs

Designed for CDMA base station applications with frequencies from 920 to 960 MHz. Can be used in Class AB and Class C for all typical cellular base station modulation formats.

- Typical Single-Carrier W-CDMA Performance:  $V_{DD} = 28$  Volts,  $I_{DQ} = 1300$  mA,  $P_{out} = 58$  Watts Avg., IQ Magnitude Clipping, Channel Bandwidth = 3.84 MHz, Input Signal PAR = 7.5 dB @ 0.01% Probability on CCDF.

Frequency	$G_{ps}$ (dB)	$\eta_D$ (%)	Output PAR (dB)	ACPR (dBc)
920 MHz	19.0	36.3	6.3	-38.2
940 MHz	19.1	37.2	6.2	-38.0
960 MHz	18.9	37.3	6.1	-37.1

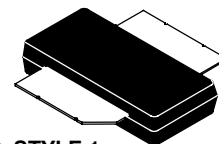
- Capable of Handling 7:1 VSWR, @ 32 Vdc, 920 MHz, 290 Watts CW Output Power (3 dB Input Overdrive from Rated  $P_{out}$ ). Designed for Enhanced Ruggedness.
- Typical  $P_{out}$  @ 1 dB Compression Point  $\approx$  200 Watts CW

### Features

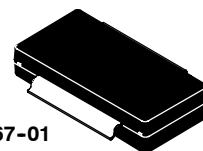
- 100% PAR Tested for Guaranteed Output Power Capability
- Characterized with Series Equivalent Large-Signal Impedance Parameters and Common Source S-Parameters
- Internally Matched for Ease of Use
- Integrated ESD Protection
- Greater Negative Gate-Source Voltage Range for Improved Class C Operation
- Designed for Digital Predistortion Error Correction Systems
- Optimized for Doherty Applications
- 225°C Capable Plastic Package
- In Tape and Reel. R3 Suffix = 250 Units, 32 mm Tape Width, 13 inch Reel.

**MRF8S9202NR3**  
**MRF8S9202GNR3**

**920-960 MHz, 58 W AVG., 28 V**  
**SINGLE W-CDMA**  
**LATERAL N-CHANNEL**  
**RF POWER MOSFETs**



**CASE 2021-03, STYLE 1**  
**OM-780-2**  
**PLASTIC**  
**MRF8S9202NR3**



**CASE 2267-01**  
**OM-780-2 GULL**  
**PLASTIC**  
**MRF8S9202GNR3**

**Table 1. Maximum Ratings**

Rating	Symbol	Value	Unit
Drain-Source Voltage	$V_{DSS}$	-0.5, +70	Vdc
Gate-Source Voltage	$V_{GS}$	-6.0, +10	Vdc
Operating Voltage	$V_{DD}$	32, +0	Vdc
Storage Temperature Range	$T_{stg}$	-65 to +150	°C
Case Operating Temperature	$T_C$	150	°C
Operating Junction Temperature (1,2)	$T_J$	225	°C

**Table 2. Thermal Characteristics**

Characteristic	Symbol	Value (2,3)	Unit
Thermal Resistance, Junction to Case Case Temperature 80°C, 58 W CW, 28 Vdc, $I_{DQ} = 1300$ mA, 920 MHz Case Temperature 90°C, 200 W CW, 28 Vdc, $I_{DQ} = 1300$ mA, 920 MHz	$R_{\theta JC}$	0.31 0.27	°C/W

- Continuous use at maximum temperature will affect MTTF.
- MTTF calculator available at <http://www.freescale.com/rf>. Select Software & Tools/Development Tools/Calculators to access MTTF calculators by product.
- Refer to AN1955, *Thermal Measurement Methodology of RF Power Amplifiers*. Go to <http://www.freescale.com/rf>. Select Documentation/Application Notes - AN1955.

**Table 3. ESD Protection Characteristics**

Test Methodology	Class
Human Body Model (per JESD22-A114)	2
Machine Model (per EIA/JESD22-A115)	A
Charge Device Model (per JESD22-C101)	IV

**Table 4. Moisture Sensitivity Level**

Test Methodology	Rating	Package Peak Temperature	Unit
Per JESD22-A113, IPC/JEDEC J-STD-020	3	260	°C

**Table 5. Electrical Characteristics** ( $T_A = 25^\circ\text{C}$  unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
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**Off Characteristics**

Zero Gate Voltage Drain Leakage Current ( $V_{DS} = 70\text{ Vdc}$ , $V_{GS} = 0\text{ Vdc}$ )	$I_{DSS}$	—	—	10	$\mu\text{Adc}$
Zero Gate Voltage Drain Leakage Current ( $V_{DS} = 28\text{ Vdc}$ , $V_{GS} = 0\text{ Vdc}$ )	$I_{DSS}$	—	—	1	$\mu\text{Adc}$
Gate-Source Leakage Current ( $V_{GS} = 5\text{ Vdc}$ , $V_{DS} = 0\text{ Vdc}$ )	$I_{GSS}$	—	—	1	$\mu\text{Adc}$

**On Characteristics**

Gate Threshold Voltage ( $V_{DS} = 10\text{ Vdc}$ , $I_D = 800\ \mu\text{Adc}$ )	$V_{GS(th)}$	1.5	2.3	3.0	Vdc
Gate Quiescent Voltage ( $V_{DS} = 28\text{ Vdc}$ , $I_D = 1300\text{ mAdc}$ )	$V_{GS(Q)}$	—	3.1	—	Vdc
Fixture Gate Quiescent Voltage (1) ( $V_{DD} = 28\text{ Vdc}$ , $I_D = 1300\text{ mAdc}$ , Measured in Functional Test)	$V_{GG(Q)}$	4.6	6.2	7.6	Vdc
Drain-Source On-Voltage ( $V_{GS} = 10\text{ Vdc}$ , $I_D = 3.3\text{ Adc}$ )	$V_{DS(on)}$	0.1	0.2	0.3	Vdc

**Functional Tests** (2,3) (In Freescale Test Fixture, 50 ohm system)  $V_{DD} = 28\text{ Vdc}$ ,  $I_{DQ} = 1300\text{ mA}$ ,  $P_{out} = 58\text{ W Avg.}$ ,  $f = 920\text{ MHz}$ , Single-Carrier W-CDMA, IQ Magnitude Clipping, Input Signal PAR = 7.5 dB @ 0.01% Probability on CCDF. ACPR measured in 3.84 MHz Channel Bandwidth @  $\pm 5\text{ MHz}$  Offset.

