



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, $I_{DQ} = 1700$ 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. = 8.3 dB @ 0.01% Probability on CCDF.
 - Output Power — 38 Watts (Avg.)
 - Power Gain — 12.1 dB
 - Efficiency — 22%
 - IM3 — 37.5 dBc
 - ACPR — -41 dBc
- Capable of Handling 5:1 VSWR, @ 28 Vdc, 2140 MHz, 170 Watts CW Output Power

Features

- Internally Matched for Ease of Use
- High Gain, High Efficiency, and High Linearity
- Integrated ESD Protection
- Designed for Maximum Gain and Insertion Phase Flatness
- Excellent Thermal Stability
- Characterized with Series Equivalent Large-Signal Impedance Parameters
- RoHS Compliant
- In Tape and Reel. R6 Suffix = 150 Units per 56 mm, 13 inch Reel.

MRF21180R6

**2110-2170 MHz, 170 W, 28 V
 LATERAL N-CHANNEL
 RF POWER MOSFET**

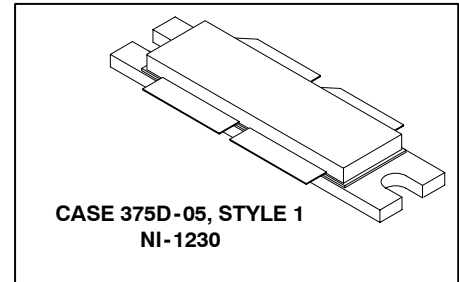


Table 1. Maximum Ratings

| 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 | 380 2.17 | W W/ $^\circ\text{C}$ |
| Storage Temperature Range | T_{stg} | -65 to +150 | $^\circ\text{C}$ |
| Case Operating Temperature | T_C | 150 | $^\circ\text{C}$ |
| Operating Junction Temperature | T_J | 200 | $^\circ\text{C}$ |

Table 2. Thermal Characteristics

| Characteristic | Symbol | Value | Unit |
|--------------------------------------|-----------------|-------|---------------------------|
| Thermal Resistance, Junction to Case | $R_{\theta JC}$ | 0.46 | $^\circ\text{C}/\text{W}$ |

Table 3. ESD Protection Characteristics

| Test Conditions | Class |
|------------------|--------------|
| Human Body Model | 1 (Minimum) |
| Machine Model | M3 (Minimum) |

