

# RF Power Field Effect Transistors

## N-Channel Enhancement-Mode Lateral MOSFETs

Designed for N-CDMA base station applications with frequencies from 1930 to 1990 MHz. Suitable for TDMA, CDMA and multicarrier amplifier applications. To be used in Class AB for PCN - PCS/cellular radio and WLL applications.

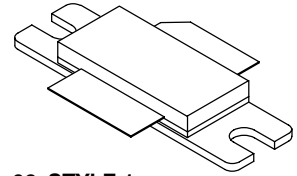
- Typical 2-Carrier N-CDMA Performance:  $V_{DD} = 28$  Volts,  $I_{DQ} = 900$  mA,  $P_{out} = 22$  Watts Avg.,  $f = 1987$  MHz, IS-95 (Pilot, Sync, Paging, Traffic Codes 8 Through 13) Channel Bandwidth = 1.2288 MHz. PAR = 9.8 dB @ 0.01% Probability on CCDF.  
Power Gain — 16.1 dB  
Drain Efficiency — 28%  
IM3 @ 2.5 MHz Offset — -37 dBc in 1.2288 MHz Channel Bandwidth  
ACPR @ 885 kHz Offset — -51 dBc in 30 kHz Channel Bandwidth
- Capable of Handling 10:1 VSWR, @ 28 Vdc, 1960 MHz, 100 Watts CW Output Power

### Features

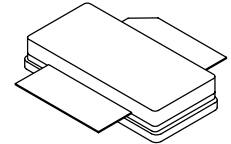
- Characterized with Series Equivalent Large-Signal Impedance Parameters
- Internally Matched for Ease of Use
- Qualified Up to a Maximum of 32  $V_{DD}$  Operation
- Integrated ESD Protection
- Designed for Lower Memory Effects and Wide Instantaneous Bandwidth Applications
- RoHS Compliant
- In Tape and Reel. R3 Suffix = 250 Units per 56 mm, 13 inch Reel.

**MRF6S19100HR3**  
**MRF6S19100HSR3**

**1930-1990 MHz, 22 W AVG., 28 V**  
**2 x N-CDMA**  
**LATERAL N-CHANNEL**  
**RF POWER MOSFETs**



**CASE 465-06, STYLE 1**  
**NI-780**  
**MRF6S19100HR3**



**CASE 465A-06, STYLE 1**  
**NI-780S**  
**MRF6S19100HSR3**

**Table 1. Maximum Ratings**

| Rating                               | Symbol    | Value        | Unit |
|--------------------------------------|-----------|--------------|------|
| Drain-Source Voltage                 | $V_{DSS}$ | -0.5, +68    | Vdc  |
| Gate-Source Voltage                  | $V_{GS}$  | -0.5, +12    | Vdc  |
| Storage Temperature Range            | $T_{stg}$ | - 65 to +150 | °C   |
| Case Operating Temperature           | $T_C$     | 150          | °C   |
| Operating Junction Temperature (1,2) | $T_J$     | 225          | °C   |

**Table 2. Thermal Characteristics**

| Characteristic                       | Symbol          | Value (2,3) | Unit |
|--------------------------------------|-----------------|-------------|------|
| Thermal Resistance, Junction to Case | $R_{\theta JC}$ | 0.44        | °C/W |
| Case Temperature 80°C, 100 W CW      |                 | 0.50        |      |
| Case Temperature 77°C, 22 W CW       |                 |             |      |

1. Continuous use at maximum temperature will affect MTTF.
2. MTTF calculator available at <http://www.freescale.com/rf>. Select Software & Tools/Development Tools/Calculators to access MTTF calculators by product.
3. 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 Methodology                      | Class        |
|---------------------------------------|--------------|
| Human Body Model (per JESD22-A114)    | 3A (Minimum) |
| Machine Model (per EIA/JESD22-A115)   | B (Minimum)  |
| Charge Device Model (per JESD22-C101) | IV (Minimum) |

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

| Characteristic | Symbol | Min | Typ | Max | Unit |
|----------------|--------|-----|-----|-----|------|
|----------------|--------|-----|-----|-----|------|

**Off Characteristics**

|                                                                                                   |           |   |   |    |                 |
|---------------------------------------------------------------------------------------------------|-----------|---|---|----|-----------------|
| Zero Gate Voltage Drain Leakage Current<br>( $V_{DS} = 68\text{ Vdc}$ , $V_{GS} = 0\text{ Vdc}$ ) | $I_{DSS}$ | — | — | 10 | $\mu\text{Adc}$ |
| Zero Gate Voltage Drain Leakage Current<br>( $V_{DS} = 28\text{ Vdc}$ , $V_{GS} = 0\text{ Vdc}$ ) | $I_{DSS}$ | — | — | 1  | $\mu\text{Adc}$ |
| Gate-Source Leakage Current<br>( $V_{GS} = 5\text{ Vdc}$ , $V_{DS} = 0\text{ Vdc}$ )              | $I_{GSS}$ | — | — | 1  | $\mu\text{Adc}$ |