Power Gain	$G_{ps}$	18.0	19.0	21.0	dB
Drain Efficiency	$\eta_D$	34.5	36.3	—	%
Output Peak-to-Average Ratio @ 0.01% Probability on CCDF	PAR	6.0	6.3	—	dB
Adjacent Channel Power Ratio	ACPR	—	-38.2	-35.0	dBc
Input Return Loss	IRL	—	-13	-9	dB

**Typical Broadband Performance** (In Freescale Test Fixture, 50 ohm system)  $V_{DD} = 28\text{ Vdc}$ ,  $I_{DQ} = 1300\text{ mA}$ ,  $P_{out} = 58\text{ W Avg.}$ , Single-Carrier W-CDMA, IQ Magnitude Clipping, Input Signal PAR = 7.5 dB @ 0.01% Probability on CCDF. ACPR measured in 3.84 MHz Channel Bandwidth @  $\pm 5\text{ MHz}$  Offset.

Frequency	$G_{ps}$ (dB)	$\eta_D$ (%)	Output PAR (dB)	ACPR (dBc)	IRL (dB)
920 MHz	19.0	36.3	6.3	-38.2	-13
940 MHz	19.1	37.2	6.2	-38.0	-15
960 MHz	18.9	37.3	6.1	-37.1	-15

- $V_{GG} = 2 \times V_{GS(Q)}$ . Parameter measured on Freescale Test Fixture, due to resistive divider network on the board. Refer to Test Circuit schematic.
- Part internally matched both on input and output.
- Measurement made with device in straight lead configuration before any lead forming operation is applied.

(continued)

**Table 5. Electrical Characteristics** ( $T_A = 25^\circ\text{C}$  unless otherwise noted) (continued)

Characteristic	Symbol	Min	Typ	Max	Unit
<b>Typical Performances</b> (In Freescale Test Fixture, 50 ohm system) $V_{DD} = 28\text{ Vdc}$ , $I_{DQ} = 1300\text{ mA}$ , 920–960 MHz Bandwidth					
$P_{out}$ @ 1 dB Compression Point, CW	$P_{1dB}$	—	200	—	W
IMD Symmetry @ 180 W PEP, $P_{out}$ where IMD Third Order Intermodulation $\cong 30\text{ dBc}$ (Delta IMD Third Order Intermodulation between Upper and Lower Sidebands $> 2\text{ dB}$ )	$IMD_{sym}$	—	7.5	—	MHz
VBW Resonance Point (IMD Third Order Intermodulation Inflection Point)	$VBW_{res}$	—	70	—	MHz
Gain Flatness in 40 MHz Bandwidth @ $P_{out} = 58\text{ W Avg.}$	$G_F$	—	0.3	—	dB
Gain Variation over Temperature ( $-30^\circ\text{C}$ to $+85^\circ\text{C}$ )	$\Delta G$	—	0.02	—	dB/ $^\circ\text{C}$
Output Power Variation over Temperature ( $-30^\circ\text{C}$ to $+85^\circ\text{C}$ )	$\Delta P_{1dB}$	—	0.006	—	dB/ $^\circ\text{C}$

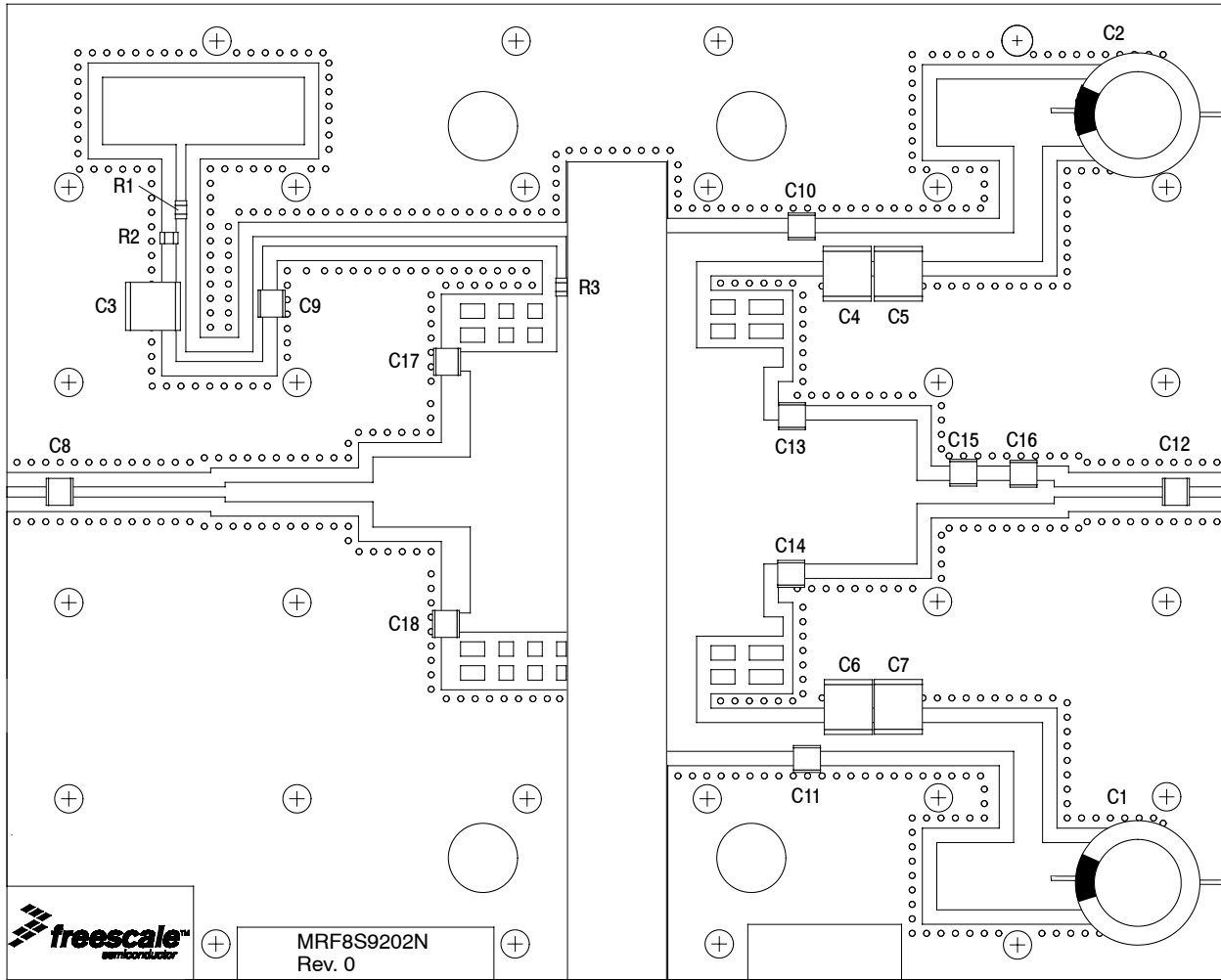
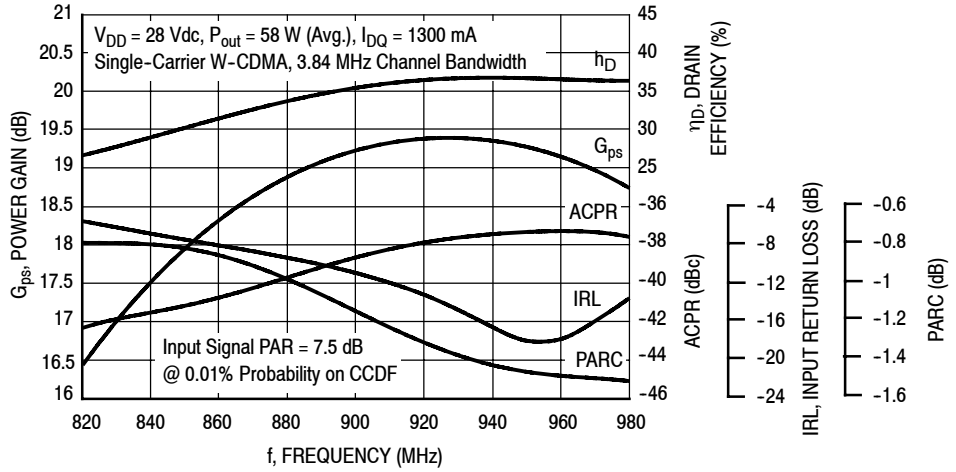


