

# RF Power Field Effect Transistors

## N-Channel Enhancement-Mode Lateral MOSFETs

Designed for CDMA base station applications with frequencies from 2110 to 2170 MHz. Suitable for CDMA and multicarrier amplifier applications. To be used in Class AB and Class C for PCN - PCS/cellular radio and WLL applications.

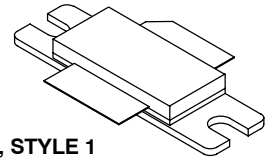
- Typical Single-Carrier W-CDMA Performance:  $V_{DD} = 28$  Volts,  $I_{DQ} = 1350$  mA,  $P_{out} = 44$  Watts Avg., Full Frequency Band, 3GPP Test Model 1, 64 DPCH with 50% Clipping, Channel Bandwidth = 3.84 MHz, Input Signal PAR = 7.5 dB @ 0.01% Probability on CCDF.  
Power Gain — 17.5 dB  
Drain Efficiency — 31%  
Device Output Signal PAR — 6.1 dB @ 0.01% Probability on CCDF  
ACPR @ 5 MHz Offset — -37 dBc in 3.84 MHz Channel Bandwidth
- Capable of Handling 5:1 VSWR, @ 32 Vdc, 2140 MHz, 150 Watts CW Peak Tuned Output Power
- $P_{out}$  @ 1 dB Compression Point  $\geq 150$  Watts CW

### Features

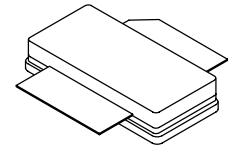
- 100% PAR Tested for Guaranteed Output Power Capability
- Characterized with Series Equivalent Large-Signal Impedance Parameters
- Internally Matched for Ease of Use
- Integrated ESD Protection
- Greater Negative Gate-Source Voltage Range for Improved Class C Operation
- Designed for Digital Predistortion Error Correction Systems
- RoHS Compliant
- In Tape and Reel. R3 Suffix = 250 Units per 56 mm, 13 inch Reel.

**MRF7S21150HR3**  
**MRF7S21150HSR3**

**2110-2170 MHz, 44 W AVG., 28 V**  
**SINGLE W-CDMA**  
**LATERAL N-CHANNEL**  
**RF POWER MOSFETs**



**CASE 465-06, STYLE 1**  
**NI-780**  
**MRF7S21150HR3**



**CASE 465A-06, STYLE 1**  
**NI-780S**  
**MRF7S21150HSR3**

**Table 1. Maximum Ratings**

| Rating                               | Symbol    | Value        | Unit |
|--------------------------------------|-----------|--------------|------|
| Drain-Source Voltage                 | $V_{DSS}$ | -0.5, +65    | Vdc  |
| Gate-Source Voltage                  | $V_{GS}$  | -6.0, +10    | Vdc  |
| Operating Voltage                    | $V_{DD}$  | 32, +0       | 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, 147 W CW      |                 | 0.33        |      |
| Case Temperature 75°C, 45 W CW       |                 | 0.37        |      |

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)   | 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<br>( $V_{DS} = 65\text{ Vdc}$ , $V_{GS} = 0\text{ Vdc}$ ) | $I_{DSS}$ | — | — | 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>( $V_{DS} = 10\text{ Vdc}$ , $I_D = 348\text{ }\mu\text{Adc}$ )                                             | $V_{GS(th)}$ | 1.2 | 2    | 2.7 | Vdc |
| Gate Quiescent Voltage<br>( $V_{DS} = 28\text{ Vdc}$ , $I_D = 1350\text{ mAdc}$ )                                                     | $V_{GS(Q)}$  | —   | 2.7  | —   | Vdc |
| Fixture Gate Quiescent Voltage <sup>(1)</sup><br>( $V_{DD} = 28\text{ Vdc}$ , $I_D = 1350\text{ mAdc}$ , Measured in Functional Test) | $V_{GG(Q)}$  | 4.5 | 5.4  | 6.5 | Vdc |
| Drain-Source On-Voltage<br>( $V_{GS} = 10\text{ Vdc}$ , $I_D = 2.7\text{ Adc}$ )                                                      | $V_{DS(on)}$ | 0.1 | 0.15 | 0.3 | Vdc |

**Dynamic Characteristics <sup>(2)</sup>**

|                                                                                                                       |           |   |     |   |    |
|-----------------------------------------------------------------------------------------------------------------------|-----------|---|-----|---|----|
| Reverse Transfer Capacitance<br>( $V_{DS} = 28\text{ Vdc} \pm 30\text{ mV(rms)ac}$ @ 1 MHz, $V_{GS} = 0\text{ Vdc}$ ) | $C_{rss}$ | — | 0.9 | — | pF |
| Output Capacitance<br>( $V_{DS} = 28\text{ Vdc} \pm 30\text{ mV(rms)ac}$ @ 1 MHz, $V_{GS} = 0\text{ Vdc}$ )           | $C_{oss}$ | — | 590 | — | pF |
| Input Capacitance<br>( $V_{DS} = 28\text{ Vdc}$ , $V_{GS} = 0\text{ Vdc} \pm 30\text{ mV(rms)ac}$ @ 1 MHz)            | $C_{iss}$ | — | 320 | — | pF |

**Functional Tests** (In Freescale Test Fixture, 50 ohm system)  $V_{DD} = 28\text{ Vdc}$ ,  $I_{DQ} = 1350\text{ mA}$ ,  $P_{out} = 44\text{ W Avg.}$ ,  $f = 2112.5\text{ MHz}$  and  $f = 2167.5\text{ MHz}$ , Single-Carrier W-CDMA, 3GPP Test Model 1, 64 DPCH, 50% Clipping, PAR = 7.5 dB @ 0.01% Probability on CCDF. ACPR measured in 3.84 MHz Channel Bandwidth @  $\pm 5\text{ MHz}$  Offset.

