Freescale Semiconductor
Technical Data

Document Number: MRF8S7235N
Rev. 0, 6/2012

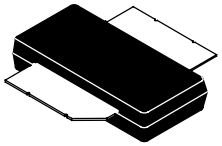
RoHS

RF Power Field Effect Transistor

N-Channel Enhancement-Mode Lateral MOSFET

MRF8S7235NR3

**728-768 MHz, 63 W AVG., 28 V
SINGLE W-CDMA
LATERAL N-CHANNEL
RF POWER MOSFET**



**OM-780-2
PLASTIC**

Designed for base station applications with frequencies from 728 to 768 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} = 1400 mA, P_{out} = 63 Watts Avg., IQ Magnitude Clipping, Channel Bandwidth = 3.84 MHz, Input Signal PAR = 7.5 dB @ 0.01% Probability on CCDF.

Frequency (MHz)	G_{ps} (dB)	η_D (%)	Output PAR (dB)	ACPR (dBc)
728	20.0	36.1	6.3	-38.1
748	20.2	36.0	6.4	-39.0
768	20.1	35.9	6.4	-38.7

- Capable of Handling 10:1 VSWR, @ 32 Vdc, 748 MHz, 360 Watts CW Output Power (3 dB Input Overdrive from Rated P_{out}), Designed for Enhanced Ruggedness
- Typical P_{out} @ 1 dB Compression Point ≃ 260 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.

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

Characteristich	Symbol	Value (2,3)	Unit
Thermal Resistance, Junction to Case Case Temperature 80°C, 63 W CW, 28 Vdc, I_{DQ} = 1400 mA, 728 MHz Case Temperature 82°C, 250 W CW, 28 Vdc, I_{DQ} = 1400 mA, 728 MHz	$R_{\theta JC}$	 0.33 0.29	°C/W

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

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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°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
Off Characteristics					
Zero Gate Voltage Drain Leakage Current (V_{DS} = 70 Vdc, V_{GS} = 0 Vdc)	I_{DSS}	—	—	10	μAdc
Zero Gate Voltage Drain Leakage Current (V_{DS} = 28 Vdc, V_{GS} = 0 Vdc)	I_{DSS}	—	—	1	μAdc
Gate-Source Leakage Current (V_{GS} = 5 Vdc, V_{DS} = 0 Vdc)	I_{GSS}	—	—	1	μAdc
On Characteristics					
Gate Threshold Voltage (V_{DS} = 10 Vdc, I_D = 920 μAdc)	$V_{GS(th)}$	1.5	2.3	3.0	Vdc
Gate Quiescent Voltage (V_{DD} = 28 Vdc, I_D = 1400 mAdc, Measured in Functional Test)	$V_{GS(Q)}$	2.3	3.0	3.8	Vdc
Drain-Source On-Voltage (V_{GS} = 10 Vdc, I_D = 3.4 Adc)	$V_{DS(on)}$	0.1	0.18	0.3	Vdc
Functional Tests (1) (In Freescale Test Fixture, 50 ohm system) V_{DD} = 28 Vdc, I_{DQ} = 1400 mA, P_{out} = 63 W Avg., f = 728 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 @ ±5 MHz Offset.					
Power Gain	G_{ps}	18.8	20.0	21.8	dB
Drain Efficiency	η_D	34.5	36.1	—	%
Output Peak-to-Average Ratio @ 0.01% Probability on CCDF	PAR	5.8	6.3	—	dB
Adjacent Channel Power Ratio	ACPR	—	-38.1	-35.5	dBc
Input Return Loss	IRL	—	-16	-10	dB

Typical Broadband Performance (In Freescale Test Fixture, 50 ohm system) V_{DD} = 28 Vdc, I_{DQ} = 1400 mA, P_{out} = 63 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 @ ±5 MHz Offset.