Figure 1. MRF8S9202NR3(GNR3) Test Circuit Component Layout

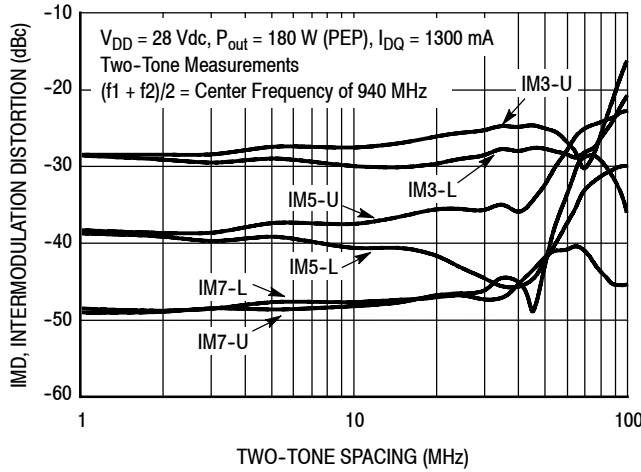
Table 6. MRF8S9202NR3(GNR3) Test Circuit Component Designations and Values

Part	Description	Part Number	Manufacturer
C1, C2	220 $\mu$ F, 63 V Electrolytic Capacitors	222212018221	Vishay BC
C3, C4, C5, C6, C7	10 $\mu$ F, 50 V Chip Capacitors	C5750X5R1H106MT	TDK
C8	2.7 pF Chip Capacitor	ATC100B2R7BT500XT	ATC
C9, C10, C11, C12	47 pF Chip Capacitors	ATC100B470JT500XT	ATC
C13, C14	1.2 pF Chip Capacitors	ATC100B1R2BT500XT	ATC
C15	2 pF Chip Capacitor	ATC100B2R0BT500XT	ATC
C16	4.3 pF Chip Capacitor	ATC100B4R3BT500XT	ATC
C17, C18	3.3 pF Chip Capacitors	ATC100B3R3BT500XT	ATC
R1, R2	1 K $\Omega$ , 1/8 W Chip Resistors	WCR08051KG	Welwyn
R3	10 $\Omega$ , 1/8 W Chip Resistor	232273461009L	Phycomp
PCB	0.020", $\epsilon_r = 3.5$	RO4350B	Rogers