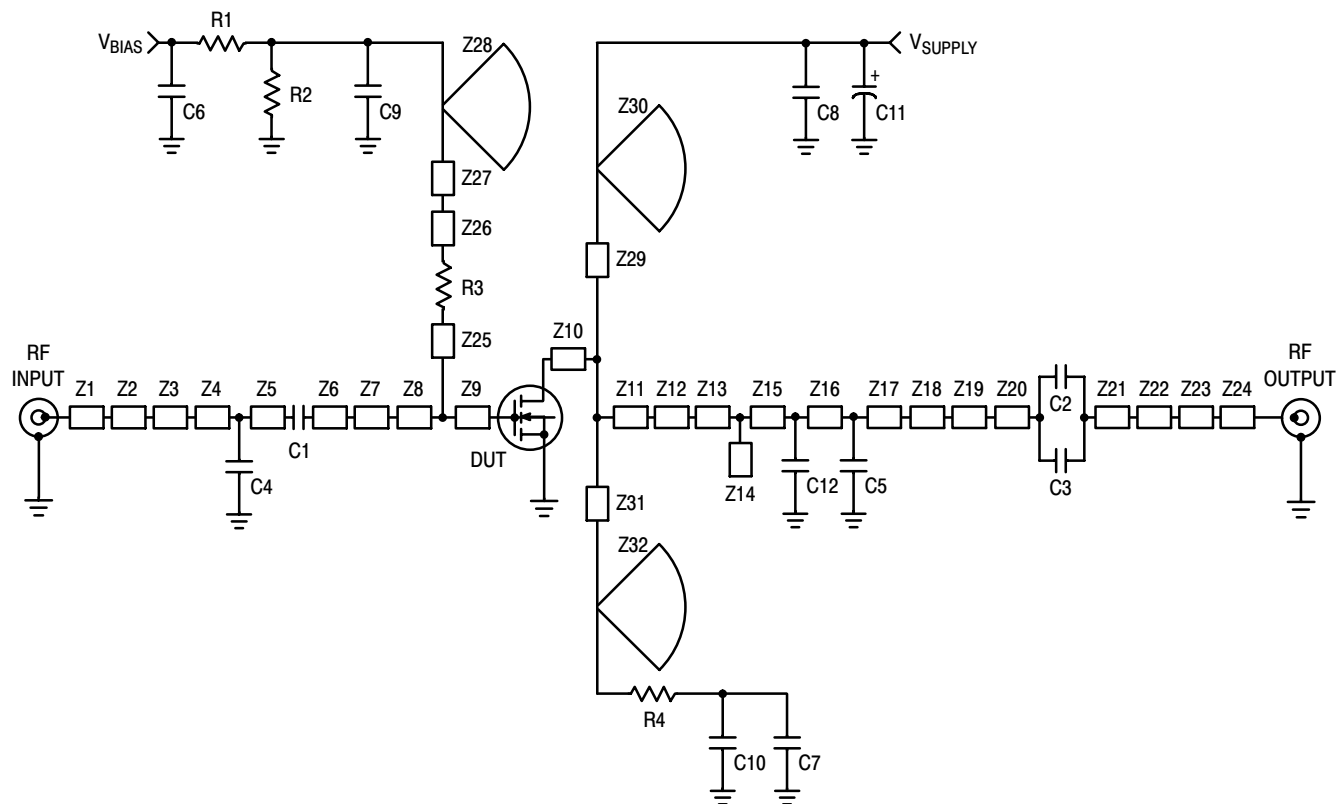
|                                                          |          |      |      |      |     |
|----------------------------------------------------------|----------|------|------|------|-----|
| Power Gain                                               | $G_{ps}$ | 16.5 | 17.5 | 19.5 | dB  |
| Drain Efficiency                                         | $\eta_D$ | 29   | 31   | —    | %   |
| Output Peak-to-Average Ratio @ 0.01% Probability on CCDF | PAR      | 5.7  | 6.1  | —    | dB  |
| Adjacent Channel Power Ratio                             | ACPR     | —    | -37  | -35  | dBc |
| Input Return Loss                                        | IRL      | —    | -15  | -9   | dB  |

- $V_{GG} = 2 \times V_{GS(Q)}$ . Parameter measured on Freescale Test Fixture, due to resistive divider network on the board. Refer to Test Circuit schematic.
- Part internally matched both on input and output.

(continued)

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

| Characteristic                                                                                                                                                                                                  | Symbol           | Min | Typ   | Max | Unit   |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|-----|-------|-----|--------|
| <b>Typical Performances</b> (In Freescale Test Fixture, 50 ohm system) $V_{DD} = 28\text{ Vdc}$ , $I_{DQ} = 1350\text{ mA}$ , 2110-2170 MHz Bandwidth                                                           |                  |     |       |     |        |
| Video Bandwidth @ 120 W PEP $P_{out}$ where $IM3 = -30\text{ dBc}$<br>(Tone Spacing from 100 kHz to VBW)<br>$\Delta IMD3 = IMD3 @ \text{VBW frequency} - IMD3 @ 100\text{ kHz} < 1\text{ dBc}$ (both sidebands) | VBW              | —   | 10    | —   | MHz    |
| Gain Flatness in 60 MHz Bandwidth @ $P_{out} = 44\text{ W Avg.}$                                                                                                                                                | $G_F$            | —   | 0.418 | —   | dB     |
| Average Deviation from Linear Phase in 60 MHz Bandwidth<br>@ $P_{out} = 150\text{ W CW}$                                                                                                                        | $\Phi$           | —   | 36.5  | —   | °      |
| Average Group Delay @ $P_{out} = 150\text{ W CW}$ , $f = 2140\text{ MHz}$                                                                                                                                       | Delay            | —   | 2.82  | —   | ns     |
| Part-to-Part Insertion Phase Variation @ $P_{out} = 150\text{ W CW}$ ,<br>$f = 2140\text{ MHz}$ , Six Sigma Window                                                                                              | $\Delta\Phi$     | —   | 1.45  | —   | °      |
| Gain Variation over Temperature<br>( $-30^\circ\text{C}$ to $+85^\circ\text{C}$ )                                                                                                                               | $\Delta G$       | —   | 0.013 | —   | dB/°C  |
| Output Power Variation over Temperature<br>( $-30^\circ\text{C}$ to $+85^\circ\text{C}$ )                                                                                                                       | $\Delta P_{1dB}$ | —   | 0.007 | —   | dBm/°C |



