

# RF Power Field Effect Transistor

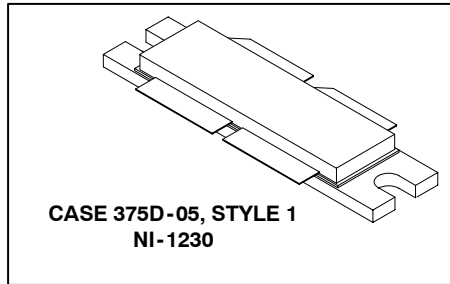
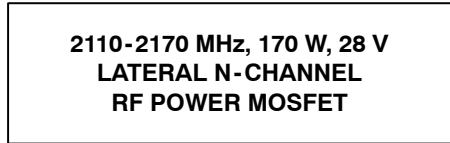
## N-Channel Enhancement-Mode Lateral MOSFET

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.



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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 $25^\circ\text{C}$	$P_D$	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	$^\circ\text{C/W}$

**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
<b>Off Characteristics</b> <sup>(1)</sup>					
Drain-Source Breakdown Voltage ( $V_{GS} = 0\text{ Vdc}$ , $I_D = 100\ \mu\text{Adc}$ )	$V_{(BR)DSS}$	65	—	—	Vdc
Zero Gate Voltage Drain Leakage Current ( $V_{DS} = 28\text{ Vdc}$ , $V_{GS} = 0\text{ Vdc}$ )	$I_{DSS}$	—	—	10	$\mu\text{Adc}$
Gate-Source Leakage Current ( $V_{GS} = 5\text{ Vdc}$ , $V_{DS} = 0\text{ Vdc}$ )	$I_{GSS}$	—	—	1	$\mu\text{Adc}$
<b>On Characteristics</b>					
Gate Threshold Voltage <sup>(1)</sup> ( $V_{DS} = 10\text{ Vdc}$ , $I_D = 200\ \mu\text{Adc}$ )	$V_{GS(th)}$	2	—	4	Vdc
Gate Quiescent Voltage <sup>(3)</sup> ( $V_{DS} = 28\text{ Vdc}$ , $I_D = 1700\text{ mAdc}$ )	$V_{GS(Q)}$	3	3.9	5	Vdc
Drain-Source On-Voltage <sup>(1)</sup> ( $V_{GS} = 10\text{ Vdc}$ , $I_D = 2\text{ Adc}$ )	$V_{DS(on)}$	—	0.18	0.22	Vdc
Forward Transconductance <sup>(1)</sup> ( $V_{DS} = 10\text{ Vdc}$ , $I_D = 2\text{ Adc}$ )	$g_{fs}$	—	6	—	S
<b>Dynamic Characteristics</b> <sup>(1,2)</sup>					
Reverse Transfer Capacitance ( $V_{DS} = 28\text{ Vdc}$ , $V_{GS} = 0$ , $f = 1\text{ MHz}$ )	$C_{rss}$	—	3.6	—	pF
<b>Functional Tests</b> <sup>(3)</sup> (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 $f_1 = 2157.5\text{ MHz}$ , $f_2 = 2167.5\text{ MHz}$ )	$\eta$	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
<b>Functional Tests</b> <sup>(1)</sup> (In Freescale Test Fixture, 50 ohm system) <b>(continued)</b>					
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 $f_1 = 2160\text{ MHz}$ , $f_2 = 2170\text{ MHz}$ )	$\eta$	—	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.