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

| Characteristic | Symbol | Min | Typ | Max | Unit |
|--|---------------|-----|-------|------|---------------|
| Off Characteristics ⁽¹⁾ | | | | | |
| Drain-Source Breakdown Voltage ($V_{GS} = 0\text{ Vdc}$, $I_D = 100\ \mu\text{A}$) | $V_{(BR)DSS}$ | 65 | — | — | Vdc |
| Zero Gate Voltage Drain Leakage Current ($V_{DS} = 28\text{ Vdc}$, $V_{GS} = 0\text{ Vdc}$) | I_{DSS} | — | — | 10 | μA |
| Gate-Source Leakage Current ($V_{GS} = 5\text{ Vdc}$, $V_{DS} = 0\text{ Vdc}$) | I_{GSS} | — | — | 1 | μA |
| On Characteristics | | | | | |
| Gate Threshold Voltage ⁽¹⁾ ($V_{DS} = 10\text{ Vdc}$, $I_D = 200\ \mu\text{A}$) | $V_{GS(th)}$ | 2 | — | 4 | Vdc |
| Gate Quiescent Voltage ⁽³⁾ ($V_{DS} = 28\text{ Vdc}$, $I_D = 1700\text{ mA}$) | $V_{GS(Q)}$ | 3 | 3.9 | 5 | Vdc |
| Drain-Source On-Voltage ⁽¹⁾ ($V_{GS} = 10\text{ Vdc}$, $I_D = 2\text{ A}$) | $V_{DS(on)}$ | — | 0.18 | 0.22 | Vdc |
| Forward Transconductance ⁽¹⁾ ($V_{DS} = 10\text{ Vdc}$, $I_D = 2\text{ A}$) | g_{fs} | — | 6 | — | S |
| Dynamic Characteristics ^(1,2) | | | | | |
| Reverse Transfer Capacitance ($V_{DS} = 28\text{ Vdc}$, $V_{GS} = 0$, $f = 1\text{ MHz}$) | C_{rss} | — | 3.6 | — | pF |
| Functional Tests ⁽³⁾ (In Freescale Test Fixture, 50 ohm system) 2-Carrier W-CDMA, 3.84 MHz Channel Bandwidth Carriers. Each carrier has Peak/Avg. = 8.3 dB @ 0.01% Probability on CCDF. | | | | | |
| Common-Source Amplifier Power Gain ($V_{DD} = 28\text{ Vdc}$, $P_{out} = 38\text{ W Avg.}$, $I_{DQ} = 1700\text{ mA}$, $f_1 = 2112.5\text{ MHz}$, $f_2 = 2122.5\text{ MHz}$ and $f_1 = 2157.5\text{ MHz}$, $f_2 = 2167.5\text{ MHz}$) | G_{ps} | 11 | 12.1 | — | dB |
| Drain Efficiency ($V_{DD} = 28\text{ Vdc}$, $P_{out} = 38\text{ W Avg.}$, $I_{DQ} = 1700\text{ mA}$, $f_1 = 2112.5\text{ MHz}$, $f_2 = 2122.5\text{ MHz}$ and $f_1 = 2157.5\text{ MHz}$, $f_2 = 2167.5\text{ MHz}$) | η | 19 | 22 | — | % |
| Third Order Intermodulation Distortion ($V_{DD} = 28\text{ Vdc}$, $P_{out} = 38\text{ W Avg.}$, $I_{DQ} = 1700\text{ mA}$, $f_1 = 2112.5\text{ MHz}$, $f_2 = 2122.5\text{ MHz}$ 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 | — | -37.5 | -35 | dBc |
| Adjacent Channel Power Ratio ($V_{DD} = 28\text{ Vdc}$, $P_{out} = 38\text{ W Avg.}$, $I_{DQ} = 1700\text{ mA}$, $f_1 = 2112.5\text{ MHz}$, $f_2 = 2122.5\text{ MHz}$ 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 | — | -41 | -39 | dBc |
| Input Return Loss ($V_{DD} = 28\text{ Vdc}$, $P_{out} = 38\text{ W Avg.}$, $I_{DQ} = 1700\text{ mA}$, $f_1 = 2112.5\text{ MHz}$, $f_2 = 2122.5\text{ MHz}$ and $f_1 = 2157.5\text{ MHz}$, $f_2 = 2167.5\text{ MHz}$) | IRL | — | -12 | -9 | dB |

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

(continued)

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

| Characteristic | Symbol | Min | Typ | Max | Unit |
|---|----------|-----|-----|-----|------|
| Functional Tests ⁽¹⁾ (In Freescale Test Fixture, 50 ohm system) (continued) | | | | | |
| Two-Tone Common-Source Amplifier Power Gain ($V_{DD} = 28\text{ Vdc}$, $P_{out} = 170\text{ W}$, $I_{DQ} = 1700\text{ mA}$, $f_1 = 2110\text{ MHz}$, $f_2 = 2120\text{ MHz}$ and $f_1 = 2160\text{ MHz}$, $f_2 = 2170\text{ MHz}$) | G_{ps} | — | 12 | — | dB |
| Two-Tone Drain Efficiency ($V_{DD} = 28\text{ Vdc}$, $P_{out} = 170\text{ W}$, $I_{DQ} = 1700\text{ mA}$, $f_1 = 2110\text{ MHz}$, $f_2 = 2120\text{ MHz}$ and $f_1 = 2160\text{ MHz}$, $f_2 = 2170\text{ MHz}$) | η | — | 33 | — | % |
| Two-Tone Intermodulation Distortion ($V_{DD} = 28\text{ Vdc}$, $P_{out} = 170\text{ W}$, $I_{DQ} = 1700\text{ mA}$, $f_1 = 2110\text{ MHz}$, $f_2 = 2120\text{ MHz}$ and $f_1 = 2160\text{ MHz}$, $f_2 = 2170\text{ MHz}$) | IMD | — | -30 | — | dBc |
| Two-Tone Input Return Loss ($V_{DD} = 28\text{ Vdc}$, $P_{out} = 170\text{ W}$, $I_{DQ} = 1700\text{ mA}$, $f_1 = 2110\text{ MHz}$, $f_2 = 2120\text{ MHz}$ and $f_1 = 2160\text{ MHz}$, $f_2 = 2170\text{ MHz}$) | IRL | — | -12 | — | dB |
| P_{out} , 1 dB Compression Point ($V_{DD} = 28\text{ Vdc}$, $I_{DQ} = 1700\text{ mA}$, $f = 2170\text{ MHz}$) | P1dB | — | 180 | — | W |

