

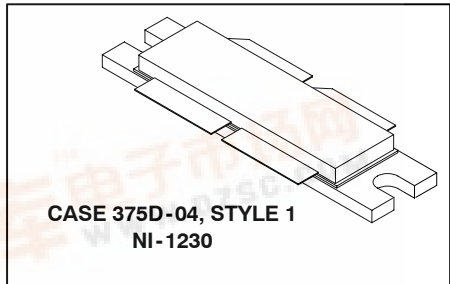
# The RF Sub-Micron MOSFET Line

## RF Power Field Effect Transistor

### N-Channel Enhancement-Mode Lateral MOSFET



**2170 MHz, 170 W, 28 V  
LATERAL N-CHANNEL  
RF POWER 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,  $I_{DQ} = 2 \times 850$  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
- Internally Input and Output Matched, 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, 2110 MHz, 170 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.

#### 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 @ $T_C = 25^\circ\text{C}$ Derate above $25^\circ\text{C}$	$P_D$	380 2.17	Watts $\text{W}/^\circ\text{C}$
Storage Temperature Range	$T_{stg}$	-65 to +150	$^\circ\text{C}$
Operating Junction Temperature	$T_J$	200	$^\circ\text{C}$

#### THERMAL CHARACTERISTICS

Characteristic	Symbol	Value (1)	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	0.46	$^\circ\text{C}/\text{W}$

#### ESD PROTECTION CHARACTERISTICS

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

(1) Refer to AN1955/D, *Thermal Measurement Methodology of RF Power Amplifiers*. Go to <http://www.motorola.com/semiconductors/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.

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

Characteristic	Symbol	Min	Typ	Max	Unit
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### OFF CHARACTERISTICS (1)

Drain-Source Breakdown Voltage (V <sub>GS</sub> = 0 Vdc, I <sub>D</sub> = 100 μAdc)	V <sub>(BR)DSS</sub>	65	—	—	Vdc
Zero Gate Voltage Drain Leakage Current (V <sub>DS</sub> = 28 Vdc, V <sub>GS</sub> = 0 Vdc)	I <sub>DSS</sub>	—	—	10	μAdc
Gate-Source Leakage Current (V <sub>GS</sub> = 5 Vdc, V <sub>DS</sub> = 0 Vdc)	I <sub>GSS</sub>	—	—	1	μAdc

### ON CHARACTERISTICS (1)

Gate Threshold Voltage (V <sub>DS</sub> = 10 Vdc, I <sub>D</sub> = 200 μAdc)	V <sub>GS(th)</sub>	2	—	4	Vdc
Gate Quiescent Voltage (V <sub>DS</sub> = 28 Vdc, I <sub>D</sub> = 850 mAdc)	V <sub>GS(Q)</sub>	3	3.9	5	Vdc
Drain-Source On-Voltage (V <sub>GS</sub> = 10 Vdc, I <sub>D</sub> = 2 Adc)	V <sub>DS(on)</sub>	—	0.18	0.22	Vdc
Forward Transconductance (V <sub>DS</sub> = 10 Vdc, I <sub>D</sub> = 2 Adc)	g <sub>fs</sub>	—	6	—	S

### DYNAMIC CHARACTERISTICS (1)

Reverse Transfer Capacitance (V <sub>DS</sub> = 28 Vdc, V <sub>GS</sub> = 0, f = 1 MHz)	C <sub>rss</sub>	—	3.6	—	pF
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### FUNCTIONAL TESTS (In Motorola Test Fixture, 50 ohm system) (2)

2-Carrier W-CDMA, 3.84 MHz Channel Bandwidth Carriers. Each carrier has Peak/Avg. ratio = 8.3 dB @ 0.01% Probability on CCDF.

