

RF Power Field Effect Transistors

N-Channel Enhancement-Mode Lateral MOSFETs

Designed for PCN and PCS 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, $I_{DQ} = 1150$ mA, $P_{out} = 29$ 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 — 16 dB
Drain Efficiency — 27.5%
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, 140 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
- Optimized for Doherty Applications
- RoHS Compliant
- In Tape and Reel. R3 Suffix = 250 Units per 56 mm, 13 inch Reel.

MRF6S19140HR3
MRF6S19140HSR3

1930-1990 MHz, 29 W AVG., 28 V
2 x N-CDMA
LATERAL N-CHANNEL
RF POWER MOSFETs

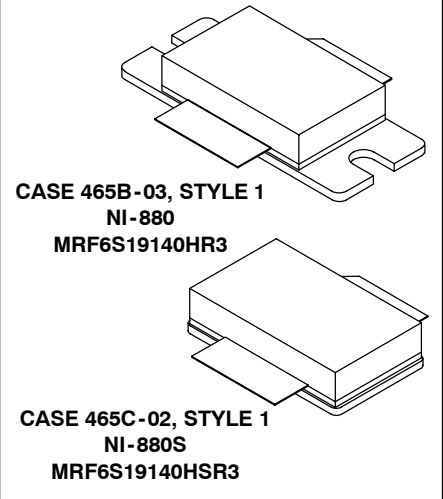


Table 1. Maximum Ratings

| 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 | $R_{\theta JC}$ | | °C/W |
| Case Temperature 80°C, 140 W CW | | 0.33 | |
| Case Temperature 77°C, 29 W CW | | 0.38 | |

1. Continuous use at maximum temperature will affect MTTF.
2. MTTF calculator available at <http://www.freescale.com/rf>. Select Tools/Software/Application Software/Calculators to access the 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) | 2 (Minimum) |
| Machine Model (per EIA/JESD22-A115) | A (Minimum) |
| Charge Device Model (per JESD22-C101) | IV (Minimum) |

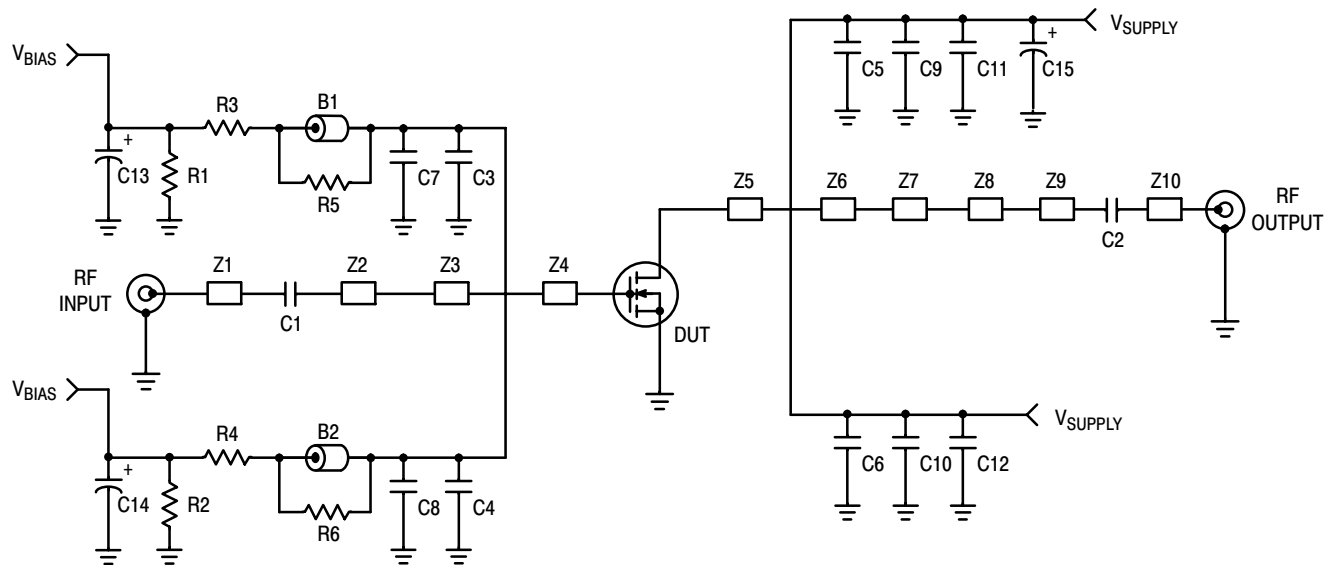
Table 4. Electrical Characteristics ($T_C = 25^\circ\text{C}$ unless otherwise noted)

