

## The RF Sub-Micron MOSFET Line

# RF Power Field Effect Transistor

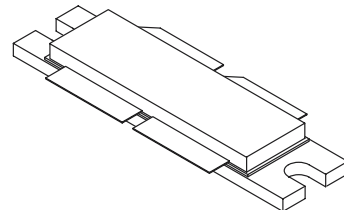
## N-Channel Enhancement-Mode Lateral MOSFET

# MRF5P20180R6

Designed for W-CDMA base station applications with frequencies from 1930 to 1990 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,  $I_{DQ} = 2 \times 800$  mA,  $f_1 = 1955$  MHz,  $f_2 = 1965$  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 — 38 Watts Avg.  
Power Gain — 14 dB  
Efficiency — 26%  
IM3 — -37.5 dBc  
ACPR — -41 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 10:1 VSWR, @ 28 Vdc, 1960 MHz, 120 Watts CW Output Power
- Excellent Thermal Stability
- Characterized with Series Equivalent Large-Signal Impedance Parameters
- Qualified Up to a Maximum of 32  $V_{DD}$  Operation
- In Tape and Reel. R6 Suffix = 150 Units per 56 mm, 13 inch Reel.

**1990 MHz, 38 W AVG.,  
2 x W-CDMA, 28 V  
LATERAL N-CHANNEL  
RF POWER MOSFET**



**CASE 375D-04, STYLE 1  
NI-1230**

### MAXIMUM RATINGS

| Rating                                                                                 | Symbol    | Value       | Unit                         |
|----------------------------------------------------------------------------------------|-----------|-------------|------------------------------|
| Drain-Source Voltage                                                                   | $V_{DSS}$ | 65          | Vdc                          |
| Gate-Source Voltage                                                                    | $V_{GS}$  | -0.5, +15   | Vdc                          |
| Total Device Dissipation @ $T_C = 25^\circ\text{C}$<br>Derate above $25^\circ\text{C}$ | $P_D$     | 407<br>2.3  | Watts<br>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        | 120         | Watts                        |

### THERMAL CHARACTERISTICS

| Characteristic                                                                                                                          | Symbol          | Max          | Unit               |
|-----------------------------------------------------------------------------------------------------------------------------------------|-----------------|--------------|--------------------|
| Thermal Resistance, Junction to Case<br>Case Temperature $80^\circ\text{C}$ , 120 W CW<br>Case Temperature $80^\circ\text{C}$ , 38 W CW | $R_{\theta JC}$ | 0.43<br>0.43 | $^\circ\text{C/W}$ |

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

## ESD PROTECTION CHARACTERISTICS

| Test Conditions     | Class        |
|---------------------|--------------|
| Human Body Model    | 2 (Minimum)  |
| Machine Model       | M3 (Minimum) |
| Charge Device Model | C7 (Minimum) |

## ELECTRICAL CHARACTERISTICS (T<sub>C</sub> = 25°C unless otherwise noted)

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

### OFF CHARACTERISTICS (1)

|                                                                                                |                  |   |   |    |      |
|------------------------------------------------------------------------------------------------|------------------|---|---|----|------|
| Zero Gate Voltage Drain Leakage Current<br>(V <sub>DS</sub> = 65 Vdc, V <sub>GS</sub> = 0 Vdc) | I <sub>DSS</sub> | — | — | 10 | μAdc |
| Zero Gate Voltage Drain Leakage Current<br>(V <sub>DS</sub> = 28 Vdc, V <sub>GS</sub> = 0)     | I <sub>DSS</sub> | — | — | 1  | μAdc |
| Gate–Source Leakage Current<br>(V <sub>GS</sub> = 5 Vdc, V <sub>DS</sub> = 0 Vdc)              | I <sub>GSS</sub> | — | — | 1  | μAdc |

### ON CHARACTERISTICS (1)

|                                                                                 |                     |     |      |     |     |
|---------------------------------------------------------------------------------|---------------------|-----|------|-----|-----|
| Gate Threshold Voltage<br>(V <sub>DS</sub> = 10 Vdc, I <sub>D</sub> = 200 μAdc) | V <sub>GS(th)</sub> | 2.5 | 2.7  | 3.5 | Vdc |
| Gate Quiescent Voltage<br>(V <sub>DS</sub> = 28 Vdc, I <sub>D</sub> = 850 mAdc) | V <sub>GS(Q)</sub>  | —   | 3.6  | —   | Vdc |
| Drain–Source On–Voltage<br>(V <sub>GS</sub> = 10 Vdc, I <sub>D</sub> = 2 Adc)   | V <sub>DS(on)</sub> | —   | 0.26 | 0.3 | Vdc |
| Forward Transconductance<br>(V <sub>DS</sub> = 10 Vdc, I <sub>D</sub> = 2 Adc)  | g <sub>fs</sub>     | —   | 5    | —   | S   |