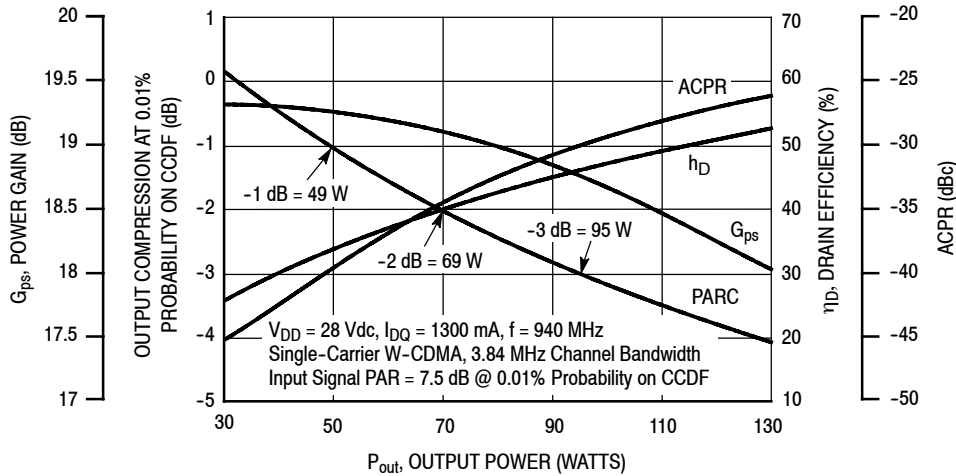
### TYPICAL CHARACTERISTICS



**Figure 2. Output Peak-to-Average Ratio Compression (PARC) Broadband Performance @  $P_{out} = 58$  Watts Avg.**

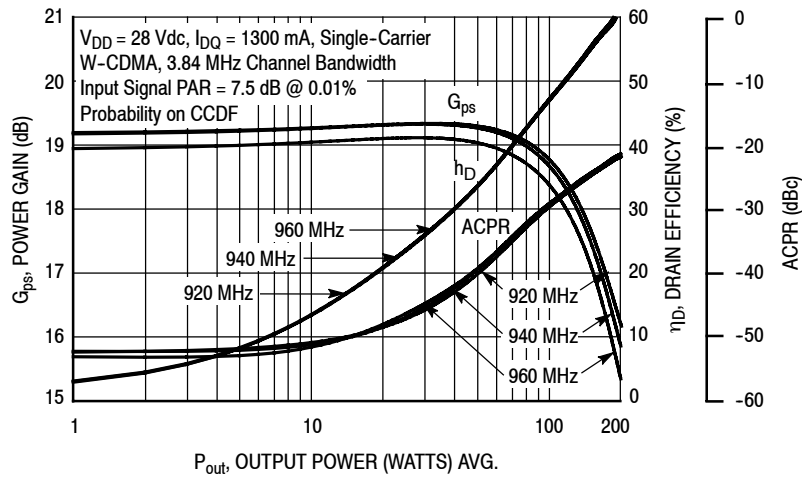


**Figure 3. Intermodulation Distortion Products versus Two-Tone Spacing**

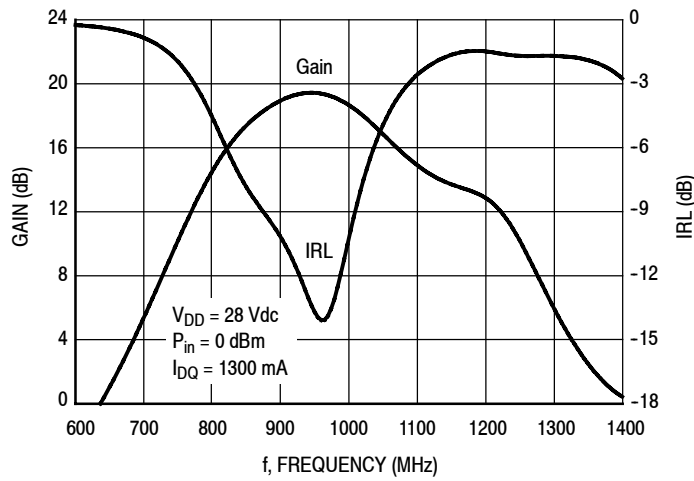


**Figure 4. Output Peak-to-Average Ratio Compression (PARC) versus Output Power**

## TYPICAL CHARACTERISTICS

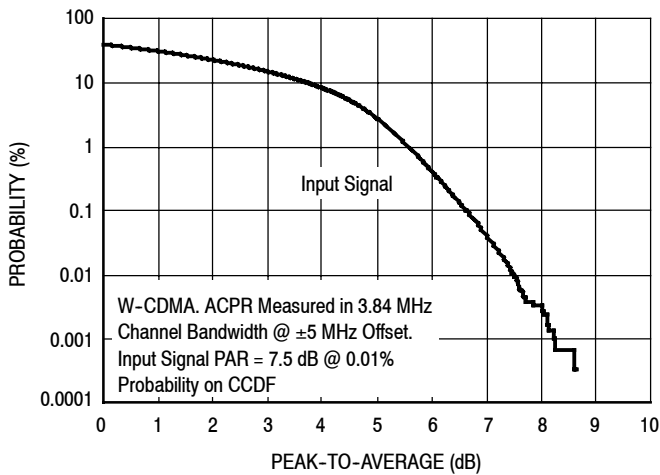


**Figure 5. Single-Carrier W-CDMA Power Gain, Drain Efficiency and ACPR versus Output Power**

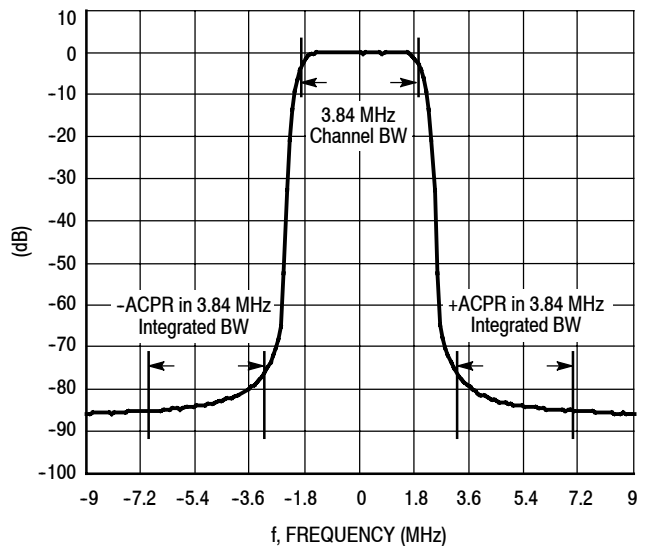


**Figure 6. Broadband Frequency Response**

## W-CDMA TEST SIGNAL



**Figure 7. CCDF W-CDMA IQ Magnitude Clipping, Single-Carrier Test Signal**



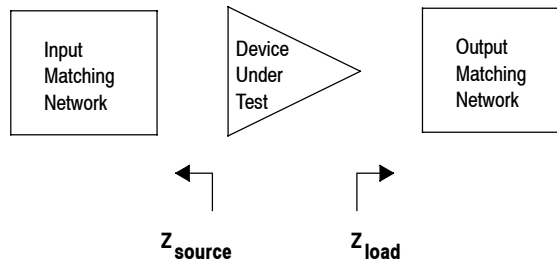
**Figure 8. Single-Carrier W-CDMA Spectrum**

