

Replaced by MRF9045NR1/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.

**MRF9045MR1**  
**MRF9045MBR1**

## RF Power Field Effect Transistors

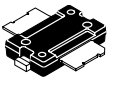
### N-Channel Enhancement-Mode Lateral MOSFETs

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 28 volt base station equipment.

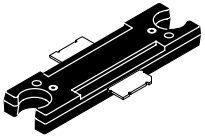
**945 MHz, 45 W, 28 V**  
**LATERAL N-CHANNEL**  
**BROADBAND**  
**RF POWER MOSFETs**

- Typical Performance at 945 MHz, 28 Volts
  - Output Power — 45 Watts PEP
  - Power Gain — 19 dB
  - Efficiency — 41% (Two Tones)
  - IMD — -31 dBc
- Integrated ESD Protection
- Guaranteed Ruggedness @ Load VSWR = 5:1, @ 28 Vdc, 945 MHz, 45 Watts CW Output Power
- 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
- TO-272 Available in Tape and Reel. R1 Suffix = 500 Units per 44 mm, 13 inch Reel.
- TO-270 Available in Tape and Reel. R1 Suffix = 500 Units per 24 mm, 13 inch Reel.

CASE 1265-08, STYLE 1  
 TO-270  
 PLASTIC  
 MRF9045MR1



CASE 1337-03, STYLE 1  
 TO-272 DUAL LEAD  
 PLASTIC  
 MRF9045MBR1



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**Table 1. Maximum Ratings**

Rating	Symbol	Value	Unit
Drain-Source Voltage	V <sub>DSS</sub>	- 0.5, +65	Vdc
Gate-Source Voltage	V <sub>GS</sub>	- 0.5, + 15	Vdc
Total Device Dissipation @ T <sub>C</sub> = 25°C Derate above 25°C	P <sub>D</sub>	177 1.18	W W/°C
Storage Temperature Range	T <sub>stg</sub>	- 65 to +150	°C
Operating Junction Temperature	T <sub>J</sub>	200	°C

**Table 2. Thermal Characteristics**

Characteristic	Symbol	Value	Unit
Thermal Resistance, Junction to Case	R <sub>θJC</sub>	0.85	°C/W

**Table 3. ESD Protection Characteristics**

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

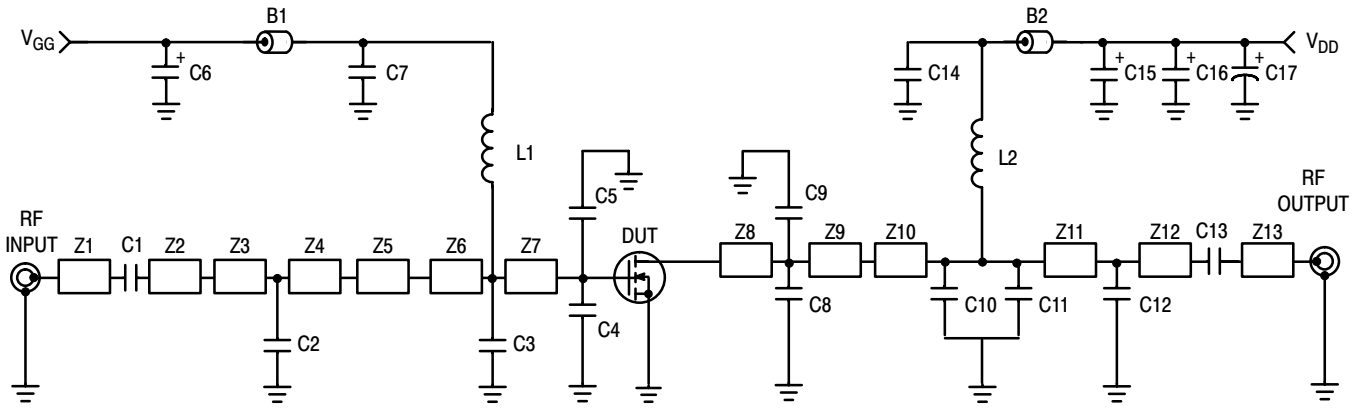
**Table 4. Moisture Sensitivity Level**

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.

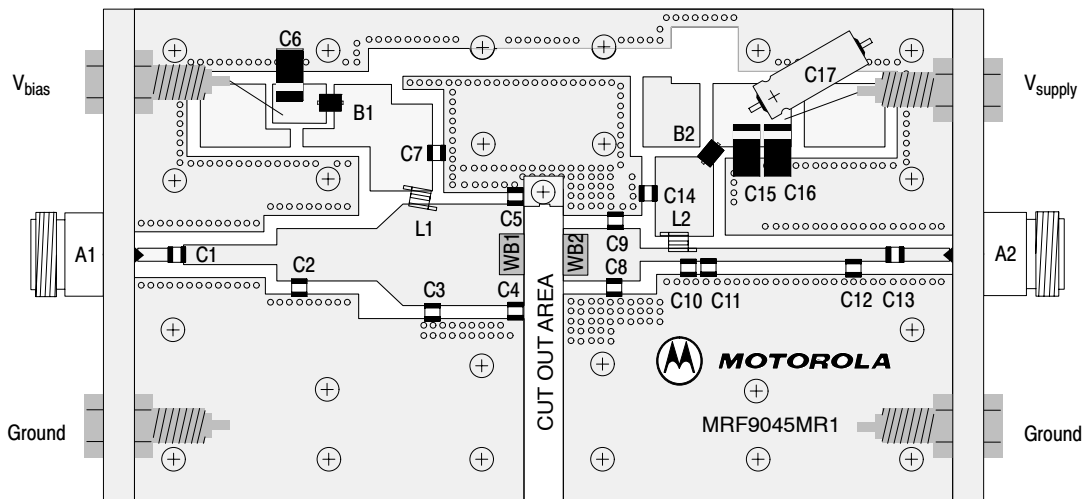
**Table 5. Electrical Characteristics** ( $T_C = 25^\circ\text{C}$  unless otherwise noted)

