

# RF Power Field Effect Transistor

## N-Channel Enhancement-Mode Lateral MOSFET

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.

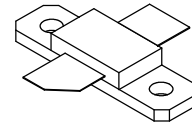
- Specified Two-Tone Performance @ 2000 MHz, 26 Volts  
Output Power = 30 Watts PEP  
Power Gain = 9 dB  
Efficiency = 30%  
Intermodulation Distortion = -29 dBc
- Typical Single-Tone Performance at 2000 MHz, 26 Volts  
Output Power = 30 Watts CW  
Power Gain = 9.5 dB  
Efficiency = 45%
- Capable of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

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



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

**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 @ $T_C = 25^\circ\text{C}$<br>Derate above $25^\circ\text{C}$ | $P_D$     | 87.5<br>0.5 | W<br>W/ $^\circ\text{C}$ |
| Storage Temperature Range                                                              | $T_{stg}$ | -65 to +150 | $^\circ\text{C}$         |
| Case Operating Temperature                                                             | $T_C$     | 150         | $^\circ\text{C}$         |
| Operating Junction Temperature                                                         | $T_J$     | 200         | $^\circ\text{C}$         |

**Table 2. Thermal Characteristics**

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

**Table 3. Electrical Characteristics** ( $T_C = 25^\circ\text{C}$  unless otherwise noted)

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

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

| Characteristic                                                                                                                                                             | Symbol       | Min | Typ  | Max | Unit |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|-----|------|-----|------|
| <b>On Characteristics</b>                                                                                                                                                  |              |     |      |     |      |
| Gate Threshold Voltage<br>( $V_{DS} = 10\text{ Vdc}$ , $I_D = 150\text{ }\mu\text{Adc}$ )                                                                                  | $V_{GS(th)}$ | 2.0 | 3.0  | 4.0 | Vdc  |
| Gate Quiescent Voltage<br>( $V_{DS} = 26\text{ Vdc}$ , $I_D = 200\text{ mAdc}$ )                                                                                           | $V_{GS(q)}$  | 3.0 | 4.0  | 5.0 | Vdc  |
| Drain-Source On-Voltage<br>( $V_{GS} = 10\text{ Vdc}$ , $I_D = 1.0\text{ Adc}$ )                                                                                           | $V_{DS(on)}$ | —   | 0.3  | 0.6 | Vdc  |
| Forward Transconductance<br>( $V_{DS} = 10\text{ Vdc}$ , $I_D = 1.0\text{ Adc}$ )                                                                                          | $g_{fs}$     | —   | 1.5  | —   | S    |
| <b>Dynamic Characteristics</b>                                                                                                                                             |              |     |      |     |      |
| Input Capacitance<br>( $V_{DS} = 26\text{ Vdc}$ , $V_{GS} = 0$ , $f = 1.0\text{ MHz}$ )                                                                                    | $C_{iss}$    | —   | 43   | —   | pF   |
| Output Capacitance<br>( $V_{DS} = 26\text{ Vdc}$ , $V_{GS} = 0$ , $f = 1.0\text{ MHz}$ )                                                                                   | $C_{oss}$    | —   | 23   | —   | pF   |
| Reverse Transfer Capacitance<br>( $V_{DS} = 26\text{ Vdc}$ , $V_{GS} = 0$ , $f = 1.0\text{ MHz}$ )                                                                         | $C_{rss}$    | —   | 1.4  | —   | pF   |
| <b>Functional Tests</b> (in Freescale Test Fixture, 50 ohm system)                                                                                                         |              |     |      |     |      |
| Common-Source Power Gain<br>( $V_{DD} = 26\text{ Vdc}$ , $P_{out} = 30\text{ W}$ , $I_{DQ} = 200\text{ mA}$ ,<br>$f_1 = 2000.0\text{ MHz}$ , $f_2 = 2000.1\text{ MHz}$ )   | $G_{ps}$     | 9   | 10.5 | —   | dB   |
| Drain Efficiency<br>( $V_{DD} = 26\text{ Vdc}$ , $P_{out} = 30\text{ W}$ , $I_{DQ} = 200\text{ mA}$ ,<br>$f_1 = 2000.0\text{ MHz}$ , $f_2 = 2000.1\text{ MHz}$ )           | $\eta$       | 30  | 35   | —   | %    |
| Intermodulation Distortion<br>( $V_{DD} = 26\text{ Vdc}$ , $P_{out} = 30\text{ W}$ , $I_{DQ} = 200\text{ mA}$ ,<br>$f_1 = 2000.0\text{ MHz}$ , $f_2 = 2000.1\text{ MHz}$ ) | IMD          | —   | -32  | -29 | dBc  |
| Input Return Loss<br>( $V_{DD} = 26\text{ Vdc}$ , $P_{out} = 30\text{ W}$ , $I_{DQ} = 200\text{ mA}$ ,<br>$f_1 = 2000.0\text{ MHz}$ , $f_2 = 2000.1\text{ MHz}$ )          | IRL          | —   | -15  | -9  | dB   |
| Common-Source Amplifier Power Gain<br>( $V_{DD} = 26\text{ Vdc}$ , $P_{out} = 30\text{ W CW}$ , $I_{DQ} = 200\text{ mA}$ ,<br>$f_1 = 2000.0\text{ MHz}$ )                  | $G_{ps}$     | 8.5 | 9.5  | —   | dB   |
| Drain Efficiency<br>( $V_{DD} = 26\text{ Vdc}$ , $P_{out} = 30\text{ W CW}$ , $I_{DQ} = 200\text{ mA}$ ,<br>$f_1 = 2000.0\text{ MHz}$ )                                    | $\eta$       | 35  | 45   | —   | %    |

