Document Number: MRF9030N
Rev. 12, 9/2008

RoHS

RF Power Field Effect Transistor

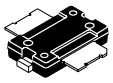
N-Channel Enhancement-Mode Lateral MOSFET

MRF9030NR1

Designed for broadband commercial and industrial applications with frequencies up to 1000 MHz. The high gain and broadband performance of this device make it ideal for large-signal, common-source amplifier applications in 26 volt base station equipment.

- Typical Performance at 945 MHz, 26 Volts
  - Output Power — 30 Watts PEP
  - Power Gain — 20 dB
  - Efficiency — 41% (Two Tones)
  - IMD — -31 dBc
- Integrated ESD Protection
- Capable of Handling 5:1 VSWR, @ 26 Vdc, 945 MHz, 30 Watts CW Output Power

945 MHz, 30 W, 26 V
LATERAL N-CHANNEL
BROADBAND
RF POWER MOSFET



CASE 1265-09, STYLE 1
TO-270-2
PLASTIC

Features

- Excellent Thermal Stability
- Characterized with Series Equivalent Large-Signal Impedance Parameters
- Dual-Lead Boltdown Plastic Package Can Also Be Used As Surface Mount.
- 200°C Capable Plastic Package
- N Suffix Indicates Lead-Free Terminations. RoHS Compliant.
- TO-270-2 in Tape and Reel. R1 Suffix = 500 Units per 24 mm, 13 inch Reel.

Table 1. Maximum Ratings

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DSS}	-0.5, +65	Vdc
Gate-Source Voltage	V_{GS}	-0.5, +15	Vdc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	139 0.93	W W/°C
Storage Temperature Range	T_{stg}	-65 to +150	°C
Operating Junction Temperature	T_J	200	°C

Table 2. Thermal Characteristics

Characteristic	Symbol	Value (1)	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.08	°C/W

Table 3. ESD Protection Characteristics

Test Conditions	Class
Human Body Model	1 (Minimum)
Machine Model	M2 (Minimum)
Charge Device Model	C7 (Minimum)

Table 4. Moisture Sensitivity Level

Test Methodology	Rating	Package Peak Temperature	Unit
Per JESD 22-A113, IPC/JEDEC J-STD-020	3	260	°C

1. MTTF calculator available at http://www.freescale.com/rf. Select Software & Tools/Development Tools/Calculators to access MTTF calculators by product.

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Table 5. Electrical Characteristics (T_c = 25°c Unless Otherwise Noted)

Characteristic	Symbol	Min	Typ	Max	Unit
Off Characteristics					
Zero Gate Voltage Drain Leakage Current (V_{DS} = 65 Vdc, V_{GS} = 0 Vdc)	I_{DSS}	—	—	10	μAdc
Zero Gate Voltage Drain Leakage Current (V_{DS} = 26 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 = 100 μAdc)	$V_{GS(th)}$	2	2.9	4	Vdc
Gate Quiescent Voltage (V_{DS} = 26 Vdc, I_D = 250 mAdc)	$V_{GS(Q)}$	3	3.8	5	Vdc
Drain-Source On-Voltage (V_{GS} = 10 Vdc, I_D = 0.7 Adc)	$V_{DS(on)}$	—	0.23	0.4	Vdc
Forward Transconductance (V_{DS} = 10 Vdc, I_D = 2 Adc)	g_{fs}	—	2.7	—	S
Dynamic Characteristics					
Input Capacitance (V_{DS} = 26 Vdc ± 30 mV(rms)ac @ 1 MHz, V_{GS} = 0 Vdc)	C_{iss}	—	49	—	pF
Output Capacitance (V_{DS} = 26 Vdc ± 30 mV(rms)ac @ 1 MHz, V_{GS} = 0 Vdc)	C_{oss}	—	27	—	pF
Reverse Transfer Capacitance (V_{DS} = 26 Vdc ± 30 mV(rms)ac @ 1 MHz, V_{GS} = 0 Vdc)	C_{rss}	—	1.2	—	pF
Functional Tests (In Freescale Test Fixture)					
Two-Tone Common-Source Amplifier Power Gain (V_{DD} = 26 Vdc, P_{out} = 30 W PEP, I_{DQ} = 250 mA, f1 = 945.0 MHz, f2 = 945.1 MHz)	G_{ps}	18	20	—	dB
Two-Tone Drain Efficiency (V_{DD} = 26 Vdc, P_{out} = 30 W PEP, I_{DQ} = 250 mA, f1 = 945.0 MHz, f2 = 945.1 MHz)	η	37	41	—	%
3rd Order Intermodulation Distortion (V_{DD} = 26 Vdc, P_{out} = 30 W PEP, I_{DQ} = 250 mA, f1 = 945.0 MHz, f2 = 945.1 MHz)	IMD	—	-31	-28	dBc
Input Return Loss (V_{DD} = 26 Vdc, P_{out} = 30 W PEP, I_{DQ} = 250 mA, f1 = 945.0 MHz, f2 = 945.1 MHz)	IRL	—	-13	-9	dB
Two-Tone Common-Source Amplifier Power Gain (V_{DD} = 26 Vdc, P_{out} = 30 W PEP, I_{DQ} = 250 mA, f1 = 930.0 MHz, f2 = 930.1 MHz and f1 = 960.0 MHz, f2 = 960.1 MHz)	G_{ps}	—	20	—	dB
Two-Tone Drain Efficiency (V_{DD} = 26 Vdc, P_{out} = 30 W PEP, I_{DQ} = 250 mA, f1 = 930.0 MHz, f2 = 930.1 MHz and f1 = 960.0 MHz, f2 = 960.1 MHz)	η	—	40.5	—	%
3rd Order Intermodulation Distortion (V_{DD} = 26 Vdc, P_{out} = 30 W PEP, I_{DQ} = 250 mA, f1 = 930.0 MHz, f2 = 930.1 MHz and f1 = 960.0 MHz, f2 = 960.1 MHz)	IMD	—	-31	—	dBc
Input Return Loss (V_{DD} = 26 Vdc, P_{out} = 30 W PEP, I_{DQ} = 250 mA, f1 = 930.0 MHz, f2 = 930.1 MHz and f1 = 960.0 MHz, f2 = 960.1 MHz)	IRL	—	-12	—	dB