Common-Source Amplifier Power Gain (V <sub>DD</sub> = 28 Vdc, P <sub>out</sub> = 38 W Avg., I <sub>DQ</sub> = 2 x 850 mA, f <sub>1</sub> = 2112.5 MHz, f <sub>2</sub> = 2122.5 MHz and f <sub>1</sub> = 2157.5 MHz, f <sub>2</sub> = 2167.5 MHz)	G <sub>ps</sub>	11	12.1	—	dB
Drain Efficiency (V <sub>DD</sub> = 28 Vdc, P <sub>out</sub> = 38 W Avg., I <sub>DQ</sub> = 2 x 850 mA, f <sub>1</sub> = 2112.5 MHz, f <sub>2</sub> = 2122.5 MHz and f <sub>1</sub> = 2157.5 MHz, f <sub>2</sub> = 2167.5 MHz)	η	19	22	—	%
Third Order Intermodulation Distortion (V <sub>DD</sub> = 28 Vdc, P <sub>out</sub> = 38 W Avg., I <sub>DQ</sub> = 2 x 850 mA, f <sub>1</sub> = 2112.5 MHz, f <sub>2</sub> = 2122.5 MHz and f <sub>1</sub> = 2157.5 MHz, f <sub>2</sub> = 2167.5 MHz; IM3 measured over 3.84 MHz BW @ f <sub>1</sub> -10 MHz and f <sub>2</sub> +10 MHz)	IM3	—	-37.5	-35	dBc
Adjacent Channel Power Ratio (V <sub>DD</sub> = 28 Vdc, P <sub>out</sub> = 38 W Avg., I <sub>DQ</sub> = 2 x 850 mA, f <sub>1</sub> = 2112.5 MHz, f <sub>2</sub> = 2122.5 MHz and f <sub>1</sub> = 2157.5 MHz, f <sub>2</sub> = 2167.5 MHz; ACPR measured over 3.84 MHz BW @ f <sub>1</sub> - 5 MHz and f <sub>2</sub> +5 MHz.)	ACPR	—	-41	-39	dBc
Input Return Loss (V <sub>DD</sub> = 28 Vdc, P <sub>out</sub> = 38 W Avg., I <sub>DQ</sub> = 2 x 850 mA, f <sub>1</sub> = 2112.5 MHz, f <sub>2</sub> = 2122.5 MHz and f <sub>1</sub> = 2157.5 MHz, f <sub>2</sub> = 2167.5 MHz)	IRL	—	-12	-9	dB
Output Mismatch Stress (V <sub>DD</sub> = 28 Vdc, P <sub>out</sub> = 170 W CW, I <sub>DQ</sub> = 2 x 850 mA, f = 2170 MHz VSWR = 5:1, All Phase Angles at Frequency of Tests)	Ψ	No Degradation In Output Power Before and After Test			

(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.

(continued)

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## ELECTRICAL CHARACTERISTICS — continued ( $T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
<b>FUNCTIONAL TESTS</b> (In Motorola Test Fixture, 50 ohm system) (2) (continued)					
Two - Tone Common - Source Amplifier Power Gain ( $V_{DD} = 28 \text{ Vdc}$ , $P_{out} = 170 \text{ W}$ , $I_{DQ} = 2 \times 850 \text{ mA}$ , $f_1 = 2110 \text{ MHz}$ , $f_2 = 2120 \text{ MHz}$ and $f_1 = 2160 \text{ MHz}$ , $f_2 = 2170 \text{ MHz}$ )	$G_{ps}$	—	12	—	dB
Two - Tone Drain Efficiency ( $V_{DD} = 28 \text{ Vdc}$ , $P_{out} = 170 \text{ W}$ , $I_{DQ} = 2 \times 850 \text{ mA}$ , $f_1 = 2110 \text{ MHz}$ , $f_2 = 2120 \text{ MHz}$ and $f_1 = 2160 \text{ MHz}$ , $f_2 = 2170 \text{ MHz}$ )	$\eta$	—	33	—	%
Two - Tone Intermodulation Distortion ( $V_{DD} = 28 \text{ Vdc}$ , $P_{out} = 170 \text{ W}$ , $I_{DQ} = 2 \times 850 \text{ mA}$ , $f_1 = 2110 \text{ MHz}$ , $f_2 = 2120 \text{ MHz}$ and $f_1 = 2160 \text{ MHz}$ , $f_2 = 2170 \text{ MHz}$ )	IMD	—	-30	—	dBc
Two - Tone Input Return Loss ( $V_{DD} = 28 \text{ Vdc}$ , $P_{out} = 170 \text{ W}$ , $I_{DQ} = 2 \times 850 \text{ mA}$ , $f_1 = 2110 \text{ MHz}$ , $f_2 = 2120 \text{ MHz}$ and $f_1 = 2160 \text{ MHz}$ , $f_2 = 2170 \text{ MHz}$ )	IRL	—	-12	—	dB
$P_{out}$ , 1 dB Compression Point ( $V_{DD} = 28 \text{ Vdc}$ , $I_{DQ} = 2 \times 850 \text{ mA}$ , $f = 2170 \text{ MHz}$ )	$P_{1dB}$	—	180	—	W

