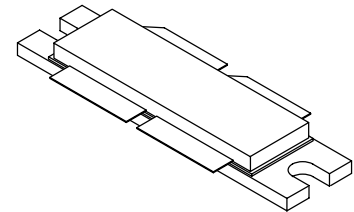


RF Power Field Effect Transistor

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: $V_{DD} = 28$ Volts, $I_{DQ} = 2 \times 950$ mA, $P_{out} = 44$ Watts Avg., Full Frequency Band, Channel Bandwidth = 3.84 MHz, PAR = 8.5 dB @ 0.01% Probability on CCDF.
Power Gain — 15.5 dB
Drain Efficiency — 26.5%
IM3 @ 10 MHz Offset — -37 dBc @ 3.84 MHz Channel Bandwidth
ACPR @ 5 MHz Offset — -40 dBc @ 3.84 MHz Channel Bandwidth
- Capable of Handling 10:1 VSWR, @ 28 Vdc, 2140 MHz, 190 Watts CW Output Power
- 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
- Lower Thermal Resistance Package
- Designed for Lower Memory Effects and Wide Instantaneous Bandwidth Applications
- Low Gold Plating Thickness on Leads, 40 μ " Nominal.
- Pb-Free and RoHS Compliant
- In Tape and Reel. R6 Suffix = 150 Units per 56 mm, 13 inch Reel.

MRF6P21190HR6**2170 MHz, 44 W AVG., 28 V
2 x W-CDMA
LATERAL N-CHANNEL
RF POWER MOSFET****CASE 375D-05, STYLE 1
NI-1230****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 |
| Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C | P_D | 700 4 | 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 | 190 | W |

Table 2. Thermal Characteristics

| Characteristic | Symbol | Value (1,2) | Unit |
|---|-----------------|--------------|---------------------------|
| Thermal Resistance, Junction to Case Case Temperature 80°C , 190 W CW Case Temperature 72°C , 44 W CW | $R_{\theta JC}$ | 0.25 0.27 | $^\circ\text{C}/\text{W}$ |

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, *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 Methodology | Class |
|---------------------------------------|---------------|
| Human Body Model (per JESD22-A114) | 1C (Minimum) |
| Machine Model (per EIA/JESD22-A115) | A (Minimum) |
| Charge Device Model (per JESD22-C101) | III (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 ($V_{DS} = 68\text{ Vdc}$, $V_{GS} = 0\text{ Vdc}$) | 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 ⁽¹⁾ ($V_{DS} = 10\text{ Vdc}$, $I_D = 250\ \mu\text{Adc}$) | $V_{GS(th)}$ | 1 | 2 | 3 | Vdc |
| Gate Quiescent Voltage ⁽³⁾ ($V_{DS} = 28\text{ Vdc}$, $I_D = 1900\text{ mAdc}$) | $V_{GS(Q)}$ | 2 | 2.8 | 4 | Vdc |
| Drain-Source On-Voltage ⁽¹⁾ ($V_{GS} = 10\text{ Vdc}$, $I_D = 2.2\text{ Adc}$) | $V_{DS(on)}$ | 0.1 | 0.21 | 0.3 | Vdc |
| Forward Transconductance ⁽¹⁾ ($V_{DS} = 10\text{ Vdc}$, $I_D = 2\text{ Adc}$) | g_{fs} | — | 5.3 | — | S |

