

**Freescale Semiconductor**  
Technical Data

Document Number: MRF6P21190HR6  
Rev. 2, 8/2005

# RF Power Field Effect Transistor

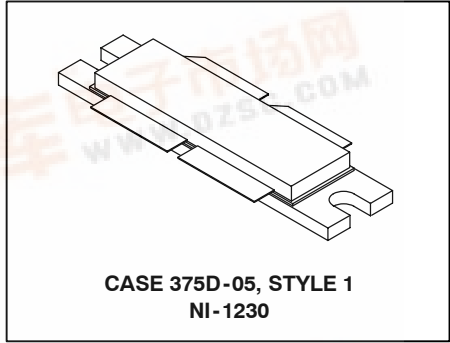
## N-Channel Enhancement-Mode Lateral MOSFET

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 $\mu$ ” Nominal.
- Pb-Free and RoHS Compliant
- In Tape and Reel. R6 Suffix = 150 Units per 56 mm, 13 inch Reel.



**2170 MHz, 44 W AVG., 28 V**  
**2 x W-CDMA**  
**LATERAL N-CHANNEL**  
**RF POWER MOSFET**



**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 $^\circ\text{C}$	$P_D$	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 $^\circ\text{C}$ , 190 W CW Case Temperature 72 $^\circ\text{C}$ , 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** <sup>(1)</sup>

Zero Gate Voltage Drain Leakage Current ( $V_{DS} = 68\text{ Vdc}$ , $V_{GS} = 0\text{ Vdc}$ )	$I_{DSS}$	—	—	10	$\mu\text{A}$
Zero Gate Voltage Drain Leakage Current ( $V_{DS} = 28\text{ Vdc}$ , $V_{GS} = 0\text{ Vdc}$ )	$I_{DSS}$	—	—	1	$\mu\text{A}$
Gate-Source Leakage Current ( $V_{GS} = 5\text{ Vdc}$ , $V_{DS} = 0\text{ Vdc}$ )	$I_{GSS}$	—	—	1	$\mu\text{A}$

**On Characteristics**

Gate Threshold Voltage <sup>(1)</sup> ( $V_{DS} = 10\text{ Vdc}$ , $I_D = 250\ \mu\text{A}$ )	$V_{GS(th)}$	1	2	3	Vdc
Gate Quiescent Voltage <sup>(3)</sup> ( $V_{DS} = 28\text{ Vdc}$ , $I_D = 1900\text{ mA}$ )	$V_{GS(Q)}$	2	2.8	4	Vdc
Drain-Source On-Voltage <sup>(1)</sup> ( $V_{GS} = 10\text{ Vdc}$ , $I_D = 2.2\text{ A}$ )	$V_{DS(on)}$	0.1	0.21	0.3	Vdc
Forward Transconductance <sup>(1)</sup> ( $V_{DS} = 10\text{ Vdc}$ , $I_D = 2\text{ A}$ )	$g_{fs}$	—	5.3	—	S

