Document Number: MRF284
Rev. 17, 5/2006

# RF Power Field Effect Transistors

## N-Channel Enhancement-Mode Lateral MOSFETs

Designed for PCN and PCS base station applications with frequencies from 1000 to 2600 MHz. Suitable for FM, TDMA, CDMA, and multicarrier amplifier applications. To be used in Class A and Class AB for PCN-PCS/cellular radio and wireless local loop.

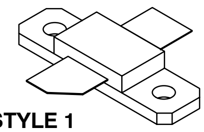
- Specified Two-Tone Performance @ 2000 MHz, 26 Volts
  Output Power = 30 Watts PEP
  Power Gain = 9 dB
  Efficiency = 30%
  Intermodulation Distortion = -29 dBc
- Typical Single-Tone Performance at 2000 MHz, 26 Volts
  Output Power = 30 Watts CW
  Power Gain = 9.5 dB
  Efficiency = 45%
- Capable of Handling 10:1 VSWR, @ 26 Vdc, 2000 MHz, 30 Watts CW Output Power

**Features**

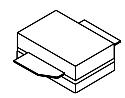
- Excellent Thermal Stability
- Characterized with Series Equivalent Large-Signal Impedance Parameters
- Low Gold Plating Thickness on Leads. L Suffix Indicates 40μ″ Nominal.
- RoHS Compliant
- In Tape and Reel. R1 Suffix = 500 Units per 32 mm, 13 inch Reel.

**MRF284LR1**
**MRF284LSR1**

**2000 MHz, 30 W, 26 V**
**LATERAL N-CHANNEL**
**BROADBAND**
**RF POWER MOSFETs**



**CASE 360B-05, STYLE 1**
**NI-360**
**MRF284LR1**



**CASE 360C-05, STYLE 1**
**NI-360S**
**MRF284LSR1**

**Table 1. Maximum Ratings**

| Rating | Symbol | Value | Unit |
|---|---|---|---|
| Drain-Source Voltage | $V_{DSS}$ | -0.5, +65 | Vdc |
| Gate-Source Voltage | $V_{GS}$ | ±20 | Vdc |
| Total Device Dissipation @ $T_C$ = 25°C<br>Derate above 25°C | $P_D$ | 87.5<br>0.5 | W<br>W/°C |
| Storage Temperature Range | $T_{stg}$ | - 65 to +150 | °C |
| Case Operating Temperature | $T_C$ | 150 | °C |
| Operating Junction Temperature | $T_J$ | 200 | °C |

**Table 2. Thermal Characteristics**

| Characteristic | Symbol | Value | Unit |
|---|---|---|---|
| Thermal Resistance, Junction to Case | $R_{\theta JC}$ | 2.0 | °C/W |

**Table 3. Electrical Characteristics** ($T_C$ = 25°C unless otherwise noted)

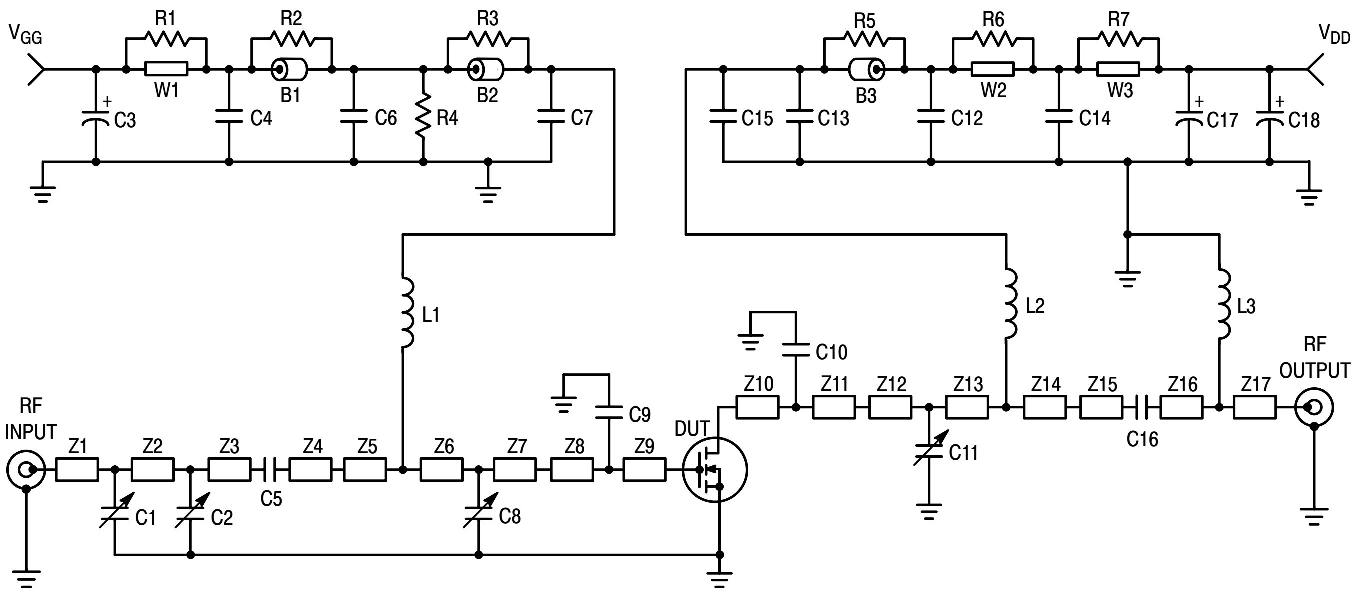
| Characteristic | Symbol | Min | Typ | Max | Unit |
|---|---|---|---|---|---|
| **Off Characteristics** | | | | | |
| Drain-Source Breakdown Voltage<br>($V_{GS}$ = 0, $I_D$ = 10 μAdc) | $V_{(BR)DSS}$ | 65 | — | — | Vdc |
| Zero Gate Voltage Drain Current<br>($V_{DS}$ = 20 Vdc, $V_{GS}$ = 0) | $I_{DSS}$ | — | — | 1.0 | μAdc |
| Gate-Source Leakage Current<br>($V_{GS}$ = 20 Vdc, $V_{DS}$ = 0) | $I_{GSS}$ | — | — | 10 | μAdc |

