

# RF Power Field Effect Transistors

## N-Channel Enhancement-Mode Lateral MOSFETs

Designed for PCN and PCS base station applications at frequencies from 1900 to 2000 MHz. Suitable for TDMA, CDMA and multicarrier amplifier applications.

- Typical 2-Carrier N-CDMA Performance for  $V_{DD} = 28$  Volts,  $I_{DQ} = 1200$  mA,  $P_{out} = 26$  Watts Avg., Full Frequency Band, IS-95 CDMA (Pilot, Sync, Paging, Traffic Codes 8 Through 13) Channel Bandwidth = 1.2288 MHz. PAR = 9.8 dB @ 0.01% Probability on CCDF.  
Power Gain — 13 dB  
Drain Efficiency — 25%  
IM3 @ 2.5 MHz Offset — -37 dBc in 1.2288 MHz Bandwidth  
ACPR @ 885 kHz Offset — -51 dB in 30 kHz Bandwidth
- Capable of Handling 10:1 VSWR, @ 28 Vdc, 1960 MHz, 110 Watts CW Output Power

### Features

- Characterized with Series Equivalent Large-Signal Impedance Parameters
- Internally Matched for Ease of Use
- Qualified Up to a Maximum of 32 V Operation
- Integrated ESD Protection
- Lower Thermal Resistance Package
- Low Gold Plating Thickness on Leads, 40 $\mu$ m Nominal.
- RoHS Compliant
- In Tape and Reel. R3 Suffix = 250 Units per 56 mm, 13 inch Reel.

**MRF5S19130HR3**  
**MRF5S19130HSR3**

**1930-1990 MHz, 26 W AVG., 28 V**  
**2 x N-CDMA**  
**LATERAL N-CHANNEL**  
**RF POWER MOSFETs**

**CASE 465B-03, STYLE 1**  
**NI-880**  
**MRF5S19130HR3**

**CASE 465C-02, STYLE 1**  
**NI-880S**  
**MRF5S19130HSR3**

**Table 1. Maximum Ratings**

| Rating  | Symbol    | Value       | Unit                     |
|---|-----------|-------------|--------------------------|
| Drain-Source Voltage  | $V_{DSS}$ | -0.5, +65   | Vdc                      |
| Gate-Source Voltage   | $V_{GS}$  | -0.5, +15   | Vdc                      |
| Total Device Dissipation @ $T_C = 25^\circ\text{C}$<br>Derate above 25 $^\circ\text{C}$ | $P_D$     | 438<br>2.50 | 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         | $^\circ\text{C}$         |
| CW Operation @ $T_C = 25^\circ\text{C}$<br>Derate above 25 $^\circ\text{C}$             | CW        | 160<br>1    | W<br>W/ $^\circ\text{C}$ |

**Table 2. Thermal Characteristics**

| Characteristic  | Symbol          | Value (1,2)  | Unit                      |
|---|-----------------|--------------|---------------------------|
| Thermal Resistance, Junction to Case<br>Case Temperature 80 $^\circ\text{C}$ , 115 W CW<br>Case Temperature 78 $^\circ\text{C}$ , 26 W CW | $R_{\theta JC}$ | 0.40<br>0.46 | $^\circ\text{C}/\text{W}$ |

1. MTTF calculator available at <http://www.freescale.com/rf>. Select Tools/Software/Application Software/Calculators to access the MTTF calculators by product.
2. Refer to AN1955, *Thermal Measurement Methodology of RF Power Amplifiers*. Go to <http://www.freescale.com/rf>. Select Documentation/Application Notes - AN1955.

**Table 3. ESD Protection Characteristics**

| Test Conditions     | Class        |
|---------------------|--------------|
| Human Body Model    | 2 (Minimum)  |
| Machine Model       | M4 (Minimum) |
| Charge Device Model | C7 (Minimum) |