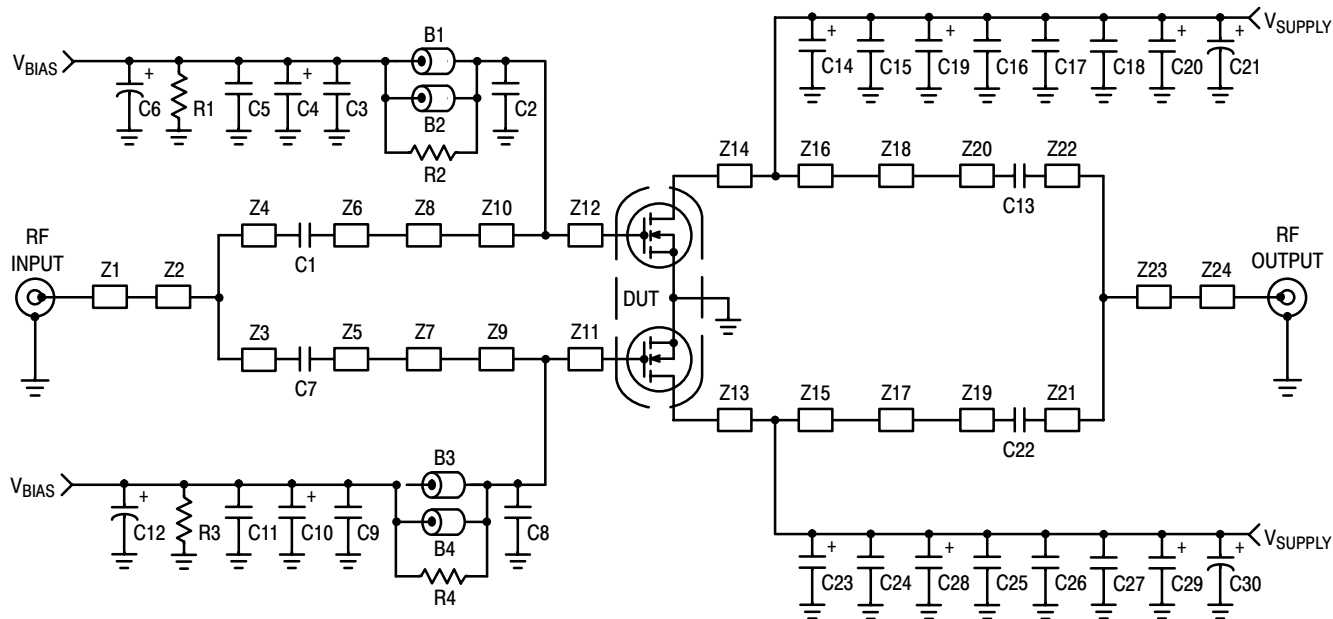
**Dynamic Characteristics** <sup>(1,2)</sup>

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** <sup>(3)</sup> (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	$\eta_D$	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.

