

MRF5P21240R6 replaced by MRF5P21240HR6. "H" suffix indicates lower thermal resistance package.

RF Power Field Effect Transistor

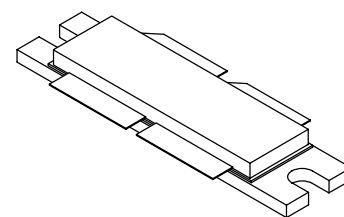
N-Channel Enhancement-Mode Lateral MOSFET

Designed for W-CDMA base station applications with frequencies from 2110 to 2170 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 W-CDMA Performance for $V_{DD} = 28$ Volts, $I_{DQ} = 2 \times 1100$ mA, $f_1 = 2135$ MHz, $f_2 = 2145$ MHz, Channel Bandwidth = 3.84 MHz, Adjacent Channels Measured over 3.84 MHz BW @ $f_1 - 5$ MHz and $f_2 + 5$ MHz. Distortion Products Measured over a 3.84 MHz BW @ $f_1 - 10$ MHz and $f_2 + 10$ MHz, Each Carrier Peak/Avg. = 8.5 dB @ 0.01% Probability on CCDF.
 - Output Power — 52 Watts Avg.
 - Power Gain — 13 dB
 - Efficiency — 24%
 - IM3 — -36 dBc
 - ACPR — -39 dBc
- Internally Matched, Controlled Q, for Ease of Use
- High Gain, High Efficiency and High Linearity
- Integrated ESD Protection
- Designed for Maximum Gain and Insertion Phase Flatness
- Capable of Handling 5:1 VSWR, @ 28 Vdc, $f = 2140$ MHz, 180 Watts CW Output Power
- Excellent Thermal Stability
- Characterized with Series Equivalent Large-Signal Impedance Parameters
- In Tape and Reel. R6 Suffix = 150 Units per 56 mm, 13 inch Reel.

MRF5P21240R6

2170 MHz, 52 W AVG., 28 V
2 x W-CDMA
LATERAL N-CHANNEL
RF POWER MOSFET



CASE 375D-05, STYLE 1
NI-1230

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Table 1. Maximum Ratings

| Rating | Symbol | Value | Unit |
|--|-----------|--------------|--------------------------|
| Drain-Source Voltage | V_{DSS} | -0.5, +65 | Vdc |
| Gate-Source Voltage | V_{GS} | -0.5, +15 | Vdc |
| Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C | P_D | 500 2.86 | W W/ $^\circ\text{C}$ |
| Storage Temperature Range | T_{stg} | - 65 to +150 | $^\circ\text{C}$ |
| Operating Junction Temperature | T_J | 200 | $^\circ\text{C}$ |
| CW Operation | CW | 180 | W |

Table 2. Thermal Characteristics

| Characteristic | Symbol | Value (1,2) | Unit |
|---|-----------------|--------------|---------------------------|
| Thermal Resistance, Junction to Case Case Temperature 55°C , 180 W CW Case Temperature 45°C , 52 W CW | $R_{\theta JC}$ | 0.35 0.40 | $^\circ\text{C}/\text{W}$ |

1. MTTF calculator available at <http://www.freescale.com/rf>. Select Tools/Software/Application Software/Calculators to access the MTTF calculators by product.
2. Refer to AN1955/D, *Thermal Measurement Methodology of RF Power Amplifiers*. Go to <http://www.freescale.com/rf>. Select Documentation/Application Notes - AN1955.

NOTE - CAUTION - MOS devices are susceptible to damage from electrostatic charge. Reasonable precautions in handling and packaging MOS devices should be observed.

Table 3. ESD Protection Characteristics

| Test Conditions | Class |
|---------------------|--------------|
| Human Body Model | 2 (Minimum) |
| Machine Model | M3 (Minimum) |
| Charge Device Model | C6 (Minimum) |

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

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

Off Characteristics ⁽¹⁾

| | | | | | |
|---|-----------|---|---|----|---------------|
| Zero Gate Voltage Drain Leakage Current ($V_{DS} = 65\text{ Vdc}$, $V_{GS} = 0\text{ Vdc}$) | I_{DSS} | — | — | 10 | μA |
| Zero Gate Voltage Drain Leakage Current ($V_{DS} = 28\text{ Vdc}$, $V_{GS} = 0\text{ Vdc}$) | I_{DSS} | — | — | 1 | μA |
| Gate-Source Leakage Current ($V_{GS} = 5\text{ Vdc}$, $V_{DS} = 0\text{ Vdc}$) | I_{GSS} | — | — | 1 | μA |

