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Technical Data

RF Power Field Effect Transistor

N-Channel Enhancement-Mode Lateral MOSFET

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

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.

Document Number: MRF9030N Rev. 12, 9/2008

. 12, 3/2000

√RoHS

MRF9030NR1

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



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

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	TJ	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.

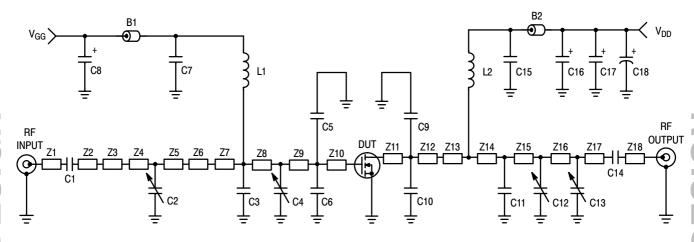


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Table 5. Electrical Characteristics (T _c = 25°c Unless Other Characteristic	Symbol	Min	Тур	Max	Unit
Off Characteristics	Syllibol	IVIIII	тур	IVIAX	Oilit
	 			10	A do
Zero Gate Voltage Drain Leakage Current (V _{DS} = 65 Vdc, V _{GS} = 0 Vdc)	I _{DSS}	_		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		<u> </u>		<u> </u>	!
Gate Threshold Voltage $(V_{DS} = 10 \text{ Vdc}, I_D = 100 \mu\text{Adc})$	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)	9 _{fs}	_	2.7	_	S
Oynamic Characteristics	•	•		•	
Input Capacitance (V_{DS} = 26 Vdc \pm 30 mV(rms)ac @ 1 MHz, V_{GS} = 0 Vdc)	C _{iss}	_	49	_	pF
Output Capacitance ($V_{DS} = 26 \text{ Vdc} \pm 30 \text{ mV(rms)ac} @ 1 \text{ MHz}, V_{GS} = 0 \text{ Vdc}$)	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 $(V_{DD} = 26 \text{ Vdc}, P_{out} = 30 \text{ W PEP}, I_{DQ} = 250 \text{ mA}, f1 = 945.0 \text{ MHz}, f2 = 945.1 \text{ MHz})$	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





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
Z 4	0.200" x 0.270" Microstrip	Z14	0.220" x 0.060" Microstrip
Z 5	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
Z 7	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
Z 9	0.370" x 0.520" Microstrip (MRF9030NR1)	Board	Taconic RF-35-0300, $\varepsilon_r = 3.5$
	0.290" x 0.520" Microstrip (MRF9030NBR1)		
Z10	0.130" x 0.520" Microstrip (MRF9030NR1)		

Figure 1. 930-960 MHz Broadband Test Circuit Schematic

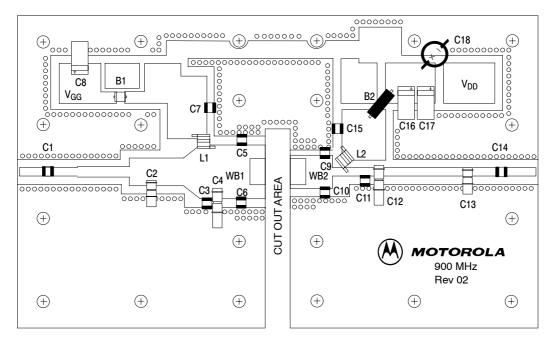
Table 6. 930 - 960 MHz Broadband Test Circuit Component Designations and Values

0.210" x 0.520" Microstrip (MRF9030NBR1)

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

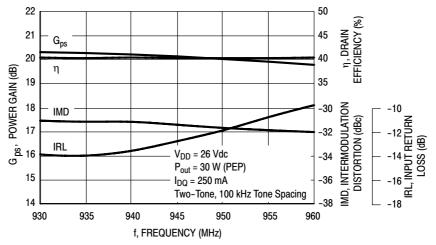


Figure 3. Class AB Broadband Circuit Performance

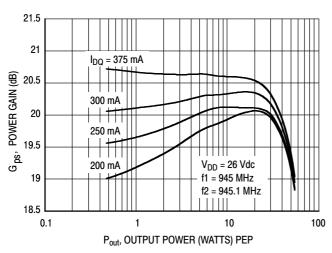


Figure 4. Power Gain versus Output Power

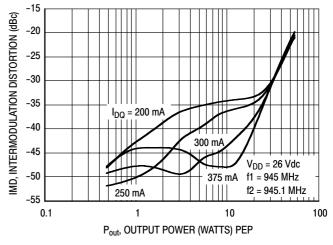


Figure 5. Intermodulation Distortion versus Output Power

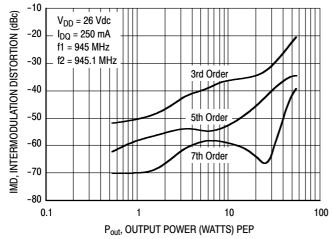


Figure 6. Intermodulation Distortion Products versus Output Power

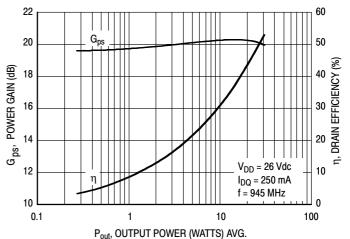


Figure 7. Power Gain and Efficiency versus
Output Power



TYPICAL CHARACTERISTICS

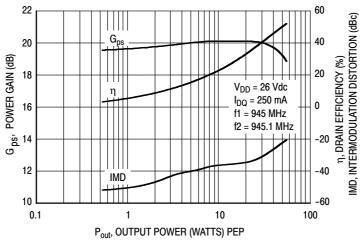
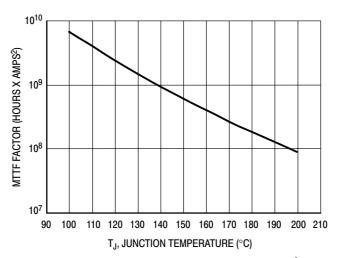