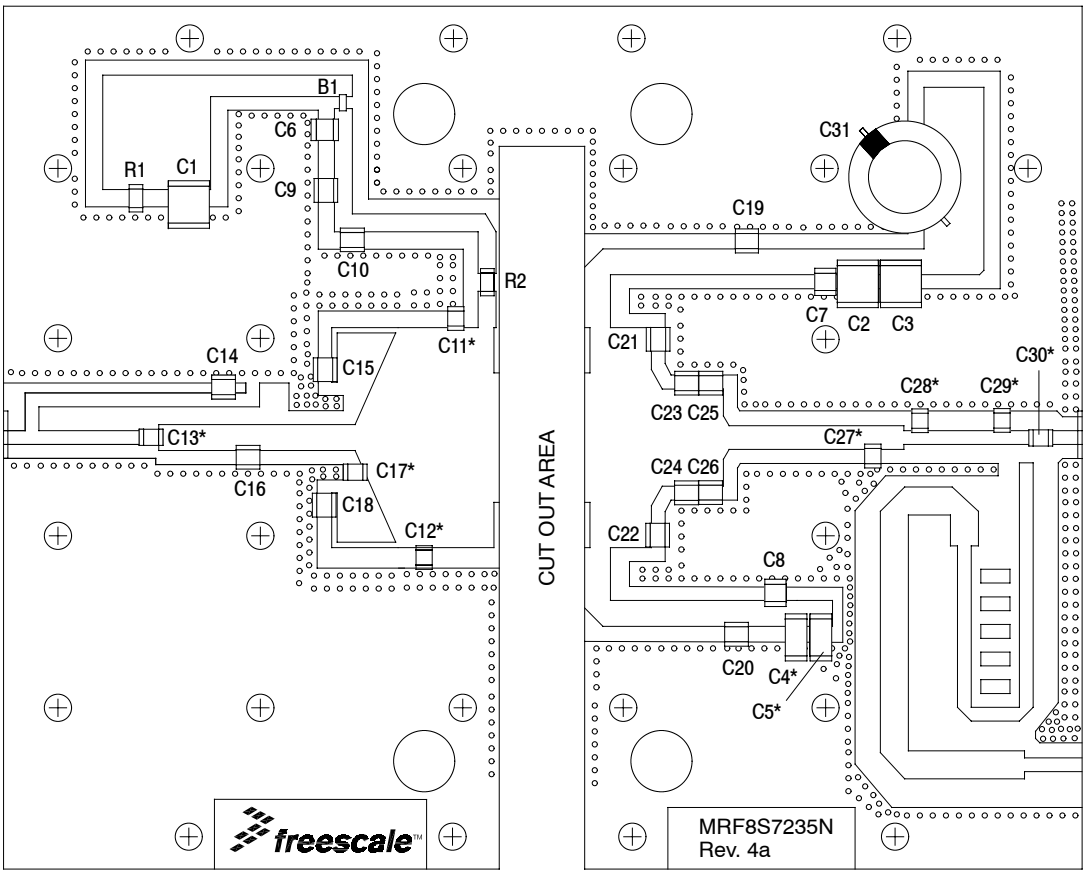
Frequency	G_{ps} (dB)	η_D (%)	Output PAR (dB)	ACPR (dBc)	IRL (dB)
728 MHz	20.0	36.1	6.3	-38.1	-16
748 MHz	20.2	36.0	6.4	-39.0	-17
768 MHz	20.1	35.9	6.4	-38.7	-15

1. Part internally matched both on input and output.

(continued)

Table 5. Electrical Characteristics (T_A = 25°C unless otherwise noted) **(continued)**

Characteristic	Symbol	Min	Typ	Max	Unit
Typical Performance (In Freescale Test Fixture, 50 ohm system) V_{DD} = 28 Vdc, I_{DQ} = 1400 mA, 728–768 MHz Bandwidth					
P_{out} @ 1 dB Compression Point, CW	P1dB	—	260	—	W
IMD Symmetry @ 107 W PEP, P_{out} where IMD Third Order Intermodulation ≅ 30 dBc (Delta IMD Third Order Intermodulation between Upper and Lower Sidebands > 2 dB)	IMD_{sym}	—	10	—	MHz
VBW Resonance Point (IMD Third Order Intermodulation Inflection Point)	VBW_{res}	—	40	—	MHz
Gain Flatness in 40 MHz Bandwidth @ P_{out} = 63 W Avg.	G_F	—	0.3	—	dB
Gain Variation over Temperature (–30°C to +85°C)	ΔG	—	0.0124	—	dB/°C
Output Power Variation over Temperature (–30°C to +85°C)	ΔP1dB	—	0.005	—	dB/°C



*C4, C5, C11, C12, C13, C17, C27, C28, C29 and C30 are mounted vertically.