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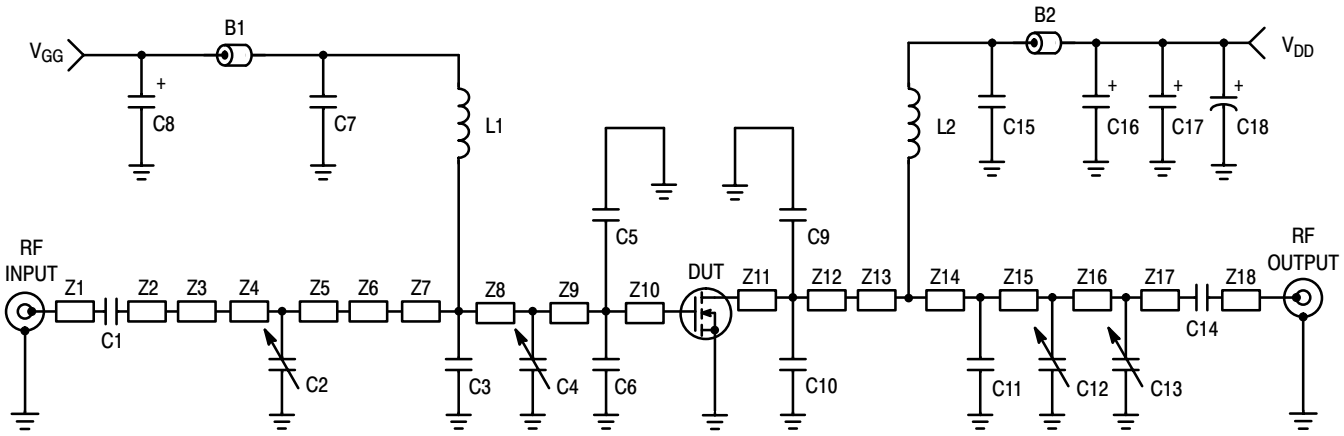

Z1	0.260″ x 0.060″ Microstrip	Z11	0.360″ x 0.270″ Microstrip
Z2	0.240″ x 0.060″ Microstrip	Z12	0.050″ x 0.270″ Microstrip
Z3	0.500″ x 0.100″ Microstrip	Z13	0.110″ x 0.060″ Microstrip
Z4	0.200″ x 0.270″ Microstrip	Z14	0.220″ x 0.060″ Microstrip
Z5	0.330″ x 0.270″ Microstrip	Z15	0.100″ x 0.060″ Microstrip
Z6	0.140″ x 0.270″ x 0.520″, Taper	Z16	0.870″ x 0.060″ Microstrip
Z7	0.040″ x 0.520″ Microstrip	Z17	0.240″ x 0.060″ Microstrip
Z8	0.090″ x 0.520″ Microstrip	Z18	0.340″ x 0.060″ Microstrip
Z9	0.370″ x 0.520″ Microstrip (MRF9030NR1) 0.290″ x 0.520″ Microstrip (MRF9030NBR1)	Board	Taconic RF-35-0300, ε_r = 3.5
Z10	0.130″ x 0.520″ Microstrip (MRF9030NR1) 0.210″ x 0.520″ Microstrip (MRF9030NBR1)		