### DYNAMIC CHARACTERISTICS (1)

|                                                                                                            |                  |   |     |   |    |
|------------------------------------------------------------------------------------------------------------|------------------|---|-----|---|----|
| Reverse Transfer Capacitance<br>(V <sub>DS</sub> = 28 Vdc ± 30 mV(rms)ac @ 1 MHz, V <sub>GS</sub> = 0 Vdc) | C <sub>rss</sub> | — | 1.7 | — | pF |
|------------------------------------------------------------------------------------------------------------|------------------|---|-----|---|----|

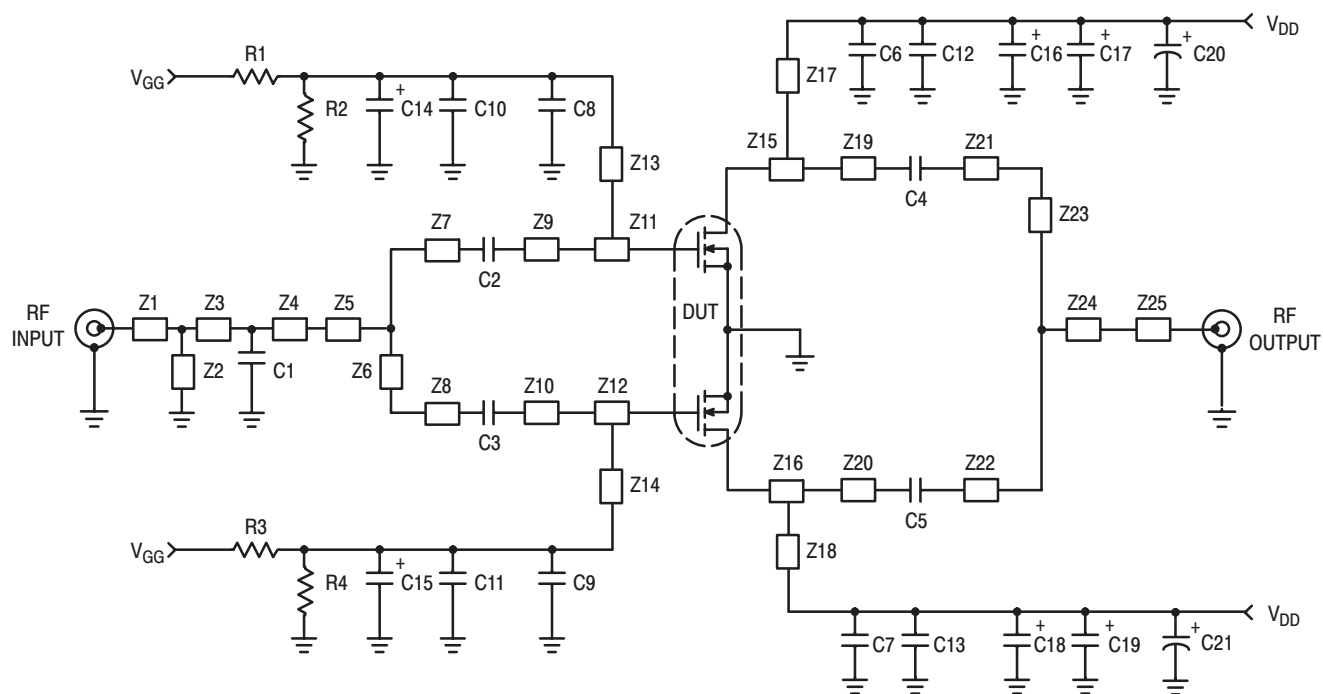
### FUNCTIONAL TESTS (In Motorola Test Fixture, 50 ohm system) (2) 2–carrier W–CDMA, 3.84 MHz Channel Bandwidth Carriers, ACPR and IM3 measured in 3.84 MHz Bandwidth. Peak/Avg. = 8.5 dB @ 0.01% Probability on CCDF.

