

# The RF Sub-Micron MOSFET Line

## RF Power Field Effect Transistors

### N-Channel Enhancement-Mode Lateral MOSFETs

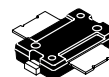
Designed for broadband commercial and industrial applications with frequencies up to 1.0 GHz. The high gain and broadband performance of these devices make them ideal for large-signal, common-source amplifier applications in 26 volt base station equipment.

- 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
- Moisture Sensitivity Level 3
- Dual-Lead Boltdown Plastic Package Can Also Be Used As Surface Mount.
- 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.

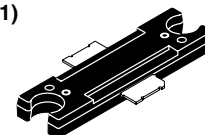
**MRF9030MR1**  
**MRF9030MBR1**

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

**CASE 1265-07, STYLE 1**  
**(TO-270)**  
**PLASTIC**  
**(MRF9030MR1)**



**CASE 1337-01, STYLE 1**  
**(TO-272 DUAL LEAD)**  
**PLASTIC**  
**(MRF9030MBR1)**



#### MAXIMUM RATINGS

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

#### ESD PROTECTION CHARACTERISTICS

| Test Conditions     | Class                        |
|---------------------|------------------------------|
| Human Body Model    | 1 (Minimum)                  |
| Machine Model       | M2 (Minimum)                 |
| Charge Device Model | C7 (Minimum)<br>C6 (Minimum) |

#### THERMAL CHARACTERISTICS

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

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



**ELECTRICAL CHARACTERISTICS** ( $T_C = 25^\circ\text{C}$  unless otherwise noted)

| Characteristic | Symbol | Min | Typ | Max | Unit |
|----------------|--------|-----|-----|-----|------|
|----------------|--------|-----|-----|-----|------|

**OFF CHARACTERISTICS**

|                                                                                                   |           |   |   |    |                 |
|---------------------------------------------------------------------------------------------------|-----------|---|---|----|-----------------|
| Zero Gate Voltage Drain Leakage Current<br>( $V_{DS} = 65\text{ Vdc}$ , $V_{GS} = 0\text{ Vdc}$ ) | $I_{DSS}$ | — | — | 10 | $\mu\text{Adc}$ |
| Zero Gate Voltage Drain Leakage Current<br>( $V_{DS} = 26\text{ Vdc}$ , $V_{GS} = 0\text{ Vdc}$ ) | $I_{DSS}$ | — | — | 1  | $\mu\text{Adc}$ |
| Gate–Source Leakage Current<br>( $V_{GS} = 5\text{ Vdc}$ , $V_{DS} = 0\text{ Vdc}$ )              | $I_{GSS}$ | — | — | 1  | $\mu\text{Adc}$ |

**ON CHARACTERISTICS**

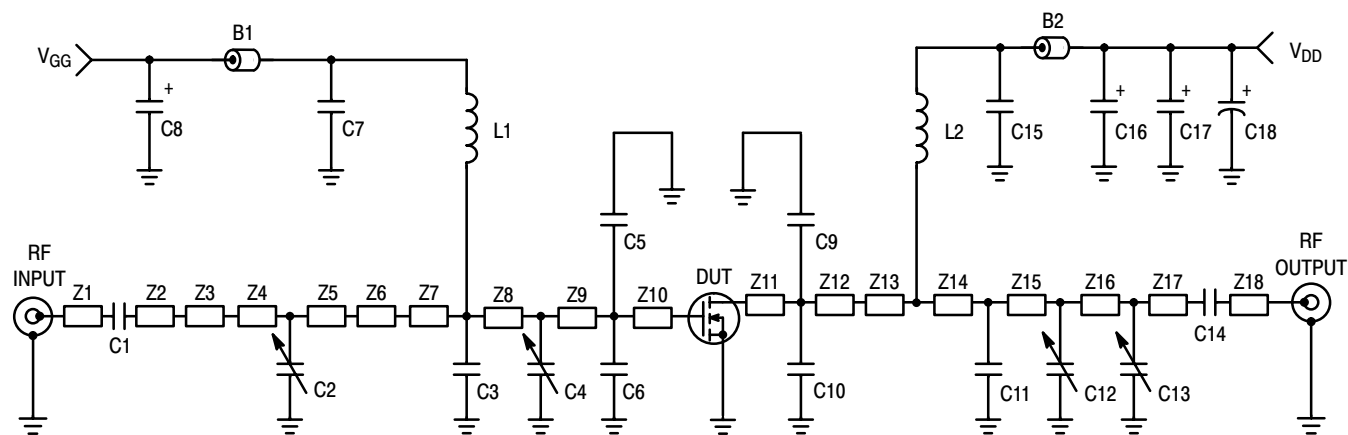
|                                                                                           |              |   |      |     |     |
|-------------------------------------------------------------------------------------------|--------------|---|------|-----|-----|
| Gate Threshold Voltage<br>( $V_{DS} = 10\text{ Vdc}$ , $I_D = 100\text{ }\mu\text{Adc}$ ) | $V_{GS(th)}$ | 2 | 2.9  | 4   | Vdc |
| Gate Quiescent Voltage<br>( $V_{DS} = 26\text{ Vdc}$ , $I_D = 250\text{ mAdc}$ )          | $V_{GS(Q)}$  | 3 | 3.8  | 5   | Vdc |
| Drain–Source On–Voltage<br>( $V_{GS} = 10\text{ Vdc}$ , $I_D = 0.7\text{ Adc}$ )          | $V_{DS(on)}$ | — | 0.23 | 0.4 | Vdc |
| Forward Transconductance<br>( $V_{DS} = 10\text{ Vdc}$ , $I_D = 2\text{ Adc}$ )           | $g_{fs}$     | — | 2.7  | —   | S   |