1. Measurement made with device in push-pull configuration.

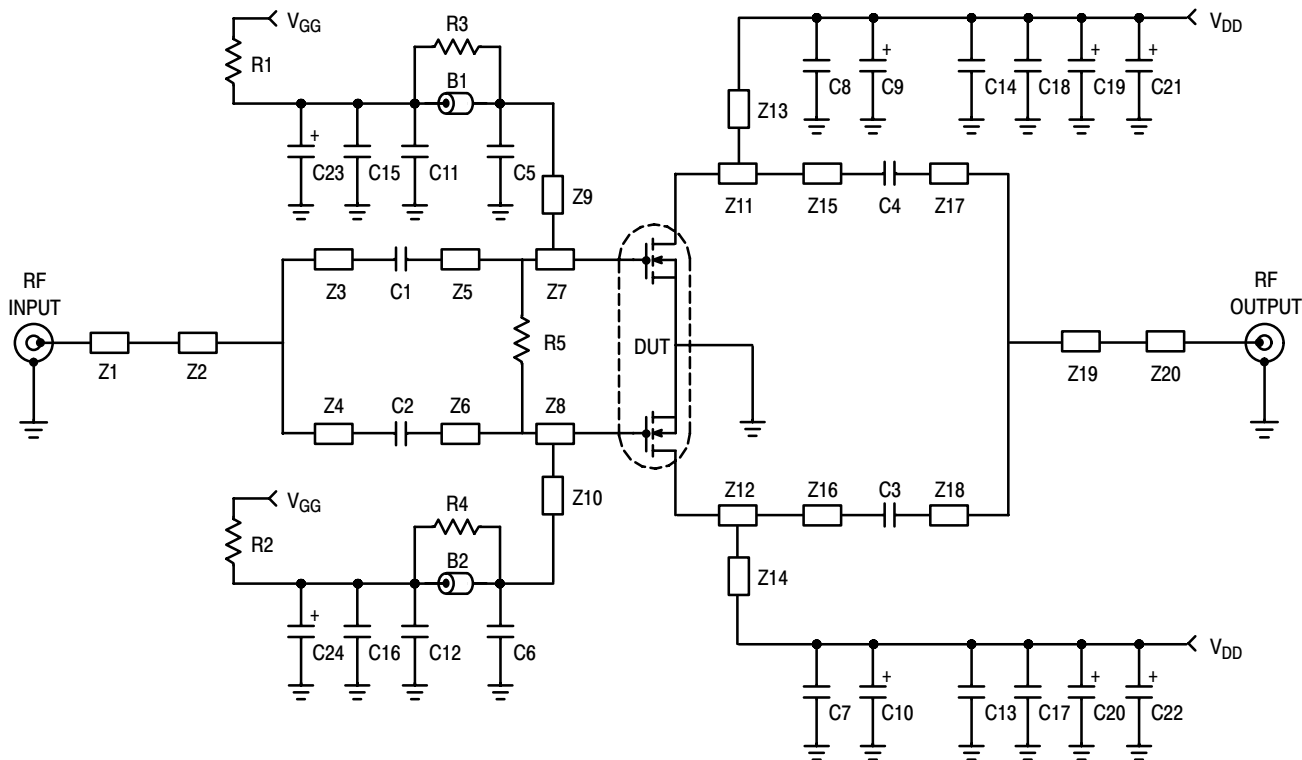
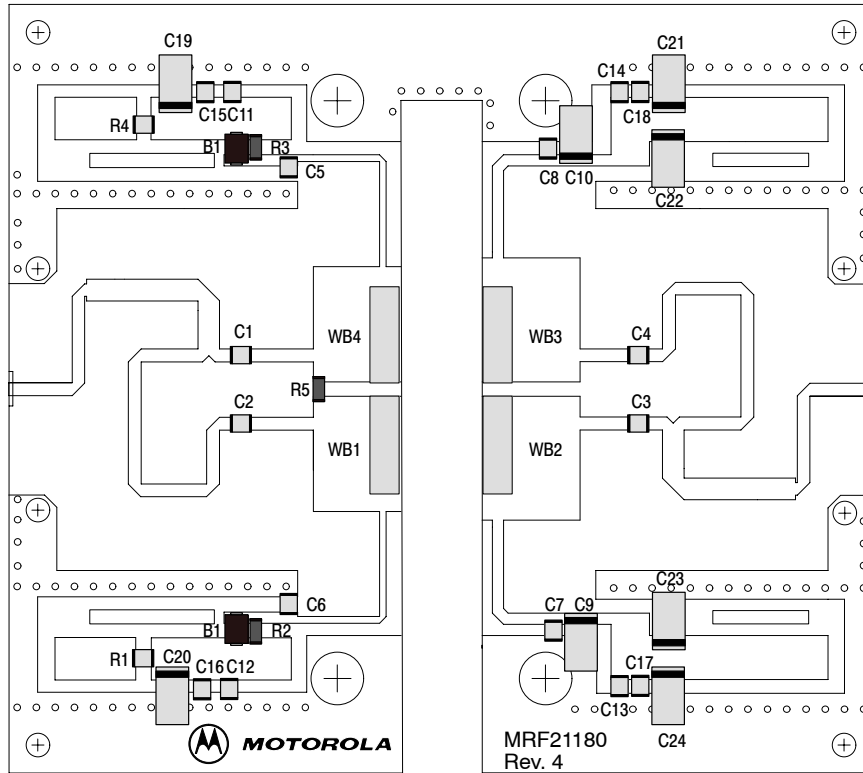


