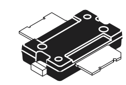
## The RF Sub-Micron MOSFET Line
# RF Power Field Effect Transistors
## N-Channel Enhancement-Mode Lateral MOSFETs

**MRF9030MR1**
**MRF9030MBR1**

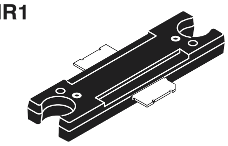
Designed for broadband commercial and industrial applications with frequencies up to 1.0 GHz. The high gain and broadband performance of these devices make them ideal for large-signal, common-source amplifier applications in 26 volt base station equipment.

- 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 Boltdown 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.

**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°C<br>Derate above 25°C | $P_D$ | 139<br>0.93 | Watts<br>W/°C |
| Storage Temperature Range | $T_{stg}$ | -65 to +150 | °C |
| Operating Junction Temperature | $T_J$ | 175 | °C |

### THERMAL CHARACTERISTICS

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

### ESD PROTECTION CHARACTERISTICS

| Test Conditions | | Class |
|---|---|---|
| Human Body Model | | 1 (Minimum) |
| Machine Model | | M2 (Minimum) |
| Charge Device Model | MRF9030MR1<br>MRF9030MBR1 | C7 (Minimum)<br>C6 (Minimum) |

### MOISTURE SENSITIVITY LEVEL

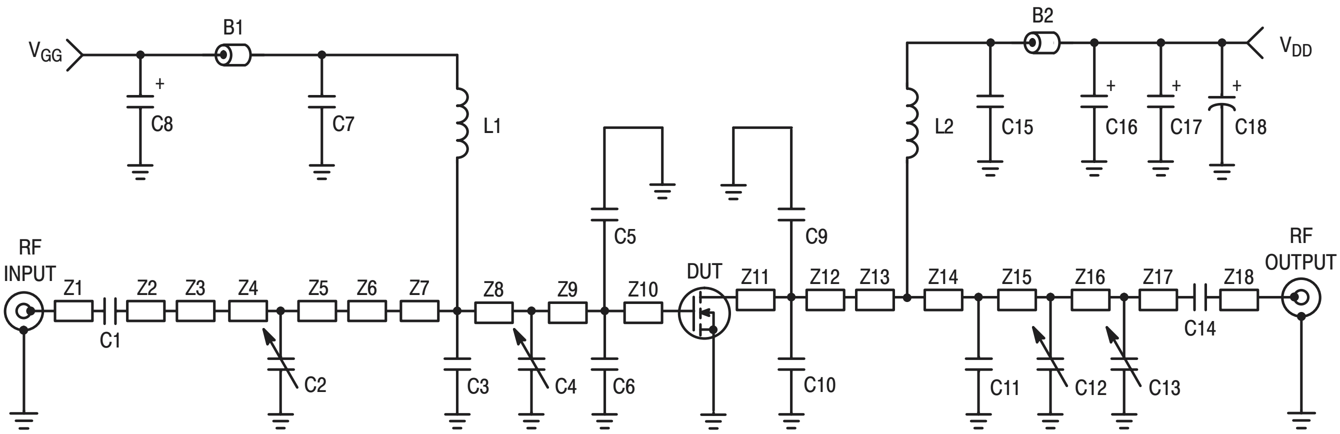
| Test Methodology | Rating |
|---|---|
| Per JESD 22-A113 | 3 |

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

REV 6

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

| Characteristic | Symbol | Min | Typ | Max | Unit |
|---|---|---|---|---|---|
| **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, 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 Vdc, $P_{out}$ = 30 W PEP, $I_{DQ}$ = 250 mA, f1 = 945.0 MHz, f2 = 945.1 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 |
| 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)<br>0.290″ x 0.520″ Microstrip (MRF9030MBR1) | Board | Taconic RF-35-0300, $\varepsilon_r$ = 3.5 |
| Z10 | 0.130″ x 0.520″ Microstrip (MRF9030MR1)<br>0.210″ x 0.520″ Microstrip (MRF9030MBR1) | | |

