## The RF MOSFET Line

# RF Power Field Effect Transistors

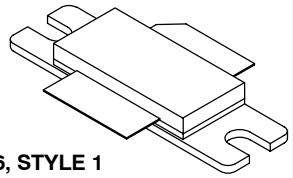
## N-Channel Enhancement-Mode Lateral MOSFETs

**MRF5S19100HR3**
**MRF5S19100HSR3**

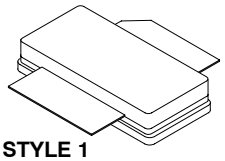
Designed for PCN and PCS base station applications with frequencies up to 1.9 to 2.0 GHz. Suitable for TDMA, CDMA and multicarrier amplifier applications.

- Typical 2-Carrier N-CDMA Performance: $V_{DD}$ = 28 Volts, $I_{DQ}$ = 1000 mA, $P_{out}$ = 22 Watts Avg., Full Frequency Band. IS-95 (Pilot, Sync, Paging, Traffic Codes 8 Through 13) Channel Bandwidth = 1.2288 MHz. Peak/Avg. = 9.8 dB @ 0.01% Probability on CCDF.
  - Power Gain — 13.9 dB
  - Drain Efficiency — 25.5%
  - IM3 @ 2.5 MHz Offset — -36.5 dBc @ 1.2288 MHz Channel Bandwidth
  - ACPR @ 885 kHz Offset — -50.7 dBc @ 30 kHz Channel Bandwidth
- Capable of Handling 10:1 VSWR, @ 28 Vdc, 1960 MHz, 100 Watts CW Output Power
- Characterized with Series Equivalent Large-Signal Impedance Parameters
- Internally Matched, Controlled Q, for Ease of Use
- Qualified Up to a Maximum of 32 $V_{DD}$ Operation
- Integrated ESD Protection
- Lower Thermal Resistance Package
- Low Gold Plating Thickness on Leads, 40μ″ Nominal.
- In Tape and Reel. R3 Suffix = 250 Units per 56 mm, 13 Inch Reel.

**1990 MHz, 22 W AVG, 28 V**
**2 x N-CDMA**
**LATERAL N-CHANNEL**
**RF POWER MOSFETs**



**CASE 465-06, STYLE 1**
**NI-780**
**MRF5S19100HR3**



**CASE 465A-06, STYLE 1**
**NI-780S**
**MRF5S19100HSR3**

**MAXIMUM RATINGS**

| Rating | Symbol | Value | Unit |
|---|---|---|---|
| Drain-Source Voltage | $V_{DSS}$ | 65 | Vdc |
| Gate-Source Voltage | $V_{GS}$ | -0.5, +15 | Vdc |
| Total Device Dissipation @ $T_C$ = 25°C<br>Derate above 25°C | $P_D$ | 269<br>1.54 | W<br>W/°C |
| Storage Temperature Range | $T_{stg}$ | -65 to +150 | °C |
| Operating Junction Temperature | $T_J$ | 200 | °C |

**THERMAL CHARACTERISTICS**

| Characteristic | Symbol | Value (1) | Unit |
|---|---|---|---|
| Thermal Resistance, Junction to Case<br>Case Temperature 75°C, 100 W CW<br>Case Temperature 70°C, 22 W CW | $R_{\theta JC}$ | <br>0.64<br>0.65 | °C/W |

(1) Refer to AN1955/D, *Thermal Measurement Methodology of RF Power Amplifiers.* Go to http://www.motorola.com/semiconductors/rf. Select Documentation/Application Notes - AN1955.

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

**ESD PROTECTION CHARACTERISTICS**

| Test Conditions | Class |
|---|---|
| Human Body Model | 2 (Minimum) |
| Machine Model | M3 (Minimum) |
| Charge Device Model | C7 (Minimum) |