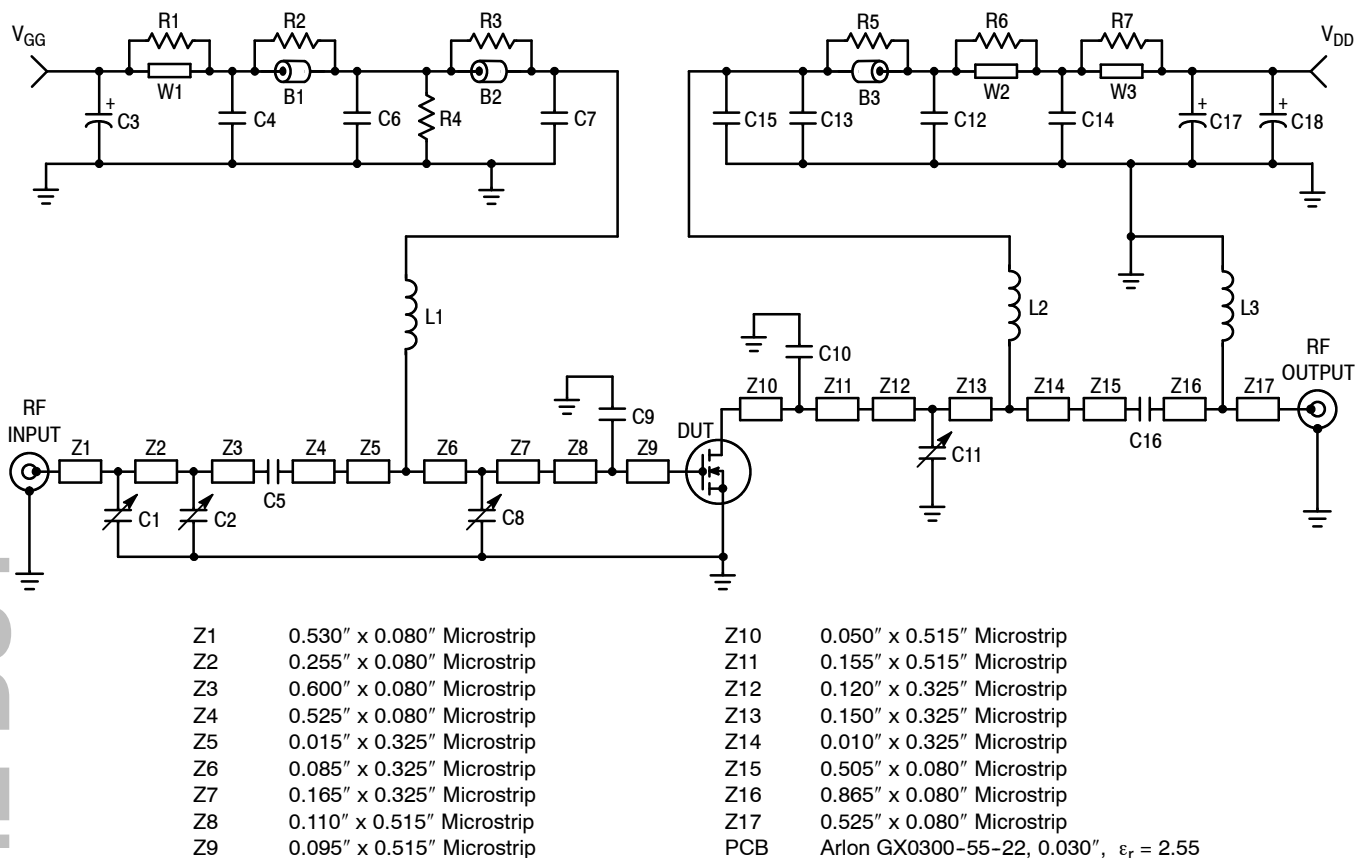
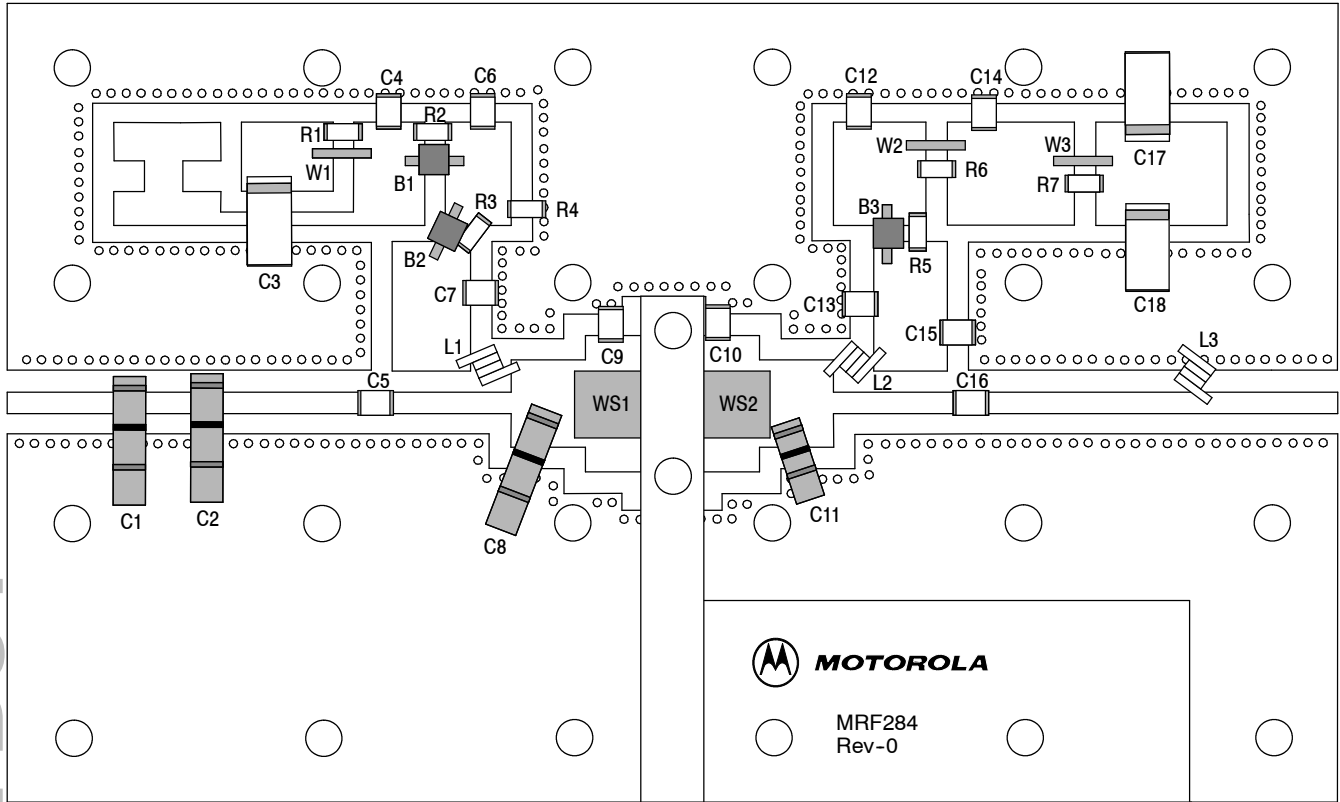