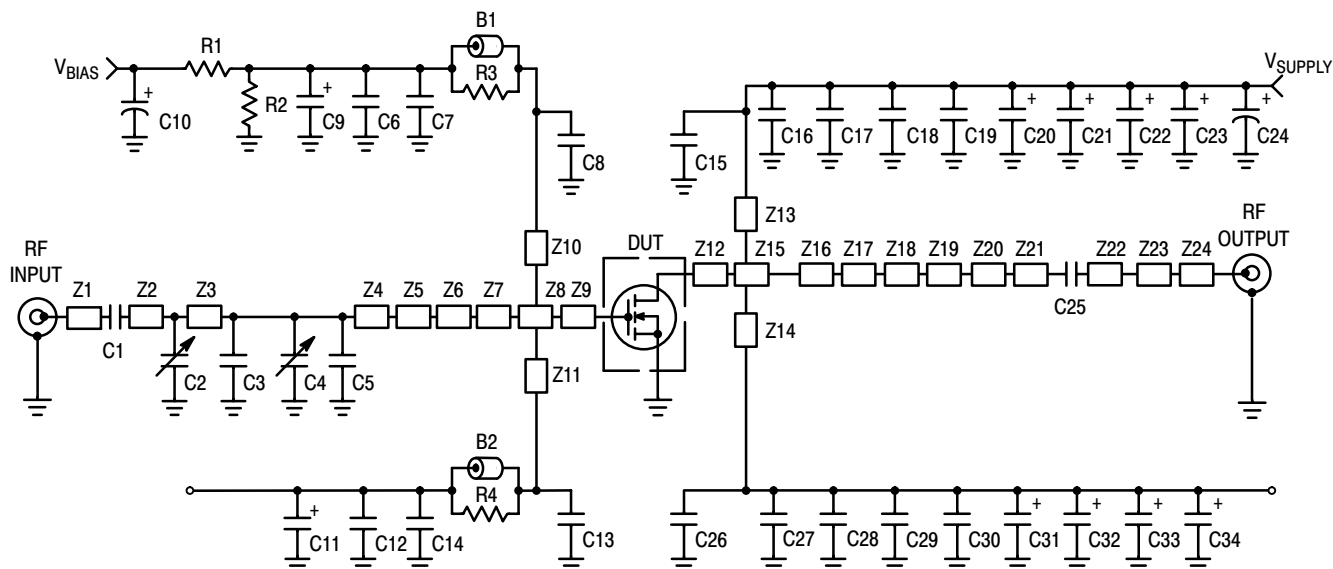
**Table 4. Electrical Characteristics** ( $T_C = 25^\circ\text{C}$  unless otherwise noted)

| Characteristic   | Symbol       | Min | Typ  | Max | Unit               |
|--|--------------|-----|------|-----|--------------------|
| <b>Off Characteristics</b>   |              |     |      |     |                    |
| Zero Gate Voltage Drain Leakage Current<br>( $V_{DS} = 65\text{ Vdc}$ , $V_{GS} = 0\text{ Vdc}$ )                          | $I_{DSS}$    | —   | —    | 10  | $\mu\text{A}_{dc}$ |
| Zero Gate Voltage Drain Leakage Current<br>( $V_{DS} = 28\text{ Vdc}$ , $V_{GS} = 0\text{ Vdc}$ )                          | $I_{DSS}$    | —   | —    | 1   | $\mu\text{A}_{dc}$ |
| Gate-Source Leakage Current<br>( $V_{GS} = 5\text{ Vdc}$ , $V_{DS} = 0\text{ Vdc}$ )                                       | $I_{GSS}$    | —   | —    | 1   | $\mu\text{A}_{dc}$ |
| <b>On Characteristics</b>  |              |     |      |     |                    |
| Gate Threshold Voltage<br>( $V_{DS} = 10\text{ Vdc}$ , $I_D = 200\ \mu\text{A}_{dc}$ )                                     | $V_{GS(th)}$ | 2.5 | 2.8  | 3.5 | Vdc                |
| Gate Quiescent Voltage<br>( $V_{DS} = 28\text{ Vdc}$ , $I_D = 1200\ \text{mA}_{dc}$ )                                      | $V_{GS(Q)}$  | —   | 3.8  | —   | Vdc                |
| Drain-Source On-Voltage<br>( $V_{GS} = 10\text{ Vdc}$ , $I_D = 3\ \text{A}_{dc}$ )   | $V_{DS(on)}$ | —   | 0.26 | —   | Vdc                |
| Forward Transconductance<br>( $V_{DS} = 10\text{ Vdc}$ , $I_D = 3\ \text{A}_{dc}$ )  | $g_{fs}$     | —   | 7.5  | —   | S                  |
| <b>Dynamic Characteristics</b>   |              |     |      |     |                    |
| Reverse Transfer Capacitance (1)<br>( $V_{DS} = 28\text{ Vdc} \pm 30\ \text{mV(rms)ac}$ @ 1 MHz, $V_{GS} = 0\text{ Vdc}$ ) | $C_{rss}$    | —   | 2.7  | —   | pF                 |

**Functional Tests** (In Freescale Test Fixture, 50 ohm system)  $V_{DD} = 28\text{ Vdc}$ ,  $I_{DQ} = 1200\ \text{mA}$ ,  $P_{out} = 26\ \text{W Avg.}$ ,  $f_1 = 1930\ \text{MHz}$ ,  $f_2 = 1932.5\ \text{MHz}$  and  $f_1 = 1987.5\ \text{MHz}$ ,  $f_2 = 1990\ \text{MHz}$ , 2-Carrier N-CDMA, 1.2288 MHz Channel Bandwidth Carriers. ACPR measured in 30 kHz Channel Bandwidth @  $\pm 885\ \text{kHz}$  Offset. IM3 measured in 1.2288 MHz Channel Bandwidth @  $\pm 2.5\ \text{MHz}$  Offset. PAR = 9.8 dB @ 0.01% Probability on CCDF.