|     |                            |          |                            |          |                                                     |
|-----|----------------------------|----------|----------------------------|----------|-----------------------------------------------------|
| Z1  | 0.980" x 0.138" Microstrip | Z12      | 0.178" x 0.067" Microstrip | Z24      | 0.096" x 0.138" Microstrip                          |
| Z2  | 0.461" x 0.066" Microstrip | Z13      | 0.039" x 0.095" Microstrip | Z25      | 0.335" x 0.066" Microstrip                          |
| Z3  | 0.534" x 0.458" Microstrip | Z14      | 0.079" x 0.060" Microstrip | Z26      | 0.069" x 0.080" Microstrip                          |
| Z4* | 0.138" x 0.126" Microstrip | Z15*     | 0.168" x 0.095" Microstrip | Z27      | 0.466" x 0.040" Microstrip                          |
| Z5* | 0.536" x 0.126" Microstrip | Z16*     | 0.113" x 0.095" Microstrip | Z28      | R = 0.526" $\alpha = 60^\circ$ Microstrip Butterfly |
| Z6  | 0.147" x 0.126" Microstrip | Z17*     | 0.128" x 0.095" Microstrip | Z29, Z31 | 0.825" x 0.066" Microstrip                          |
| Z7  | 0.060" x 0.513" Microstrip | Z18      | 0.079" x 0.215" Microstrip | Z30, Z32 | R = 0.526" $\alpha = 60^\circ$ Microstrip Butterfly |
| Z8  | 0.151" x 0.630" Microstrip | Z19      | 0.020" x 0.095" Microstrip | PCB      | Taconic TLX8-0300, 0.030", $\epsilon_r = 2.55$      |
| Z9  | 0.112" x 0.630" Microstrip | Z20, Z21 | 0.070" x 0.215" Microstrip |          |                                                     |
| Z10 | 0.337" x 0.957" Microstrip | Z22      | 0.392" x 0.067" Microstrip |          |                                                     |
| Z11 | 0.176" x 0.957" Microstrip | Z23      | 0.370" x 0.089" Microstrip |          |                                                     |

\* Variable for tuning

Figure 1. MRF7S21150HR3(HSR3) Test Circuit Schematic

Table 5. MRF7S21150HR3(HSR3) Test Circuit Component Designations and Values

| Part       | Description                                     | Part Number       | Manufacturer         |
|------------|-------------------------------------------------|-------------------|----------------------|
| C1         | 0.7 pF Chip Capacitor                           | ATC100B0R7BT500XT | ATC                  |
| C2, C3     | 6.8 pF Chip Capacitors                          | ATC100B6R8BT500XT | ATC                  |
| C4, C12    | 0.2 pF Chip Capacitors                          | ATC100B0R2BT500XT | ATC                  |
| C5         | 0.3 pF Chip Capacitor                           | ATC100B0R3BT500XT | ATC                  |
| C6, C7, C8 | 10 $\mu$ F Chip Capacitors                      | C5750X5R1H106M    | TDK                  |
| C9, C10    | 100 nF Chip Capacitors                          | C1206C104K2RAC    | Kemet                |
| C11        | 220 $\mu$ F, 63 V Electrolytic Capacitor, Axial | 222212018221      | Vishay BC Components |
| R1, R2     | 10 k $\Omega$ , 1/4 W Chip Resistors            | CRCW12061002FKEA  | Vishay               |
| R3         | 10 $\Omega$ , 1/4 W Chip Resistor               | CRCW120610R0FKEA  | Vishay               |
| R4         | 2.2 $\Omega$ , 1/4 W Chip Resistor              | CRCW12062R20FKEA  | Vishay               |

