

Technical Data

Replaced by MRF9030NR1/NBR1. There are no form, fit or function changes with this part replacement. N suffix added to part number to indicate transition to lead-free terminations.

# RF Power Field Effect Transistors

## N-Channel Enhancement-Mode Lateral MOSFETs

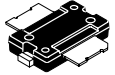
Designed for broadband commercial and industrial applications with frequencies up to 1000 MHz. The high gain and broadband performance of these devices make them ideal for large-signal, common-source amplifier applications in 26 volt base station equipment.

- 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.
- 200°C Capable Plastic Package
- 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.

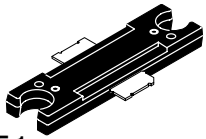
**MRF9030MR1**  
**MRF9030MBR1**

**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**



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**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 @ $T_C = 25^\circ\text{C}$ 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	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) C6 (Minimum)

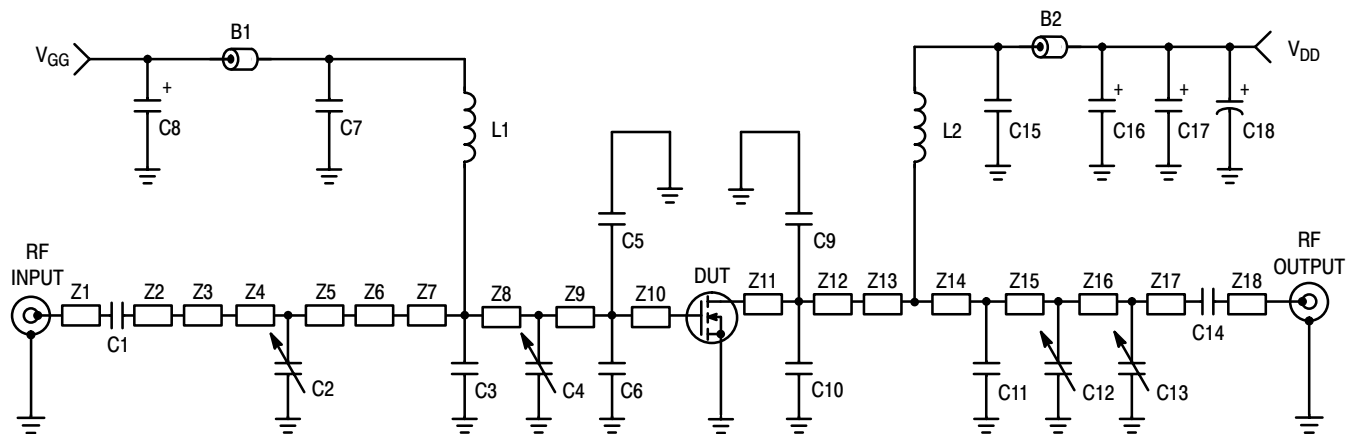
**Table 4. Moisture Sensitivity Level**

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

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

**Table 5. Electrical Characteristics** ( $T_c = 25^\circ\text{C}$  Unless Otherwise Noted)

Characteristic	Symbol	Min	Typ	Max	Unit
<b>Off Characteristics</b>					
Zero Gate Voltage Drain Leakage Current ( $V_{DS} = 65\text{ Vdc}$ , $V_{GS} = 0\text{ Vdc}$ )	$I_{DSS}$	—	—	10	$\mu\text{Adc}$
Zero Gate Voltage Drain Leakage Current ( $V_{DS} = 26\text{ Vdc}$ , $V_{GS} = 0\text{ Vdc}$ )	$I_{DSS}$	—	—	1	$\mu\text{Adc}$
Gate-Source Leakage Current ( $V_{GS} = 5\text{ Vdc}$ , $V_{DS} = 0\text{ Vdc}$ )	$I_{GSS}$	—	—	1	$\mu\text{Adc}$
<b>On Characteristics</b>					
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 ( $V_{DS} = 26\text{ Vdc}$ , $I_D = 250\text{ mAdc}$ )	$V_{GS(Q)}$	3	3.8	5	Vdc
Drain-Source On-Voltage ( $V_{GS} = 10\text{ Vdc}$ , $I_D = 0.7\text{ Adc}$ )	$V_{DS(on)}$	—	0.23	0.4	Vdc
Forward Transconductance ( $V_{DS} = 10\text{ Vdc}$ , $I_D = 2\text{ Adc}$ )	$g_{fs}$	—	2.7	—	S
<b>Dynamic Characteristics</b>					
Input Capacitance ( $V_{DS} = 26\text{ Vdc} \pm 30\text{ mV(rms)ac}$ @ 1 MHz, $V_{GS} = 0\text{ Vdc}$ )	$C_{iss}$	—	49	—	pF
Output Capacitance ( $V_{DS} = 26\text{ Vdc} \pm 30\text{ mV(rms)ac}$ @ 1 MHz, $V_{GS} = 0\text{ Vdc}$ )	$C_{oss}$	—	27	—	pF