$V_{DD} = 28 \text{ Vdc}$ ,  $I_{DQ} = 1300 \text{ mA}$ ,  $P_{out} = 58 \text{ W Avg.}$

f MHz	$Z_{source}$ $\Omega$	$Z_{load}$ $\Omega$
820	1.46 - j3.27	2.14 - j2.57
840	1.62 - j3.12	2.08 - j2.30
860	1.80 - j3.01	2.05 - j2.05
880	2.00 - j2.95	2.05 - j1.82
900	2.20 - j2.95	2.06 - j1.60
920	2.38 - j3.00	2.09 - j1.38
940	2.52 - j3.12	2.14 - j1.18
960	2.62 - j3.29	2.21 - j0.98
980	2.63 - j3.49	2.30 - j0.81

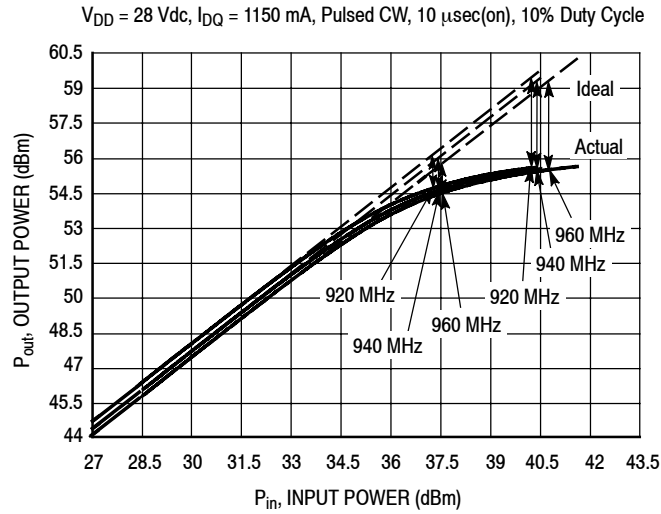
$Z_{source}$  = Test circuit impedance as measured from gate to ground.

$Z_{load}$  = Test circuit impedance as measured from drain to ground.



**Figure 9. Series Equivalent Source and Load Impedance**

## ALTERNATIVE PEAK TUNE LOAD PULL CHARACTERISTICS



NOTE: Load Pull Test Fixture Tuned for Peak P1dB Output Power @ 28 V

f (MHz)	P1dB		P3dB	
	Watts	dBm	Watts	dBm
920	298	54.7	362	55.6
940	290	54.6	358	55.5
960	283	54.5	352	55.5

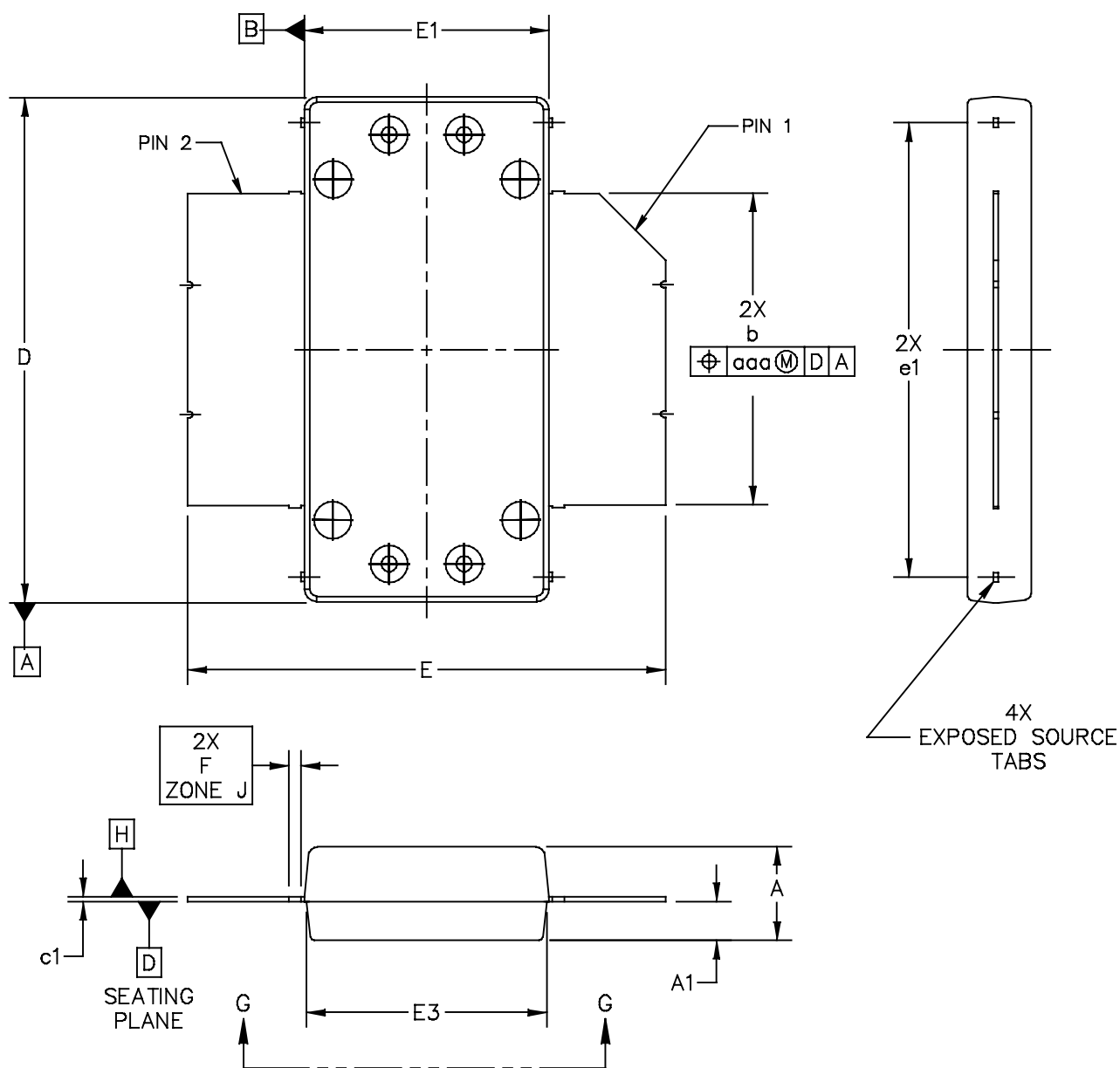
Test Impedances per Compression Level

f (MHz)		$Z_{source}$ $\Omega$	$Z_{load}$ $\Omega$
920	P1dB	1.66 - j3.06	4.27 - j0.73
940	P1dB	2.08 - j3.44	4.57 + j0.04
960	P1dB	2.86 - j3.13	4.40 + j0.94

