Document Number: MRF6S19120H
Rev. 2, 12/2008

RoHS

# RF Power Field Effect Transistors

## N-Channel Enhancement-Mode Lateral MOSFETs

**MRF6S19120HR3**
**MRF6S19120HSR3**

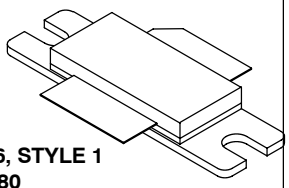
**1930-1990 MHz, 19 W AVG., 28 V**
**SINGLE N-CDMA**
**LATERAL N-CHANNEL**
**RF POWER MOSFETs**

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.

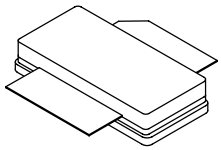
- Typical Single-Carrier N-CDMA Performance: $V_{DD}$ = 28 Volts, $I_{DQ}$ = 1000 mA, $P_{out}$ = 19 Watts Avg., f = 1990 MHz, IS-95 CDMA (Pilot, Sync, Paging, Traffic Codes 8 Through 13) Channel Bandwidth = 1.2288 MHz. PAR = 9.8 dB @ 0.01% Probability on CCDF.
  - Power Gain — 15 dB
  - Drain Efficiency — 21.5%
  - ACPR @ 885 kHz Offset — -54 dBc in 30 kHz Bandwidth
- Capable of Handling 10:1 VSWR, @ 28 Vdc, 1960 MHz, 120 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.



**CASE 465-06, STYLE 1**
**NI-780**
**MRF6S19120HR3**



**CASE 465A-06, STYLE 1**
**NI-780S**
**MRF6S19120HSR3**

**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<br>Case Temperature 80°C, 120 W CW<br>Case Temperature 73°C, 19 W CW | $R_{\theta JC}$ | <br>0.43<br>0.45 | °C/W |

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.



ARCHIVE INFORMATION



freescale semiconductor

**Table 3. ESD Protection Characteristics**

| Test Methodology | Class |
|---|---|
| Human Body Model (per JESD22-A114) | 1A (Minimum) |
| Machine Model (per EIA/JESD22-A115) | A (Minimum) |
| Charge Device Model (per JESD22-C101) | IV (Minimum) |

**Table 4. Electrical Characteristics** ($T_C$ = 25°C unless otherwise noted)

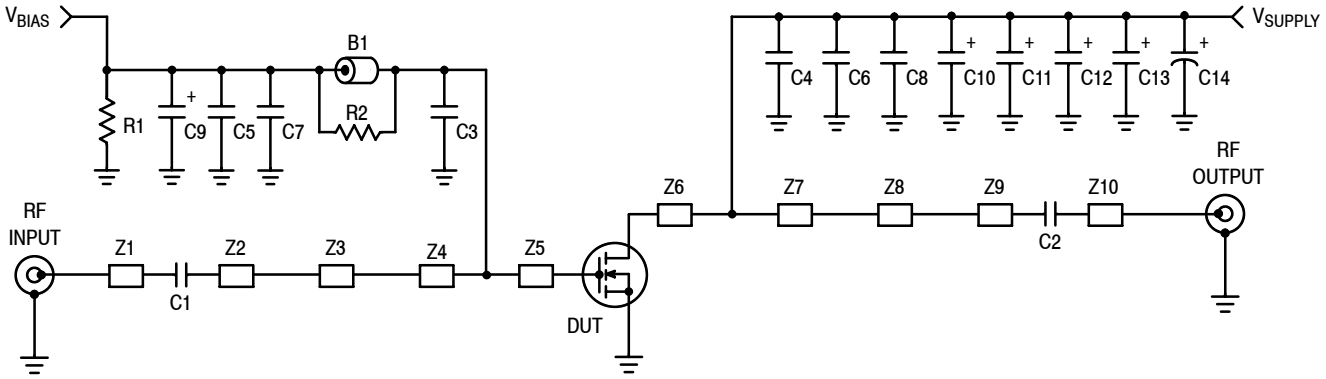
| Characteristic | Symbol | Min | Typ | Max | Unit |
|---|---|---|---|---|---|
| **Off Characteristics** | | | | | |
| Zero Gate Voltage Drain Leakage Current ($V_{DS}$ = 68 Vdc, $V_{GS}$ = 0 Vdc) | $I_{DSS}$ | — | — | 10 | μAdc |
| Zero Gate Voltage Drain Leakage Current ($V_{DS}$ = 28 Vdc, $V_{GS}$ = 0 Vdc) | $I_{DSS}$ | — | — | 1 | μAdc |
| Gate-Source Leakage Current ($V_{GS}$ = 5 Vdc, $V_{DS}$ = 0 Vdc) | $I_{GSS}$ | — | — | 1 | μAdc |
| **On Characteristics** | | | | | |
| Gate Threshold Voltage ($V_{DS}$ = 10 Vdc, $I_D$ = 270 μAdc) | $V_{GS(th)}$ | 1 | 2 | 3 | Vdc |
| Gate Quiescent Voltage ($V_{DD}$ = 28 Vdc, $I_D$ = 1000 mAdc Measured in Functional Test) | $V_{GS(Q)}$ | 2 | 2.8 | 4 | Vdc |
| Drain-Source On-Voltage ($V_{GS}$ = 10 Vdc, $I_D$ = 2.7 Adc) | $V_{DS(on)}$ | — | 0.21 | 0.3 | Vdc |
| **Dynamic Characteristics** (1) | | | | | |
| Reverse Transfer Capacitance ($V_{DS}$ = 28 Vdc ± 30 mV(rms)ac @ 1 MHz, $V_{GS}$ = 0 Vdc) | $C_{rss}$ | — | 1.95 | — | pF |

