

The RF Sub-Micron MOSFET Line
RF Power Field Effect Transistors
N-Channel Enhancement-Mode Lateral MOSFETs

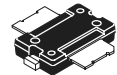
Designed for broadband commercial and industrial applications with frequencies up to 1.0 GHz. The high gain and broadband performance of these devices make them ideal for large-signal, common-source amplifier applications in 26 volt base station equipment.

- 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
- Excellent Thermal Stability
- Characterized with Series Equivalent Large-Signal Impedance Parameters
- Dual-Lead Bolt-down Plastic Package Can Also Be Used As Surface Mount.
- TO-272-2 in Tape and Reel. R1 Suffix = 500 Units per 44 mm, 13 inch Reel.
- TO-270-2 in Tape and Reel. R1 Suffix = 500 Units per 24 mm, 13 inch Reel.

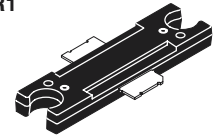
MRF9030MR1
MRF9030MBR1

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

CASE 1265-08, STYLE 1
TO-270-2
PLASTIC
MRF9030MR1



CASE 1337-03, STYLE 1
TO-272-2
PLASTIC
MRF9030MBR1



MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DSS}	65	Vdc
Gate-Source Voltage	V_{GS}	+15, -0.5	Vdc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C	P_D	139 0.93	Watts $\text{W}/^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +150	$^\circ\text{C}$
Operating Junction Temperature	T_J	175	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.08	$^\circ\text{C}/\text{W}$

ESD PROTECTION CHARACTERISTICS

Test Conditions	Class
Human Body Model	1 (Minimum)
Machine Model	M2 (Minimum)
Charge Device Model	C7 (Minimum) C6 (Minimum)

MOISTURE SENSITIVITY LEVEL

Test Methodology	Rating
Per JESD 22-A113	3

NOTE - CAUTION - MOS devices are susceptible to damage from electrostatic charge. Reasonable precautions in handling and packaging MOS devices should be observed.

Freescale Semiconductor, Inc.

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
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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

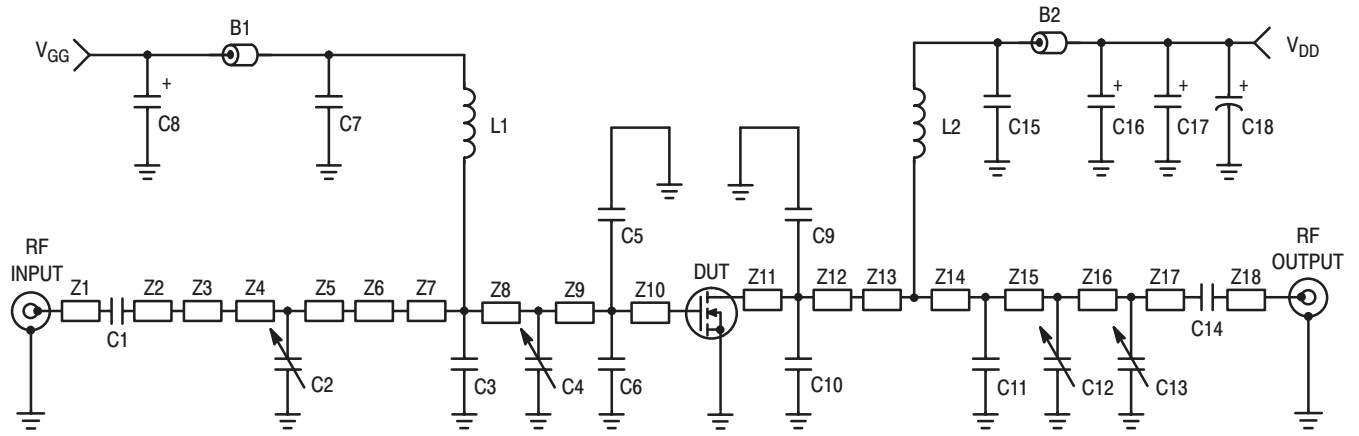
Gate Threshold Voltage (V _{DS} = 10 Vdc, I _D = 100 μAdc)	V _{GS(th)}	2	2.9	4	Vdc
Gate Quiescent Voltage (V _{DS} = 26 Vdc, I _D = 250 mAdc)	V _{GS(Q)}	3	3.8	5	Vdc
Drain-Source On-Voltage (V _{GS} = 10 Vdc, I _D = 0.7 Adc)	V _{DS(on)}	—	0.23	0.4	Vdc
Forward Transconductance (V _{DS} = 10 Vdc, I _D = 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 Motorola Test Fixture)