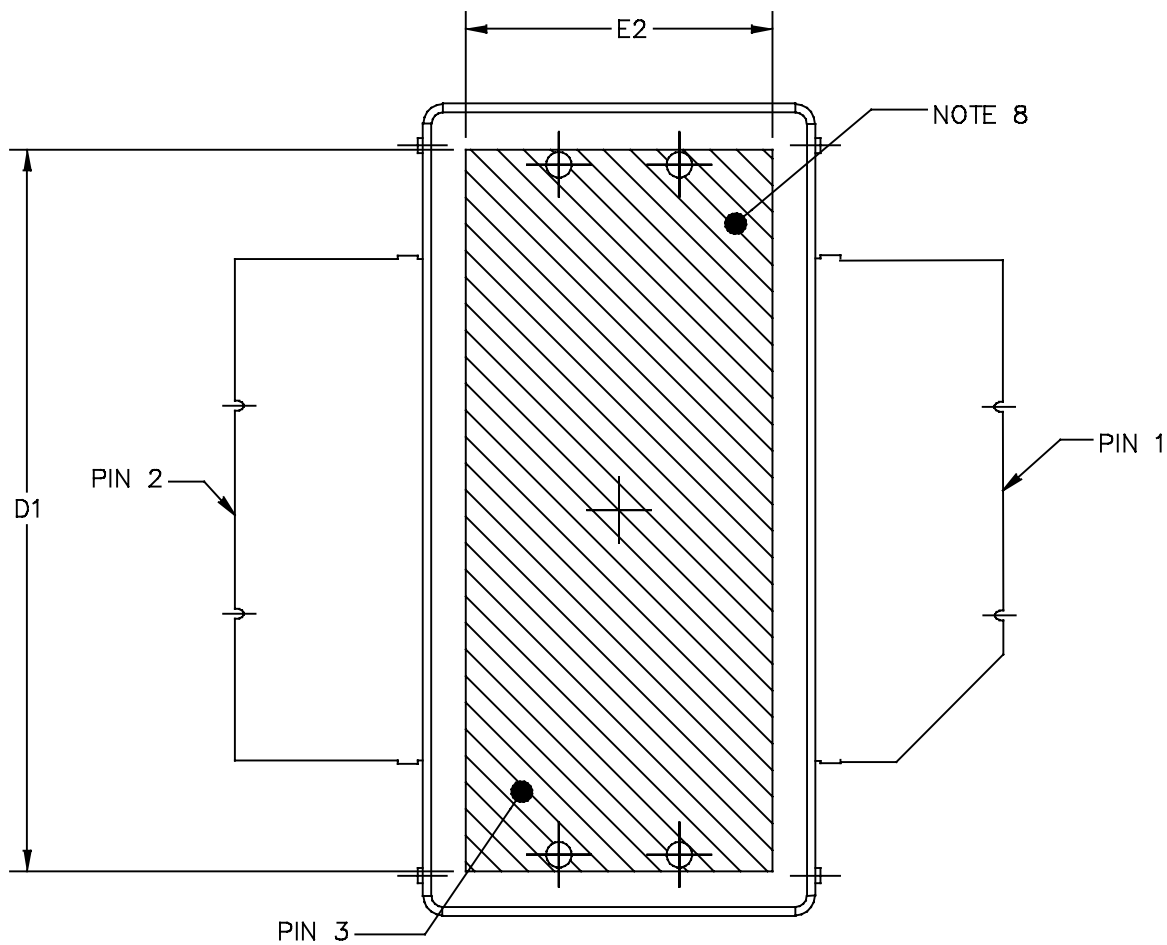
**Figure 10. Pulsed CW Output Power versus Input Power @ 28 V**