On Characteristics ⁽¹⁾

| | | | | | |
|---|--------------|---|------|-----|-----|
| Gate Threshold Voltage ($V_{DS} = 10\text{ Vdc}$, $I_D = 300\ \mu\text{A}$) | $V_{GS(th)}$ | 2 | 2.8 | 4 | Vdc |
| Gate Quiescent Voltage ($V_{DS} = 28\text{ Vdc}$, $I_D = 1100\ \text{mA}$) | $V_{GS(Q)}$ | 3 | 3.8 | 5 | Vdc |
| Drain-Source On-Voltage ($V_{GS} = 10\text{ Vdc}$, $I_D = 3\ \text{A}$) | $V_{DS(on)}$ | — | 0.26 | 0.3 | Vdc |
| Forward Transconductance ($V_{DS} = 10\text{ Vdc}$, $I_D = 3\ \text{A}$) | g_{fs} | — | 7.5 | — | S |

Dynamic Characteristics ⁽¹⁾

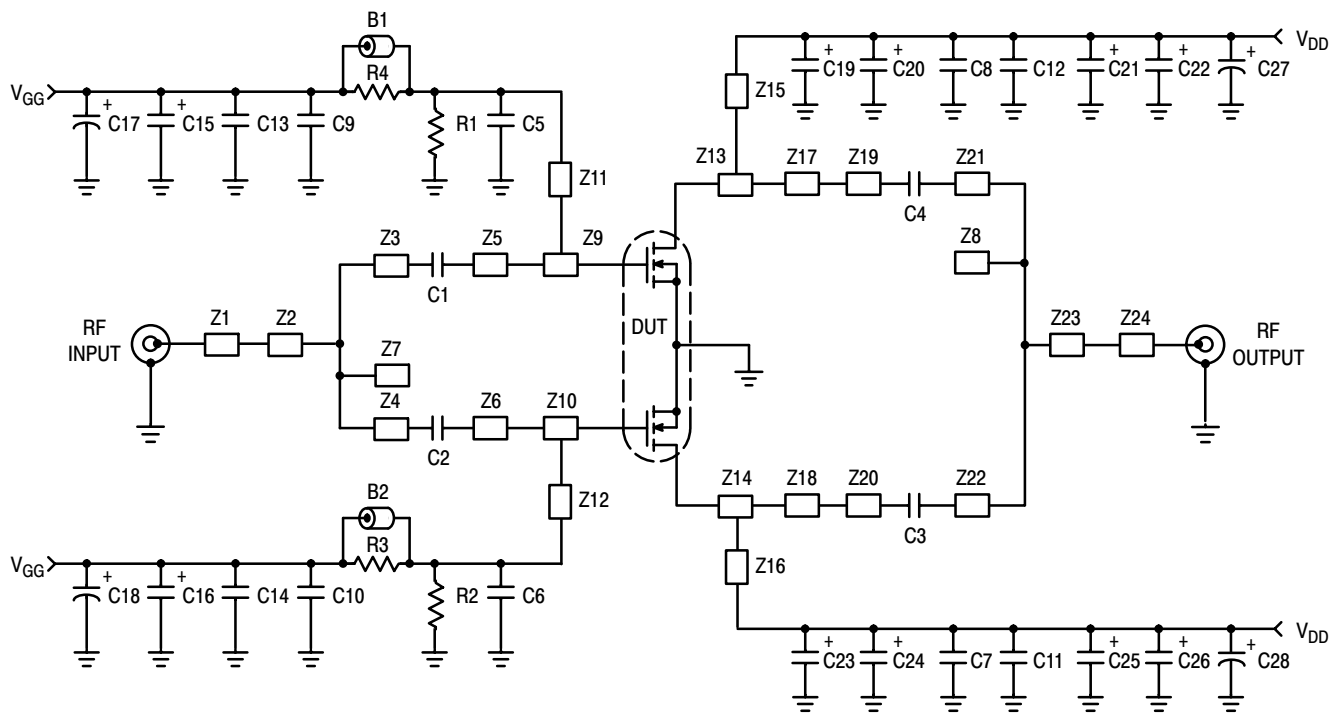
| | | | | | |
|---|-----------|---|------|---|----|
| Reverse Transfer Capacitance ($V_{DS} = 28\text{ Vdc}$, $V_{GS} = 0$, $f = 1\ \text{MHz}$) | C_{rss} | — | 2.75 | — | pF |
|---|-----------|---|------|---|----|

Functional Tests (In Freescale Test Fixture, 50 ohm system) ⁽²⁾

2-Carrier W-CDMA, 3.84 MHz Channel Bandwidth Carriers. Each carrier has Peak/Avg. ratio = 8.5 dB @ 0.01% Probability on CCDF.

