



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 TD-SCDMA and PCN-PCS/cellular radio applications.

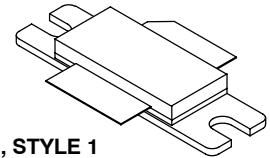
- Typical Single-Carrier W-CDMA Performance: $V_{DD} = 28$ Volts, $I_{DQ} = 800$ mA, $P_{out} = 22$ Watts Avg., $f = 2167.5$ MHz, IQ Magnitude Clipping, Channel Bandwidth = 3.84 MHz, Input Signal PAR = 7.5 dB @ 0.01% Probability on CCDF.
Power Gain — 18 dB
Drain Efficiency — 32%
Device Output Signal PAR — 6.5 dB @ 0.01% Probability on CCDF
ACPR @ 5 MHz Offset — -38 dBc in 3.84 MHz Channel Bandwidth
- Capable of Handling 10:1 VSWR, @ 32 Vdc, 2140 MHz, 80 Watts CW Peak Tuned Output Power
- P_{out} @ 1 dB Compression Point \approx 80 Watts CW

Features

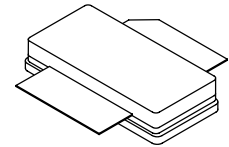
- 100% PAR Tested for Guaranteed Output Power Capability
- Characterized with Series Equivalent Large-Signal Impedance Parameters
- Internally Matched for Ease of Use
- Integrated ESD Protection
- Greater Negative Gate-Source Voltage Range for Improved Class C Operation
- Designed for Digital Predistortion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

MRF7S21080HR3
MRF7S21080HSR3

2110-2170 MHz, 22 W AVG., 28 V
SINGLE W-CDMA
LATERAL N-CHANNEL
RF POWER MOSFETs



CASE 465-06, STYLE 1
NI-780
MRF7S21080HR3



CASE 465A-06, STYLE 1
NI-780S
MRF7S21080HSR3

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 Case Temperature 79°C, 79 W CW Case Temperature 75°C, 22 W CW | $R_{\theta JC}$ | 0.60 0.65 | °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.

Table 3. ESD Protection Characteristics

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

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

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

Off Characteristics

| | | | | | |
|---|-----------|---|---|----|-----------------|
| Zero Gate Voltage Drain Leakage Current ($V_{DS} = 65\text{ Vdc}$, $V_{GS} = 0\text{ Vdc}$) | 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 ($V_{DS} = 10\text{ Vdc}$, $I_D = 174\ \mu\text{Adc}$) | $V_{GS(th)}$ | 1.5 | 2 | 3 | Vdc |
| Gate Quiescent Voltage ($V_{DS} = 28\text{ Vdc}$, $I_D = 800\text{ mAdc}$) | $V_{GS(Q)}$ | — | 2.7 | — | Vdc |
| Fixture Gate Quiescent Voltage (1) ($V_{DD} = 28\text{ Vdc}$, $I_D = 800\text{ mAdc}$, Measured in Functional Test) | $V_{GG(Q)}$ | 4 | 5.5 | 7 | Vdc |
| Drain-Source On-Voltage ($V_{GS} = 10\text{ Vdc}$, $I_D = 1.74\text{ Adc}$) | $V_{DS(on)}$ | 0.1 | 0.2 | 0.3 | Vdc |

Dynamic Characteristics (2)

| | | | | | |
|---|-----------|---|------|---|----|
| Reverse Transfer Capacitance ($V_{DS} = 28\text{ Vdc} \pm 30\text{ mV(rms)ac}$ @ 1 MHz, $V_{GS} = 0\text{ Vdc}$) | C_{rss} | — | 0.64 | — | pF |
| Output Capacitance ($V_{DS} = 28\text{ Vdc} \pm 30\text{ mV(rms)ac}$ @ 1 MHz, $V_{GS} = 0\text{ Vdc}$) | C_{oss} | — | 296 | — | pF |
| Input Capacitance ($V_{DS} = 28\text{ Vdc}$, $V_{GS} = 0\text{ Vdc} \pm 30\text{ mV(rms)ac}$ @ 1 MHz) | C_{iss} | — | 160 | — | pF |

Functional Tests (In Freescale Test Fixture, 50 ohm system) $V_{DD} = 28\text{ Vdc}$, $I_{DQ} = 800\text{ mA}$, $P_{out} = 22\text{ W Avg.}$, $f = 2167.5\text{ MHz}$, Single-Carrier W-CDMA, IQ Magnitude Clipping, PAR = 7.5 dB @ 0.01% Probability on CCDF. ACPR measured in 3.84 MHz Channel Bandwidth @ $\pm 5\text{ MHz}$ Offset.