Figure 1. MRF21180 Test Circuit Schematic

Table 5. MRF21180 Test Circuit Component Designations and Values

| Part | Description | Part Number | Manufacturer |
|--------------------|--------------------------------------|----------------------------|--------------|
| B1, B2 | Short Ferrite Beads | 2743019447 | Fair Rite |
| C1, C2, C3, C4 | 30 pF Chip Capacitors | 100B300JCA500X | ATC |
| C5, C6, C7, C8 | 5.6 pF Chip Capacitors | 100B5R6JCA500X | ATC |
| C9, C10 | 10 μ F Tantalum Capacitors | T495X106K035AS4394 | Kemet |
| C11, C12, C13, C14 | 1000 pF Chip Capacitors | 100B102JCA500X | ATC |
| C15, C16, C17, C18 | 0.1 μ F Chip Capacitors | CDR33BX104AKWS | Kemet |
| C19, C20 | 1.0 μ F Tantalum Capacitors | T491C105M050 | Kemet |
| C21, C22, C23, C24 | 22 μ F Tantalum Capacitors | T491X226K035AS4394 | Kemet |
| N1, N2 | Type N Flange Mounts | 3052-1648-10 | Omni Spectra |
| R1, R2, R3, R4 | 10 Ω , 1/8 W Chip Resistors | | |
| R5 | 1.0 k Ω , 1/8 W Chip Resistor | | |
| Z1, Z20 | Microstrip | 0.790" x 0.065" | |
| Z2, Z19 | Microstrip | 0.830" x 0.112" | |
| Z3, Z18 | Microstrip | 0.145" x 0.065" | |
| Z4, Z17 | Microstrip | 1.700" x 0.065" | |
| Z5, Z6 | Microstrip | 0.340" x 0.065" | |
| Z7, Z8 | Microstrip | 0.455" x 0.600" | |
| Z9, Z10 | Microstrip | 0.980" x 0.035" | |
| Z11, Z12 | Microstrip | 0.510" x 0.645" | |
| Z13, Z14 | Microstrip | 0.770" x 0.058" | |
| Z15, Z16 | Microstrip | 0.280" x 0.065" | |
| WB1, WB2, WB3, WB4 | Wear Blocks | | |
| Board | 0.030" Glass Teflon® | RF-35, $\epsilon_r = 3.50$ | Taconic |
| PCB | Etched Circuit Boards | MRF21180 Rev. 4 | CMR |



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. MRF21180 Test Circuit Component Layout