Figure 1. 1930-2000 MHz Broadband Test Circuit Schematic

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 $\mu$ F, 35 V Tantalum Surface Mount Chip Capacitors, Kemet #T491X226K035AT |
| C4, C14                | 0.1 $\mu$ F Chip Capacitors, Kemet #CDR33BX104AKYS                             |
| C5                     | 220 pF Chip Capacitor, ATC #100B221KT500XT                                     |
| C6, C12                | 1000 pF Chip Capacitors, ATC #100B102JT50XT                                    |
| C7, C13                | 5.1 pF Chip Capacitors, ATC #100B5R1CT500XT                                    |
| C9                     | 1.2 pF Chip Capacitor, ATC #100B1R2CT500XT                                     |
| C10                    | 2.7 pF Chip Capacitor, ATC #100B2R7CT500XT                                     |
| C11                    | 0.6-4.5 pF Gigatrim Variable Capacitors, Johanson #27271SL                     |
| C15, C16               | 200 pF Chip Capacitors, ATC #100B201KT500XT                                    |
| C18                    | 10 $\mu$ F, 35 V Tantalum Surface Mount Chip Capacitor, Kemet #T495X106K035AT  |
| 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 $\Omega$ , 1/4 W Chip Resistors, 0.08" x 0.13", Vishay #CRCW120612R0FKEA    |
| R4                     | 560 k $\Omega$ , 1/4 W Chip Resistor, 0.08" x 0.13", Vishay #CRCW12065600FKEA  |



Freescall has begun the transition of marking Printed Circuit Boards (PCBs) with the Freescall Semiconductor signature/logo. PCBs may have either Motorola or Freescall 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**