| | | | | | |
|---|----------|------|-----|-----|-----|
| Common-Source Amplifier Power Gain ($V_{DD} = 28\text{ Vdc}$, $P_{out} = 52\ \text{W Avg.}$, $I_{DQ} = 2 \times 1100\ \text{mA}$, $f_1 = 2112.5\ \text{MHz}$, $f_2 = 2122.5\ \text{MHz}$ and $f_1 = 2157.5\ \text{MHz}$, $f_2 = 2167.5\ \text{MHz}$) | G_{ps} | 12 | 13 | — | dB |
| Drain Efficiency ($V_{DD} = 28\text{ Vdc}$, $P_{out} = 52\ \text{W Avg.}$, $I_{DQ} = 2 \times 1100\ \text{mA}$, $f_1 = 2112.5\ \text{MHz}$, $f_2 = 2122.5\ \text{MHz}$ and $f_1 = 2157.5\ \text{MHz}$, $f_2 = 2167.5\ \text{MHz}$) | η | 22.5 | 24 | — | % |
| Third Order Intermodulation Distortion ($V_{DD} = 28\text{ Vdc}$, $P_{out} = 52\ \text{W Avg.}$, $I_{DQ} = 2 \times 1100\ \text{mA}$, $f_1 = 2112.5\ \text{MHz}$, $f_2 = 2122.5\ \text{MHz}$ and $f_1 = 2157.5\ \text{MHz}$, $f_2 = 2167.5\ \text{MHz}$; IM3 measured over 3.84 MHz BW @ $f_1 - 10\ \text{MHz}$ and $f_2 + 10\ \text{MHz}$) | IM3 | — | -36 | -34 | dBc |
| Adjacent Channel Power Ratio ($V_{DD} = 28\text{ Vdc}$, $P_{out} = 52\ \text{W Avg.}$, $I_{DQ} = 2 \times 1100\ \text{mA}$, $f_1 = 2112.5\ \text{MHz}$, $f_2 = 2122.5\ \text{MHz}$ and $f_1 = 2157.5\ \text{MHz}$, $f_2 = 2167.5\ \text{MHz}$; ACPR measured over 3.84 MHz BW @ $f_1 - 5\ \text{MHz}$ and $f_2 + 5\ \text{MHz}$.) | ACPR | — | -39 | -37 | dBc |
| Input Return Loss ($V_{DD} = 28\text{ Vdc}$, $P_{out} = 52\ \text{W Avg.}$, $I_{DQ} = 2 \times 1100\ \text{mA}$, $f_1 = 2112.5\ \text{MHz}$, $f_2 = 2122.5\ \text{MHz}$ and $f_1 = 2157.5\ \text{MHz}$, $f_2 = 2167.5\ \text{MHz}$) | IRL | — | -12 | -9 | dB |

- Each side of device measured separately. Part is internally matched both on input and output.
- Measurements made with device in push-pull configuration.