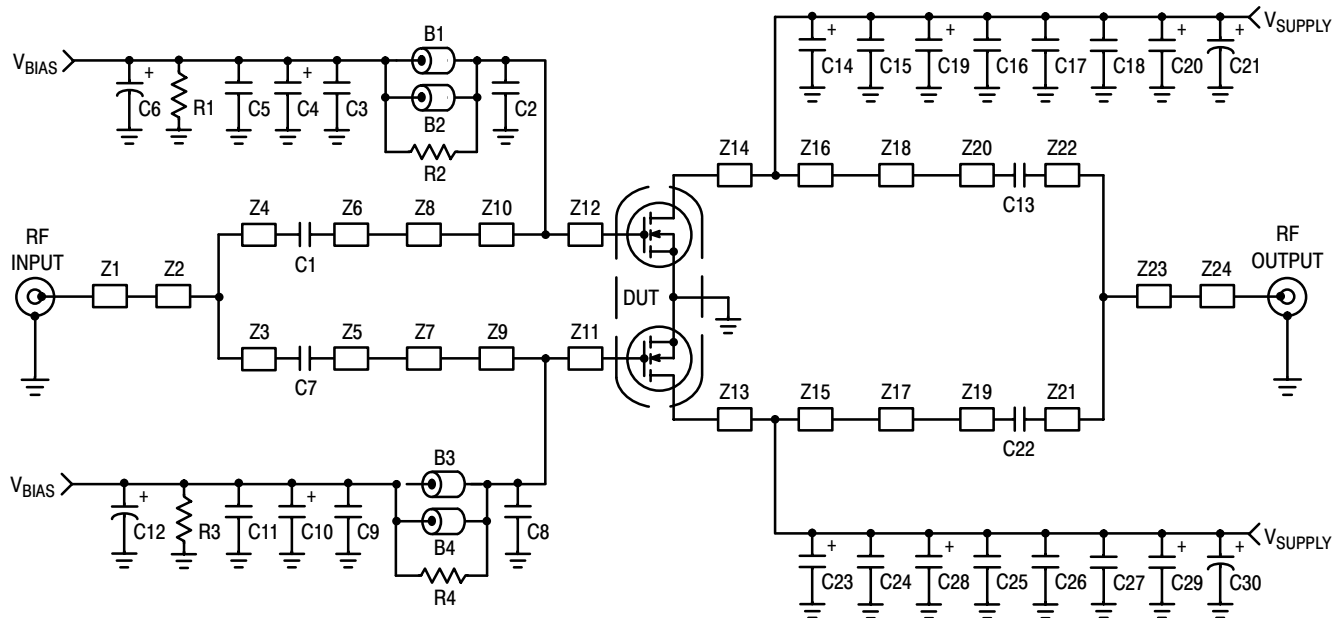
Dynamic Characteristics ^(1,2)

| | | | | | |
|---|-----------|---|-----|---|----|
| Reverse Transfer Capacitance ($V_{DS} = 28\text{ Vdc} \pm 30\text{ mV(rms)ac}$ @ 1 MHz, $V_{GS} = 0\text{ Vdc}$) | C_{rss} | — | 1.5 | — | pF |
|---|-----------|---|-----|---|----|

Functional Tests ⁽³⁾ (In Freescale Test Fixture, 50 ohm system) $V_{DD} = 28\text{ Vdc}$, $I_{DQ} = 2 \times 950\text{ mA}$, $P_{out} = 44\text{ W Avg.}$, $f_1 = 2112.5\text{ MHz}$, $f_2 = 2122.5\text{ MHz}$ and $f_1 = 2157.5\text{ MHz}$, $f_2 = 2167.5\text{ MHz}$, 2-carrier W-CDMA, 3.84 MHz Channel Bandwidth Carriers. ACPR measured in 3.84 MHz Channel Bandwidth @ $\pm 5\text{ MHz}$ Offset. IM3 measured in 3.84 MHz Channel Bandwidth @ $\pm 10\text{ MHz}$ Offset. PAR = 8.5 dB @ 0.01% Probability on CCDF.

| | | | | | |
|------------------------------|----------|------|------|------|-----|
| Power Gain | G_{ps} | 14.5 | 15.5 | 17.5 | dB |
| Drain Efficiency | η_D | 25 | 26.5 | — | % |
| Intermodulation Distortion | IM3 | — | -37 | -35 | dBc |
| Adjacent Channel Power Ratio | ACPR | — | -40 | -38 | dBc |
| Input Return Loss | IRL | — | -15 | -9 | dB |