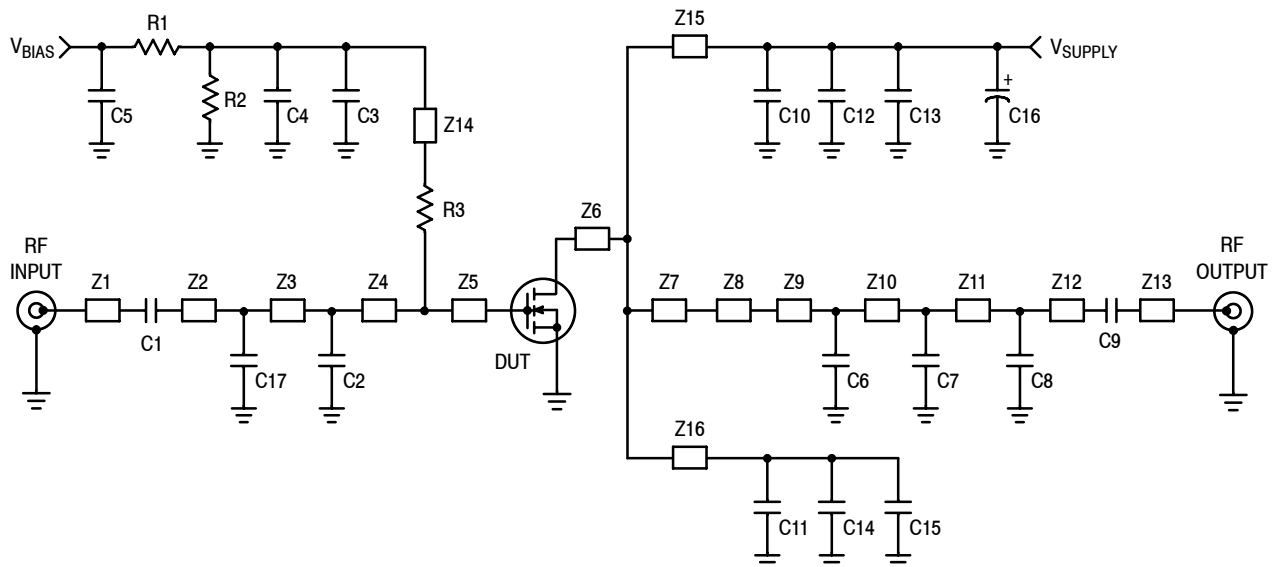
| | | | | | |
|--|----------|------|-----|------|-----|
| Power Gain | G_{ps} | 16.5 | 18 | 19.5 | dB |
| Drain Efficiency | η_D | 30 | 32 | — | % |
| Output Peak-to-Average Ratio @ 0.01% Probability on CCDF | PAR | 5.7 | 6.5 | — | dB |
| Adjacent Channel Power Ratio | ACPR | — | -38 | -35 | dBc |
| Input Return Loss | IRL | — | -16 | -9 | dB |

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

(continued)

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

| Characteristic | Symbol | Min | Typ | Max | Unit |
|--|------------------|-----|-------|-----|----------------------|
| Typical Performances (In Freescale Test Fixture, 50 ohm system) $V_{DD} = 28\text{ Vdc}$, $I_{DQ} = 800\text{ mA}$, 2110-2170 MHz Bandwidth | | | | | |
| Video Bandwidth @ 70 W PEP P_{out} where $IM3 = -30\text{ dBc}$ (Tone Spacing from 100 kHz to VBW) $\Delta IMD3 = IMD3 @ \text{VBW frequency} - IMD3 @ 100\text{ kHz} < 1\text{ dBc}$ (both sidebands) | VBW | — | 10 | — | MHz |
| Gain Flatness in 60 MHz Bandwidth @ $P_{out} = 22\text{ W Avg.}$ | G_F | — | 0.12 | — | dB |
| Average Deviation from Linear Phase in 60 MHz Bandwidth @ $P_{out} = 80\text{ W CW}$ | Φ | — | 22.3 | — | $^\circ$ |
| Average Group Delay @ $P_{out} = 80\text{ W CW}$, $f = 2140\text{ MHz}$ | Delay | — | 6.21 | — | ns |
| Part-to-Part Insertion Phase Variation @ $P_{out} = 80\text{ W CW}$, $f = 2140\text{ MHz}$, Six Sigma Window | $\Delta\Phi$ | — | 151.6 | — | $^\circ$ |
| Gain Variation over Temperature (-30°C to $+85^\circ\text{C}$) | ΔG | — | 0.009 | — | dB/ $^\circ\text{C}$ |
| Output Power Variation over Temperature (-30°C to $+85^\circ\text{C}$) | ΔP_{1dB} | — | 0.008 | — | dB/ $^\circ\text{C}$ |



| | | | |
|-----|----------------------------|-----------|--|
| Z1 | 0.325" x 0.083" Microstrip | Z10* | 0.457" x 0.083" Microstrip |
| Z2* | 0.921" x 0.083" Microstrip | Z11* | 0.118" x 0.083" Microstrip |
| Z3* | 0.126" x 0.083" Microstrip | Z12* | 0.206" x 0.083" Microstrip |
| Z4* | 0.645" x 0.083" Microstrip | Z13 | 0.301" x 0.083" Microstrip |
| Z5 | 0.275" x 0.669" Microstrip | Z14* | 1.220" x 0.080" Microstrip |
| Z6 | 0.114" x 0.764" Microstrip | Z15, Z16* | 0.720" x 0.080" Microstrip |
| Z7 | 0.374" x 0.764" Microstrip | PCB | Taconic TLX8-0300, 0.030", $\epsilon_r = 2.55$ |
| Z8 | 0.180" x 0.524" Microstrip | | |
| Z9* | 0.075" x 0.083" Microstrip | | |

* Variable for tuning

Figure 1. MRF7S21080HR3(HSR3) Test Circuit Schematic

Table 5. MRF7S21080HR3(HSR3) Test Circuit Component Designations and Values

| Part | Description | Part Number | Manufacturer |
|------------------------|--|-------------------|--------------|
| C1, C3, C9, C10, C11 | 6.8 pF Chip Capacitors | ATC100B6R8BT500XT | ATC |
| C2 | 0.5 pF Chip Capacitor | ATC100B0R5BT500XT | ATC |
| C4 | 220 nF Chip Capacitor | 18125C224KAT1A | AVX |
| C5, C12, C13, C14, C15 | 10 μ F, 50 V Chip Capacitors | C5750X5R1H106M | TDK |
| C6 | 1.5 pF Chip Capacitor | ATC100B1R5BT500XT | ATC |
| C7, C8, C17 | 0.2 pF Chip Capacitors | ATC100B0R2BT500XT | ATC |
| C16 | 220 μ F, 63 V Electrolytic Capacitor, Radial | 222213668221 | Vishay |
| R1, R2 | 2 K Ω , 1/4 W Chip Resistors | CRCW12062001FKEA | Vishay |
| R3 | 10 Ω , 1/4 W Chip Resistor | CRCW120610R0FKEA | Vishay |