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

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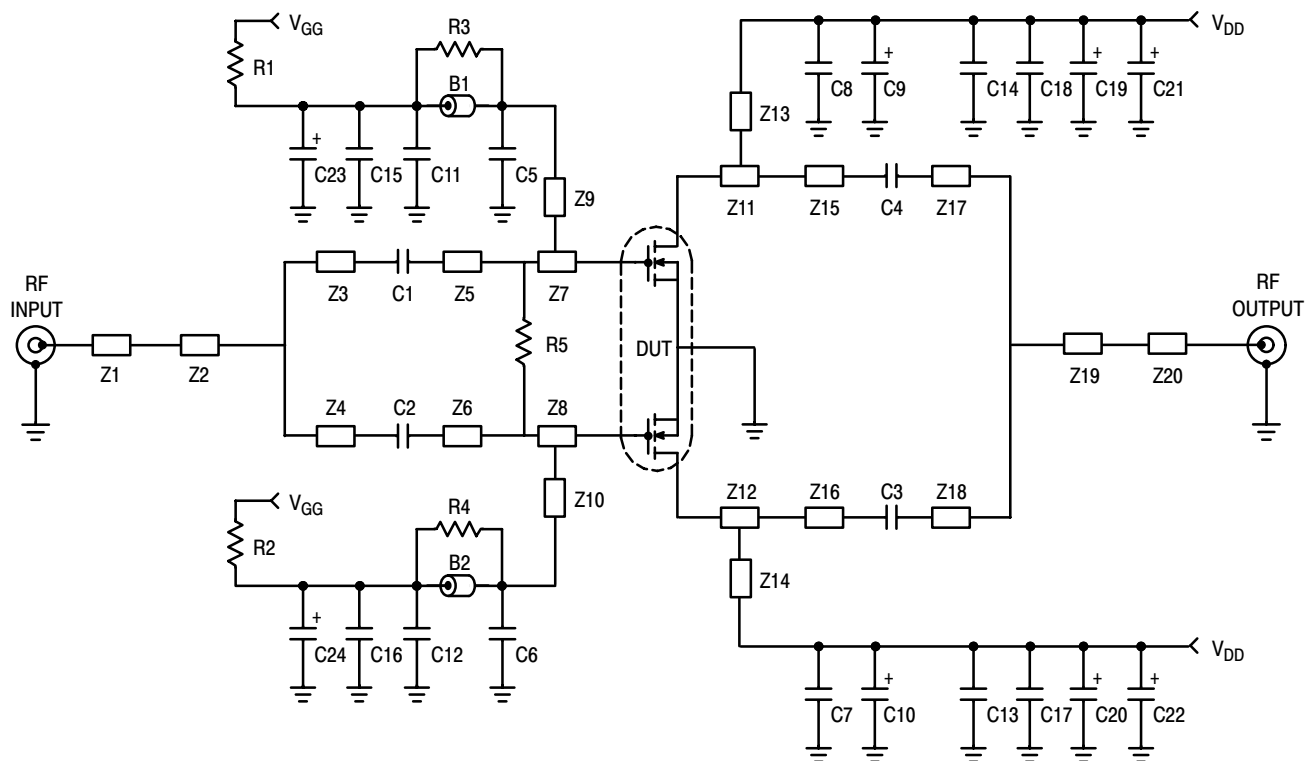


Figure 1. MRF21180 Test Circuit Schematic

Table 1. MRF21180 Test Circuit Component Designations and Values

Part	Description	Value, P/N or DWG	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 $\mu$ F Tantalum Capacitors	T495X106K035AS4394	Kemet
C11, C12, C13, C14	1000 pF Chip Capacitors	100B102JCA500X	ATC
C15, C16, C17, C18	0.1 $\mu$ F Chip Capacitors	CDR33BX104AKWS	Kemet
C19, C20	1.0 $\mu$ F Tantalum Capacitors	T491C105M050	Kemet
C21, C22, C23, C24	22 $\mu$ F Tantalum Capacitors	T491X226K035AS4394	Kemet
N1, N2	Type N Flange Mounts	3052-1648-10	Omni Spectra
R1, R2, R3, R4	10 $\Omega$ , 1/8 W Chip Resistors		
R5	1.0 k $\Omega$ , 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