Reverse Transfer Capacitance ( $V_{DS} = 26\text{ Vdc} \pm 30\text{ mV(rms)ac}$ @ 1 MHz, $V_{GS} = 0\text{ Vdc}$ )	$C_{rss}$	—	1.2	—	pF
<b>Functional Tests</b> (In Freescale Test Fixture)					
Two-Tone Common-Source Amplifier Power Gain ( $V_{DD} = 26\text{ Vdc}$ , $P_{out} = 30\text{ W PEP}$ , $I_{DQ} = 250\text{ mA}$ , $f_1 = 945.0\text{ MHz}$ , $f_2 = 945.1\text{ MHz}$ )	$G_{ps}$	18	20	—	dB
Two-Tone Drain Efficiency ( $V_{DD} = 26\text{ Vdc}$ , $P_{out} = 30\text{ W PEP}$ , $I_{DQ} = 250\text{ mA}$ , $f_1 = 945.0\text{ MHz}$ , $f_2 = 945.1\text{ MHz}$ )	$\eta$	37	41	—	%
3rd Order Intermodulation Distortion ( $V_{DD} = 26\text{ Vdc}$ , $P_{out} = 30\text{ W PEP}$ , $I_{DQ} = 250\text{ mA}$ , $f_1 = 945.0\text{ MHz}$ , $f_2 = 945.1\text{ MHz}$ )	IMD	—	-31	-28	dBc
Input Return Loss ( $V_{DD} = 26\text{ Vdc}$ , $P_{out} = 30\text{ W PEP}$ , $I_{DQ} = 250\text{ mA}$ , $f_1 = 945.0\text{ MHz}$ , $f_2 = 945.1\text{ MHz}$ )	IRL	—	-13	-9	dB
Two-Tone Common-Source Amplifier Power Gain ( $V_{DD} = 26\text{ Vdc}$ , $P_{out} = 30\text{ W PEP}$ , $I_{DQ} = 250\text{ mA}$ , $f_1 = 930.0\text{ MHz}$ , $f_2 = 930.1\text{ MHz}$ and $f_1 = 960.0\text{ MHz}$ , $f_2 = 960.1\text{ MHz}$ )	$G_{ps}$	—	20	—	dB
Two-Tone Drain Efficiency ( $V_{DD} = 26\text{ Vdc}$ , $P_{out} = 30\text{ W PEP}$ , $I_{DQ} = 250\text{ mA}$ , $f_1 = 930.0\text{ MHz}$ , $f_2 = 930.1\text{ MHz}$ and $f_1 = 960.0\text{ MHz}$ , $f_2 = 960.1\text{ MHz}$ )	$\eta$	—	40.5	—	%
3rd Order Intermodulation Distortion ( $V_{DD} = 26\text{ Vdc}$ , $P_{out} = 30\text{ W PEP}$ , $I_{DQ} = 250\text{ mA}$ , $f_1 = 930.0\text{ MHz}$ , $f_2 = 930.1\text{ MHz}$ and $f_1 = 960.0\text{ MHz}$ , $f_2 = 960.1\text{ MHz}$ )	IMD	—	-31	—	dBc
Input Return Loss ( $V_{DD} = 26\text{ Vdc}$ , $P_{out} = 30\text{ W PEP}$ , $I_{DQ} = 250\text{ mA}$ , $f_1 = 930.0\text{ MHz}$ , $f_2 = 930.1\text{ MHz}$ and $f_1 = 960.0\text{ MHz}$ , $f_2 = 960.1\text{ MHz}$ )	IRL	—	-12	—	dB

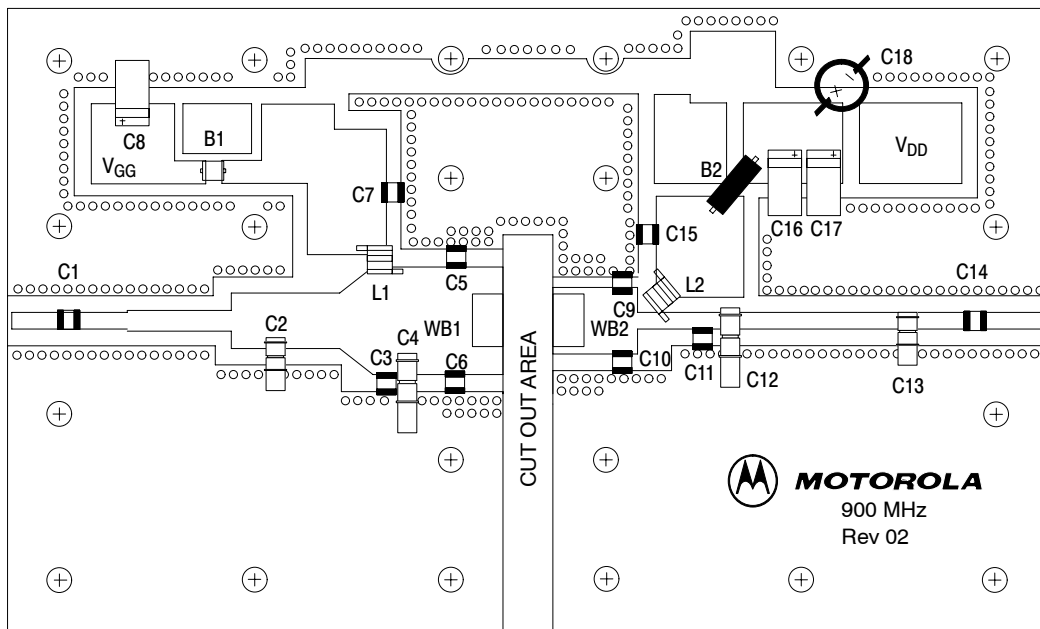


Z1	0.260" x 0.060" Microstrip	Z11	0.360" x 0.270" Microstrip
Z2	0.240" x 0.060" Microstrip	Z12	0.050" x 0.270" Microstrip
Z3	0.500" x 0.100" Microstrip	Z13	0.110" x 0.060" Microstrip
Z4	0.200" x 0.270" Microstrip	Z14	0.220" x 0.060" Microstrip
Z5	0.330" x 0.270" Microstrip	Z15	0.100" x 0.060" Microstrip
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, $\epsilon_r = 3.5$
Z10	0.290" x 0.520" Microstrip (MRF9030MR1)		
	0.130" x 0.520" Microstrip (MRF9030MR1)		
	0.210" x 0.520" Microstrip (MRF9030MR1)		