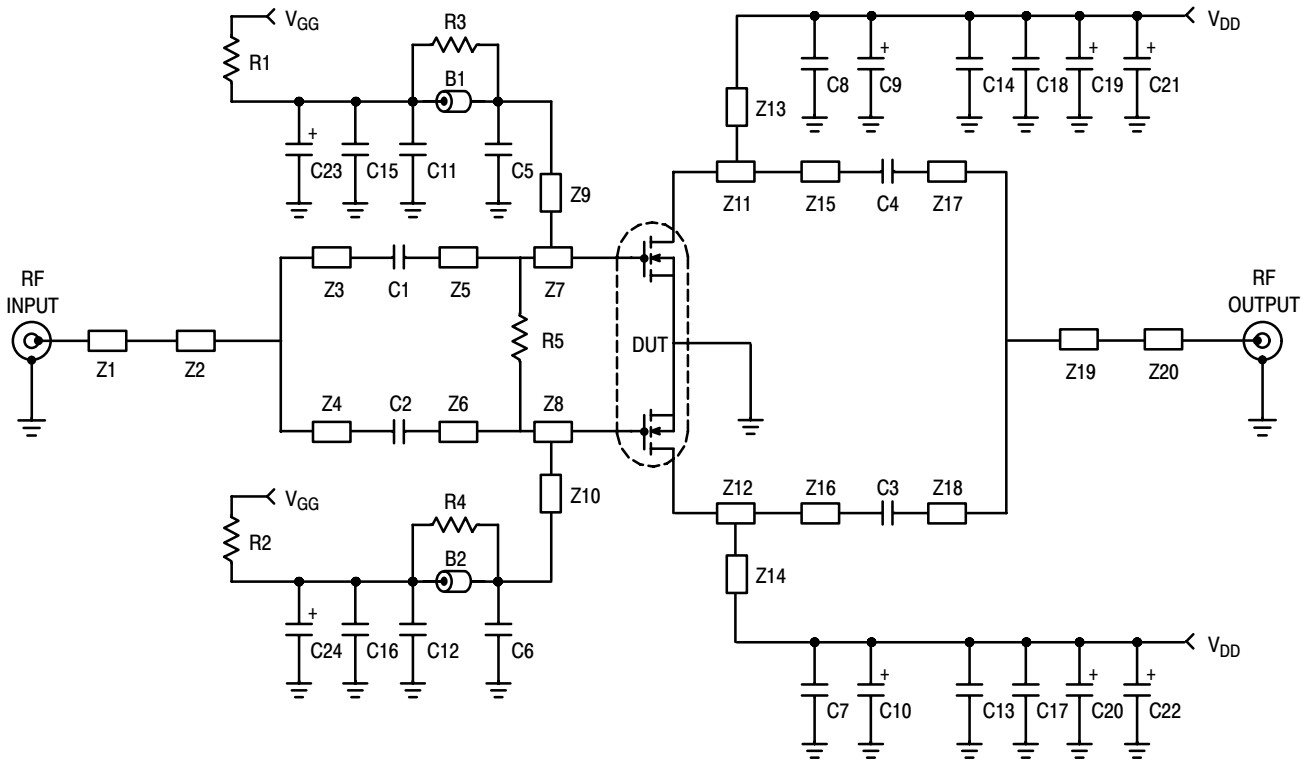
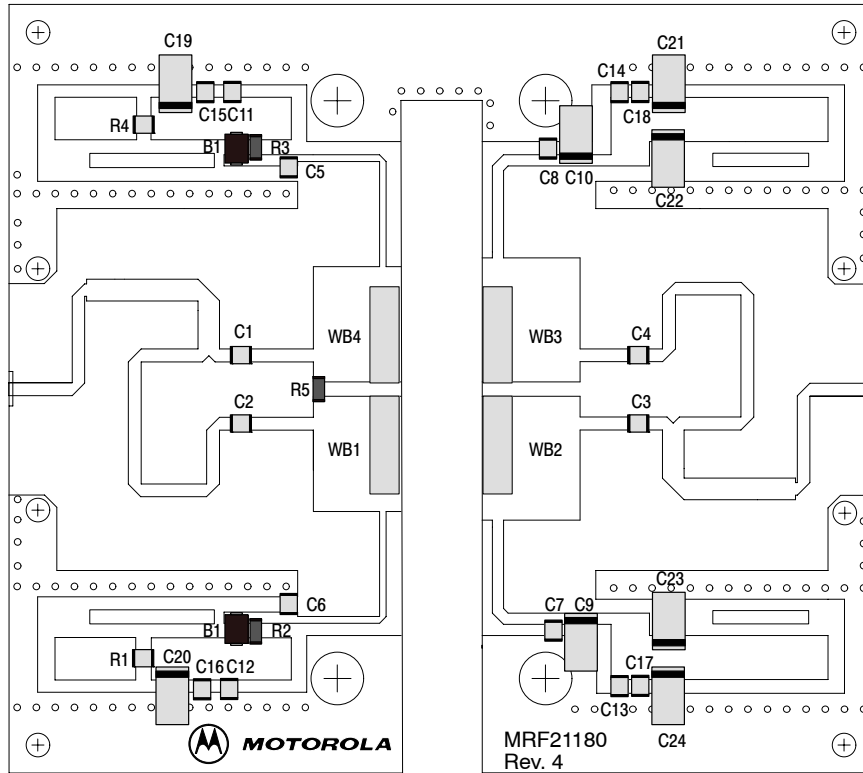