| Characteristic | Symbol | Min | Typ | Max | Unit |
|---|--------------|-----|------|-----|-----------------|
| Off Characteristics | | | | | |
| Zero Gate Voltage Drain Leakage Current ($V_{DS} = 68\text{ Vdc}$, $V_{GS} = 0\text{ Vdc}$) | I_{DSS} | — | — | 10 | μAdc |
| Zero Gate Voltage Drain Leakage Current ($V_{DS} = 28\text{ Vdc}$, $V_{GS} = 0\text{ Vdc}$) | I_{DSS} | — | — | 1 | μAdc |
| Gate-Source Leakage Current ($V_{GS} = 5\text{ Vdc}$, $V_{DS} = 0\text{ Vdc}$) | I_{GSS} | — | — | 1 | μAdc |
| On Characteristics | | | | | |
| Gate Threshold Voltage ($V_{DS} = 10\text{ Vdc}$, $I_D = 300\ \mu\text{Adc}$) | $V_{GS(th)}$ | 1 | 2 | 3 | Vdc |
| Gate Quiescent Voltage ($V_{DD} = 28\text{ Vdc}$, $I_D = 1150\text{ mAdc}$, Measured in Functional Test) | $V_{GS(Q)}$ | 2 | 2.8 | 4 | Vdc |
| Drain-Source On-Voltage ($V_{GS} = 10\text{ Vdc}$, $I_D = 3\text{ Adc}$) | $V_{DS(on)}$ | 0.1 | 0.21 | 0.3 | Vdc |
| Dynamic Characteristics ⁽¹⁾ | | | | | |
| Reverse Transfer Capacitance ($V_{DS} = 28\text{ Vdc} \pm 30\text{ mV(rms)ac}$ @ 1 MHz, $V_{GS} = 0\text{ Vdc}$) | C_{rss} | — | 2 | — | pF |

Functional Tests (In Freescale Test Fixture, 50 ohm system) $V_{DD} = 28\text{ Vdc}$, $I_{DQ} = 1150\text{ mA}$, $P_{out} = 29\text{ W Avg.}$, $f_1 = 1930\text{ MHz}$, $f_2 = 1932.5\text{ MHz}$ 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} | 15 | 16 | 18 | dB |
| Drain Efficiency | η_D | 26 | 27.5 | — | % |
| 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.