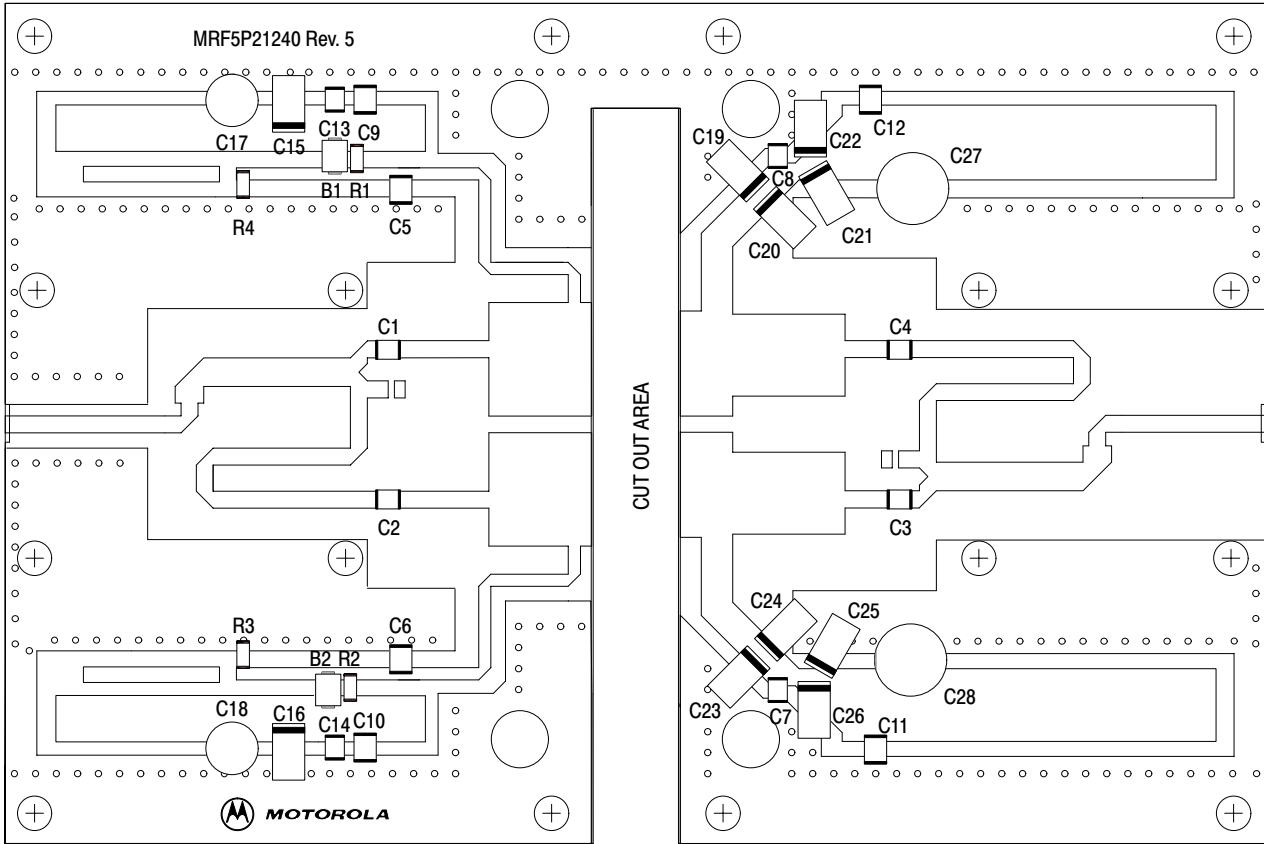


| | | | |
|---------|----------------------------|----------|--|
| Z1 | 0.898" x 0.080" Microstrip | Z11, Z12 | 1.270" x 0.058" Microstrip |
| Z2, Z23 | 0.775" x 0.136" Microstrip | Z13, Z14 | 0.250" x 0.500" Microstrip |
| Z3, Z22 | 0.060" x 0.080" Microstrip | Z15, Z16 | 0.850" x 0.150" Microstrip |
| Z4, Z21 | 1.867" x 0.080" Microstrip | Z17, Z18 | 0.535" x 0.390" Microstrip |
| Z5, Z6 | 0.443" x 0.080" Microstrip | Z19, Z20 | 0.218" x 0.080" Microstrip |
| Z7, Z8 | 0.100" x 0.080" Microstrip | Z24 | 0.825" x 0.080" Microstrip |
| Z9, Z10 | 0.490" x 0.540" Microstrip | PCB | Arlon GX-0300-55-22, 0.030", $\epsilon_r = 2.55$ |

Figure 1. MRF5P21240R6 Test Circuit Schematic

Table 5. MRF5P21240R6 Test Circuit Component Designations and Values

| Part | Description | Part Number | Manufacturer |
|--|---------------------------------------|--------------------|--------------|
| B1, B2 | Short Ferrite Beads | 2743019447 | Fair Rite |
| C1, C2, C3, C4 | 18 pF Chip Capacitors | 100B180JCA500X | ATC |
| C5, C6, C7, C8 | 6.8 pF Chip Capacitors | 100B6R8JCA500X | ATC |
| C9, C10, C11, C12 | 0.1 μ F Chip Capacitors | CDR33BX104AKWS | Kemet |
| C13, C14 | 1000 pF Chip Capacitors | 100B102JCA500X | ATC |
| C15, C16 | 4.7 μ F Tantalum Capacitors | T491C475M050 | Kemet |
| C17, C18 | 10 μ F Electrolytic Capacitors | EEV-HB1H100P | Panasonic |
| C19, C20, C21, C22 C23, C24, C25, C26 | 22 μ F Tantalum Capacitors | T491X226K035AS4394 | Kemet |
| C27, C28 | 100 μ F Electrolytic Capacitors | 517D107M050BB6A | Sprague |
| R1, R2 | 1.0 k Ω , 1/8 W Chip Resistors | | |
| R3, R4 | 10 Ω , 1/8 W Chip Resistors | | |



Freescale has begun the transition of marking Printed Circuit Boards (PCBs) with the Freescale Semiconductor signature/logo. PCBs may have either Motorola or Freescale markings during the transition period. These changes will have no impact on form, fit or function of the current product.