|                                                                                                                                                                                                                                                                                                                                                                                          |                 |      |       |     |     |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|------|-------|-----|-----|
| Common–Source Amplifier Power Gain<br>(V <sub>DD</sub> = 28 Vdc, P <sub>out</sub> = 38 W Avg., I <sub>DQ</sub> = 2 x 800 mA,<br>f <sub>1</sub> = 1932.5 MHz, f <sub>2</sub> = 1942.5 MHz and f <sub>1</sub> = 1977.5 MHz,<br>f <sub>2</sub> = 1987.5 MHz)                                                                                                                                | G <sub>ps</sub> | 12.5 | 14    | —   | dB  |
| Drain Efficiency<br>(V <sub>DD</sub> = 28 Vdc, P <sub>out</sub> = 38 W Avg., I <sub>DQ</sub> = 2 x 800 mA,<br>f <sub>1</sub> = 1932.5 MHz, f <sub>2</sub> = 1942.5 MHz and f <sub>1</sub> = 1977.5 MHz,<br>f <sub>2</sub> = 1987.5 MHz)                                                                                                                                                  | η               | 23   | 26    | —   | %   |
| Third Order Intermodulation Distortion<br>(V <sub>DD</sub> = 28 Vdc, P <sub>out</sub> = 38 W Avg., I <sub>DQ</sub> = 2 x 800 mA,<br>f <sub>1</sub> = 1932.5 MHz, f <sub>2</sub> = 1942.5 MHz and f <sub>1</sub> = 1977.5 MHz,<br>f <sub>2</sub> = 1987.5 MHz; IM3 measured over 3.84 MHz BW @ f <sub>1</sub> –10 MHz<br>and f <sub>2</sub> +10 MHz referenced to carrier channel power.) | IM3             | —    | –37.5 | –35 | dBc |
| Adjacent Channel Power Ratio<br>(V <sub>DD</sub> = 28 Vdc, P <sub>out</sub> = 38 W Avg., I <sub>DQ</sub> = 2 x 800 mA,<br>f <sub>1</sub> = 1932.5 MHz, f <sub>2</sub> = 1942.5 MHz and f <sub>1</sub> = 1977.5 MHz,<br>f <sub>2</sub> = 1987.5 MHz; ACPR measured over 3.84 MHz BW @ f <sub>1</sub> –5 MHz<br>and f <sub>2</sub> +5 MHz.)                                                | ACPR            | —    | –41   | –38 | dBc |
| Input Return Loss<br>(V <sub>DD</sub> = 28 Vdc, P <sub>out</sub> = 38 W Avg., I <sub>DQ</sub> = 2 x 800 mA,<br>f <sub>1</sub> = 1932.5 MHz, f <sub>2</sub> = 1942.5 MHz and f <sub>1</sub> = 1977.5 MHz,<br>f <sub>2</sub> = 1987.5 MHz)                                                                                                                                                 | IRL             | —    | –16   | –9  | dB  |

(1) Each side of device measured separately. Part is internally matched both on input and output.

(2) Measurements made with device in push–pull configuration.

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|         |                            |          |                                                |
|---------|----------------------------|----------|------------------------------------------------|
| Z1      | 0.081" x 1.126" Microstrip | Z11, Z12 | 0.341" x 0.945" Microstrip                     |
| Z2      | 0.079" x 0.138" Microstrip | Z13, Z14 | 0.035" x 0.913" Microstrip                     |
| Z3      | 0.081" x 0.091" Microstrip | Z15, Z16 | 0.581" x 0.823" Microstrip                     |
| Z4      | 0.081" x 0.117" Microstrip | Z17, Z18 | 0.059" x 1.057" Microstrip                     |
| Z5, Z24 | 0.134" x 0.874" Microstrip | Z19, Z20 | 0.081" x 0.046" Microstrip                     |
| Z6, Z23 | 0.081" x 2.269" Microstrip | Z21, Z22 | 0.081" x 0.126" Microstrip                     |
| Z7, Z8  | 0.081" x 0.118" Microstrip | Z25      | 0.081" x 0.793" Microstrip                     |
| Z9, Z10 | 0.081" x 0.079" Microstrip | PCB      | Taconic TLX8-0300, 0.030", $\epsilon_r = 2.55$ |