**DYNAMIC CHARACTERISTICS**

|                                                                                                                       |           |   |     |   |    |
|-----------------------------------------------------------------------------------------------------------------------|-----------|---|-----|---|----|
| Input Capacitance<br>( $V_{DS} = 26\text{ Vdc} \pm 30\text{ mV(rms)ac}$ @ 1 MHz, $V_{GS} = 0\text{ Vdc}$ )            | $C_{iss}$ | — | 49  | — | pF |
| Output Capacitance<br>( $V_{DS} = 26\text{ Vdc} \pm 30\text{ mV(rms)ac}$ @ 1 MHz, $V_{GS} = 0\text{ Vdc}$ )           | $C_{oss}$ | — | 27  | — | pF |
| Reverse Transfer Capacitance<br>( $V_{DS} = 26\text{ Vdc} \pm 30\text{ mV(rms)ac}$ @ 1 MHz, $V_{GS} = 0\text{ Vdc}$ ) | $C_{rss}$ | — | 1.2 | — | pF |

**FUNCTIONAL TESTS** (In Motorola Test Fixture)

|                                                                                                                                                                                                                                                          |          |    |      |     |     |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|----|------|-----|-----|
| Two–Tone Common–Source Amplifier Power Gain<br>( $V_{DD} = 26\text{ Vdc}$ , $P_{out} = 30\text{ W PEP}$ , $I_{DQ} = 250\text{ mA}$ ,<br>$f_1 = 945.0\text{ MHz}$ , $f_2 = 945.1\text{ MHz}$ )                                                            | $G_{ps}$ | 18 | 20   | —   | dB  |
| Two–Tone Drain Efficiency<br>( $V_{DD} = 26\text{ Vdc}$ , $P_{out} = 30\text{ W PEP}$ , $I_{DQ} = 250\text{ mA}$ ,<br>$f_1 = 945.0\text{ MHz}$ , $f_2 = 945.1\text{ MHz}$ )                                                                              | $\eta$   | 37 | 41   | —   | %   |
| 3rd Order Intermodulation Distortion<br>( $V_{DD} = 26\text{ Vdc}$ , $P_{out} = 30\text{ W PEP}$ , $I_{DQ} = 250\text{ mA}$ ,<br>$f_1 = 945.0\text{ MHz}$ , $f_2 = 945.1\text{ MHz}$ )                                                                   | IMD      | —  | –31  | –28 | dBc |
| Input Return Loss<br>( $V_{DD} = 26\text{ Vdc}$ , $P_{out} = 30\text{ W PEP}$ , $I_{DQ} = 250\text{ mA}$ ,<br>$f_1 = 945.0\text{ MHz}$ , $f_2 = 945.1\text{ MHz}$ )                                                                                      | IRL      | —  | –13  | –9  | dB  |
| Two–Tone Common–Source Amplifier Power Gain<br>( $V_{DD} = 26\text{ Vdc}$ , $P_{out} = 30\text{ W PEP}$ , $I_{DQ} = 250\text{ mA}$ ,<br>$f_1 = 930.0\text{ MHz}$ , $f_2 = 930.1\text{ MHz}$ and $f_1 = 960.0\text{ MHz}$ ,<br>$f_2 = 960.1\text{ MHz}$ ) | $G_{ps}$ | —  | 20   | —   | dB  |
| Two–Tone Drain Efficiency<br>( $V_{DD} = 26\text{ Vdc}$ , $P_{out} = 30\text{ W PEP}$ , $I_{DQ} = 250\text{ mA}$ ,<br>$f_1 = 930.0\text{ MHz}$ , $f_2 = 930.1\text{ MHz}$ and $f_1 = 960.0\text{ MHz}$ ,<br>$f_2 = 960.1\text{ MHz}$ )                   | $\eta$   | —  | 40.5 | —   | %   |
| 3rd Order Intermodulation Distortion<br>( $V_{DD} = 26\text{ Vdc}$ , $P_{out} = 30\text{ W PEP}$ , $I_{DQ} = 250\text{ mA}$ ,<br>$f_1 = 930.0\text{ MHz}$ , $f_2 = 930.1\text{ MHz}$ and $f_1 = 960.0\text{ MHz}$ ,<br>$f_2 = 960.1\text{ MHz}$ )        | IMD      | —  | –31  | —   | dBc |
| Input Return Loss<br>( $V_{DD} = 26\text{ Vdc}$ , $P_{out} = 30\text{ W PEP}$ , $I_{DQ} = 250\text{ mA}$ ,<br>$f_1 = 930.0\text{ MHz}$ , $f_2 = 930.1\text{ MHz}$ and $f_1 = 960.0\text{ MHz}$ ,<br>$f_2 = 960.1\text{ MHz}$ )                           | 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, $\epsilon_r = 3.5$ |
|     | 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 $\mu$ 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)<br>0.6–4.5 Variable Capacitor, Gigatrim (MRF9030MR1) | 100B1R8BP<br>44F3360           | ATC<br>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 |