PACKAGE DIMENSIONS



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BOTTOM VIEW  
VIEW G-G

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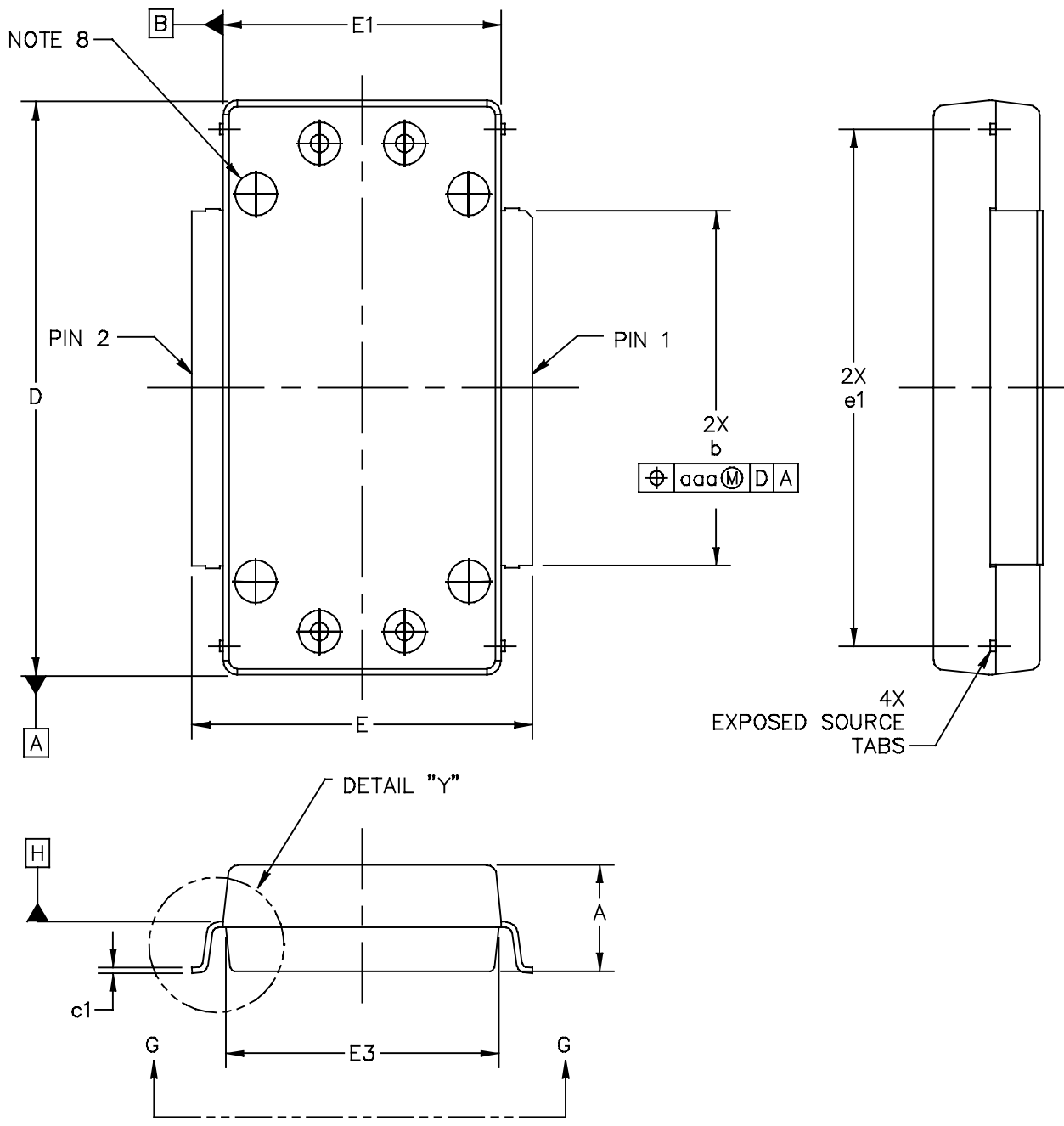
NOTES:

1. CONTROLLING DIMENSION: INCH
2. INTERPRET DIMENSIONS AND TOLERANCES PER ASME Y14.5M-1994.
3. DATUM PLANE -H- IS LOCATED AT TOP OF LEAD AND IS COINCIDENT WITH THE LEAD WHERE THE LEAD EXITS THE PLASTIC BODY AT THE TOP OF THE PARTING LINE.
4. DIMENSIONS "D" AND "E1" DO NOT INCLUDE MOLD PROTRUSION. ALLOWABLE PROTRUSION IS .006 PER SIDE. DIMENSIONS "D AND "E1" DO INCLUDE MOLD MISMATCH AND ARE DETERMINED AT DATUM PLANE -H-.
5. DIMENSION b DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE .005 TOTAL IN EXCESS OF THE b DIMENSION AT MAXIMUM MATERIAL CONDITION.
6. DATUMS -A- AND -B- TO BE DETERMINED AT DATUM PLANE -H-.
7. DIMENSION A1 APPLIES WITHIN ZONE "J" ONLY
8. HATCHING REPRESENTS THE EXPOSED AREA OF THE HEAT SLUG. THE DIMENSIONS D1 AND E2 REPRESENT THE VALUES BETWEEN THE TWO OPPOSITE POINTS ALONG THE EDGES OF EXPOSED AREA OF HEAT SLUG.

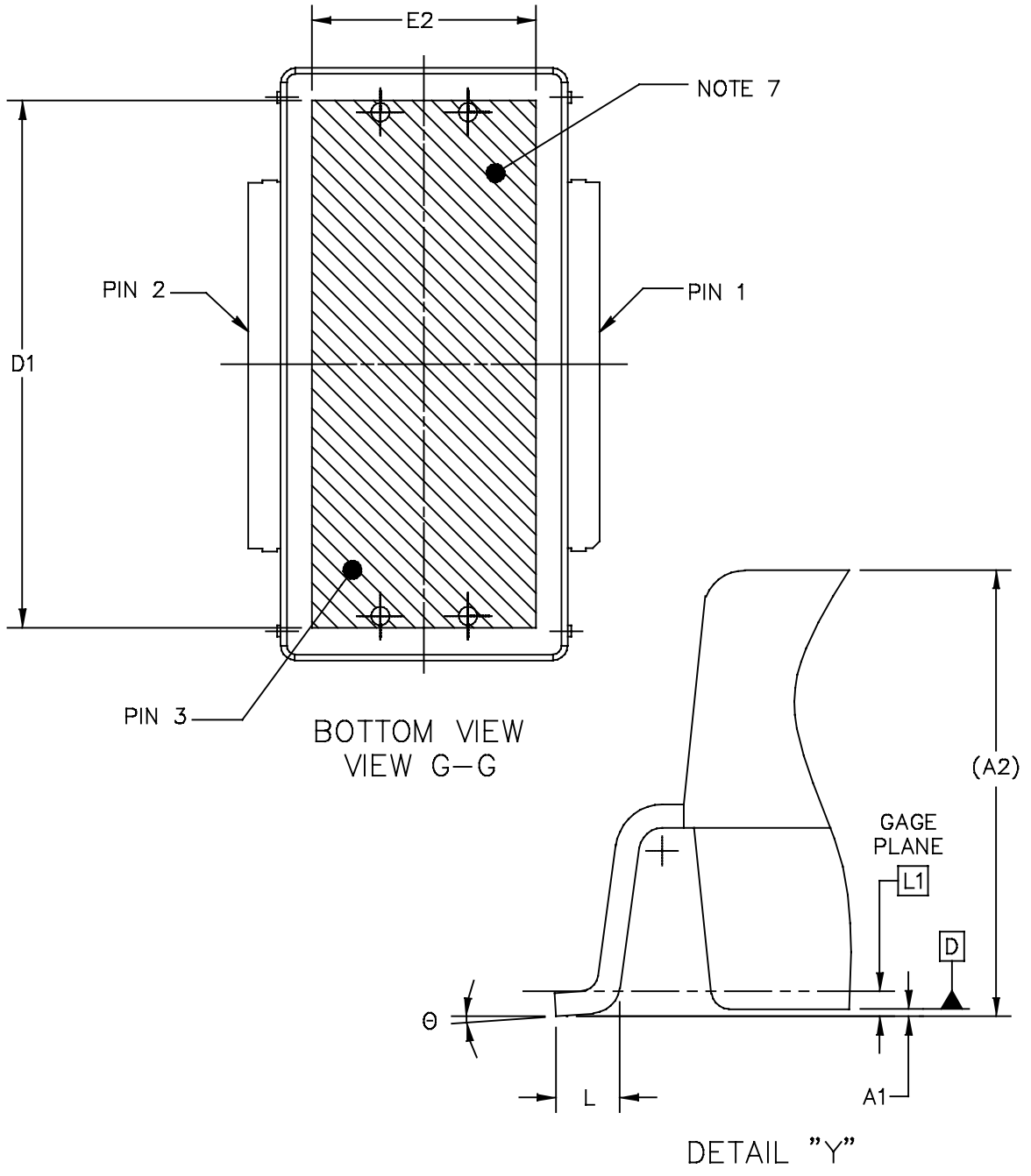
STYLE 1:  
 PIN 1 - DRAIN  
 PIN 2 - GATE  
 PIN 3 - SOURCE