Two-Tone Common-Source Amplifier Power Gain (V _{DD} = 26 Vdc, P _{out} = 30 W PEP, I _{DQ} = 250 mA, f ₁ = 945.0 MHz, f ₂ = 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, f ₁ = 945.0 MHz, f ₂ = 945.1 MHz)	η	37	41	—	%
3rd Order Intermodulation Distortion (V _{DD} = 26 Vdc, P _{out} = 30 W PEP, I _{DQ} = 250 mA, f ₁ = 945.0 MHz, f ₂ = 945.1 MHz)	IMD	—	-31	-28	dBc
Input Return Loss (V _{DD} = 26 Vdc, P _{out} = 30 W PEP, I _{DQ} = 250 mA, f ₁ = 945.0 MHz, f ₂ = 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, f ₁ = 930.0 MHz, f ₂ = 930.1 MHz and f ₁ = 960.0 MHz, f ₂ = 960.1 MHz)	G _{ps}	—	20	—	dB
Two-Tone Drain Efficiency (V _{DD} = 26 Vdc, P _{out} = 30 W PEP, I _{DQ} = 250 mA, f ₁ = 930.0 MHz, f ₂ = 930.1 MHz and f ₁ = 960.0 MHz, f ₂ = 960.1 MHz)	η	—	40.5	—	%
3rd Order Intermodulation Distortion (V _{DD} = 26 Vdc, P _{out} = 30 W PEP, I _{DQ} = 250 mA, f ₁ = 930.0 MHz, f ₂ = 930.1 MHz and f ₁ = 960.0 MHz, f ₂ = 960.1 MHz)	IMD	—	-31	—	dBc
Input Return Loss (V _{DD} = 26 Vdc, P _{out} = 30 W PEP, I _{DQ} = 250 mA, f ₁ = 930.0 MHz, f ₂ = 930.1 MHz and f ₁ = 960.0 MHz, f ₂ = 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 |
| 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 (MRF9030MR1) | Board | Taconic RF-35-0300, $\epsilon_r = 3.5$ |
| | 0.290" x 0.520" Microstrip (MRF9030MR1) | | |
| Z10 | 0.130" x 0.520" Microstrip (MRF9030MR1) | | |
| | 0.210" x 0.520" Microstrip (MRF9030MR1) | | |

Figure 1. 930-960 MHz Broadband Test Circuit Schematic

Table 1. 930 - 960 MHz Broadband Test Circuit Component Designations and Values

Part	Description	Value, P/N or DWG	Manufacturer
B1	Short Ferrite Bead, Surface Mount	95F786	Newark
B2	Long Ferrite Bead, Surface Mount	95F787	Newark
C1, C7, C14, C15	47 pF Chip Capacitors, B Case	100B470JP 500X	ATC
C2	0.6-4.5 Variable Capacitor, Gigatrim	44F3360	Newark
C3, C11	3.9 pF Chip Capacitors, B Case	100B3R6BP 500X	ATC
C4, C12	0.8-8.0 Variable Capacitors, Gigatrim	44F3360	Newark
C5, C6	6.8 pF Chip Capacitors, B Case	100B7R5JP 500X	ATC
C8, C16, C17	10 μ F, 35 V Tantalum Chip Capacitors	93F2975	Newark
C9, C10	10 pF Chip Capacitors, B Case	100B100JP 500X	ATC
C13	1.8 pF Chip Capacitor, B Case (MRF9030MR1) 0.6-4.5 Variable Capacitor, Gigatrim (MRF9030MR1)	100B1R8BP 44F3360	ATC Newark
C18	220 μ F Electrolytic Chip Capacitor	14F185	Newark
L1, L2	12.5 nH Coilcraft Inductors	A04T-5	Coilcraft
WB1, WB2	20 mil Brass Shim (0.250 x 0.250)	RF-Design Lab	RF-Design Lab
PCB	Etched Circuit Board	900 MHz μ 250/Viper Rev 02	DSElectronics