|                              |          |    |     |     |     |
|------------------------------|----------|----|-----|-----|-----|
| Power Gain                   | $G_{ps}$ | 12 | 13  | —   | dB  |
| Drain Efficiency             | $\eta_D$ | 23 | 25  | —   | %   |
| Intermodulation Distortion   | IM3      | —  | -37 | -35 | dBc |
| Adjacent Channel Power Ratio | ACPR     | —  | -51 | -48 | dBc |
| Input Return Loss            | IRL      | —  | -15 | -9  | dB  |

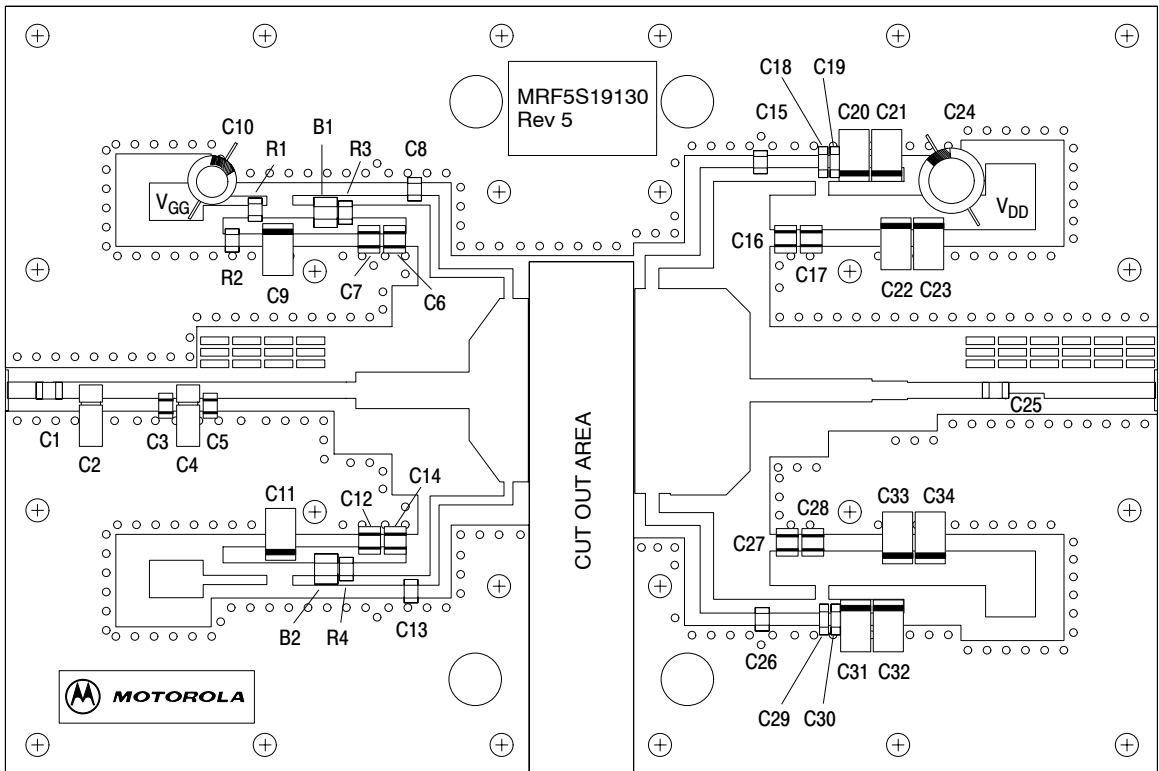
1. Part internally matched both on input and output.



|          |                                |          |  |
|----------|--------------------------------|----------|--|
| Z1       | 0.200" x 0.085" Microstrip     | Z13, Z14 | 1.125" x 0.068" Microstrip                     |
| Z2       | 0.170" x 0.085" Microstrip     | Z15      | 0.071" x 1.080" Microstrip                     |
| Z3       | 0.480" x 0.085" Microstrip     | Z16      | 0.060" x 1.080" Microstrip                     |
| Z4       | 0.926" x 0.085" Microstrip     | Z17      | 0.290" x 1.080" Microstrip                     |
| Z5       | 0.590" x 0.085" Microstrip     | Z18      | 1.075" x 0.825" x 0.125" Taper                 |
| Z6       | 0.519" x 0.955" x 0.160" Taper | Z19      | 0.635" x 0.120" Microstrip                     |
| Z7       | 0.022" x 0.955" Microstrip     | Z20      | 0.185" x 0.096" Microstrip                     |
| Z8       | 0.046" x 0.955" Microstrip     | Z21      | 0.414" x 0.084" Microstrip                     |
| Z9       | 0.080" x 0.955" Microstrip     | Z22      | 0.040" x 0.084" Microstrip                     |
| Z10, Z11 | 1.280" x 0.046" Microstrip     | Z23      | 0.199" x 0.057" Microstrip                     |
| Z12      | 0.053" x 1.080" Microstrip     | PCB      | Arlon GX0300-55-22, 0.03", $\epsilon_r = 2.55$ |