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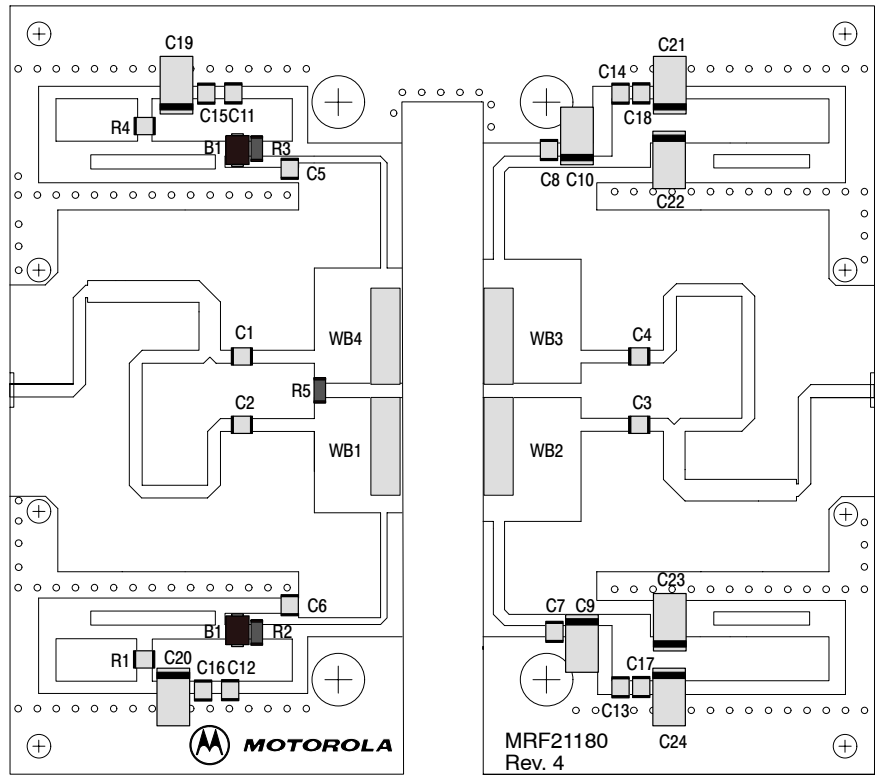
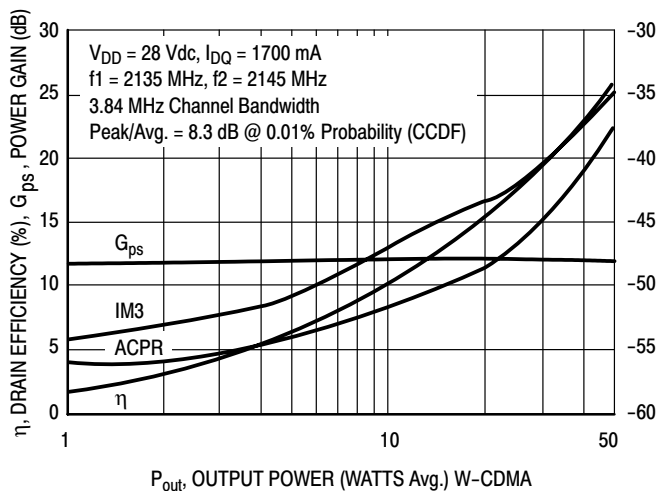


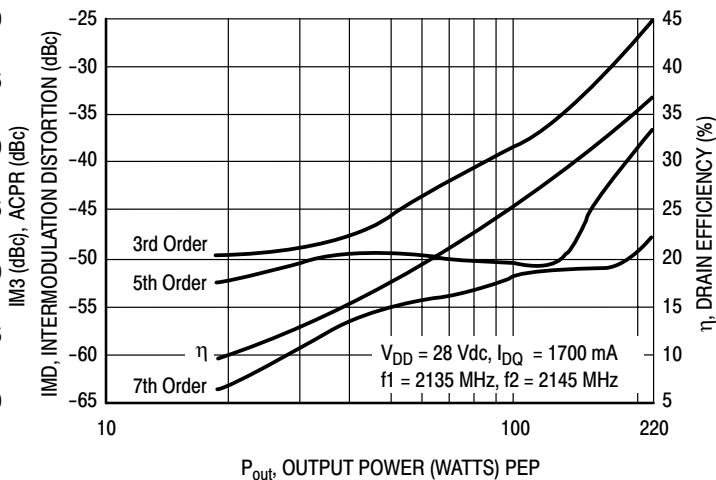
Figure 2. MRF21180 Test Circuit Component Layout