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 ( $V_{DS} = 28\text{ Vdc}$ , $V_{GS} = 0\text{ Vdc}$ )	$I_{DSS}$	—	—	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 ( $V_{DS} = 10\text{ Vdc}$ , $I_D = 150\ \mu\text{Adc}$ )	$V_{GS(th)}$	2	2.8	4	Vdc
Gate Quiescent Voltage ( $V_{DS} = 28\text{ Vdc}$ , $I_D = 350\text{ mAdc}$ )	$V_{GS(Q)}$	3	3.7	5	Vdc
Drain-Source On-Voltage ( $V_{GS} = 10\text{ Vdc}$ , $I_D = 1\text{ Adc}$ )	$V_{DS(on)}$	—	0.22	0.4	Vdc
Forward Transconductance ( $V_{DS} = 10\text{ Vdc}$ , $I_D = 3\text{ Adc}$ )	$g_{fs}$	—	4	—	S
<b>Dynamic Characteristics</b>					
Input Capacitance ( $V_{DS} = 28\text{ Vdc} \pm 30\text{ mV(rms)ac}$ @ 1 MHz, $V_{GS} = 0\text{ Vdc}$ )	$C_{iss}$	—	70	—	pF
Output Capacitance ( $V_{DS} = 28\text{ Vdc} \pm 30\text{ mV(rms)ac}$ @ 1 MHz, $V_{GS} = 0\text{ Vdc}$ )	$C_{oss}$	—	38	—	pF
Reverse Transfer Capacitance ( $V_{DS} = 28\text{ Vdc} \pm 30\text{ mV(rms)ac}$ @ 1 MHz, $V_{GS} = 0\text{ Vdc}$ )	$C_{rss}$	—	1.7	—	pF
<b>Functional Tests</b> (In Freescale Test Fixture, 50 ohm system)					
Two-Tone Common-Source Amplifier Power Gain ( $V_{DD} = 28\text{ Vdc}$ , $P_{out} = 45\text{ W PEP}$ , $I_{DQ} = 350\text{ mA}$ , $f_1 = 945.0\text{ MHz}$ , $f_2 = 945.1\text{ MHz}$ )	$G_{ps}$	17	19	—	dB
Two-Tone Drain Efficiency ( $V_{DD} = 28\text{ Vdc}$ , $P_{out} = 45\text{ W PEP}$ , $I_{DQ} = 350\text{ mA}$ , $f_1 = 945.0\text{ MHz}$ , $f_2 = 945.1\text{ MHz}$ )	$\eta$	38	41	—	%
3rd Order Intermodulation Distortion ( $V_{DD} = 28\text{ Vdc}$ , $P_{out} = 45\text{ W PEP}$ , $I_{DQ} = 350\text{ mA}$ , $f_1 = 945.0\text{ MHz}$ , $f_2 = 945.1\text{ MHz}$ )	IMD	—	-31	-28	dBc
Input Return Loss ( $V_{DD} = 28\text{ Vdc}$ , $P_{out} = 45\text{ W PEP}$ , $I_{DQ} = 350\text{ mA}$ , $f_1 = 945.0\text{ MHz}$ , $f_2 = 945.1\text{ MHz}$ )	IRL	—	-14	-9	dB
Two-Tone Common-Source Amplifier Power Gain ( $V_{DD} = 28\text{ Vdc}$ , $P_{out} = 45\text{ W PEP}$ , $I_{DQ} = 350\text{ mA}$ , $f_1 = 930.0\text{ MHz}$ , $f_2 = 930.1\text{ MHz}$ and $f_1 = 960.0\text{ MHz}$ , $f_2 = 960.1\text{ MHz}$ )	$G_{ps}$	—	19	—	dB
Two-Tone Drain Efficiency ( $V_{DD} = 28\text{ Vdc}$ , $P_{out} = 45\text{ W PEP}$ , $I_{DQ} = 350\text{ mA}$ , $f_1 = 930.0\text{ MHz}$ , $f_2 = 930.1\text{ MHz}$ and $f_1 = 960.0\text{ MHz}$ , $f_2 = 960.1\text{ MHz}$ )	$\eta$	—	41	—	%
3rd Order Intermodulation Distortion ( $V_{DD} = 28\text{ Vdc}$ , $P_{out} = 45\text{ W PEP}$ , $I_{DQ} = 350\text{ mA}$ , $f_1 = 930.0\text{ MHz}$ , $f_2 = 930.1\text{ MHz}$ and $f_1 = 960.0\text{ MHz}$ , $f_2 = 960.1\text{ MHz}$ )	IMD	—	-31	—	dBc
Input Return Loss ( $V_{DD} = 28\text{ Vdc}$ , $P_{out} = 45\text{ W PEP}$ , $I_{DQ} = 350\text{ mA}$ , $f_1 = 930.0\text{ MHz}$ , $f_2 = 930.1\text{ MHz}$ and $f_1 = 960.0\text{ MHz}$ , $f_2 = 960.1\text{ MHz}$ )	IRL	—	-13	—	dB