Figure 1. MRF21180 Test Circuit Schematic

Table 5. MRF21180 Test Circuit Component Designations and Values

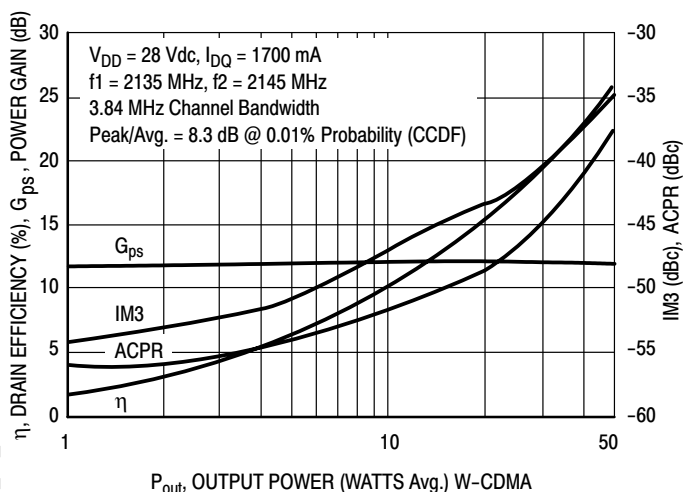
Part	Description	Part Number	Manufacturer
B1, B2	Short Ferrite Beads	2743019447	Fair Rite
C1, C2, C3, C4	30 pF Chip Capacitors	100B300JCA500X	ATC
C5, C6, C7, C8	5.6 pF Chip Capacitors	100B5R6JCA500X	ATC
C9, C10	10 $\mu$ F Tantalum Capacitors	T495X106K035AS4394	Kemet
C11, C12, C13, C14	1000 pF Chip Capacitors	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



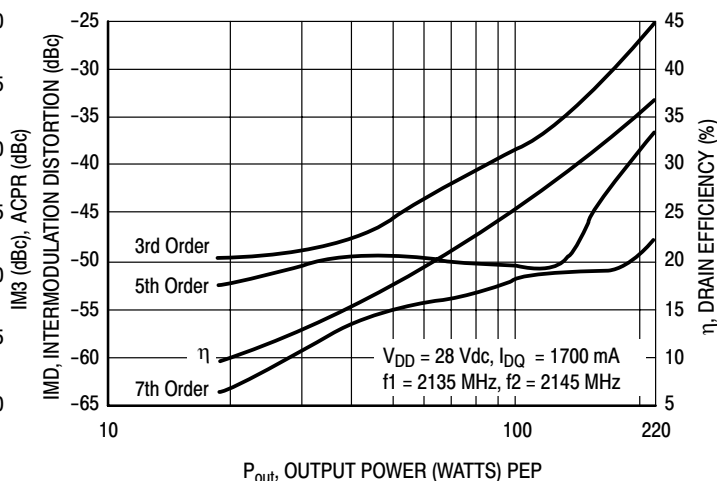
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**Figure 2. MRF21180 Test Circuit Component Layout**