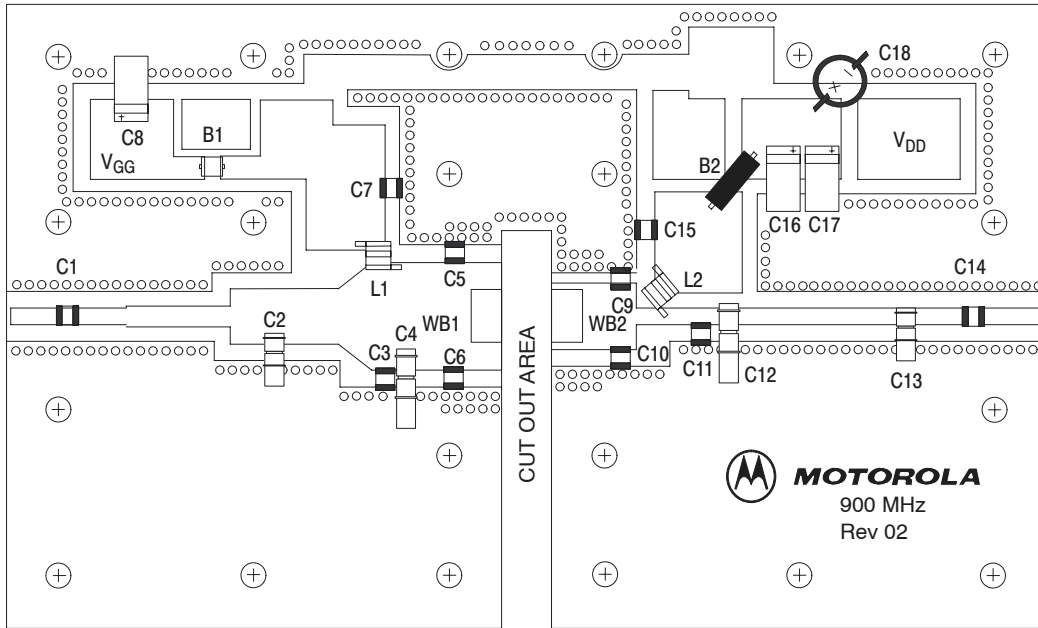


Figure 2. 930-960 MHz Broadband Test Circuit Component Layout (MRF9030MR1)

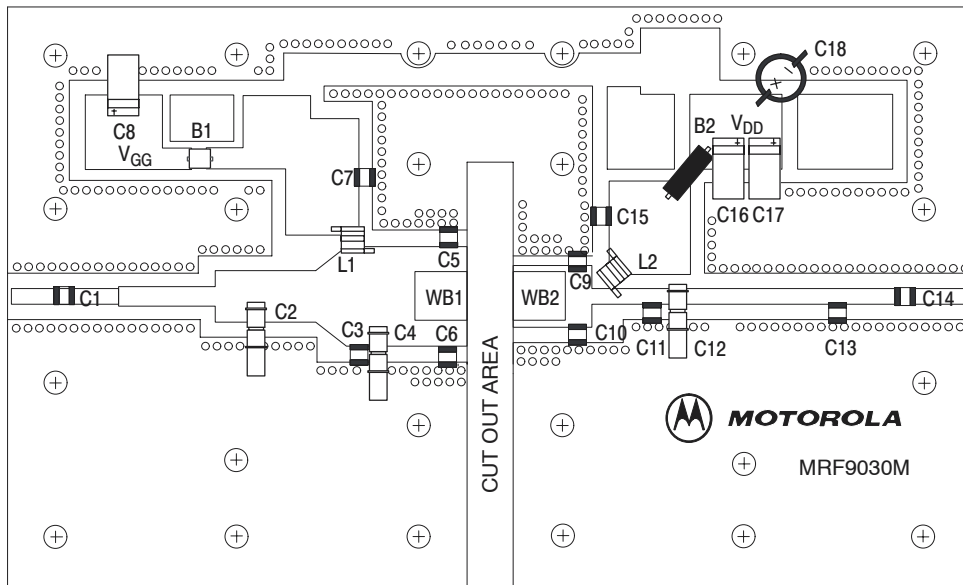


Figure 3. 930-960 MHz Broadband Test Circuit Component Layout (MRF9030MBR1)