Figure 2. MRF5P21240R6 Test Circuit Component Layout

TYPICAL CHARACTERISTICS

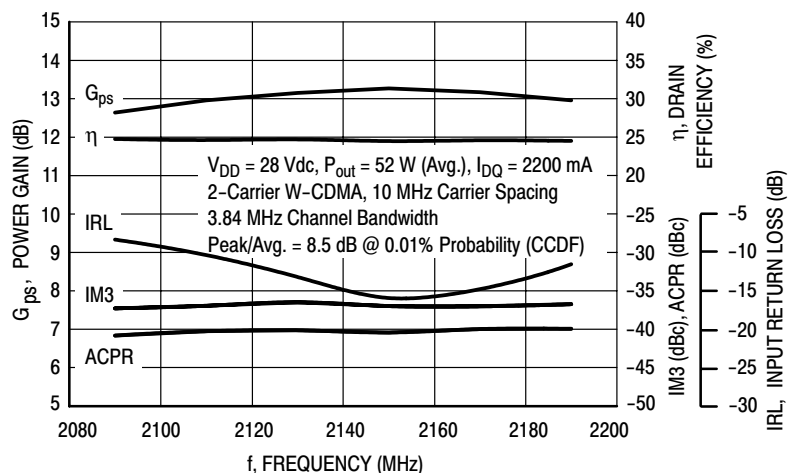


Figure 3. 2-Carrier W-CDMA Broadband Performance

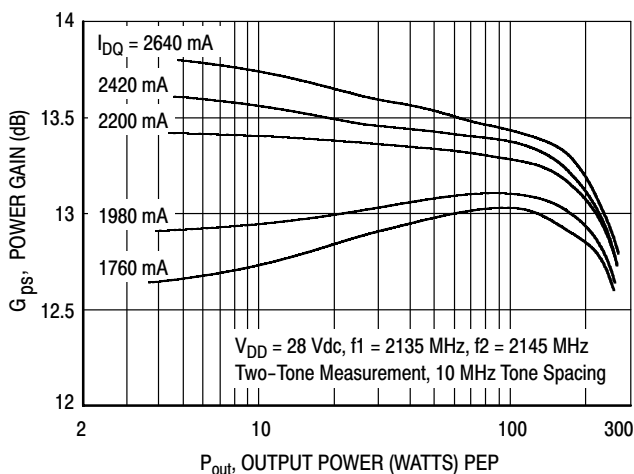


Figure 4. Two-Tone Power Gain versus Output Power

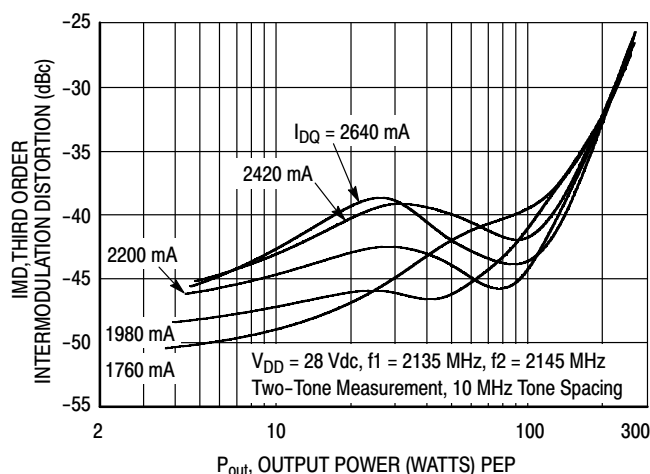


Figure 5. Third Order Intermodulation Distortion versus Output Power

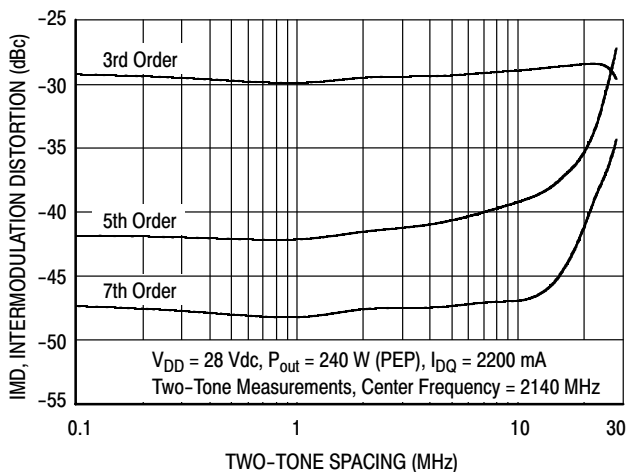


Figure 6. Intermodulation Distortion Products versus Tone Spacing