TYPICAL CHARACTERISTICS

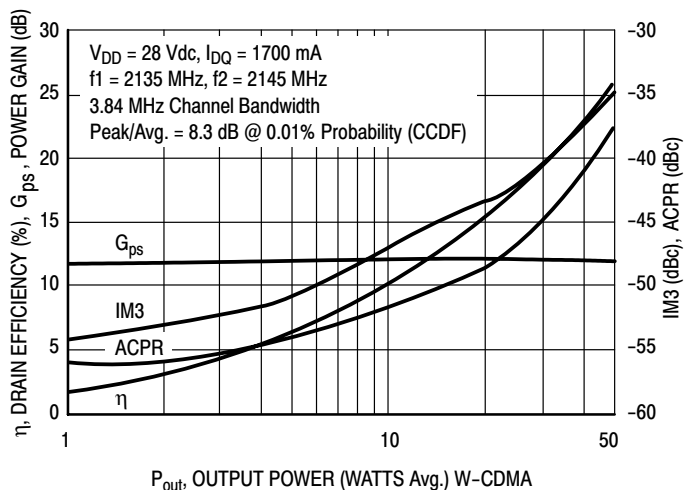


Figure 3. 2-Carrier W-CDMA ACPR, IM3, Power Gain and Drain Efficiency versus Output Power