**Figure 1. MRF5P20180 Test Circuit Schematic**

**Table 1. MRF5P20180 Test Circuit Component Designations and Values**

| Part                         | Description                               | Value, P/N or DWG | Manufacturer |
|------------------------------|-------------------------------------------|-------------------|--------------|
| C1                           | 1.8 pF 100B Chip Capacitor                | 100B1R8BW         | ATC          |
| C2, C3, C4, C5, C6, C7       | 10 pF 100B Chip Capacitors                | 100B100GW         | ATC          |
| C8, C9                       | 6.8 pF 100B Chip Capacitors               | 100B6R8CW         | ATC          |
| C10, C11, C12, C13           | 10 nF 200B Chip Capacitors                | 200B103MW         | ATC          |
| C14, C15, C16, C17, C18, C19 | 22 $\mu$ F, 35 V Tantalum Capacitors      | TAJE226M035       | AVX          |
| C20, C21                     | 220 $\mu$ F, 63 V Electrolytic Capacitors | 13668221          | Philips      |
| R1, R2, R3, R4               | 10 k $\Omega$ Chip Resistors (1206)       |                   |              |

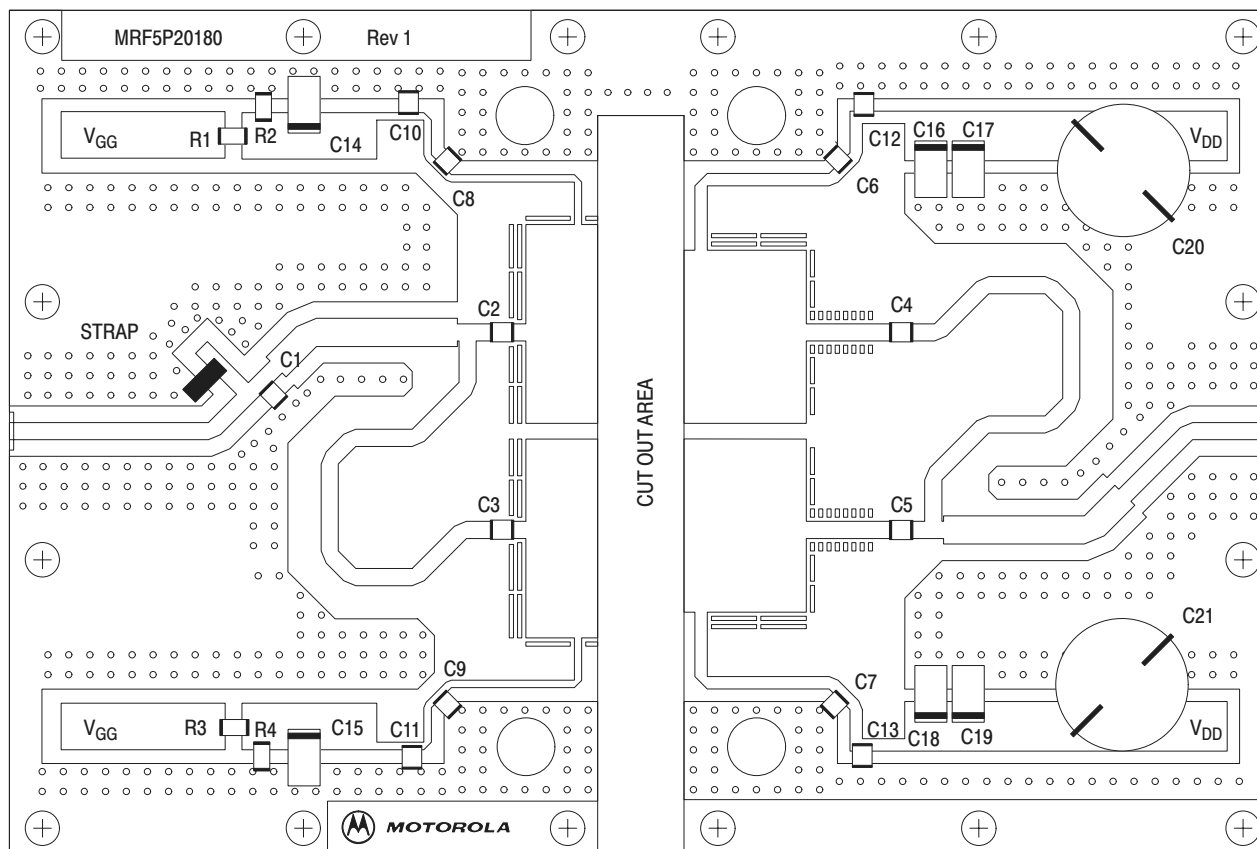


Figure 2. MRF5P20180 Test Circuit Component Layout