**Functional Tests** (In Freescale Test Fixture, 50 ohm system) $V_{DD}$ = 28 Vdc, $I_{DQ}$ = 1000 mA, $P_{out}$ = 19 W Avg. N-CDMA, f = 1990 MHz, Single-Carrier N-CDMA, 1.2288 MHz Channel Bandwidth Carrier. ACPR measured in 30 kHz Channel Bandwidth @ ±885 kHz Offset. PAR = 9.8 dB @ 0.01% Probability on CCDF.

| | | | | | |
|---|---|---|---|---|---|
| Power Gain | $G_{ps}$ | 14 | 15 | 17 | dB |
| Drain Efficiency | $\eta_D$ | 20 | 21.5 | — | % |
| Adjacent Channel Power Ratio | ACPR | — | -54 | -48 | dBc |
| Input Return Loss | IRL | — | -13 | -9 | dB |

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


ARCHIVE INFORMATION




| | | | |
|---|---|---|---|
| Z1 | 1.242″ x 0.084″ Microstrip | Z7 | 0.387″ x 1.098″ Microstrip |
| Z2 | 0.839″ x 0.084″ Microstrip | Z8 | 0.169″ x 0.316″ Microstrip |
| Z3 | 0.230″ x 0.180″ Microstrip | Z9 | 0.781″ x 0.084″ Microstrip |
| Z4 | 0.320″ x 1.100″ Microstrip | Z10 | 1.228″ x 0.084″ Microstrip |
| Z5 | 0.093″ x 1.100″ Microstrip | PCB | Arlon CuClad 250GX-0300-55-22, 0.030″, $\varepsilon_r$ = 2.55 |
| Z6 | 0.160″ x 1.098″ Microstrip | | |

**Figure 1. MRF6S19120HR3(SR3) Test Circuit Schematic**

**Table 5. MRF6S19120HR3(SR3) Test Circuit Component Designations and Values**

| Part | Description | Part Number | Manufacturer |
|---|---|---|---|
| B1 | Short RF Bead | 2743019447 | Fair-Rite |
| C1, C2 | 10 pF Chip Capacitors | ATC100B100JT500XT | ATC |
| C3, C4 | 5.1 pF Chip Capacitors | ATC100B5R1CT500XT | ATC |
| C5, C6 | 1.0 nF Chip Capacitors | ATC100B102JT500XT | ATC |
| C7, C8 | 0.1 μF Chip Capacitors | C1825C100J5RAC | Kemet |
| C9 | 10 μF, 35 V Tantalum Chip Capacitor | T491X106K035AT | Kemet |
| C10, C11 | 10 μF, 35 V Tantalum Chip Capacitors | GRM55DR61H106KA88L | Murata |
| C12, C13 | 22 μF, 50 V Tantalum Chip Capacitors | T491C105K022AT | Kemet |
| C14 | 470 μF, 63 V Electrolytic Capacitor, Radial | EMVY630GTR471MLN0S | Nippon Chemi-Con |
| R1 | 560 KΩ, 1/4 W Chip Resistor | CRCW12065603FKEA | Vishay |
| R2 | 10 Ω, 1/4 W Chip Resistor | CRCW120610R0FKEA | Vishay |