(continued)

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

**Table 3. Electrical Characteristics** ($T_C$ = 25°C unless otherwise noted) **(continued)**

| Characteristic | Symbol | Min | Typ | Max | Unit |
|---|---|---|---|---|---|
| **On Characteristics** | | | | | |
| Gate Threshold Voltage ($V_{DS}$ = 10 Vdc, $I_D$ = 150 μAdc) | $V_{GS(th)}$ | 2.0 | 3.0 | 4.0 | Vdc |
| Gate Quiescent Voltage ($V_{DS}$ = 26 Vdc, $I_D$ = 200 mAdc) | $V_{GS(q)}$ | 3.0 | 4.0 | 5.0 | Vdc |
| Drain-Source On-Voltage ($V_{GS}$ = 10 Vdc, $I_D$ = 1.0 Adc) | $V_{DS(on)}$ | — | 0.3 | 0.6 | Vdc |
| Forward Transconductance ($V_{DS}$ = 10 Vdc, $I_D$ = 1.0 Adc) | $g_{fs}$ | — | 1.5 | — | S |
| **Dynamic Characteristics** | | | | | |
| Input Capacitance ($V_{DS}$ = 26 Vdc, $V_{GS}$ = 0, f = 1.0 MHz) | $C_{iss}$ | — | 43 | — | pF |
| Output Capacitance ($V_{DS}$ = 26 Vdc, $V_{GS}$ = 0, f = 1.0 MHz) | $C_{oss}$ | — | 23 | — | pF |
| Reverse Transfer Capacitance ($V_{DS}$ = 26 Vdc, $V_{GS}$ = 0, f = 1.0 MHz) | $C_{rss}$ | — | 1.4 | — | pF |
| **Functional Tests** (in Freescale Test Fixture, 50 ohm system) | | | | | |
| Common-Source Power Gain ($V_{DD}$ = 26 Vdc, $P_{out}$ = 30 W, $I_{DQ}$ = 200 mA, f1 = 2000.0 MHz, f2 = 2000.1 MHz) | $G_{ps}$ | 9 | 10.5 | — | dB |
| Drain Efficiency ($V_{DD}$ = 26 Vdc, $P_{out}$ = 30 W, $I_{DQ}$ = 200 mA, f1 = 2000.0 MHz, f2 = 2000.1 MHz) | η | 30 | 35 | — | % |
| Intermodulation Distortion ($V_{DD}$ = 26 Vdc, $P_{out}$ = 30 W, $I_{DQ}$ = 200 mA, f1 = 2000.0 MHz, f2 = 2000.1 MHz) | IMD | — | -32 | -29 | dBc |
| Input Return Loss ($V_{DD}$ = 26 Vdc, $P_{out}$ = 30 W, $I_{DQ}$ = 200 mA, f1 = 2000.0 MHz, f2 = 2000.1 MHz) | IRL | — | -15 | -9 | dB |
| Common-Source Amplifier Power Gain ($V_{DD}$ = 26 Vdc, $P_{out}$ = 30 W PEP, $I_{DQ}$ = 200 mA, f1 = 1930.0 MHz, f2 = 1930.1 MHz) | $G_{ps}$ | 9 | 10.4 | — | dB |
| Drain Efficiency ($V_{DD}$ = 26 Vdc, $P_{out}$ = 30 W PEP, $I_{DQ}$ = 200 mA, f1 = 1930.0 MHz, f2 = 1930.1 MHz) | η | — | 35 | — | % |
| Intermodulation Distortion ($V_{DD}$ = 26 Vdc, $P_{out}$ = 30 W PEP, $I_{DQ}$ = 200 mA, f1 = 1930.0 MHz, f2 = 1930.1 MHz) | IMD | — | -34 | — | dBc |
| Input Return Loss ($V_{DD}$ = 26 Vdc, $P_{out}$ = 30 W PEP, $I_{DQ}$ = 200 mA, f1 = 1930.0 MHz, f2 = 1930.1 MHz) | IRL | — | -15 | -9 | dB |
| Common-Source Amplifier Power Gain ($V_{DD}$ = 26 Vdc, $P_{out}$ = 30 W CW, $I_{DQ}$ = 200 mA, f1 = 2000.0 MHz) | $G_{ps}$ | 8.5 | 9.5 | — | dB |
| Drain Efficiency ($V_{DD}$ = 26 Vdc, $P_{out}$ = 30 W CW, $I_{DQ}$ = 200 mA, f1 = 2000.0 MHz) | η | 35 | 45 | — | % |