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TYPICAL CHARACTERISTICS

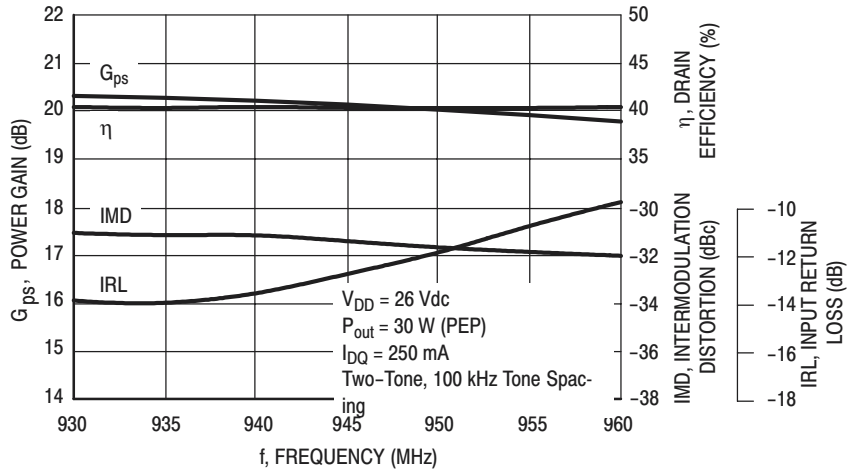


Figure 4. Class AB Broadband Circuit Performance

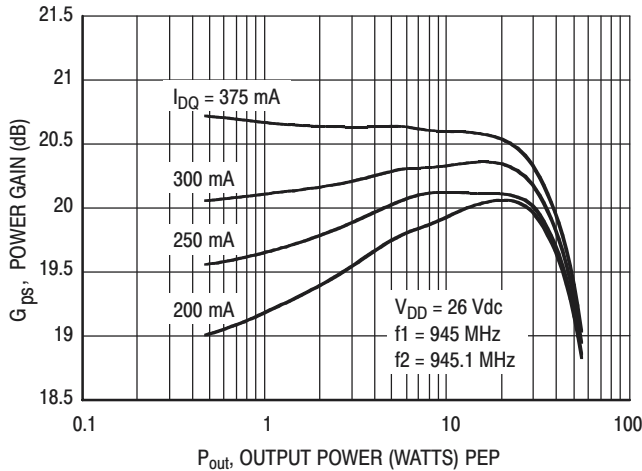


Figure 5. Power Gain versus Output Power

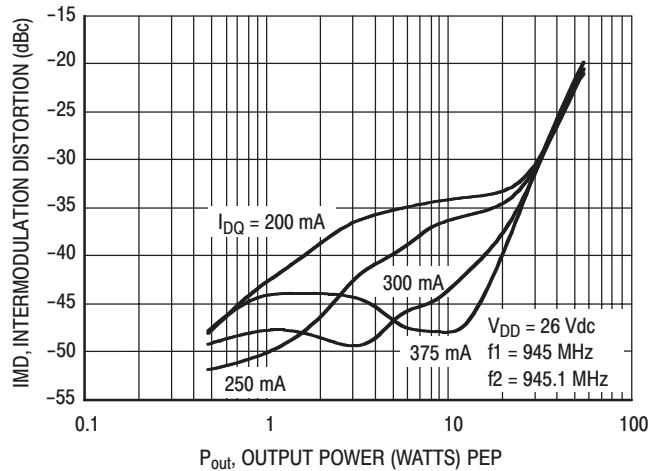


Figure 6. Intermodulation Distortion versus Output Power

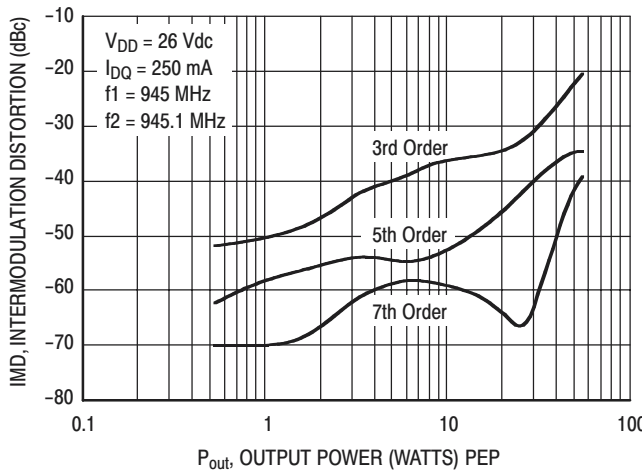