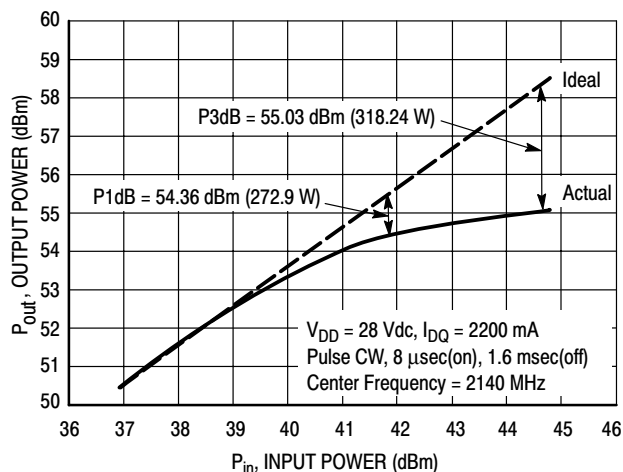


Figure 7. Pulse CW Output Power versus Input Power

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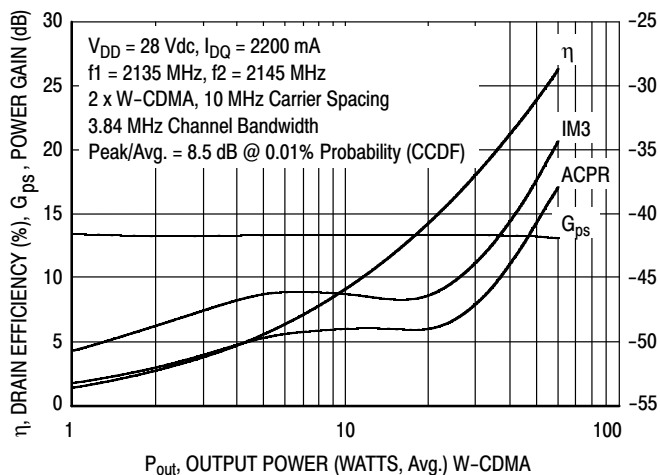


Figure 8. 2-Carrier W-CDMA ACPR, IM3, Power Gain and Drain Efficiency versus Output Power

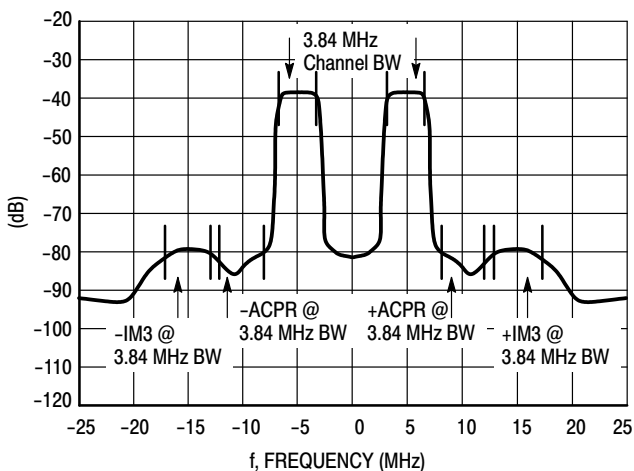


Figure 9. 2-Carrier W-CDMA Spectrum

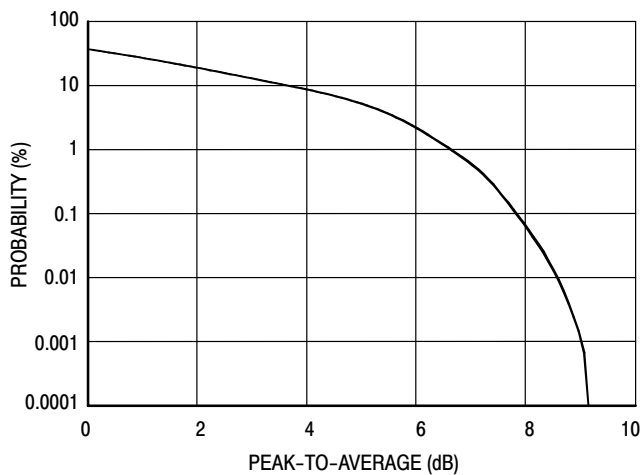
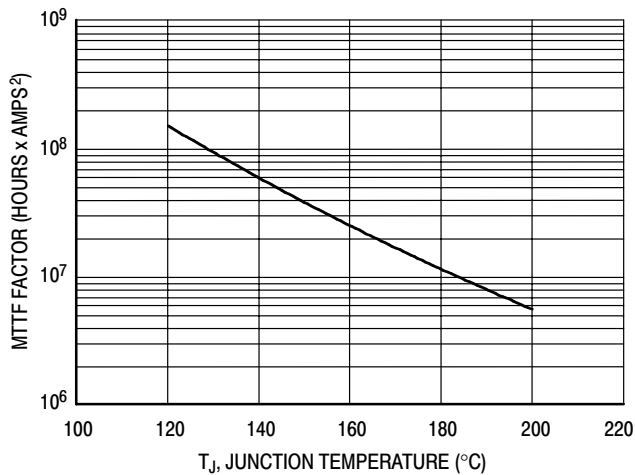