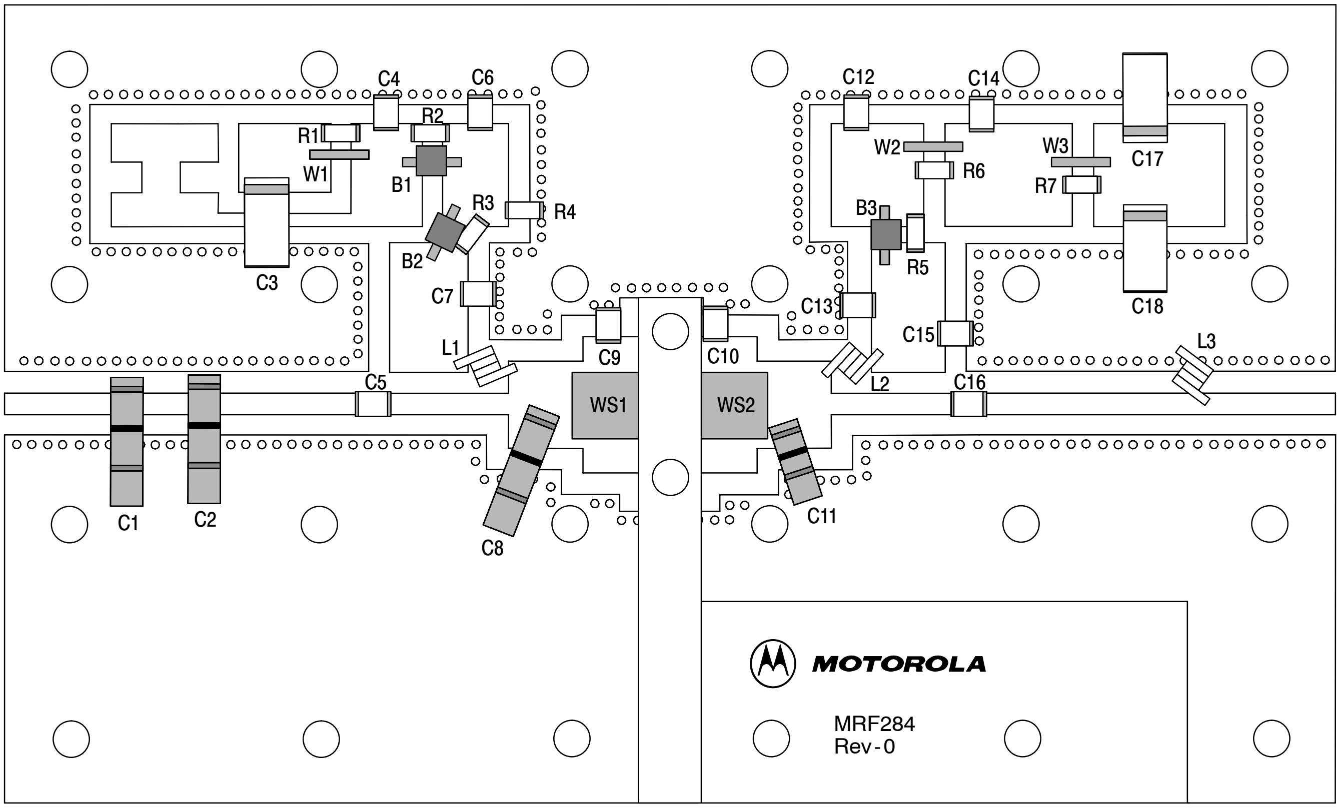



| | | | |
|---|---|---|---|
| Z1 | 0.530″ x 0.080″ Microstrip | Z11 | 0.155″ x 0.515″ Microstrip |
| Z2 | 0.255″ x 0.080″ Microstrip | Z12 | 0.120″ x 0.325″ Microstrip |
| Z3 | 0.600″ x 0.080″ Microstrip | Z13 | 0.150″ x 0.325″ Microstrip |
| Z4 | 0.525″ x 0.080″ Microstrip | Z14 | 0.010″ x 0.325″ Microstrip |
| Z5 | 0.015″ x 0.325″ Microstrip | Z15 | 0.505″ x 0.080″ Microstrip |
| Z6 | 0.085″ x 0.325″ Microstrip | Z16 | 0.865″ x 0.080″ Microstrip |
| Z7 | 0.165″ x 0.325″ Microstrip | Z17 | 0.525″ x 0.080″ Microstrip |
| Z8 | 0.110″ x 0.515″ Microstrip | PCB | Arlon GX0300-55-22, 0.030″, $\varepsilon_r$ = 2.55 |
| Z9 | 0.095″ x 0.515″ Microstrip | | |
| Z10 | 0.050″ x 0.515″ Microstrip | | |

**Figure 1. 1930-2000 MHz Broadband Test Circuit Schematic**

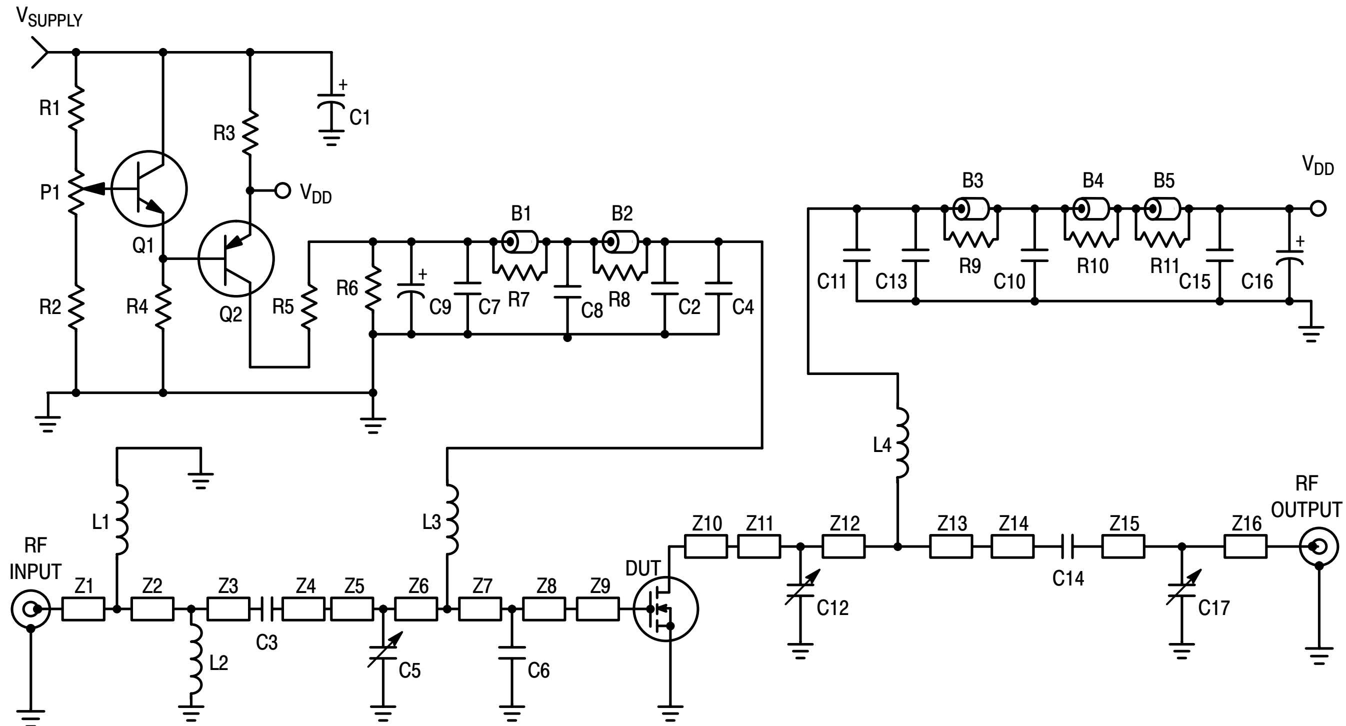
**Table 4. 1930-2000 MHz Broadband Test Circuit Component Designations and Values**