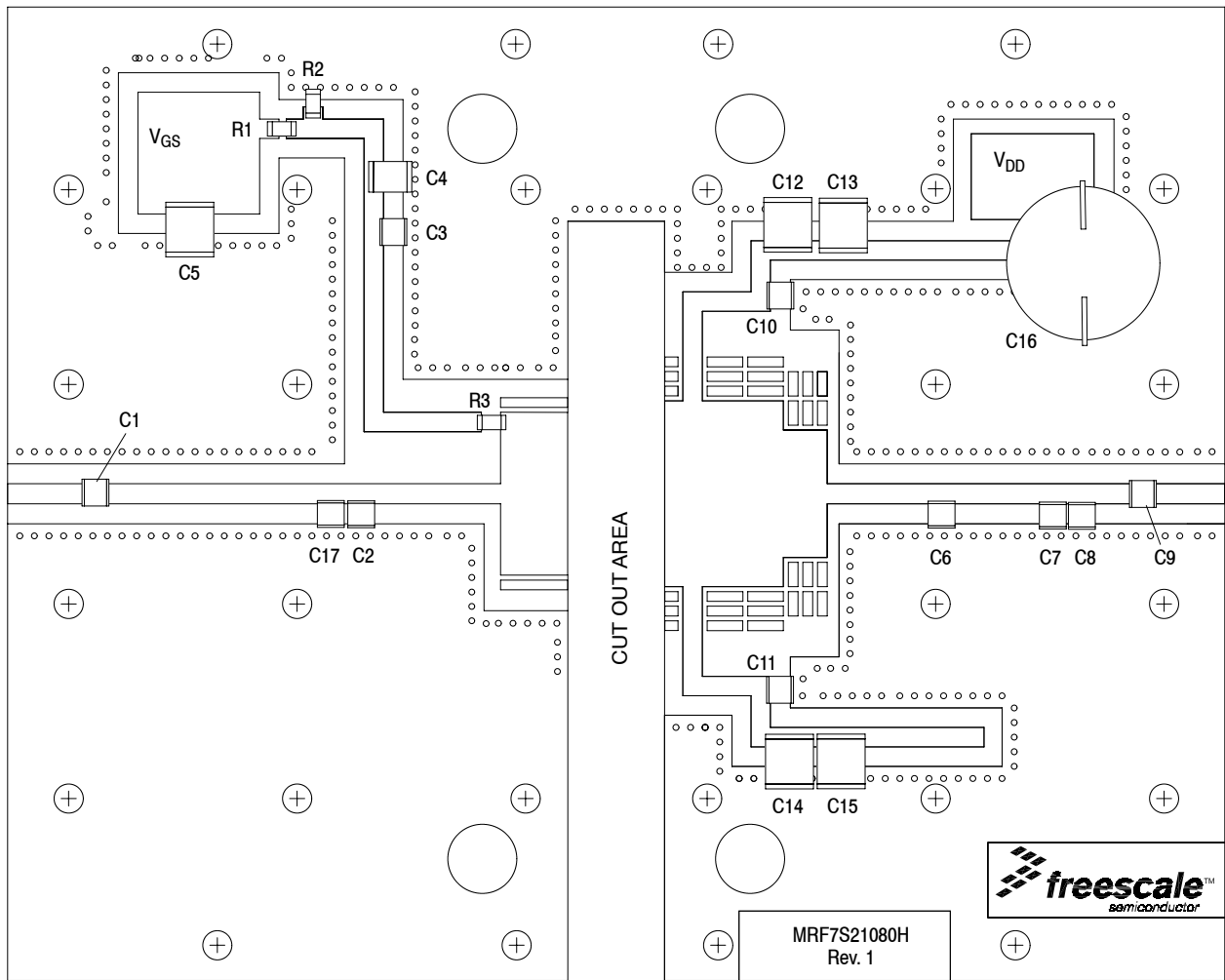


Figure 2. MRF7S21080HR3(HSR3) Test Circuit Component Layout

TYPICAL CHARACTERISTICS

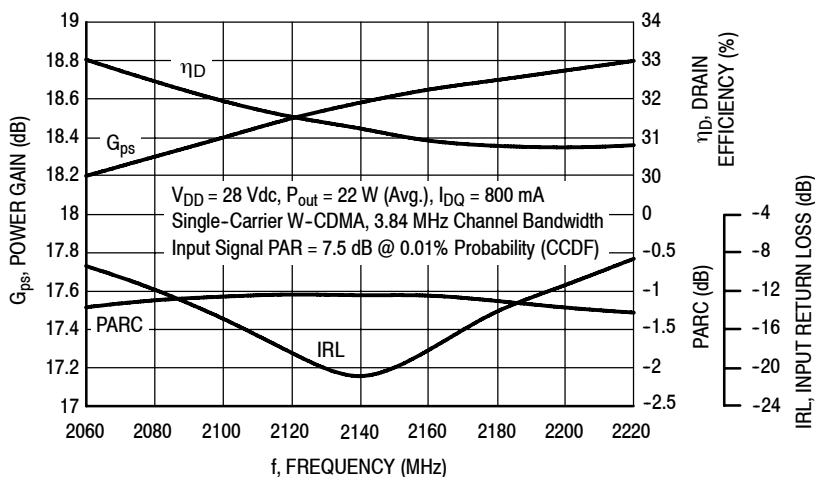


Figure 3. Output Peak-to-Average Ratio Compression (PARC) Broadband Performance @ $P_{out} = 22$ Watts Avg.