**On Characteristics**

|                                                                                                               |              |     |      |     |     |
|---------------------------------------------------------------------------------------------------------------|--------------|-----|------|-----|-----|
| Gate Threshold Voltage<br>( $V_{DS} = 10\text{ Vdc}$ , $I_D = 250\text{ }\mu\text{Adc}$ )                     | $V_{GS(th)}$ | 1   | 2    | 3   | Vdc |
| Gate Quiescent Voltage<br>( $V_{DD} = 28\text{ Vdc}$ , $I_D = 900\text{ mAdc}$ , Measured in Functional Test) | $V_{GS(Q)}$  | 2   | 2.8  | 4   | Vdc |
| Drain-Source On-Voltage<br>( $V_{GS} = 10\text{ Vdc}$ , $I_D = 2.2\text{ Adc}$ )                              | $V_{DS(on)}$ | 0.1 | 0.21 | 0.3 | Vdc |

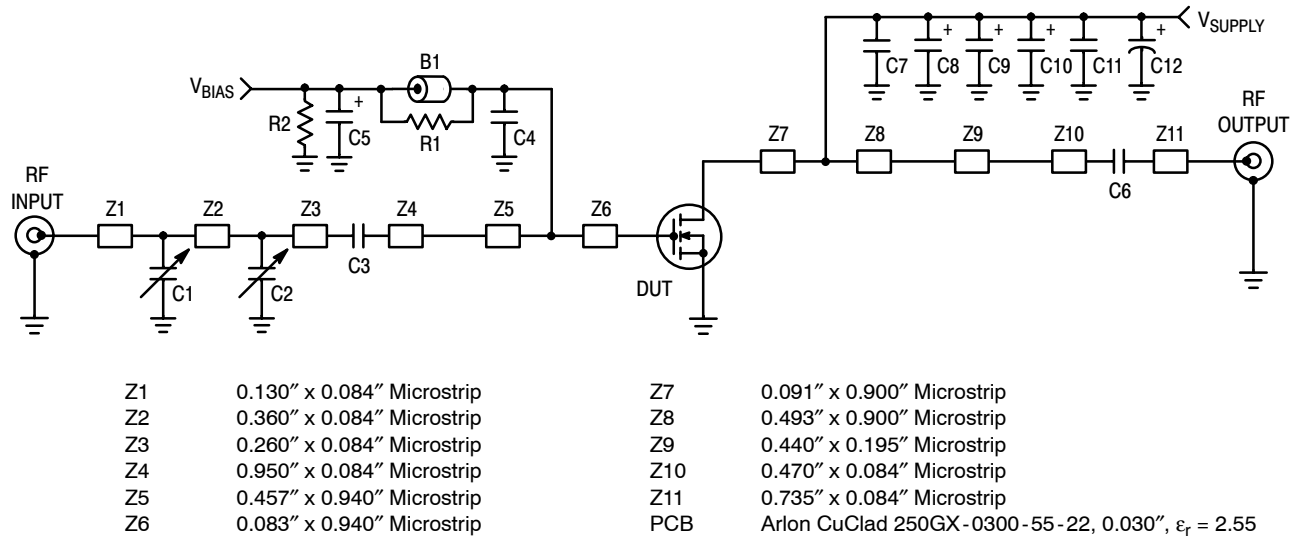
**Dynamic Characteristics <sup>(1)</sup>**

|                                                                                                                        |           |   |     |   |    |
|------------------------------------------------------------------------------------------------------------------------|-----------|---|-----|---|----|
| Reverse Transfer Capacitance<br>( $V_{DS} = 28\text{ Vdc} \pm 30\text{ mV(rms)}$ ac @ 1 MHz, $V_{GS} = 0\text{ Vdc}$ ) | $C_{rss}$ | — | 1.5 | — | pF |
|------------------------------------------------------------------------------------------------------------------------|-----------|---|-----|---|----|

**Functional Tests** (In Freescale Test Fixture, 50 ohm system)  $V_{DD} = 28\text{ Vdc}$ ,  $I_{DQ} = 900\text{ mA}$ ,  $P_{out} = 22\text{ W Avg.}$ ,  $f = 1987\text{ MHz}$ , 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                   | $G_{ps}$ | 15 | 16.1 | 18  | dB  |
| Drain Efficiency             | $\eta_D$ | 26 | 28   | —   | %   |
| Intermodulation Distortion   | IM3      | —  | -37  | -35 | dBc |
| Adjacent Channel Power Ratio | ACPR     | —  | -51  | -48 | dBc |
| Input Return Loss            | IRL      | —  | -15  | -9  | dB  |