Figure 8. Power Gain, Efficiency and IMD versus Output Power

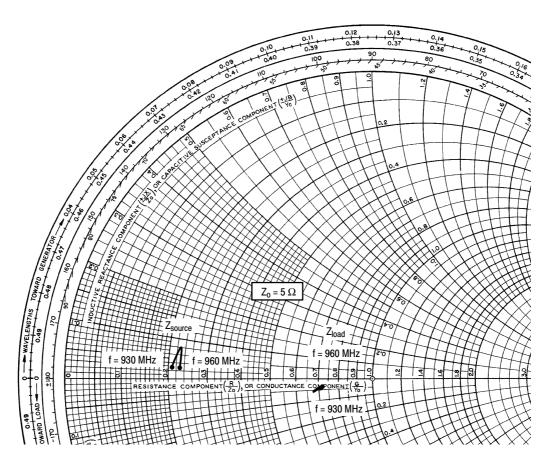


This above graph displays calculated MTTF in hours x ampere 2 drain current. Life tests at elevated temperatures have correlated to better than $\pm 10\%$ of the theoretical prediction for metal failure. Divide MTTF factor by $I_D{}^2$ for MTTF in a particular application.

Figure 9. MTTF Factor versus Junction Temperature



NOT RECOMMENDED FOR NEW DESIGN



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

f MHz	$\mathbf{Z_{source}}_{\Omega}$	$oldsymbol{Z_{load}}{\Omega}$
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.

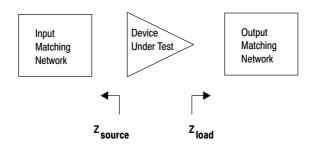
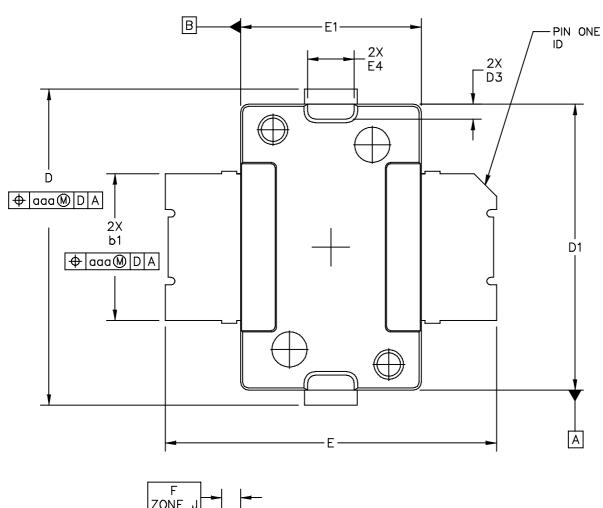
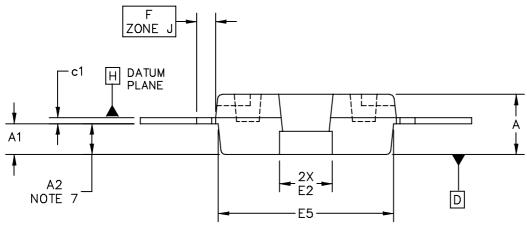


Figure 10. Series Equivalent Source and Load Impedance



PACKAGE DIMENSIONS





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TITLE:		DOCUMENT NO): 98ASH98117A	REV: K
TO-270 SURFACE MOUN	Т	CASE NUMBER	R: 1265–09	29 JUN 2007
SON ACE MOON	1	STANDARD: JE	DEC TO-270 AA	



E3 **EXPOSED** HEATSINK AREA PIN 1 PIN 2 RECOMMENDED FOR NEW D (D1) D₂ PIN 3 BOTTOM VIEW © FREESCALE SEMICONDUCTOR, ALL RIGHTS RESERVED. PRINT VERSION NOT TO SCALE MECHANICAL OUTLINE DOCUMENT NO: 98ASH98117A REV: K TO - 270CASE NUMBER: 1265-09 29 JUN 2007 SURFACE MOUNT

(E5)

NOT RECOMMENDED FOR NEW DESIGN

TITLE: STANDARD: JEDEC TO-270 AA



NOTES:

- 1. CONTROLLING DIMENSION: INCH
- 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

	1 11 3 - 3001(CL								
	IN	ICH	MILL	IMETER			INCH	MILLIN	METER
DIM	MIN	MAX	MIN	MAX	DIM	MIN	MAX	MIN	MAX
A	.078	.082	1.98	2.08	F	.c)25 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					
0	FREESCALE SE	MICONDUCTOR,	INC.	MECHANICA	L OUT	LINE	PRINT VERS	SION NOT TO	O SCALE

TO - 270SURFACE MOUNT DOCUMENT NO: 98ASH98117A REV: K CASE NUMBER: 1265-09 29 JUN 2007

STANDARD: JEDEC TO-270 AA

MRF9030NR1

TITLE:



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 .290320 to .290 Min; E3 changed from Min-Max .150180 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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