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

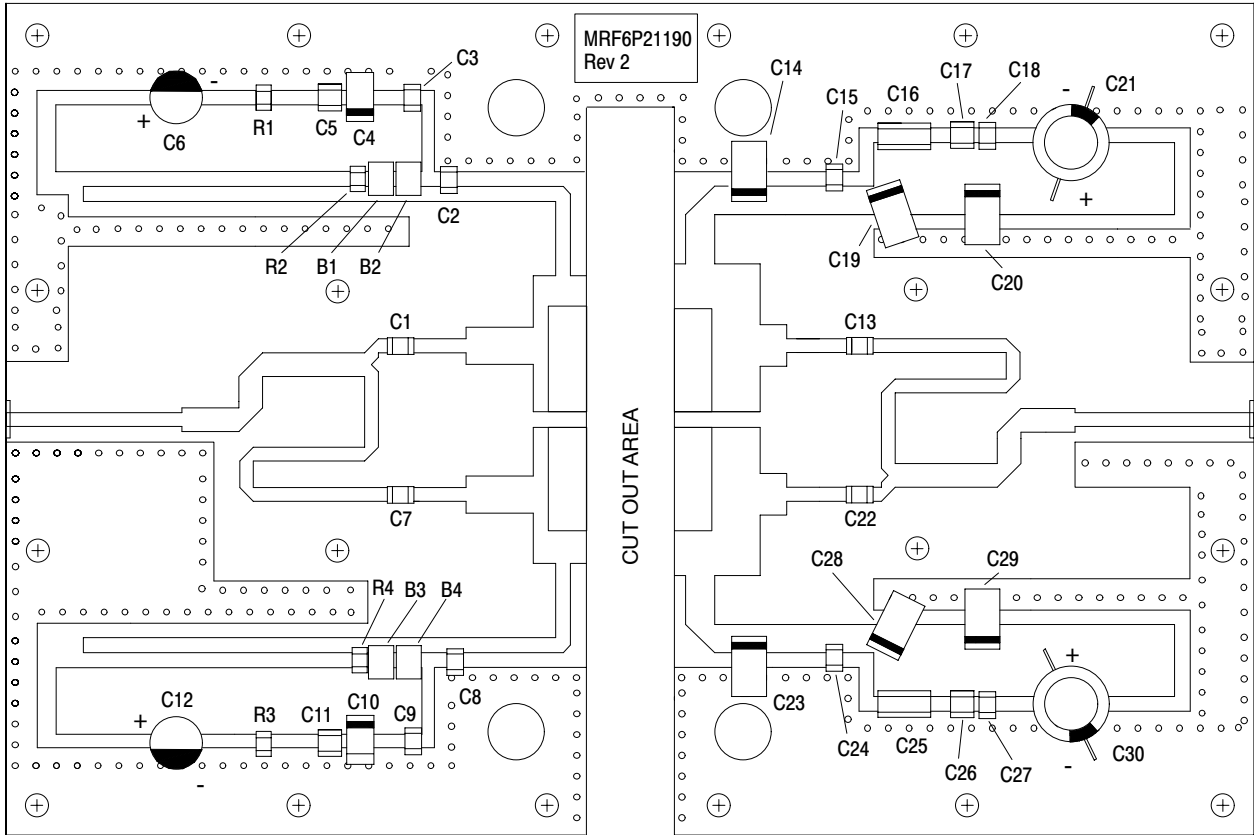


| | | | |
|----------|----------------------------|----------|---|
| Z1 | 0.850" x 0.067" Microstrip | Z15, Z16 | 0.289" x 0.712" Microstrip |
| Z2 | 1.140" x 0.114" Microstrip | Z17, Z18 | 0.127" x 0.200" Microstrip |
| Z3 | 1.830" x 0.067" Microstrip | Z19, Z20 | 0.288" x 0.067" Microstrip |
| Z4 | 0.088" x 0.067" Microstrip | Z21 | 0.088" x 0.067" Microstrip |
| Z5, Z6 | 0.250" x 0.067" Microstrip | Z22 | 1.830" x 0.067" Microstrip |
| Z7, Z8 | 0.324" x 0.178" Microstrip | Z23 | 1.140" x 0.114" Microstrip |
| Z9, Z10 | 0.143" x 0.655" Microstrip | Z24 | 0.850" x 0.066" Microstrip |
| Z11, Z12 | 0.111" x 0.655" Microstrip | PCB | Taconic RF-35, 0.030", $\epsilon_r = 3.5$ |
| Z13, Z14 | 0.124" x 0.712" Microstrip | | |