**Figure 1. MRF5S19130HR3(SR3) Test Circuit Schematic**
**Table 5. MRF5S19130HR3(SR3) Test Circuit Component Designations and Values**

| Part                                   | Description                               | Part Number    | Manufacturer        |
|--|---|----------------|---------------------|
| B1, B2                                 | Short RF Bead                             | 95F786         | Newark              |
| C1                                     | 0.8 pF Chip Capacitor                     | 100B0R8BP 500X | ATC                 |
| C2, C4                                 | 0.6 – 4.5 pF Gigatrim Variable Capacitors | 44F3358        | Newark              |
| C3                                     | 2.2 pF Chip Capacitor                     | 100B2R2BP 500X | ATC                 |
| C5                                     | 1.7 pF Chip Capacitor                     | 100B1R7BP 500X | ATC                 |
| C8, C13                                | 9.1 pF Chip Capacitors                    | 100B9R1CP 500X | ATC                 |
| C9, C11                                | 1 $\mu$ F, 25 V Tantalum Capacitors       | 92F1845        | Newark              |
| C10                                    | 47 $\mu$ F, 50 V Electrolytic Capacitor   | 51F2913        | Newark              |
| C6, C14, C17, C18, C19, C28, C29, C30  | 0.1 $\mu$ F Chip Capacitors               | CDR33BX104AKWS | Kemet               |
| C7, C12, C16, C27                      | 1000 pF Chip Capacitors                   | 100B102JP 500X | ATC                 |
| C15, C26                               | 8.2 pF Chip Capacitors                    | 100B8R2CP 500X | ATC                 |
| C20, C21, C22, C23, C31, C32, C33, C34 | 22 $\mu$ F, 35 V Tantalum Capacitors      | 92F1853        | Newark              |
| C24                                    | 470 $\mu$ F, 63 V Electrolytic Capacitor  | 95F4579        | Newark              |
| C25                                    | 6.2 pF Chip Capacitor                     | 100B6R2CP 500X | ATC                 |
| R1                                     | 1 k $\Omega$ Chip Resistor                | D5534M07B1K00R | Newark              |
| R2                                     | 560 k $\Omega$ Chip Resistor              | CR1206 564JT   | Newark              |
| R3, R4                                 | 12 $\Omega$ Chip Resistors                | RM73B2B120JT   | Garrett Electronics |



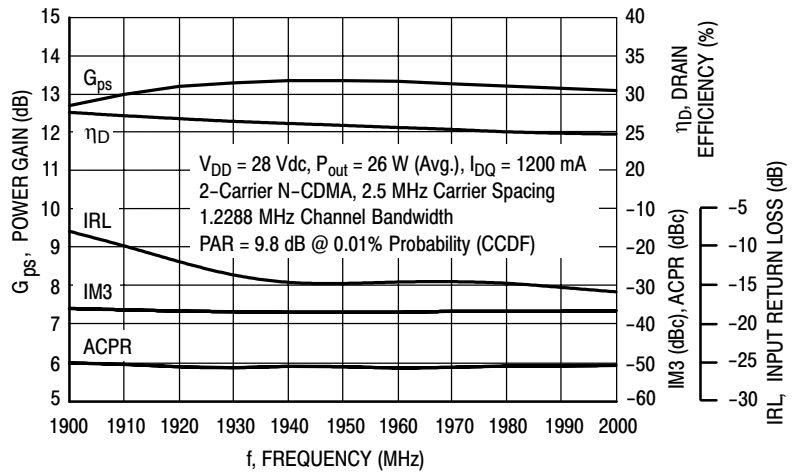
Freescall has begun the transition of marking Printed Circuit Boards (PCBs) with the Freescall Semiconductor signature/logo. PCBs may have either Motorola or Freescall markings during the transition period. These changes will have no impact on form, fit or function of the current product.