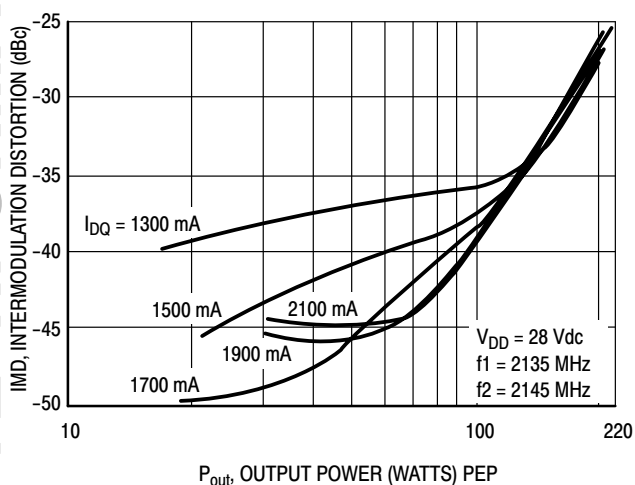
## TYPICAL CHARACTERISTICS



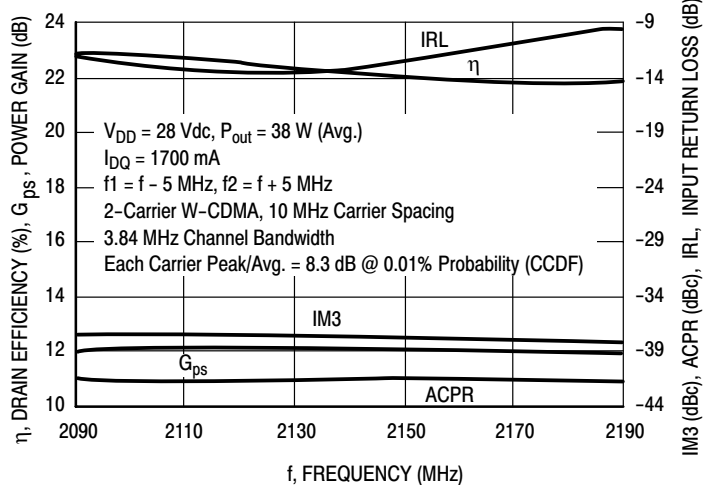
**Figure 3. 2-Carrier W-CDMA ACPR, IM3, Power Gain and Drain Efficiency versus Output Power**



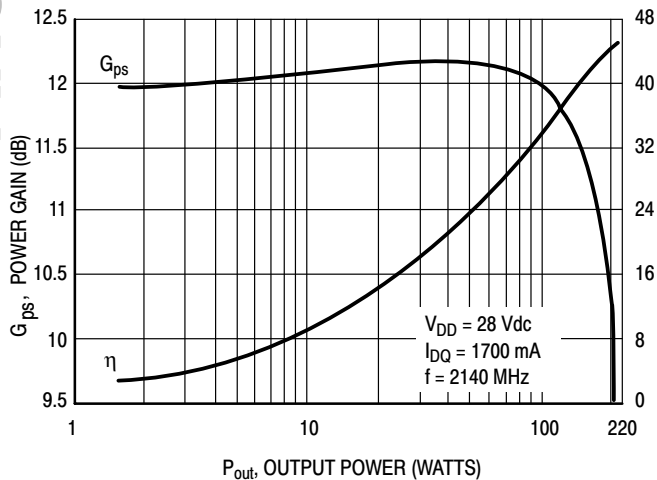
**Figure 4. Intermodulation Distortion Products versus Output Power**



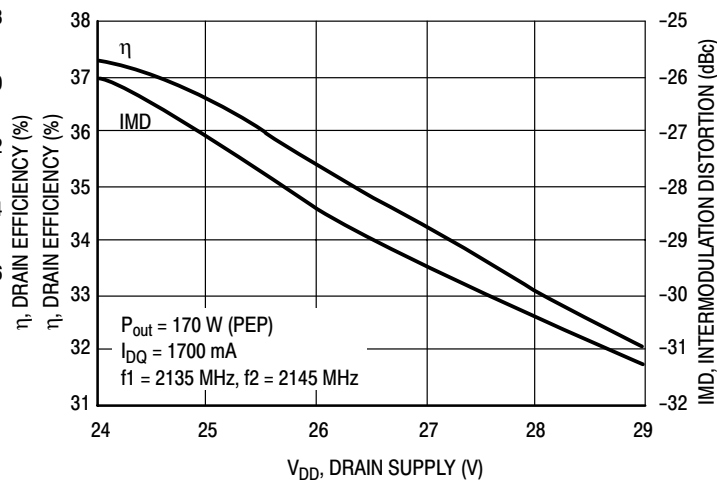
**Figure 5. Intermodulation Distortion versus Output Power**