| Designators | Description |
|---|---|
| B1 - B3 | Ferrite Beads, Round, Ferroxcube #56-590-65-3B |
| C1, C2, C8 | 0.8-8.0 pF Gigatrim Variable Capacitors, Johanson #27291SL |
| C3, C17 | 22 μF, 35 V Tantalum Surface Mount Chip Capacitors, Kemet #T491X226K035AS4394 |
| C4, C14 | 0.1 μF Chip Capacitors, Kemet #CDR33BX104AKWS |
| C5 | 220 pF Chip Capacitor, ATC #100B221KP500X |
| C6, C12 | 1000 pF Chip Capacitors, ATC #100B102JCA50X |
| C7, C13 | 5.1 pF Chip Capacitors, ATC #100B5R1CCA500X |
| C9 | 1.2 pF Chip Capacitor, ATC #100B1R2CCA500X |
| C10 | 2.7 pF Chip Capacitor, ATC #100B2R7CCA500X |
| C11 | 0.6-4.5 pF Gigatrim Variable Capacitors, Johanson #27271SL |
| C15, C16 | 200 pF Chip Capacitors, ATC #100B201KP500X |
| C18 | 10 μF, 35 V Tantalum Surface Mount Chip Capacitor, Kemet #T495X106K035AS4394 |
| L1, L2 | 4 Turns, #24 AWG, 0.120″ OD, 0.140″ Long, (12.5 nH), Coilcraft #A04T-5 |
| L3 | 2 Turns, #24 AWG, 0.120″ OD, 0.140″ Long, (5.0 nH), Coilcraft #A02T-5 |
| R1, R2, R3, R5, R6, R7 | 12 Ω, 1/4 W Chip Resistors, 0.08″ x 0.13″, Garrett Instruments #RM73B2B120JT |
| R4 | 560 kΩ, 1/4 W Chip Resistor, 0.08″ x 0.13″ |
| W1, W2, W3 | Solid Copper Buss Wire, 16 AWG |
| WS1, WS2 | Beryllium Copper Wear Blocks 0.005″ x 0.250″ x 0.250″ |




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. 1930-2000 MHz Broadband Test Circuit Component Layout**




| | | | |
|---|---|---|---|
| Z1 | 0.363″ x 0.080″ Microstrip | Z10 | 0.210″ x 0.515″ Microstrip |
| Z2 | 0.080″ x 0.080″ Microstrip | Z11 | 0.235″ x 0.325″ Microstrip |
| Z3 | 0.916″ x 0.080″ Microstrip | Z12 | 0.02″ x 0.325″ Microstrip |
| Z4 | 0.517″ x 0.080″ Microstrip | Z13 | 0.02″ x 0.325″ Microstrip |
| Z5 | 0.050″ x 0.325″ Microstrip | Z14 | 0.510″ x 0.080″ Microstrip |
| Z6 | 0.050″ x 0.325″ Microstrip | Z15 | 0.990″ x 0.080″ Microstrip |
| Z7 | 0.071″ x 0.325″ Microstrip | Z16 | 0.390″ x 0.080″ Microstrip |
| Z8 | 0.125″ x 0.325″ Microstrip | PCB | Arlon GX0300-55-22, 0.030″, |
| Z9 | 0.210″ x 0.515″ Microstrip | | $\varepsilon_r$ = 2.55 |

**Figure 3. 2000 MHz Class A Test Circuit Schematic**

**Table 5. 2000 MHz Class A Test Circuit Component Designations and Values**

| Designators | Description |
|---|---|
| B1 - B5 | Ferrite Beads, Round, Ferroxcube # 56-590-65-3B |
| C1, C9, C16 | 100 μF, 50 V Electrolytic Capacitors, Mallory #SME50VB101M12X25L |
| C2, C13 | 51 pF Chip Capacitors, ATC #100B510JCA500x |
| C3, C14 | 10 pF Chip Capacitors, ATC #100B100JCA500X |
| C4, C11 | 12 pF Chip Capacitors, ATC #100B120JCA500X |
| C5 | 0.8 - 8.0 pF Variable Capacitor, Johansen Gigatrim #27291SL |
| C6 | 4.7 pF Chip Capacitor, ATC #100B4R7CCA500X |
| C7, C15 | 91 pF Chip Capacitors, ATC #100B910KP500X |
| C8 | 1000 pF Chip Capacitor, ATC #100B102JCA50X |
| C10 | 0.1 μF Chip Capacitor, Kemet #CDR33BX104AKWS |
| C12, C17 | 0.6 - 4.5 pF Variable Capacitors, Johansen Gigatrim #27271SL |
| L1 | 4 Turns, #27 AWG, 0.087″ OD, 0.050″ ID, 0.069″ Long, 10 nH |
| L2 | 5 Turns, #24 AWG, 0.083″ OD, 0.040″ ID, 0.128″ Long, 12.5 nH |
| L3, L4 | 9 Turns, #26 AWG, 0.080″ OD, 0.046″ ID, 0.170″ Long, 30.8 nH |
| P1 | 1000 Ω Potentiometer, 1/2 W, 10 Turns, Bourns |
| Q1 | Transistor, NPN, #MJD31, Case 369A-10 |
| Q2 | Transistor, PNP, #MJD32, Case 369A-10 |
| R1 | 360 Ω, Fixed Film Chip Resistor, 0.08″ x 0.13″, Garrett Instruments #RM73B2B361JT |
| R2 | 2 x 12 kΩ, Fixed Film Chip Resistor, 0.08″ x 0.13″, Garrett Instruments #RM73B2B122JT |
| R3 | 1 Ω, Wirewound, 5 W, 3% Resistor, Dale # RE60G1R00 |
| R4 | 4 x 6.8 kΩ, Fixed Film Chip Resistor, 0.08″ x 0.13″, Garrett Instruments #RM73B2B682JT |
| R5 | 2 x 1500 Ω, Fixed Film Chip Resistor, 0.08″ x 0.13″, Garrett Instruments #RM73B2B152JT |
| R6 | 270 Ω, Fixed Film Chip Resistor, 0.08″ x 0.13″, Garrett Instruments #RM73B2B271JT |
| R7 - R11 | 12 Ω, Fixed Film Chip Resistors, 0.08″ x 0.13″, Garrett Instruments #RM73B2B120JT |