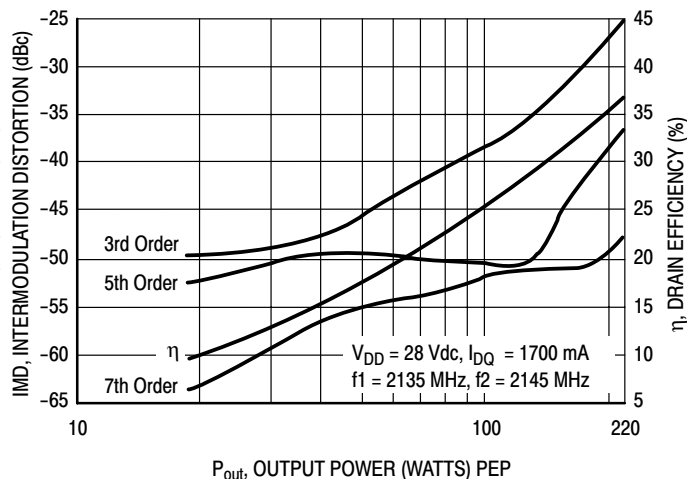


Figure 4. Intermodulation Distortion Products versus Output Power

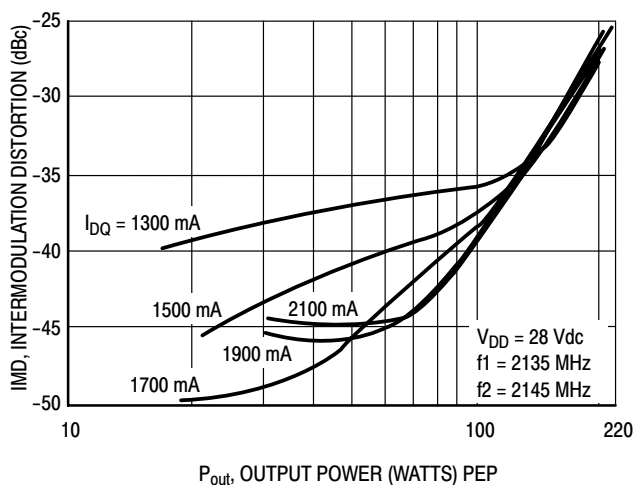


Figure 5. Intermodulation Distortion versus Output Power

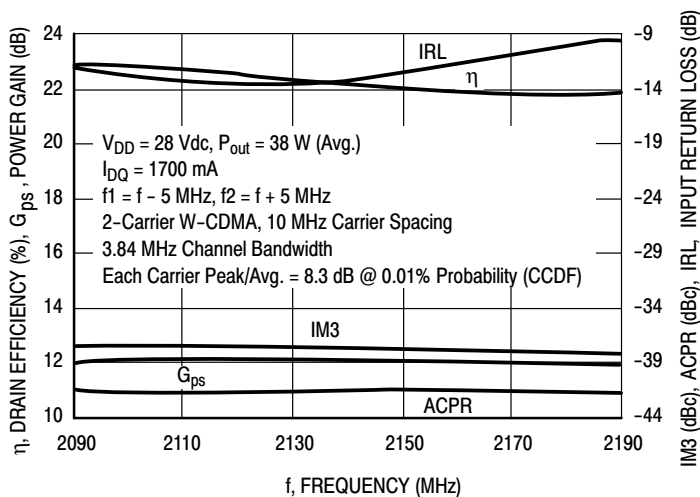


Figure 6. 2-Carrier W-CDMA Broadband Performance

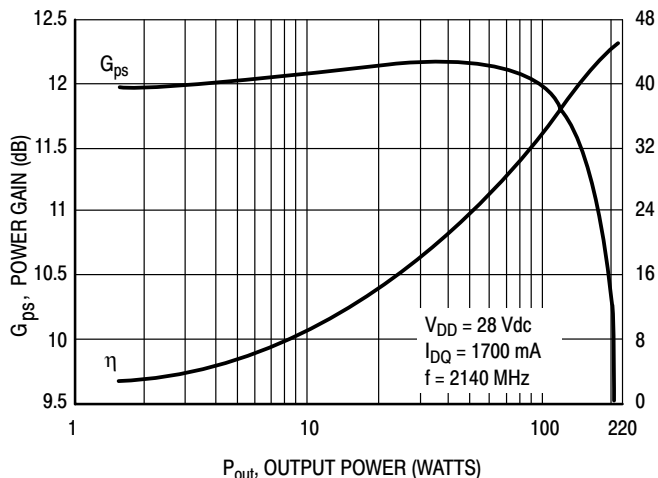


Figure 7. CW Performance

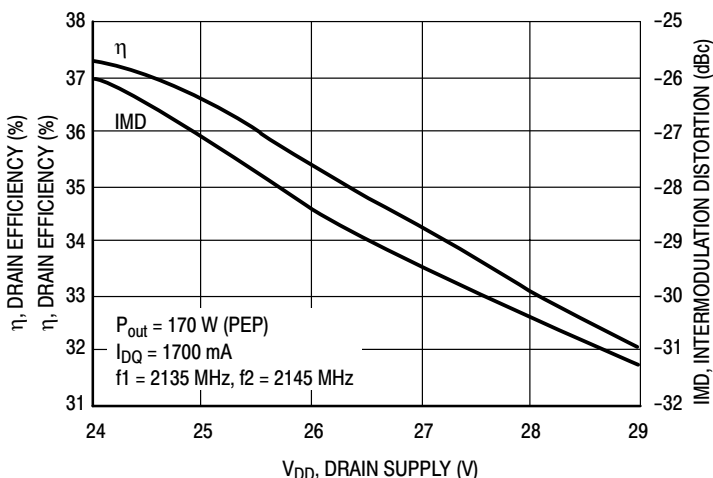


Figure 8. Two-Tone Intermodulation Distortion and Drain Efficiency versus Drain Supply