Figure 1. 930-960 MHz Broadband Test Circuit Schematic

Table 6. 930 - 960 MHz Broadband Test Circuit Component Designations and Values

Part	Description	Part Number	Manufacturer
B1	Short Ferrite Bead, Surface Mount	2743019447	Fair-Rite
B2	Long Ferrite Bead, Surface Mount	2743029446	Fair-Rite
C1, C7, C14, C15	47 pF Chip Capacitors	ATC100B470JT500XT	ATC
C2	0.6-4.5 Variable Capacitor, Gigatrim	27271SL	Johanson
C3, C11	3.9 pF Chip Capacitors	ATC100B3R6BT500XT	ATC
C4, C12	0.8-8.0 Variable Capacitors, Gigatrim	27291SL	Johanson
C5, C6	6.8 pF Chip Capacitors	ATC100B7R5JT500XT	ATC
C8, C16, C17	10 μF, 35 V Tantulum Chip Capacitors	T491D106K035AT	Kemet
C9, C10	10 pF Chip Capacitors	ATC100B100JT500XT	ATC
C13	1.8 pF Chip Capacitor (MRF9030NR1) 0.6-4.5 Variable Capacitor, Gigatrim (MRF9030NBR1)	ATC100B1R8BT500XT 27271SL	ATC Johanson
C18	220 μF Electrolytic Chip Capacitor	MCAX63V227M13X22	Multicomp
L1, L2	12.5 nH Coilcraft Inductors	A04T-5	Coilcraft

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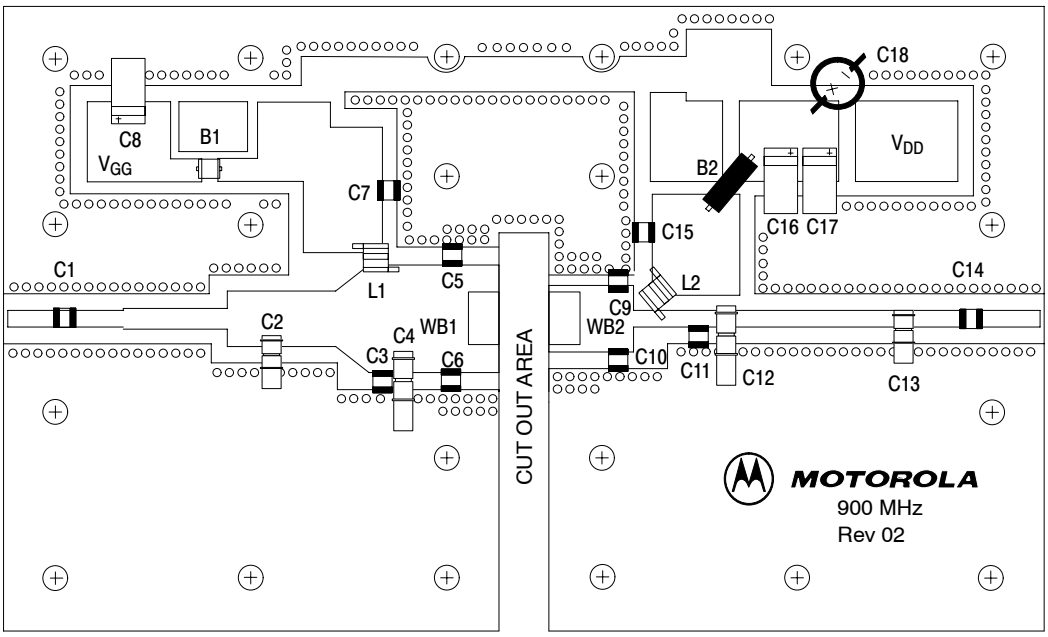


Freescale has begun the transition of marking Printed Circuit Boards (PCBs) with the Freescale Semiconductor signature/logo. PCBs may have either Motorola or Freescale markings during the transition period. These changes will have no impact on form, fit or function of the current product.