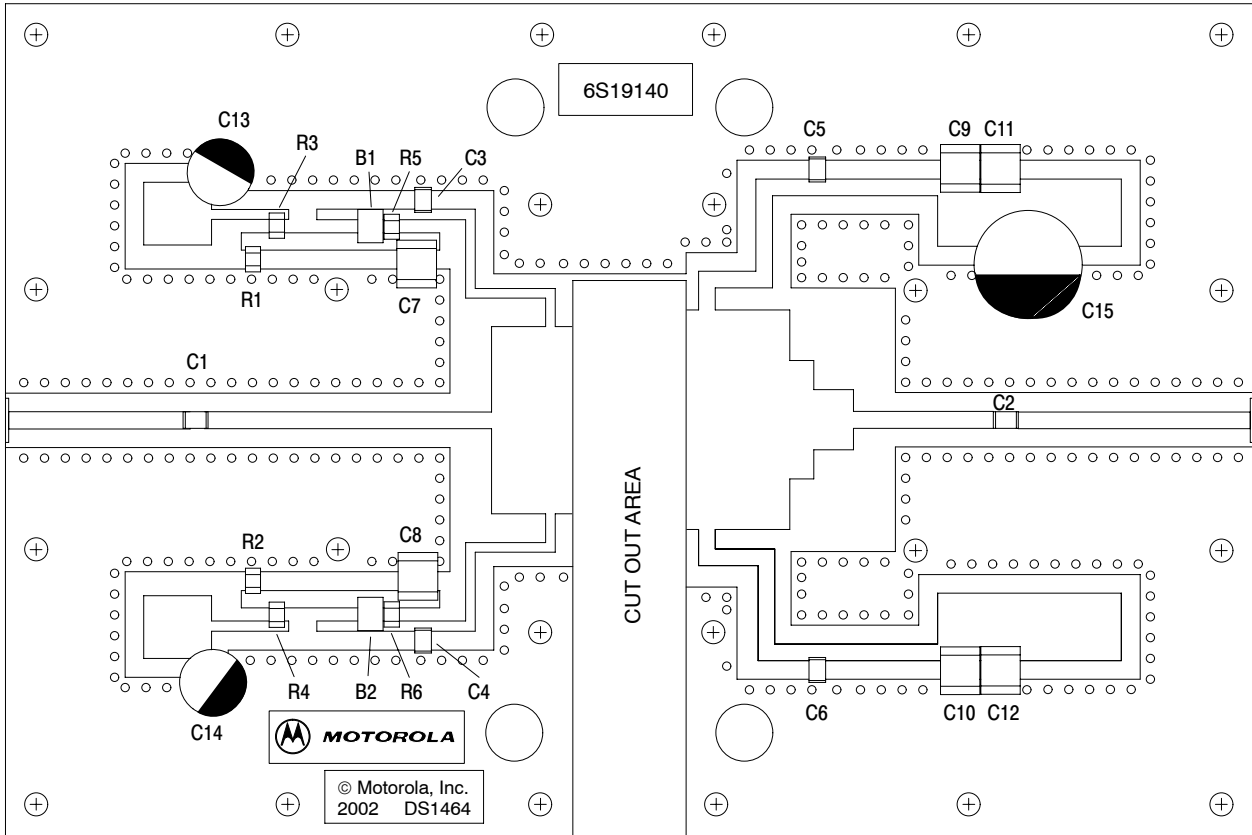


| | | | |
|----|----------------------------|-----|--|
| Z1 | 0.864" x 0.082" Microstrip | Z7 | 0.115" x 0.569" Microstrip |
| Z2 | 1.373" x 0.082" Microstrip | Z8 | 0.191" x 0.289" Microstrip |
| Z3 | 0.282" x 0.900" Microstrip | Z9 | 0.681" x 0.081" Microstrip |
| Z4 | 0.103" x 0.900" Microstrip | Z10 | 1.140" x 0.081" Microstrip |
| Z5 | 0.094" x 1.055" Microstrip | PCB | Arlon GX0300-55-22, 0.030", $\epsilon_r = 2.5$ |
| Z6 | 0.399" x 1.055" Microstrip | | |

Figure 1. MRF6S19140HR3(HSR3) Test Circuit Schematic

Table 5. MRF6S19140HR3(HSR3) Test Circuit Component Designations and Values

| Part | Description | Part Number | Manufacturer |
|---------------------------|--|--------------------|------------------|
| B1, B2 | Beads, Surface Mount | 2743019447 | Fair-Rite |
| C1, C2 | 39 pF Chip Capacitors | ATC100B390JT500XT | ATC |
| C3, C4, C5, C6 | 9.1 pF Chip Capacitors | ATC100B9R1CT500XT | ATC |
| C7, C8, C9, C10, C11, C12 | 10 μ F, 50 V Chip Capacitors | GRM55DR61H106KA88B | Murata |
| C13, C14 | 47 μ F, 50 V Electrolytic Capacitors | EMVY500ADA470MF80G | Nippon |
| C15 | 470 μ F, 63 V Electrolytic Capacitor | ESMG630ELL471MK205 | United Chemi-Con |
| R1, R2 | 560 k Ω , 1/4 W Chip Resistors | CRCW12065600FKTA | Vishay |
| R3, R4 | 1.0 k Ω , 1/4 W Chip Resistors | CRCW12061001FKTA | Vishay |
| R5, R6 | 12 Ω , 1/4 W Chip Resistors | CRCW120612R0FKTA | Vishay |



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. MRF6S19140HR3(HSR3) Test Circuit Component Layout

TYPICAL CHARACTERISTICS

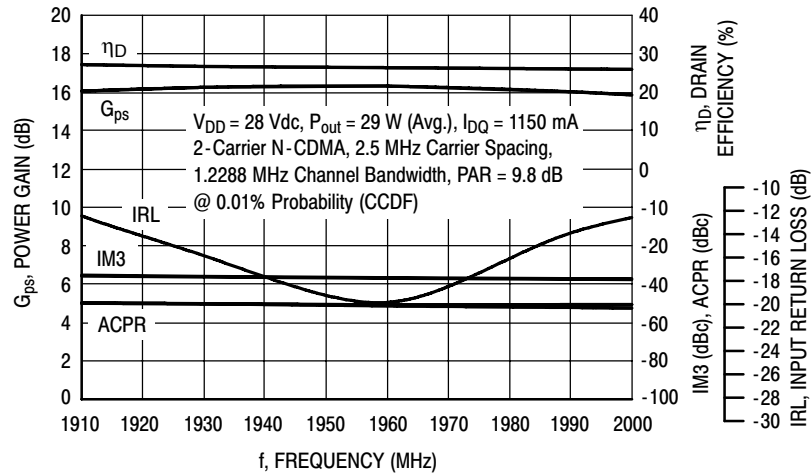


Figure 3. 2-Carrier N-CDMA Broadband Performance @ $P_{out} = 29$ Watts Avg.