**Figure 2. MRF5S19130HR3(SR3) Test Circuit Component Layout**

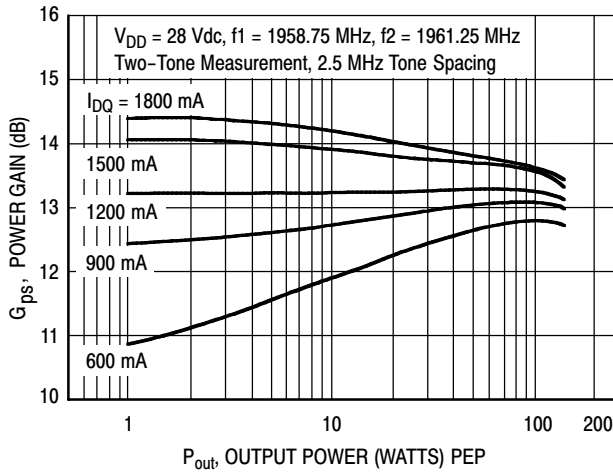
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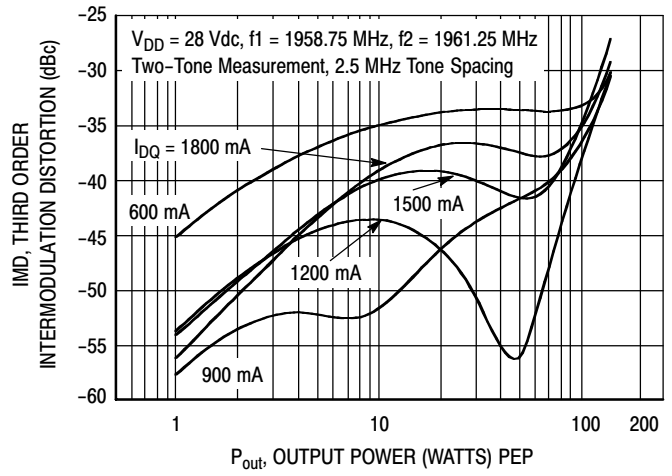
### TYPICAL CHARACTERISTICS



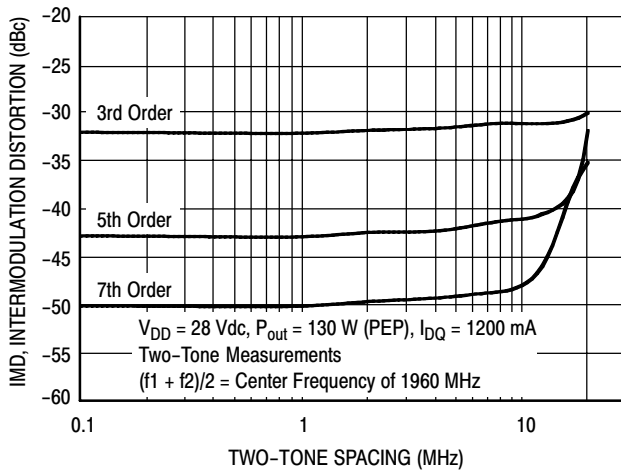
**Figure 3. 2-Carrier N-CDMA Broadband Performance @  $P_{out} = 26$  Watts Avg.**



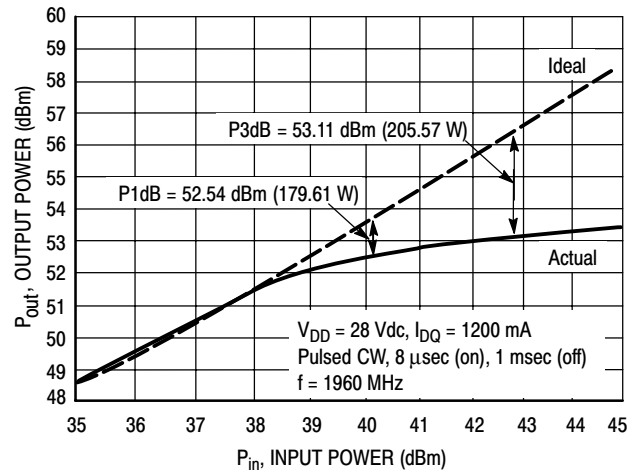
**Figure 4. Two-Tone Power Gain versus Output Power**