Figure 10. CCDF W-CDMA 3GPP, Test Model 1, 64 DPCH, 67% Clipping, Single Carrier Test Signal

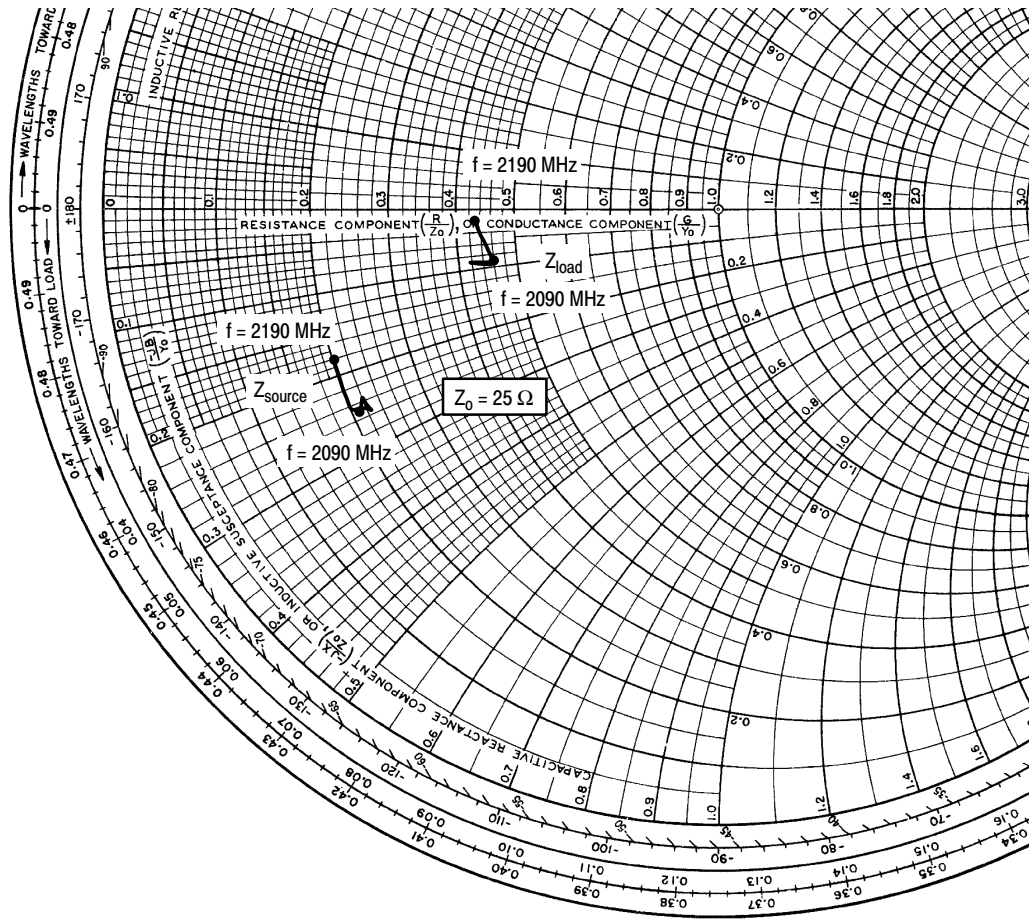


This above graph displays calculated MTTF in hours x ampere² drain current. Life tests at elevated temperatures have correlated to better than $\pm 10\%$ of the theoretical prediction for metal failure. Divide MTTF factor by I_D^2 for MTTF in a particular application.