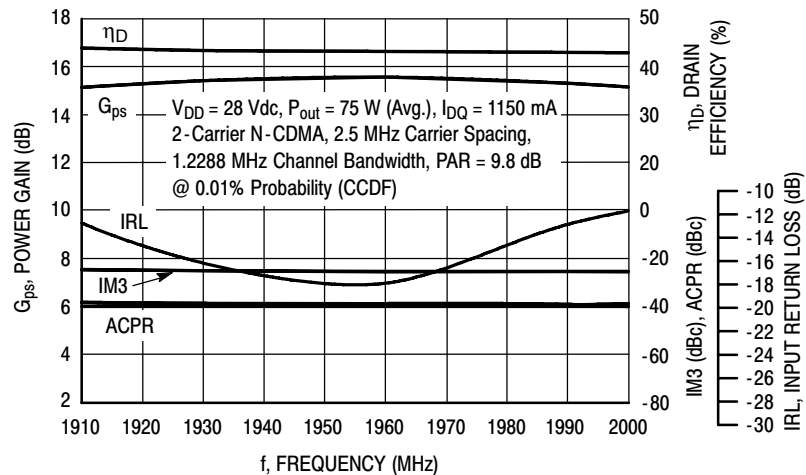


Figure 4. 2-Carrier N-CDMA Broadband Performance @ $P_{out} = 75$ Watts Avg.