Figure 1. 930-960 MHz Broadband Test Circuit Schematic

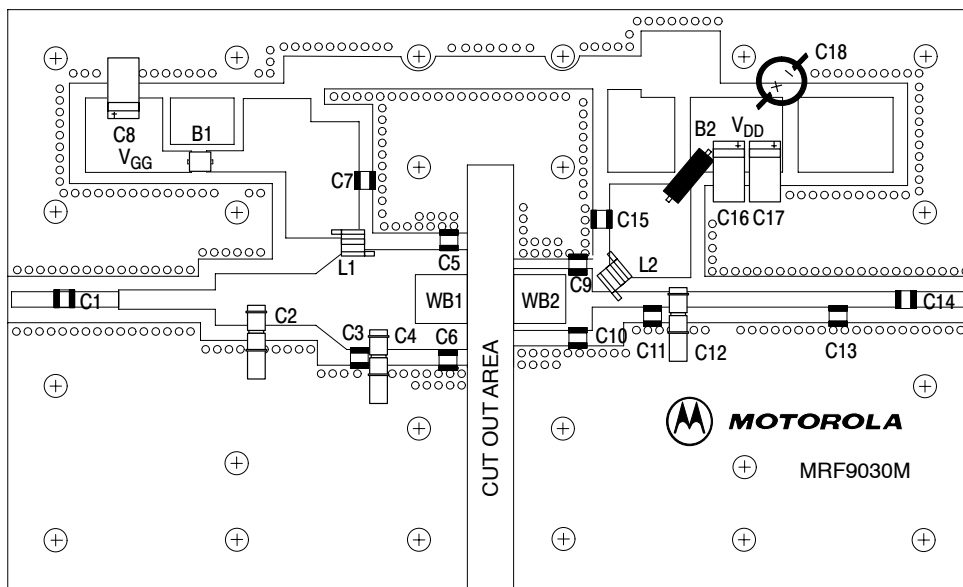
Table 6. 930 - 960 MHz Broadband Test Circuit Component Designations and Values

Part	Description	Part Number	Manufacturer
B1	Short Ferrite Bead, Surface Mount	95F786	Newark
B2	Long Ferrite Bead, Surface Mount	95F787	Newark
C1, C7, C14, C15	47 pF Chip Capacitors	100B470JP 500X	ATC
C2	0.6-4.5 Variable Capacitor, Gigatrim	44F3360	Newark
C3, C11	3.9 pF Chip Capacitors	100B3R6BP 500X	ATC
C4, C12	0.8-8.0 Variable Capacitors, Gigatrim	44F3360	Newark
C5, C6	6.8 pF Chip Capacitors	100B7R5JP 500X	ATC
C8, C16, C17	10 $\mu$ F, 35 V Tantalum Chip Capacitors	93F2975	Newark
C9, C10	10 pF Chip Capacitors	100B100JP 500X	ATC
C13	1.8 pF Chip Capacitor (MRF9030MR1) 0.6-4.5 Variable Capacitor, Gigatrim (MRF9030MR1)	100B1R8BP 44F3360	ATC Newark
C18	220 $\mu$ 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 $\mu$ 250/Viper Rev 02	DSElectronics