**Figure 5. Third Order Intermodulation Distortion versus Output Power**



**Figure 6. Intermodulation Distortion Products versus Tone Spacing**

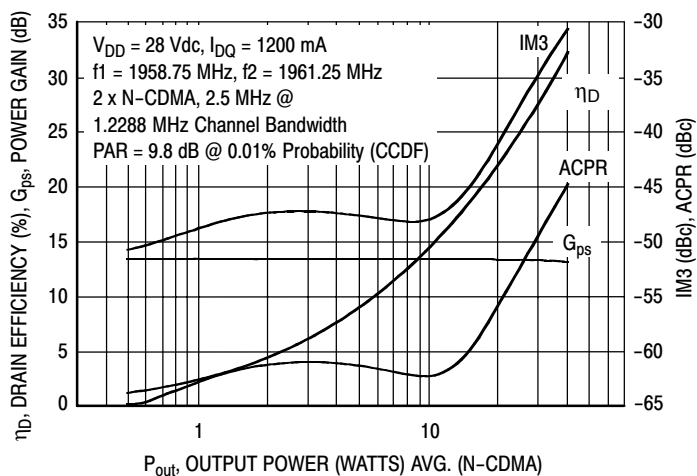


**Figure 7. Pulse CW Output Power versus Input Power**

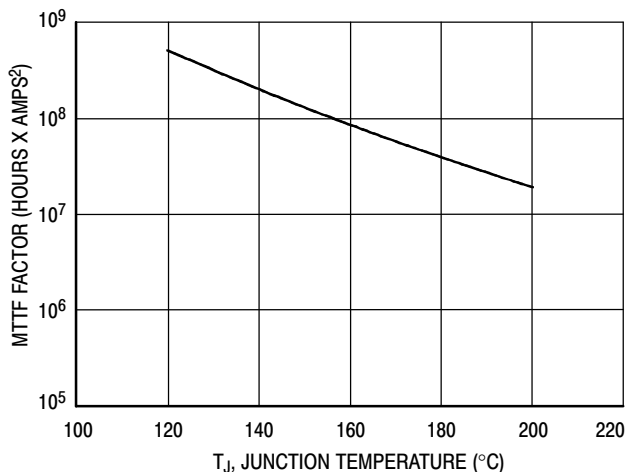
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### TYPICAL CHARACTERISTICS



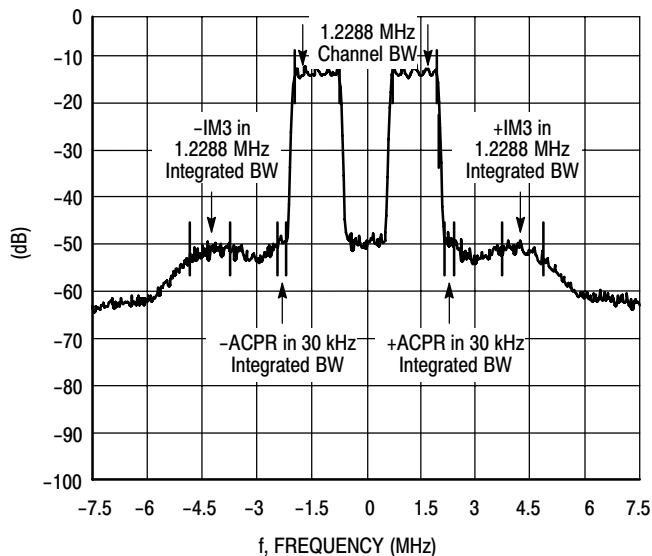
**Figure 8. 2-Carrier N-CDMA ACPR, IM3, Power Gain and Drain Efficiency versus Output Power**



This above graph displays calculated MTTF in hours x ampere<sup>2</sup> drain current. Life tests at elevated temperatures 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 9. MTTF Factor versus Junction Temperature**