**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 μF, 35 V Tantulum 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 (MRF9030MBR1) | 100B1R8BP<br>44F3360 | ATC<br>Newark |
| C18 | 220 μF 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 μ250/Viper Rev 02 | DSelectronics |

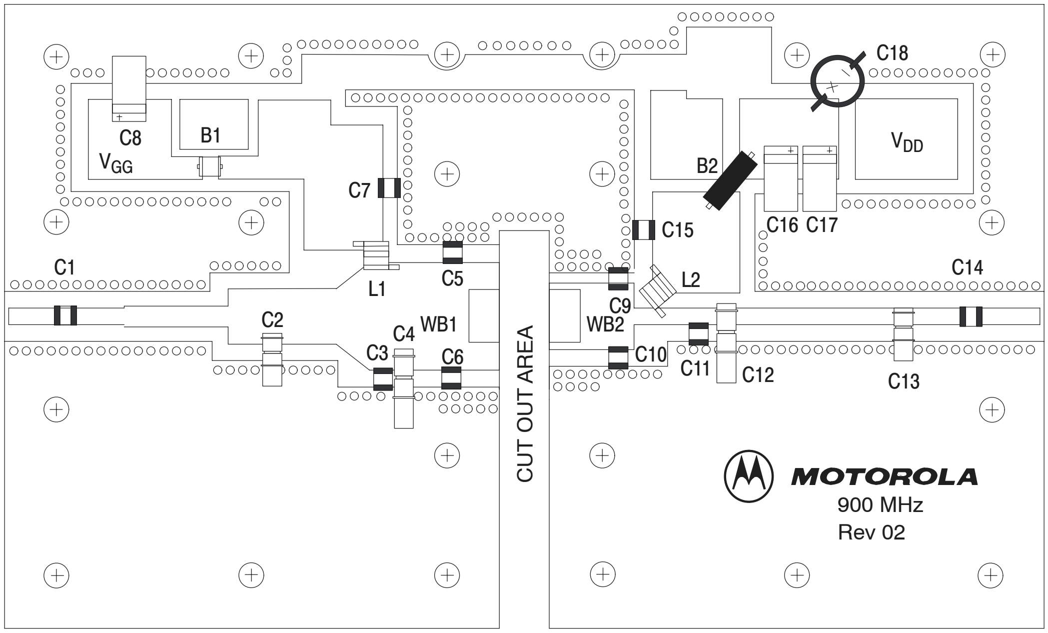