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 (MRF9030MR1)**



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

### TYPICAL CHARACTERISTICS

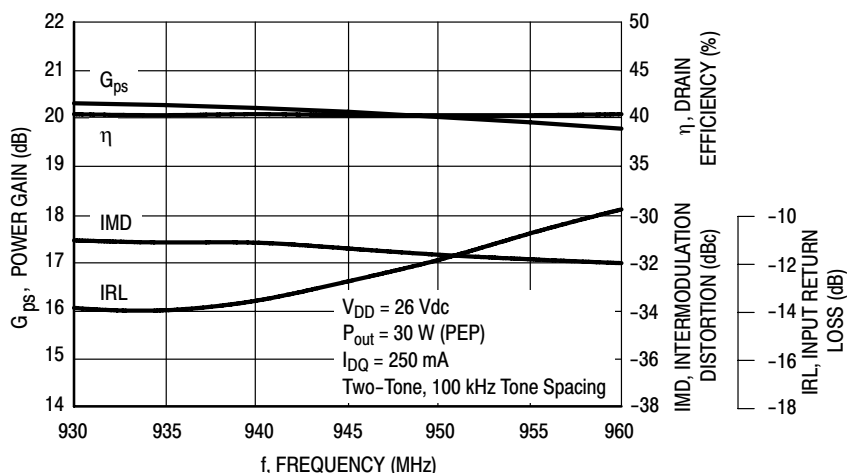


Figure 4. Class AB Broadband Circuit Performance

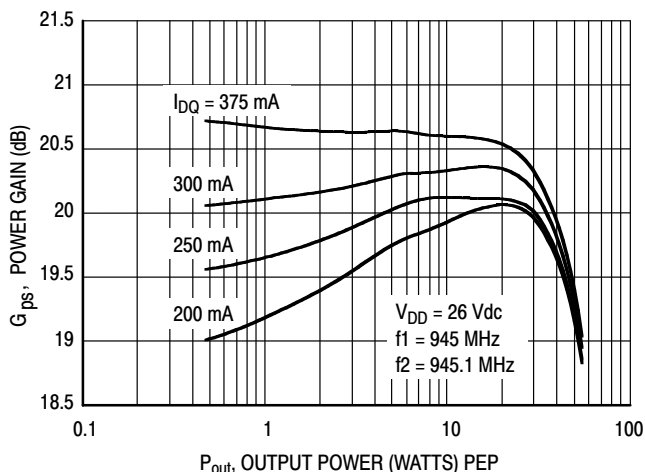


Figure 5. Power Gain versus Output Power

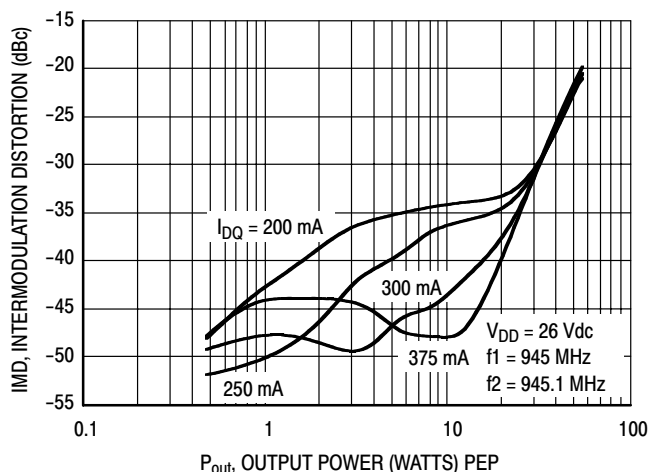


Figure 6. Intermodulation Distortion versus Output Power

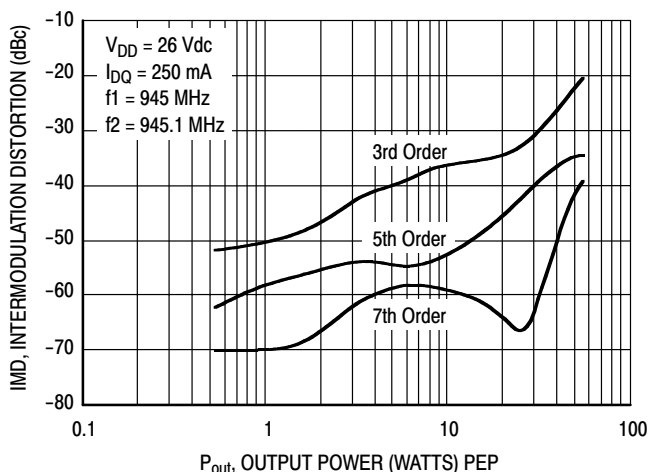


Figure 7. Intermodulation Distortion Products versus Output Power

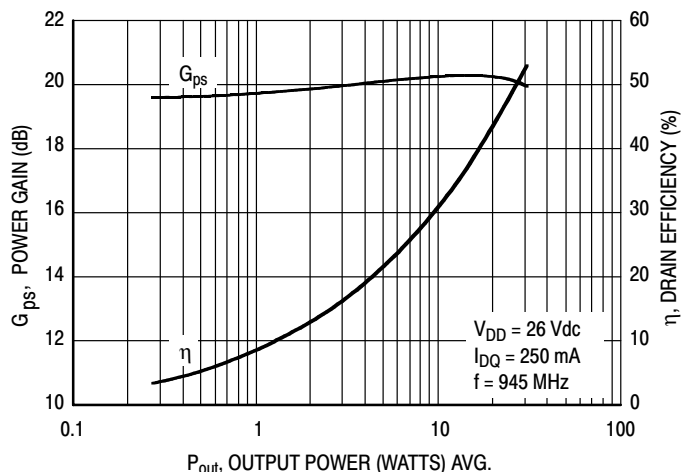
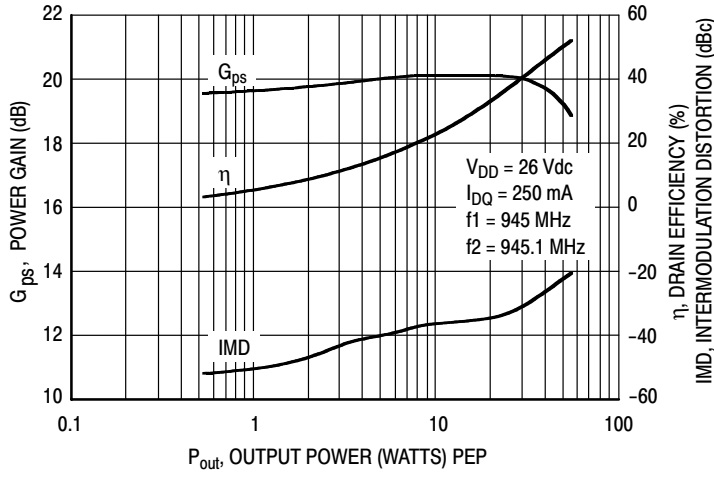