ARCHIVE INFORMATION

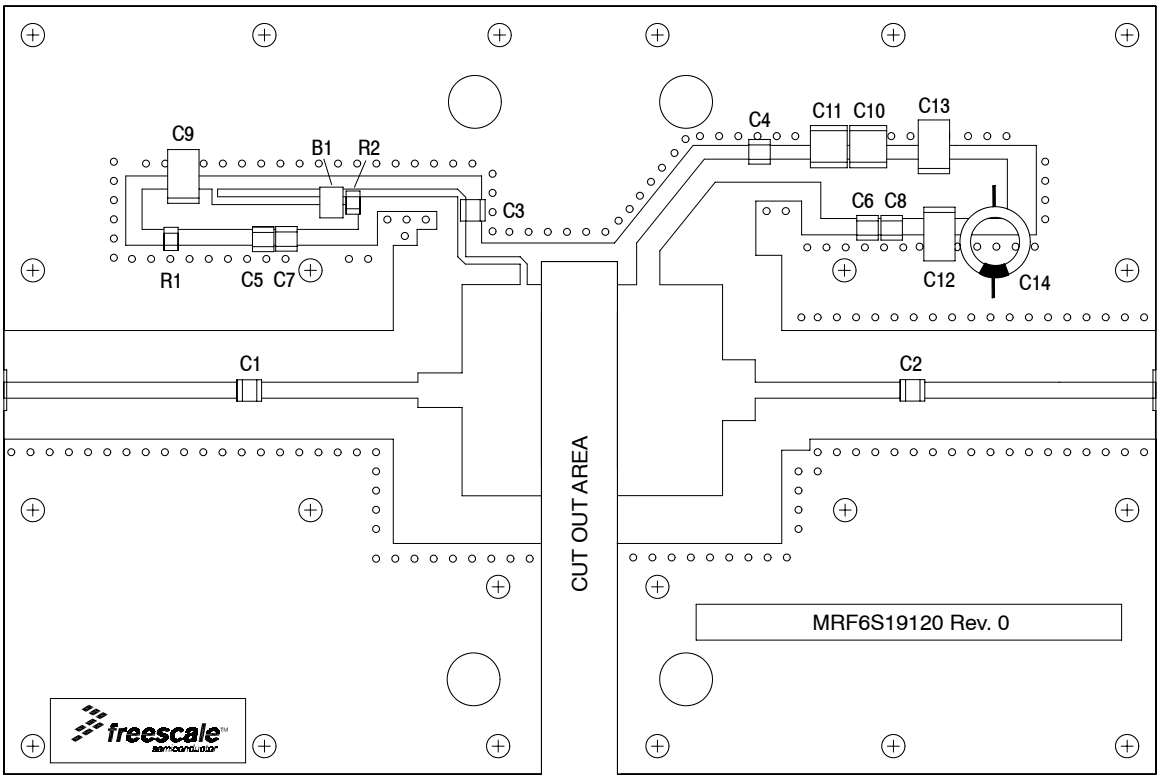



**Figure 2. MRF6S19120HR3(SR3) Test Circuit Component Layout**

## TYPICAL CHARACTERISTICS

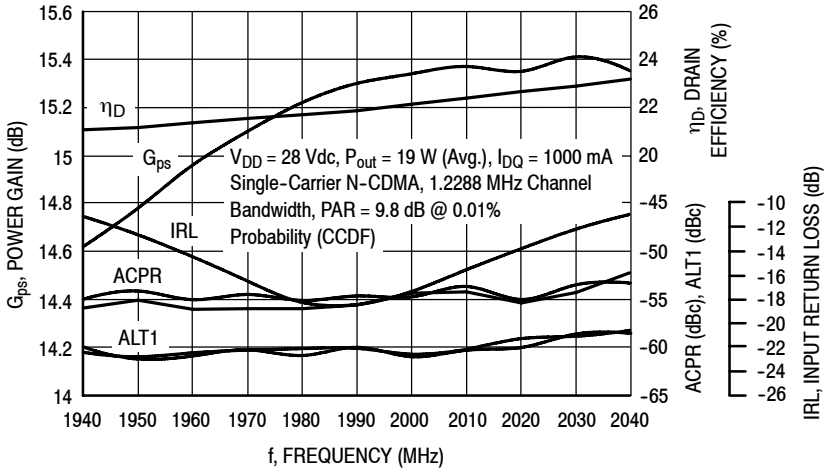



**Figure 3. 2-Carrier N-CDMA Broadband Performance @ $P_{out}$ = 19 Watts Avg.**

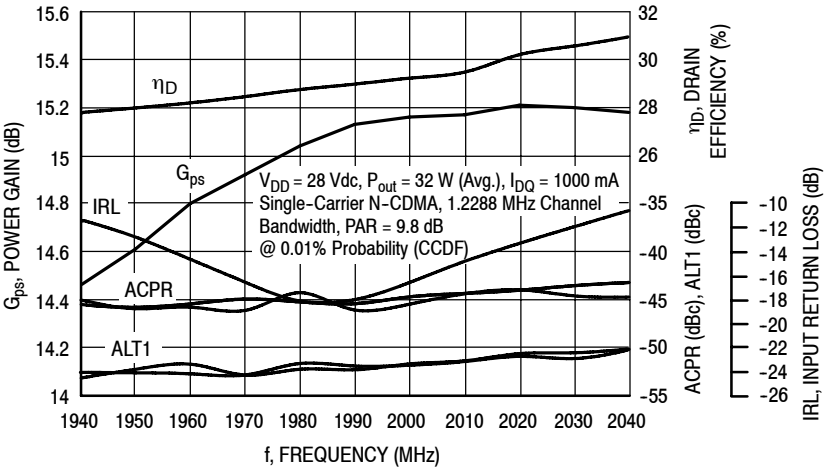



**Figure 4. 2-Carrier N-CDMA Broadband Performance @ $P_{out}$ = 32 Watts Avg.**

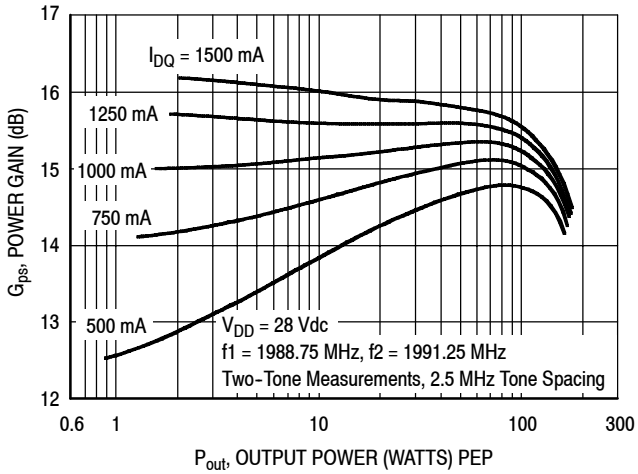