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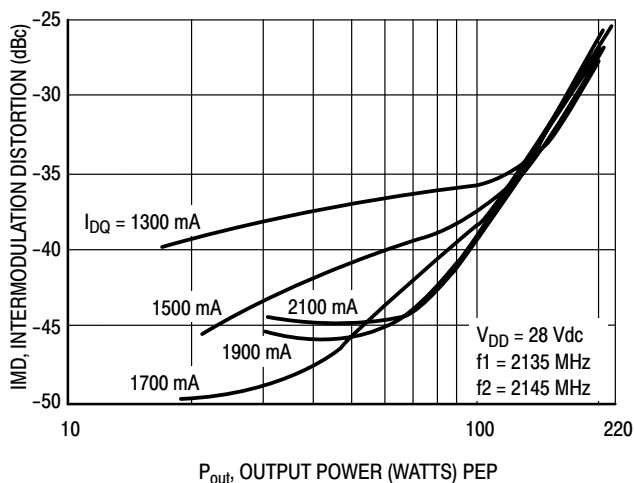
## TYPICAL CHARACTERISTICS



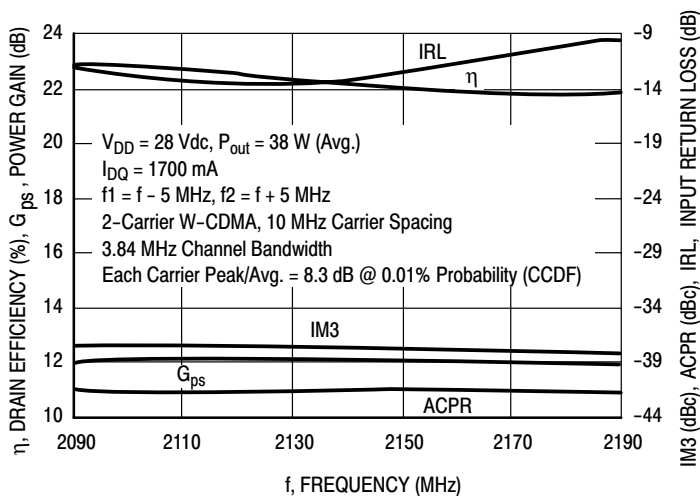
**Figure 3. 2-Carrier W-CDMA ACPR, IM3, Power Gain and Drain Efficiency versus Output Power**



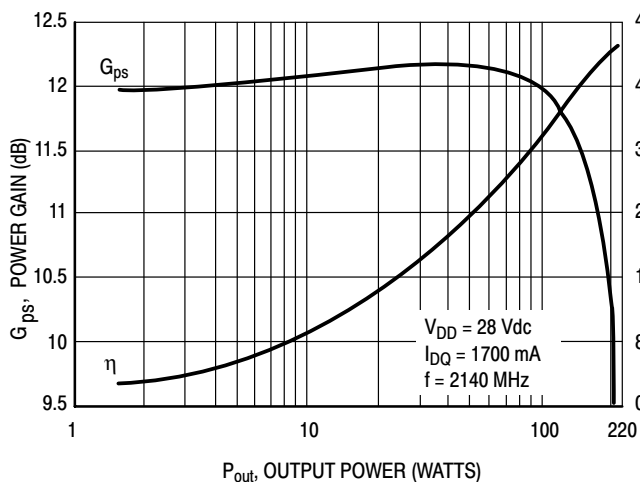
**Figure 4. Intermodulation Distortion Products versus Output Power**