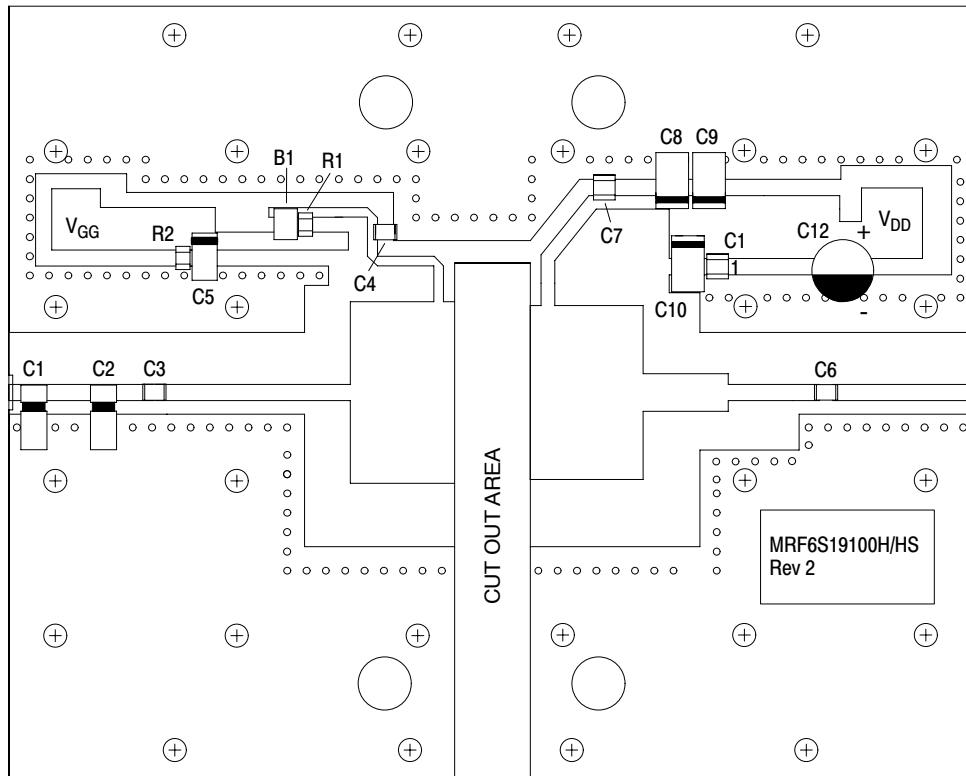
1. Part is internally matched both on input and output.



**Figure 1. MRF6S19100HR3(HSR3) Test Circuit Schematic**

**Table 5. MRF6S19100HR3(HSR3) Test Circuit Component Designations and Values**

| Part    | Description                                   | Part Number            | Manufacturer         |
|---------|-----------------------------------------------|------------------------|----------------------|
| B1      | RF Bead                                       | 2743019447             | Fair-Rite            |
| C1, C2  | 0.6 - 4.5 pF Variable Capacitors, Gigatronics | 27271SL                | Johanson Dielectrics |
| C3      | 15 pF Chip Capacitor                          | ATC100B150CT500XT      | ATC                  |
| C4, C7  | 5.6 pF Chip Capacitors                        | ATC100B5R6JT500XT      | ATC                  |
| C5      | 1 $\mu$ F, 50 V Tantalum Chip Capacitor       | T491C105K050AT         | Kemet                |
| C6      | 43 pF Chip Capacitor                          | ATC100B430CT500XT      | ATC                  |
| C8, C10 | 22 $\mu$ F, 35 V Tantalum Chip Capacitors     | T491X226K035AT         | Kemet                |
| C9      | 10 $\mu$ F, 35 V Tantalum Chip Capacitor      | T491C106K035AT         | Kemet                |
| C11     | 0.1 $\mu$ F Chip Capacitor                    | C1825C14J5RAC          | Kemet                |
| C12     | 100 $\mu$ F, 50 V Electrolytic Capacitor      | MCHT101M1HB- 1017 - RH | Multicomp            |
| R1      | 12 $\Omega$ , 1/4 W Chip Resistor             | CRCW120612R0FKEA       | Vishay               |
| R2      | 2 k $\Omega$ , 1/4 W Chip Resistor            | CRCW12062001FKEA       | Vishay               |



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**Figure 2. MRF6S19100HR3(HSR3) Test Circuit Component Layout**