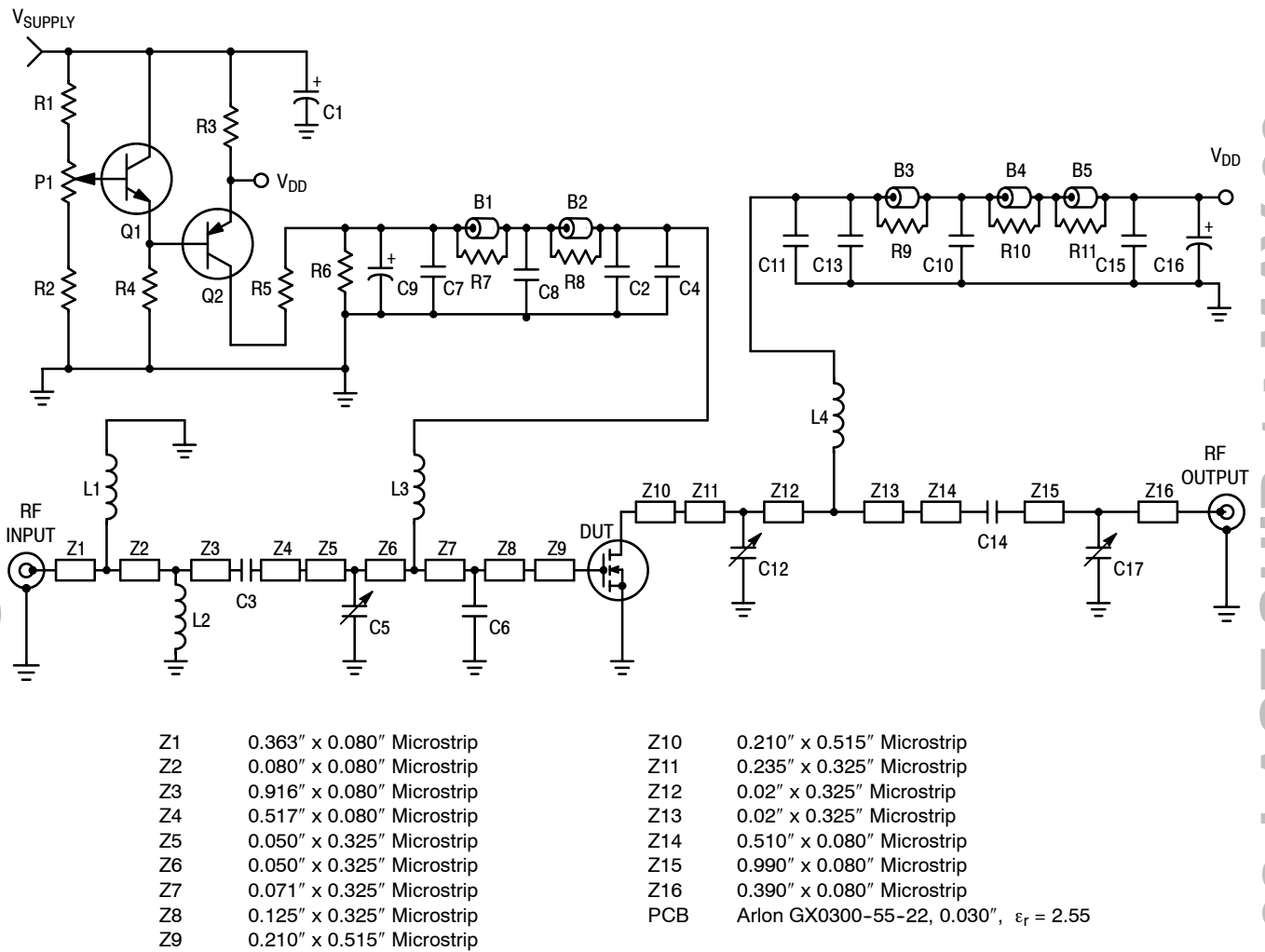


Figure 3. 2000 MHz Class A Test Circuit Schematic

**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 $\mu$ F, 50 V Electrolytic Capacitors, Multicomp #MCHT101M1HB-1017-RH     |
| C2, C13     | 51 pF Chip Capacitors, ATC #100B510JT500XT                                    |
| C3, C14     | 10 pF Chip Capacitors, ATC #100B100JT500XT                                    |
| C4, C11     | 12 pF Chip Capacitors, ATC #100B120JT500XT                                    |
| C5          | 0.8 - 8.0 pF Variable Capacitor, Johansen Gigatrim #27291SL                   |
| C6          | 4.7 pF Chip Capacitor, ATC #100B4R7CT500XT                                    |
| C7, C15     | 91 pF Chip Capacitors, ATC #100B910KT500XT                                    |
| C8          | 1000 pF Chip Capacitor, ATC #100B102JT50XT                                    |
| C10         | 0.1 $\mu$ F Chip Capacitor, Kemet #CDR33BX104AKYS                             |
| 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 $\Omega$ Potentiometer, 1/2 W, 10 Turns, Bourns #3224W                   |
| Q1          | Transistor, NPN, #MJD31, Case 369A-10, On Semi #MJD31T4G                      |
| Q2          | Transistor, PNP, #MJD32, Case 369A-10, On Semi #MJD32T4G                      |
| R1          | 360 $\Omega$ , 1/4 W Fixed Film Chip Resistor, Vishay #CRCW12063600FKEA       |
| R2          | 2 x 12 k $\Omega$ , 1/4 W Fixed Film Chip Resistor, Vishay #CRCW120612R0FKEA  |
| R3          | 1 $\Omega$ , Wirewound, 5 W, 3% Resistor, Dale # RE60G1R00C02                 |
| R4          | 4 x 6.8 k $\Omega$ , 1/4 W Fixed Film Chip Resistor, Vishay #CRCW12066801FKEA |
| R5          | 2 x 1500 $\Omega$ , 1/4 W Fixed Film Chip Resistor, Vishay #CRCW12061501FKEA  |
| R6          | 270 $\Omega$ , 1/4 W Fixed Film Chip Resistor, Vishay #CRCW12062700FKEA       |
| R7 - R11    | 12 $\Omega$ , 1/4 W Fixed Film Chip Resistors, Vishay #CRCW120612R0FKEA       |