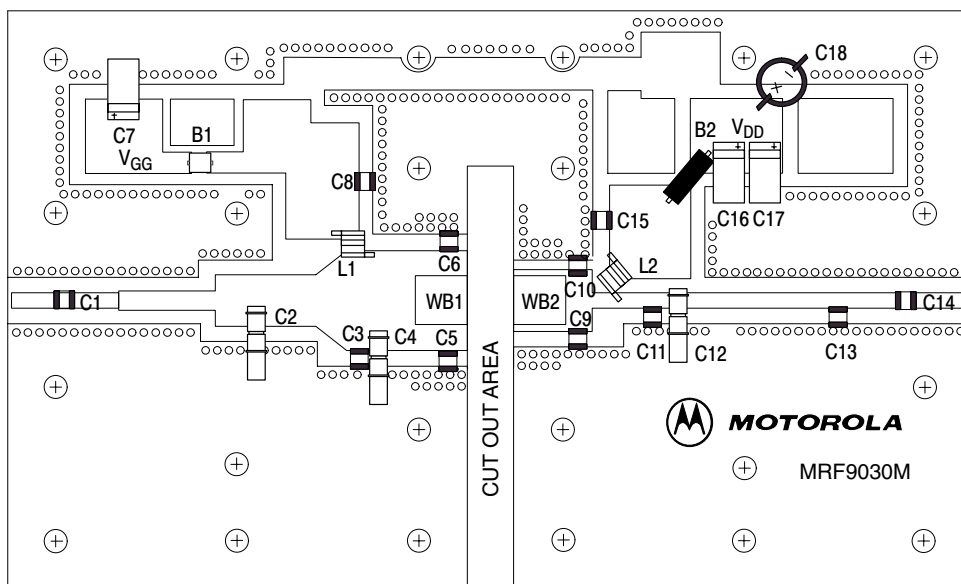


Figure 2. 930–960 MHz Broadband Test Circuit Component Layout (MRF9030MR1)

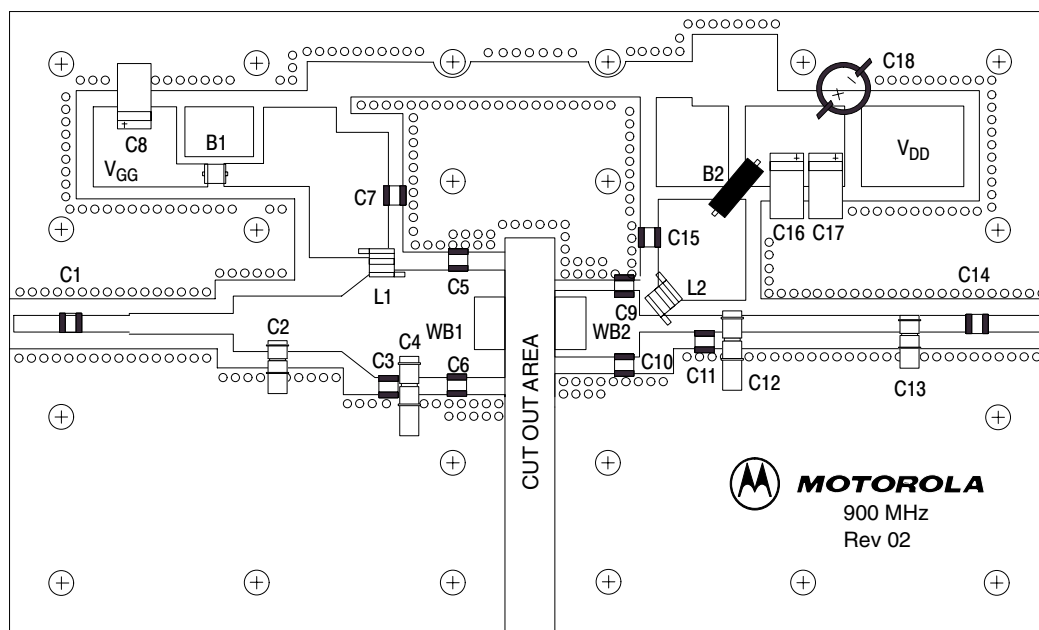


Figure 3. 930–960 MHz Broadband Test Circuit Component Layout (MRF9030MBR1)