**Figure 2. 930-960 MHz Broadband Test Circuit Component Layout (MRF9030MR1)**

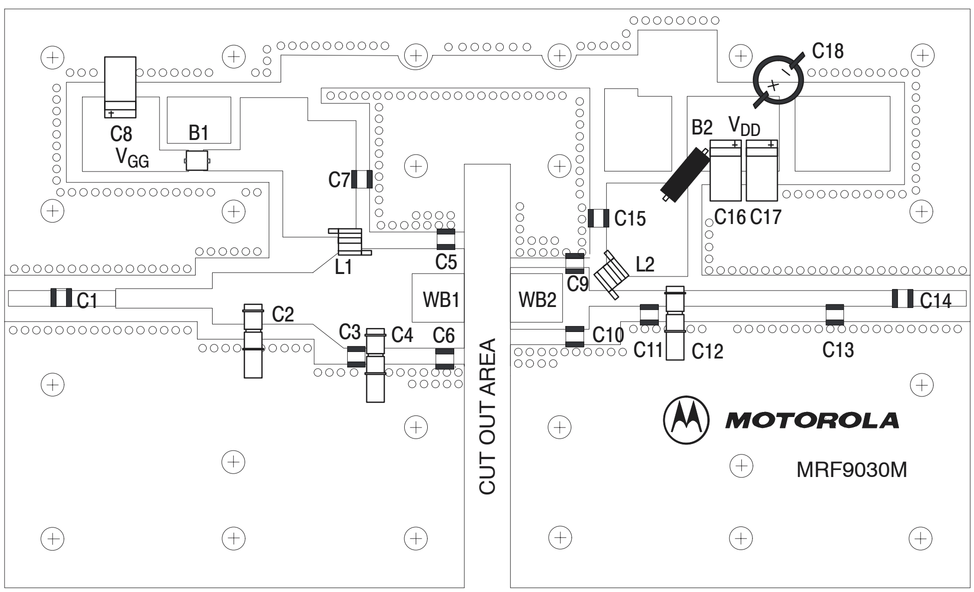



**Figure 3. 930-960 MHz Broadband Test Circuit Component Layout (MRF9030MBR1)**

## TYPICAL CHARACTERISTICS

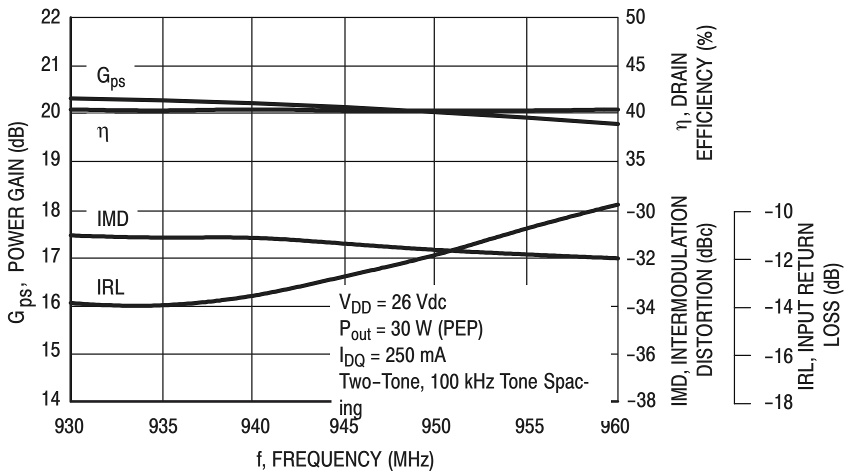



**Figure 4. Class AB Broadband Circuit Performance**

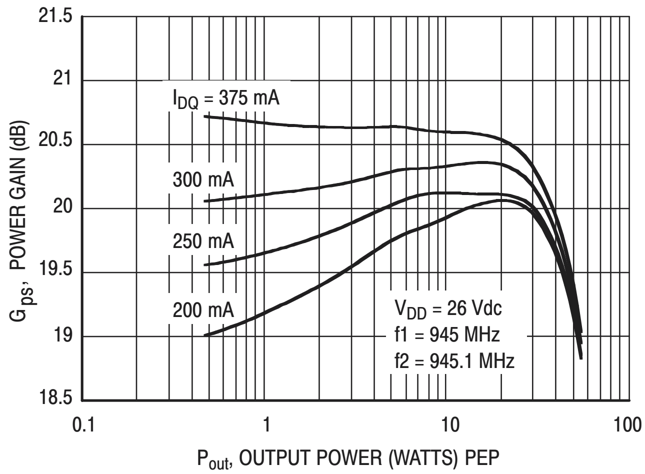