## TYPICAL CHARACTERISTICS

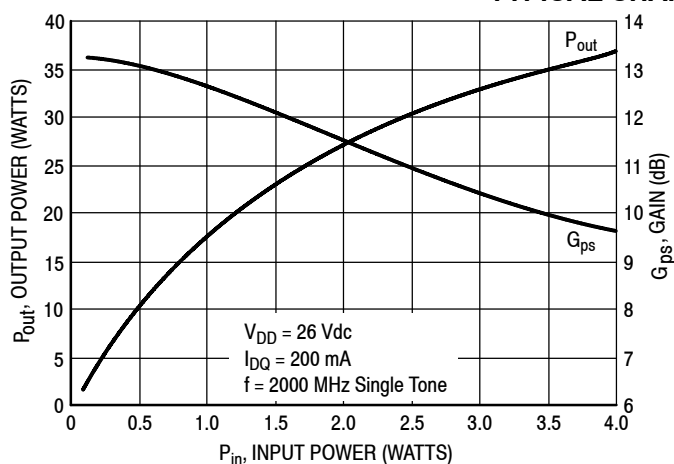


Figure 4. Output Power &amp; Power Gain versus Input Power

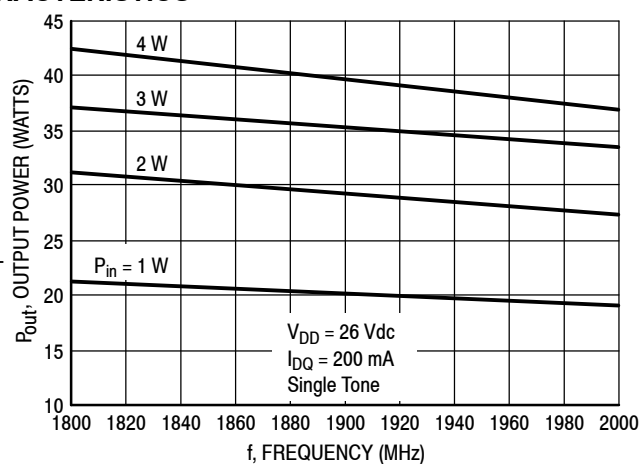


Figure 5. Output Power versus Frequency

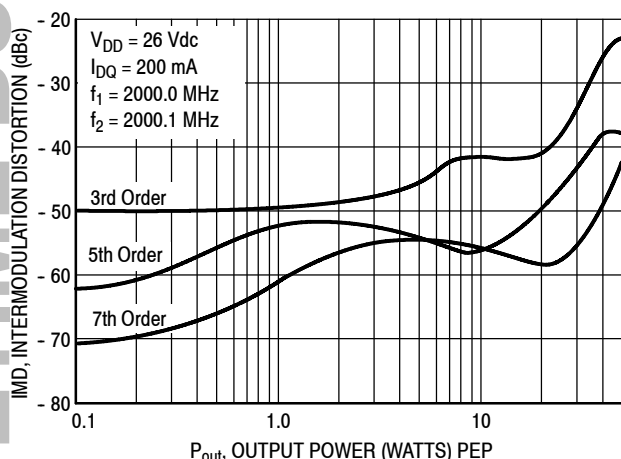


Figure 6. Intermodulation Distortion Products versus Output Power

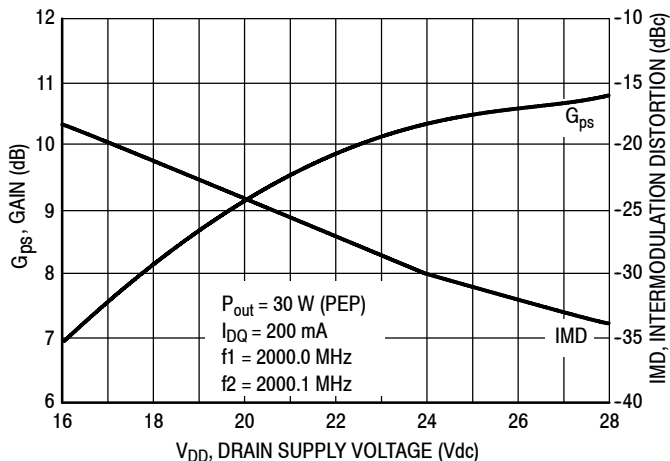