Figure 7. Intermodulation Distortion Products versus Output Power

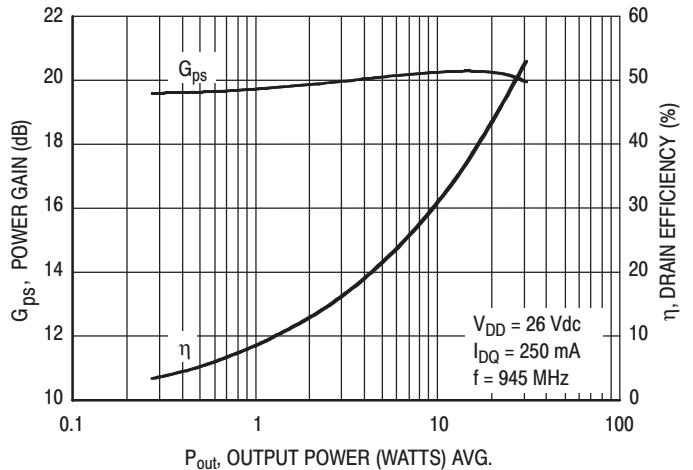


Figure 8. Power Gain and Efficiency versus Output Power

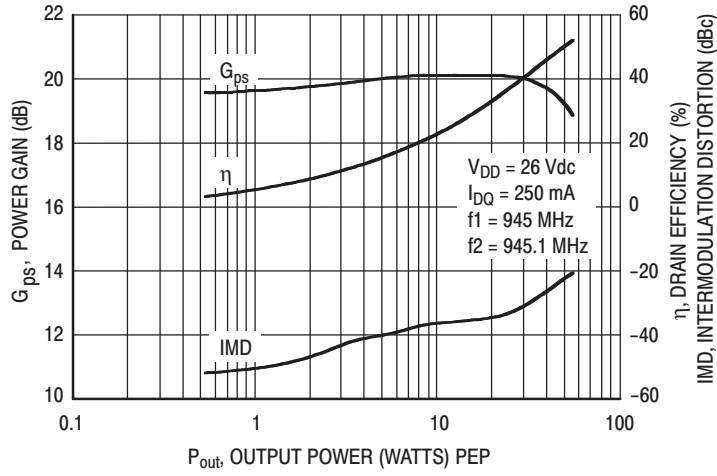
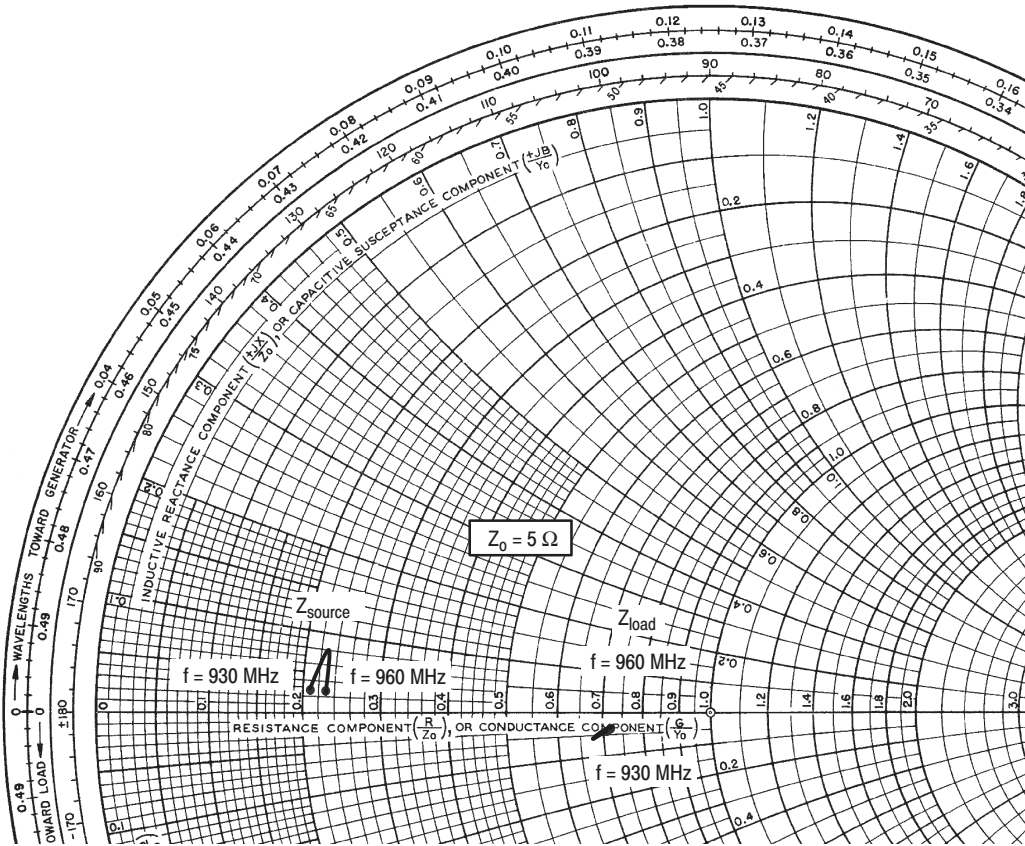


Figure 9. Power Gain, Efficiency and IMD versus Output Power



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

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.