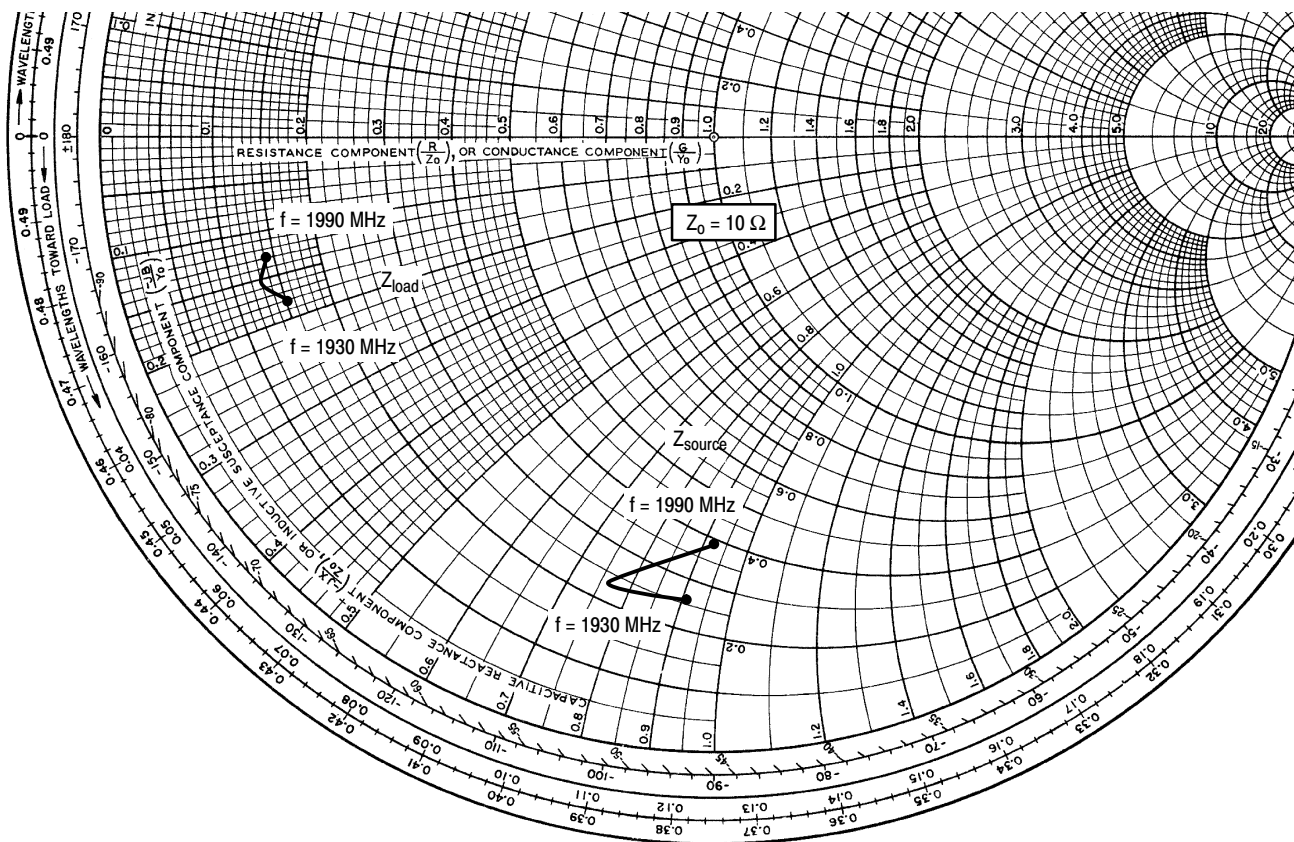
### N-CDMA TEST SIGNAL



**Figure 10. 2-Carrier N-CDMA Spectrum**

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$V_{DD} = 28\text{ V}$ ,  $I_{DQ} = 1.2\text{ A}$ ,  $P_{out} = 26\text{ W Avg.}$

| f<br>MHz | $Z_{source}$<br>$\Omega$ | $Z_{load}$<br>$\Omega$ |
|----------|--------------------------|------------------------|
| 1930     | $2.57 - j9.1$            | $1.48 - j1.8$          |
| 1960     | $2.35 - j7.6$            | $1.28 - j1.5$          |
| 1990     | $3.86 - j9.2$            | $1.42 - j1.3$          |

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

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

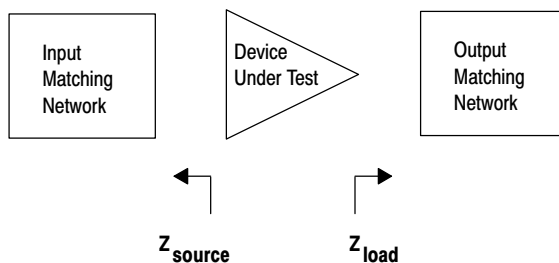
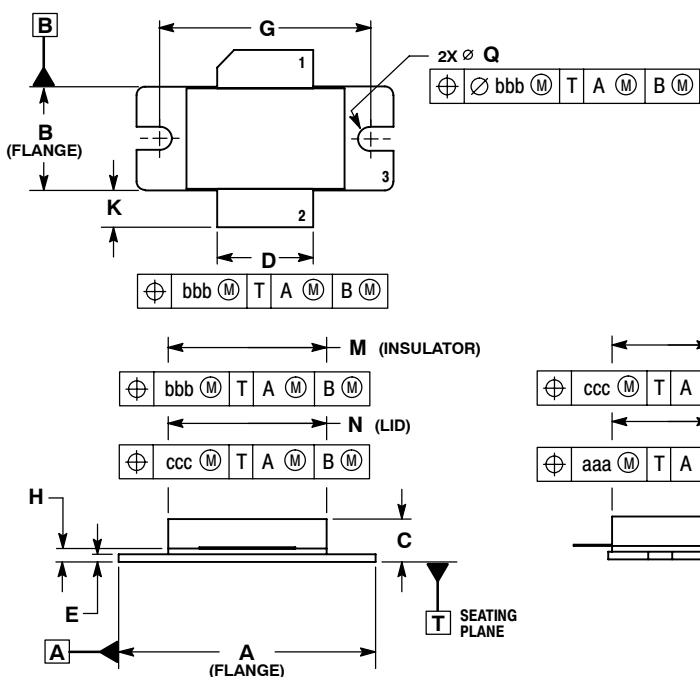