Figure 1. MRF6P21190HR6 Test Circuit Schematic

Table 5. MRF6P21190HR6 Test Circuit Component Designations and Values

| Part | Description | Part Number | Manufacturer |
|------------------------------|---|------------------|--------------|
| B1, B2, B3, B4 | RF Beads | 2743019447 | Fair-Rite |
| C1, C7 | 30 pF Chip Capacitors | 100B300JP500X | ATC |
| C2, C8, C15, C24 | 6.8 pF Chip Capacitors | 100B6R8CP500X | ATC |
| C3, C9, C18, C27 | 1k pF Chip Capacitors | 100B102JP50X | ATC |
| C4, C10 | 1 μ F, 50 V Tantalum Chip Capacitors | T491C105K050AS | Kemet |
| C5, C11, C17, C26 | 0.1 μ F Chip Capacitors | CDR33BX104AKWS | Kemet |
| C6, C12 | 100 μ F, 50 V Electrolytic Capacitors, Radial | MCR50V107M8X11 | Multicomp |
| C13, C22 | 43 pF Chip Capacitors | 100B430JP500X | ATC |
| C14, C19, C20, C23, C28, C29 | 22 μ F, 35 V Tantalum Chip Capacitors | T491X226K035AS | Kemet |
| C16, C25 | 0.56 μ F Chip Capacitors (1825) | C1825C564J5RAC | Kemet |
| C21, C30 | 470 μ F, 63 V Electrolytic Capacitors, Radial | MCR63V477M13X26 | Multicomp |
| R1, R3 | 1 k Ω , 1/4 W Chip Resistors (1206) | CRCW12061001F100 | Vishay |
| R2, R4 | 12 Ω , 1/4 W Chip Resistors (1206) | CRCW120612R0F100 | Vishay |



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

Figure 2. MRF6P21190HR6 Test Circuit Component Layout

TYPICAL CHARACTERISTICS

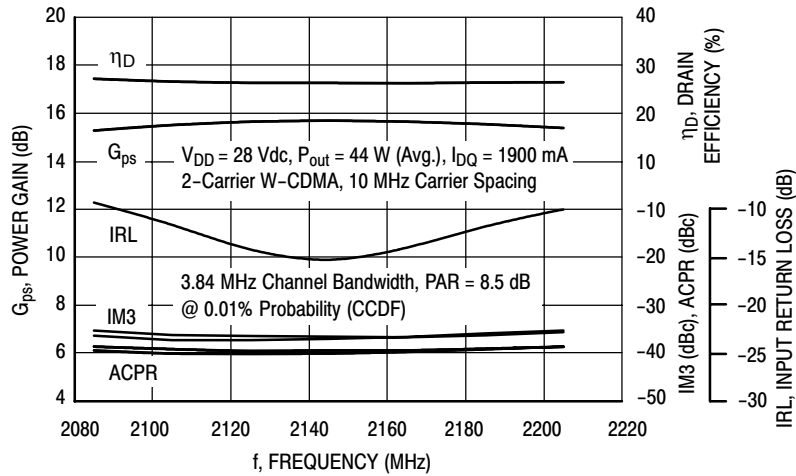


Figure 3. 2-Carrier W-CDMA Broadband Performance @ $P_{out} = 44$ Watts Avg.

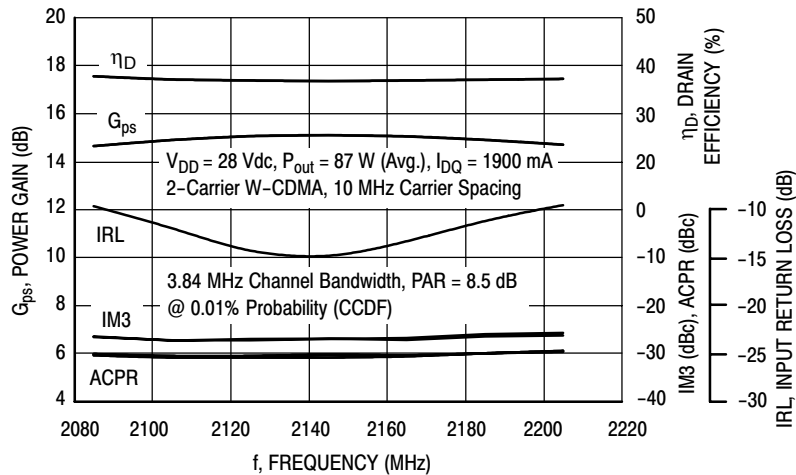


Figure 4. 2-Carrier W-CDMA Broadband Performance @ $P_{out} = 87$ Watts Avg.