Figure 1. MRF8S7235NR3 Test Circuit Component Layout

Table 6. MRF8S7235NR3 Test Circuit Component Designations and Values

Part	Description	Part Number	Manufacturer
B1	Ferrite Bead	MPZ2012S300A	Murata
C1, C2, C3, C4, C5	22 μF Chip Capacitors	C5750KF1H226ZT	TDK
C6, C7, C8	3.3 μF Chip Capacitors	C3225JB1H335MT	TDK
C9, C19, C20	68 pF Chip Capacitors	ATC100B680JT500XT	ATC
C10	12 pF Chip Capacitor	ATC100B120JT500XT	ATC
C11, C12	10 pF Chip Capacitors	ATC100B100CT500XT	ATC
C13	2.7 pF Chip Capacitor	ATC100B2R7CT500XT	ATC
C14	110 pF Chip Capacitor	ATC100B111JT500XT	ATC
C15, C16, C17, C18, C27	3.6 pF Chip Capacitors	ATC100B3R6CT500XT	ATC
C21, C22	15 pF Chip Capacitors	ATC100B150JT500XT	ATC
C23, C24	6.2 pF Chip Capacitors	ATC100B6R2CT500XT	ATC
C25, C26	8.2 pF Chip Capacitors	ATC100B8R2CT500XT	ATC
C28	3.3 pF Chip Capacitor	ATC100B3R3CT500XT	ATC
C29	1.0 pF Chip Capacitor	ATC100B1R0BT500XT	ATC
C30	39 pF Chip Capacitor	ATC100B390JT500XT	ATC
C31	470 μF Electrolytic Capacitor	MCGPR63V477M13X26-RH	Multicomp
R1	27 KΩ, 1/4 W Chip Resistor	CRCW120627K0JNEA	Vishay
R2	4.75 Ω, 1/4 W Chip Resistor	CRCW12064R75FNEA	Vishay
PCB	0.030″, ε_r = 3.5	RF35–A2	Taconic

TYPICAL CHARACTERISTICS

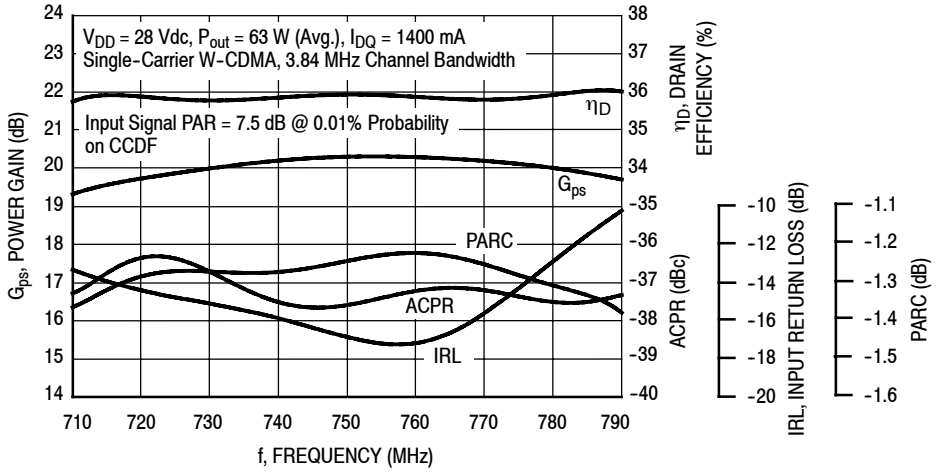


Figure 2. Output Peak-to-Average Ratio Compression (PARC) Broadband Performance @ P_{out} = 63 Watts Avg.