Figure 11. Series Equivalent Source and Load Impedance

### PACKAGE DIMENSIONS

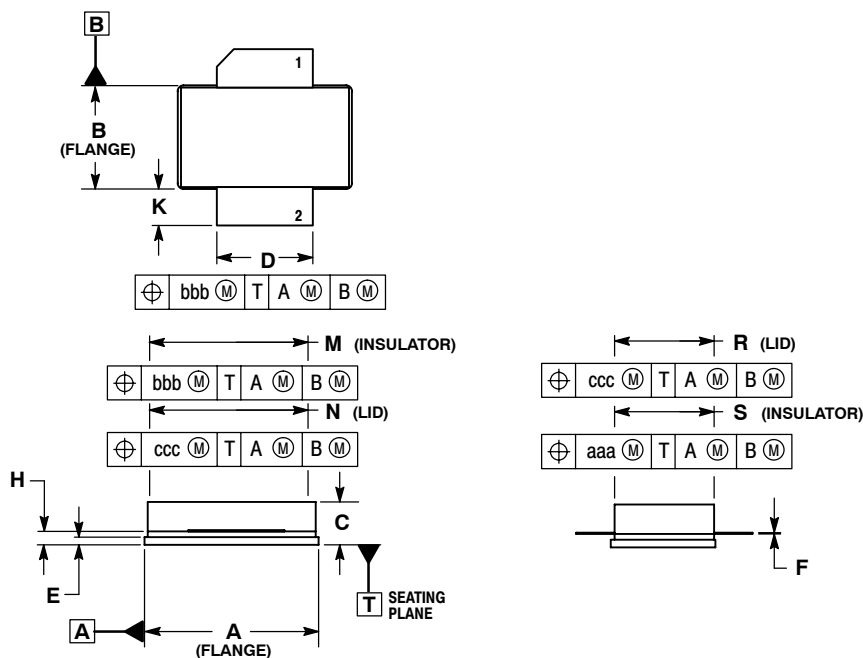


- NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M-1994.
  2. CONTROLLING DIMENSION: INCH.
  3. DIMENSION H IS MEASURED 0.030 (0.762) AWAY FROM PACKAGE BODY.
  4. DELETED

| DIM | INCHES    |       | MILLIMETERS |       |
|-----|-----------|-------|-------------|-------|
|     | MIN       | MAX   | MIN         | MAX   |
| A   | 1.335     | 1.345 | 33.91       | 34.16 |
| B   | 0.535     | 0.545 | 13.6        | 13.8  |
| C   | 0.147     | 0.200 | 3.73        | 5.08  |
| D   | 0.495     | 0.505 | 12.57       | 12.83 |
| E   | 0.035     | 0.045 | 0.89        | 1.14  |
| F   | 0.003     | 0.006 | 0.08        | 0.15  |
| G   | 1.100 BSC |       | 27.94 BSC   |       |
| H   | 0.057     | 0.067 | 1.45        | 1.70  |
| K   | 0.170     | 0.210 | 4.32        | 5.33  |
| M   | 0.872     | 0.888 | 22.15       | 22.55 |
| N   | 0.871     | 0.889 | 19.30       | 22.60 |
| Q   | Ø.118     | Ø.138 | Ø3.00       | Ø3.51 |
| R   | 0.515     | 0.525 | 13.10       | 13.30 |
| S   | 0.515     | 0.525 | 13.10       | 13.30 |
| aaa | 0.007 REF |       | 0.178 REF   |       |
| bbb | 0.010 REF |       | 0.254 REF   |       |
| ccc | 0.015 REF |       | 0.381 REF   |       |

- STYLE 1:
- PIN 1. DRAIN
  - GATE
  - SOURCE

**CASE 465B-03  
ISSUE D  
NI-880  
MRF5S19130HR3**



- NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI 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   | 0.905     | 0.915 | 22.99       | 23.24 |
| B   | 0.535     | 0.545 | 13.60       | 13.80 |
| C   | 0.147     | 0.200 | 3.73        | 5.08  |
| D   | 0.495     | 0.505 | 12.57       | 12.83 |
| E   | 0.035     | 0.045 | 0.89        | 1.14  |
| F   | 0.003     | 0.006 | 0.08        | 0.15  |
| H   | 0.057     | 0.067 | 1.45        | 1.70  |
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| bbb | 0.010 REF |       | 0.254 REF   |       |
| ccc | 0.015 REF |       | 0.381 REF   |       |

- STYLE 1:
- PIN 1. DRAIN
  - GATE
  - SOURCE

**CASE 465C-02  
ISSUE D  
NI-880S  
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