TYPICAL CHARACTERISTICS

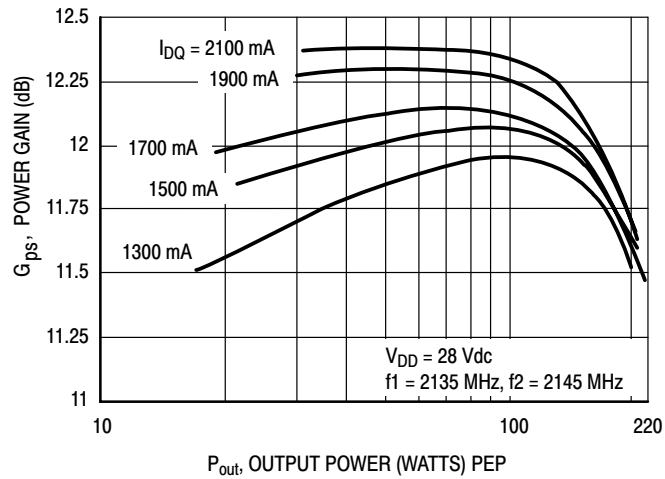


Figure 9. Two-Tone Power Gain versus Output Power

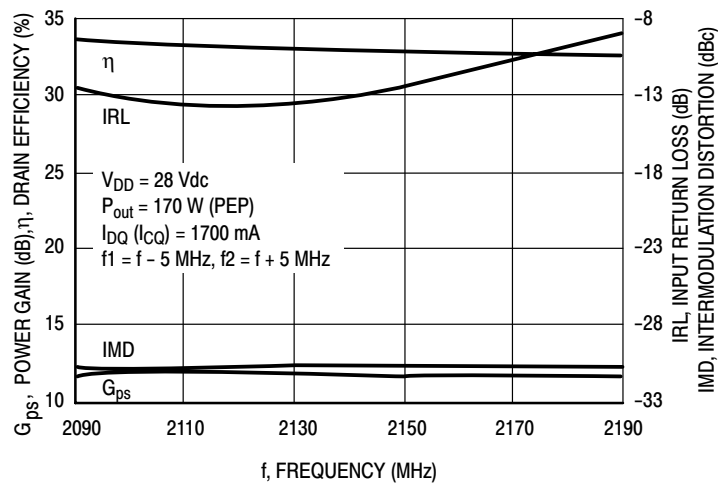


Figure 10. Two-Tone Broadband Performance

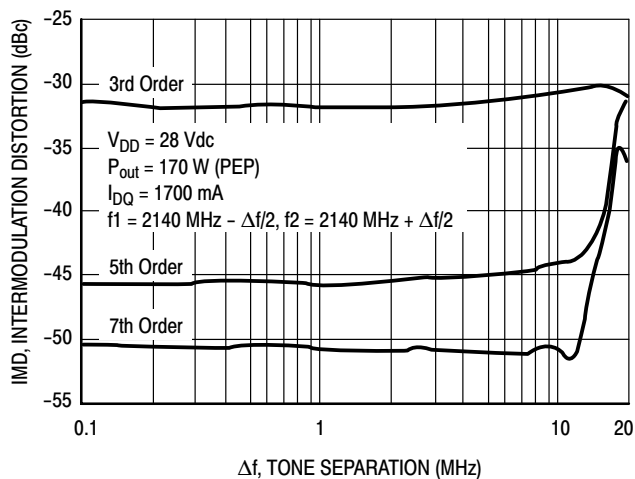


Figure 11. Intermodulation Distortion Products versus Two-Tone Spacing

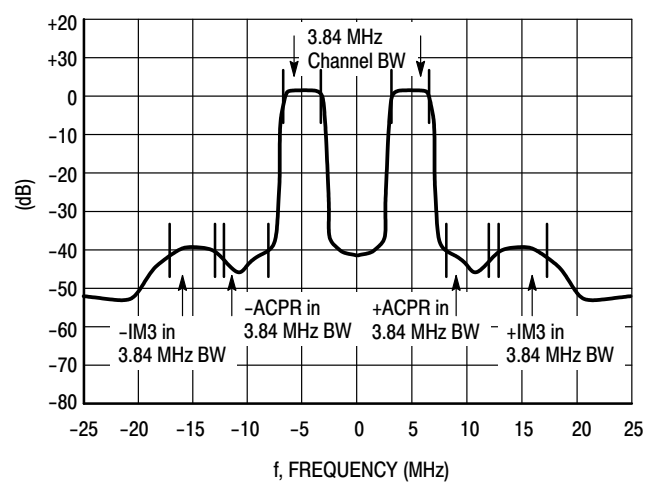
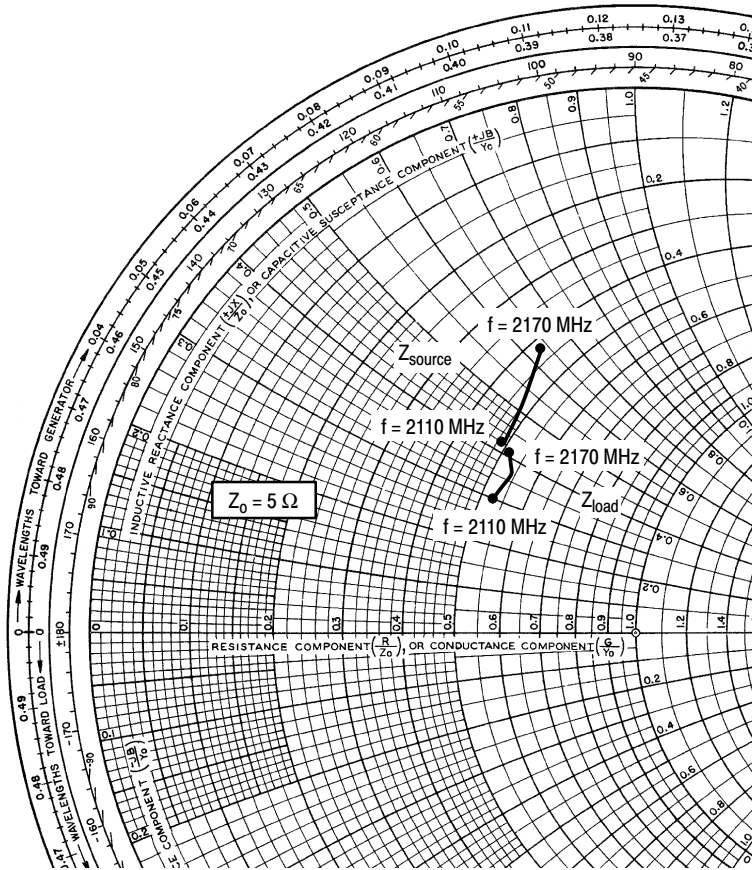