**Figure 5. Power Gain versus Output Power**

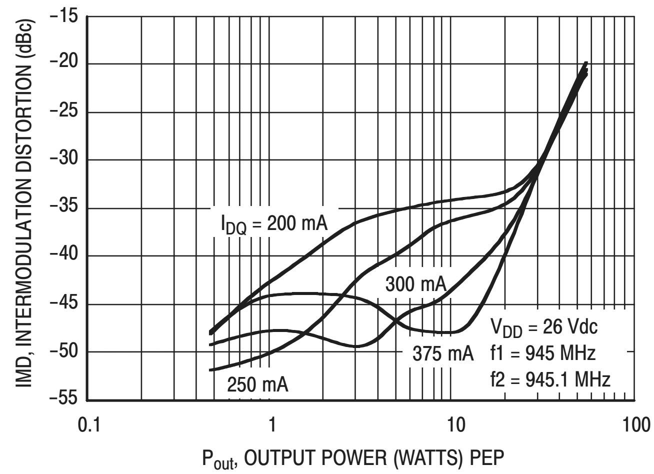



**Figure 6. Intermodulation Distortion versus Output Power**

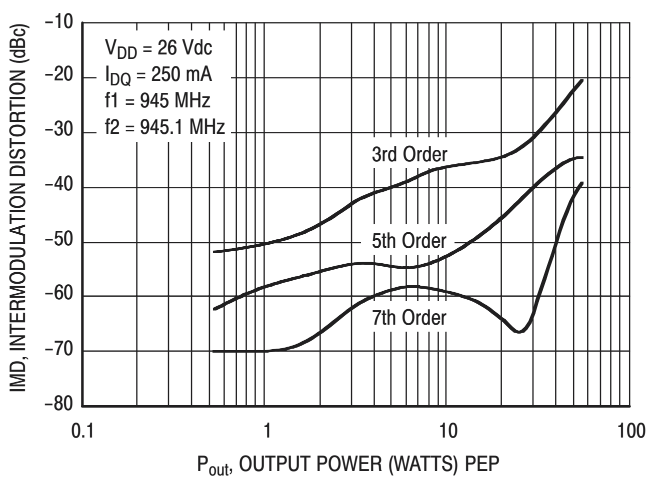



**Figure 7. Intermodulation Distortion Products versus Output Power**

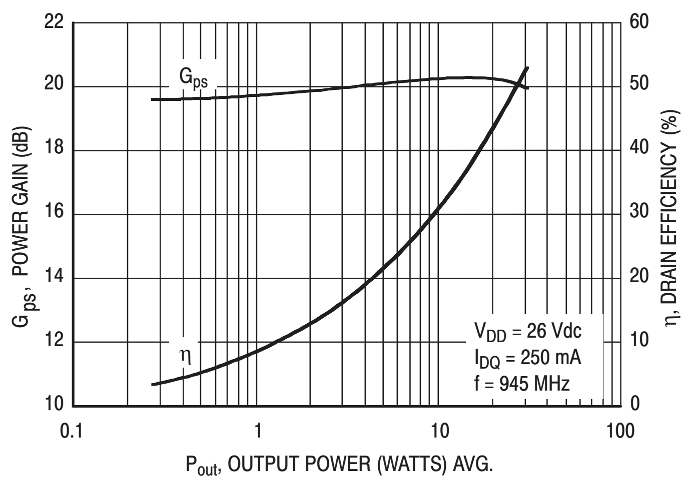