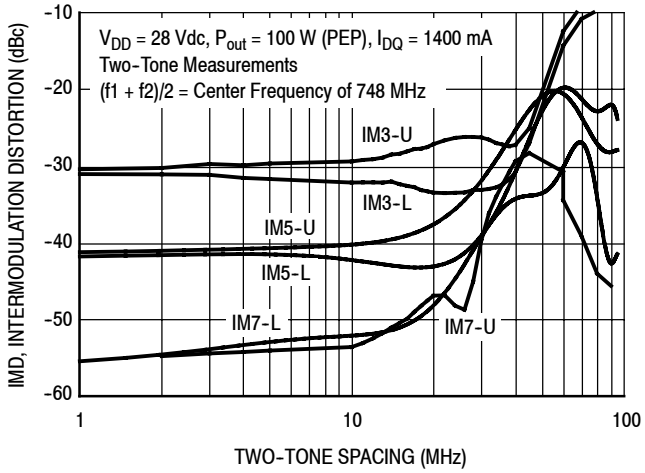


Figure 3. Intermodulation Distortion Products versus Two-Tone Spacing

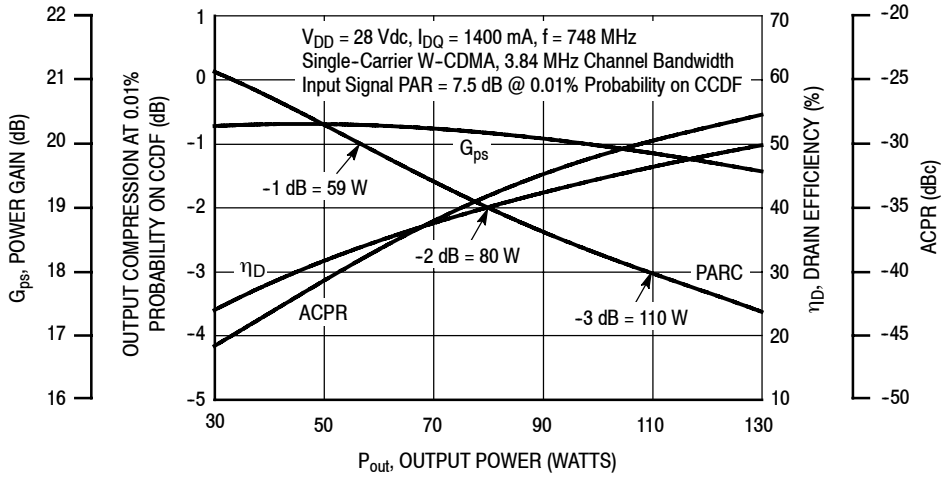


Figure 4. Output Peak-to-Average Ratio Compression (PARC) versus Output Power

TYPICAL CHARACTERISTICS

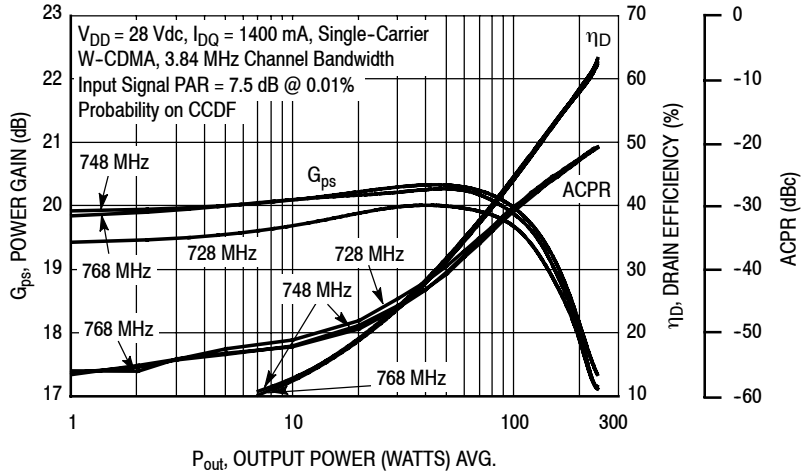


Figure 5. Single-Carrier W-CDMA Power Gain, Drain Efficiency and ACPR versus Output Power