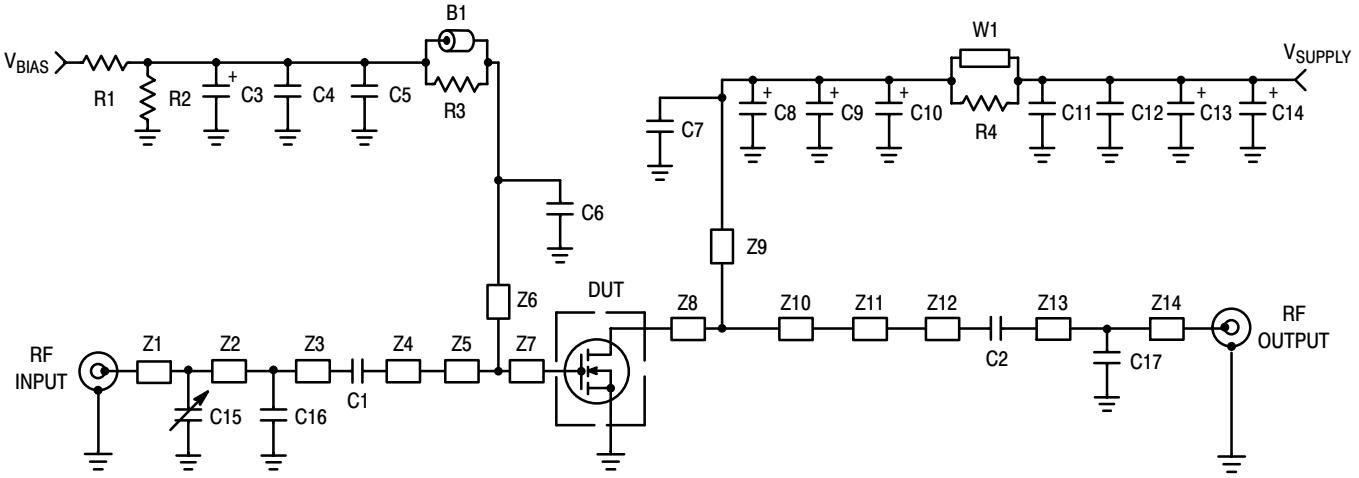
**ELECTRICAL CHARACTERISTICS** ($T_C$ = 25°C unless otherwise noted)

| 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 ($V_{DS}$ = 28 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 (DC)** | | | | | |
| Gate Threshold Voltage ($V_{DS}$ = 10 Vdc, $I_D$ = 240 μAdc) | $V_{GS(th)}$ | — | 2.7 | — | Vdc |
| Gate Quiescent Voltage ($V_{DS}$ = 28 Vdc, $I_D$ = 1000 mAdc) | $V_{GS(Q)}$ | — | 3.7 | — | Vdc |
| Drain-Source On-Voltage ($V_{GS}$ = 10 Vdc, $I_D$ = 2.4 Adc) | $V_{DS(on)}$ | — | 0.26 | — | Vdc |
| Forward Transconductance ($V_{DS}$ = 10 Vdc, $I_D$ = 2.4 Adc) | $g_{fs}$ | — | 6.3 | — | S |
| **DYNAMIC CHARACTERISTICS** | | | | | |
| Reverse Transfer Capacitance (1) ($V_{DS}$ = 28 Vdc, $V_{GS}$ = 0, f = 1.0 MHz) | $C_{rss}$ | — | 2.2 | — | pF |

**FUNCTIONAL TESTS** (In Motorola Test Fixture, 50 ohm system) $V_{DD}$ = 28 Vdc, $I_{DQ}$ = 1000 mA, $P_{out}$ = 22 W Avg., f1 = 1930 MHz, f2 = 1932.5 MHz and f1 = 1987.5 MHz, f2 =1990 MHz, 2-Carrier N-CDMA, 1.2288 MHz Channel Bandwidth Carriers. ACPR measured in 30 kHz Bandwidth @ ±885 kHz Offset. IM3 measured in 1.2288 MHz Channel Bandwidth @ ±2.5 MHz Offset. Peak/Avg. = 9.8 dB @ 0.01% Probability on CCDF.

| | | | | | |
|---|---|---|---|---|---|
| Power Gain | $G_{ps}$ | 12.5 | 13.9 | — | dB |
| Drain Efficiency | $\eta_D$ | 24 | 25.5 | — | % |
| Intermodulation Distortion | IM3 | — | -36.5 | -35 | dBc |
| Adjacent Channel Power Ratio | ACPR | — | -50.7 | -48 | dBc |
| Input Return Loss | IRL | — | -13 | -9 | dB |

(1) Part is internally matched both on input and output.