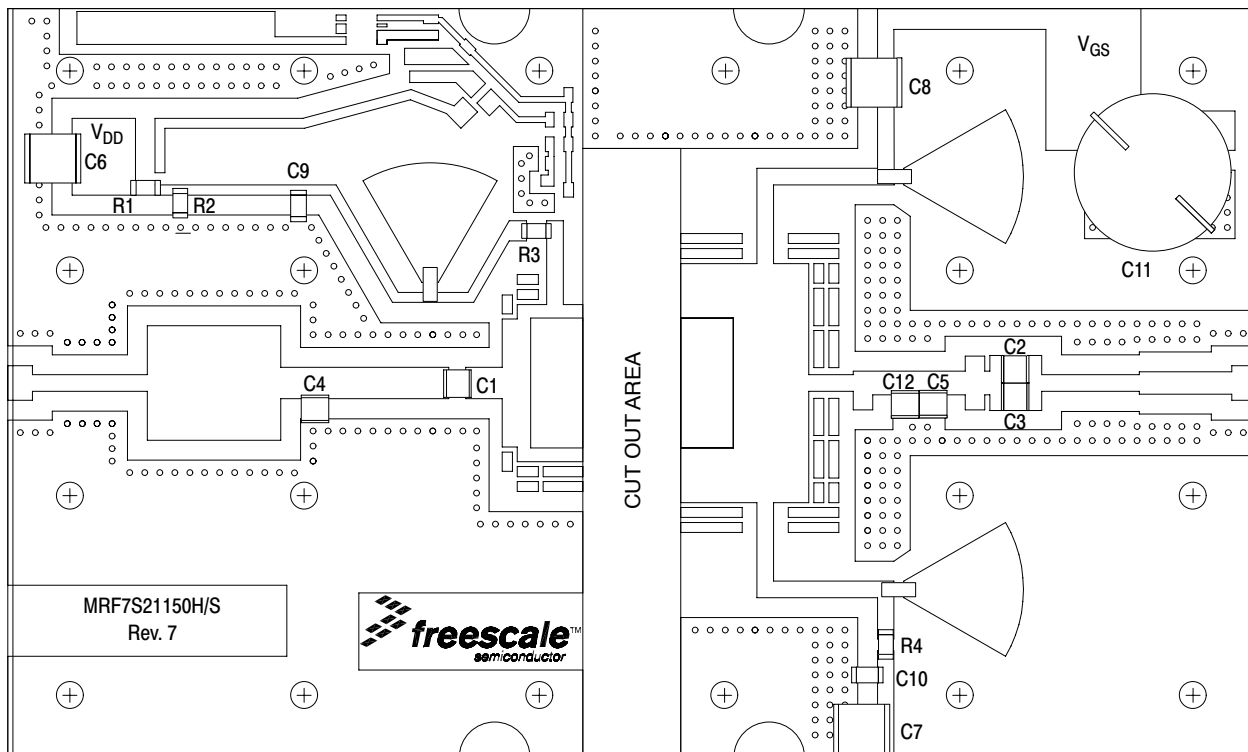
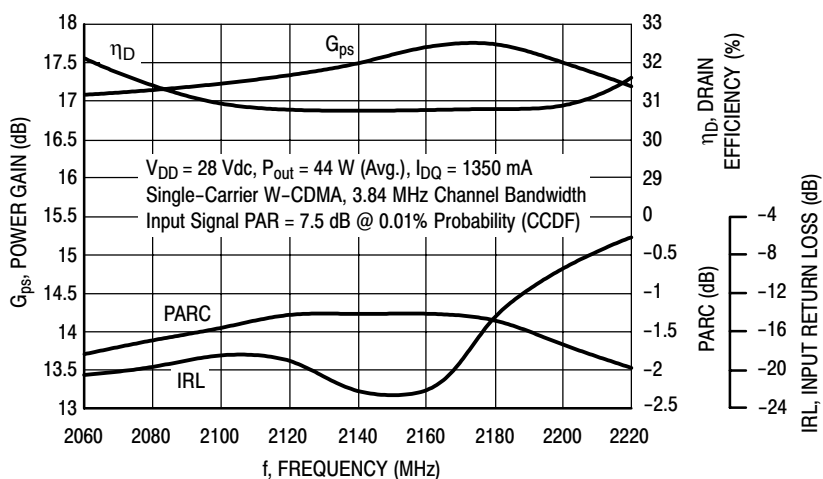
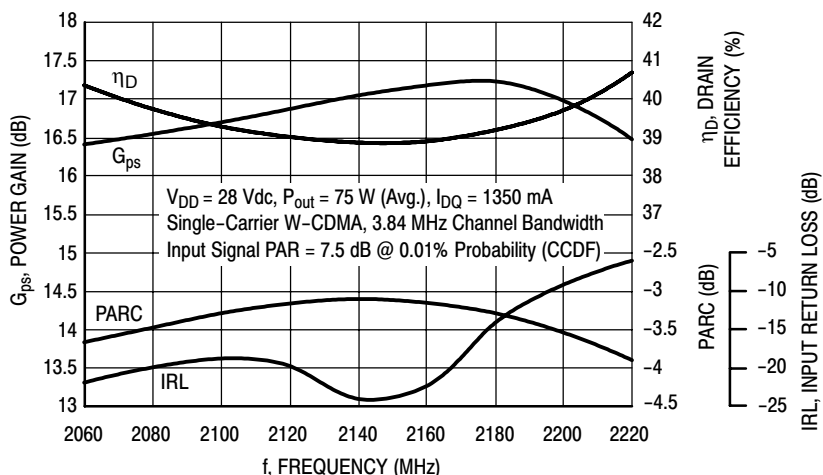


Figure 2. MRF7S21150HR3(HSR3) Test Circuit Component Layout

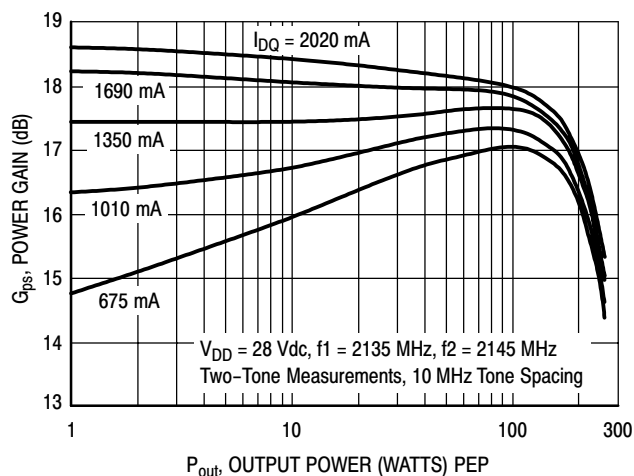
## TYPICAL CHARACTERISTICS



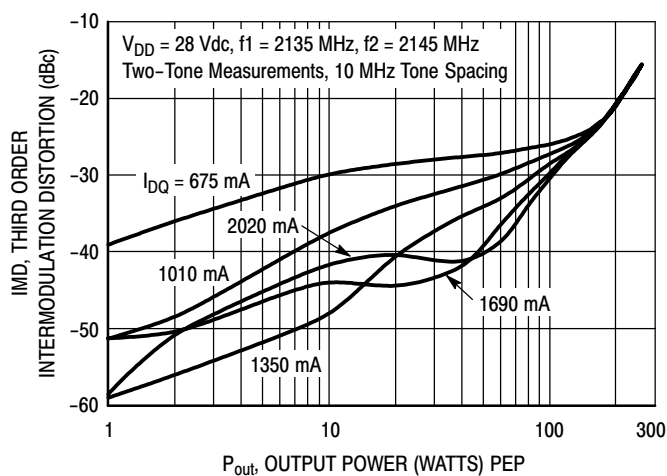
**Figure 3. Output Peak-to-Average Ratio Compression (PARC)  
Broadband Performance @  $P_{out} = 44$  Watts Avg.**