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## TYPICAL CHARACTERISTICS

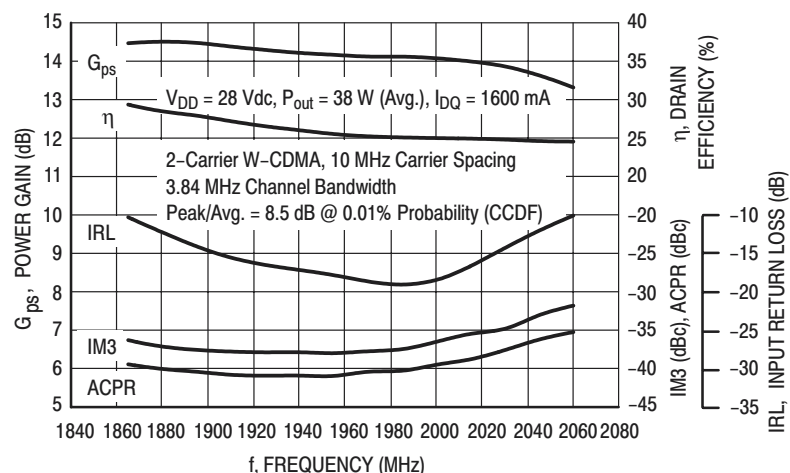


Figure 3. 2-Carrier W-CDMA Broadband Performance

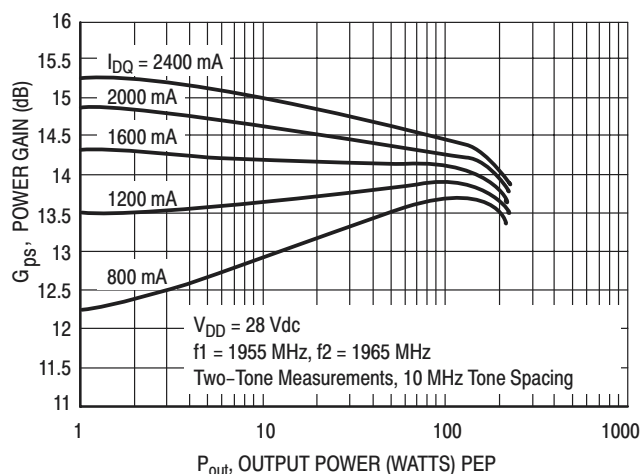


Figure 4. Two-Tone Power Gain versus Output Power

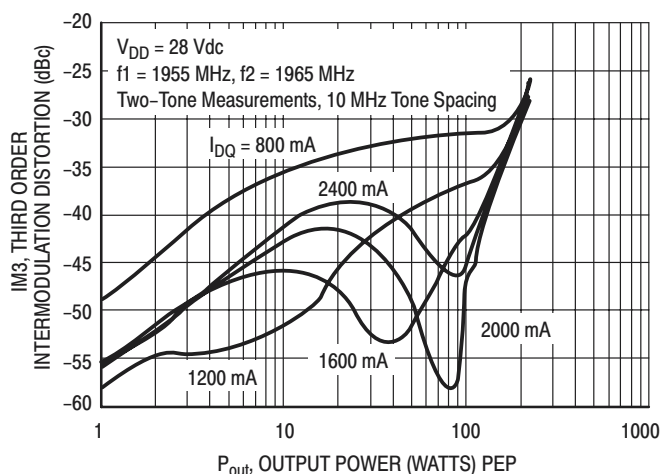


Figure 5. Third Order Intermodulation Distortion versus Output Power

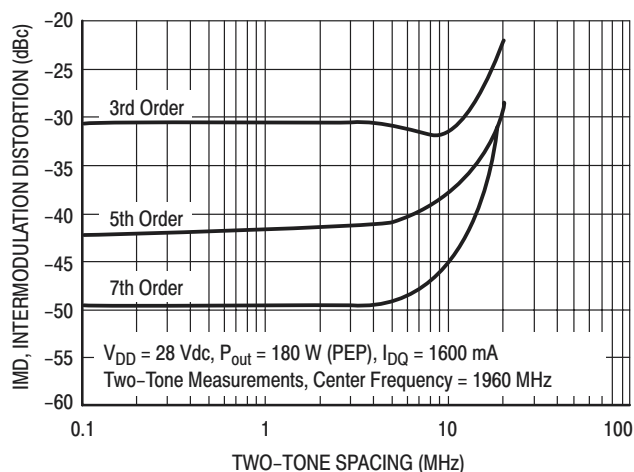


Figure 6. Intermodulation Distortion Products versus Tone Spacing

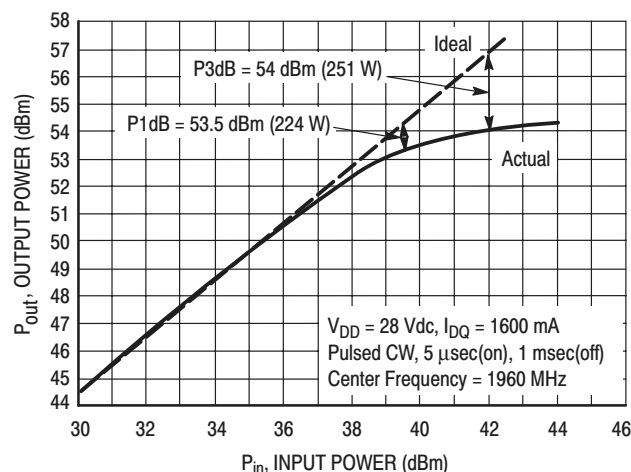
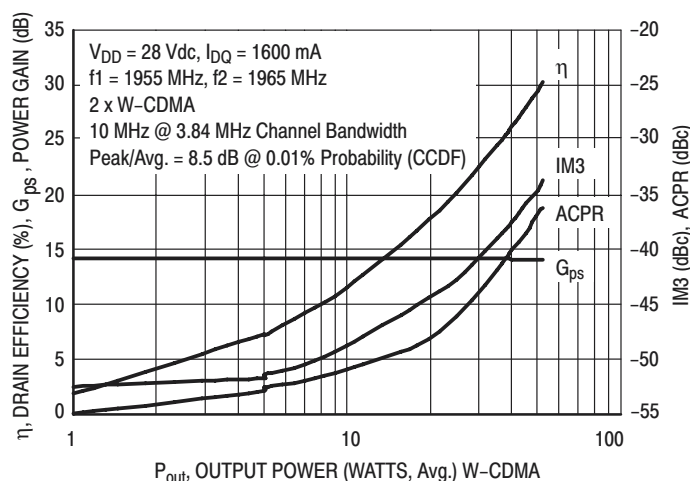


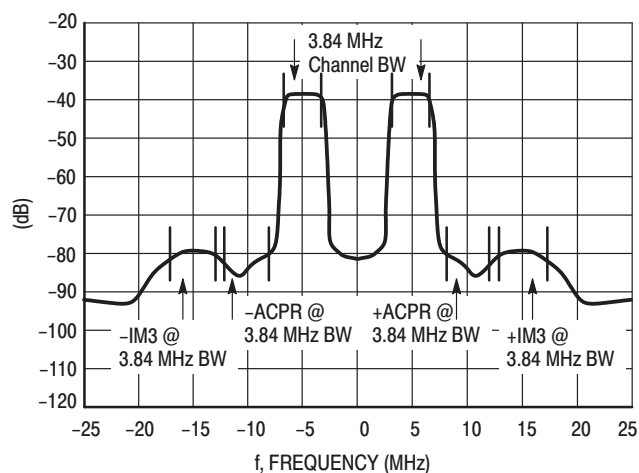
Figure 7. Pulse CW Output Power versus Input Power