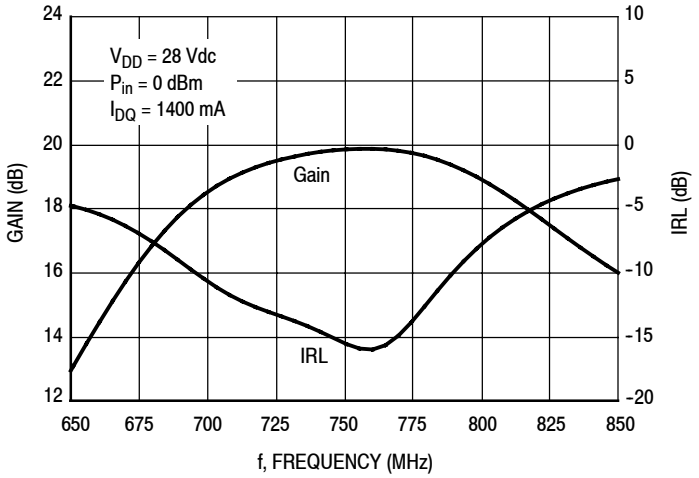


Figure 6. Broadband Frequency Response

W-CDMA TEST SIGNAL

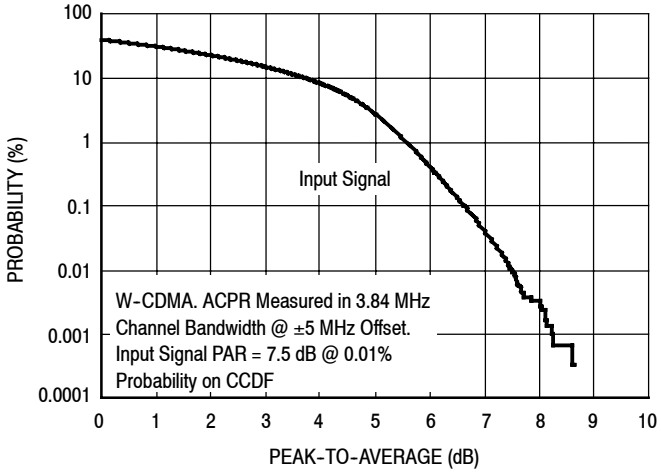


Figure 7. CCDF W-CDMA IQ Magnitude Clipping, Single-Carrier Test Signal

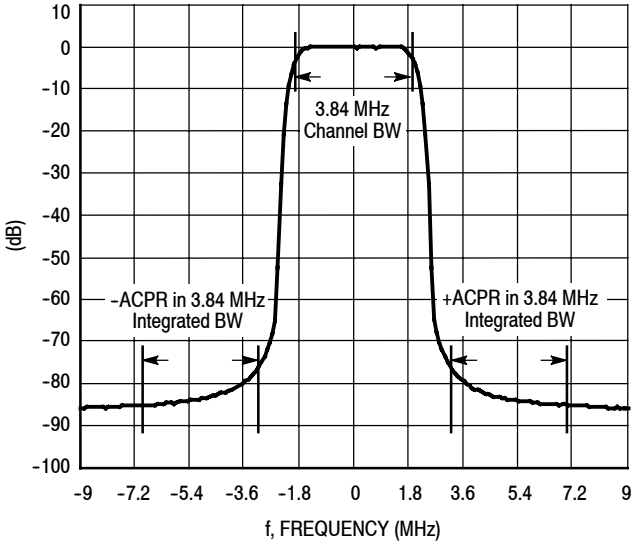


Figure 8. Single-Carrier W-CDMA Spectrum

V_{DD} = 28 Vdc, I_{DQ} = 1400 mA, P_{out} = 63 W Avg.