Figure 2. 930-960 MHz Broadband Test Circuit Component Layout

TYPICAL CHARACTERISTICS

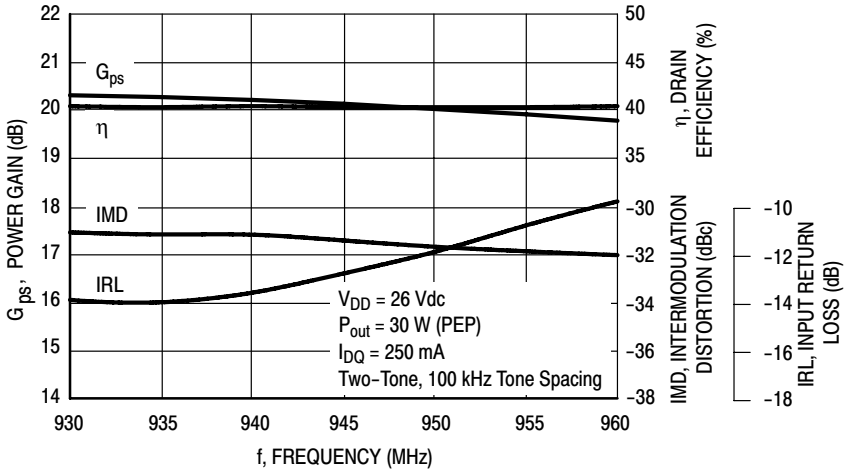


Figure 3. Class AB Broadband Circuit Performance

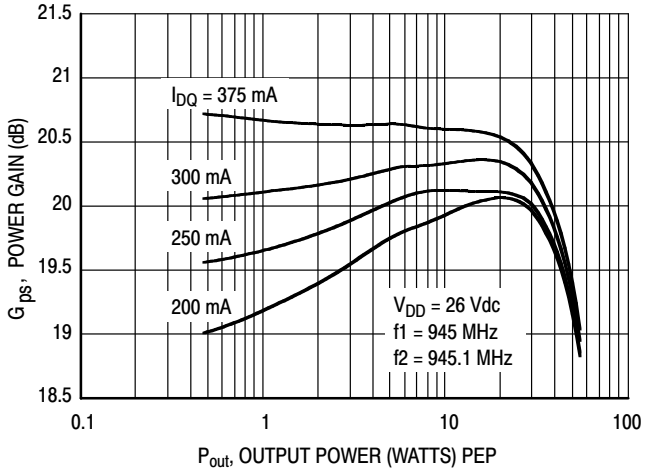


Figure 4. Power Gain versus Output Power

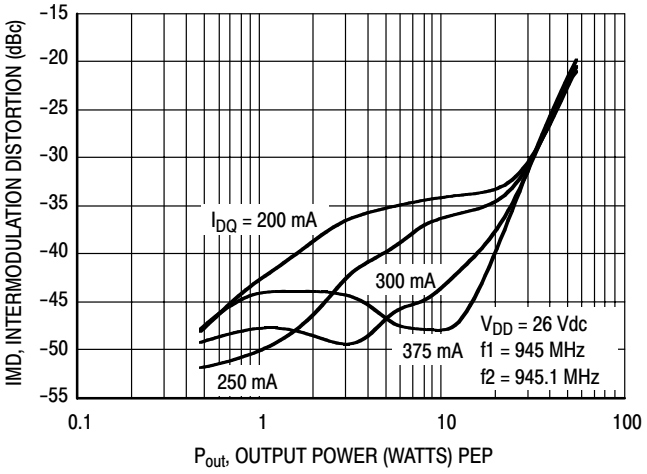


Figure 5. Intermodulation Distortion versus Output Power