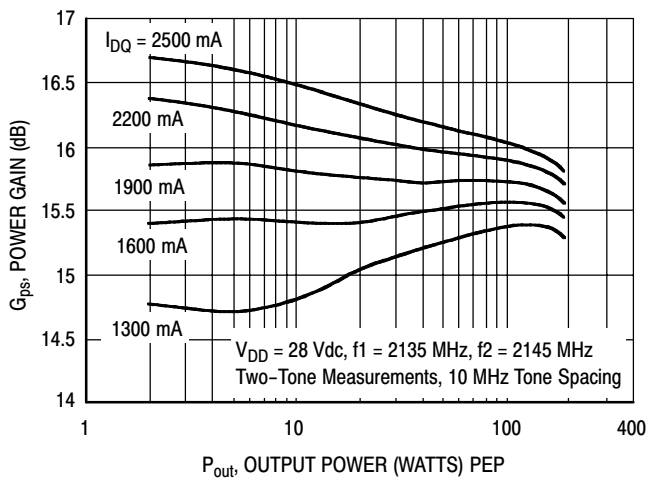


Figure 5. Two-Tone Power Gain versus Output Power

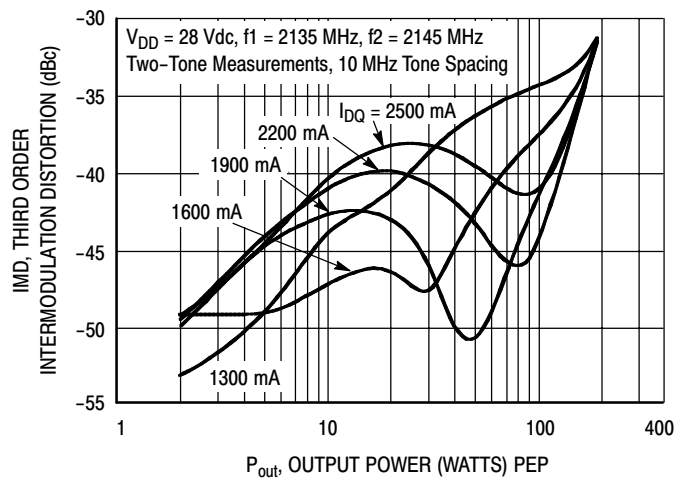


Figure 6. Third Order Intermodulation Distortion versus Output Power

TYPICAL CHARACTERISTICS

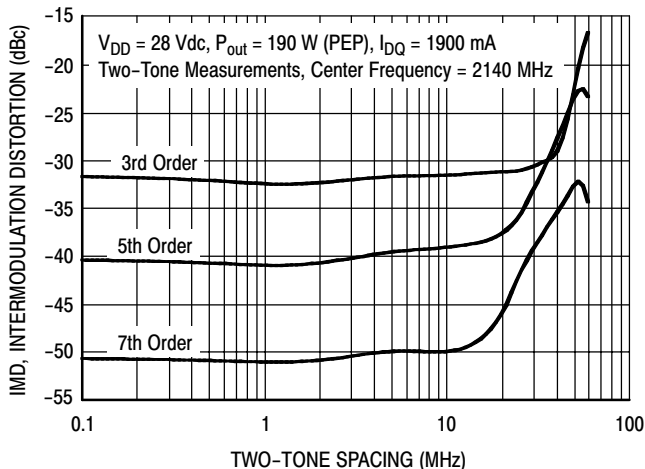


Figure 7. Intermodulation Distortion Products versus Tone Spacing

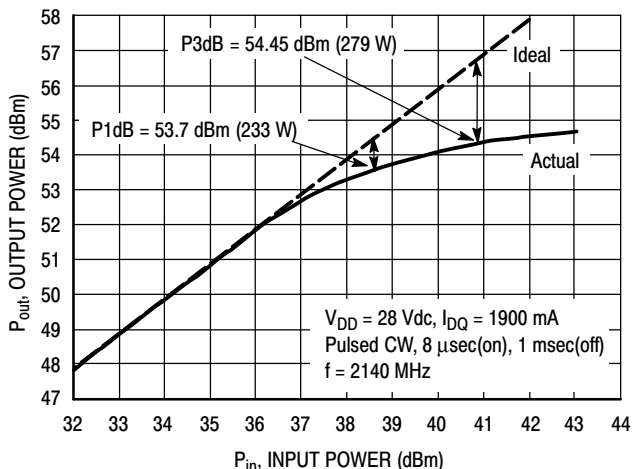


Figure 8. Pulse CW Output Power versus Input Power

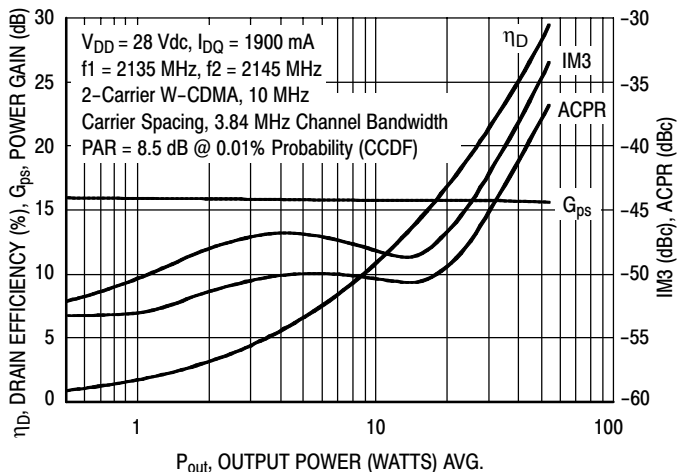


Figure 9. 2-Carrier W-CDMA ACPR, IM3, Power Gain and Drain Efficiency versus Output Power