**Figure 4. Output Peak-to-Average Ratio Compression (PARC)  
Broadband Performance @  $P_{out} = 75$  Watts Avg.**

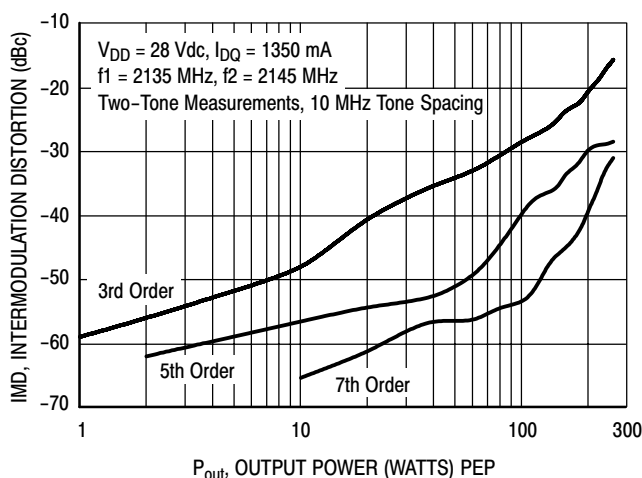


**Figure 5. Two-Tone Power Gain versus  
Output Power**

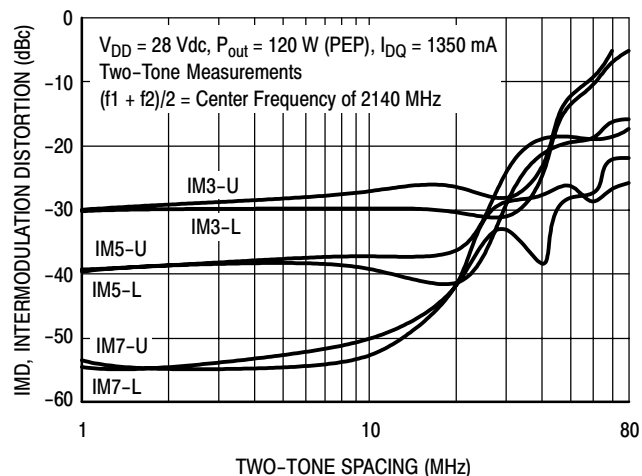


**Figure 6. Third Order Intermodulation Distortion  
versus Output Power**

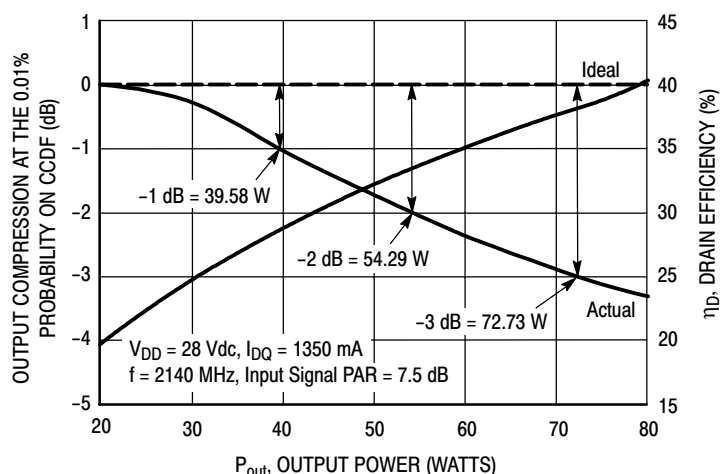
## TYPICAL CHARACTERISTICS



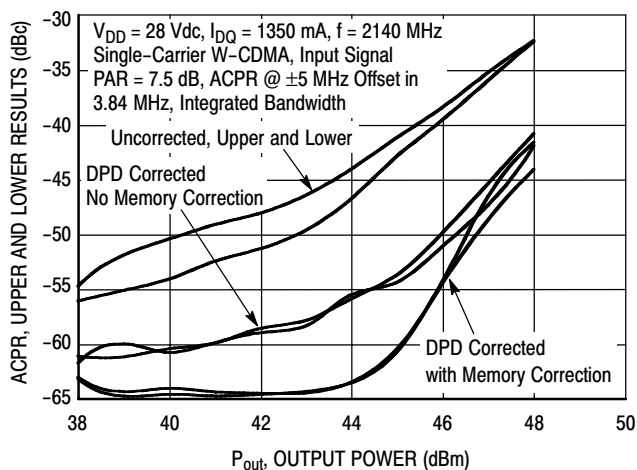
**Figure 7. Intermodulation Distortion Products versus Output Power**



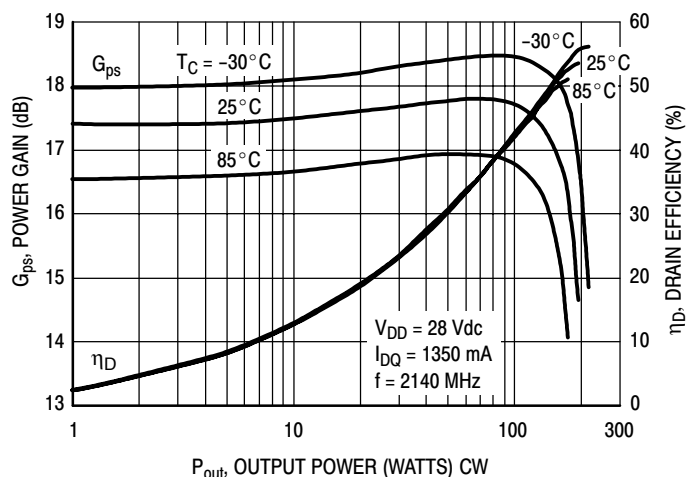
**Figure 8. Intermodulation Distortion Products versus Tone Spacing**



**Figure 9. Output Peak-to-Average Ratio Compression (PARC) versus Output Power**



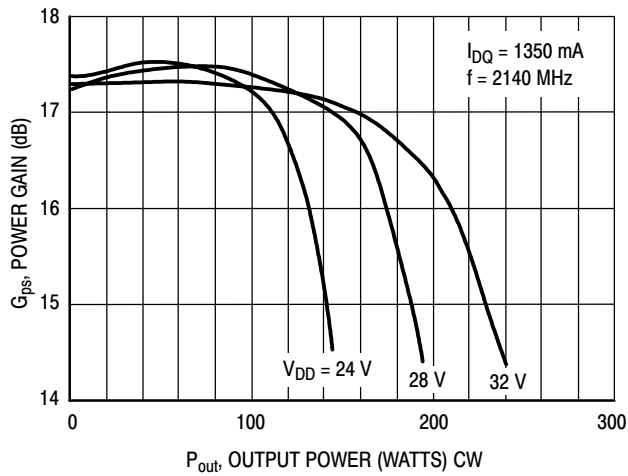
**Figure 10. Digital Predistortion Correction versus ACPR and Output Power**