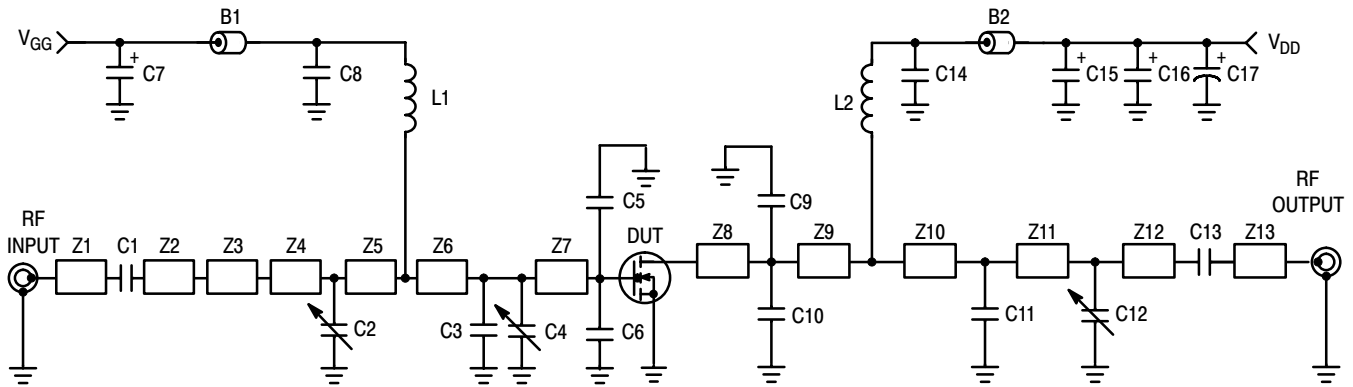
B1, B2	Short Ferrite Beads, Surface Mount	Z3	0.14" x 0.32" Microstrip
C1, C7, C13, C14	47 pF Chip Capacitors	Z4	0.47" x 0.32" Microstrip
C2, C8	2.7 pF Chip Capacitors	Z5	0.16" x 0.32" x 0.62" Taper
C3	3.9 pF Chip Capacitor	Z6	0.18" x 0.62" Microstrip
C4, C5, C8, C9	10 pF Chip Capacitors	Z7	0.56" x 0.62" Microstrip
C6, C15, C16	10 $\mu$ F, 35 V Tantalum Surface Mount Capacitors	Z8	0.33" x 0.32" Microstrip
C10	2.2 pF Chip Capacitor	Z9	0.14" x 0.32" Microstrip
C11	4.7 pF Chip Capacitor	Z10	0.36" x 0.08" Microstrip
C12	1.2 pF Chip Capacitor	Z11	1.01" x 0.08" Microstrip
C17	220 $\mu$ F, 50 V Electrolytic Capacitor	Z12	0.15" x 0.08" Microstrip
L1, L2	12.5 nH Inductors	Z13	0.29" x 0.08" Microstrip
Z1	0.20" x 0.08" Microstrip		
Z2	0.57" x 0.12" Microstrip		

**Figure 1. MRF9045MR1( MBR1) 930-960 MHz Broadband Test Circuit Schematic**



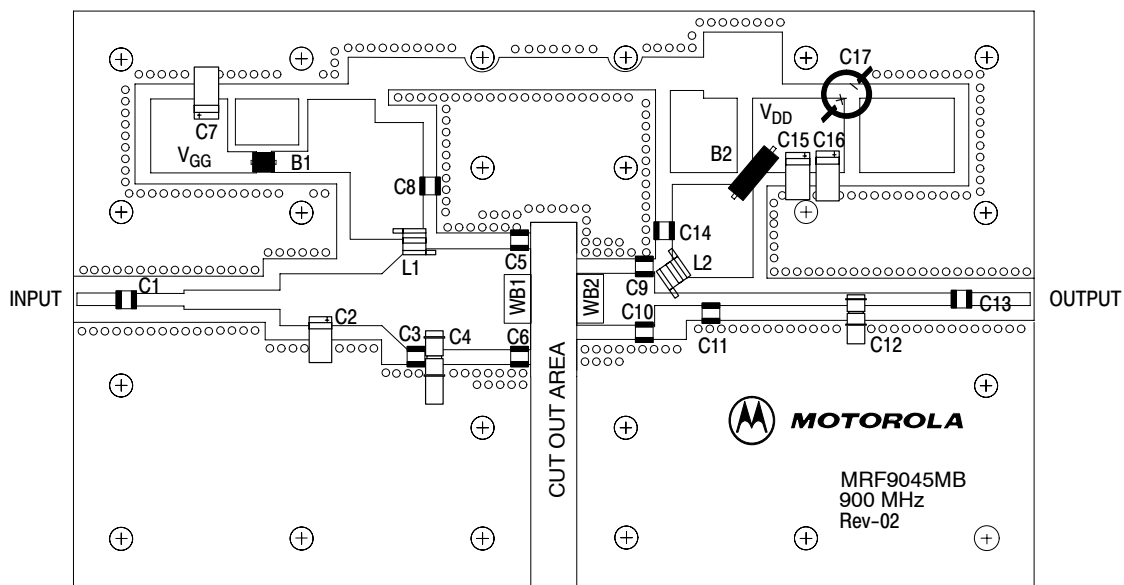
Freescale has begun the transition of marking Printed Circuit Boards (PCBs) with the Freescale Semiconductor signature/logo. PCBs may have either Motorola or Freescale markings during the transition period. These changes will have no impact on form, fit or function of the current product.

**Figure 2. MRF9045MR1( MBR1) 930-960 MHz Broadband Test Circuit Component Layout**



B1	Short Ferrite Bead	Z1	0.260" x 0.060" Microstrip
B2	Long Ferrite Bead	Z2	0.240" x 0.060" Microstrip
C1, C8, C13, C14	47 pF Chip Capacitors	Z3	0.500" x 0.100" Microstrip
C2	0.4 - 2.5 pF Variable Capacitor, Johanson Gigatrim	Z4	0.215" x 0.270" Microstrip
C3	3.6 pF Chip Capacitor	Z5	0.315" x 0.270" Microstrip
C4	0.8 - 8.0 pF Variable Capacitor, Johanson Gigatrim	Z6	0.160" x 0.270" x 0.520" Taper
C5, C6, C9, C10	10 pF Chip Capacitors	Z7	0.285" x 0.520" Microstrip
C7, C15, C16	10 $\mu$ F, 35 V Tantalum Chip Capacitors	Z8	0.140" x 0.270" Microstrip
C11	7.5 pF Chip Capacitor	Z9	0.450" x 0.270" Microstrip
C12	0.6 - 4.5 pF Variable Capacitor, Johanson Gigatrim	Z10	0.250" x 0.060" Microstrip
C17	220 $\mu$ F Electrolytic Chip Capacitor	Z11	0.720" x 0.060" Microstrip
L1, L2	12.5 nH Surface Mount Inductors	Z12	0.490" x 0.060" Microstrip
WB1, WB2	10 mil Brass Wear Blocks	Z13	0.290" x 0.060" Microstrip
		Board	Taconic RF-35-0300, $\epsilon_r = 3.5$