Figure 12. 2-Carrier W-CDMA Spectrum



$V_{DD} = 28 \text{ Vdc}$, $I_{DQ} = 1700 \text{ mA}$, $P_{out} = 38 \text{ W Avg.}$

| f MHz | Z_{source} Ω | Z_{load} Ω |
|----------|--------------------------|------------------------|
| 2110 | $2.45 + j2.08$ | $2.65 + j1.52$ |
| 2140 | $2.39 + j2.51$ | $2.71 + j1.80$ |
| 2170 | $2.16 + j3.14$ | $2.64 + j2.04$ |

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.

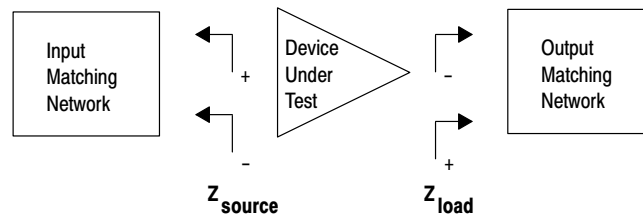


Figure 13. Series Equivalent Source and Load Impedance

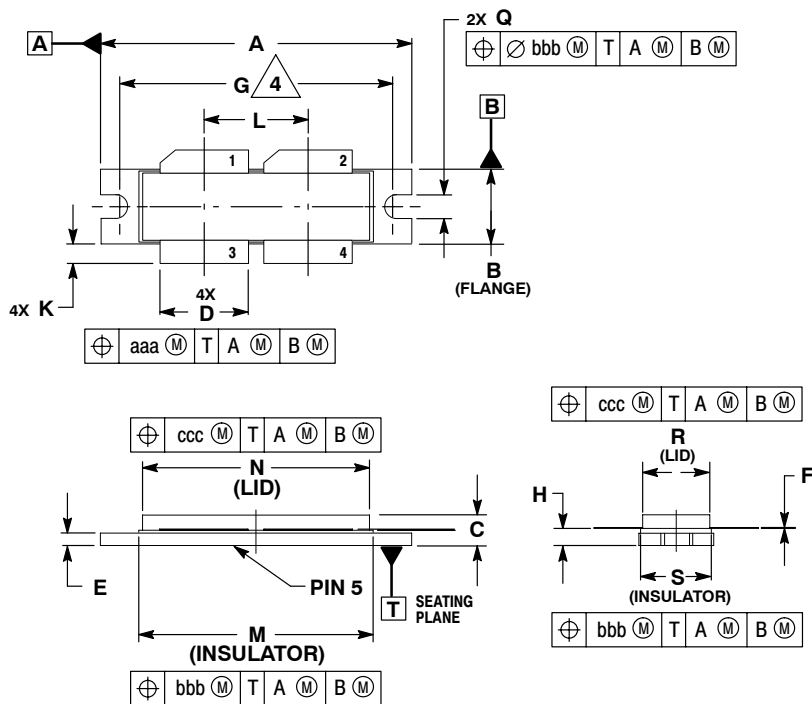


NOTES



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**

How to Reach Us:

Home Page:

www.freescale.com

E-mail:

support@freescale.com

USA/Europe or Locations Not Listed:

Freescale Semiconductor
Technical Information Center, CH370
1300 N. Alma School Road
Chandler, Arizona 85224
+1-800-521-6274 or +1-480-768-2130
support@freescale.com

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)
support@freescale.com

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

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

For Literature Requests Only:

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