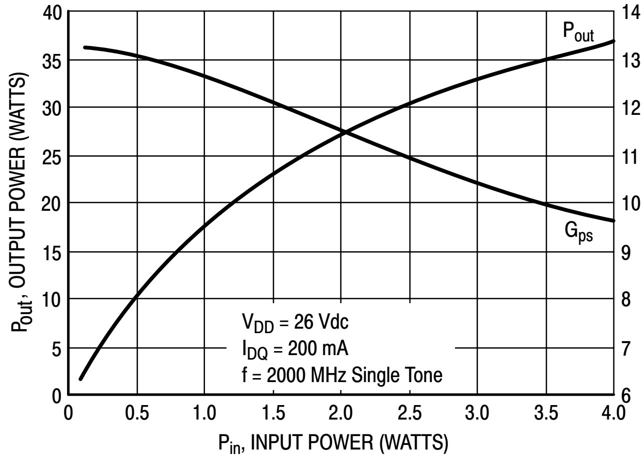



**Figure 4. Output Power & Power Gain versus Input Power**

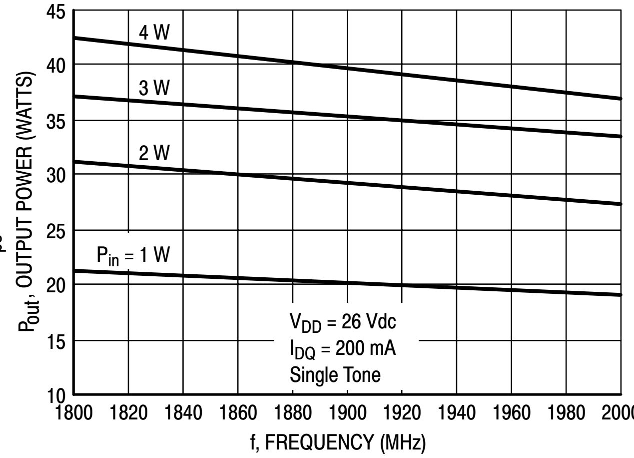



**Figure 5. Output Power versus Frequency**

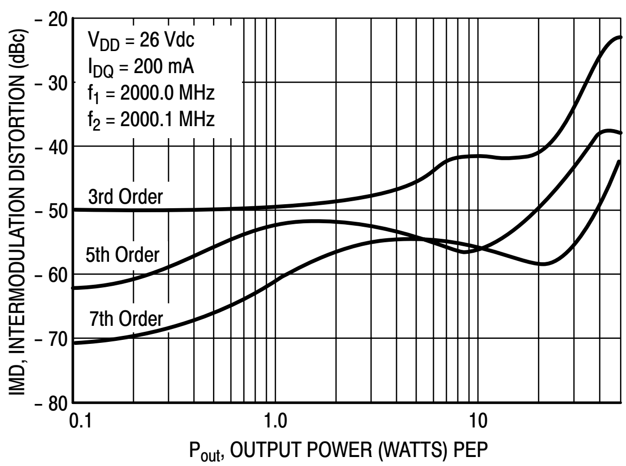



**Figure 6. Intermodulation Distortion Products versus Output Power**

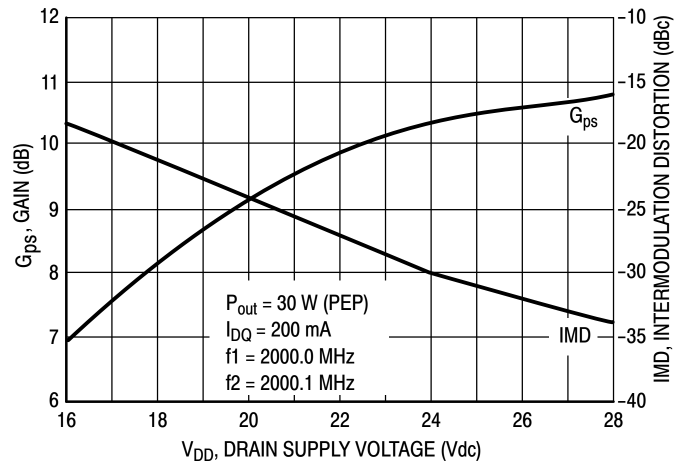



**Figure 7. Power Gain and Intermodulation Distortion versus Supply Voltage**

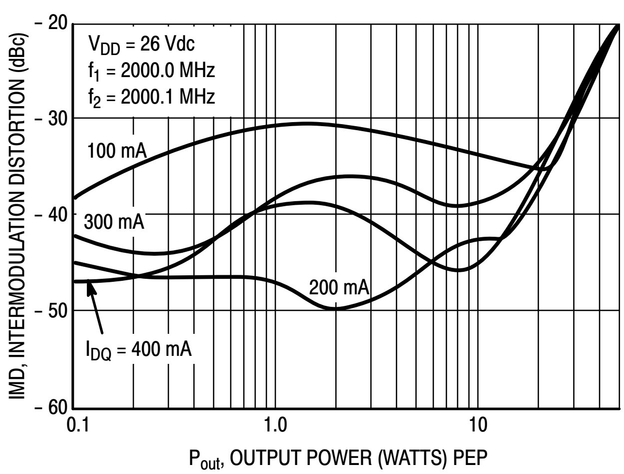



**Figure 8. Intermodulation Distortion versus Output Power**

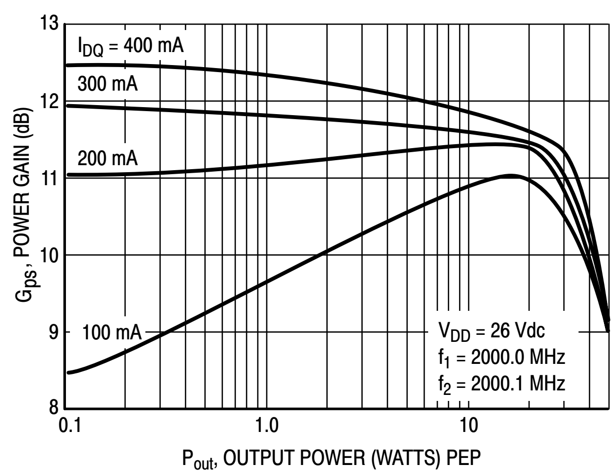



**Figure 9. Power Gain versus Output Power**

## TYPICAL CHARACTERISTICS

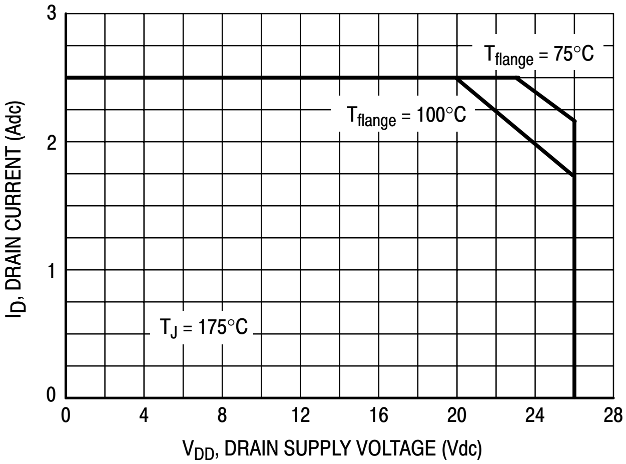