**Figure 3. MRF9045MR1 (MBR1) 930-960 MHz Broadband Test Circuit Schematic**



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

**Figure 4. MRF9045MR1 (MBR1) 930-960 MHz Broadband Test Circuit Component Layout**

## TYPICAL CHARACTERISTICS

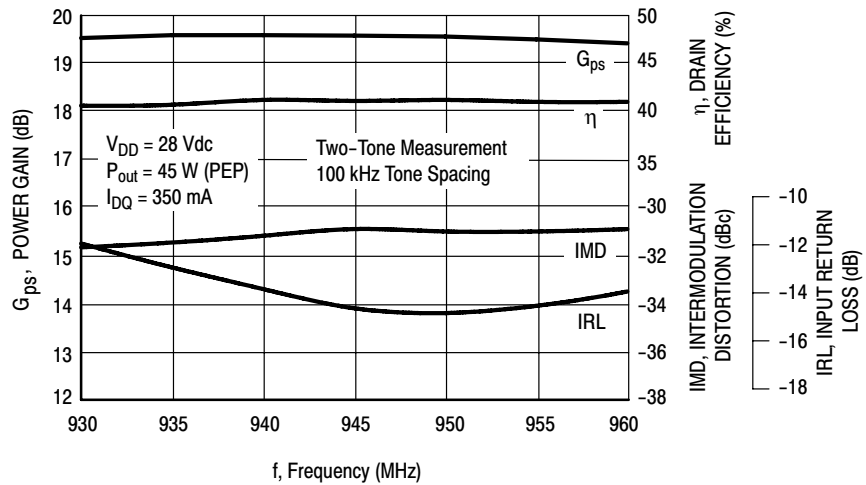


Figure 5. Class AB Broadband Circuit Performance

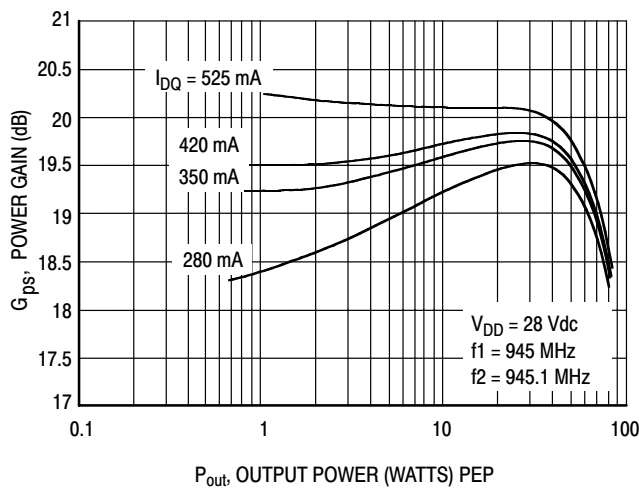


Figure 6. Power Gain versus Output Power

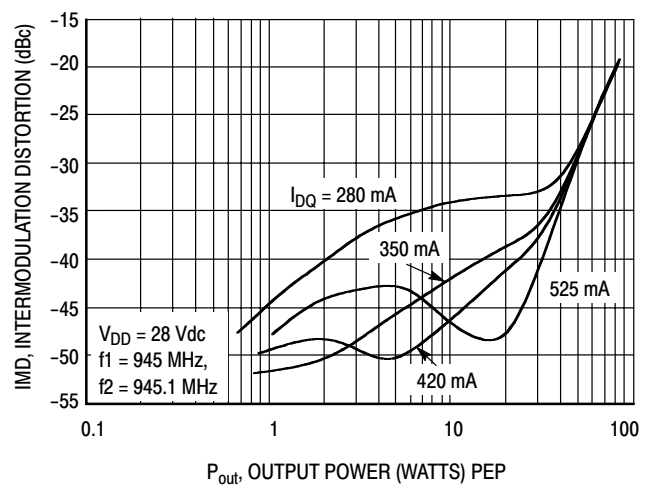


Figure 7. Intermodulation Distortion versus Output Power

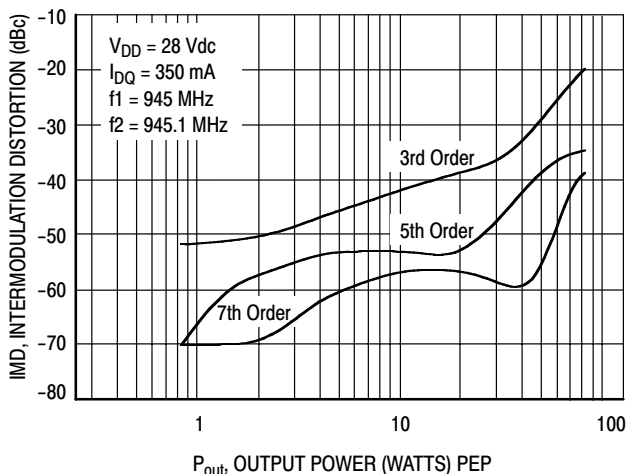


Figure 8. Intermodulation Distortion Products versus Output Power

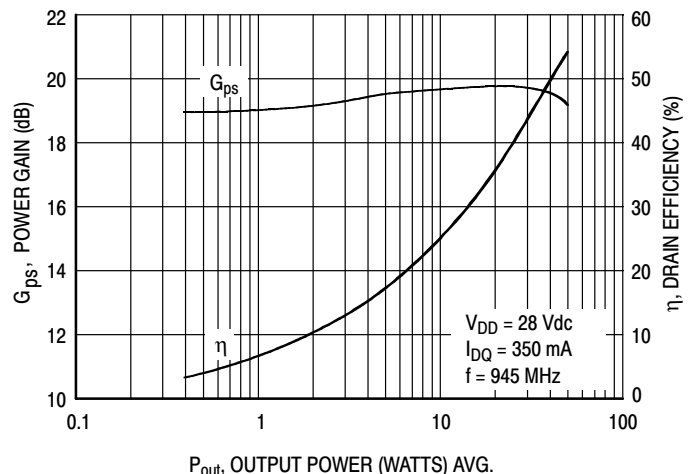