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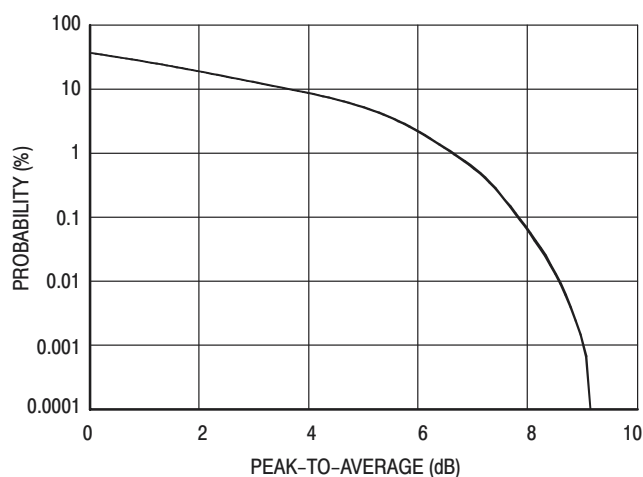
## TYPICAL CHARACTERISTICS



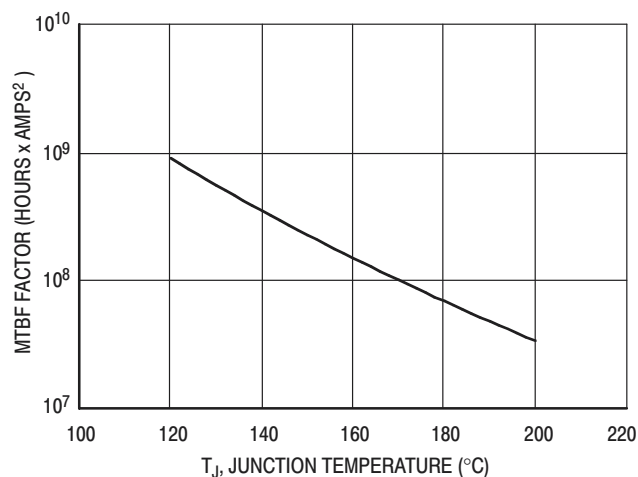
**Figure 8. 2-Carrier W-CDMA ACPR, IM3, Power Gain and Drain Efficiency versus Output Power**