f MHz	Z_{source} Ω	Z_{load} Ω
710	0.95 - j0.82	1.19 - j1.03
720	0.93 - j0.81	1.05 - j0.99
730	0.89 - j0.77	0.92 - j0.91
740	0.87 - j0.73	0.85 - j0.82
750	0.89 - j0.73	0.83 - j0.78
760	0.92 - j0.77	0.83 - j0.77
770	0.89 - j0.81	0.79 - j0.76
780	0.80 - j0.77	0.71- j0.68
790	0.70 - j0.66	0.61 - j0.56

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

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

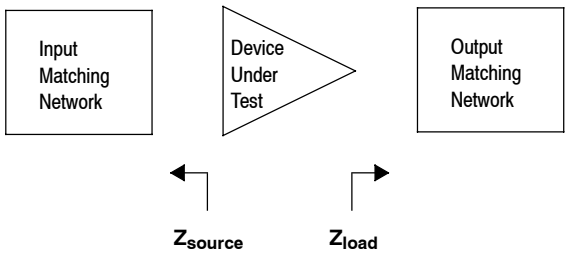


Figure 9. Series Equivalent Source and Load Impedance

V_{DD} = 28 Vdc, I_{DQ} = 1200 mA, Pulsed CW, 10 μsec(on), 10% Duty Cycle

f (MHz)	Z_{source} (Ω)	Z_{load} (1) (Ω)	Max Output Power					
			P1dB			P3dB		
			(dBm)	(W)	η_D (%)	(dBm)	(W)	η_D (%)
728	1.00 - j0.80	0.50 - j0.70	55.3	339	54.1	56.2	417	57.2
748	0.70 - j1.10	0.50 - j0.60	55.4	347	53.9	56.2	417	56.9
768	0.80 - j1.25	0.50 - j0.60	55.3	339	53.5	56.1	407	56.9

(1) Load impedance for optimum P1dB power.

Z_{source} = Impedance as measured from gate contact to ground.
Z_{load} = Impedance as measured from drain contact to ground.

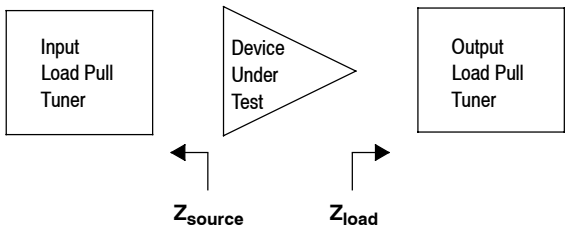


Figure 10. Load Pull Performance — Maximum P1dB Tuning

V_{DD} = 28 Vdc, I_{DQ} = 1200 mA, Pulsed CW, 10 μsec(on), 10% Duty Cycle

f (MHz)	Z_{source} (Ω)	Z_{load} (1) (Ω)	Max Drain Efficiency					
			P1dB			P3dB		
			(dBm)	(W)	η_D (%)	(dBm)	(W)	η_D (%)
728	1.00 - j0.80	1.40 + j0.20	52.4	174	67.4	53.1	204	70.0
748	0.70 - j1.10	1.20 + j0.10	52.6	182	67.0	53.5	224	69.9
768	0.80 - j1.25	1.10 + j0.20	52.6	182	67.1	53.3	214	69.9

(1) Load impedance for optimum P1dB efficiency.

Z_{source} = Impedance as measured from gate contact to ground.
Z_{load} = Impedance as measured from drain contact to ground.