Figure 8. Power Gain and Efficiency versus Output Power

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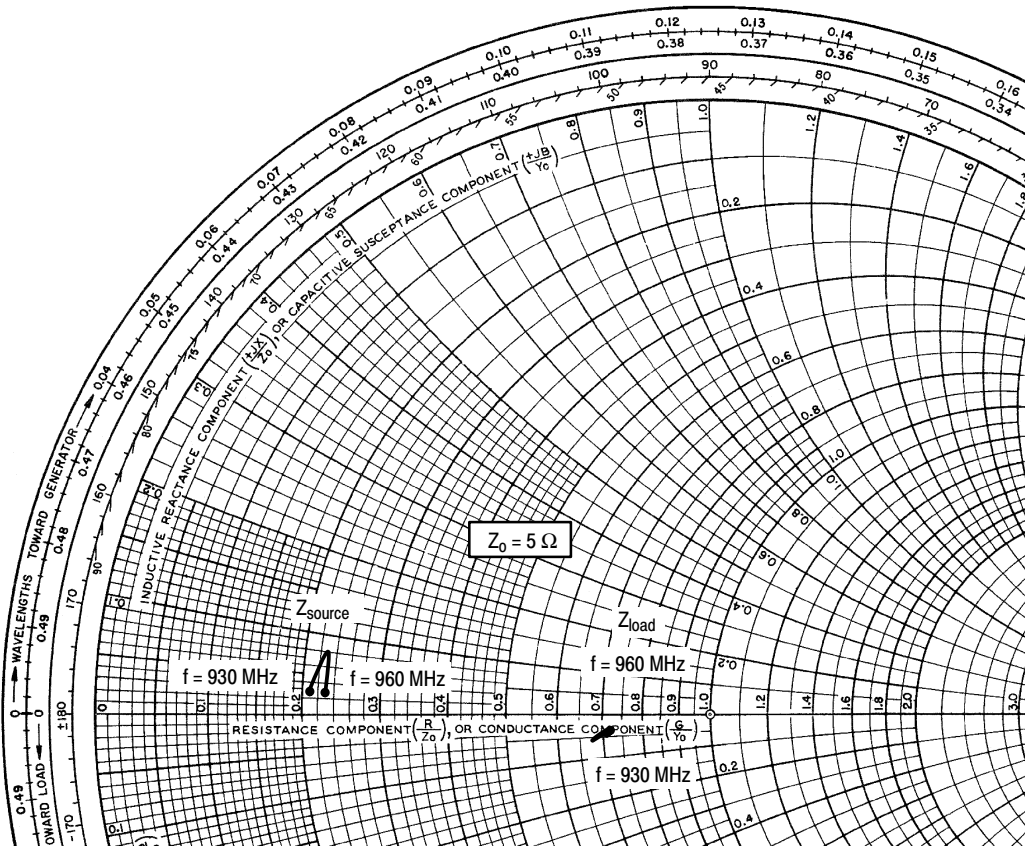
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**Figure 9. Power Gain, Efficiency and IMD versus Output Power**

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

f MHz	$Z_{source}$ $\Omega$	$Z_{load}$ $\Omega$
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.

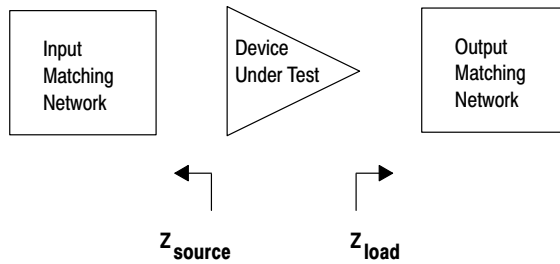
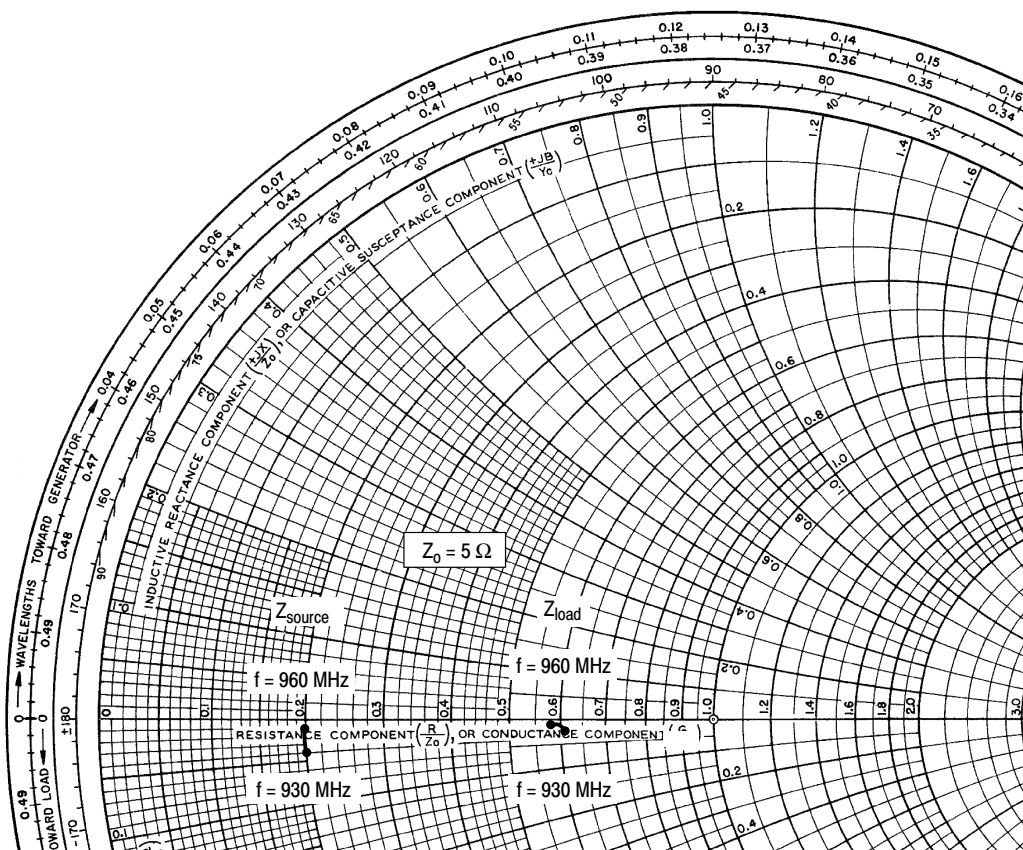