**Figure 5. Two-Tone Power Gain versus Output Power**

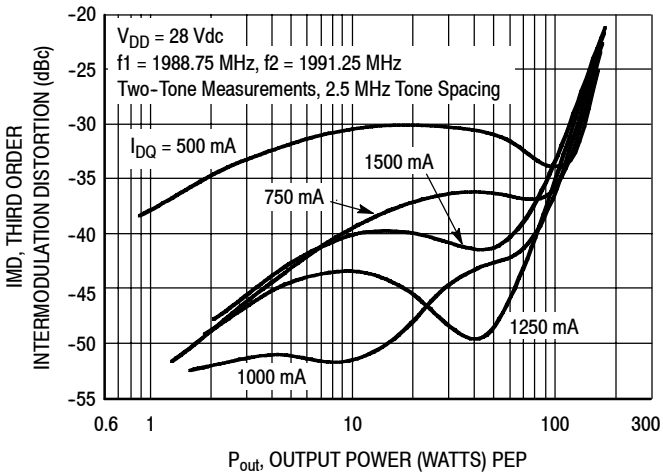



**Figure 6. Third Order Intermodulation Distortion versus Output Power**

## TYPICAL CHARACTERISTICS

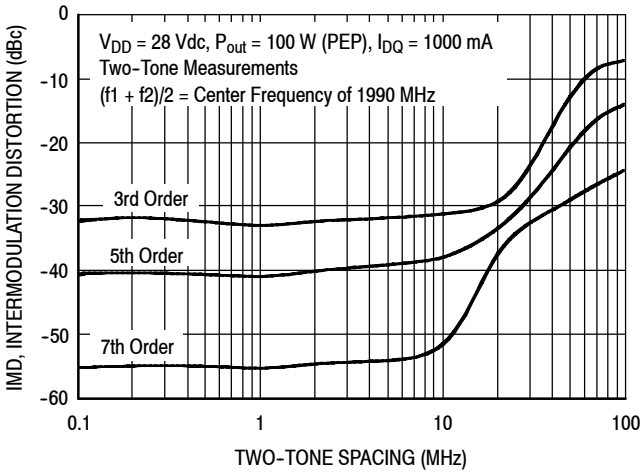



**Figure 7. Intermodulation Distortion Products versus Tone Spacing**

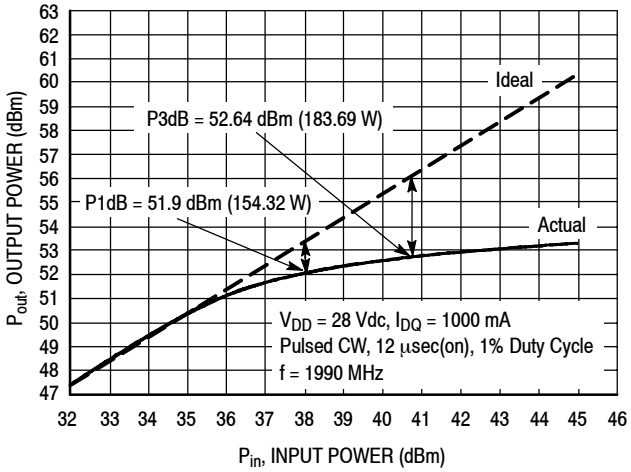



**Figure 8. Pulsed CW Output Power versus Input Power**

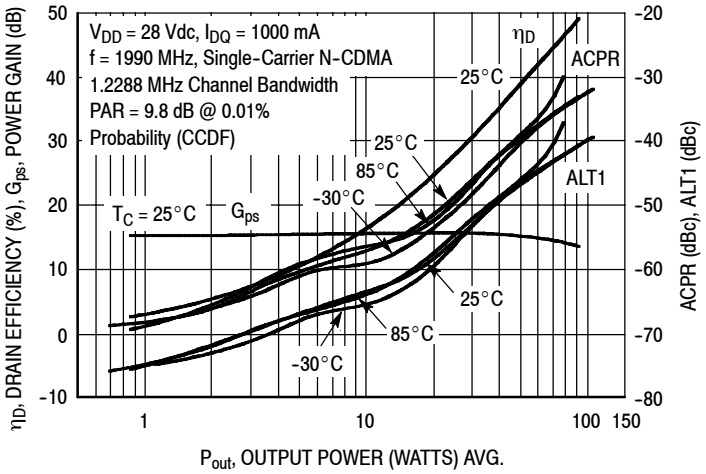