Figure 7. Power Gain and Intermodulation Distortion versus Supply Voltage

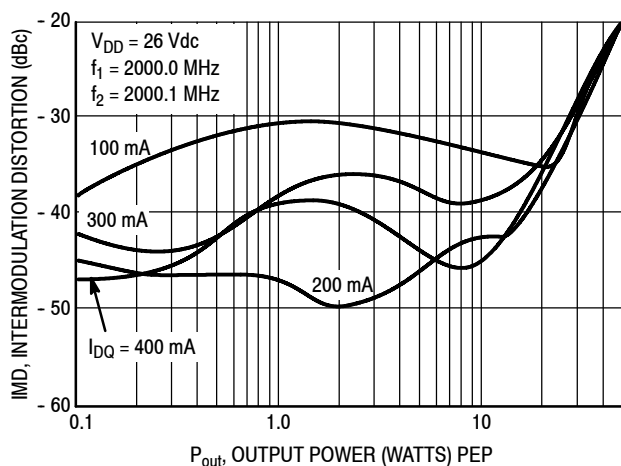


Figure 8. Intermodulation Distortion versus Output Power

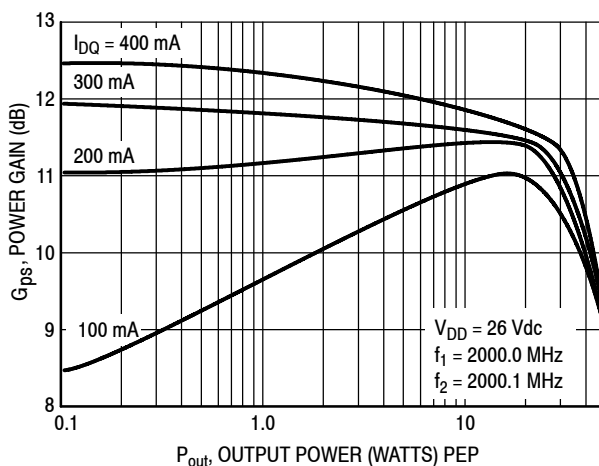


Figure 9. Power Gain versus Output Power

## TYPICAL CHARACTERISTICS

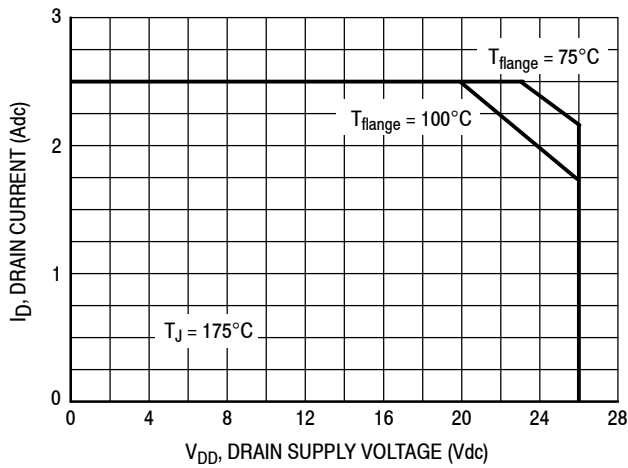