| | | | |
|---|---|---|---|
| Z1, Z3 | 0.140″ x 0.080″ Microstrip | Z9 | 0.590″ x 0.071″ Microstrip |
| Z2 | 0.450″ x 0.080″ Microstrip | Z10 | 0.450″ x 1.133″ Microstrip |
| Z4 | 0.525″ x 0.080″ Microstrip | Z11 | 0.450″ x 0.141″ Microstrip |
| Z5 | 0.636″ x 0.141″ Microstrip | Z12 | 0.490″ x 0.080″ Microstrip |
| Z6 | 0.650″ x 0.050″ Microstrip | Z13 | 0.085″ x 0.080″ Microstrip |
| Z7 | 0.320″ x 1.299″ Microstrip | Z14 | 1.124″ x 0.080″ Microstrip |
| Z8 | 0.091″ x 1.133″ Microstrip | PCB | Arlon GX-0300-55-22, 0.030″, $\varepsilon_r$ = 2.55 |

**Figure 1. MRF5S19100HR3(HSR3) Test Circuit Schematic**

**Table 1. MRF5S19100HR3(HSR3) Test Circuit Component Designations and Values**

| Part | Description | Part Number | Manufacturer |
|---|---|---|---|
| B1 | Short RF Bead | 95F786 | Newark |
| C1 | 22 pF Chip Capacitor, B Case | 100B220CP 500X | ATC |
| C2 | 10 pF Chip Capacitor, B Case | 100B100CP 500X | ATC |
| C3 | 1 μF, 50 V Tantalum Capacitor | T494C105(1)050AS | Kemet |
| C4, C12 | 0.1 μF Chip Capacitors, B Case | CDR33BX104AKWS | Kemet |
| C5, C11 | 1K pF Chip Capacitors, B Case | 100B102JP 500X | ATC |
| C6 | 2.7 pF Chip Capacitor, B Case | 100B2R7BP 500X | ATC |
| C7 | 4.3 pF Chip Capacitor, B Case | 100B4R3JP 500X | ATC |
| C8 | 10 μF, 35 V Tantalum Capacitor | T494D106(1)035AS | Kemet |
| C9, C10, C13, C14 | 22 μF, 35 V Tantalum Capacitors | T494X226(1)035AS | Kemet |
| C15 | 0.6 – 4.5 Gigatrim Variable Capacitor | 44F3358 | Newark |
| C16 | 2.2 pF Chip Capacitor, B Case | 100B2R2BP 500X | ATC |
| C17* | 0.3 pF Chip Capacitor, B Case | 100B0R3BP 500X | ATC |
| R1 | 1 kΩ Chip Resistor | D5534M07B1K00R | Newark |
| R2 | 560 kΩ Chip Resistor | CR1206 564JT | Newark |
| R3, R4 | 12 Ω Chip Resistors | RM73B2B120JT | Garrett Electronics |
| W1 | 1 turn 14 gauge wire | | |

* Need for part will vary from fixture to fixture.