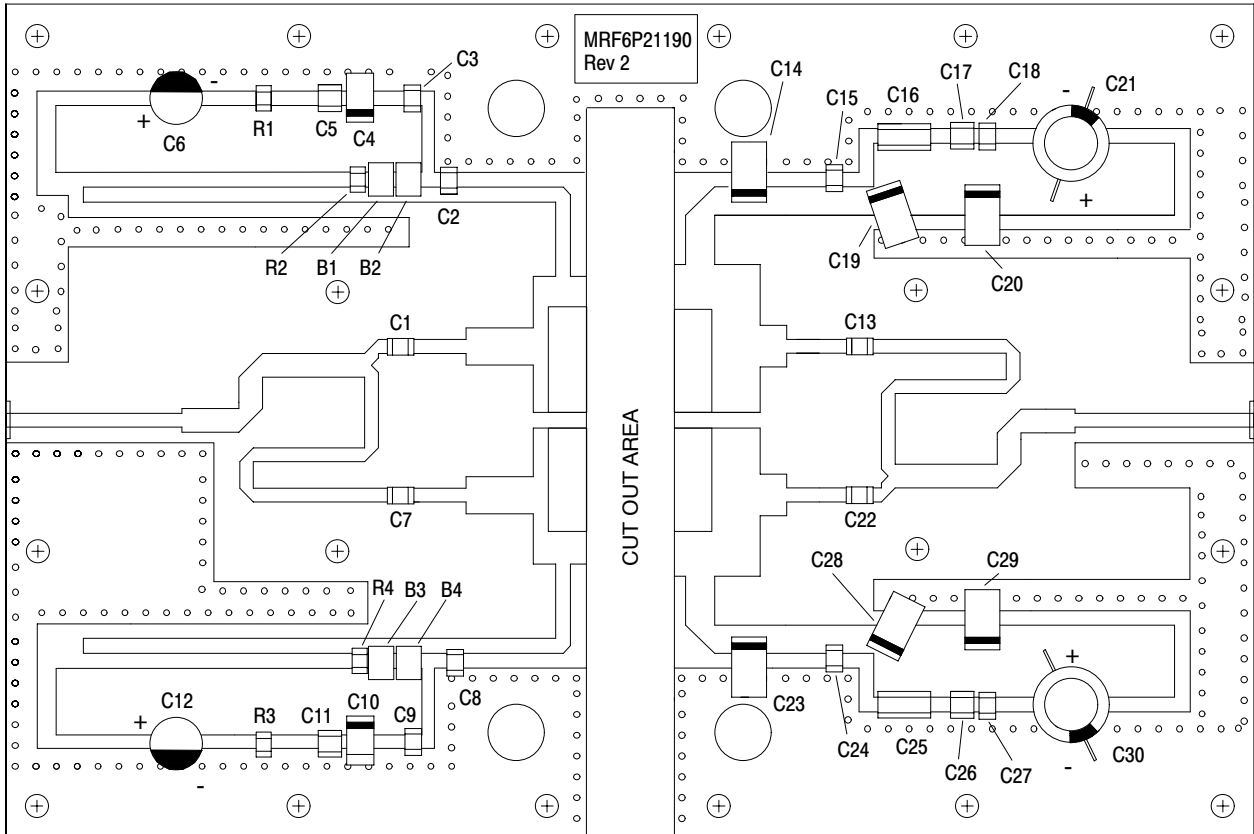


Z1	0.850" x 0.067" Microstrip	Z15, Z16	0.289" x 0.712" Microstrip
Z2	1.140" x 0.114" Microstrip	Z17, Z18	0.127" x 0.200" Microstrip
Z3	1.830" x 0.067" Microstrip	Z19, Z20	0.288" x 0.067" Microstrip
Z4	0.088" x 0.067" Microstrip	Z21	0.088" x 0.067" Microstrip
Z5, Z6	0.250" x 0.067" Microstrip	Z22	1.830" 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 $\mu$ F, 50 V Tantalum Chip Capacitors	T491C105K050AS	Kemet
C5, C11, C17, C26	0.1 $\mu$ F Chip Capacitors	CDR33BX104AKWS	Kemet
C6, C12	100 $\mu$ F, 50 V Electrolytic Capacitors, Radial	MCR50V107M8X11	Multicomp
C13, C22	43 pF Chip Capacitors	100B430JP500X	ATC
C14, C19, C20, C23, C28, C29	22 $\mu$ F, 35 V Tantalum Chip Capacitors	T491X226K035AS	Kemet
C16, C25	0.56 $\mu$ F Chip Capacitors (1825)	C1825C564J5RAC	Kemet
C21, C30	470 $\mu$ F, 63 V Electrolytic Capacitors, Radial	MCR63V477M13X26	Multicomp
R1, R3	1 k $\Omega$ , 1/4 W Chip Resistors (1206)	CRCW12061001F100	Vishay
R2, R4	12 $\Omega$ , 1/4 W Chip Resistors (1206)	CRCW120612R0F100	Vishay



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. MRF6P21190HR6 Test Circuit Component Layout**

### TYPICAL CHARACTERISTICS

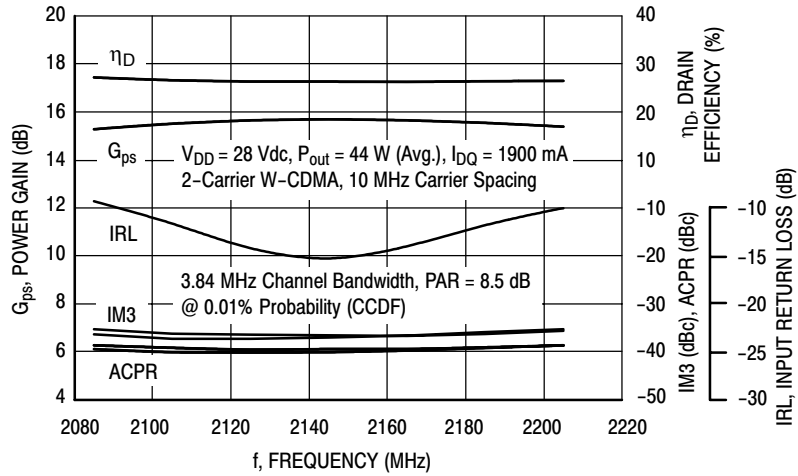


Figure 3. 2-Carrier W-CDMA Broadband Performance @  $P_{out} = 44$  Watts Avg.