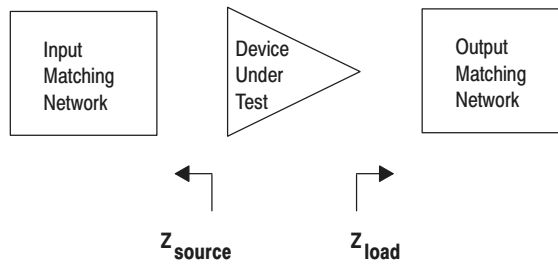
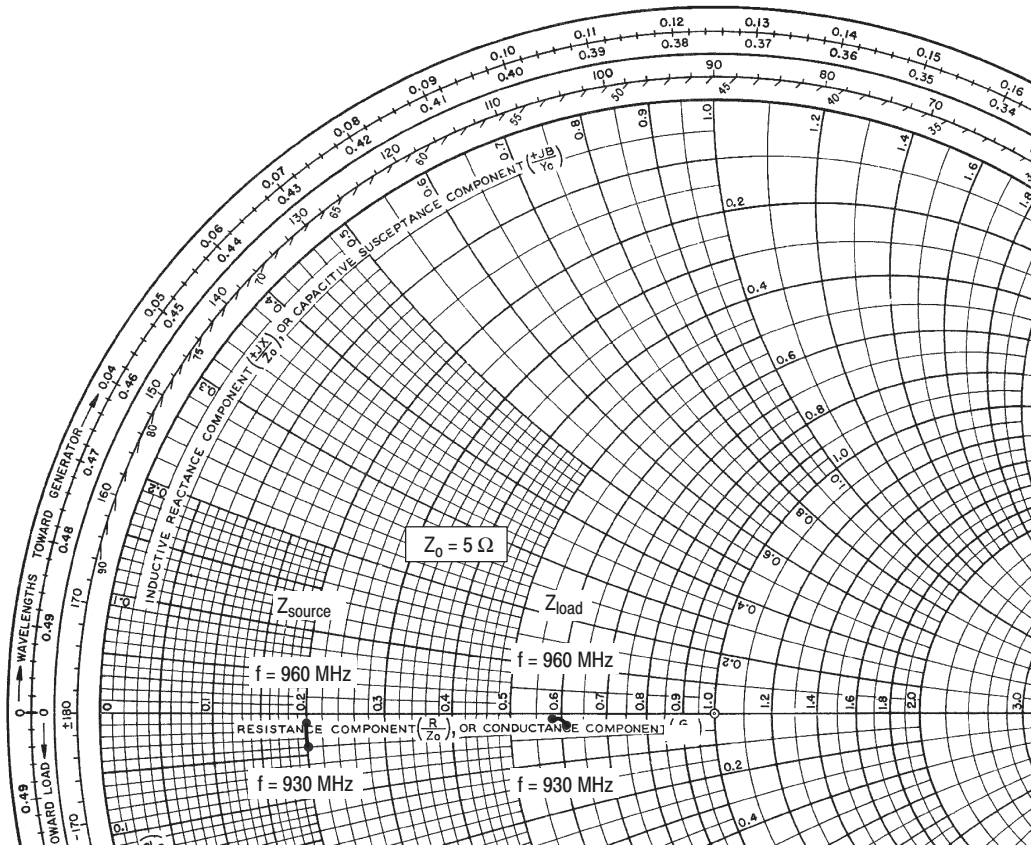


Figure 10. Series Equivalent Input and Output Impedance (MRF9030MR1)



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

f MHz	Z_{source} Ω	Z_{load} Ω
930	$1.0 - j0.18$	$3.05 - j0.09$
945	$1.0 - j0.10$	$3.00 - j0.07$
960	$1.0 - j0.03$	$2.95 - j0.03$

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.