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



**Figure 7. CW Performance**

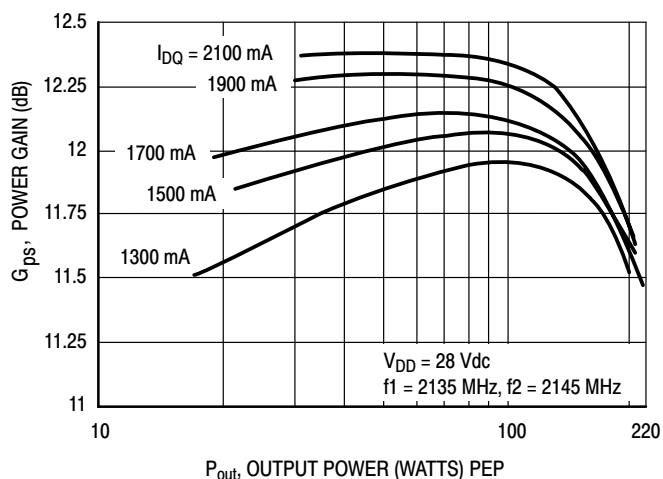


**Figure 8. Two-Tone Intermodulation Distortion and Drain Efficiency versus Drain Supply**

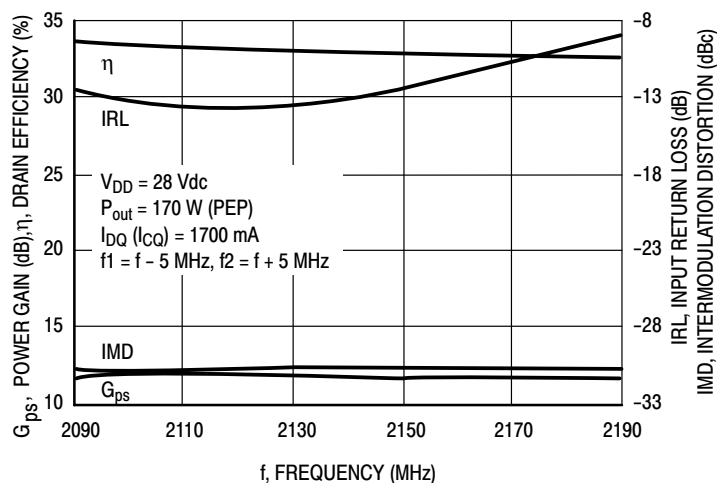
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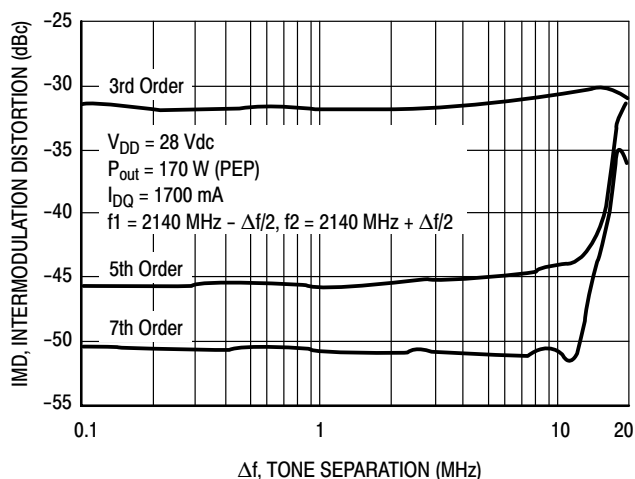
### TYPICAL CHARACTERISTICS



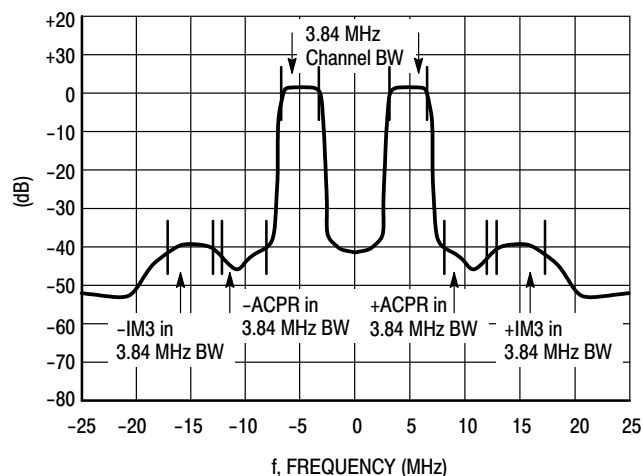
**Figure 9. Two-Tone Power Gain versus Output Power**