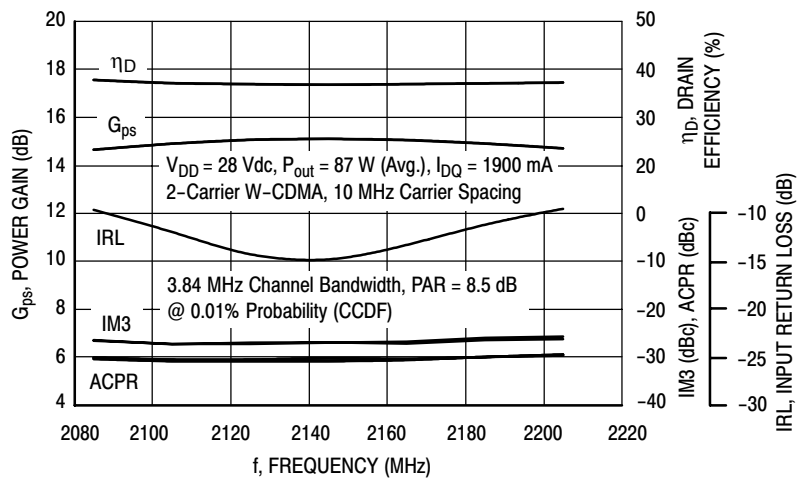


Figure 4. 2-Carrier W-CDMA Broadband Performance @  $P_{out} = 87$  Watts Avg.

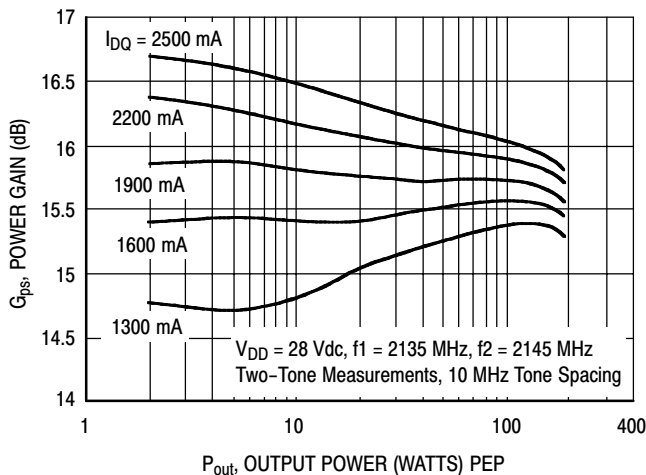


Figure 5. Two-Tone Power Gain versus Output Power

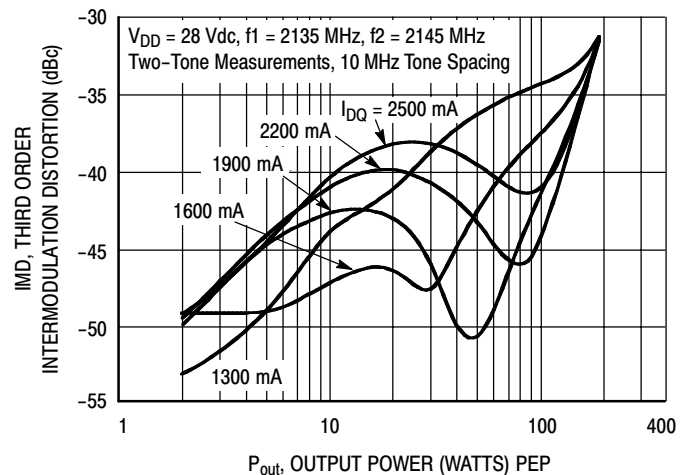
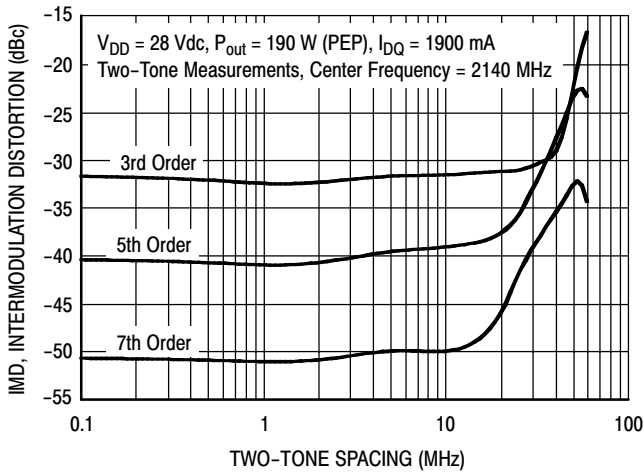
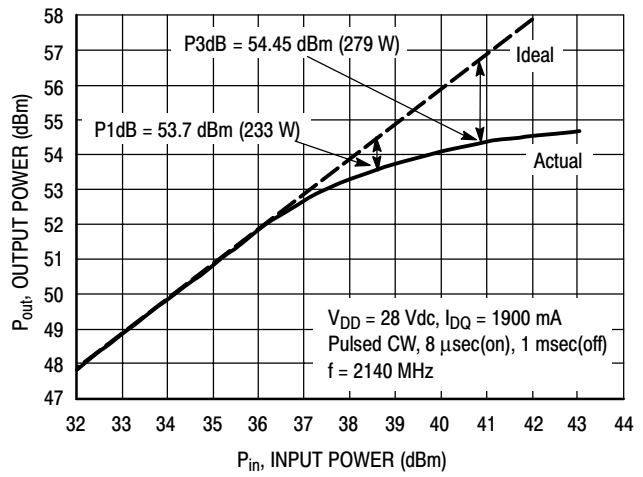