## TYPICAL CHARACTERISTICS

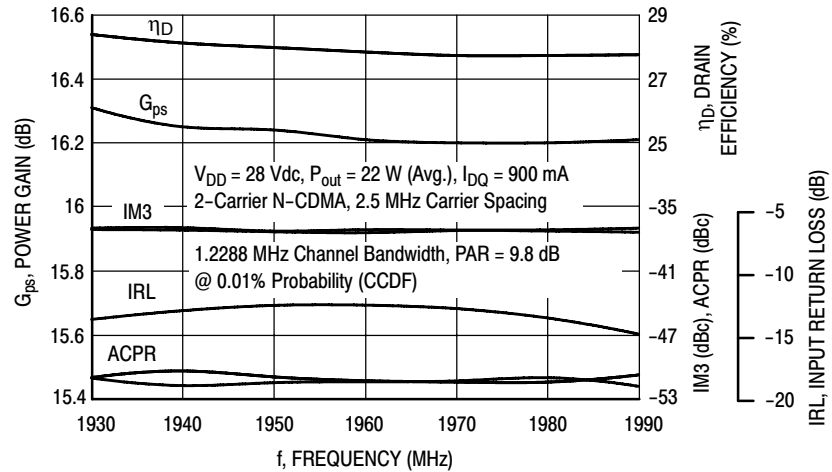


Figure 3. 2-Carrier N-CDMA Broadband Performance @  $P_{out} = 22$  Watts Avg.

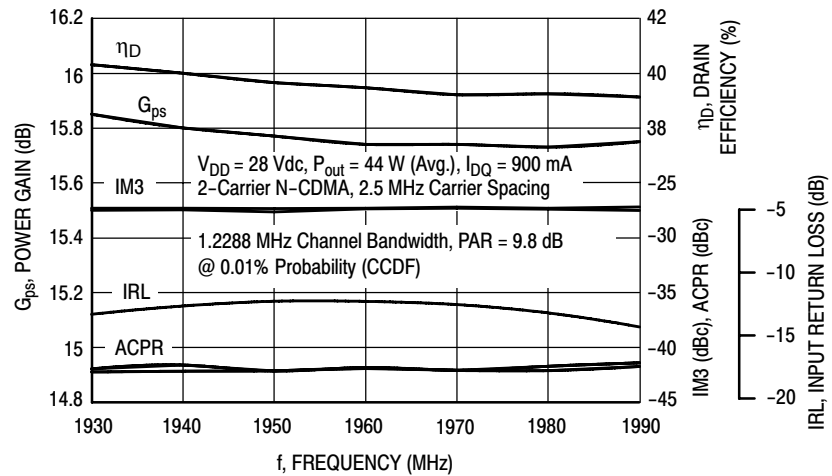


Figure 4. 2-Carrier N-CDMA Broadband Performance @  $P_{out} = 44$  Watts Avg.