**Figure 9. Single-Carrier N-CDMA ACPR, ALT1, Power Gain and Drain Efficiency versus Output Power**

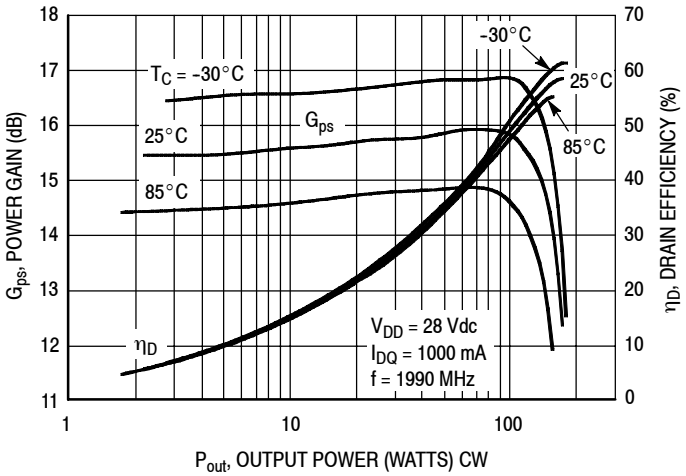



**Figure 10. Power Gain and Drain Efficiency versus CW Output Power**

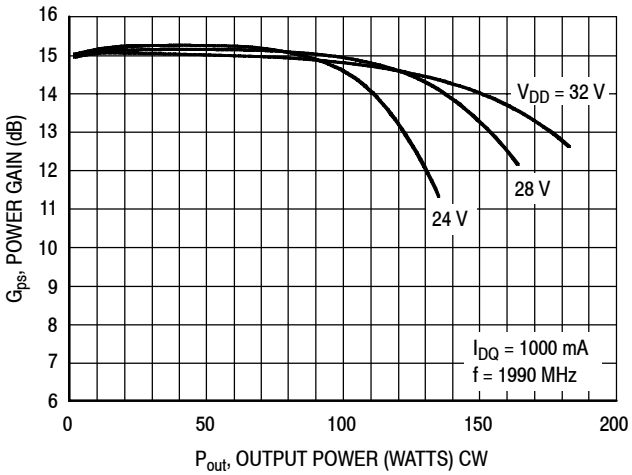
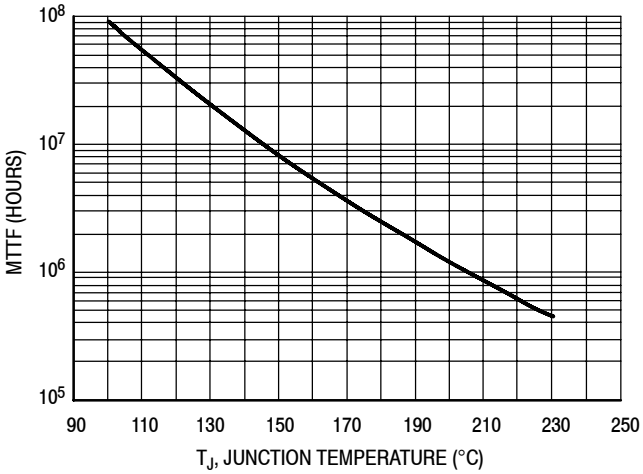



**Figure 11. Power Gain versus Output Power**

## TYPICAL CHARACTERISTICS




This above graph displays calculated MTTF in hours when the device is operated at $V_{DD}$ = 28 Vdc, $P_{out}$ = 19 W Avg., and $\eta_D$ = 21.5%.