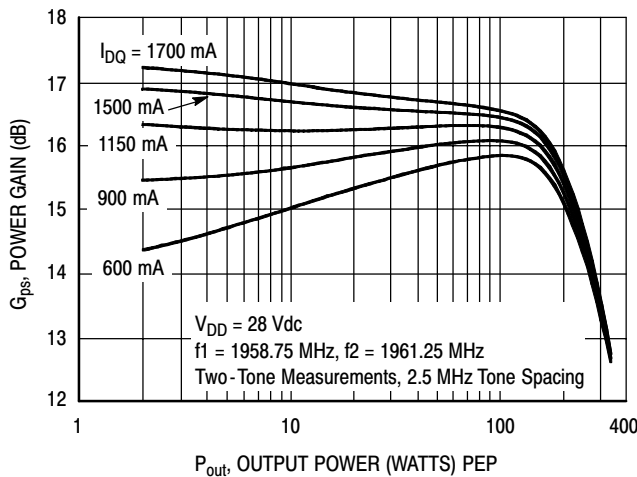


Figure 5. Two-Tone Power Gain versus Output Power

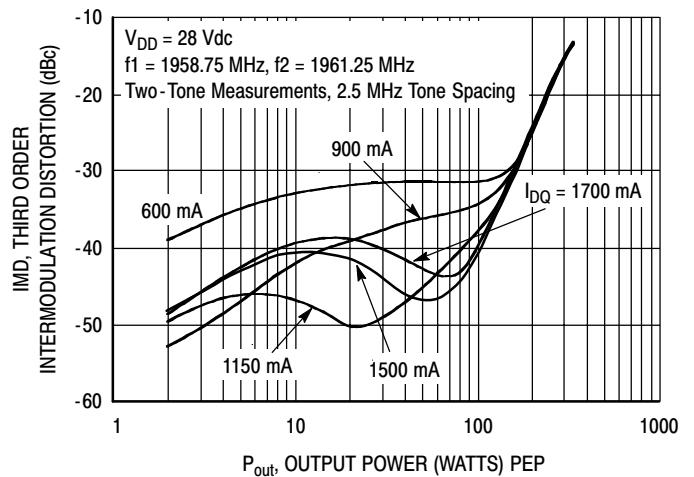


Figure 6. Third Order Intermodulation Distortion versus Output Power

TYPICAL CHARACTERISTICS

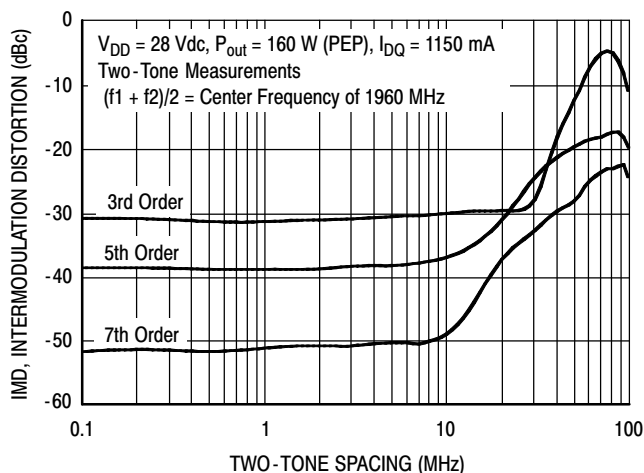


Figure 7. Intermodulation Distortion Products versus Tone Spacing

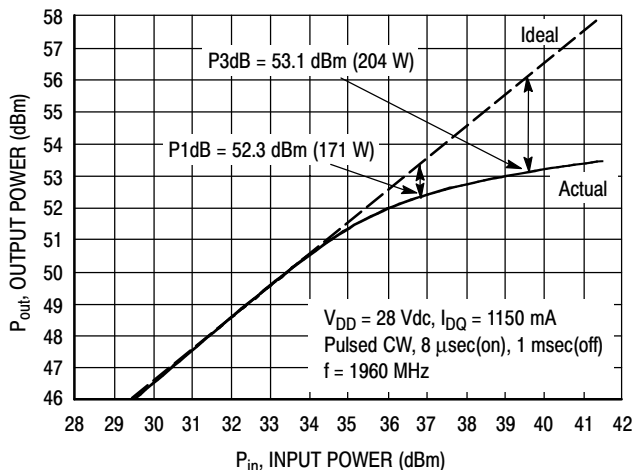


Figure 8. Pulsed CW Output Power versus Input Power

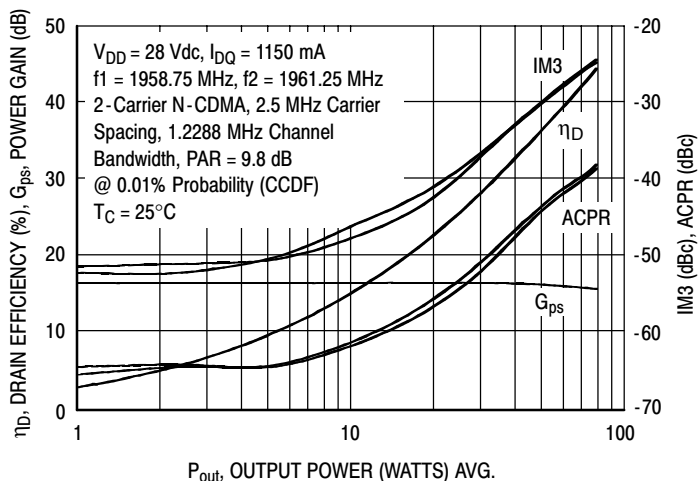


Figure 9. 2-Carrier N-CDMA ACPR, IM3, Power Gain and Drain Efficiency versus Output Power