Figure 9. Power Gain and Efficiency versus Output Power

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## TYPICAL CHARACTERISTICS

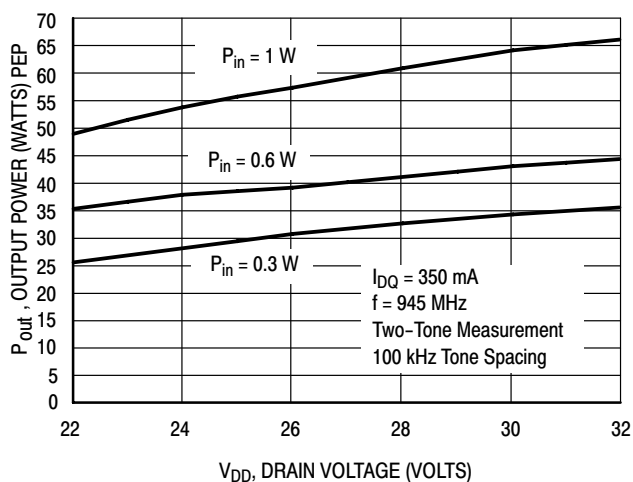


Figure 10. Output Voltage versus Supply Voltage (MRF9045MR1)

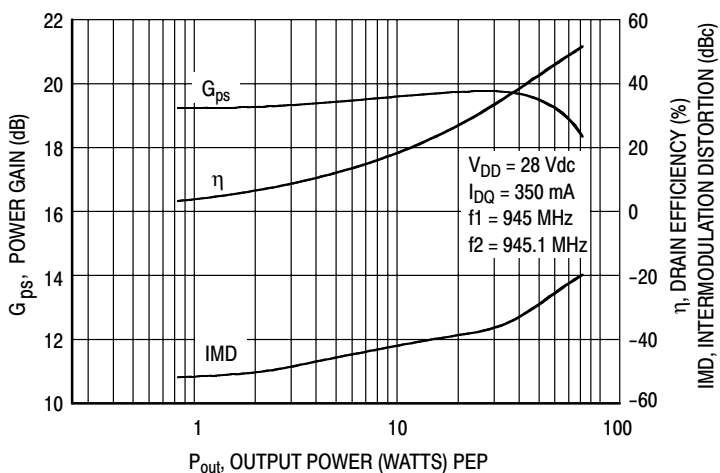
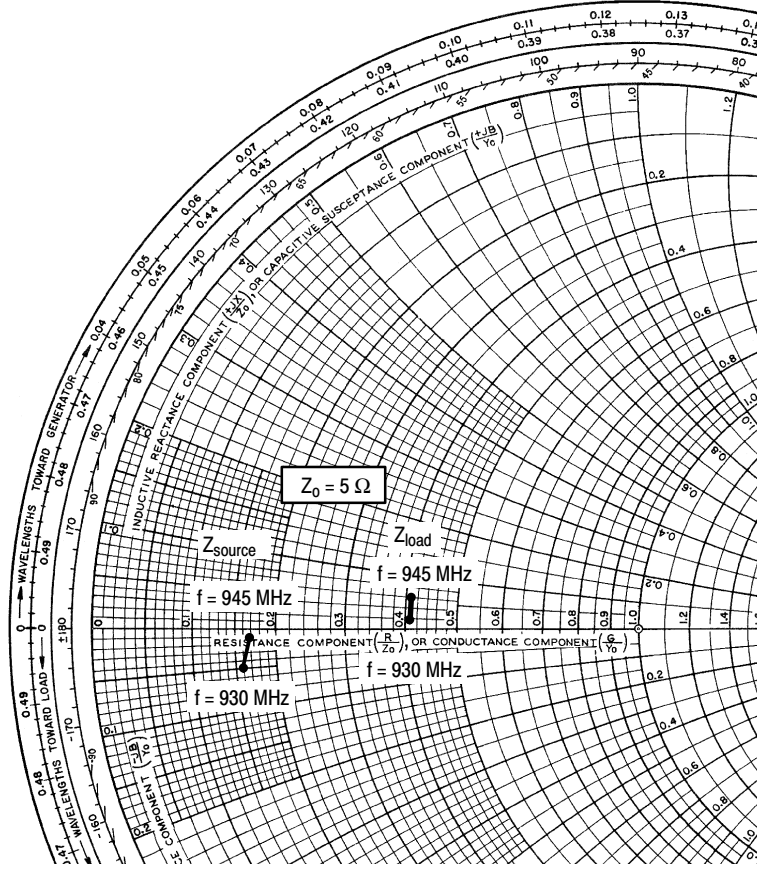


Figure 11. Power Gain, Efficiency and IMD versus Output Power (MRF9045MR1)

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$V_{DD} = 28\text{ V}$ ,  $I_{DQ} = 350\text{ mA}$ ,  $P_{out} = 45\text{ W (PEP)}$

f MHz	$Z_{source}$ $\Omega$	$Z_{load}$ $\Omega$
930	$0.81 - j0.25$	$2.03 + j0.09$
945	$0.85 - j0.05$	$2.03 + j0.28$