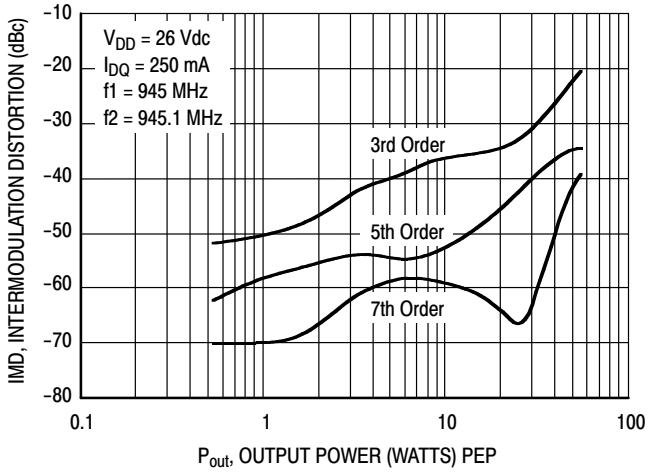


Figure 6. Intermodulation Distortion Products versus Output Power

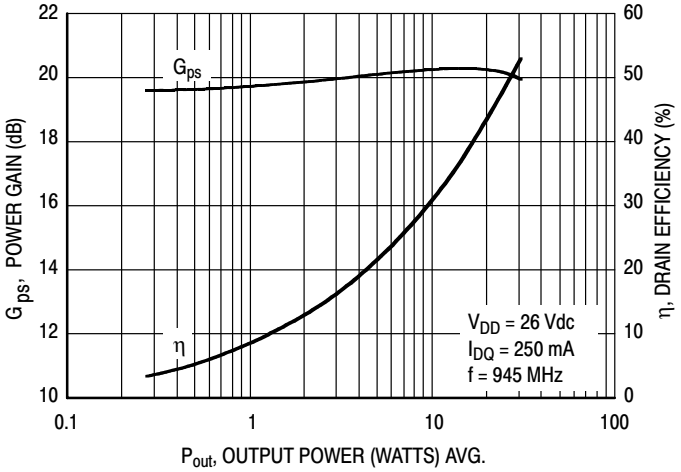


Figure 7. Power Gain and Efficiency versus Output Power

TYPICAL CHARACTERISTICS

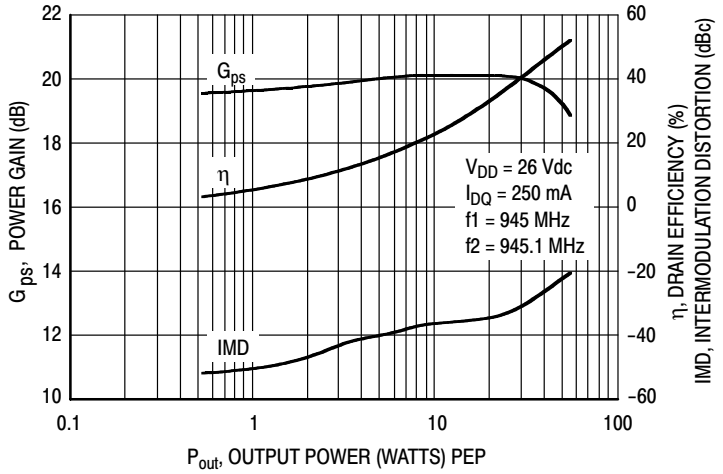
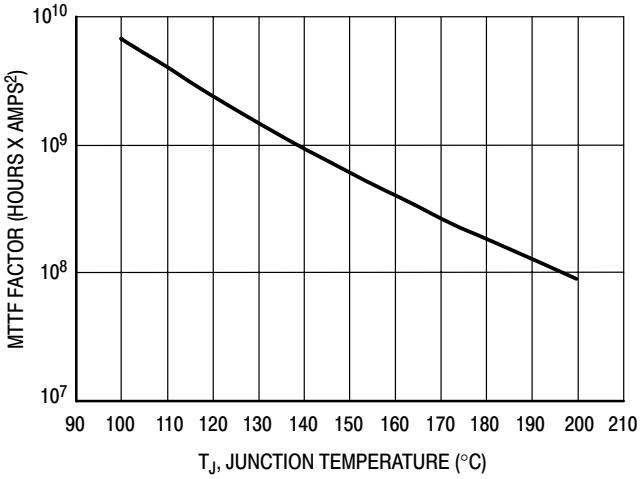
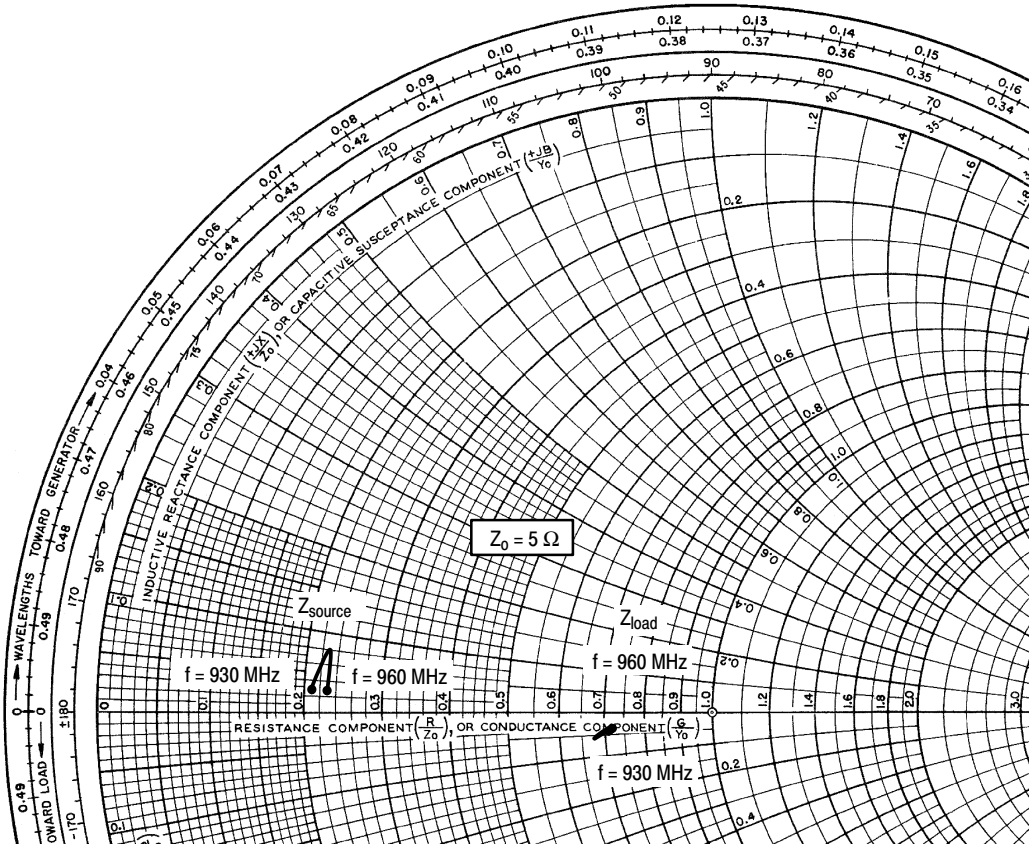