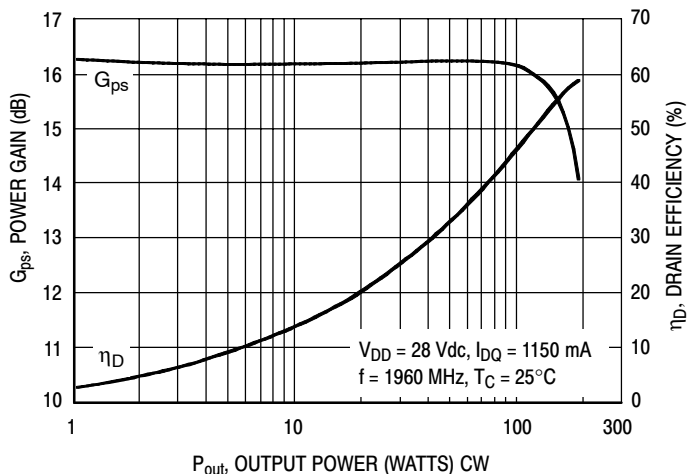


Figure 10. Power Gain and Drain Efficiency versus CW Output Power

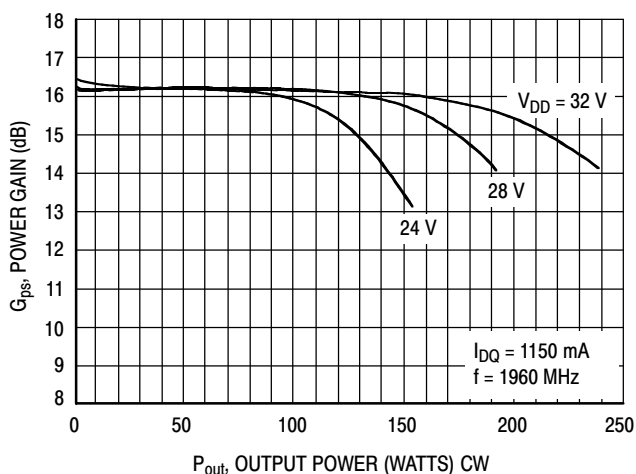
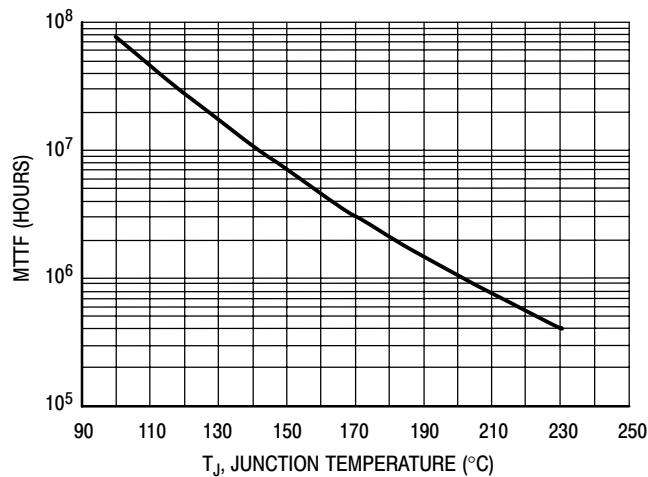


Figure 11. Power Gain versus Output Power

TYPICAL CHARACTERISTICS



This above graph displays calculated MTTF in hours when the device is operated at $V_{DD} = 28$ Vdc, $P_{out} = 29$ W Avg., and $\eta_D = 27.5\%$.