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

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

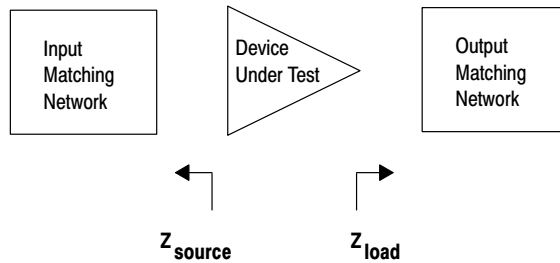
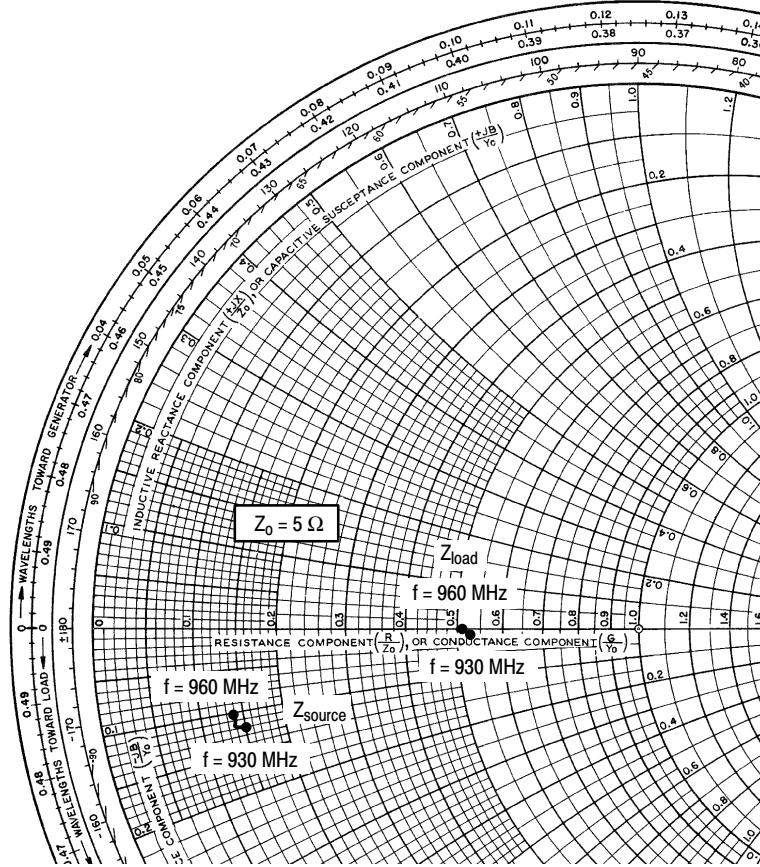


Figure 12. Series Equivalent Source and Load Impedance (MRF9045MR1)



$V_{DD} = 28\text{ V}$ ,  $I_{DQ} = 350\text{ mA}$ ,  $P_{out} = 45\text{ W (PEP)}$

f MHz	$Z_{source}$ $\Omega$	$Z_{load}$ $\Omega$
930	$0.75 - j0.6$	$2.65 - j0.05$
945	$0.72 - j0.6$	$2.60 - j0.05$
960	$0.70 - j0.5$	$2.55 - j0.02$

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

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

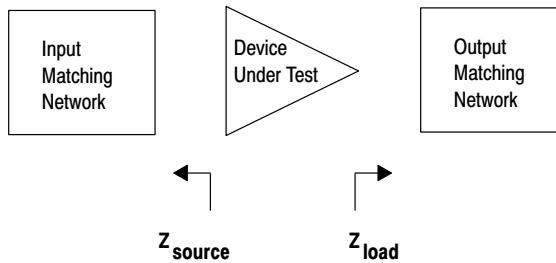


Figure 13. Series Equivalent Source and Load Impedance (MRF9045MR1)