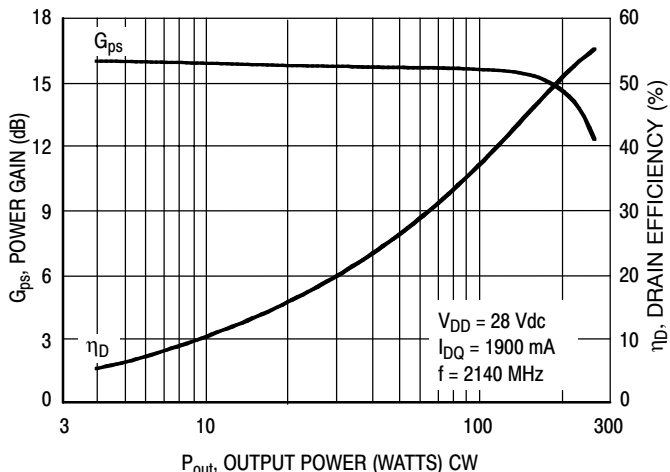


Figure 10. Power Gain and Drain Efficiency versus CW Output Power

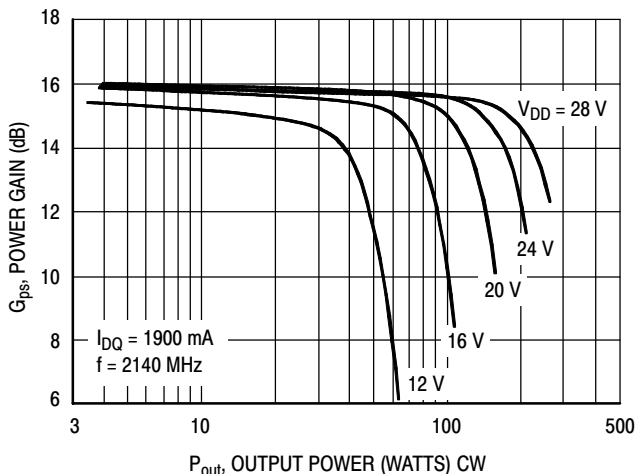
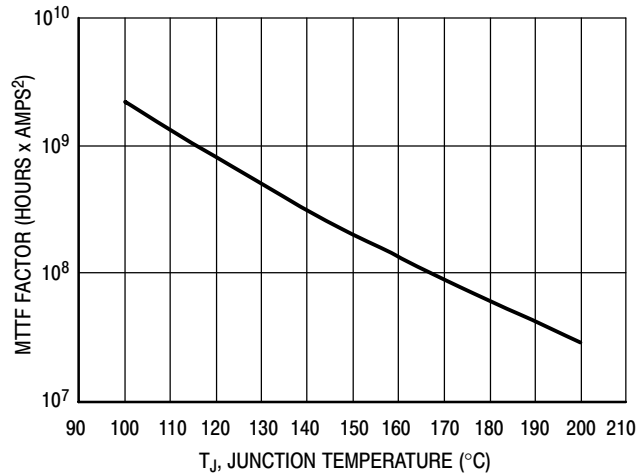


Figure 11. Power Gain versus Output Power

TYPICAL CHARACTERISTICS



This above graph displays calculated MTTF in hours x ampere² drain current. Life tests at elevated temperatures have correlated to better than ±10% of the theoretical prediction for metal failure. Divide MTTF factor by I_D² for MTTF in a particular application.