Figure 10. DC Safe Operating Area

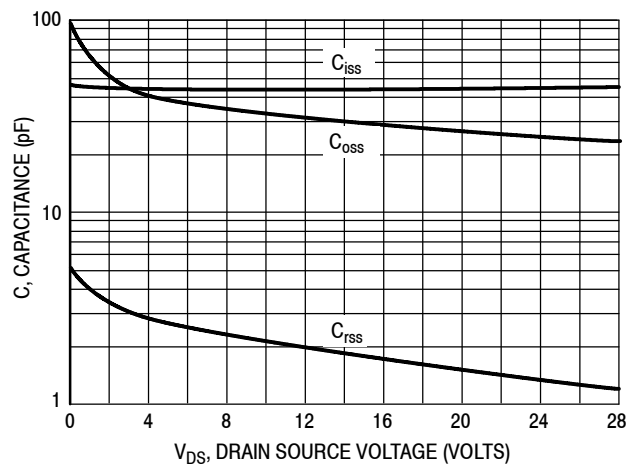


Figure 11. Capacitance versus Drain Source Voltage

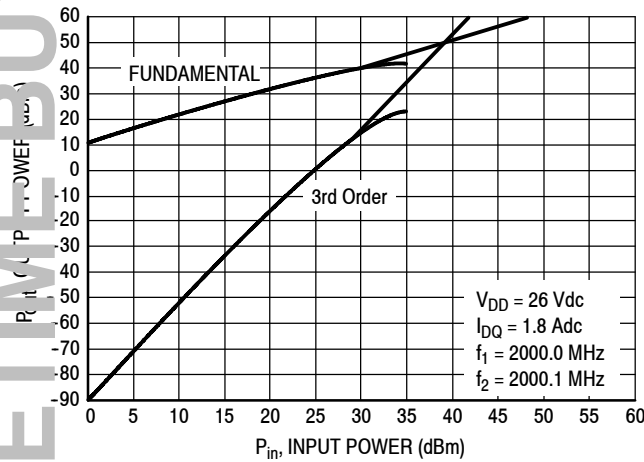


Figure 12. Class A Third Order Intercept Point

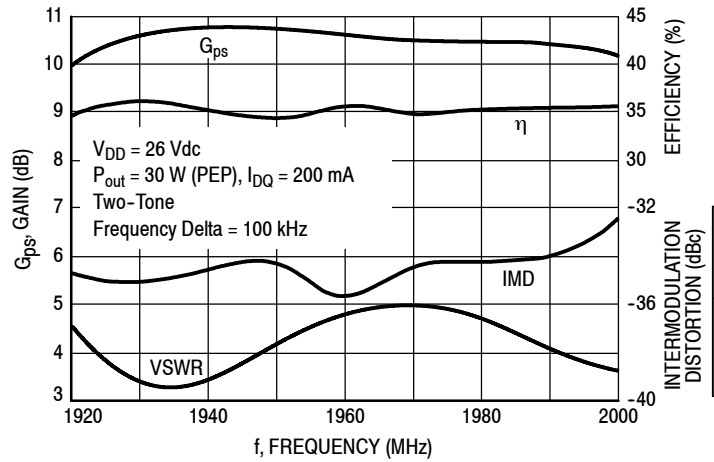
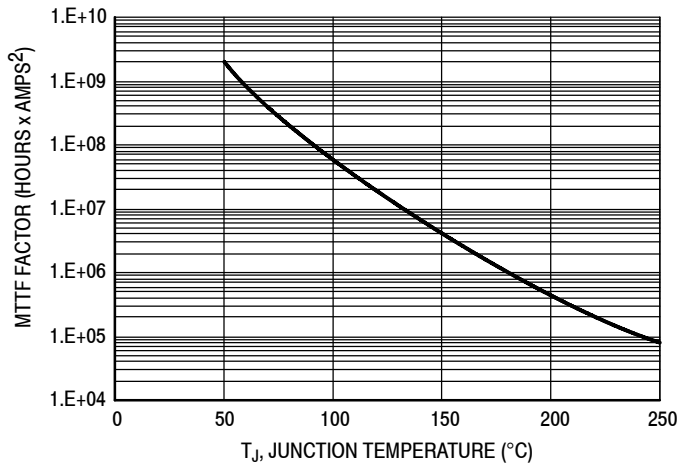
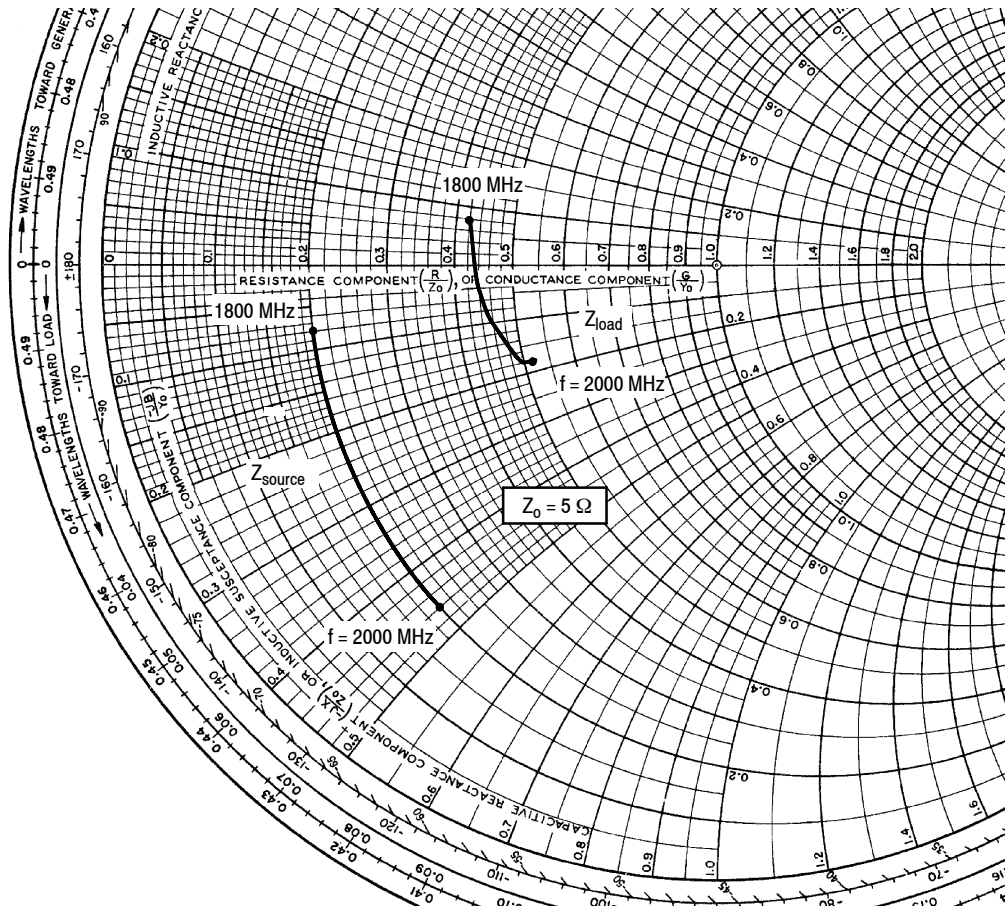