**Figure 8. Power Gain and Efficiency versus Output Power**

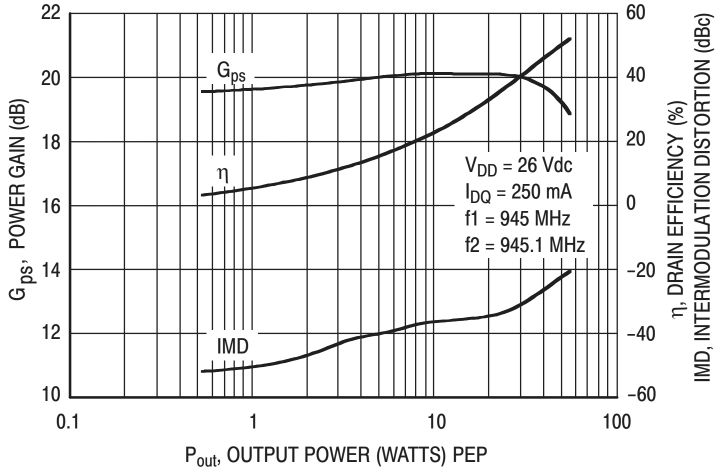
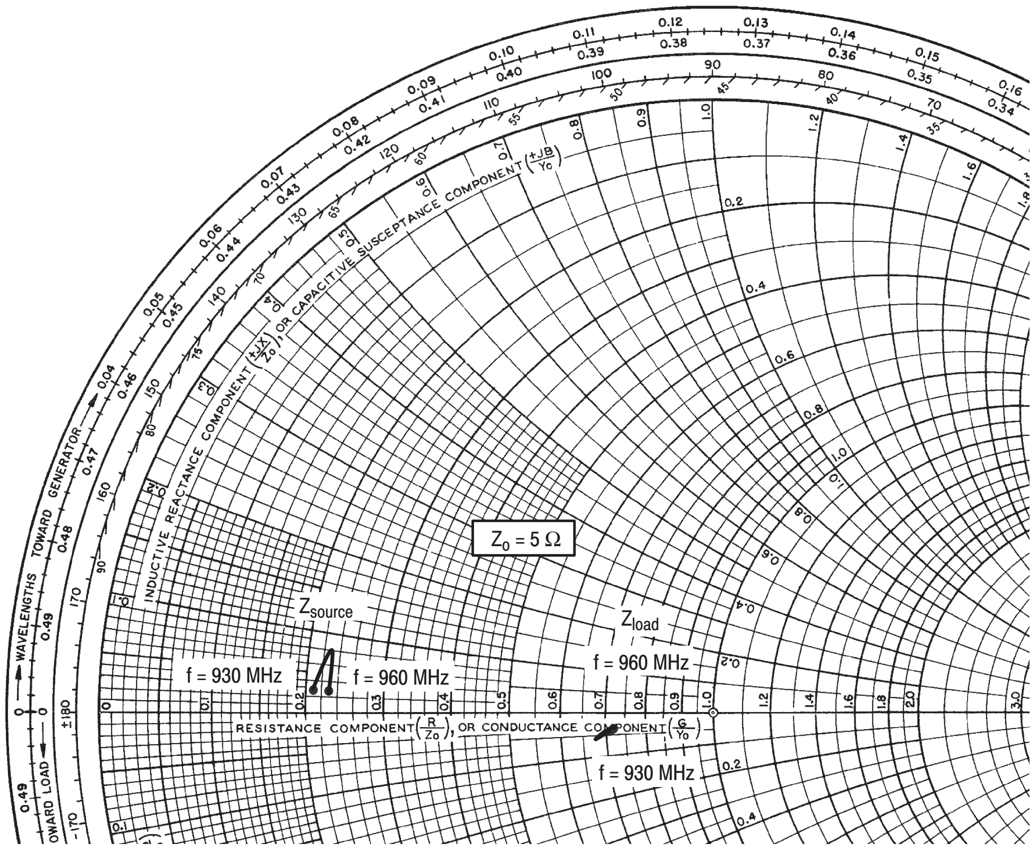



**Figure 9. Power Gain, Efficiency and IMD versus Output Power**




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

| f<br>MHz | $Z_{source}$<br>Ω | $Z_{load}$<br>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.