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



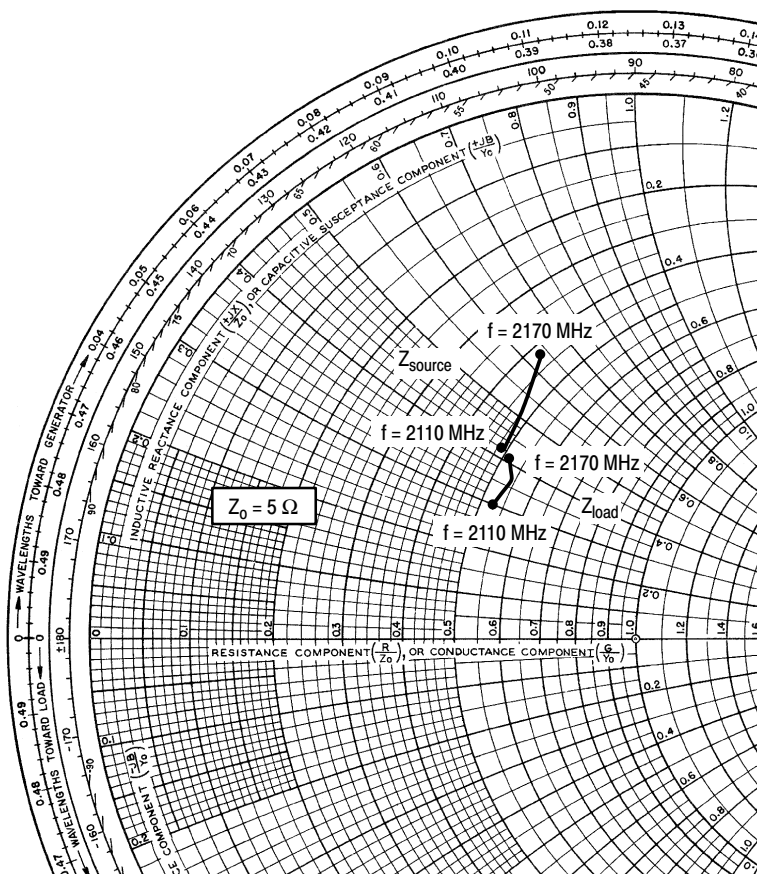
**Figure 11. Intermodulation Distortion Products versus Two-Tone Spacing**



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

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

f MHz	$Z_{source}$ $\Omega$	$Z_{load}$ $\Omega$
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.

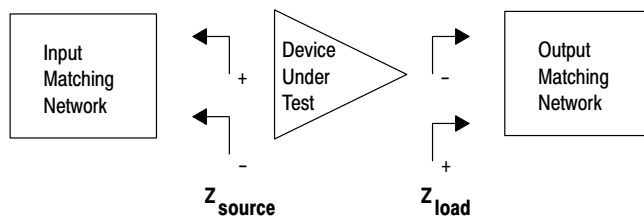


Figure 13. Series Equivalent Source and Load Impedance



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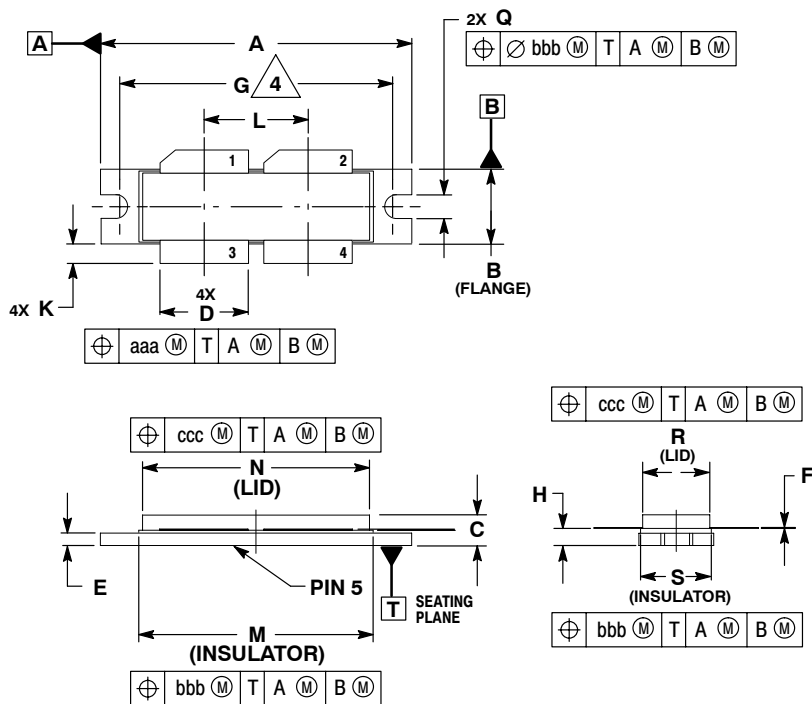
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# NOTES

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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:
1. DRAIN
  2. DRAIN
  3. GATE
  4. GATE
  5. SOURCE

CASE 375D-05  
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