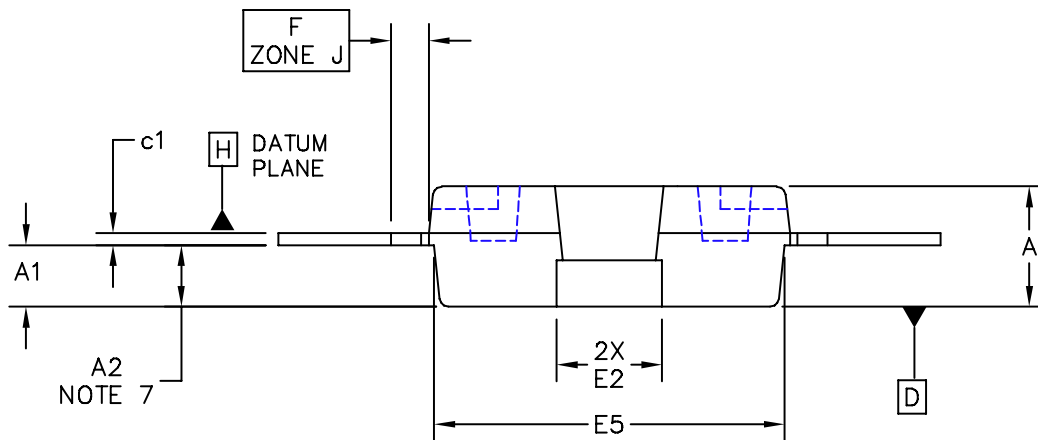
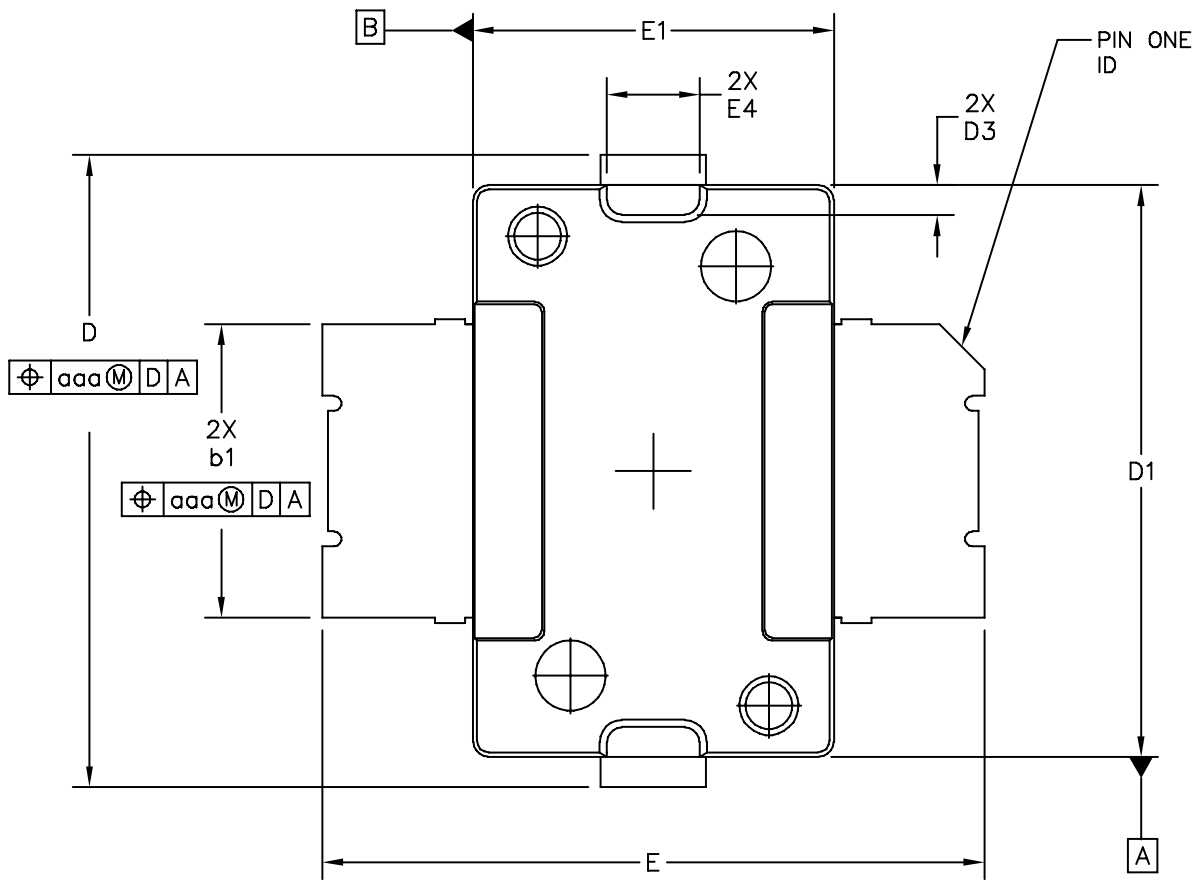
# NOTES