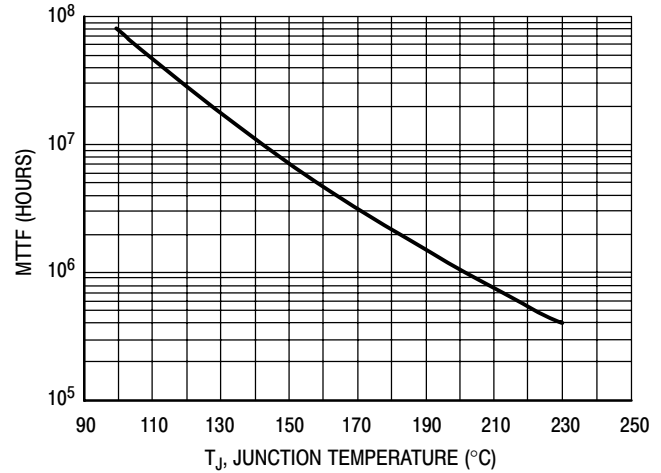
**Figure 11. Power Gain and Drain Efficiency versus CW Output Power**

MRF7S21150HR3 MRF7S21150HSR3

## TYPICAL CHARACTERISTICS



**Figure 12. Power Gain versus Output Power**

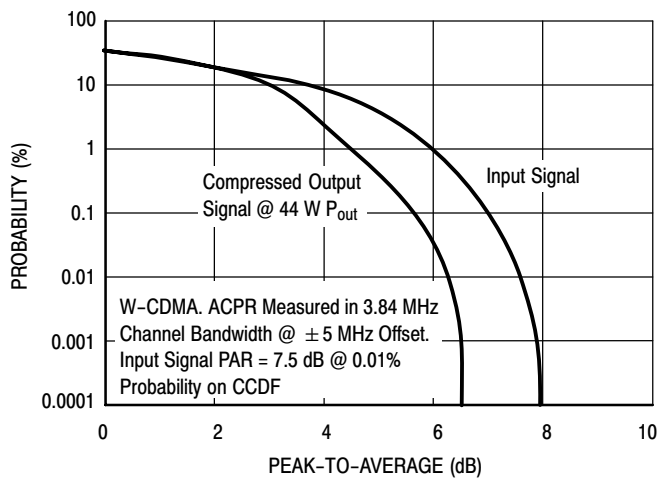


This above graph displays calculated MTTF in hours when the device is operated at  $V_{DD} = 28$  Vdc,  $P_{out} = 44$  W Avg., and  $\eta_D = 31\%$ .

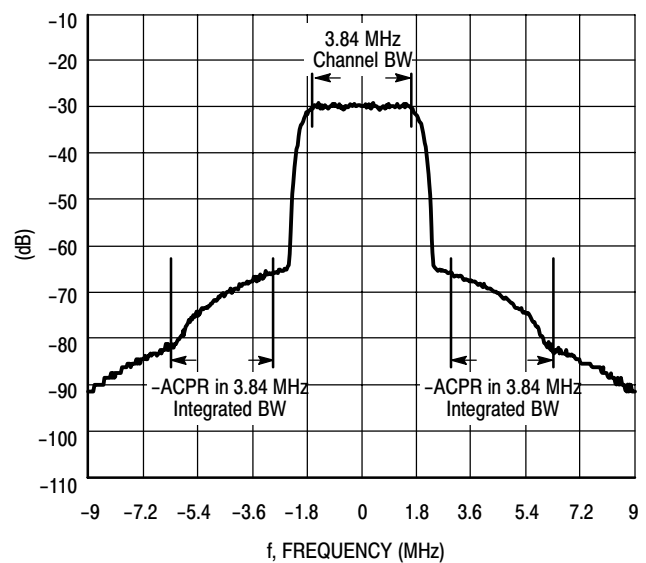
MTTF calculator available at <http://www.freescale.com/rf>. Select Software & Tools/Development Tools/Calculators to access MTTF calculators by product.

**Figure 13. MTTF versus Junction Temperature**

## W-CDMA TEST SIGNAL

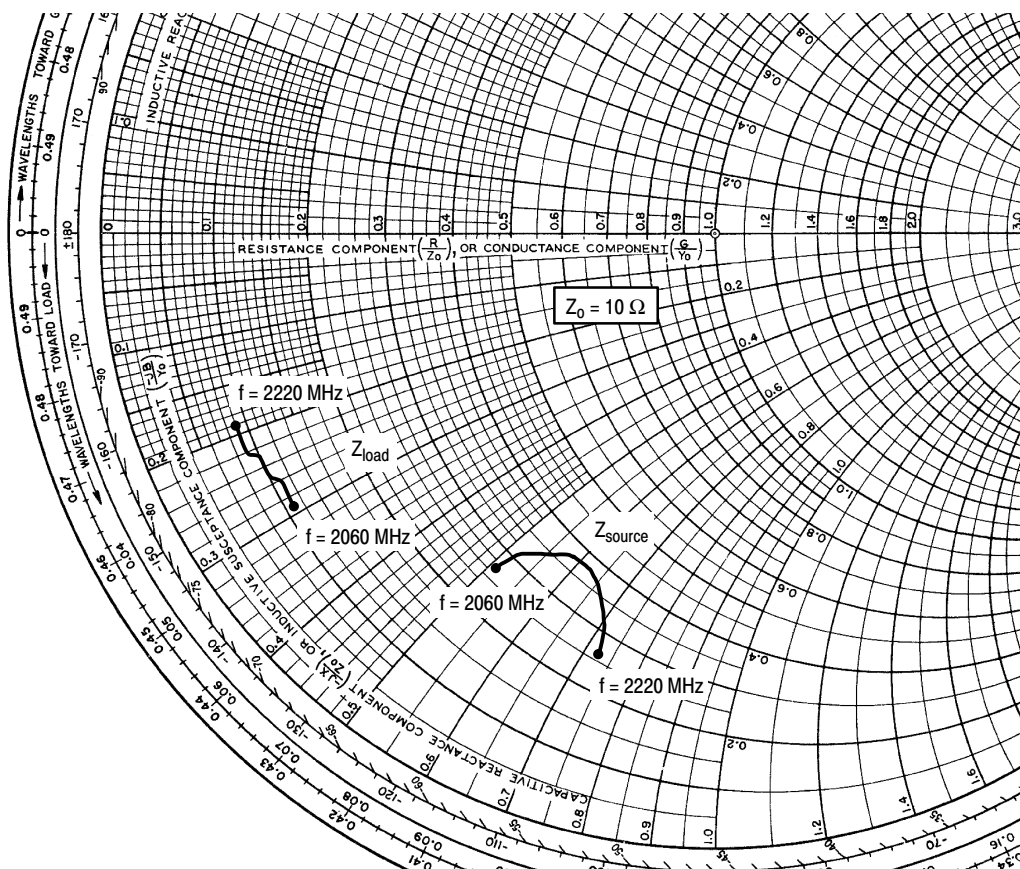


**Figure 14. CCDF W-CDMA 3GPP, Test Model 1, 64 DPCH, 50% Clipping, Single-Carrier Test Signal**



**Figure 15. Single-Carrier W-CDMA Spectrum**





$V_{DD} = 28 \text{ Vdc}$ ,  $I_{DQ} = 1350 \text{ mA}$ ,  $P_{out} = 44 \text{ W Avg.}$