Figure 12. MTTF Factor versus Junction Temperature

W-CDMA TEST SIGNAL

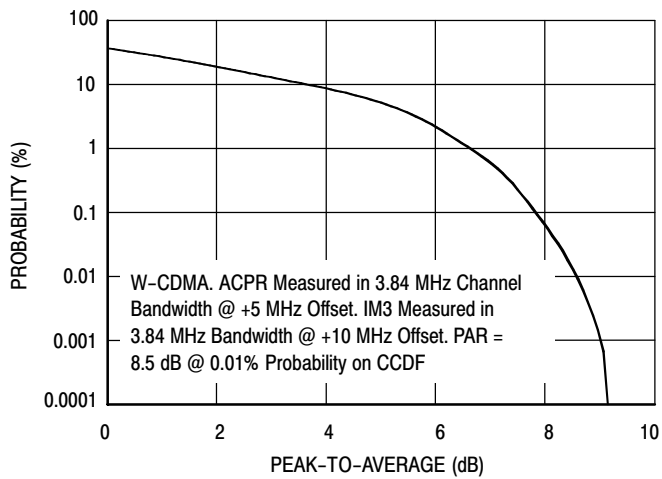


Figure 13. CCDF W-CDMA 3GPP, Test Model 1, 64 DPCH, 67% Clipping, Single-Carrier Test Signal

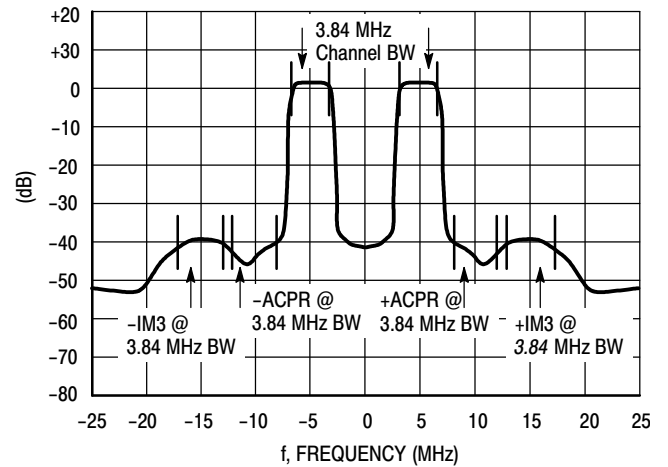
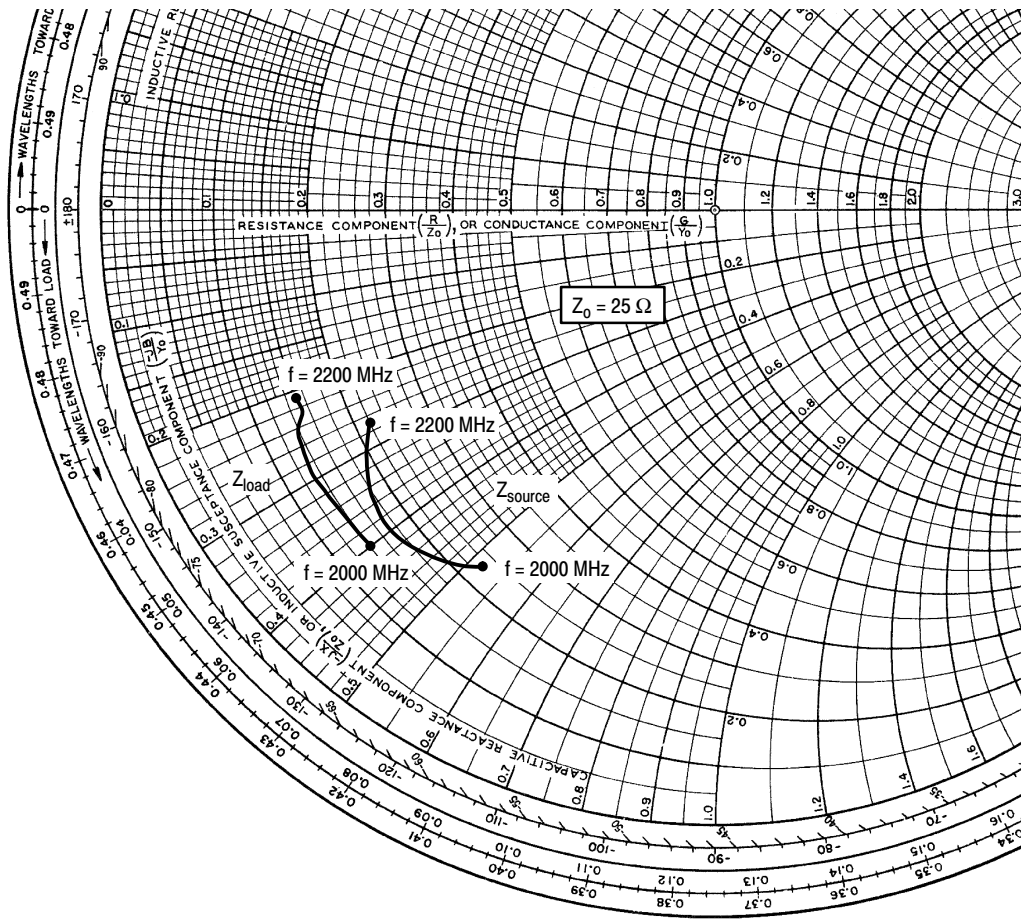