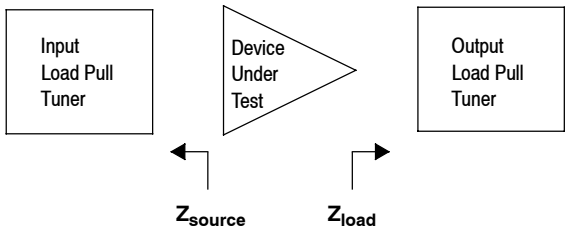
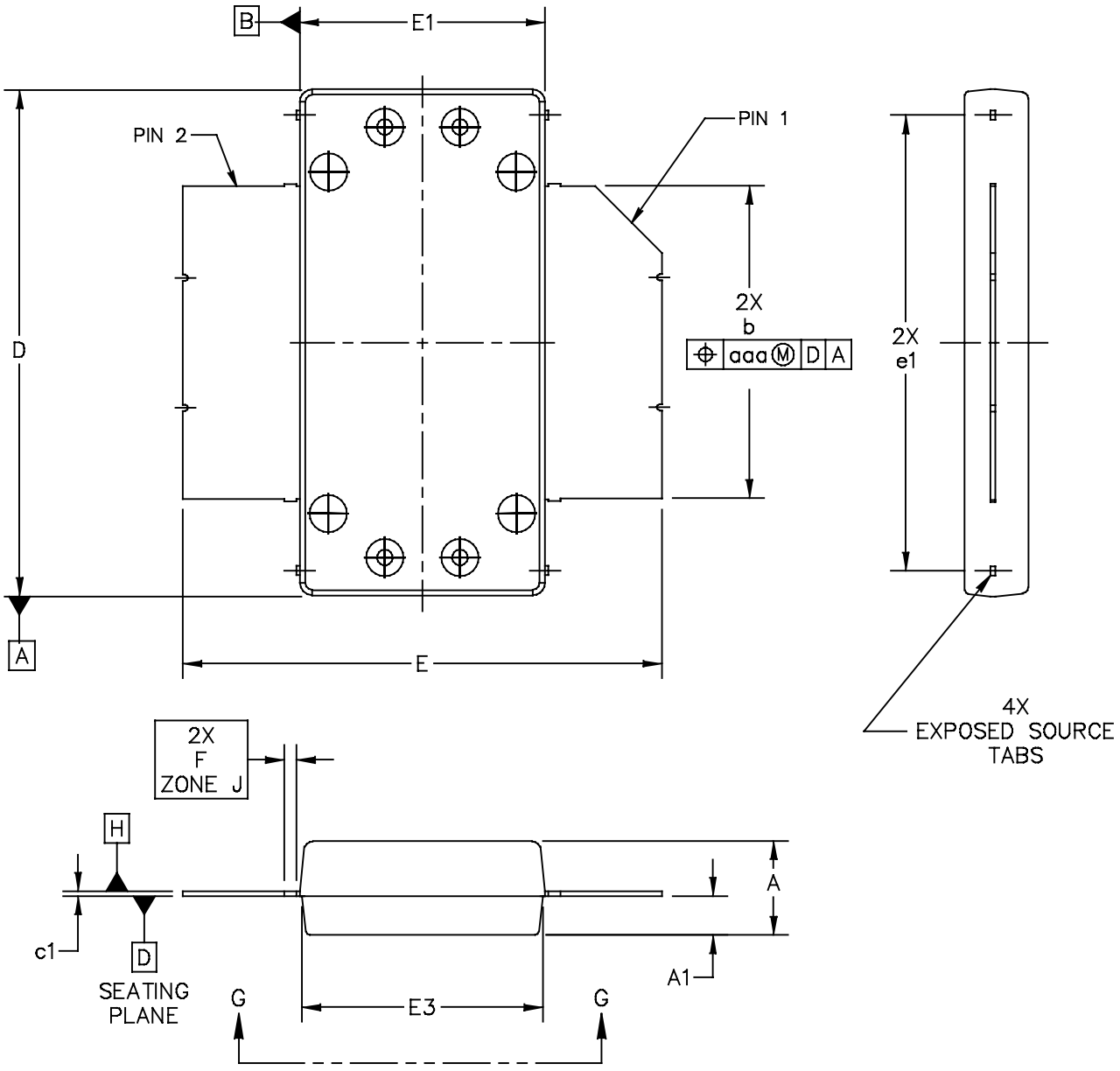