## TYPICAL CHARACTERISTICS

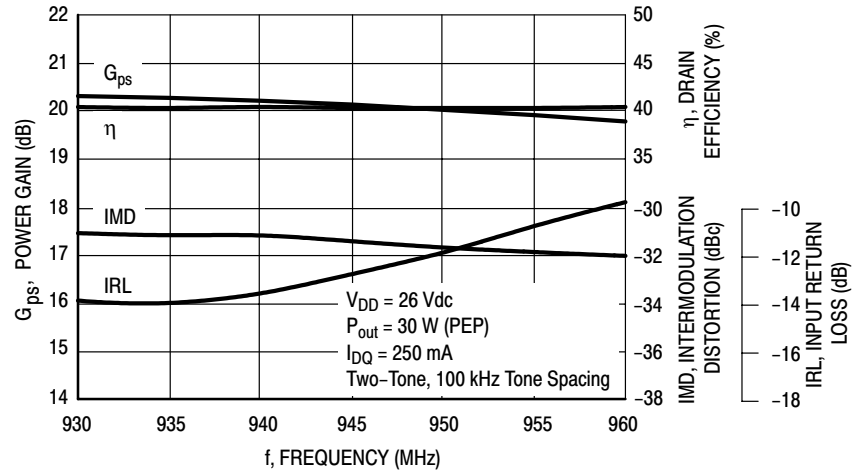


Figure 4. Class AB Broadband Circuit Performance

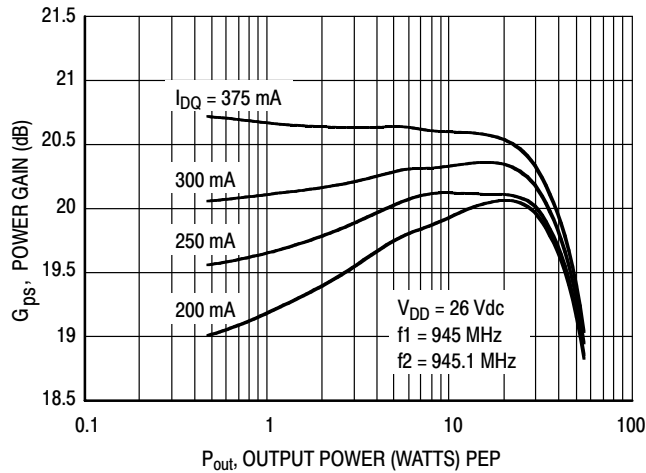


Figure 5. Power Gain versus Output Power

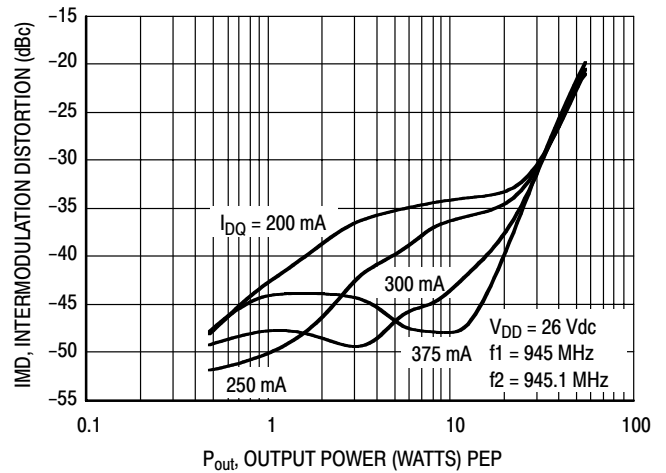