Figure 10. Series Equivalent Source and Load Impedance (MRF9030MR1)



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

f MHz	$Z_{source}$ $\Omega$	$Z_{load}$ $\Omega$
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.

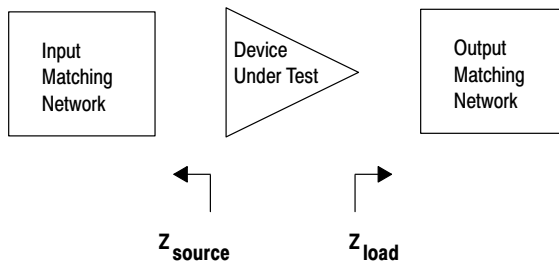


Figure 11. Series Equivalent Source and Load Impedance (MRF9030MBR1)

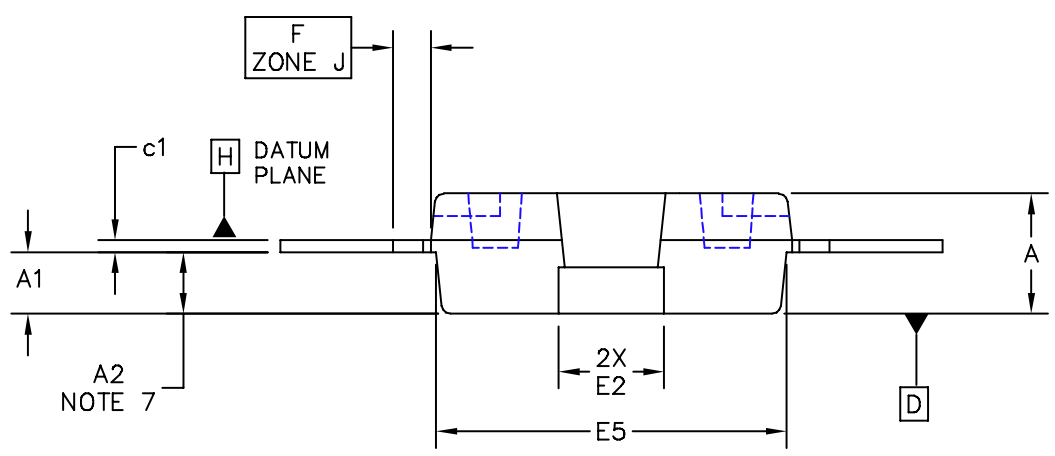
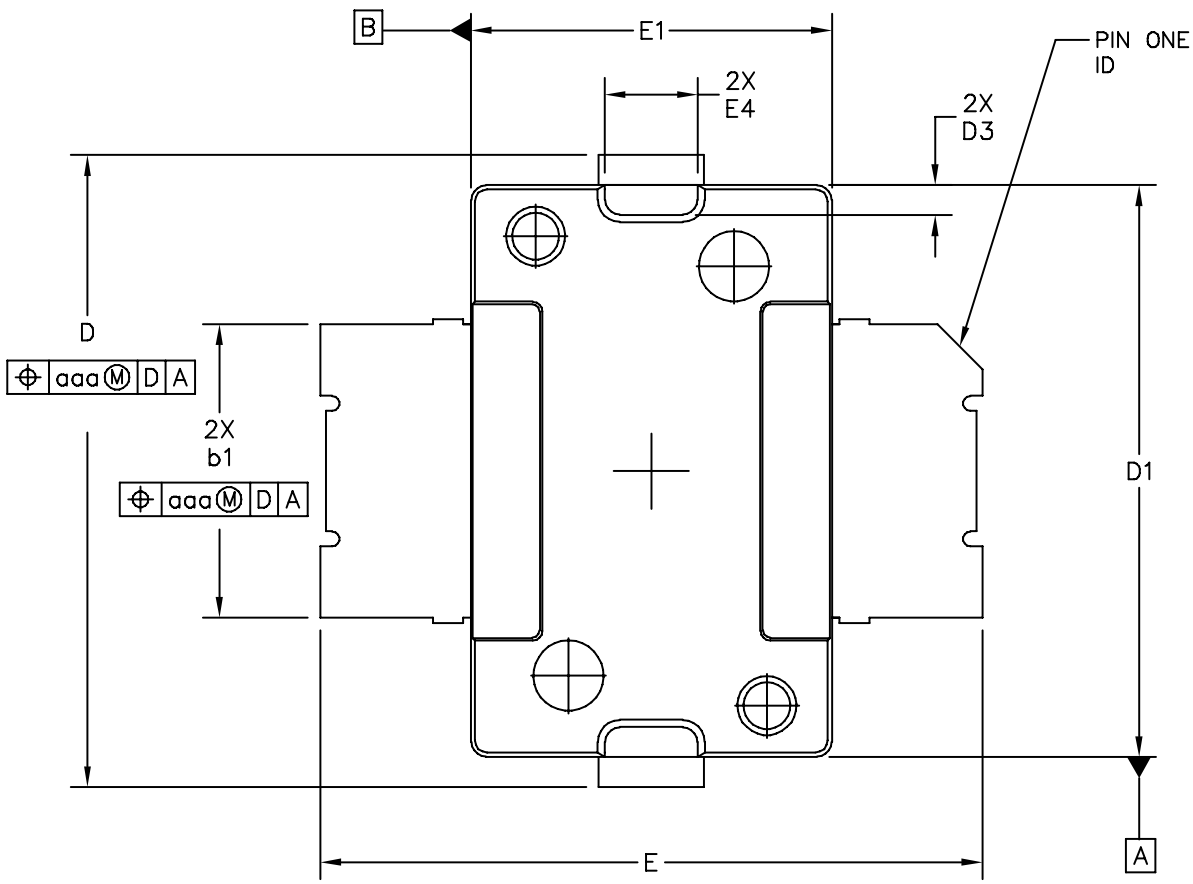