**Figure 10. DC Safe Operating Area**

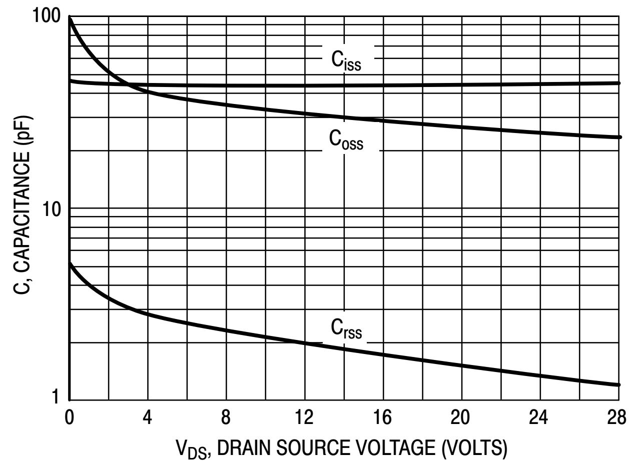



**Figure 11. Capacitance versus Drain Source Voltage**

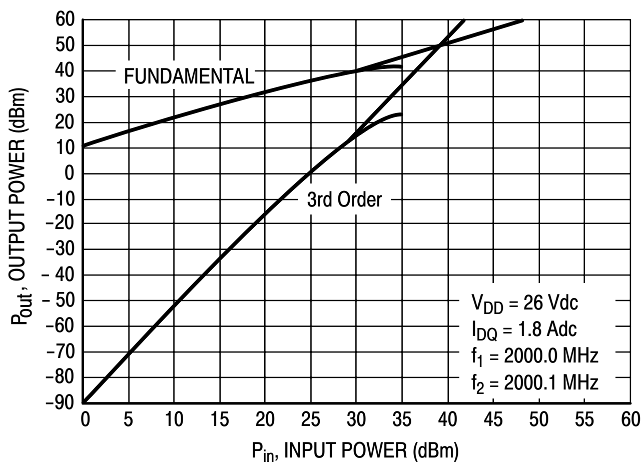



**Figure 12. Class A Third Order Intercept Point**

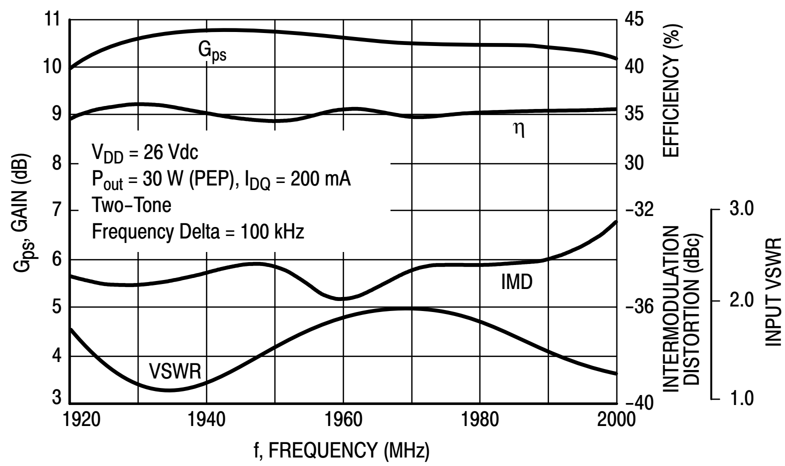
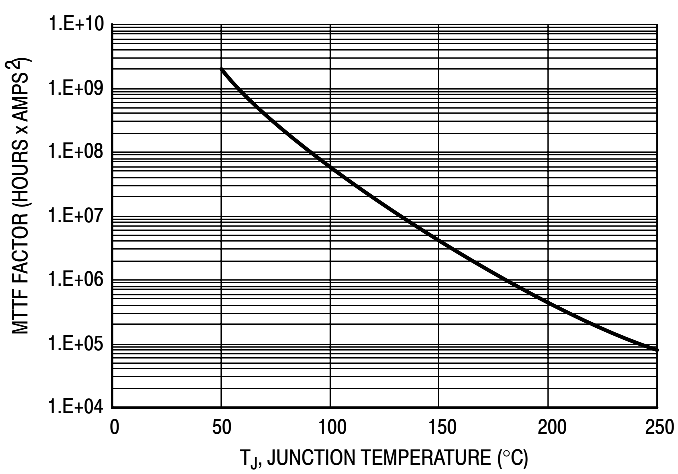
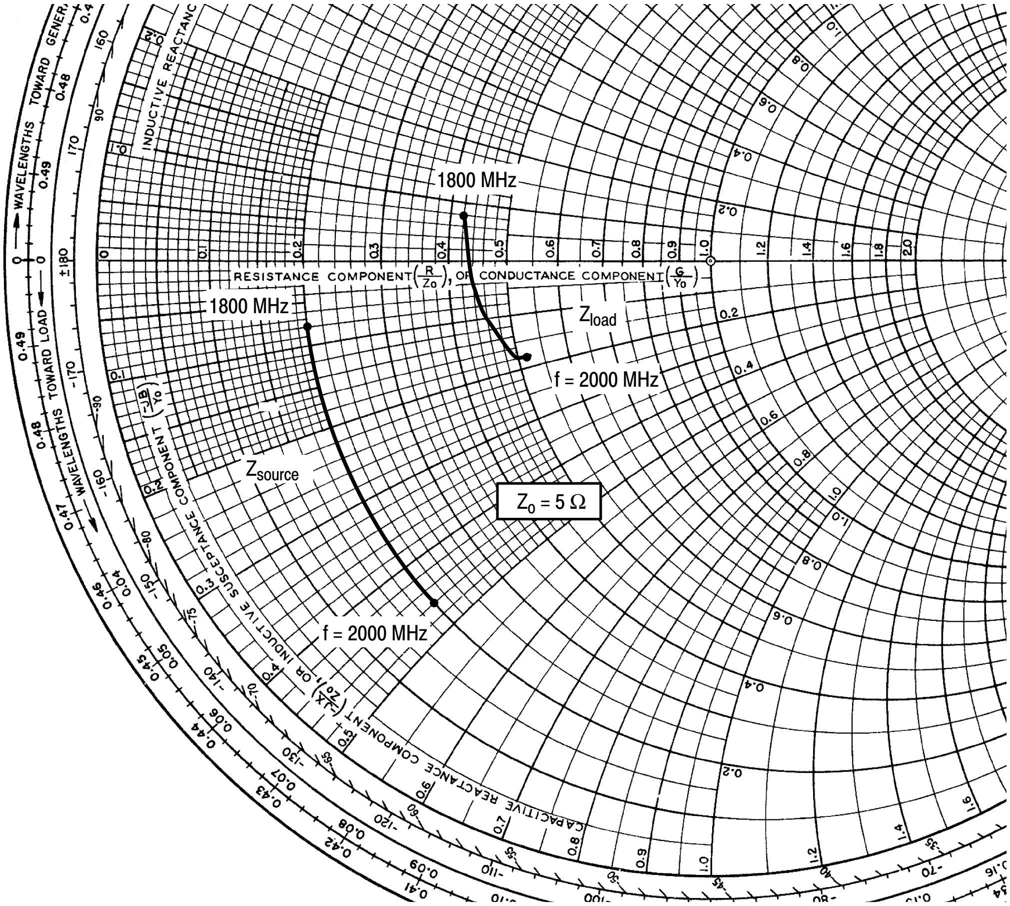



**Figure 13. 1920-2000 MHz Broadband Circuit Performance**




This graph displays calculated MTTF in hours x ampere$^2$ drain current. Life tests at elevated temperature have correlated to better than ±10% of the theoretical