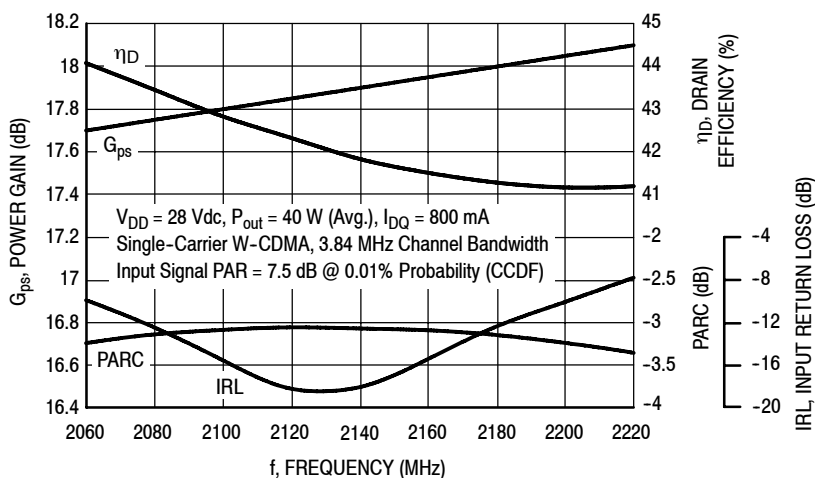


Figure 4. Output Peak-to-Average Ratio Compression (PARC) Broadband Performance @ $P_{out} = 40$ Watts Avg.