| f<br>MHz | $Z_{source}$<br>$\Omega$ | $Z_{load}$<br>$\Omega$ |
|----------|--------------------------|------------------------|
| 2060     | $2.72 - j5.08$           | $1.14 - j2.89$         |
| 2080     | $3.10 - j5.17$           | $1.11 - j2.75$         |
| 2100     | $3.43 - j5.39$           | $1.08 - j2.62$         |
| 2120     | $3.66 - j5.74$           | $1.04 - j2.50$         |
| 2140     | $3.72 - j6.17$           | $1.00 - j2.39$         |
| 2160     | $3.59 - j6.59$           | $0.96 - j2.28$         |
| 2180     | $3.33 - j6.91$           | $0.93 - j2.17$         |
| 2200     | $2.98 - j7.10$           | $0.89 - j2.05$         |
| 2220     | $2.62 - j7.17$           | $0.86 - j1.93$         |

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

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

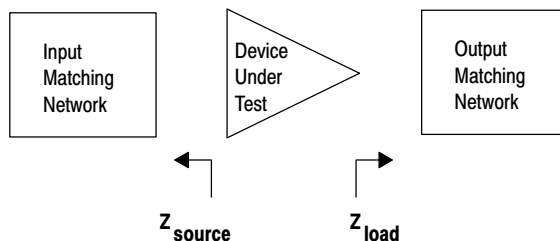
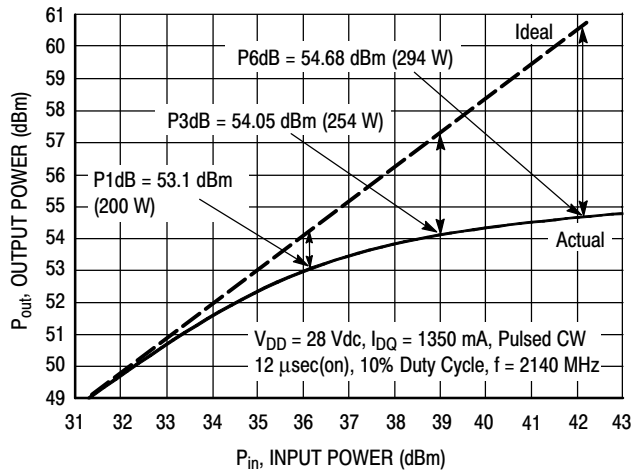


Figure 16. Series Equivalent Source and Load Impedance

## ALTERNATIVE PEAK TUNE LOAD PULL CHARACTERISTICS

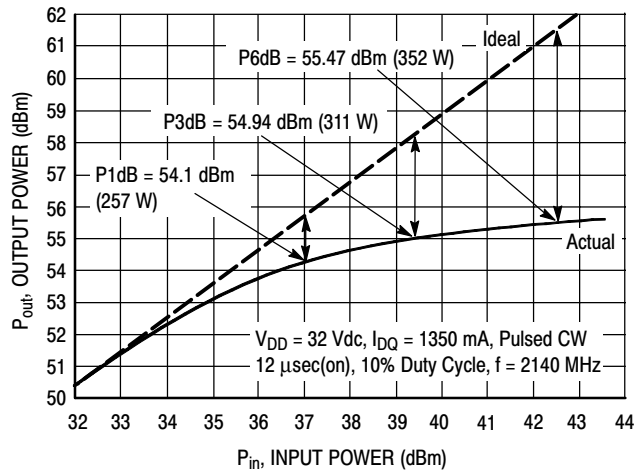


NOTE: Load Pull Test Fixture Tuned for Peak Output Power @ 28 V

Test Impedances per Compression Level

|      | $Z_{source}$<br>$\Omega$ | $Z_{load}$<br>$\Omega$ |
|------|--------------------------|------------------------|
| P3dB | 4.66 - j8.05             | 0.53 - j2.26           |

**Figure 17. Pulsed CW Output Power versus Input Power @ 28 V**



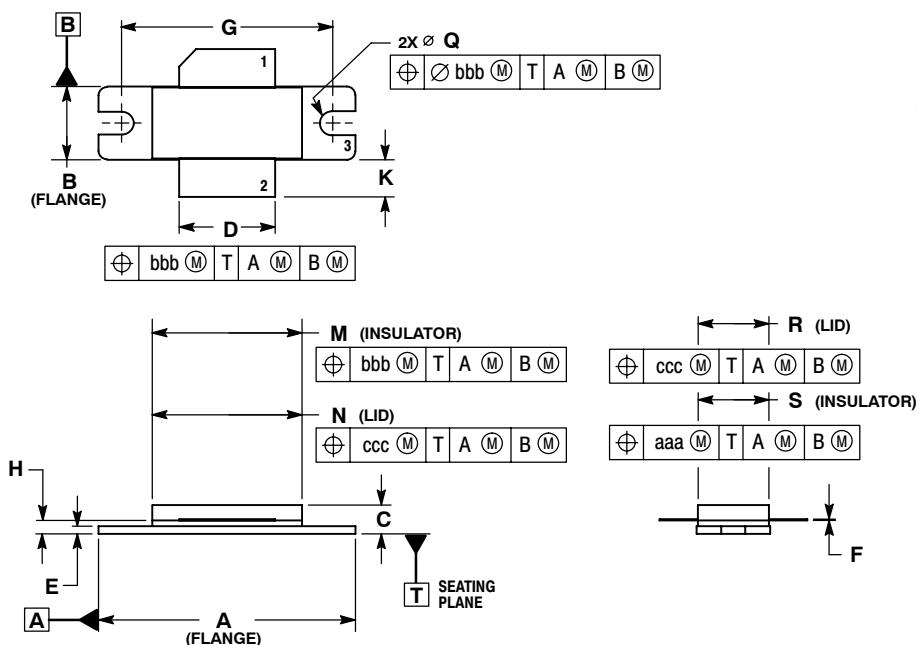
NOTE: Load Pull Test Fixture Tuned for Peak Output Power @ 32 V