Figure 6. Third Order Intermodulation Distortion versus Output Power

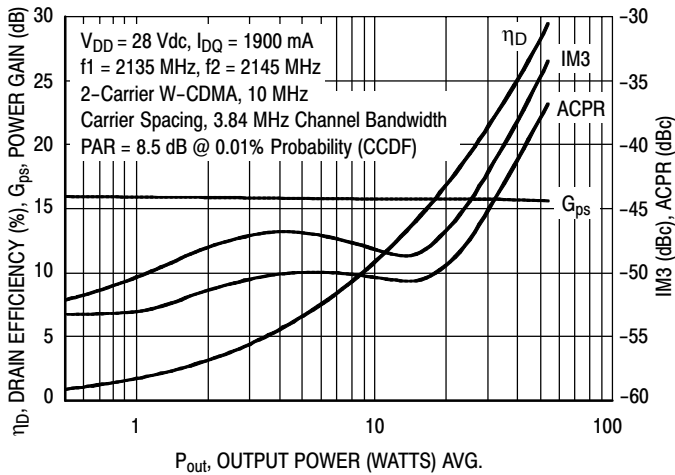
## TYPICAL CHARACTERISTICS



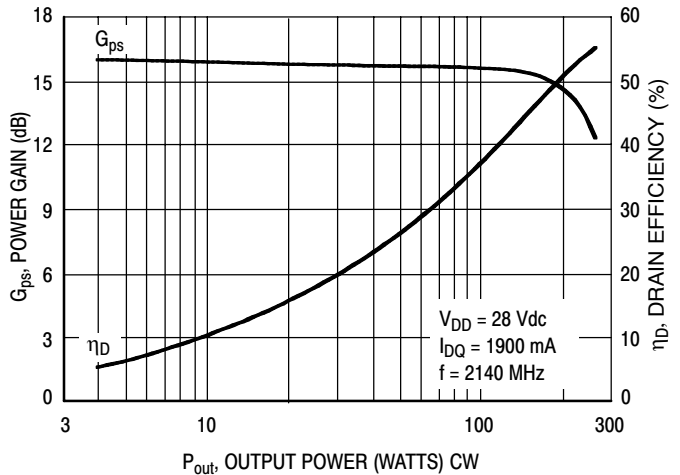
**Figure 7. Intermodulation Distortion Products versus Tone Spacing**