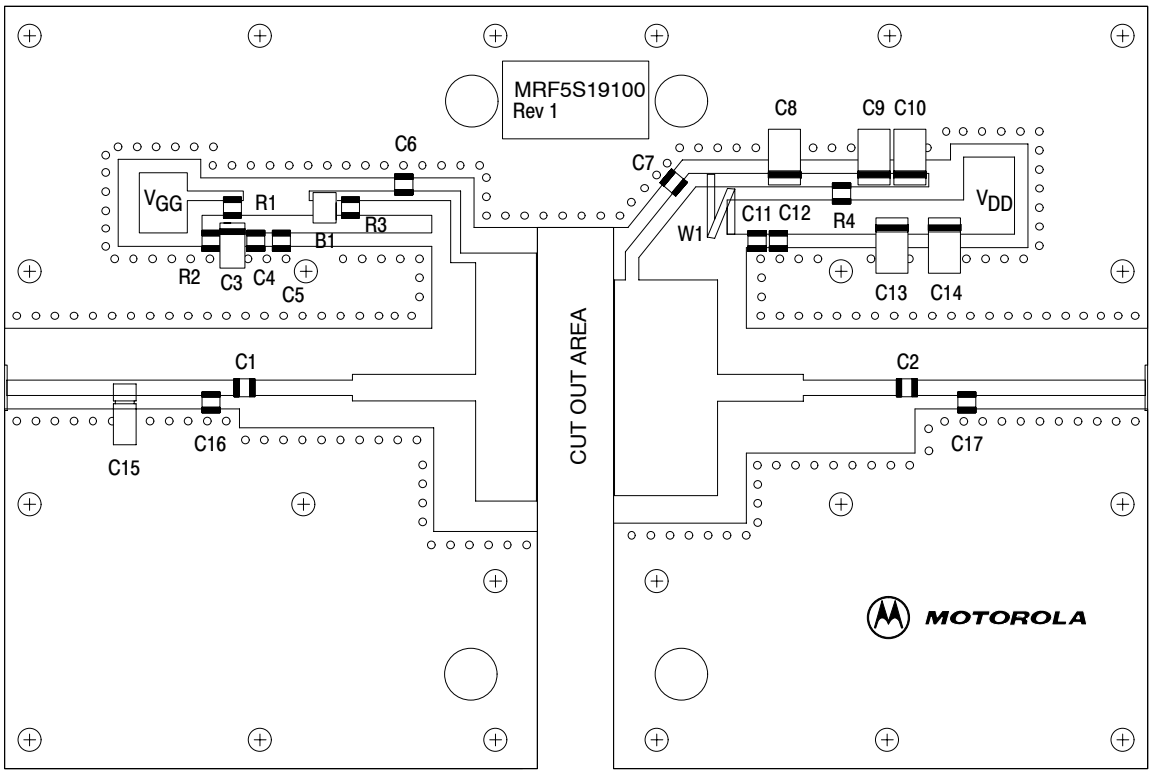



**Figure 2. MRF5S19100HR3(HSR3) Test Circuit Component Layout**

## TYPICAL CHARACTERISTICS

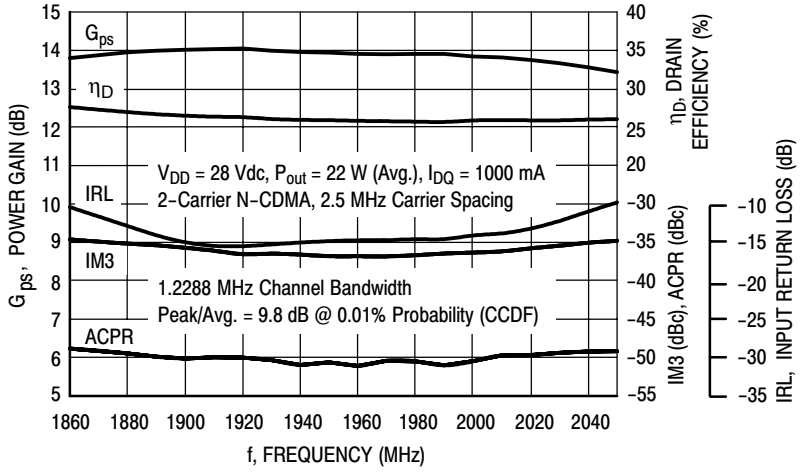



**Figure 3. 2-Carrier N-CDMA Broadband Performance**

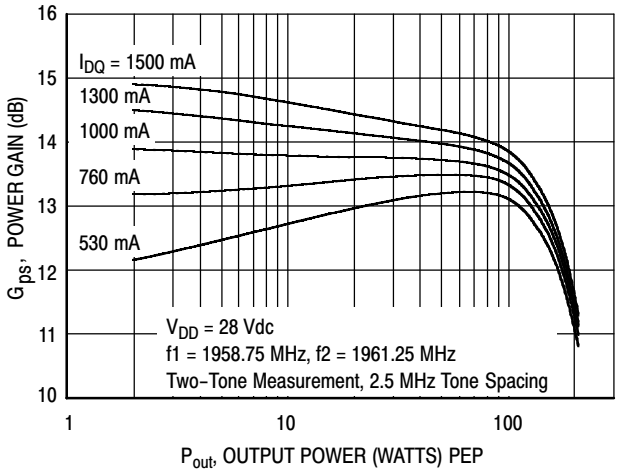



**Figure 4. Two-Tone Power Gain versus Output Power**

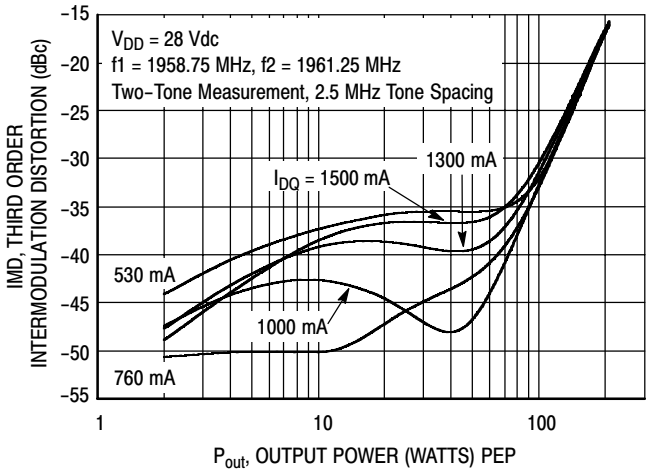