Figure 6. Intermodulation Distortion versus Output Power

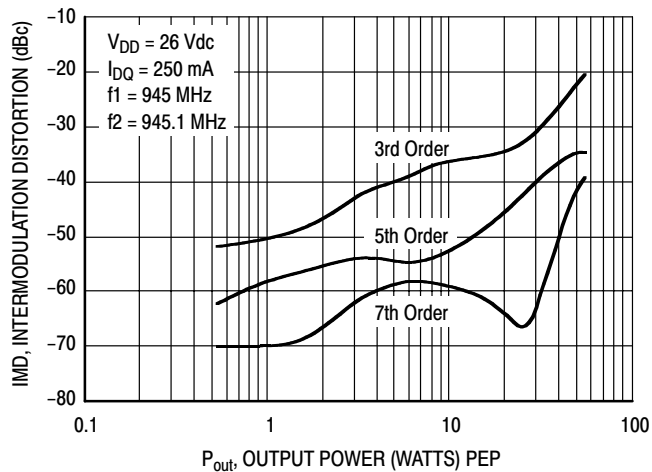


Figure 7. Intermodulation Distortion Products versus Output Power

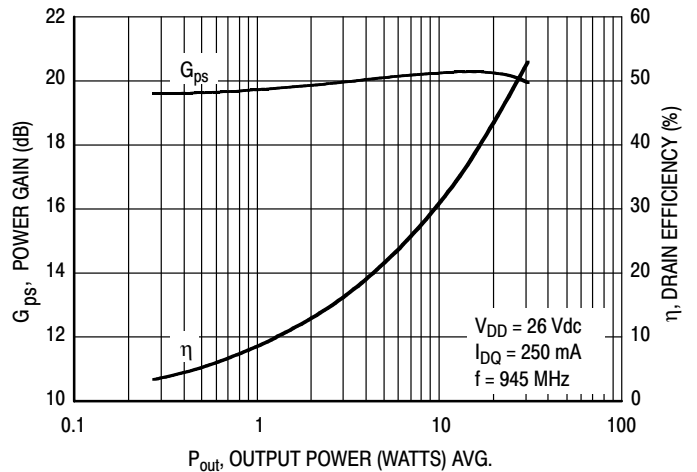
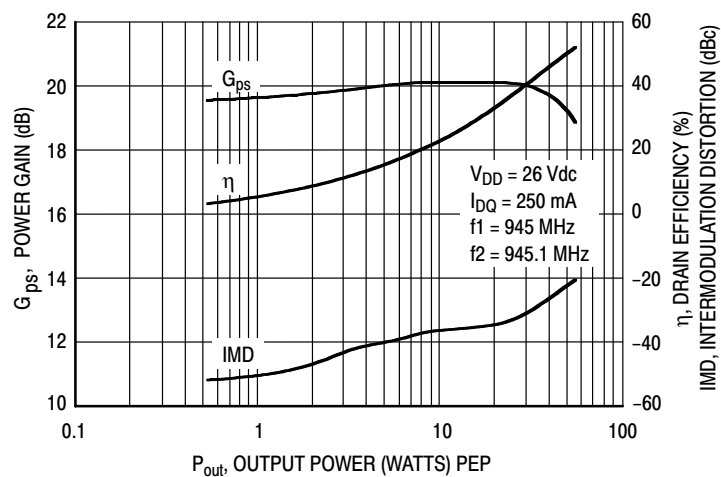
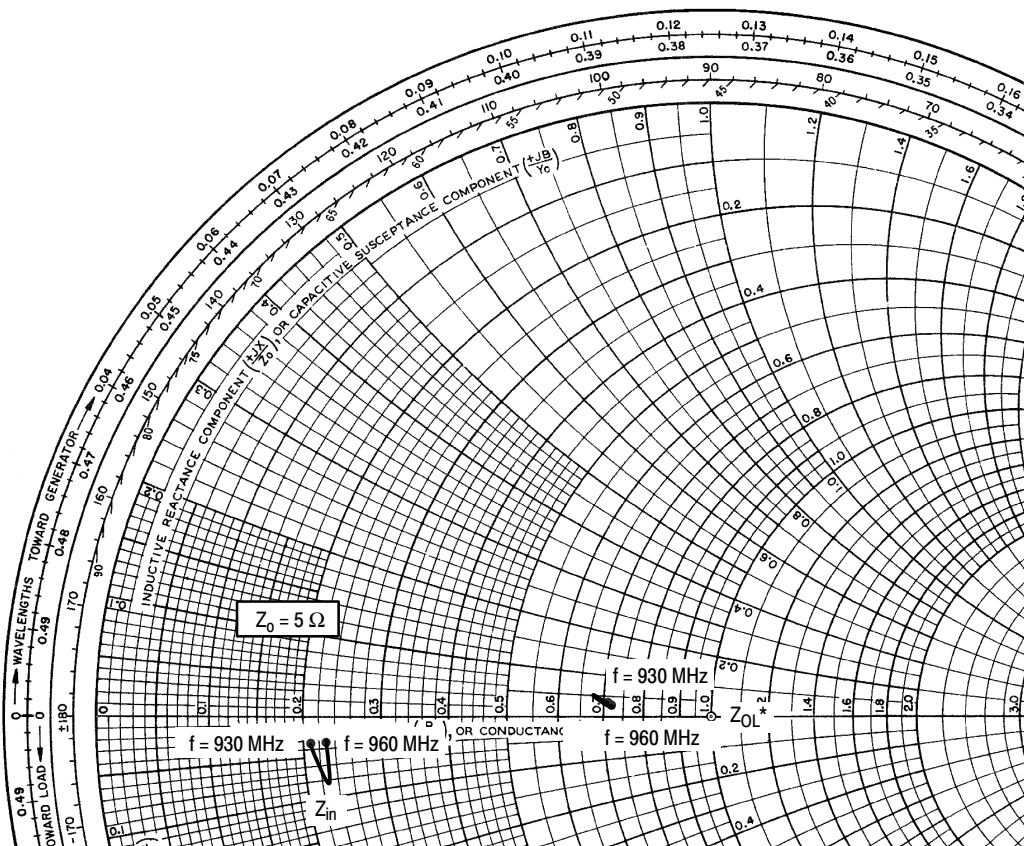