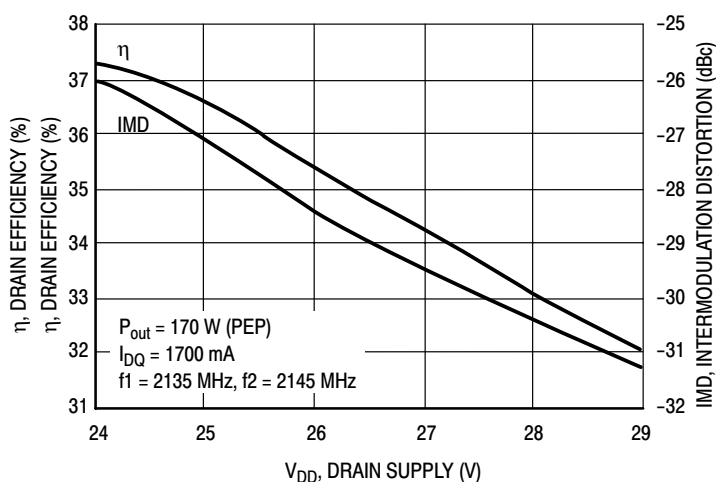
**Figure 5. Intermodulation Distortion versus Output Power**



**Figure 6. 2-Carrier W-CDMA Broadband Performance**



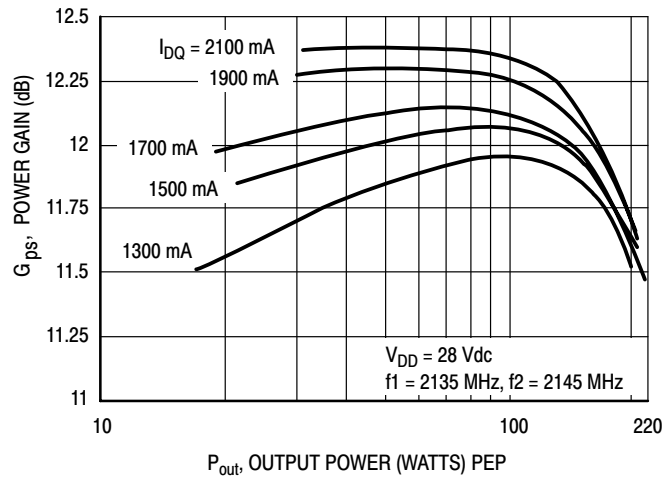
**Figure 7. CW Performance**



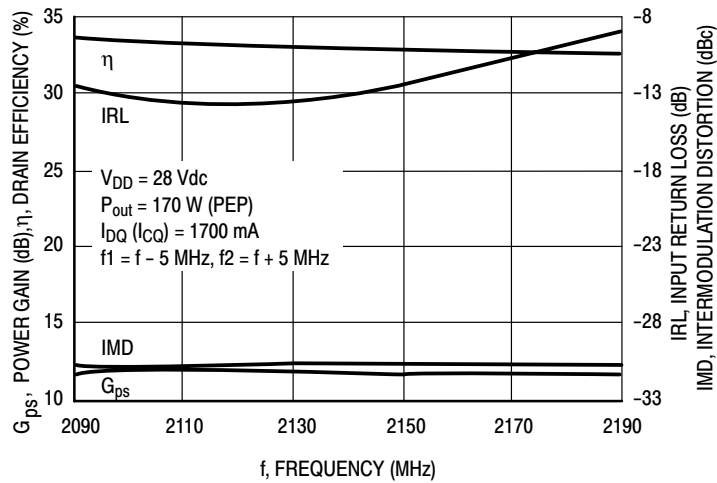
**Figure 8. Two-Tone Intermodulation Distortion and Drain Efficiency versus Drain Supply**

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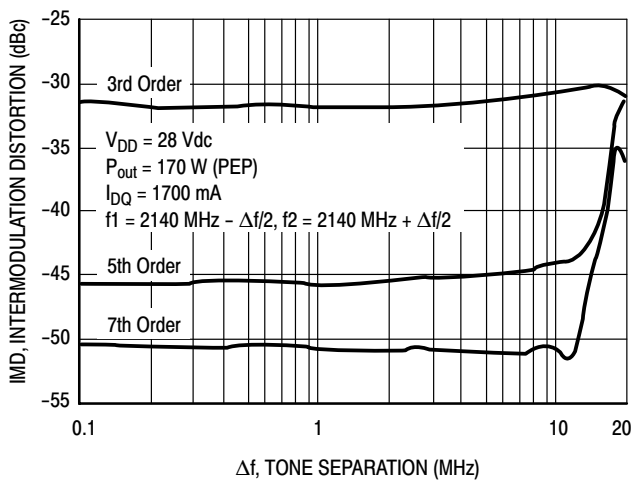
## TYPICAL CHARACTERISTICS