# NOTES

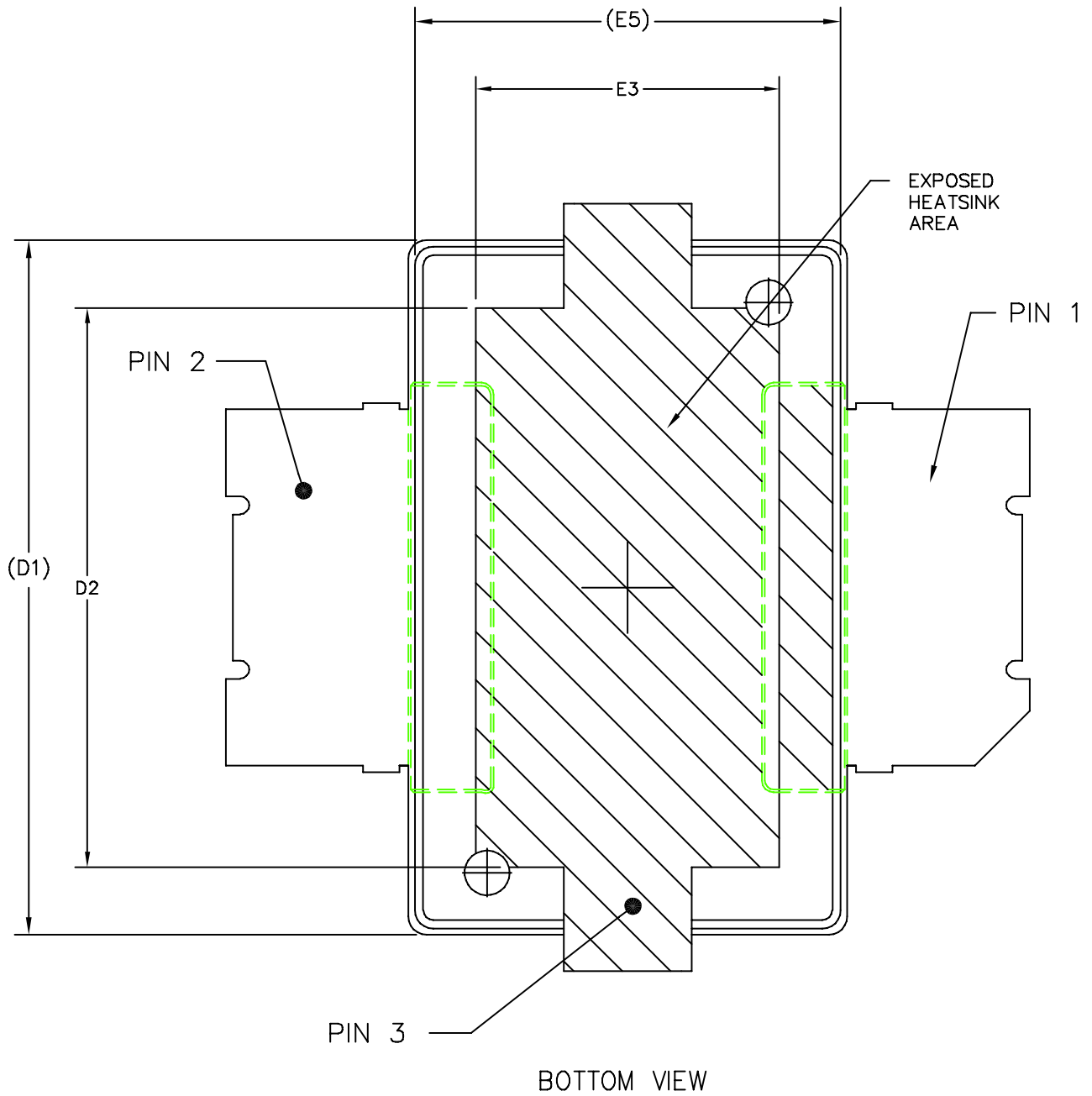


# NOTES

**PACKAGE DIMENSIONS**



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TITLE: <div style="text-align: center; padding: 10px;"> <b>TO-270 SURFACE MOUNT</b> </div>	DOCUMENT NO: 98ASH98117A		REV: J
	CASE NUMBER: 1265-08		01 APR 2005
	STANDARD: NON-JEDEC		



BOTTOM VIEW

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TITLE: <p style="text-align: center;">TO-270 SURFACE MOUNT</p>	DOCUMENT NO: 98ASH98117A	REV: J	
	CASE NUMBER: 1265-08	01 APR 2005	
	STANDARD: NON-JEDEC		

MRF9045MR1 MRF9045MBR1

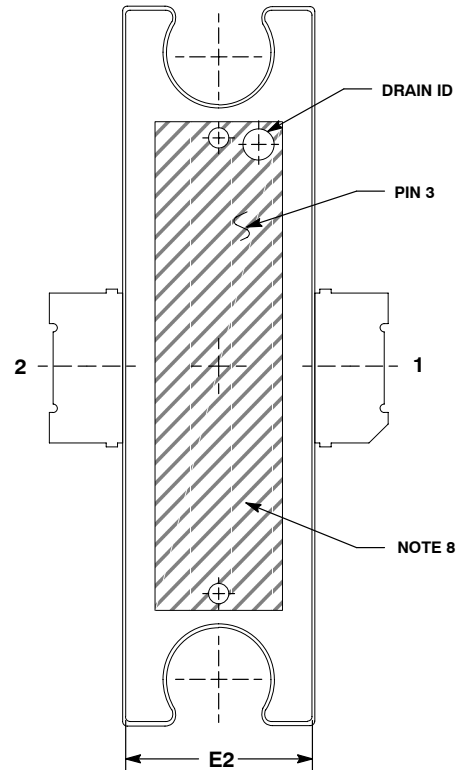
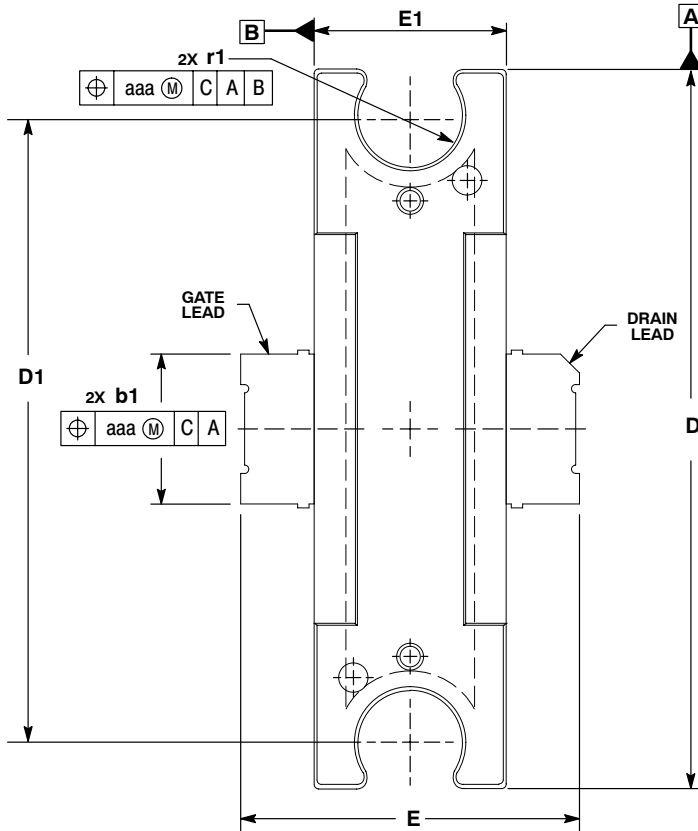
NOTES:

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-.

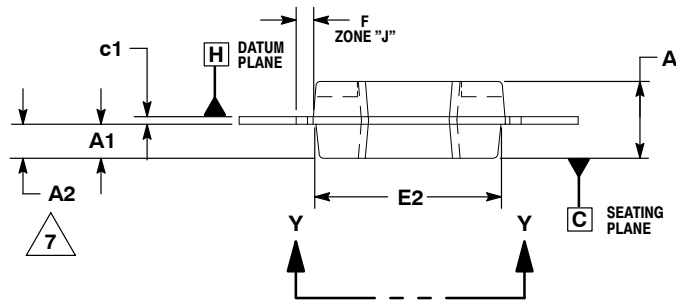
STYLE 1:  
 PIN 1 - DRAIN  
 PIN 2 - GATE  
 PIN 3 - SOURCE

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 DUAL LEAD  
 PLASTIC  
 MRF9045MBR1**

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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