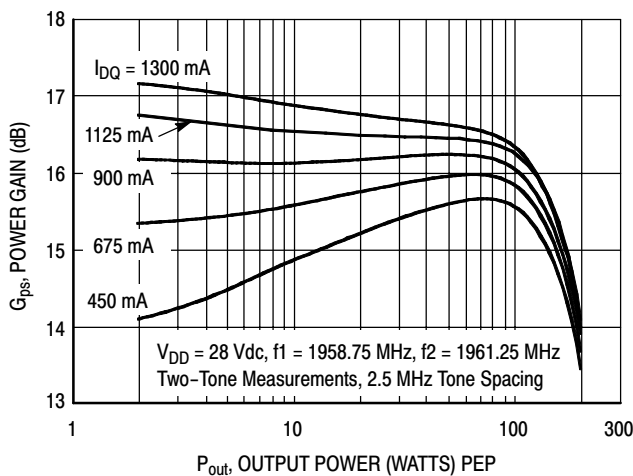


Figure 5. Two-Tone Power Gain versus Output Power

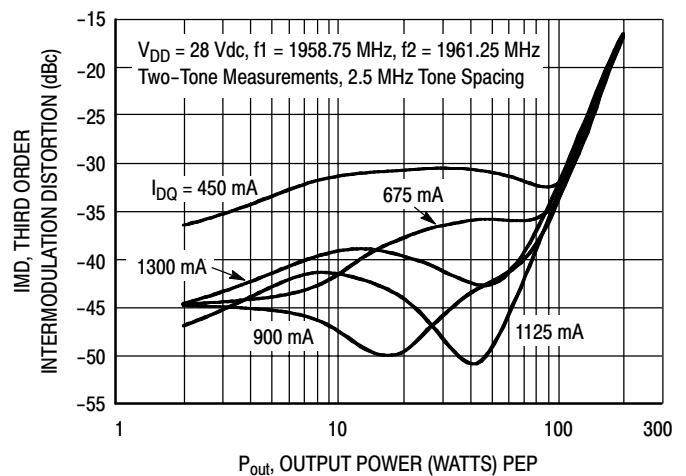
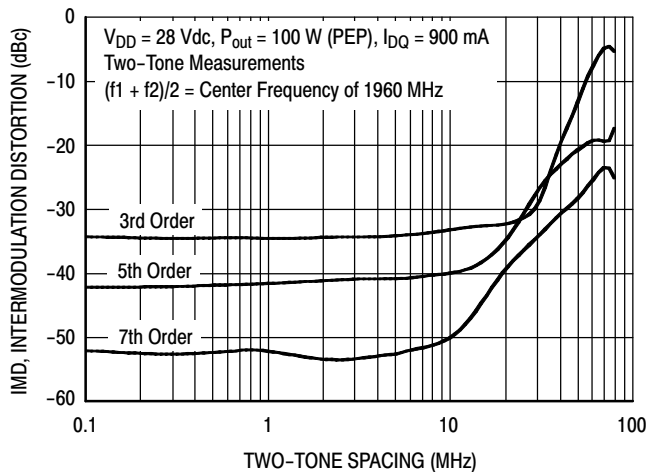
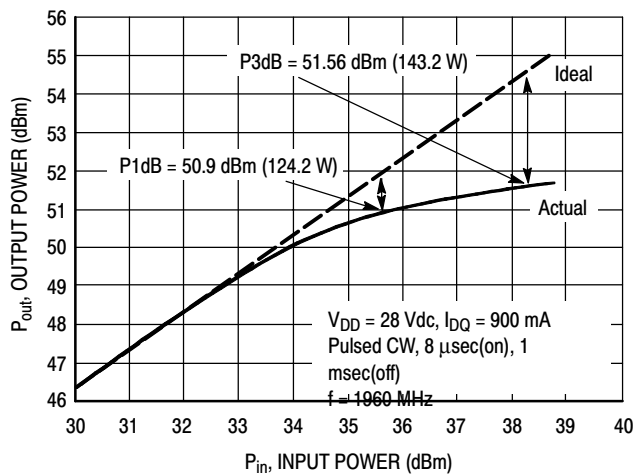


Figure 6. Third Order Intermodulation Distortion versus Output Power

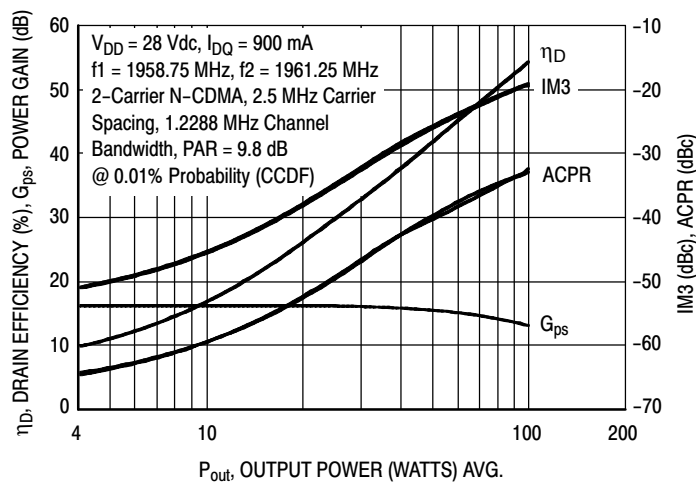
## TYPICAL CHARACTERISTICS



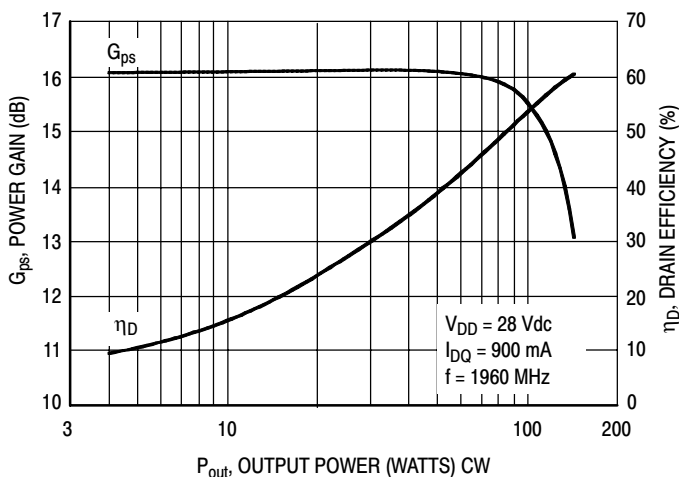
**Figure 7. Intermodulation Distortion Products versus Tone Spacing**