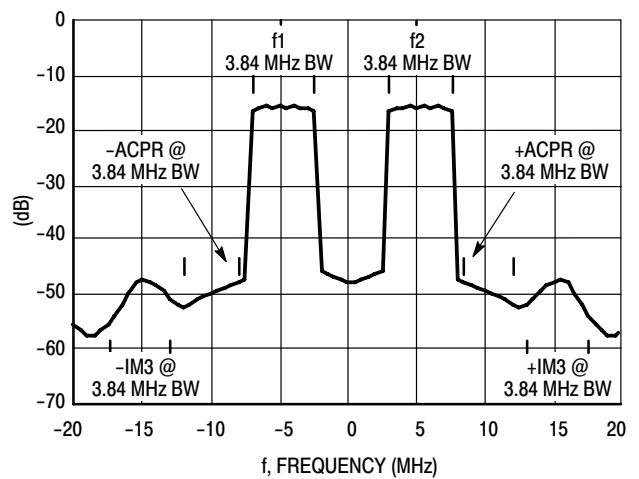
**Figure 9. Two-Tone Power Gain versus Output Power**



**Figure 10. Two-Tone Broadband Performance**

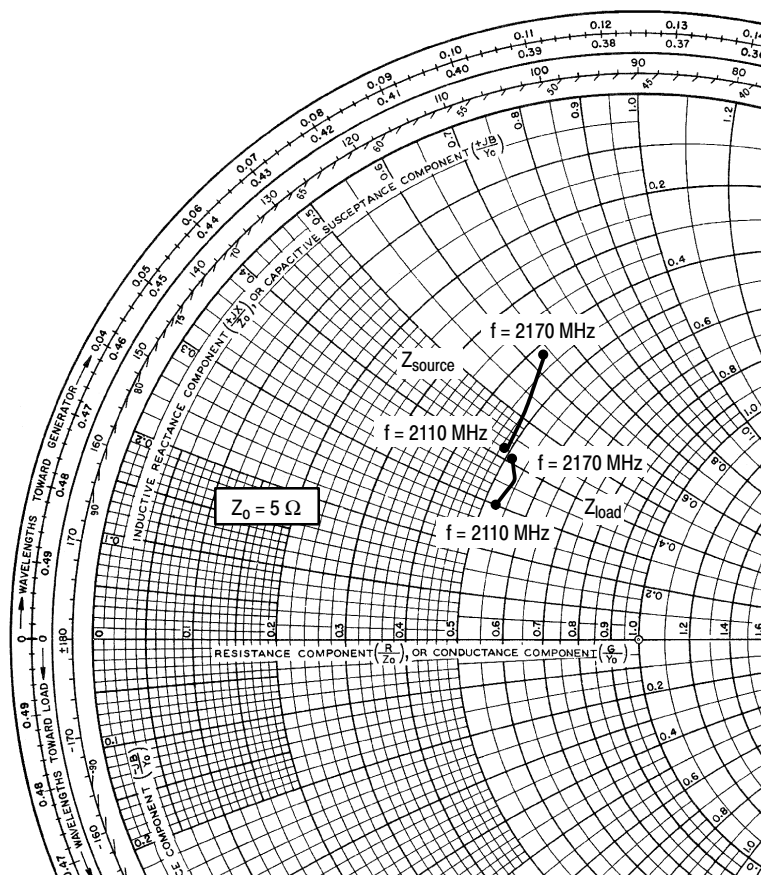


**Figure 11. Intermodulation Distortion Products versus Two-Tone Spacing**



**Figure 12. 2-Carrier W-CDMA Spectrum**

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$V_{DD} = 28 \text{ Vdc}$ ,  $I_{DQ} = 2 \times 850 \text{ mA}$ ,  $P_{out} = 38 \text{ W Avg.}$

f MHz	Z <sub>source</sub> Ω	Z <sub>load</sub> 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<sub>source</sub> = Test circuit impedance as measured from gate to gate, balanced configuration.  
 Z<sub>load</sub> = Test circuit impedance as measured from drain to drain, balanced configuration.