**Figure 5. Third Order Intermodulation Distortion versus Output Power**

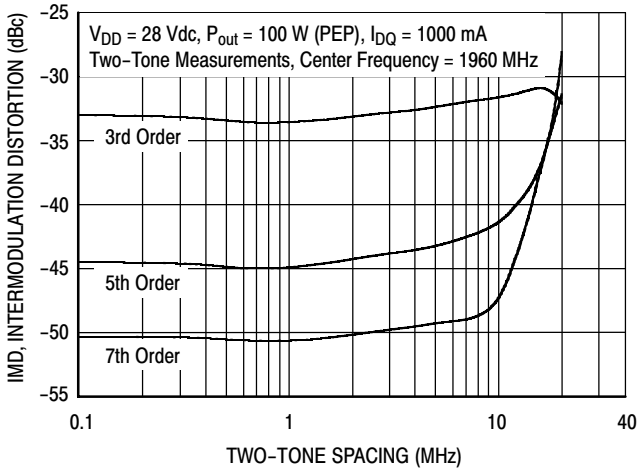



**Figure 6. Intermodulation Distortion Products versus Tone Spacing**

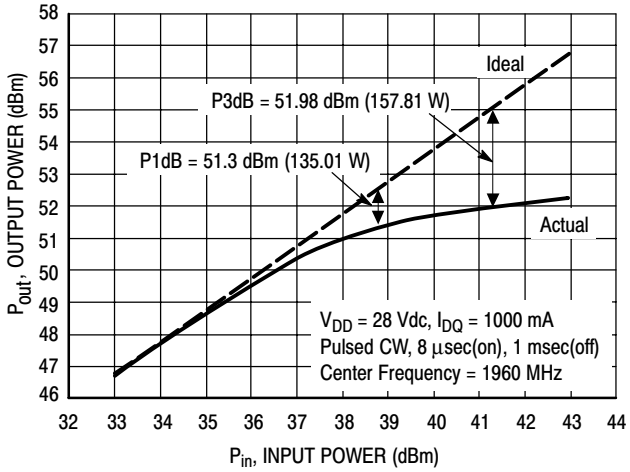



**Figure 7. Pulse CW Output Power versus Input Power**

## TYPICAL CHARACTERISTICS

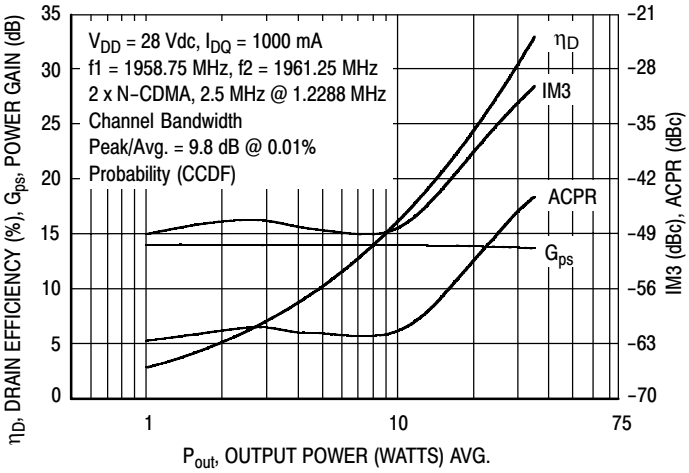
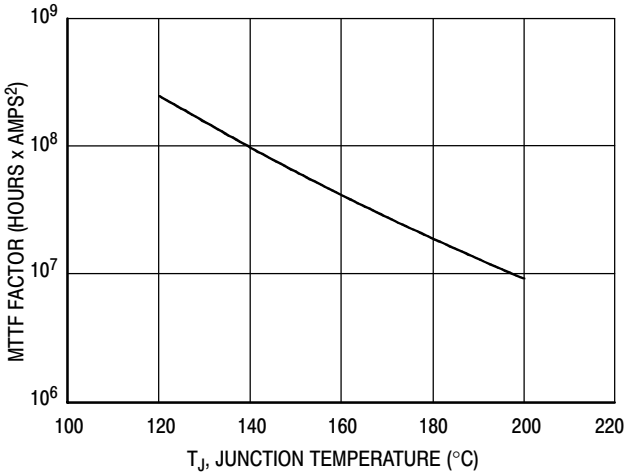