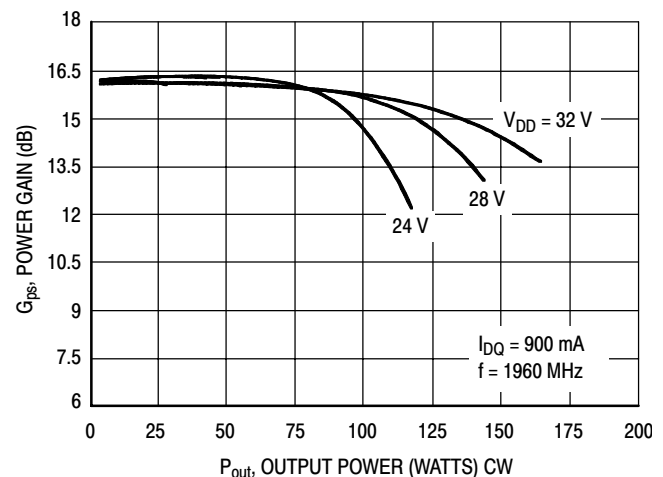
**Figure 8. Pulsed CW Output Power versus Input Power**



**Figure 9. 2-Carrier N-CDMA ACPR, IM3, Power Gain and Drain Efficiency versus Output Power**

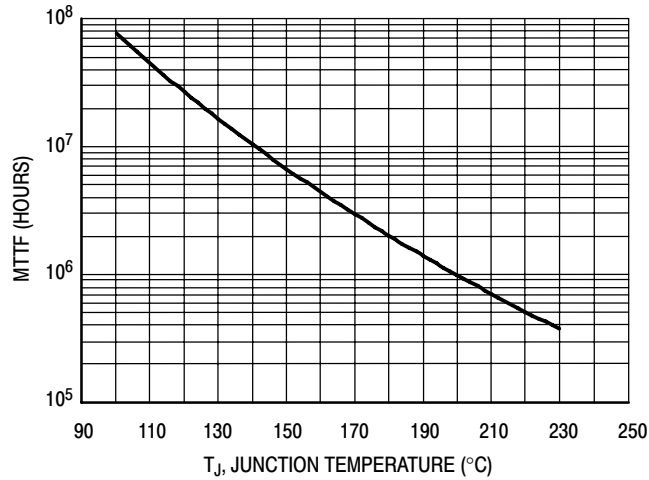


**Figure 10. Power Gain and Drain Efficiency versus CW Output Power**



**Figure 11. Power Gain versus Output Power**

## TYPICAL CHARACTERISTICS

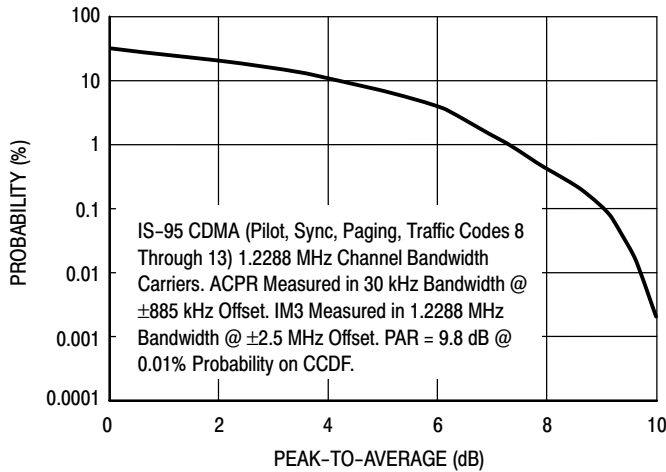


This above graph displays calculated MTTF in hours when the device is operated at  $V_{DD} = 28$  Vdc,  $P_{out} = 22$  W Avg., and  $\eta_D = 28\%$ .

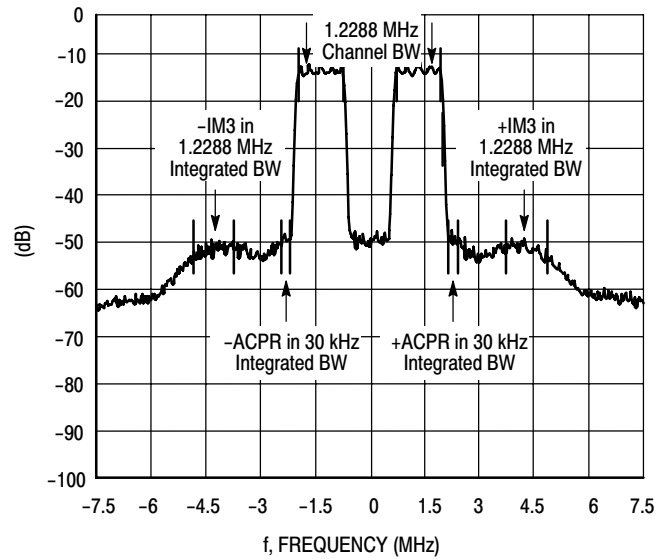
MTTF calculator available at <http://www.freescale.com/rf>. Select Software & Tools/Development Tools/Calculators to access MTTF calculators by product.