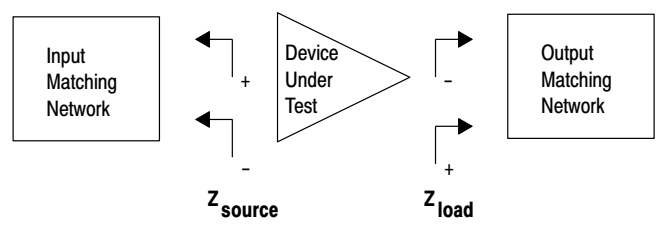


Figure 13. Series Equivalent Input and Output Impedance



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**NOTES**

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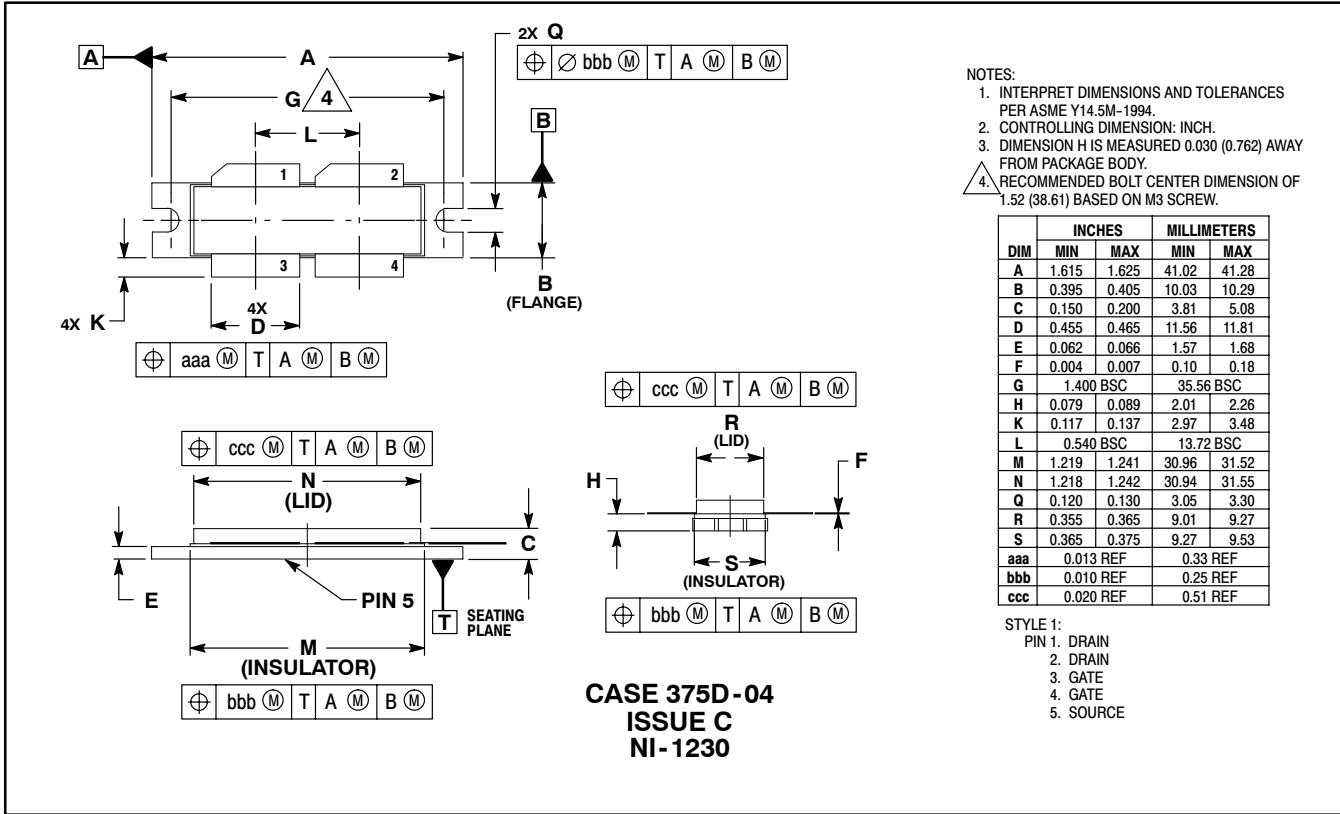
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