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

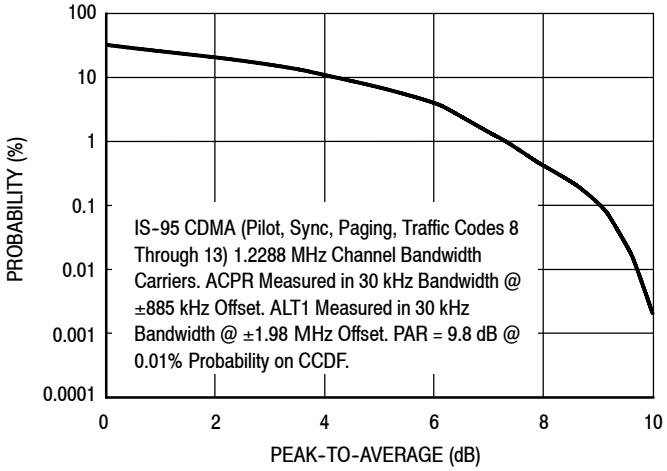



**Figure 13. Single-Carrier CCDF N-CDMA**

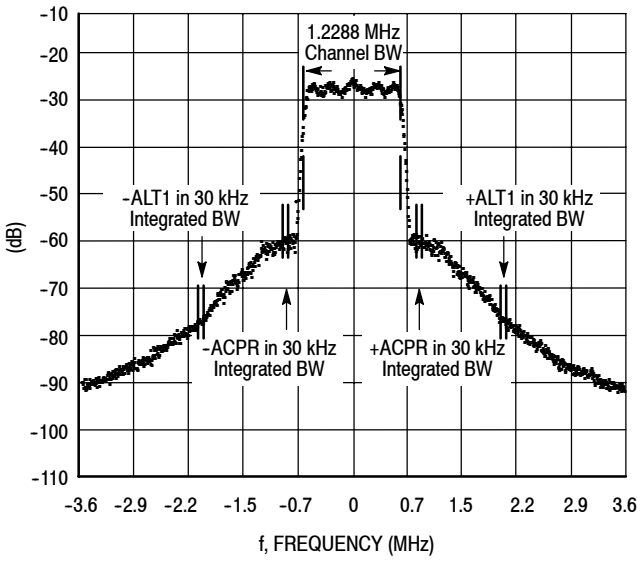
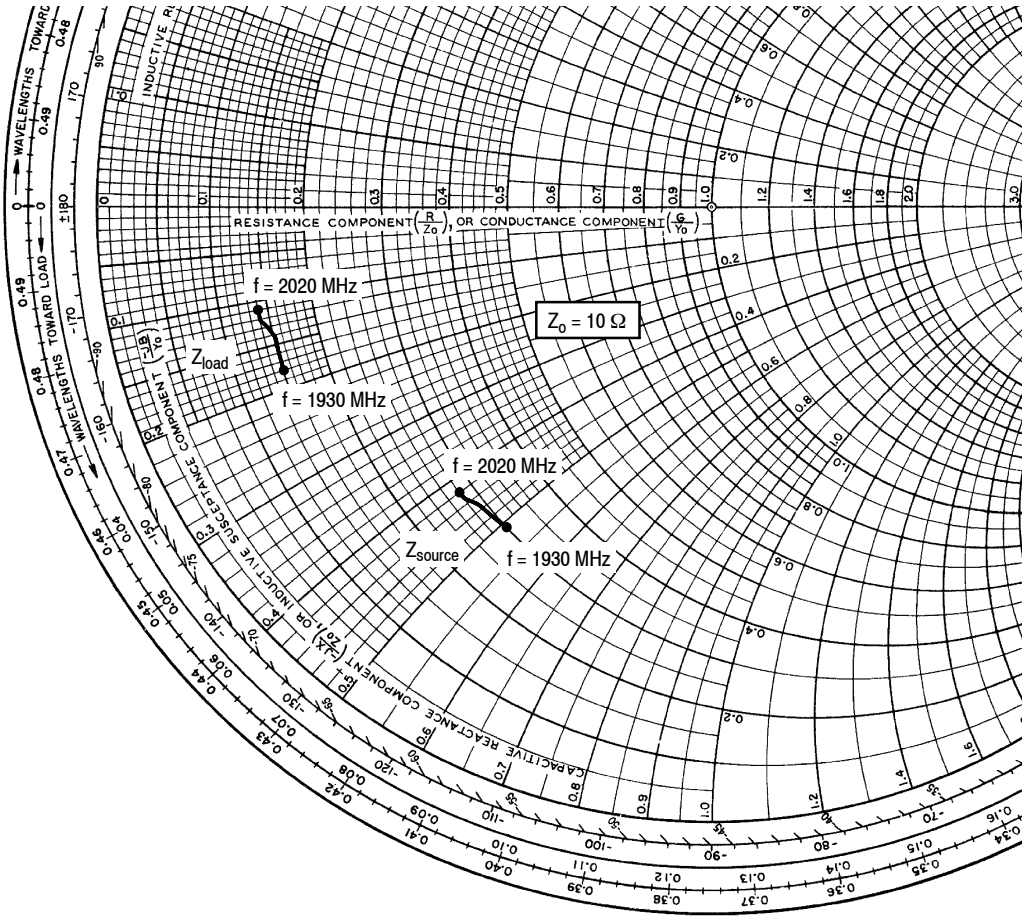