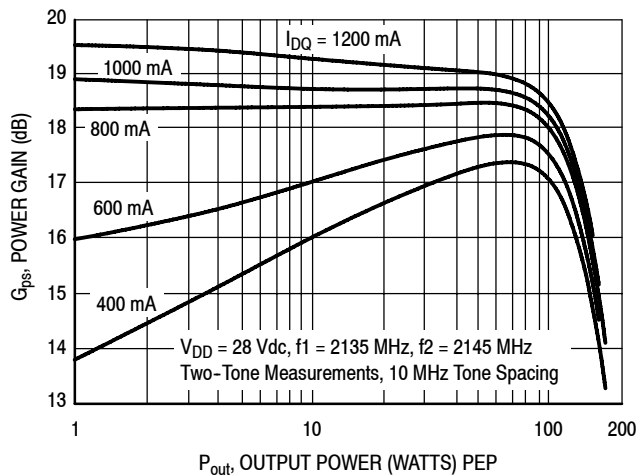


Figure 5. Two-Tone Power Gain versus Output Power

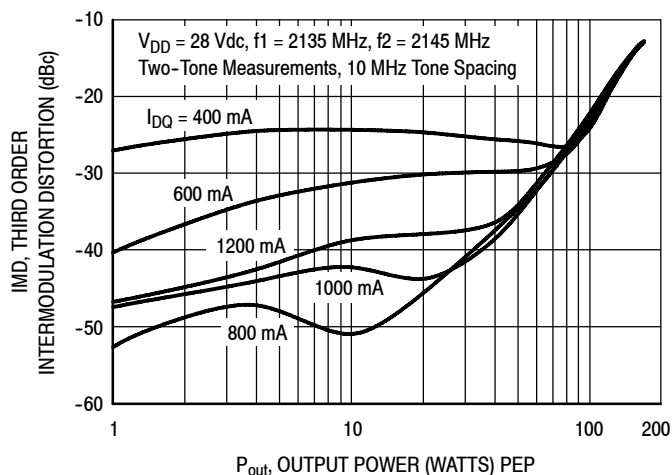


Figure 6. Third Order Intermodulation Distortion versus Output Power

TYPICAL CHARACTERISTICS

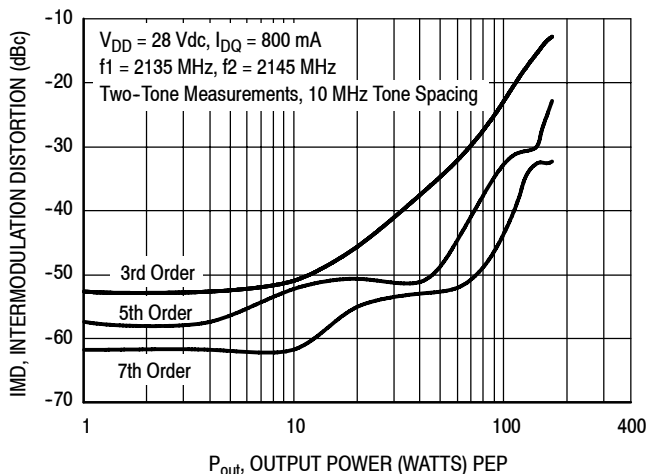


Figure 7. Intermodulation Distortion Products versus Output Power

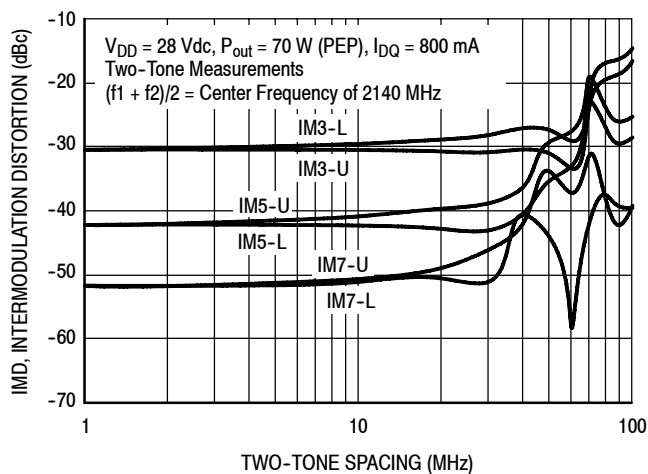


Figure 8. Intermodulation Distortion Products versus Tone Spacing

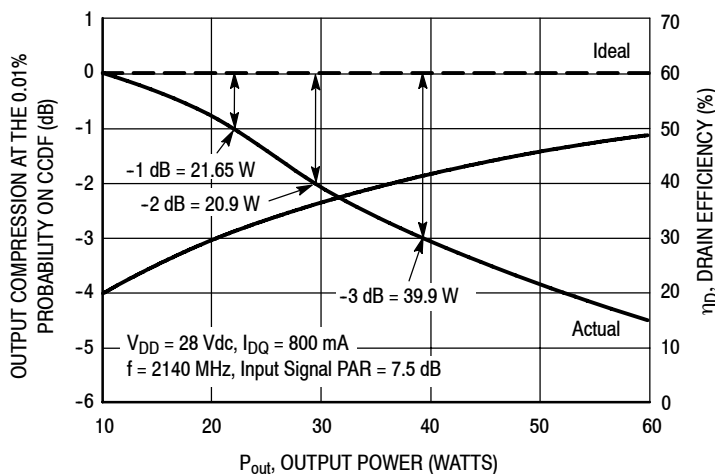


Figure 9. Output Peak-to-Average Ratio Compression (PARC) versus Output Power

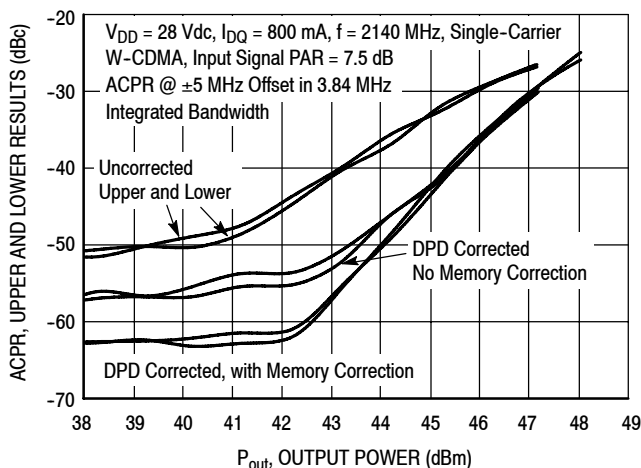


Figure 10. Digital Predistortion Correction versus ACPR and Output Power

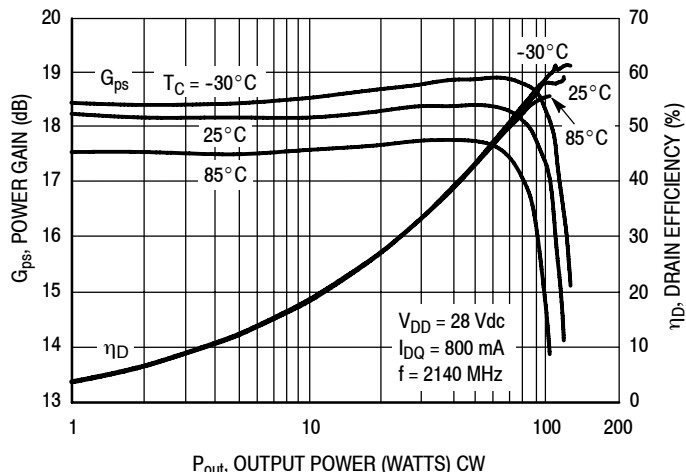


Figure 11. Power Gain and Drain Efficiency versus CW Output Power

MRF7S21080HR3 MRF7S21080HSR3

TYPICAL CHARACTERISTICS

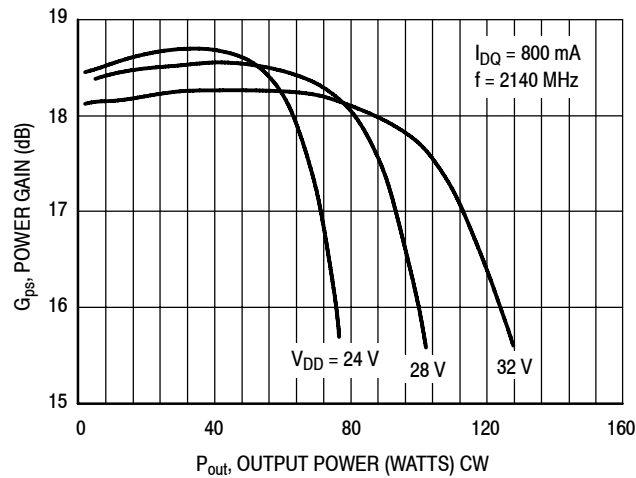