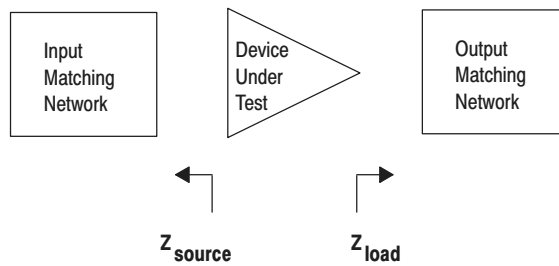
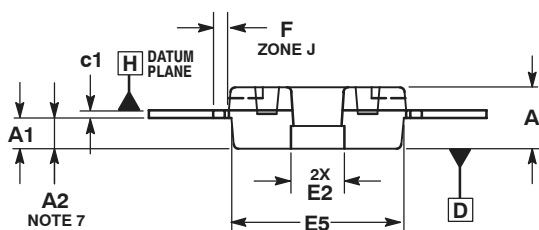
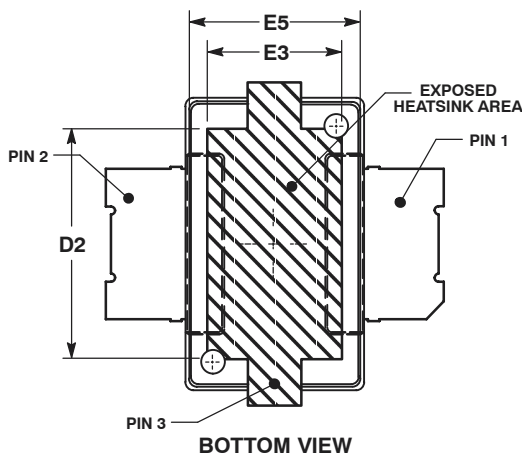
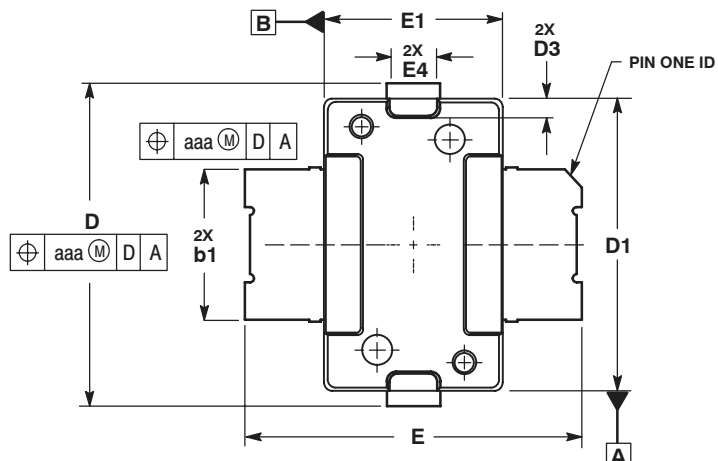


Figure 11. Series Equivalent Input and Output Impedance (MRF9030MBR1)

NOTES

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PACKAGE DIMENSIONS



NOTES:

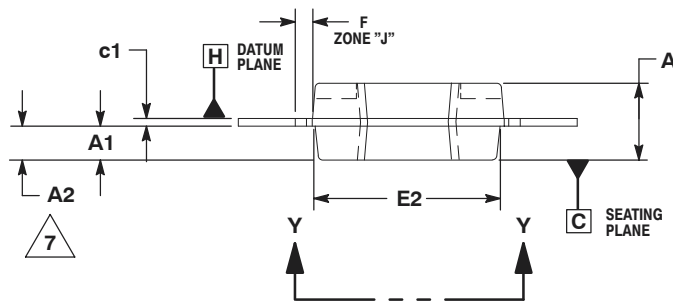
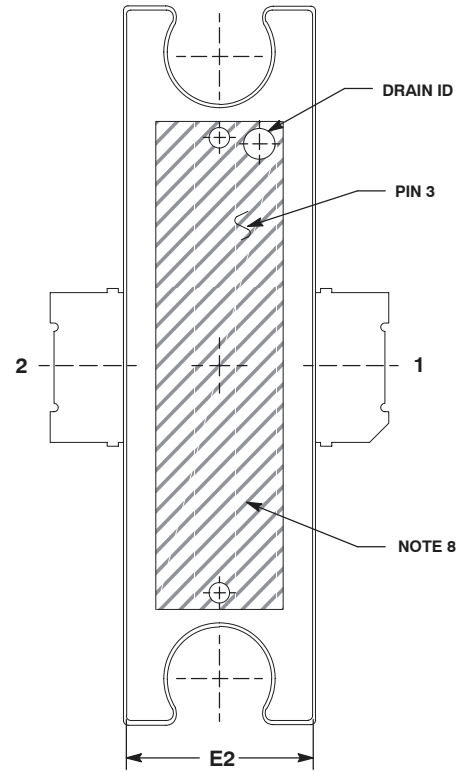
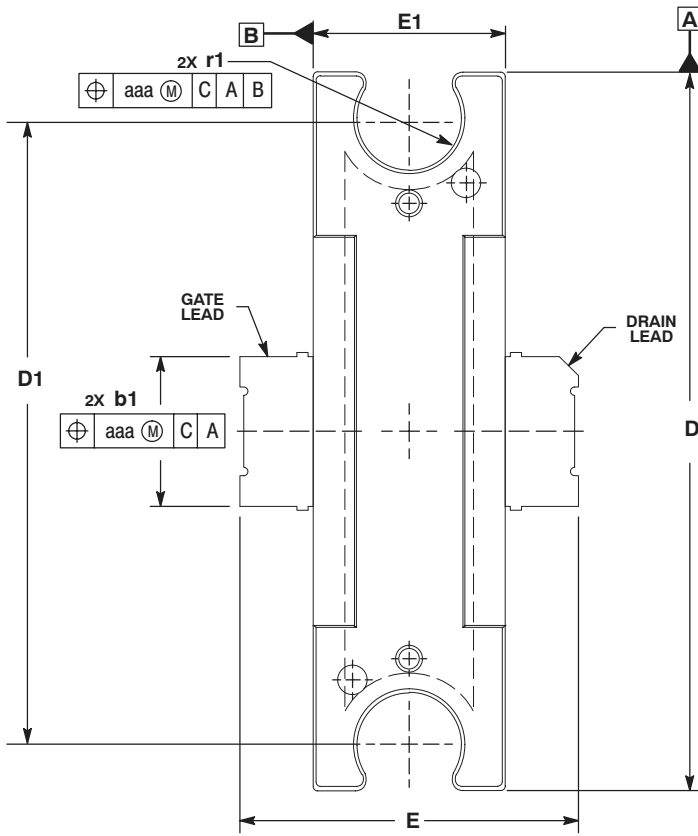
1. CONTROLLING DIMENSION: INCH.
2. INTERPRET DIMENSIONS AND TOLERANCES PER ASME Y14.5M-1994.
3. DATUM PLANE -H- IS LOCATED AT TOP OF LEAD AND IS COINCIDENT WITH THE LEAD WHERE THE LEAD EXITS THE PLASTIC BODY AT THE TOP OF THE PARTING LINE.
4. DIMENSIONS "D1" AND "E1" DO NOT INCLUDE MOLD PROTRUSION. ALLOWABLE 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. ALLOWABLE PROTRUSION IS .003 PER SIDE. DIMENSIONS "D" AND "E2" DO INCLUDE MOLD MISMATCH AND ARE DETERMINED AT DATUM PLANE -D-.

DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	.078	.082	1.98	2.08
A1	.039	.043	0.99	1.09
A2	.040	.042	1.02	1.07
D	.416	.424	10.57	10.77
D1	.378	.382	9.60	9.70
D2	.290	.320	7.37	8.13
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	.180	3.81	4.57
E4	.058	.066	1.47	1.68
E5	.231	.235	5.87	5.97
F	.025 BSC		0.64 BSC	
b1	.193	.199	4.90	5.06
c1	.007	.011	0.18	0.28
aaa	.004		0.10	

STYLE 1:

1. DRAIN
2. GATE
3. SOURCE

CASE 1265-08
ISSUE G
TO-270-2
PLASTIC
MRF9030MR1



NOTES:

1. CONTROLLING DIMENSION: INCH.
2. INTERPRET DIMENSIONS AND TOLERANCES PER ASME Y14.5M, 1994.
3. DATUM PLANE -H- IS LOCATED AT THE 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 "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. CROSSHATCHING REPRESENTS THE EXPOSED AREA OF THE HEAT SLUG.

DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	.100	.104	2.54	2.64
A1	.039	.043	0.99	1.09
A2	.040	.042	1.02	1.07
D	.928	.932	23.57	23.67
D1	.810 BSC		20.57 BSC	
E	.438	.442	11.12	11.23
E1	.248	.252	6.30	6.40
E2	.241	.245	6.12	6.22
F	.025 BSC		0.64 BSC	
b1	.193	.199	4.90	5.05
c1	.007	.011	.18	.28
r1	.063	.068	1.60	1.73
aaa	.004		.10	

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

CASE 1337-03
 ISSUE B
 TO-272-2
 PLASTIC
 MRF9030MBR1

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