**Figure 12. MTTF Factor versus Junction Temperature**

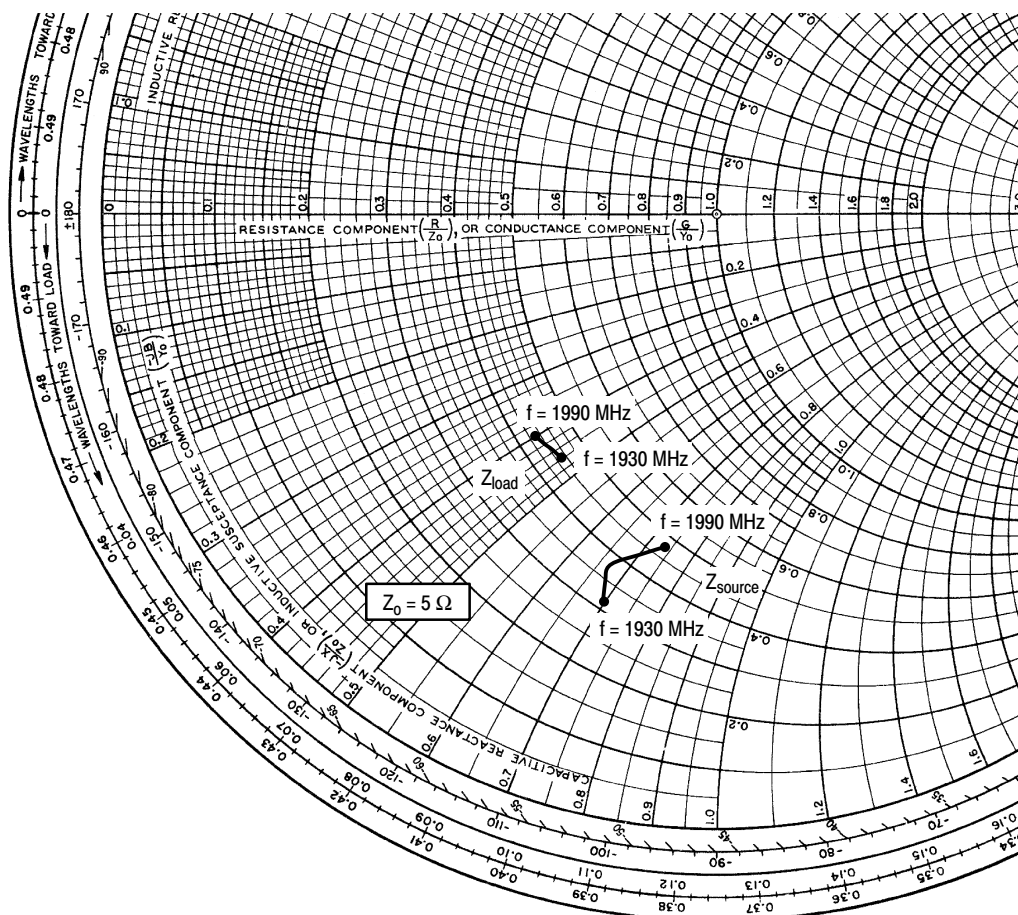
## N-CDMA TEST SIGNAL



**Figure 13. 2-Carrier CCDF N-CDMA**



**Figure 14. 2-Carrier N-CDMA Spectrum**



$V_{DD} = 28 \text{ Vdc}$ ,  $I_{DQ} = 900 \text{ mA}$ ,  $P_{out} = 22 \text{ W Avg.}$

| f<br>MHz | $Z_{source}$<br>$\Omega$ | $Z_{load}$<br>$\Omega$ |
|----------|--------------------------|------------------------|
| 1930     | $1.57 - j3.50$           | $2.26 - j2.31$         |
| 1960     | $1.83 - j3.29$           | $2.22 - j2.13$         |
| 1990     | $2.34 - j3.71$           | $2.14 - j2.00$         |