Figure 12. Power Gain versus Output Power

W-CDMA TEST SIGNAL

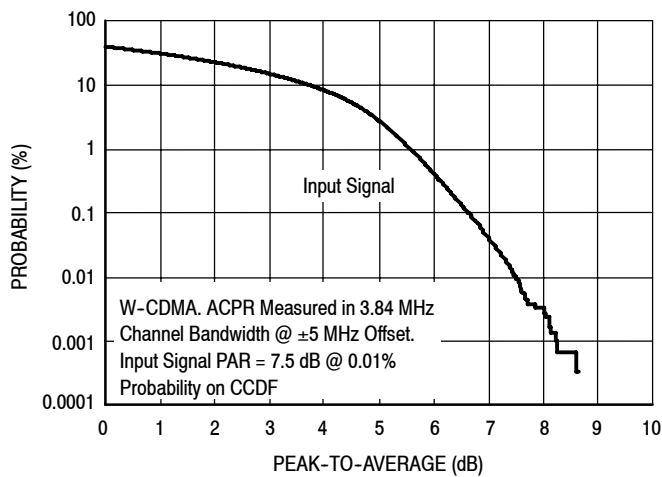


Figure 13. CCDF W-CDMA IQ Magnitude Clipping, Single-Carrier Test Signal

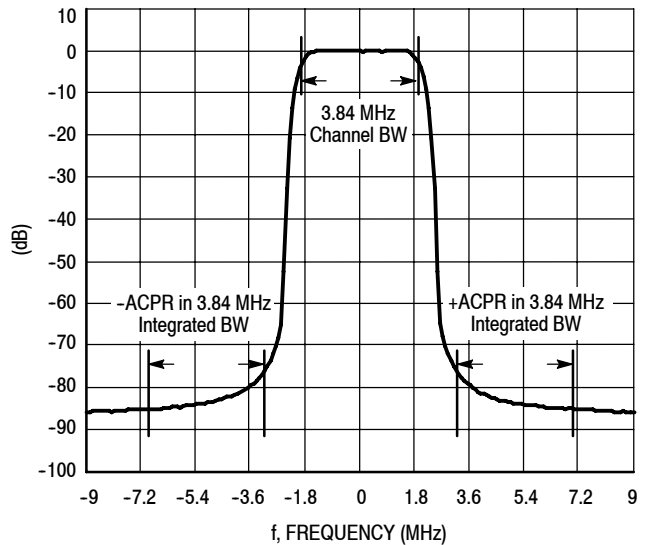
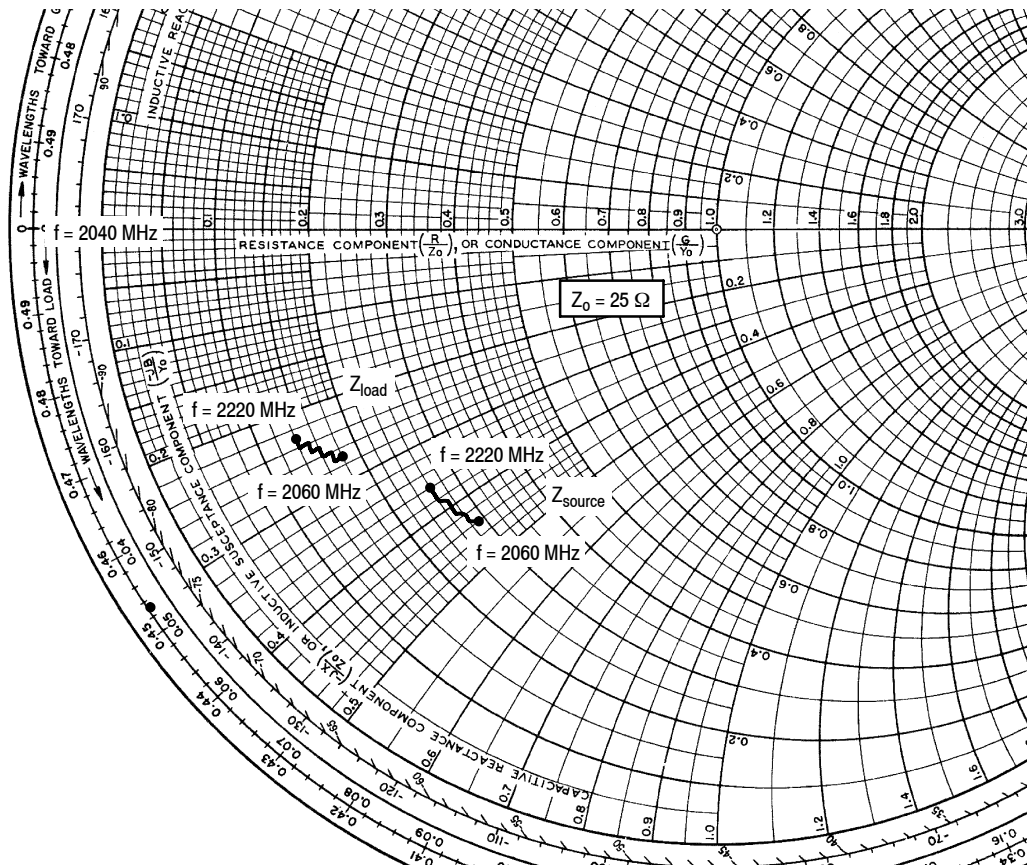


Figure 14. Single-Carrier W-CDMA Spectrum



$V_{DD} = 28 \text{ Vdc}$, $I_{DQ} = 800 \text{ mA}$, $P_{out} = 22 \text{ W Avg.}$

| f MHz | Z_{source} Ω | Z_{load} Ω |
|----------|--------------------------|------------------------|
| 2060 | $7.16 - j11.074$ | $4.403 - j6.809$ |
| 2080 | $7.066 - j10.796$ | $4.275 - j6.662$ |
| 2100 | $6.954 - j10.526$ | $4.147 - j6.515$ |
| 2120 | $6.857 - j10.260$ | $4.017 - j6.375$ |
| 2140 | $6.745 - j9.980$ | $3.889 - j6.233$ |
| 2160 | $6.668 - j9.728$ | $3.764 - j6.126$ |
| 2180 | $6.588 - j9.462$ | $3.642 - j6.016$ |
| 2200 | $6.511 - j9.203$ | $3.519 - j5.895$ |
| 2220 | $6.403 - j8.892$ | $3.401 - j5.774$ |