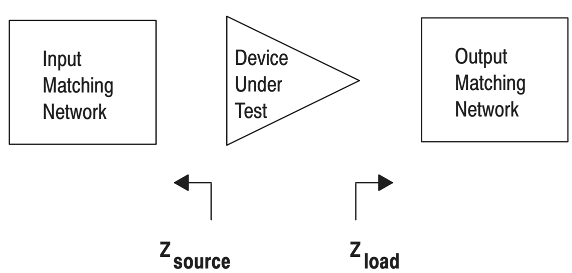
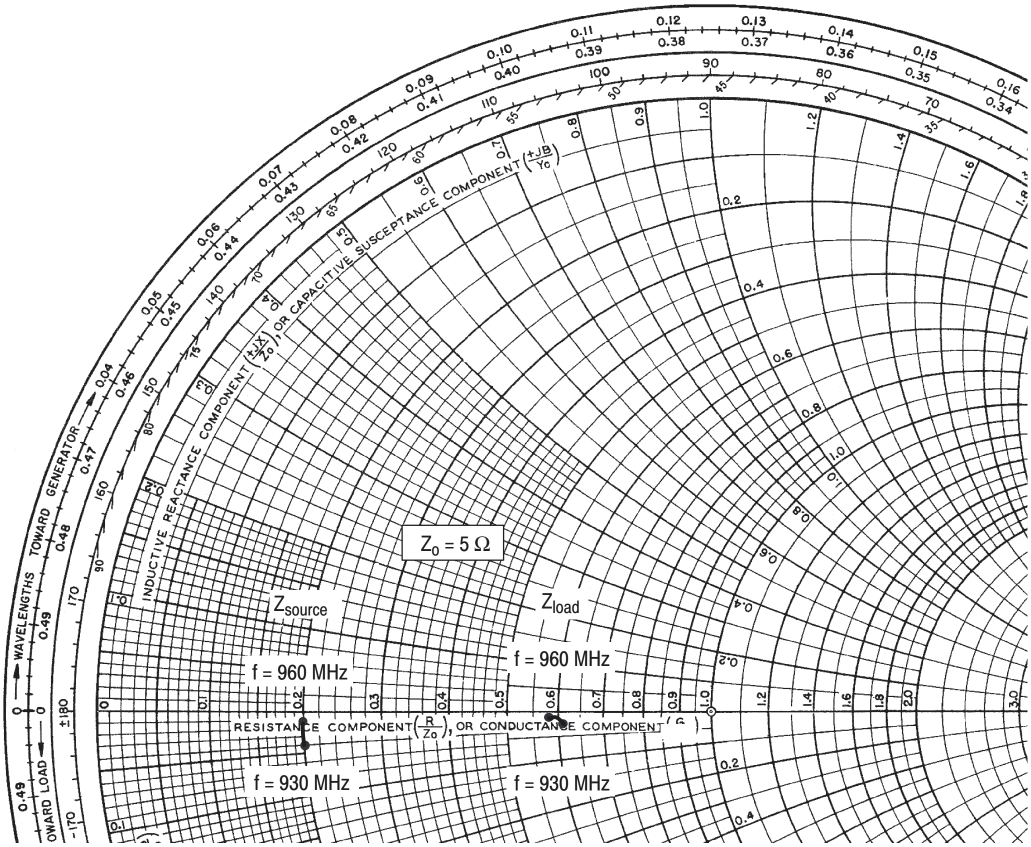



**Figure 10. Series Equivalent Input and Output Impedance (MRF9030MR1)**




$V_{DD}$ = 26 V, $I_{DQ}$ = 250 mA, $P_{out}$ = 30 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.