**Figure 14. Single-Carrier N-CDMA Spectrum**

ARCHIVE INFORMATION




$V_{DD}$ = 28 Vdc, $I_{DQ}$ = 1000 mA, $P_{out}$ = 19 W Avg.

| f MHz | $Z_{source}$ Ω | $Z_{load}$ Ω |
|---|---|---|
| 1930 | 3.03 – j5.14 | 1.52 – j1.77 |
| 1960 | 2.94 – j4.54 | 1.51 – j1.37 |
| 1990 | 2.75 – j4.34 | 1.38 – j1.20 |
| 2020 | 2.75 – j4.18 | 1.41 – j1.11 |

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

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

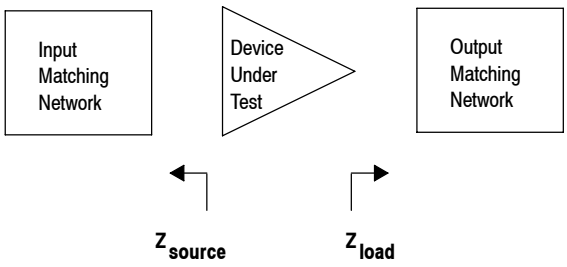
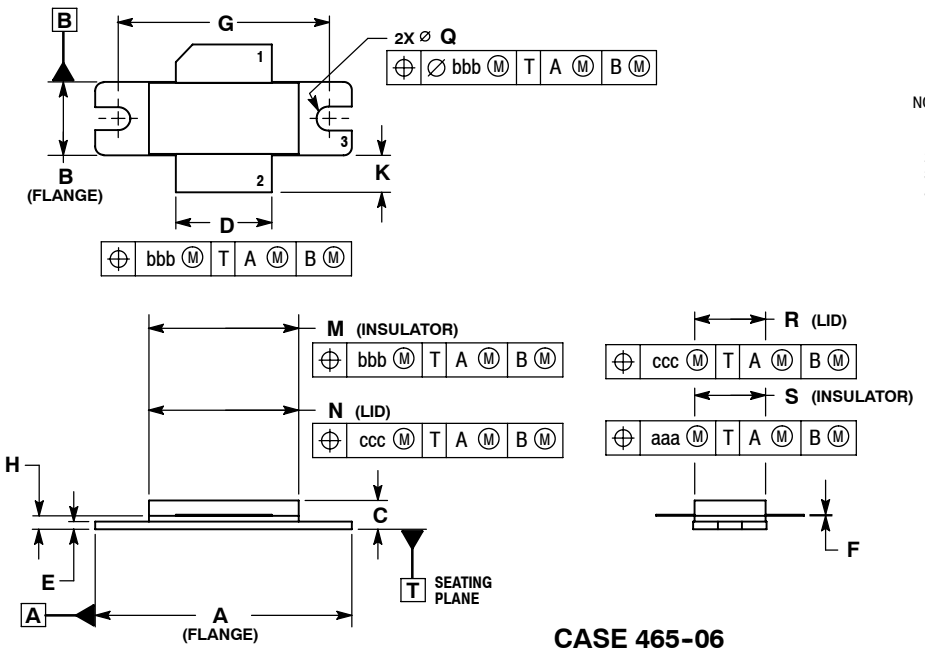