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

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

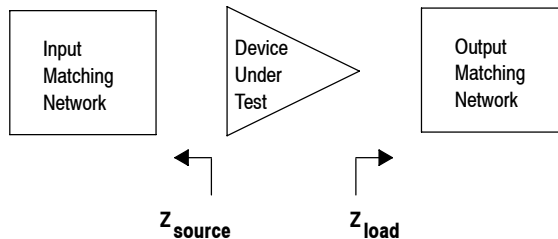
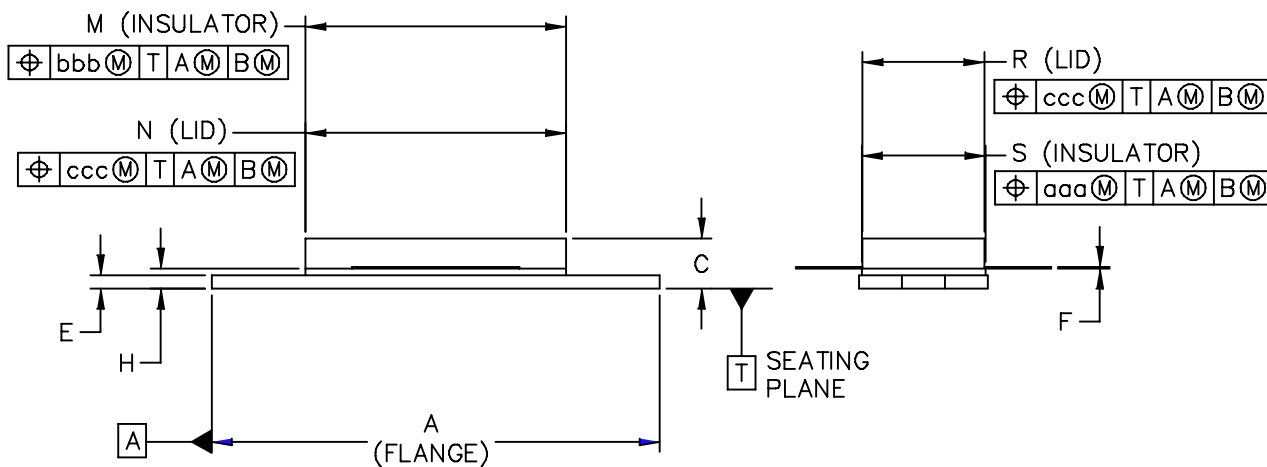
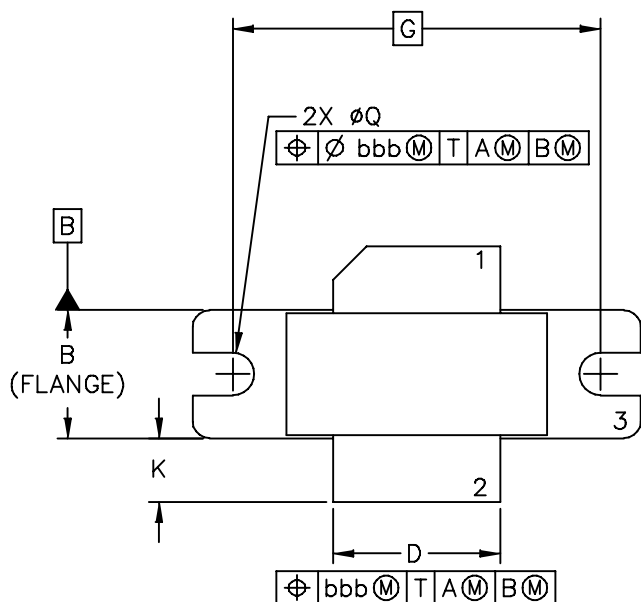


Figure 15. Series Equivalent Source and Load Impedance

PACKAGE DIMENSIONS



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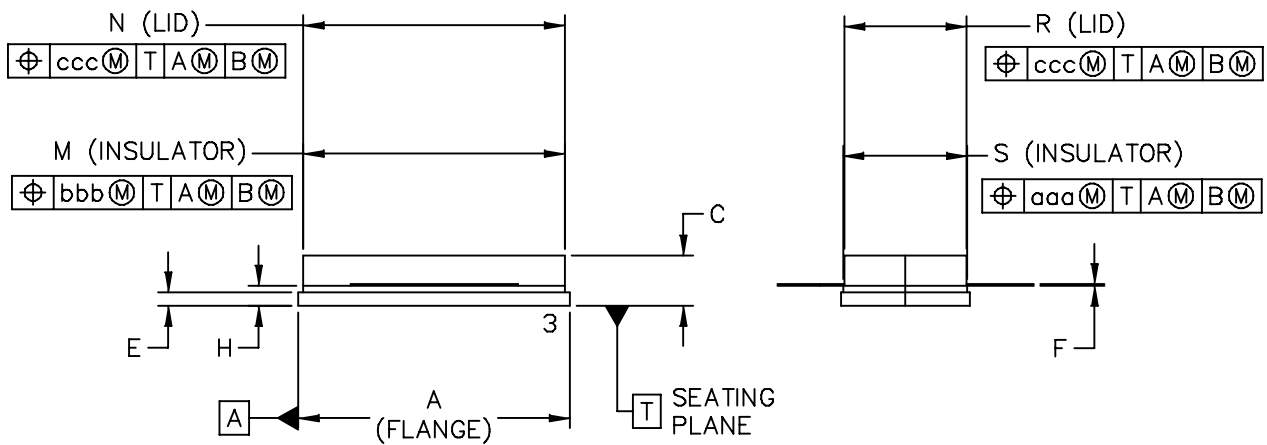
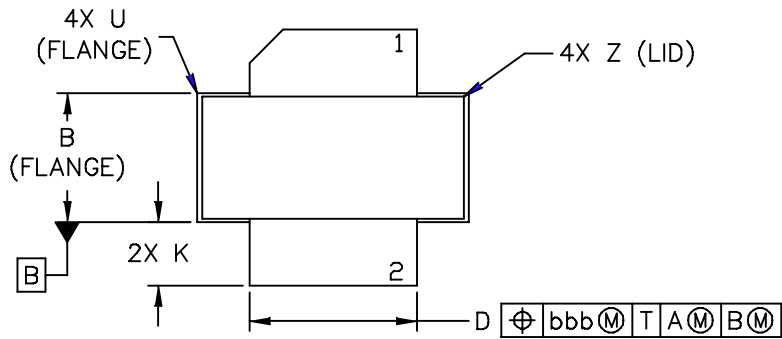
NOTES:

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M-1994.
2. CONTROLLING DIMENSION: INCH.
3. DELETED
4. DIMENSION H IS MEASURED .030 (.762) AWAY FROM PACKAGE BODY.

STYLE 1:

- PIN 1. DRAIN
 2. GATE
 3. SOURCE

| DIM | INCH | | MILLIMETER | | DIM | INCH | | MILLIMETER | |
|---|-----------|-------|--------------------|-------|--------------------------|----------------------------|------|-------------|-------|
| | MIN | MAX | MIN | MAX | | MIN | MAX | MIN | MAX |
| A | 1.335 | 1.345 | 33.91 | 34.16 | R | .365 | .375 | 9.27 | 9.53 |
| B | .380 | .390 | 9.65 | 9.91 | S | .365 | .375 | 9.27 | 9.52 |
| C | .125 | .170 | 3.18 | 4.32 | aaa | — | .005 | — | 0.127 |
| D | .495 | .505 | 12.57 | 12.83 | bbb | — | .010 | — | 0.254 |
| E | .035 | .045 | 0.89 | 1.14 | ccc | — | .015 | — | 0.381 |
| F | .003 | .006 | 0.08 | 0.15 | — | — | — | — | — |
| G | 1.100 BSC | | 27.94 BSC | | — | — | — | — | — |
| H | .057 | .067 | 1.45 | 1.7 | — | — | — | — | — |
| K | .170 | .210 | 4.32 | 5.33 | — | — | — | — | — |
| M | .774 | .786 | 19.66 | 19.96 | — | — | — | — | — |
| N | .772 | .788 | 19.6 | 20 | — | — | — | — | — |
| Q | ∅.118 | ∅.138 | ∅3 | ∅3.51 | — | — | — | — | — |
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2. CONTROLLING DIMENSION: INCH.
3. DELETED
4. DIMENSION H IS MEASURED .030 (0.762) AWAY FROM PACKAGE BODY.

STYLE 1:

- PIN 1. DRAIN
2. GATE
3. SOURCE

| DIM | INCH | | MILLIMETER | | DIM | INCH | | MILLIMETER | |
|---|------|-------|--------------------|-------|--------------------------|----------------------------|-----|-------------|------|
| | MIN | MAX | MIN | MAX | | MIN | MAX | MIN | MAX |
| A | .805 | -.815 | 20.45 | 20.7 | U | -.040 | | | 1.02 |
| B | .380 | -.390 | 9.65 | 9.91 | Z | -.030 | | | 0.76 |
| C | .125 | -.170 | 3.18 | 4.32 | aaa | -.005 | | 0.127 | |
| D | .495 | -.505 | 12.57 | 12.83 | bbb | -.010 | | 0.254 | |
| E | .035 | -.045 | 0.89 | 1.14 | ccc | -.015 | | 0.381 | |
| F | .003 | -.006 | 0.08 | 0.15 | - | | | | |
| H | .057 | -.067 | 1.45 | 1.7 | - | | | | |
| K | .170 | -.210 | 4.32 | 5.33 | - | | | | |
| M | .774 | -.786 | 19.61 | 20.02 | - | | | | |
| N | .772 | -.788 | 19.61 | 20.02 | - | | | | |
| R | .365 | -.375 | 9.27 | 9.53 | - | | | | |
| S | .365 | -.375 | 9.27 | 9.52 | - | | | | |
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| | | | | | CASE NUMBER: 465A-06 | | | 31 MAR 2005 | |
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PRODUCT DOCUMENTATION AND SOFTWARE

Refer to the following documents and software 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

Software

- Electromigration MTTF Calculator
- RF High Power Model

For Software, do a Part Number search at <http://www.freescale.com>, and select the "Part Number" link. Go to the Software & Tools tab on the part's Product Summary page to download the respective tool.

REVISION HISTORY

The following table summarizes revisions to this document.

| Revision | Date | Description |
|----------|-----------|--|
| 0 | Nov. 2007 | <ul style="list-style-type: none">• Initial Release of Data Sheet |
| 1 | Mar. 2011 | <ul style="list-style-type: none">• Modified data sheet to reflect RF Test Reduction described in Product and Process Change Notification number, PCN13628, p. 1, 2• Fig. 13, MTTF versus Junction Temperature removed, p. 8. Refer to the device's MTTF Calculator available at freescale.com/RFpower. Go to Design Resources > Software and Tools.• Fig. 14, CCDF W-CDMA IQ Magnitude Clipping, Single-Carrier Test Signal and Fig. 15, Single-Carrier W-CDMA Spectrum updated to show the undistorted input test signal, p. 8 (renumbered as Figs. 13 and 14 respectively after Fig. 13 removed)• Added Electromigration MTTF Calculator and RF High Power Model availability to Product Software, p. 14 |

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