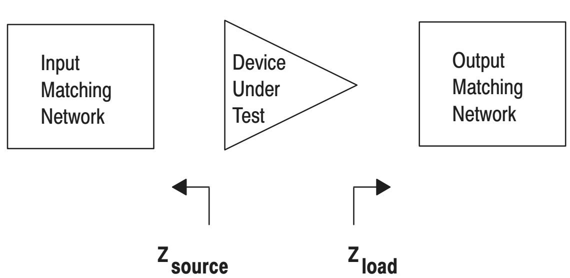
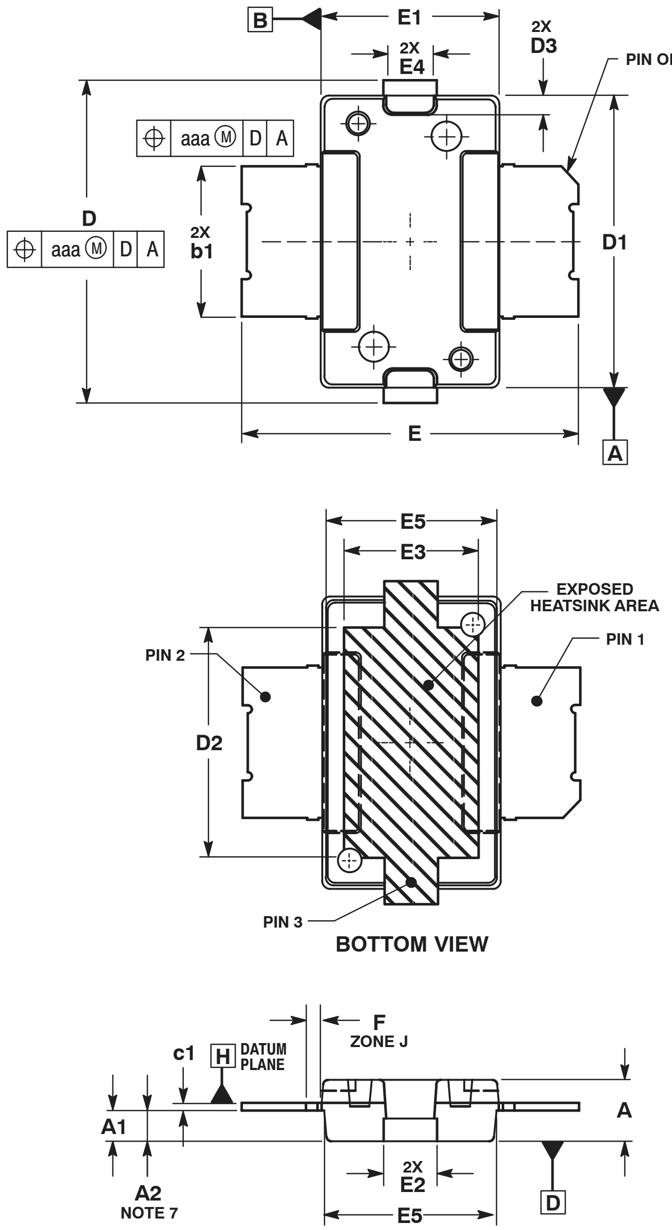