# NOTES

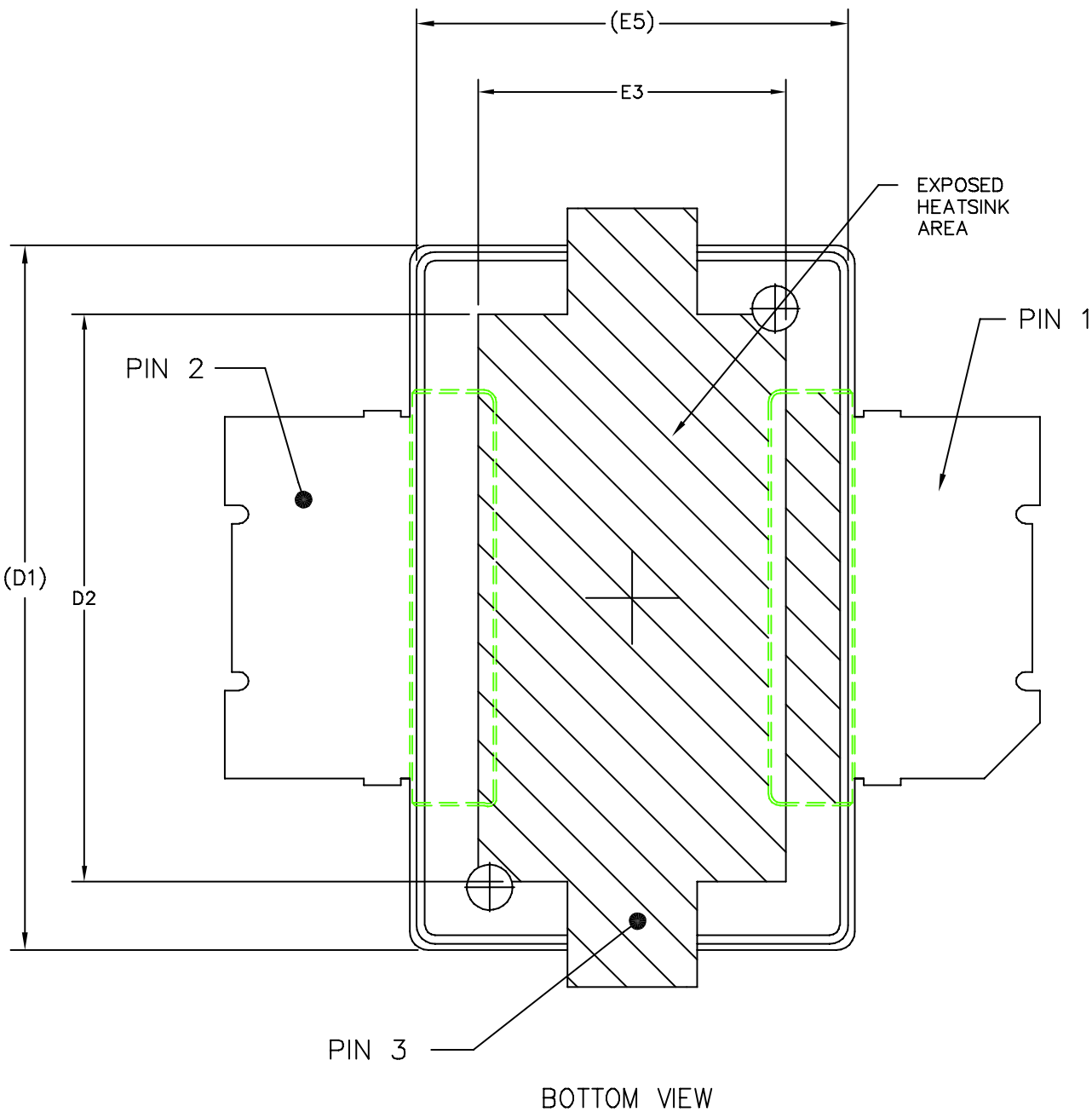
# NOTES

# NOTES

**PACKAGE DIMENSIONS**



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TITLE: <b>TO-270 SURFACE MOUNT</b>	DOCUMENT NO: 98ASH98117A	REV: J	
	CASE NUMBER: 1265-08	01 APR 2005	
	STANDARD: NON-JEDEC		