Figure 13. 1920-2000 MHz Broadband Circuit Performance



This graph displays calculated MTTF in hours x ampere<sup>2</sup> drain current. Life tests at elevated temperature have correlated to better than  $\pm 10\%$  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



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

| f<br>MHz | $Z_{source}$<br>$\Omega$ | $Z_{load}$<br>$\Omega$ |
|----------|--------------------------|------------------------|
| 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.

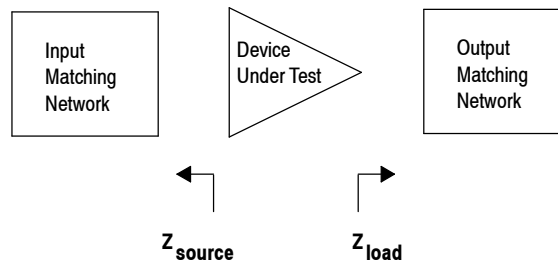
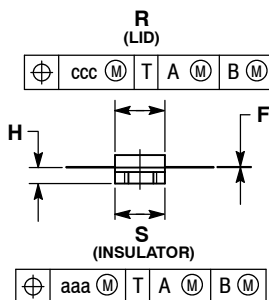
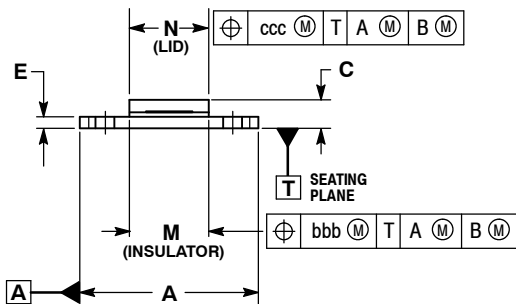
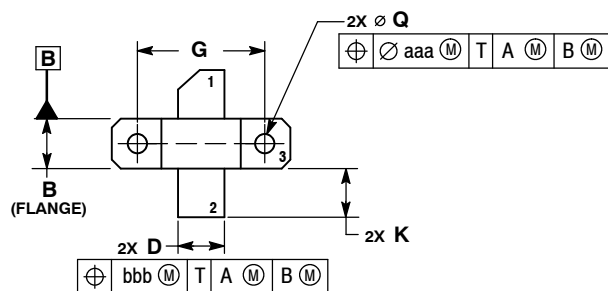


Figure 15. Series Equivalent Source and Load Impedance

## PACKAGE DIMENSIONS



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

### 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.

| DIM | INCHES    |       | MILLIMETERS |       |
|-----|-----------|-------|-------------|-------|
|     | 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
- GATE
- SOURCE

## PRODUCT DOCUMENTATION

Refer to the following documents to aid your design process.

### Engineering Bulletins

- EB212: Using Data Sheet Impedances for RF LDMOS Devices

## REVISION HISTORY

The following table summarizes revisions to this document.

| Revision | Date      | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|----------|-----------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 19       | Oct. 2008 | <ul style="list-style-type: none"><li>• Data sheet revised to reflect part status change, p. 1, including use of applicable overlay.</li><li>• Modified data sheet to reflect RF Test Reduction described in Product and Process Change Notification number, PCN12779, p. 2</li><li>• Updated Part Numbers in Tables 4 and 5, Component Designations and Values, to RoHS compliant part numbers, p. 3, 6</li><li>• Added Product Documentation and Revision History, p. 11</li></ul> |

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