**Figure 15. Series Equivalent Source and Load Impedance**

## PACKAGE DIMENSIONS

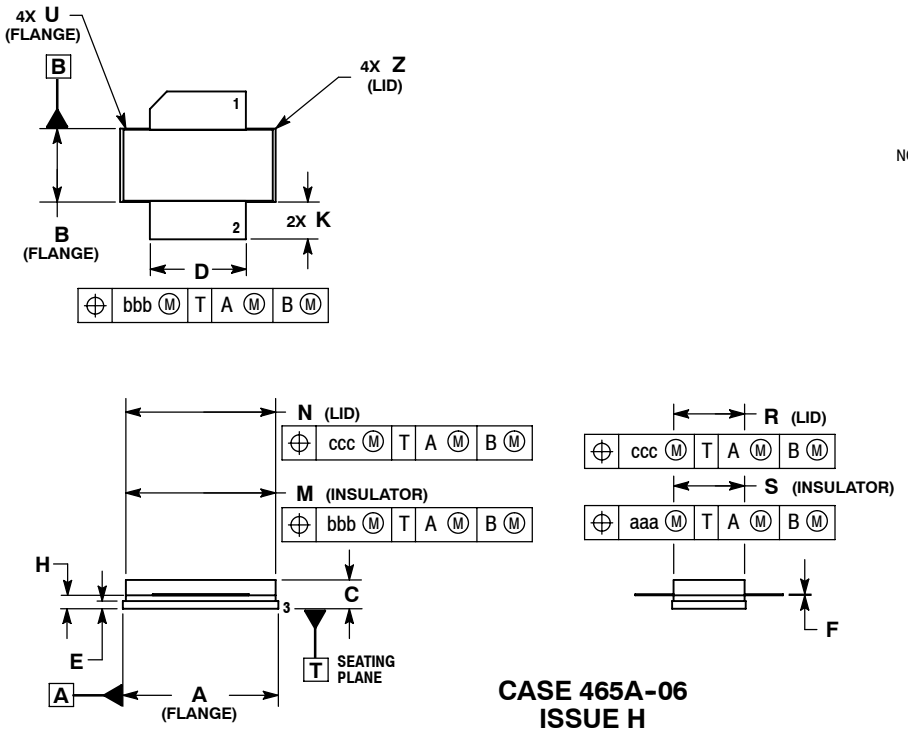



NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M-1994.
2. CONTROLLING DIMENSION: INCH.
3. DELETED
4. DIMENSION H IS MEASURED 0.030 (0.762) AWAY FROM PACKAGE BODY.

| | 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 G**
**NI-780**
**MRF6S19120HR3**




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 | 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 H**
**NI-780S**
**MRF6S19120HSR3**

## 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 |
|---|---|---|
| 2 | Dec. 2008 | • Changed ”Full Frequency Band” to ”f = 1990 MHz” to match functional tests, p. 1<br>• Removed Lower Thermal Resistance and Low Gold Plating bullets from Features section as functionality is standard, p. 1<br>• Removed Total Device Dissipation from Max Ratings table as data was redundant (information already provided in Thermal Characteristics table), p. 1<br>• 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<br>• Corrected $V_{DS}$ to $V_{DD}$ in the RF test condition voltage callout for $V_{GS(Q)}$, and added “Measured in Functional Test”, On Characteristics table, p. 2<br>• Removed Forward Transconductance from On Characteristics table as it no longer provided usable information, p. 2<br>• Updated PCB information to show more specific material details, Fig. 1, Test Circuit Schematic, p. 3<br>• Updated Part Numbers in Table 5, Component Designations and Values, to latest RoHS compliant part numbers, p. 3<br>• Removed lower voltage tests from Fig. 11, Power Gain versus Output Power, due to fixed tuned fixture limitations, p. 6<br>• Replaced Fig. 12, MTTF versus Junction Temperature with updated graph. Removed $Amps^2$ and listed operating characteristics and location of MTTF calculator for device, p. 7<br>• Updated ALT1 Bandwidth and Offset in Fig. 13, Single-Carrier CCDF N-CDMA, p. 7<br>• Updated -ALT1 and +ALT1 Bandwidths in Fig. 14, Single-Carrier N-CDMA Spectrum, p. 7<br>• Added Product Documentation and Revision History, p. 10 |
| | Dec. 2010 | • Data sheet archived. Parts no longer manufactured. |



ARCHIVE INFORMATION

ARCHIVE INFORMATION

## *How to Reach Us:*

**Home Page:**
www.freescale.com

**Web Support:**
http://www.freescale.com/support

**USA/Europe or Locations Not Listed:**
Freescale Semiconductor, Inc.
Technical Information Center, EL516
2100 East Elliot Road
Tempe, Arizona 85284
1-800-521-6274 or +1-480-768-2130
www.freescale.com/support

**Europe, Middle East, and Africa:**
Freescale Halbleiter Deutschland GmbH
Technical Information Center
Schatzbogen 7
81829 Muenchen, Germany
+44 1296 380 456 (English)
+46 8 52200080 (English)
+49 89 92103 559 (German)
+33 1 69 35 48 48 (French)
www.freescale.com/support

**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
support.japan@freescale.com

**Asia/Pacific:**
Freescale Semiconductor China Ltd.
Exchange Building 23F
No. 118 Jianguo Road
Chaoyang District
Beijing 100022
China
+86 10 5879 8000
support.asia@freescale.com

***For Literature Requests Only:***
Freescale Semiconductor Literature Distribution Center
P.O. Box 5405
Denver, Colorado 80217
1-800-441-2447 or +1-303-675-2140
Fax: +1-303-675-2150
LDCForFreescaleSemiconductor@hibbertgroup.com



Document Number: MRF6S19120H
Rev. 2, 12/2008