Figure 11. Load Pull Performance — Maximum Drain Efficiency Tuning

PACKAGE DIMENSIONS



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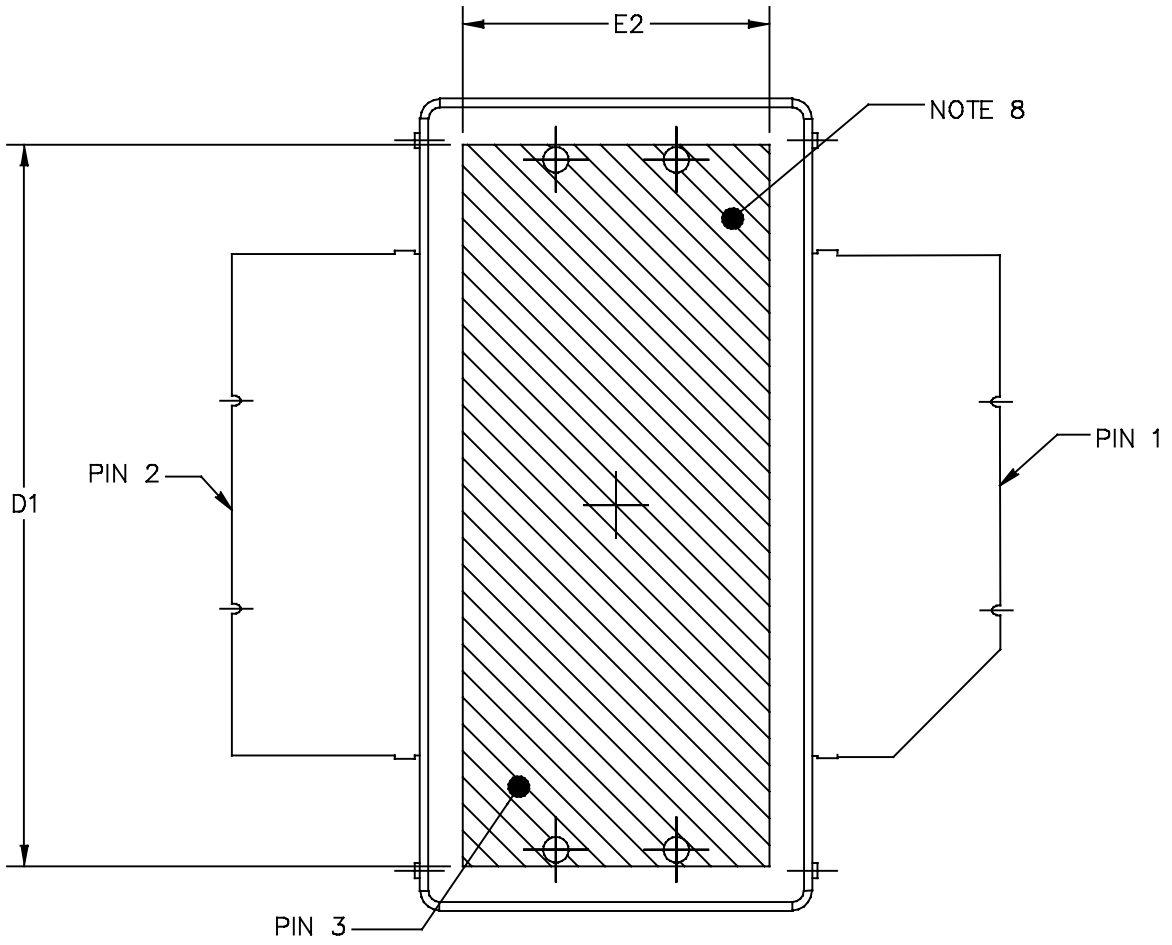

BOTTOM VIEW
VIEW G–G

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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 MIN	INCH MAX	MILLIMETER MIN	MILLIMETER MAX	DIM	INCH MIN	INCH MAX	MILLIMETER MIN	MILLIMETER 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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PRODUCT DOCUMENTATION, SOFTWARE AND TOOLS

Refer to the following documents, software and tools 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

Development Tools

- Printed Circuit Boards

For Software and Tools, 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	June 2012	• Initial Release of Data Sheet

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