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

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

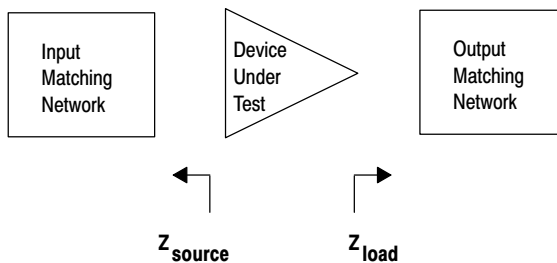
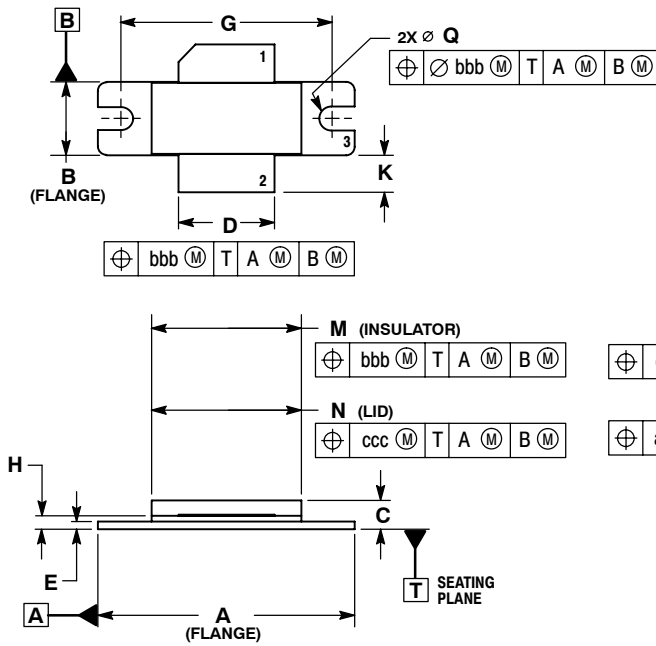


Figure 15. Series Equivalent Source and Load Impedance

## PACKAGE DIMENSIONS



### NOTES:

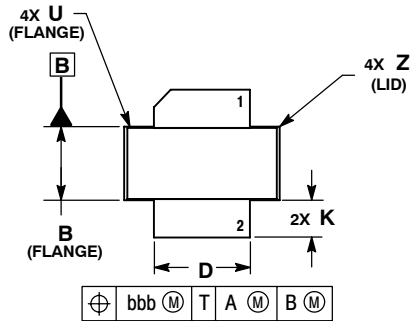
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M-1994.
2. CONTROLLING DIMENSION: INCH.
3. DELETED
4. DIMENSION H IS MEASURED 0.030 (0.762) AWAY FROM PACKAGE BODY.

| DIM | INCHES              |                     | MILLIMETERS        |                    |
|-----|---------------------|---------------------|--------------------|--------------------|
|     | 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   | $\varnothing 1.118$ | $\varnothing 1.138$ | $\varnothing 3.00$ | $\varnothing 3.51$ |
| 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
- GATE
- SOURCE

**CASE 465-06  
ISSUE G  
NI-780  
MRF6S19100HR3**



### 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.

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

**CASE 465A-06  
ISSUE H  
NI-780S  
MRF6S19100HSR3**

**MRF6S19100HR3 MRF6S19100HSR3**

## PRODUCT DOCUMENTATION

Refer to the following documents to aid your design process.

### Application Notes

- AN1955: Thermal Measurement Methodology of RF Power Amplifiers

### Engineering Bulletins

- EB212: Using Data Sheet Impedances for RF LDMOS Devices

## REVISION HISTORY

The following table summarizes revisions to this document.

| Revision | Date      | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|----------|-----------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 5        | Dec. 2008 | <ul style="list-style-type: none"><li>• Modified data sheet to reflect RF Test Reduction described in Product and Process Change Notification number, PCN13232, p. 1, 2</li><li>• Removed Lower Thermal Resistance and Low Gold Plating bullets from Features section as functionality is standard, p. 1</li><li>• Removed Total Device Dissipation from Max Ratings table as data was redundant (information already provided in Thermal Characteristics table), p. 1</li><li>• Operating Junction Temperature increased from 200°C to 225°C in Maximum Ratings table, related "Continuous use at maximum temperature will affect MTTF" footnote added, p. 1</li><li>• Corrected <math>V_{DS}</math> to <math>V_{DD}</math> in the RF test condition voltage callout for <math>V_{GS(Q)}</math>, and added "Measured in Functional Test", On Characteristics table, p. 2</li><li>• Removed Forward Transconductance from On Characteristics table as it no longer provided usable information, p. 2</li><li>• Updated PCB information to show more specific material details, Fig. 1, Test Circuit Schematic, p. 3</li><li>• Updated Part Numbers in Table 5, Component Designations and Values, to RoHS compliant part numbers, p. 3</li><li>• Removed lower voltage tests from Fig. 11, Power Gain versus Output Power, due to fixed tuned fixture limitations, p. 6</li><li>• Replaced Fig. 12, MTTF versus Junction Temperature with updated graph. Removed Amps<sup>2</sup> and listed operating characteristics and location of MTTF calculator for device, p. 7</li><li>• Added Product Documentation and Revision History, p. 10</li></ul> |

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1-8-1, Shimo-Meguro, Meguro-ku,  
Tokyo 153-0064  
Japan  
0120 191014 or +81 3 5437 9125  
[support.japan@freescale.com](mailto:support.japan@freescale.com)

### **Asia/Pacific:**

Freescale Semiconductor China Ltd.  
Exchange Building 23F  
No. 118 Jianguo Road  
Chaoyang District  
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