**Figure 9. 2-Carrier W-CDMA Spectrum**

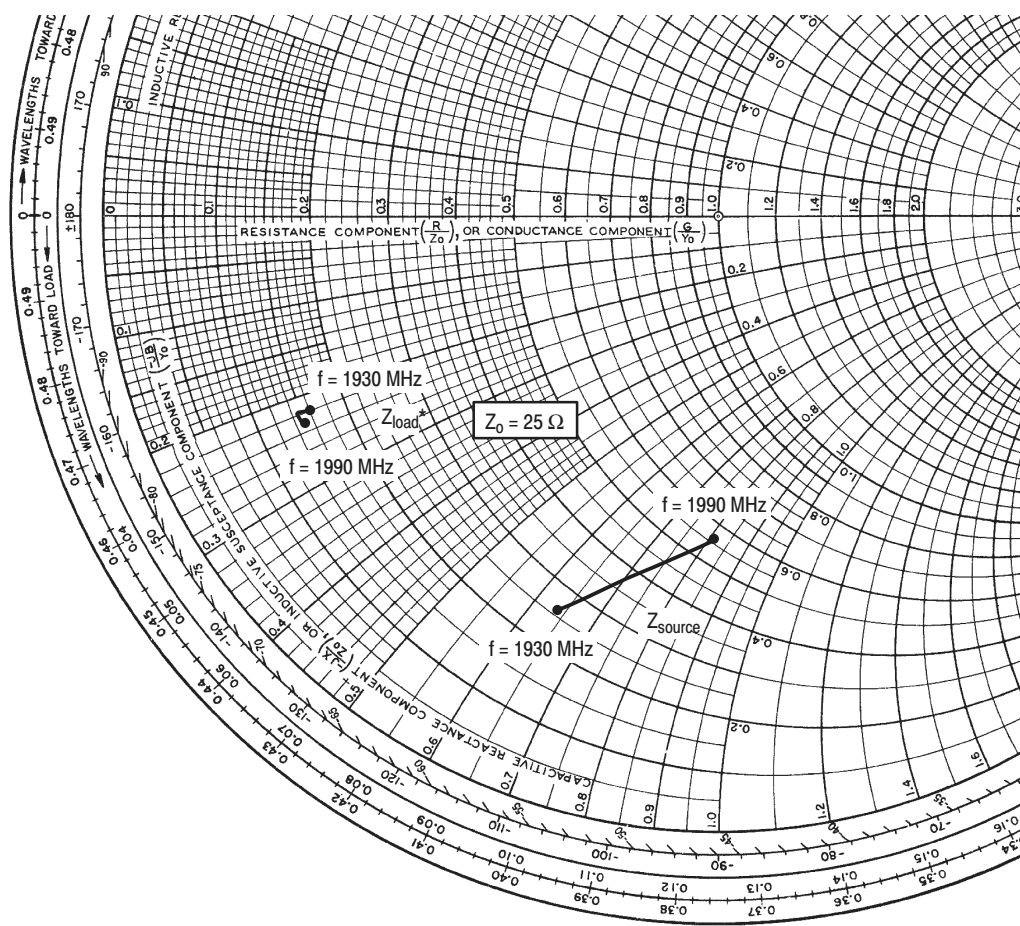


**Figure 10. CCDF W-CDMA 3GPP, Test Model 1, 64 DPCH, 67% Clipping, Single Carrier Test Signal**



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

**Figure 11. MTBF Factor versus Junction Temperature**

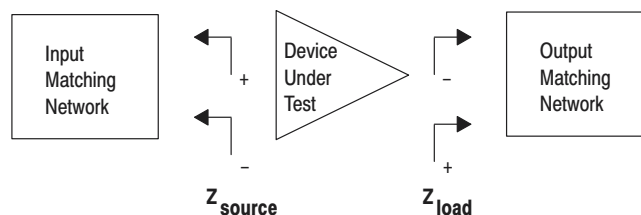


$V_{DD} = 28\text{ V}$ ,  $I_{DQ} = 2 \times 800\text{ mA}$ ,  $P_{out} = 38\text{ W Avg.}$

| f<br>MHz | $Z_{source}$<br>$\Omega$ | $Z_{load}$<br>$\Omega$ |
|----------|--------------------------|------------------------|
| 1930     | $6.54 - j16.04$          | $4.06 - j5.56$         |
| 1960     | $9.70 - j17.92$          | $3.70 - j5.48$         |
| 1990     | $13.88 - j20.46$         | $3.64 - j5.76$         |

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

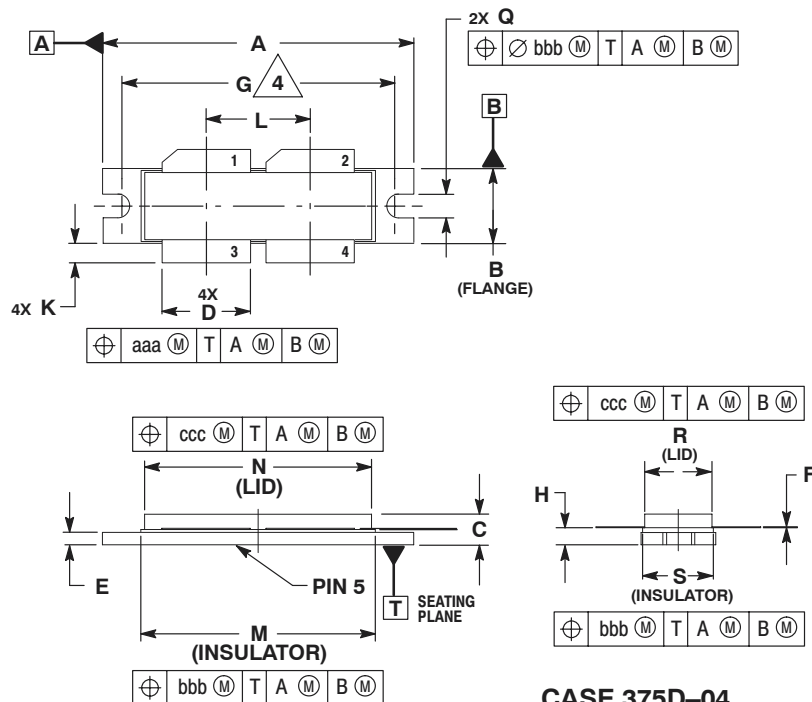
$Z_{load}$  = Test circuit impedance as measured from drain to drain, balanced configuration.



**Figure 12. Series Equivalent Input and Output Impedance**

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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   | 0.079     | 0.089 | 2.01        | 2.26  |
| 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:
1. PIN 1. DRAIN
  2. DRAIN
  3. GATE
  4. GATE
  5. SOURCE

**CASE 375D-04  
ISSUE C  
NI-1230**

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