Figure 14. 2-Carrier W-CDMA Spectrum



$V_{DD} = 28 \text{ Vdc}$, $I_{DQ} = 1900 \text{ mA}$, $P_{out} = 44 \text{ W Avg.}$

| f MHz | Z_{source} Ω | Z_{load} Ω |
|----------|--------------------------|------------------------|
| 2000 | $5.63 - j12.88$ | $3.43 - j10.06$ |
| 2110 | $4.36 - j10.02$ | $3.22 - j7.13$ |
| 2140 | $4.56 - j8.49$ | $3.39 - j6.07$ |
| 2170 | $5.11 - j7.41$ | $3.76 - j5.45$ |
| 2200 | $5.42 - j6.67$ | $3.69 - j5.16$ |

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.

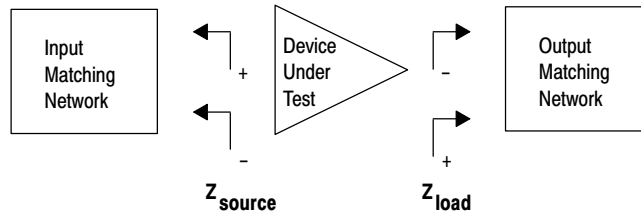
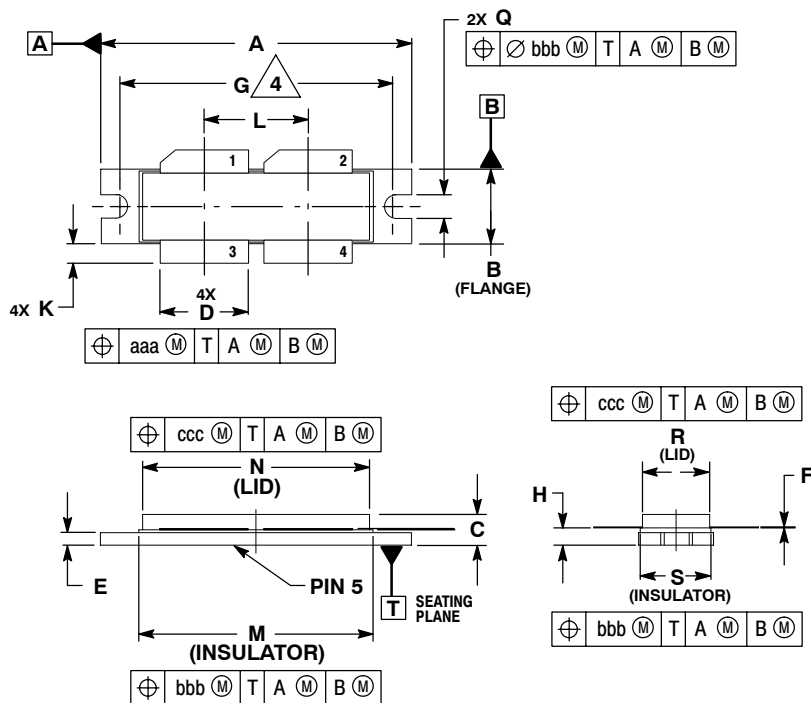


Figure 15. Series Equivalent Source and Load Impedance

NOTES

NOTES

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 |
| Q | 0.120 | 0.130 | 3.05 | 3.30 |
| R | 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 E
NI-1230**

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