**Figure 8. 2-Carrier N-CDMA ACPR, IM3, Power Gain and Drain Efficiency versus Output Power**




This above graph displays calculated MTTF in hours x ampere$^2$ drain current. Life tests at elevated temperatures 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 10. MTTF Factor versus Junction Temperature**

## TYPICAL CHARACTERISTICS
## N-CDMA TEST SIGNAL

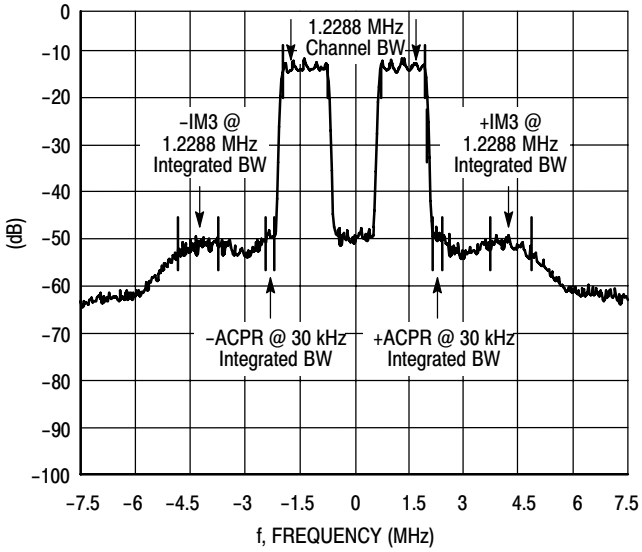
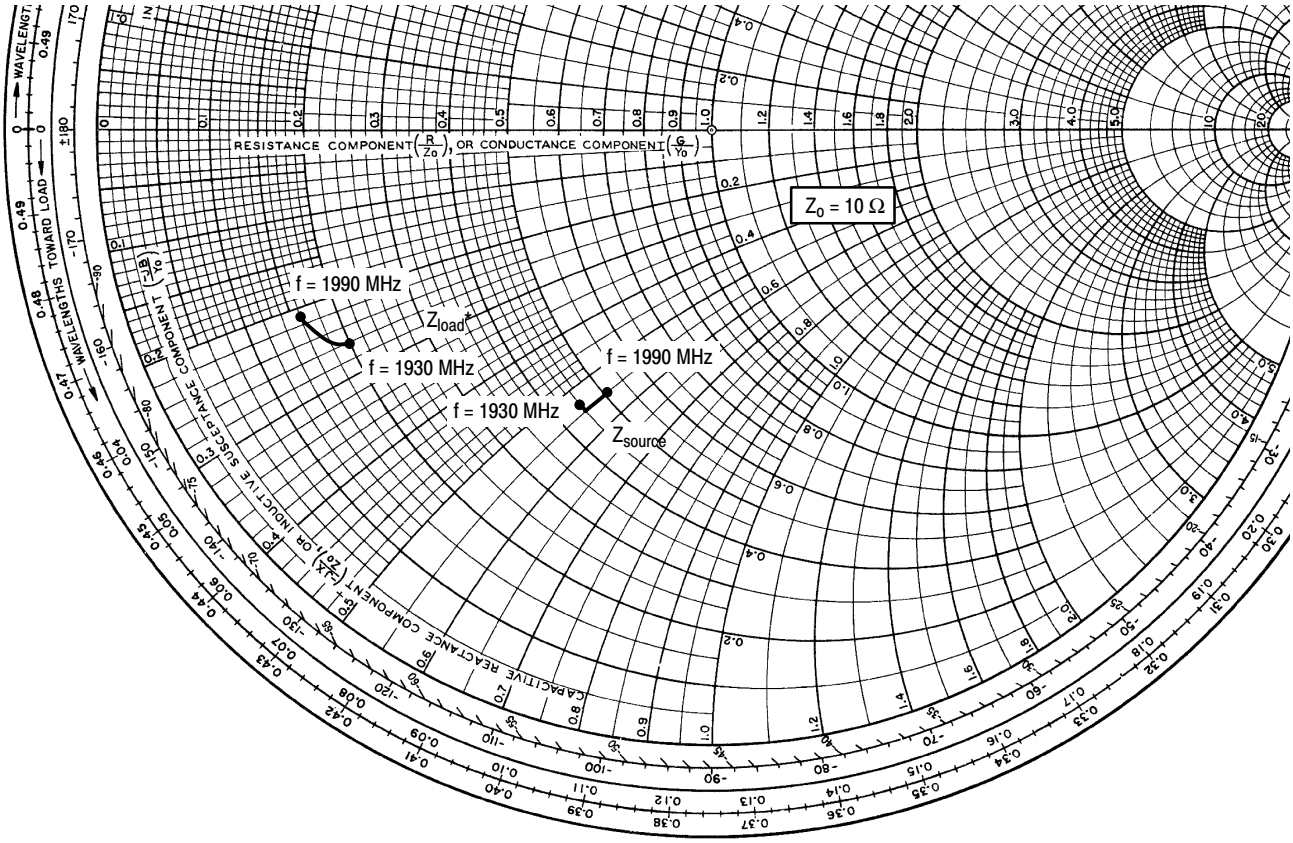