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

Figure 12. MTTF versus Junction Temperature

N-CDMA TEST SIGNAL

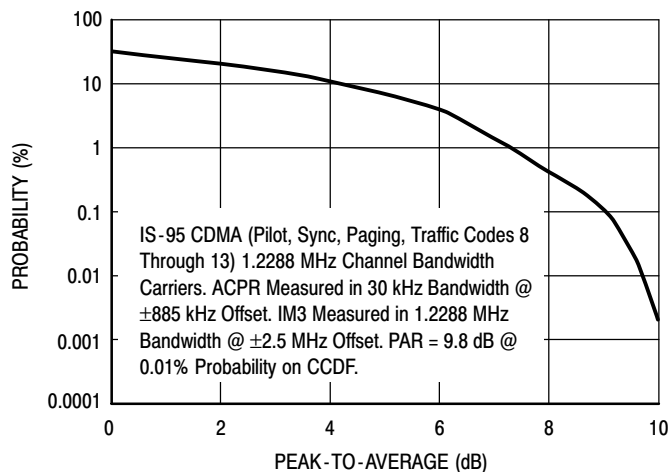


Figure 13. 2-Carrier CCDF N-CDMA

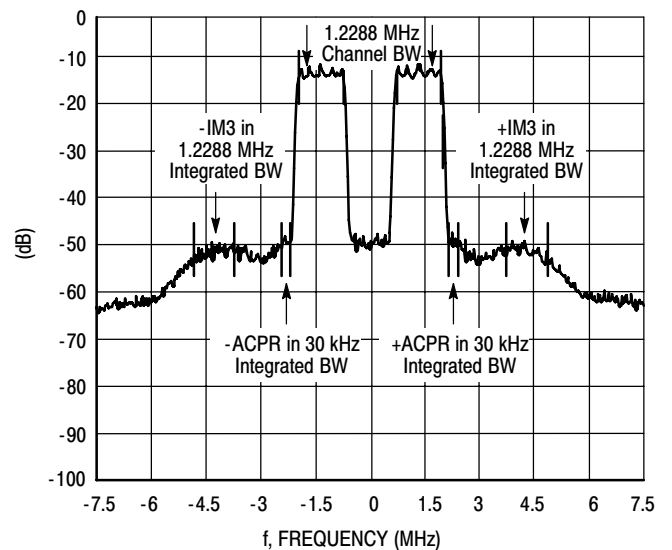
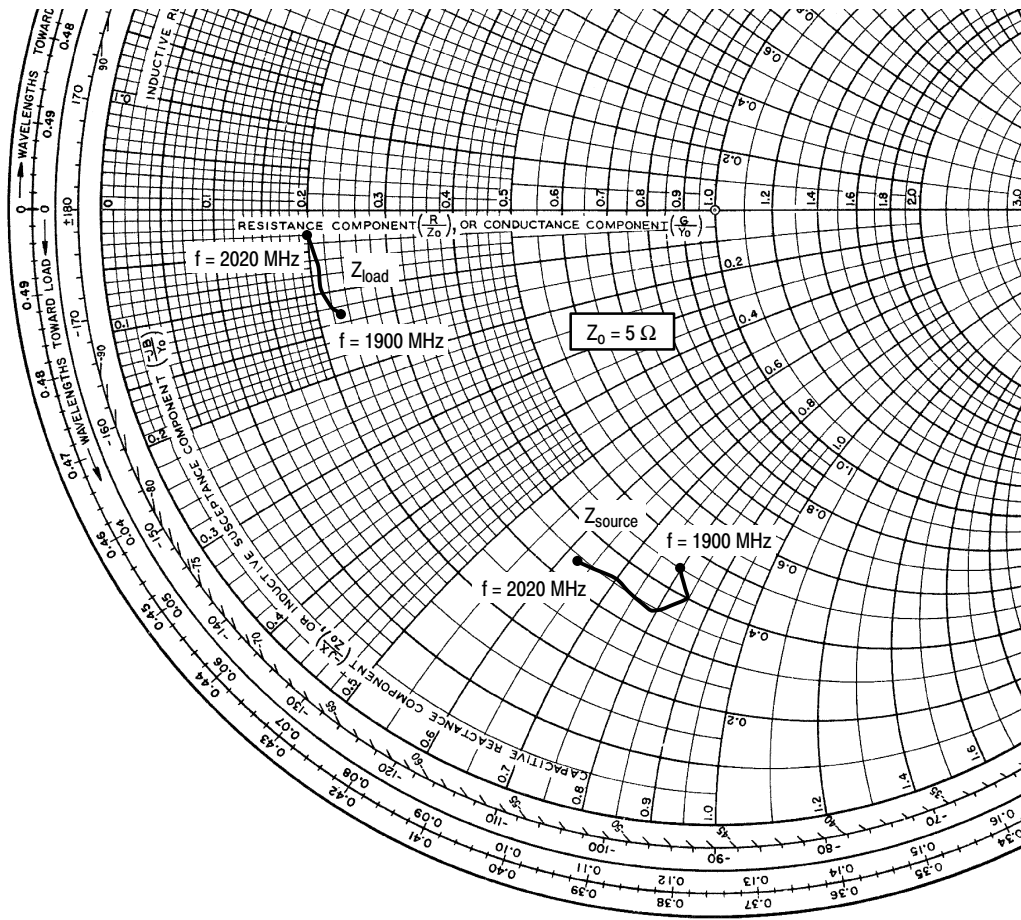


Figure 14. 2-Carrier N-CDMA Spectrum



$V_{DD} = 28 \text{ Vdc}$, $I_{DQ} = 1150 \text{ mA}$, $P_{out} = 29 \text{ W Avg.}$

| f MHz | Z_{source} Ω | Z_{load} Ω |
|----------|--------------------------|------------------------|
| 1900 | $2.27 - j3.95$ | $1.13 - j0.67$ |
| 1930 | $2.00 - j4.24$ | $1.11 - j0.60$ |
| 1960 | $1.72 - j3.96$ | $1.07 - j0.46$ |
| 1990 | $1.80 - j3.51$ | $1.06 - j0.30$ |
| 2020 | $1.69 - j3.17$ | $1.01 - j0.17$ |

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

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

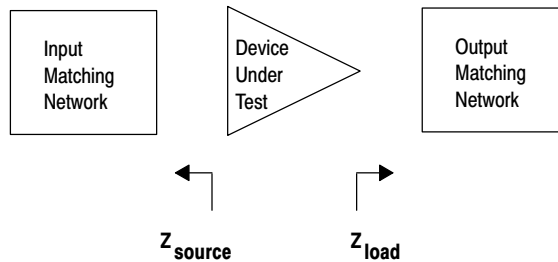
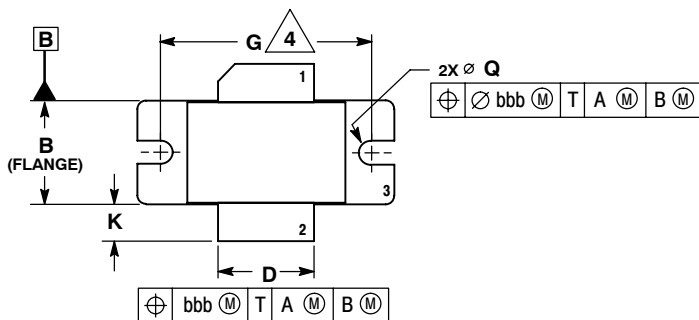