Test Impedances per Compression Level

|      | $Z_{source}$<br>$\Omega$ | $Z_{load}$<br>$\Omega$ |
|------|--------------------------|------------------------|
| P3dB | 4.66 - j8.05             | 0.64 - j2.17           |

**Figure 18. Pulsed CW Output Power versus Input Power @ 32 V**

## PACKAGE DIMENSIONS



### NOTES:

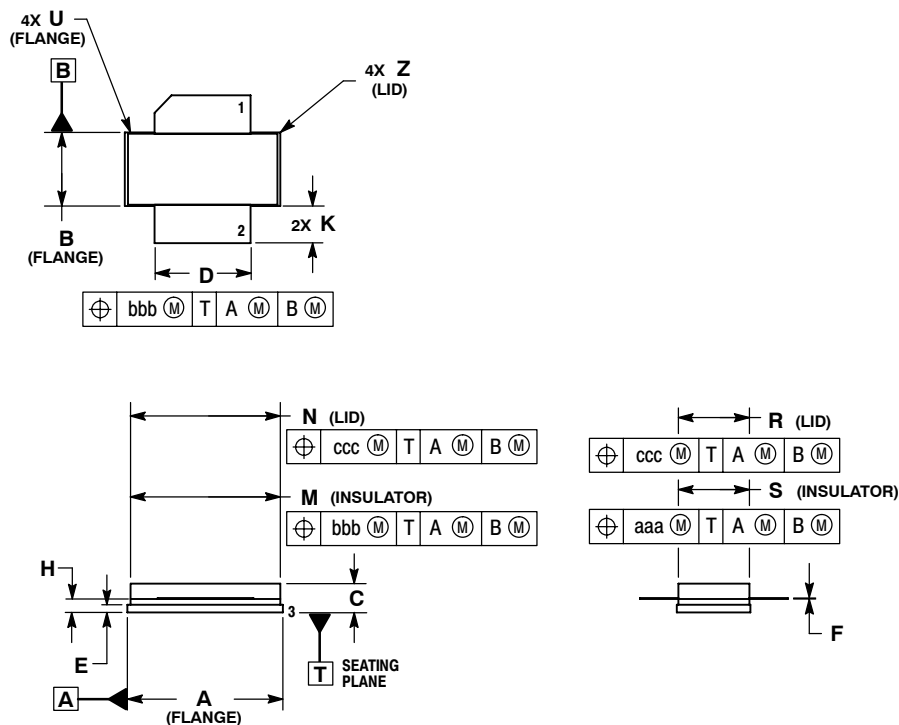
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M-1994.
2. CONTROLLING DIMENSION: INCH.
3. DELETED
4. DIMENSION H IS MEASURED 0.030 (0.762) AWAY FROM PACKAGE BODY.

| 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   | Ø.118     | Ø.138 | Ø3.00       | Ø3.51 |
| 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:

1. DRAIN
2. GATE
3. SOURCE

**CASE 465-06**  
**ISSUE G**  
**NI-780**  
**MRF7S21150HR3**



### 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:

1. DRAIN
2. GATE
5. SOURCE

**CASE 465A-06**  
**ISSUE H**  
**NI-780S**  
**MRF7S21150HSR3**

**MRF7S21150HR3 MRF7S21150HSR3**

## 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                                                                     |
|----------|-----------|---------------------------------------------------------------------------------|
| 0        | Nov. 2007 | <ul style="list-style-type: none"><li>• Initial Release of Data Sheet</li></ul> |

## ***How to Reach Us:***

### **Home Page:**

[www.freescale.com](http://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](http://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](http://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](mailto:support.japan@freescale.com)

### **Asia/Pacific:**

Freescale Semiconductor Hong Kong Ltd.  
Technical Information Center  
2 Dai King Street  
Tai Po Industrial Estate  
Tai Po, N.T., Hong Kong  
+800 2666 8080  
[support.asia@freescale.com](mailto: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 303-675-2140  
Fax: 303-675-2150  
[LDCForFreescaleSemiconductor@hibbertgroup.com](mailto:LDCForFreescaleSemiconductor@hibbertgroup.com)

Information in this document is provided solely to enable system and software implementers to use Freescale Semiconductor products. There are no express or implied copyright licenses granted hereunder to design or fabricate any integrated circuits or integrated circuits based on the information in this document.

Freescale Semiconductor reserves the right to make changes without further notice to any products herein. Freescale Semiconductor makes no warranty, representation or guarantee regarding the suitability of its products for any particular purpose, nor does Freescale Semiconductor assume any liability arising out of the application or use of any product or circuit, and specifically disclaims any and all liability, including without limitation consequential or incidental damages. "Typical" parameters that may be provided in Freescale Semiconductor data sheets and/or specifications can and do vary in different applications and actual performance may vary over time. All operating parameters, including "Typicals", must be validated for each customer application by customer's technical experts. Freescale Semiconductor does not convey any license under its patent rights nor the rights of others. Freescale Semiconductor products are not designed, intended, or authorized for use as components in systems intended for surgical implant into the body, or other applications intended to support or sustain life, or for any other application in which the failure of the Freescale Semiconductor product could create a situation where personal injury or death may occur. Should Buyer purchase or use Freescale Semiconductor products for any such unintended or unauthorized application, Buyer shall indemnify and hold Freescale Semiconductor and its officers, employees, subsidiaries, affiliates, and distributors harmless against all claims, costs, damages, and expenses, and reasonable attorney fees arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized use, even if such claim alleges that Freescale Semiconductor was negligent regarding the design or manufacture of the part.

Freescale™ and the Freescale logo are trademarks of Freescale Semiconductor, Inc. All other product or service names are the property of their respective owners.

© Freescale Semiconductor, Inc. 2007. All rights reserved.