**Figure 9. 2-Carrier N-CDMA Spectrum**




$V_{DD}$ = 28 Vdc, $I_{DQ}$ = 1000 mA, $P_{out}$ = 22 W Avg.

| f MHz | $Z_{source}$ Ω | $Z_{load}$ Ω |
|---|---|---|
| 1930 | 4.45 - j5.32 | 1.98 - j2.58 |
| 1960 | 4.53 - j5.40 | 1.83 - j2.55 |
| 1990 | 5.12 - j5.45 | 1.60 - j2.15 |

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

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

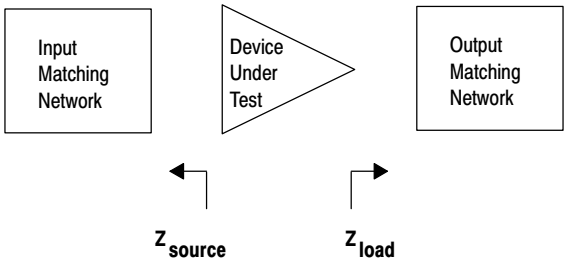


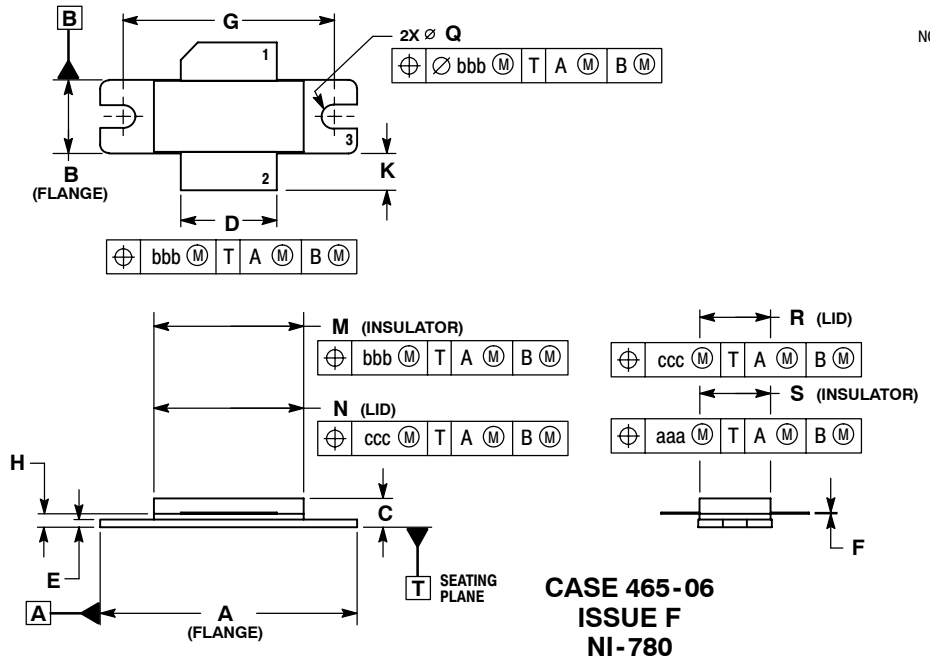

**Figure 11. Series Equivalent Input and Output Impedance**

# NOTES

# NOTES

# NOTES

## PACKAGE DIMENSIONS

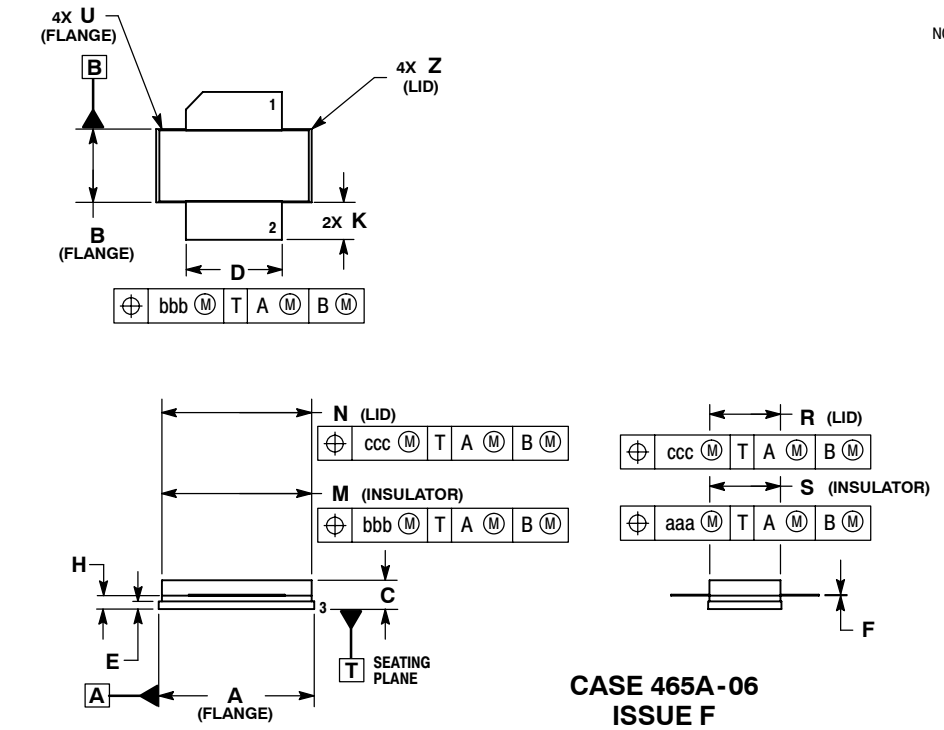



NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M–1994.
2. CONTROLLING DIMENSION: INCH.
3. DELETED
4. DIMENSION H IS MEASURED 0.030 (0.762) AWAY FROM PACKAGE BODY.

| | INCHES | | MILLIMETERS | |
|---|---|---|---|---|
| DIM | MIN | MAX | MIN | MAX |
| A | 1.335 | 1.345 | 33.91 | 34.16 |
| B | 0.380 | 0.390 | 9.65 | 9.91 |
| C | 0.125 | 0.170 | 3.18 | 4.32 |
| 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 | 0.774 | 0.786 | 19.66 | 19.96 |
| N | 0.772 | 0.788 | 19.60 | 20.00 |
| Q | ⌀.118 | ⌀.138 | ⌀3.00 | ⌀3.51 |