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	CASE NUMBER: 1265-08	01 APR 2005	
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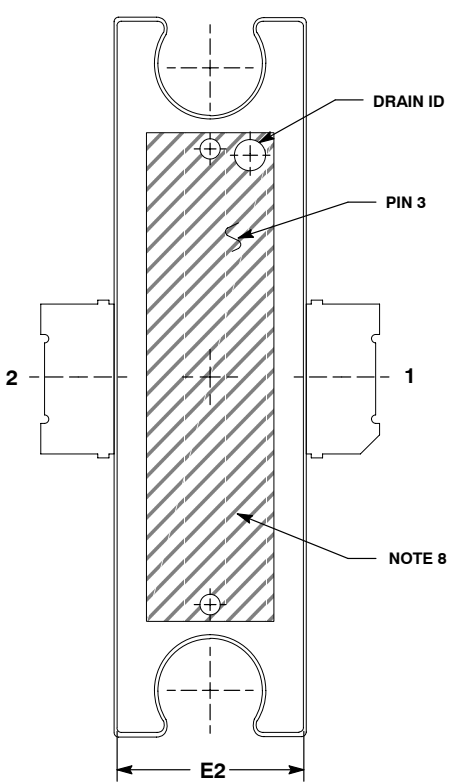
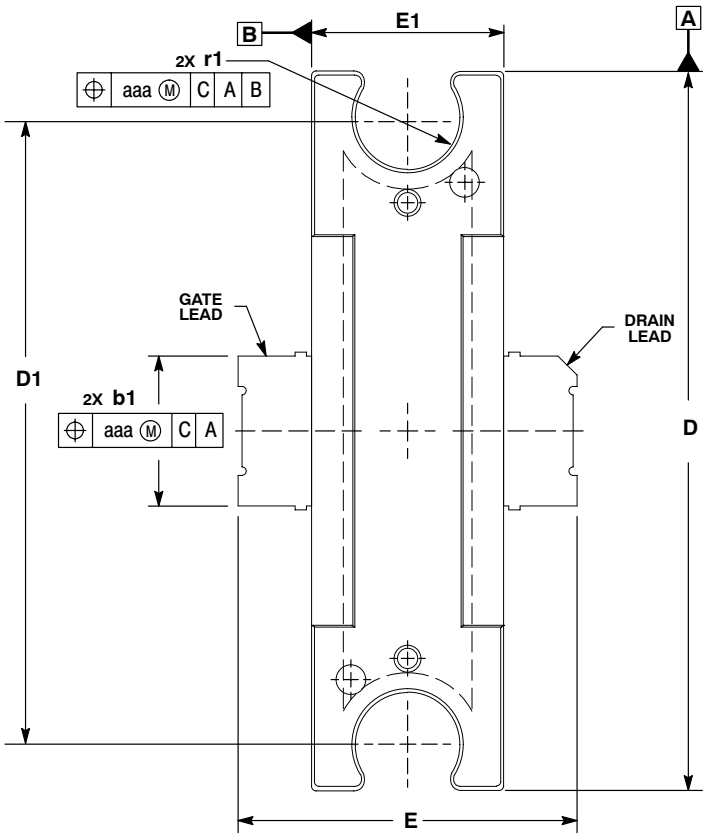
NOTES:

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 "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-.

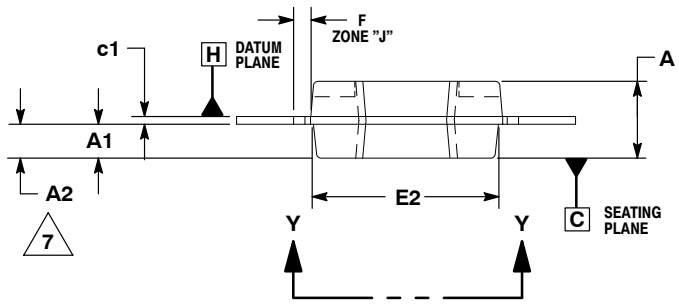
STYLE 1:  
 PIN 1 - DRAIN  
 PIN 2 - GATE  
 PIN 3 - SOURCE

DIM	INCH		MILLIMETER		DIM	INCH		MILLIMETER	
	MIN	MAX	MIN	MAX		MIN	MAX	MIN	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	.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					

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TITLE:  TO-270 SURFACE MOUNT		DOCUMENT NO: 98ASH98117A		REV: J	
		CASE NUMBER: 1265-08		01 APR 2005	
		STANDARD: NON-JEDEC			



VIEW Y-Y



- 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.

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

**CASE 1337-03  
 ISSUE C  
 TO-272-2  
 PLASTIC  
 MRF9030MBR1**

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	

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[LDCForFreescaleSemiconductor@hibbertgroup.com](mailto:LDCForFreescaleSemiconductor@hibbertgroup.com)

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