prediction for metal failure. Divide MTTF factor by $I_D^2$ for MTTF in a particular application.

**Figure 14. MTTF Factor versus Junction Temperature**




$V_{CC}$ = 26 V, $I_{DQ}$ = 200 mA, $P_{out}$ = 15 W Avg.

| f MHz | $Z_{source}$ Ω | $Z_{load}$ Ω |
|---|---|---|
| 1800 | 1.0 - j0.4 | 2.1 + j0.4 |
| 1860 | 1.0 - j0.8 | 2.2 - j0.2 |
| 1900 | 1.0 - j1.1 | 2.3 - j0.5 |
| 1960 | 1.0 - j1.4 | 2.5 - j0.9 |
| 2000 | 1.0 - j2.3 | 2.6 - j0.92 |

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

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

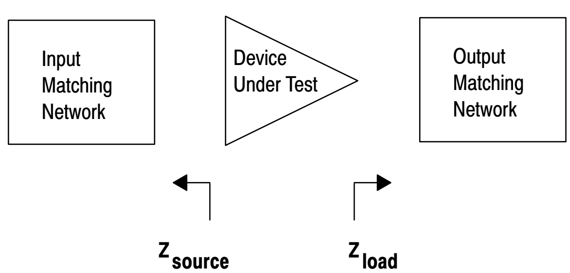
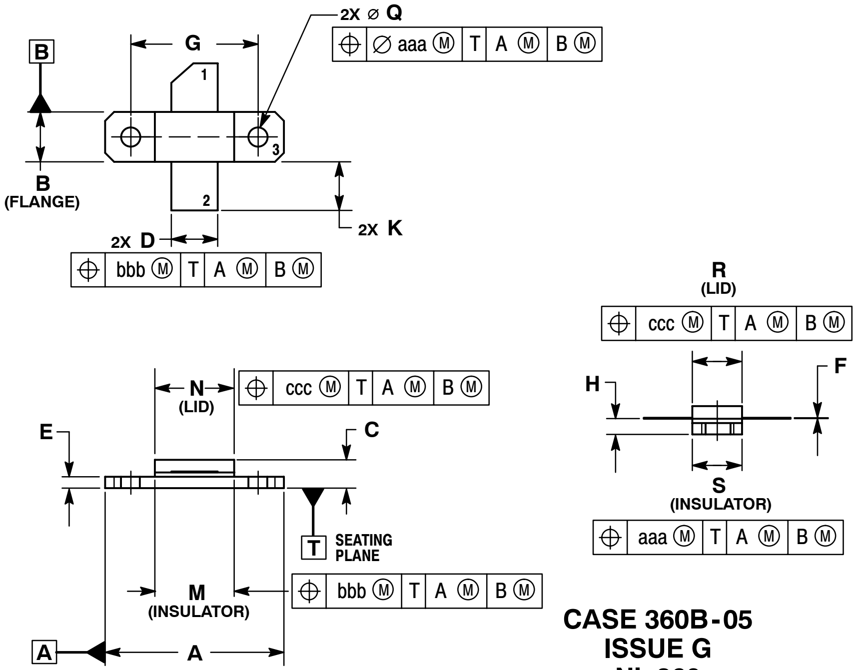