| R | 0.365 | 0.375 | 9.27 | 9.53 |
| S | 0.365 | 0.375 | 9.27 | 9.52 |
| aaa | 0.005 REF | | 0.127 REF | |
| bbb | 0.010 REF | | 0.254 REF | |
| ccc | 0.015 REF | | 0.381 REF | |

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

**CASE 465-06**
**ISSUE F**
**NI-780**
**MRF5S19100HR3**

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| | INCHES | | MILLIMETERS | |
|---|---|---|---|---|
| DIM | MIN | MAX | MIN | MAX |
| A | 0.805 | 0.815 | 20.45 | 20.70 |
| B | 0.380 | 0.390 | 9.65 | 9.91 |
| C | 0.125 | 0.170 | 3.18 | 4.32 |
| 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 |
| K | 0.170 | 0.210 | 4.32 | 5.33 |
| M | 0.774 | 0.786 | 19.61 | 20.02 |
| N | 0.772 | 0.788 | 19.61 | 20.02 |
| R | 0.365 | 0.375 | 9.27 | 9.53 |
| S | 0.365 | 0.375 | 9.27 | 9.52 |
| U | --- | 0.040 | --- | 1.02 |
| Z | --- | 0.030 | --- | 0.76 |
| aaa | 0.005 REF | | 0.127 REF | |
| bbb | 0.010 REF | | 0.254 REF | |
| ccc | 0.015 REF | | 0.381 REF | |

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

**CASE 465A-06**
**ISSUE F**
**NI-780S**
**MRF5S19100HSR3**

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