Figure 8. Power Gain, Efficiency and IMD versus Output Power



This above graph displays calculated MTTF in hours x ampere^2 drain current. Life tests at elevated temperatures have correlated to better than ±10% of the theoretical prediction for metal failure. Divide MTTF factor by I_D^2 for MTTF in a particular application.

Figure 9. MTTF Factor versus Junction Temperature



V_{DD} = 26 V, I_{DQ} = 250 mA, P_{out} = 30 Watts (PEP)

f MHz	Z_{source} Ω	Z_{load} Ω
930	1.07 + j0.160	3.53 - j0.20
945	1.14 + j0.385	3.41 - j0.24
960	1.17 + j0.170	3.60 - j0.17

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

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

Note: Z_{load} was chosen based on tradeoffs between gain, output power, drain efficiency and intermodulation distortion.

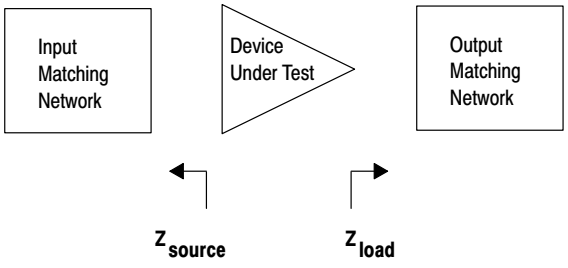
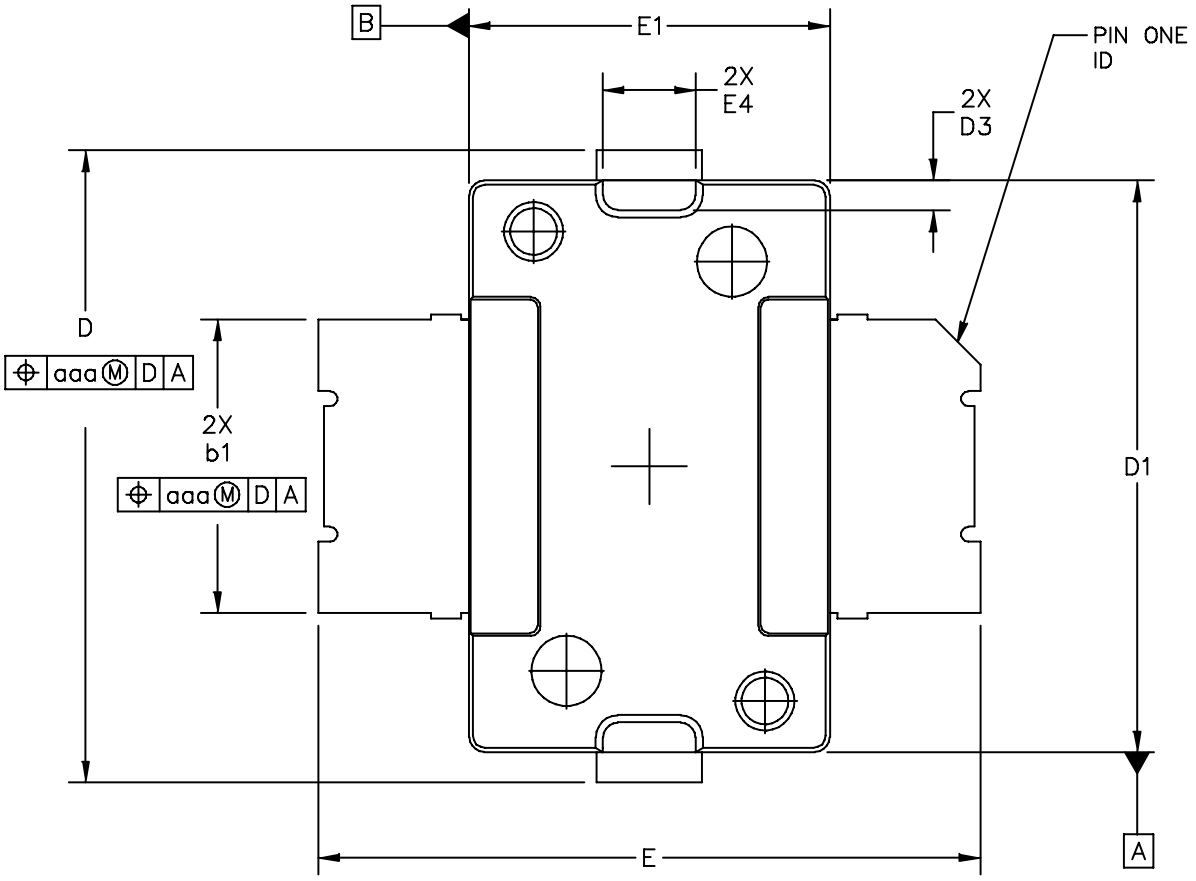
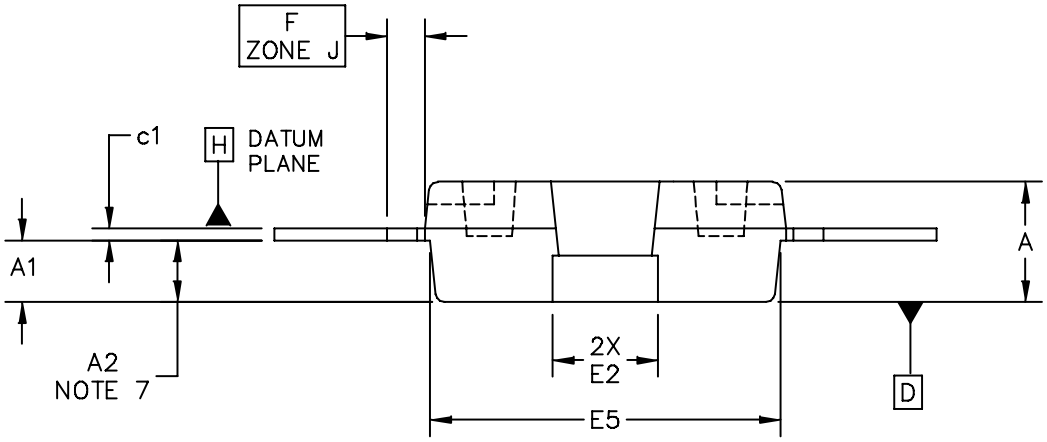