**Figure 15. Series Equivalent Source and Load Impedence**

# NOTES

# PACKAGE DIMENSIONS




NOTES:
1. INTERPRET DIMENSIONS AND TOLERANCES PER ASME Y14.5M-1994.
2. CONTROLLING DIMENSION: INCH.
3. DIMENSION H IS MEASURED 0.030 (0.762) AWAY FROM PACKAGE BODY.

| | INCHES | | MILLIMETERS | |
|---|---|---|---|---|
| DIM | MIN | MAX | MIN | MAX |
| A | 0.795 | 0.805 | 20.19 | 20.45 |
| B | 0.225 | 0.235 | 5.72 | 5.97 |
| C | 0.125 | 0.175 | 3.18 | 4.45 |
| D | 0.210 | 0.220 | 5.33 | 5.59 |
| E | 0.055 | 0.065 | 1.40 | 1.65 |
| F | 0.004 | 0.006 | 0.10 | 0.15 |
| G | 0.562 BSC | | 14.28 BSC | |
| H | 0.077 | 0.087 | 1.96 | 2.21 |
| K | 0.220 | 0.250 | 5.59 | 6.35 |
| M | 0.355 | 0.365 | 9.02 | 9.27 |
| N | 0.357 | 0.363 | 9.07 | 9.22 |
| Q | 0.125 | 0.135 | 3.18 | 3.43 |
| R | 0.227 | 0.233 | 5.77 | 5.92 |
| S | 0.225 | 0.235 | 5.72 | 5.97 |
| aaa | 0.005 REF | | 0.13 REF | |
| bbb | 0.010 REF | | 0.25 REF | |
| ccc | 0.015 REF | | 0.38 REF | |

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

**CASE 360B-05**
**ISSUE G**
**NI-360**
**MRF284LR1**

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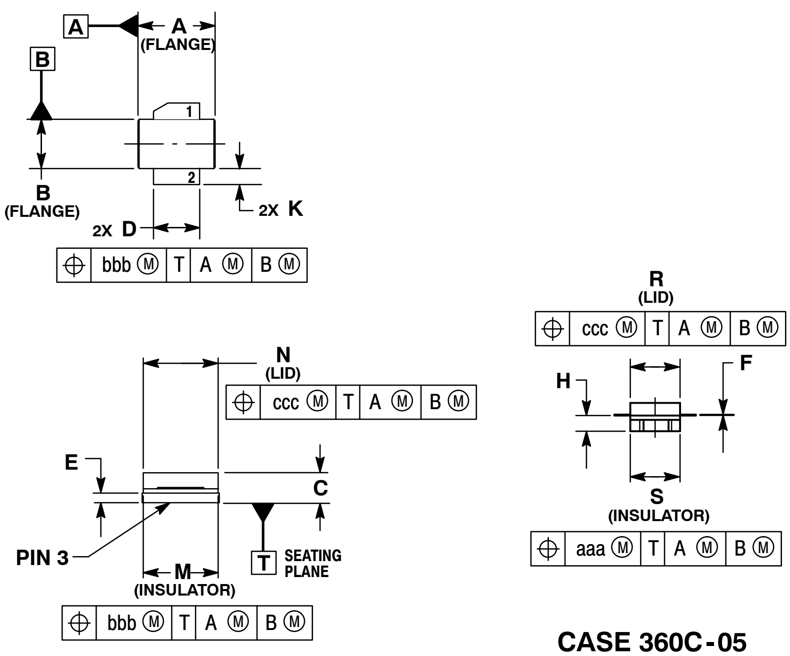


NOTES:
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2. CONTROLLING DIMENSION: INCH.
3. DIMENSION H IS MEASURED 0.030 (0.762) AWAY FROM PACKAGE BODY.

| | INCHES | | MILLIMETERS | |
|---|---|---|---|---|
| DIM | MIN | MAX | MIN | MAX |
| A | 0.375 | 0.385 | 9.53 | 9.78 |
| B | 0.225 | 0.235 | 5.72 | 5.97 |
| C | 0.105 | 0.155 | 2.67 | 3.94 |
| D | 0.210 | 0.220 | 5.33 | 5.59 |
| E | 0.035 | 0.045 | 0.89 | 1.14 |
| F | 0.004 | 0.006 | 0.10 | 0.15 |
| H | 0.057 | 0.067 | 1.45 | 1.70 |
| K | 0.085 | 0.115 | 2.16 | 2.92 |
| M | 0.355 | 0.365 | 9.02 | 9.27 |
| N | 0.357 | 0.363 | 9.07 | 9.22 |
| R | 0.227 | 0.23 | 5.77 | 5.92 |
| S | 0.225 | 0.235 | 5.72 | 5.97 |
| aaa | 0.005 REF | | 0.13 REF | |
| bbb | 0.010 REF | | 0.25 REF | |
| ccc | 0.015 REF | | 0.38 REF | |

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

**CASE 360C-05**
**ISSUE E**
**NI-360S**
**MRF284LSR1**

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support@freescale.com

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Freescale Semiconductor
Technical Information Center, CH370
1300 N. Alma School Road
Chandler, Arizona 85224
+1-800-521-6274 or +1-480-768-2130
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**Europe, Middle East, and Africa:**
Freescale Halbleiter Deutschland GmbH
Technical Information Center
Schatzbogen 7
81829 Muenchen, Germany
+44 1296 380 456 (English)
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**Japan:**
Freescale Semiconductor Japan Ltd.
Headquarters
ARCO Tower 15F
1-8-1, Shimo-Meguro, Meguro-ku,
Tokyo 153-0064
Japan
0120 191014 or +81 3 5437 9125
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**Asia/Pacific:**
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2 Dai King Street
Tai Po Industrial Estate
Tai Po, N.T., Hong Kong
+800 2666 8080
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Document Number: MRF284
Rev. 17, 5/2006