Figure 8. Power Gain and Efficiency versus Output Power



**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<br>MHz | $Z_{in}$<br>$\Omega$ | $Z_{OL}^*$<br>$\Omega$ |
|----------|----------------------|------------------------|
| 930      | $1.07 - j0.160$      | $3.53 + j0.20$         |
| 945      | $1.14 - j0.385$      | $3.41 + j0.24$         |
| 960      | $1.17 - j0.170$      | $3.60 + j0.17$         |

$Z_{in}$  = Complex conjugate of source impedance.

$Z_{OL}^*$  = Complex conjugate of the optimum load impedance at a given output power, voltage, IMD, bias current and frequency.

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

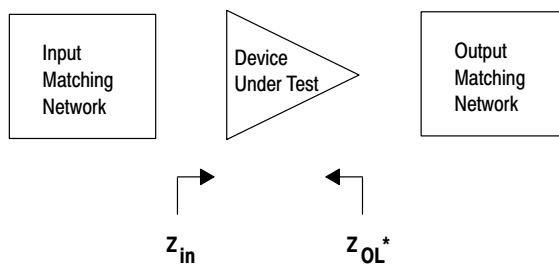
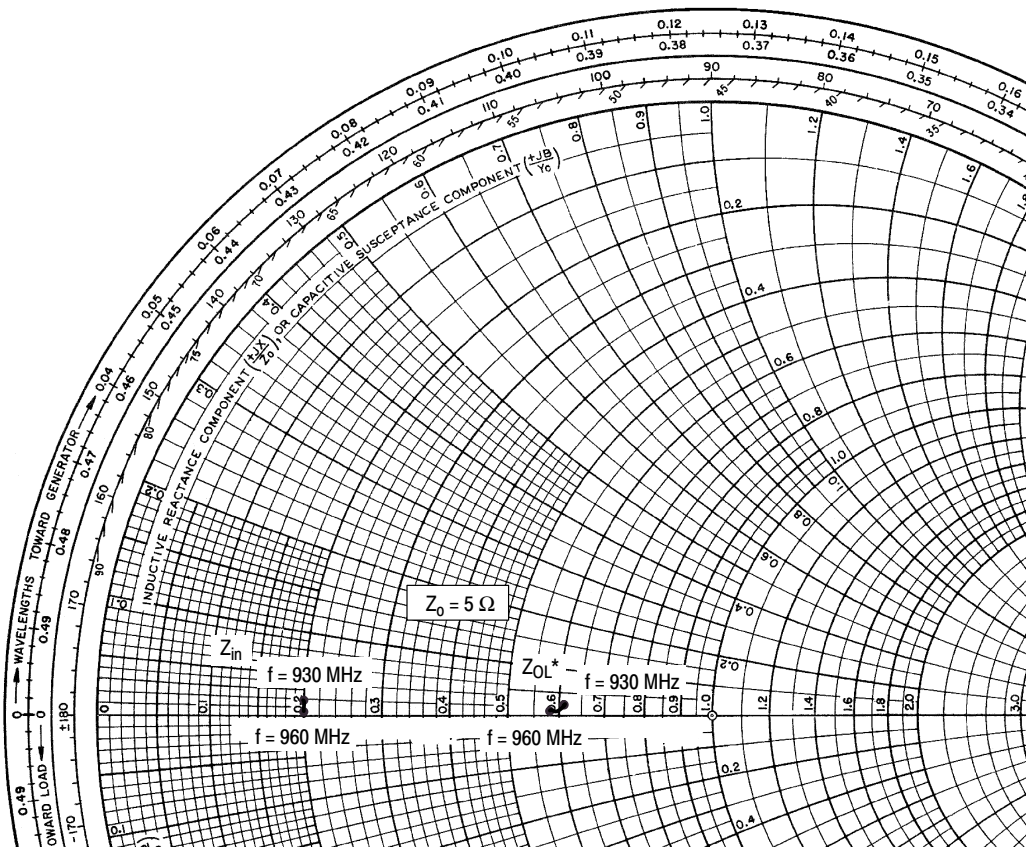


Figure 10. Series Equivalent Input and Output Impedance (MRF9030MR1)



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

| f<br>MHz | $Z_{in}$<br>$\Omega$ | $Z_{OL}^*$<br>$\Omega$ |
|----------|----------------------|------------------------|
| 930      | $1.0 + j0.18$        | $3.05 + j0.09$         |
| 945      | $1.0 + j0.10$        | $3.00 + j0.07$         |
| 960      | $1.0 + j0.03$        | $2.95 + j0.03$         |

$Z_{in}$  = Complex conjugate of source impedance.