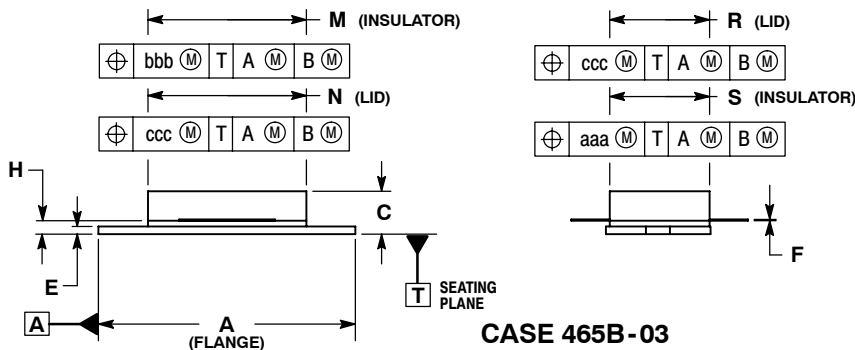
Figure 15. Series Equivalent Source and Load Impedance

PACKAGE DIMENSIONS



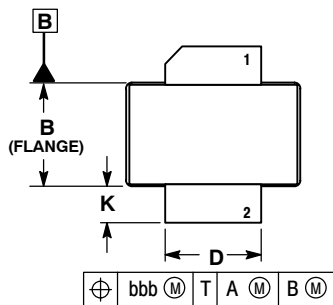
- NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M-1994.
 2. CONTROLLING DIMENSION: INCH.
 3. DIMENSION H IS MEASURED 0.030 (0.762) AWAY FROM PACKAGE BODY.
 4. RECOMMENDED BOLT CENTER DIMENSION OF .16 (29.57) BASED ON M3 SCREW.

| 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 | 0.175 | 0.205 | 4.44 | 5.21 |
| 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 | |



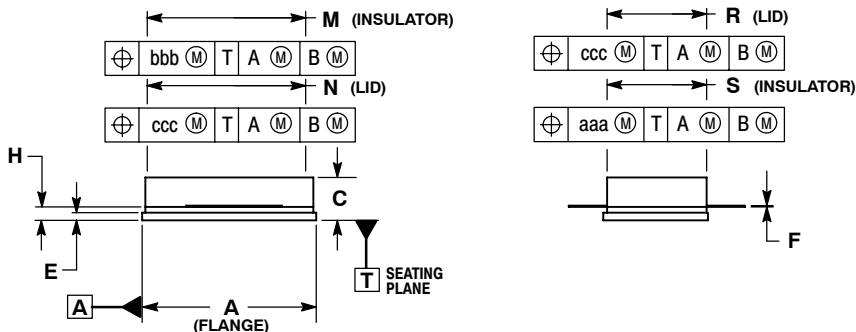
**CASE 465B-03
ISSUE D
NI-880
MRF6S19140HR3**

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



- 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 |
| 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 |
| 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 | |



**CASE 465C-02
ISSUE D
NI-880S
MRF6S19140HSR3**

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

MRF6S19140HR3 MRF6S19140HSR3

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 | May 2007 | <ul style="list-style-type: none">• Removed Lower Thermal Resistance and Low Gold Plating bullets from Features section as functionality is standard, p. 1• Removed “Designed for Lower Memory Effects and Wide Instantaneous Bandwidth Applications” bullet as functionality is standard, p. 1• Added “Optimized for Doherty Applications” bullet to Features section, p. 1• Removed Total Device Dissipation from Max Ratings table as data was redundant (information already provided in Thermal Characteristics table), p. 1• Operating Junction Temperature increased from 200°C to 225°C in Maximum Ratings table and related “Continuous use at maximum temperature will affect MTTF” footnote added, p. 1• 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• Removed Forward Transconductance from On Characteristics table as it no longer provided usable information, p. 2• Updated Part Numbers in Table 5, Component Designations and Values, to RoHS compliant part numbers, p. 3• Removed lower voltage tests from Fig. 11, Power Gain versus Output Power, due to fixed tuned fixture limitations, p. 6• 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• Added Product Documentation and Revision History, p. 10 |

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Freescale Semiconductor Japan Ltd.
Headquarters
ARCO Tower 15F
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Tokyo 153-0064
Japan
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