Figure 10. Series Equivalent Source and Load Impedance

PACKAGE DIMENSIONS





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	CASE NUMBER: 1265−09	29 JUN 2007
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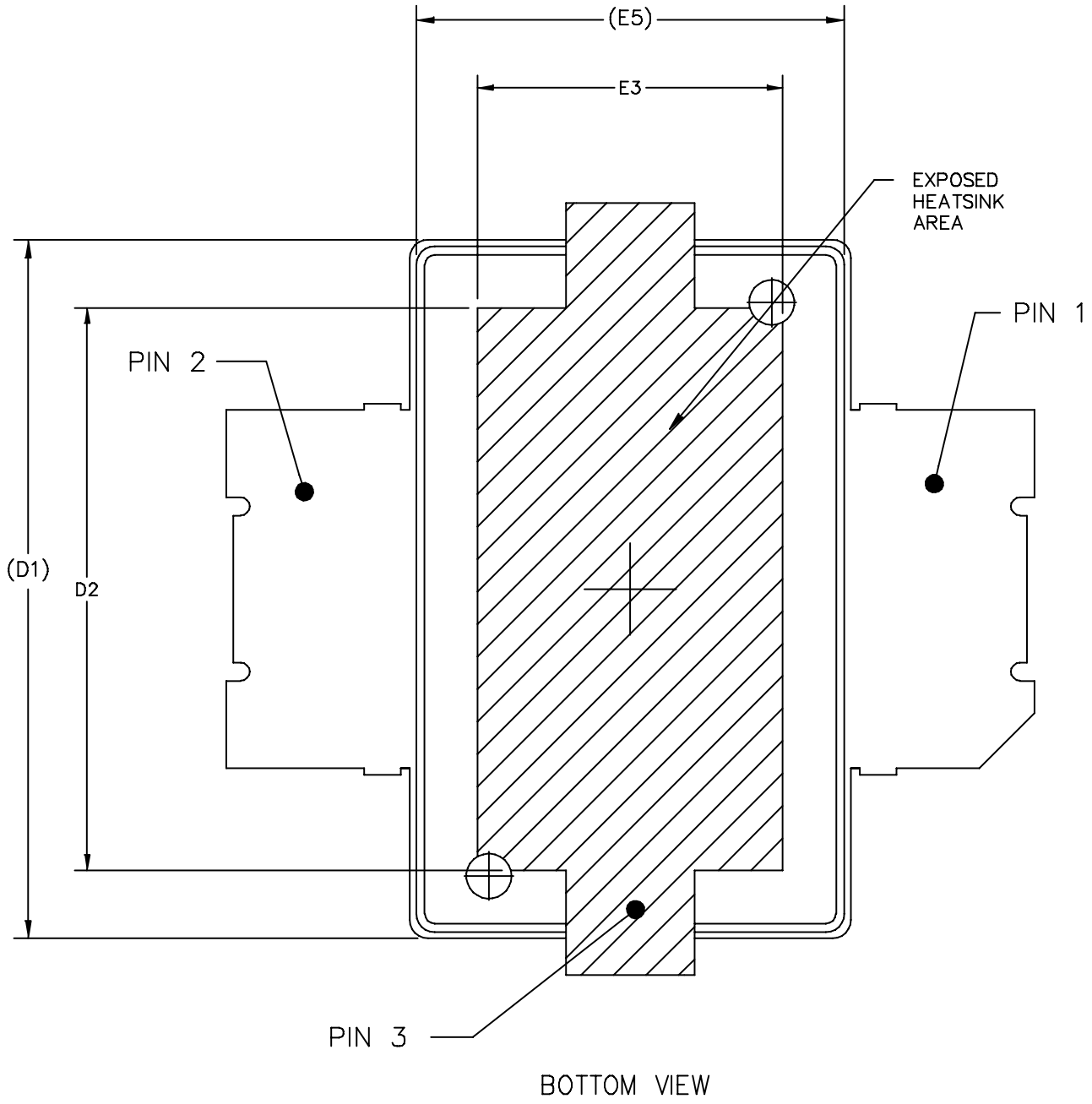