$Z_{OL}^*$  = Complex conjugate of the optimum load impedance at a given output power, voltage, IMD, bias current and frequency.

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

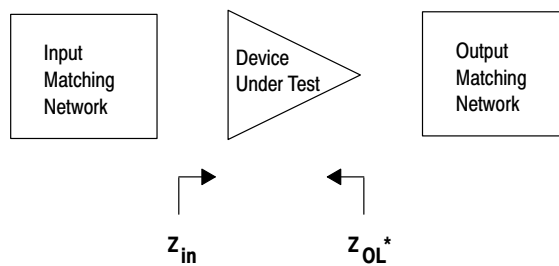
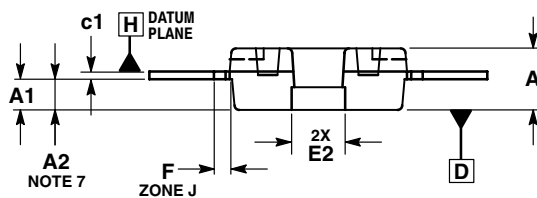
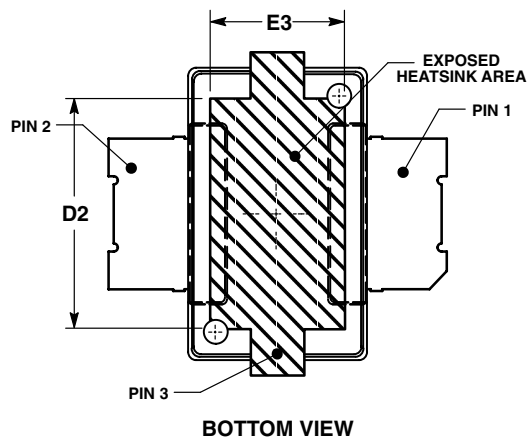
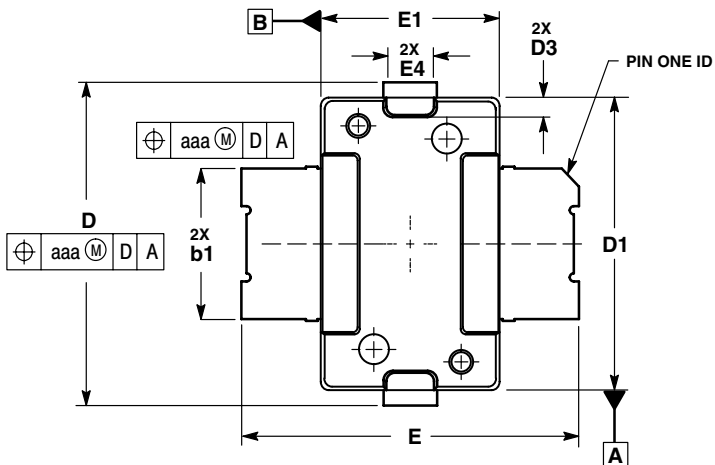


Figure 11. Series Equivalent Input and Output Impedance (MRF9030MBR1)