DIM	INCH		MILLIMETER		DIM	INCH		MILLIMETER	
	MIN	MAX	MIN	MAX		MIN	MAX	MIN	MAX
A	0.148	.152	3.76	3.86	b	.497	.503	12.62	12.78
A1	.059	.065	1.50	1.65	c1	.007	.011	0.18	0.28
D	.808	.812	20.52	20.62	e1	.721	.729	18.31	18.52
D1	.720	----	18.29	----					
E	.762	.770	19.36	19.56	aaa	.004		0.10	
E1	.390	.394	9.91	10.01					
E2	.306	----	7.77	----					
E3	.383	.387	9.73	9.83					
F	.025 BSC		0.635 BSC						

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NOTES:

1. CONTROLLING DIMENSION: INCH
2. INTERPRET DIMENSIONS AND TOLERANCES PER ASME Y14.5M-1994.
3. DATUM PLANE H IS LOCATED AT TOP OF LEAD AND IS COINCIDENT WITH THE LEAD WHERE THE LEAD EXITS THE PLASTIC BODY AT THE TOP OF THE PARTING LINE.
4. DIMENSIONS D AND E1 DO NOT INCLUDE MOLD PROTRUSION. ALLOWABLE PROTRUSION IS .006 INCH (0.15 MM) PER SIDE. DIMENSIONS D AND E1 DO INCLUDE MOLD MISMATCH AND ARE DETERMINED AT DATUM PLANE H.
5. DIMENSION b DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE .005 INCH (0.13 MM) TOTAL IN EXCESS OF THE b DIMENSION AT MAXIMUM MATERIAL CONDITION.
6. DATUM A AND B TO BE DETERMINED AT DATUM PLANE H.
7. HATCHING REPRESENT THE EXPOSED AREA OF THE HEAT SLUG. THE DIMENSIONS D1 AND E2 REPRESENT THE VALUES BETWEEN THE TWO OPPOSITE POINTS ALONG THE EDGES OF EXPOSED AREA OF HEAT SLUG.
8. DIMPLED HOLE REPRESENTS INPUT SIDE.
9. DIMENSION A1 IS MEASURED WITH REFERENCE TO DATUM D. THE POSITIVE VALUE IMPLIES THAT THE BOTTOM OF THE PACKAGE IS HIGHER THAN THE BOTTOM OF THE LEAD.

DIM	INCH		MILLIMETER		DIM	INCH		MILLIMETER	
	MIN	MAX	MIN	MAX		MIN	MAX	MIN	MAX
A	.148	.152	3.76	3.86	b	.497	.503	12.62	12.78
A1	-.003	.003	-0.08	0.08	c1	.007	.011	0.18	0.28
A2	(.150)		(3.81)		θ	0°	8°	0°	8°
D	.808	.812	20.52	20.62	e1	.721	.729	18.31	18.52
D1	.720	----	18.29	----	aaa	.004		0.10	
E	.472	.480	11.99	12.19					
E1	.390	.394	9.91	10.01					
E2	.306	----	7.77	----					
E3	.383	.387	9.73	9.83					
L	.018	.024	0.46	0.61					
L1	.01 BSC		0.25 BSC						
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					CASE NUMBER: 2267-01			14 DEC 2011	
					STANDARD: NON-JEDEC				

## PRODUCT DOCUMENTATION AND SOFTWARE

Refer to the following documents and software to aid your design process.

### Application Notes

- AN1907: Solder Reflow Attach Method for High Power RF Devices in Over-Molded Plastic Packages
- AN1955: Thermal Measurement Methodology of RF Power Amplifiers
- AN3789: Clamping of High Power RF Transistors and RFICs in Over-Molded Plastic Packages

### Engineering Bulletins

- EB212: Using Data Sheet Impedances for RF LDMOS Devices

### Software

- Electromigration MTTF Calculator
- RF High Power Model
- .s2p File

For Software, do a Part Number search at <http://www.freescale.com>, and select the “Part Number” link. Go to the Software & Tools tab on the part’s Product Summary page to download the respective tool.

## REVISION HISTORY

The following table summarizes revisions to this document.

Revision	Date	Description
0	Dec. 2010	<ul style="list-style-type: none"> <li>• Initial Release of Data Sheet</li> </ul>
1	Feb. 2012	<ul style="list-style-type: none"> <li>• Added part number MRF8S9202GNR3, p. 1</li> <li>• Added 2267-01 (OM-780-2 Gull) package isometric, p. 1, and Mechanical Outline, p. 12-14</li> </ul>

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Freescale Semiconductor Japan Ltd.  
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Tokyo 153-0064  
Japan  
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[support.japan@freescale.com](mailto:support.japan@freescale.com)

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Exchange Building 23F  
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