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	CASE NUMBER: 1265−09	29 JUN 2007
	STANDARD: JEDEC TO−270 AA	

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 "D1" AND "E1" DO NOT INCLUDE MOLD PROTRUSION. ALLOWABLE PROTRUSION IS .006 PER SIDE. DIMENSIONS "D1 AND "E1" DO INCLUDE MOLD MISMATCH AND ARE DETERMINED AT DATUM PLANE –H–.

5. DIMENSION "b1" DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE .005 TOTAL IN EXCESS OF THE "b1" DIMENSION AT MAXIMUM MATERIAL CONDITION.

6. DATUMS –A– AND –B– TO BE DETERMINED AT DATUM PLANE –H–.

7. DIMENSION "A2" APPLIES WITHIN ZONE "J" ONLY.

8. DIMENSIONS "D" AND "E2" DO NOT INCLUDE MOLD PROTRUSION. OVERALL LENGTH INCLUDING MOLD PROTRUSION SHOULD NOT EXCEED 0.430 INCH FOR DIMENSION "D" AND 0.080 INCH FOR DIMENSION "E2". DIMENSIONS "D" AND "E2" DO INCLUDE MOLD MISMATCH AND ARE DETERMINED AT DATUM PLANE –D–.

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	.078	.082	1.98	2.08	F	.025 BSC		0.64 BSC	
A1	.039	.043	0.99	1.09	b1	.193	.199	4.90	5.06
A2	.040	.042	1.02	1.07	c1	.007	.011	0.18	0.28
D	.416	.424	10.57	10.77	aaa	.004		0.10	
D1	.378	.382	9.60	9.70					
D2	.290	----	7.37	----					
D3	.016	.024	0.41	0.61					
E	.436	.444	11.07	11.28					
E1	.238	.242	6.04	6.15					
E2	.066	.074	1.68	1.88					
E3	.150	----	3.81	----					
E4	.058	.066	1.47	1.68					
E5	.231	.235	5.87	5.97					

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TO–270 SURFACE MOUNT	CASE NUMBER: 1265–09	29 JUN 2007
	STANDARD: JEDEC TO–270 AA	

PRODUCT DOCUMENTATION

Refer to the following documents to aid your design process.

Application Notes

- AN1955: Thermal Measurement Methodology of RF Power Amplifiers

Engineering Bulletins

- EB212: Using Data Sheet Impedances for RF LDMOS Devices

REVISION HISTORY

The following table summarizes revisions to this document.

Revision	Date	Description
12	Sept. 2008	• Data sheet revised to reflect part status change, p. 1, including use of applicable overlay. • Replaced Case Outline 1265-08 with 1265-09, Issue K, p. 1, 8-10. Corrected cross hatch pattern in bottom view and changed its dimensions (D2 and E3) to minimum value on source contact (D2 changed from Min-Max .290-.320 to .290 Min; E3 changed from Min-Max .150-.180 to .150 Min). Added JEDEC Standard Package Number. • Updated Part Numbers in Table 6, Component Designations and Values, to RoHS compliant part numbers, p. 3 • Removed Fig. 3, Test Circuit Component Layout (MRF9030NBR1) and Fig. 12, Series Equivalent Source and Load Impedance (MRF9030NBR1), renumbered Figures accordingly, p. 4-7 • Added Product Documentation and Revision History, p. 11

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For information on Freescale’s Environmental Products program, go to http://www.freescale.com/epp.

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