**Figure 11. Series Equivalent Input and Output Impedance (MRF9030MBR1)**

# NOTES

## PACKAGE DIMENSIONS

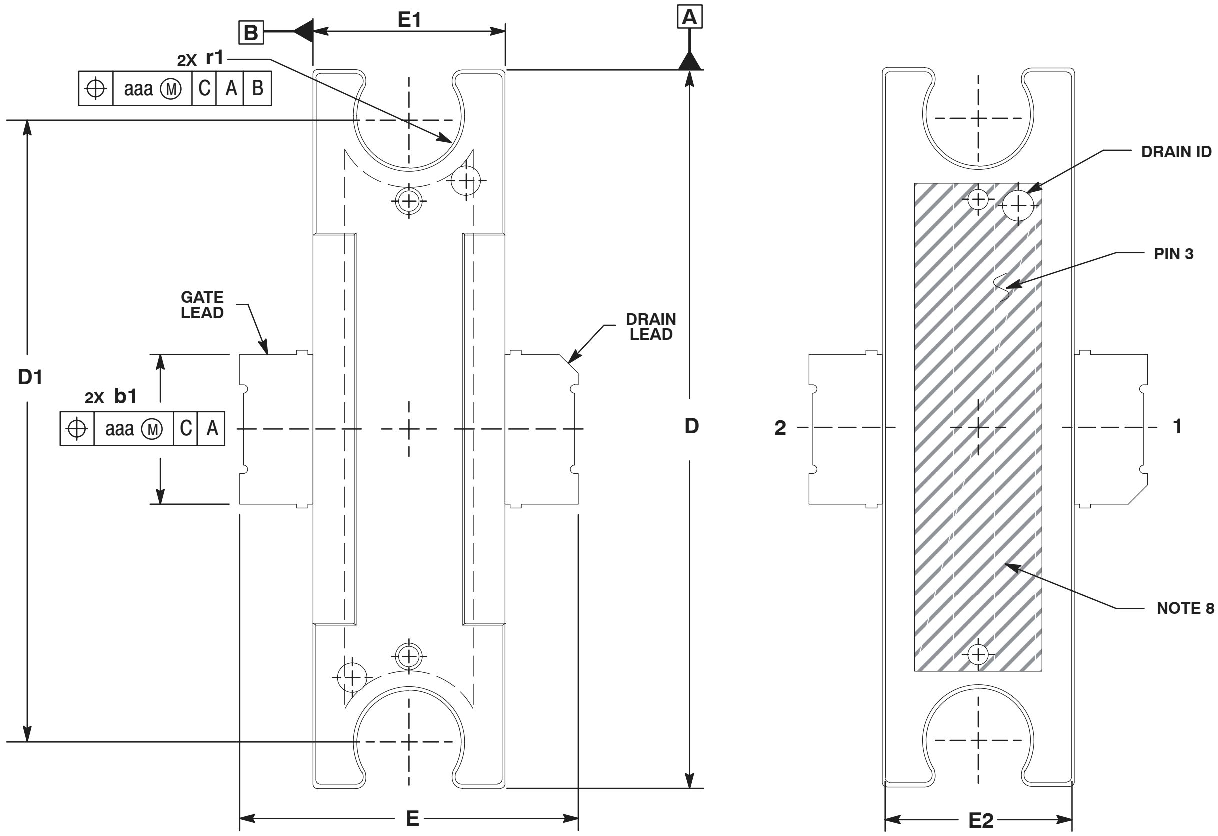



NOTES:
1. CONTROLLING DIMENSION: INCH.
2. INTERPRET DIMENSIONS AND TOLERANCES PER ASME Y14.5M–1994.
3. DATUM PLANE –H– IS LOCATED AT TOP OF LEAD AND IS COINCIDENT WITH THE LEAD WHERE THE LEAD EXITS THE PLASTIC BODY AT THE TOP OF THE PARTING LINE.
4. DIMENSIONS "D1" AND "E1" DO NOT INCLUDE MOLD PROTRUSION.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

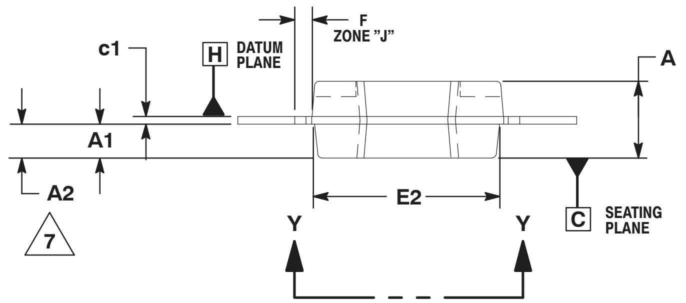
| | INCHES | | MILLIMETERS | |
|---|---|---|---|---|
| DIM | MIN | MAX | MIN | MAX |
| A | .078 | .082 | 1.98 | 2.08 |
| A1 | .039 | .043 | 0.99 | 1.09 |
| A2 | .040 | .042 | 1.02 | 1.07 |
| D | .416 | .424 | 10.57 | 10.77 |
| D1 | .378 | .382 | 9.60 | 9.70 |
| D2 | .290 | .320 | 7.37 | 8.13 |
| D3 | .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:
PIN 1. DRAIN
2. GATE
3. SOURCE

**CASE 1265-08**
**ISSUE G**
**TO-270-2**
**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.
8. CROSSHATCHING REPRESENTS THE EXPOSED AREA OF THE HEAT SLUG.

| | INCHES | | MILLIMETERS | |
|---|---|---|---|---|
| DIM | 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**

**HOW TO REACH US:**

**USA/EUROPE/LOCATIONS NOT LISTED**:
Motorola Literature Distribution
P.O. Box 5405, Denver, Colorado 80217
1-800-521-6274 or 480-768-2130

**JAPAN**: Motorola Japan Ltd.; SPS, Technical Information Center,
3-20-1, Minami-Azabu, Minato-ku, Tokyo 106-8573, Japan
81-3-3440-3569

**ASIA/PACIFIC**: Motorola Semiconductors H.K. Ltd.; Silicon Harbour Centre,
2 Dai King Street, Tai Po Industrial Estate, Tai Po, N.T., Hong Kong
852-26668334

**HOME PAGE**: http://motorola.com/semiconductors