# NOTES

## PACKAGE DIMENSIONS



### NOTES:

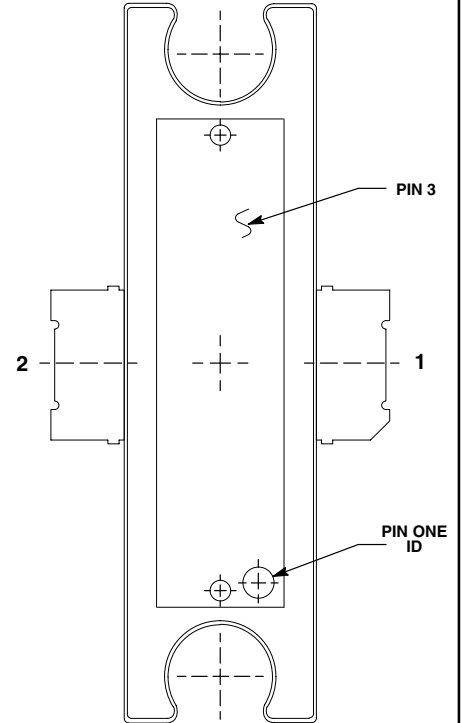
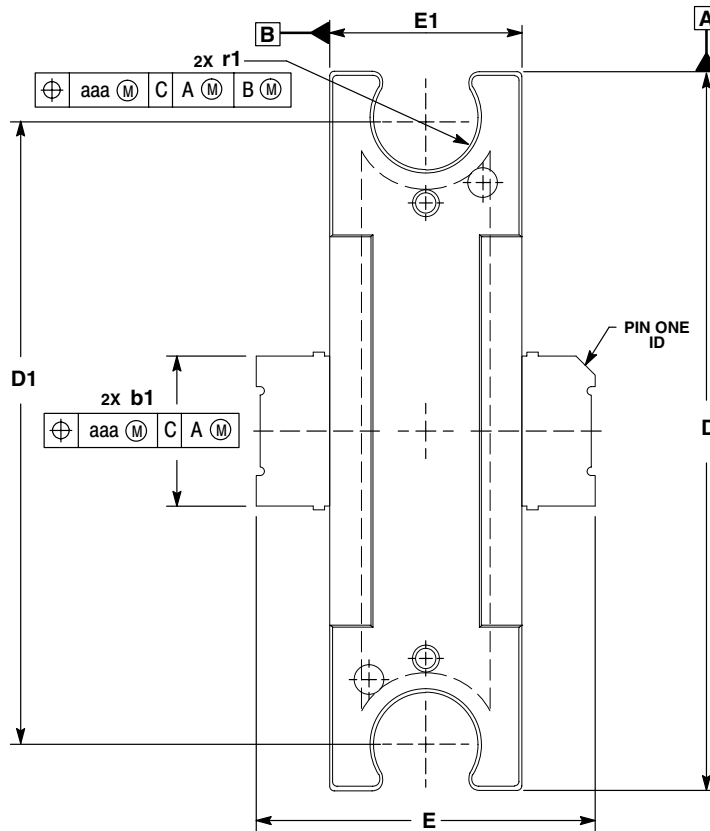
1. CONTROLLING DIMENSION: INCH.
2. INTERPRET DIMENSIONS AND TOLERANCES PER ASME Y14.5M-1994.
3. DATUM PLANE -H- IS LOCATED AT TOP OF LEAD AND IS COINCIDENT WITH THE LEAD WHERE THE LEAD EXITS THE PLASTIC BODY AT THE TOP OF THE PARTING LINE.
4. DIMENSIONS "D1" AND "E1" DO NOT INCLUDE MOLD PROTRUSION. ALLOWABLE 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   | .076     | .084 | 1.93        | 2.13  |
| A1  | .038     | .044 | 0.96        | 1.12  |
| A2  | .040     | .042 | 1.02        | 1.07  |
| D   | .416     | .424 | 10.57       | 10.77 |
| D1  | .376     | .384 | 9.55        | 9.75  |
| D2  | .290     | .320 | 7.37        | 8.13  |
| D3  | .016     | .024 | 0.41        | 0.61  |
| E   | .436     | .444 | 11.07       | 11.28 |
| E1  | .236     | .244 | 5.99        | 6.20  |
| E2  | .066     | .074 | 1.68        | 1.88  |
| E3  | .150     | .180 | 3.81        | 4.57  |
| E4  | .058     | .066 | 1.47        | 1.68  |
| F   | .025 BSC |      | 0.64 BSC    |       |
| b1  | .193     | .199 | 4.90        | 5.06  |
| c1  | .007     | .011 | 0.18        | 0.28  |
| aaa | .004     |      | 0.10        |       |

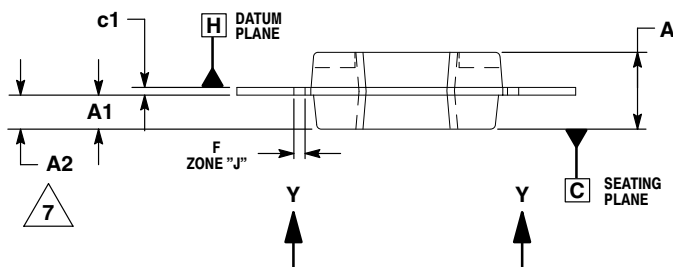
### STYLE 1:

1. DRAIN
2. GATE
3. SOURCE

CASE 1265-07  
ISSUE F  
(TO-270)  
PLASTIC  
(MRF9030MR1)



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.

| DIM | INCHES   |      | MILLIMETERS |       |
|-----|----------|------|-------------|-------|
|     | MIN      | MAX  | MIN         | MAX   |
| A   | .098     | .110 | 2.49        | 2.79  |
| A1  | .038     | .044 | 0.96        | 1.12  |
| A2  | .040     | .042 | 1.02        | 1.07  |
| D   | .926     | .934 | 23.52       | 23.72 |
| D1  | .810 BSC |      | 20.57 BSC   |       |
| E   | .438     | .442 | 11.12       | 11.23 |
| E1  | .246     | .254 | 6.25        | 6.45  |
| 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 1337-01  
ISSUE O  
(TO-272 DUAL LEAD)  
PLASTIC  
(MRF9030MBR1)

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