Figure 11. MTTF Factor versus Junction Temperature

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$V_{DD} = 28\text{ V}$, $I_{DQ} = 2 \times 1100\text{ mA}$, $P_{out} = 52\text{ W Avg.}$

| f MHz | Z _{source} Ω | Z _{load} Ω |
|----------|--------------------------|------------------------|
| 2090 | 5.33 - j6.21 | 11.42 - j2.25 |
| 2110 | 5.44 - j5.88 | 10.45 - j2.16 |
| 2130 | 5.40 - j6.16 | 11.28 - j2.14 |
| 2150 | 5.12 - j6.06 | 11.38 - j2.14 |
| 2170 | 4.96 - j5.25 | 11.04 - j1.25 |
| 2190 | 4.98 - j4.47 | 10.73 - j0.40 |

Z_{source} = Test circuit impedance as measured from gate to gate, balanced configuration.

Z_{load} = Test circuit impedance as measured from drain to drain, balanced configuration.

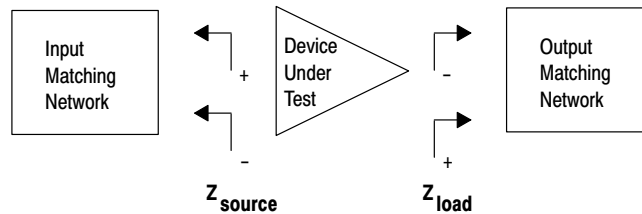


Figure 12. Series Equivalent Source and Load Impedance

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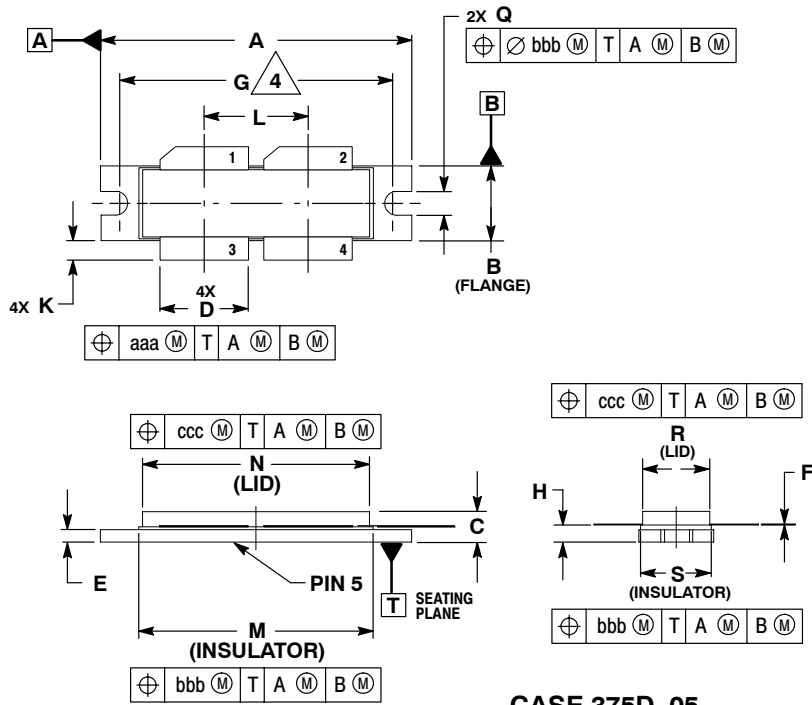
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PACKAGE DIMENSIONS



- NOTES:
1. INTERPRET DIMENSIONS AND TOLERANCES PER ASME 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 1.52 (38.61) BASED ON M3 SCREW.

| DIM | INCHES | | MILLIMETERS | |
|-----|-----------|-------|-------------|-------|
| | MIN | MAX | MIN | MAX |
| A | 1.615 | 1.625 | 41.02 | 41.28 |
| B | 0.395 | 0.405 | 10.03 | 10.29 |
| C | 0.150 | 0.200 | 3.81 | 5.08 |
| D | 0.455 | 0.465 | 11.56 | 11.81 |
| E | 0.062 | 0.066 | 1.57 | 1.68 |
| F | 0.004 | 0.007 | 0.10 | 0.18 |
| G | 1.400 BSC | | 35.56 BSC | |
| H | 0.082 | 0.090 | 2.08 | 2.29 |
| K | 0.117 | 0.137 | 2.97 | 3.48 |
| L | 0.540 BSC | | 13.72 BSC | |
| M | 1.219 | 1.241 | 30.96 | 31.52 |
| N | 1.218 | 1.242 | 30.94 | 31.55 |
| O | 0.120 | 0.130 | 3.05 | 3.30 |
| Q | 0.355 | 0.365 | 9.01 | 9.27 |
| S | 0.365 | 0.375 | 9.27 | 9.53 |
| aaa | 0.013 REF | | 0.33 REF | |
| bbb | 0.010 REF | | 0.25 REF | |
| ccc | 0.020 REF | | 0.51 REF | |

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

**CASE 375D-05
 ISSUE D
 NI-1230**

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