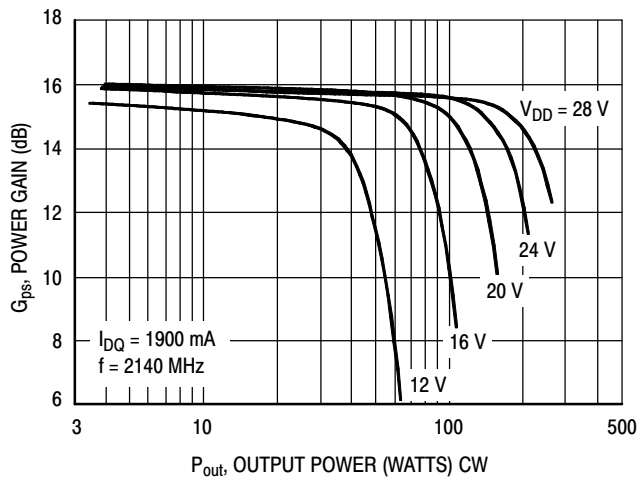
**Figure 8. Pulse CW Output Power versus Input Power**



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

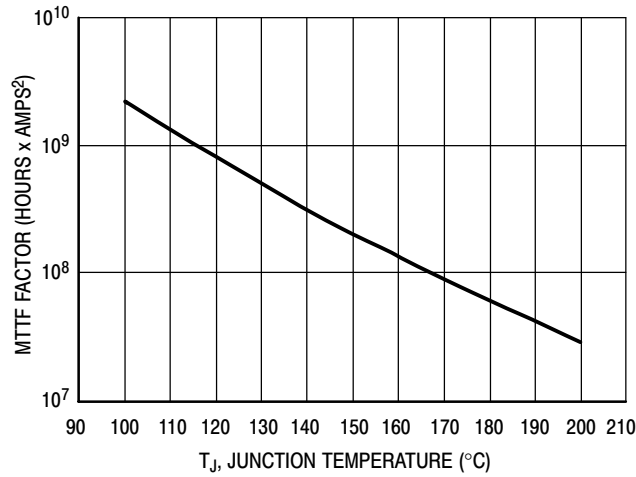


**Figure 10. Power Gain and Drain Efficiency versus CW Output Power**



**Figure 11. Power Gain versus Output Power**

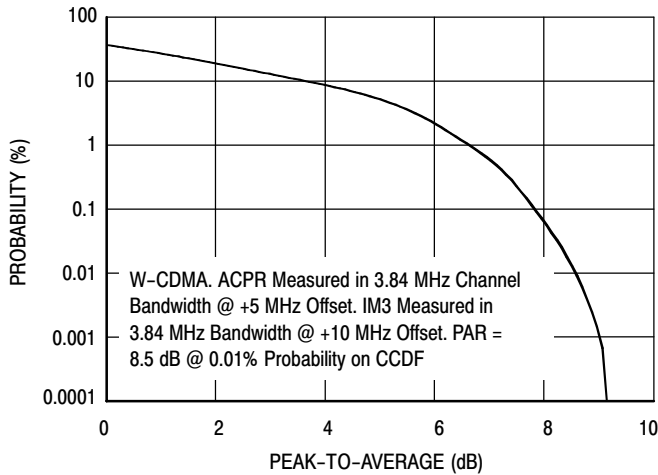
## TYPICAL CHARACTERISTICS



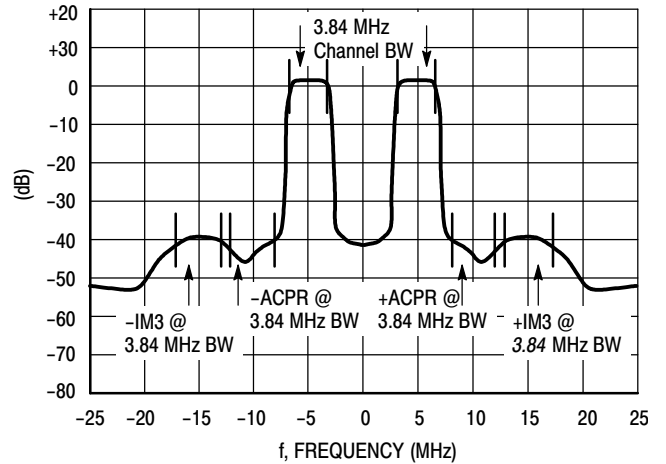
This above graph displays calculated MTTF in hours x ampere<sup>2</sup> drain current. Life tests at elevated temperatures have correlated to better than  $\pm 10\%$  of the theoretical prediction for metal failure. Divide MTTF factor by  $I_D^2$  for MTTF in a particular application.

**Figure 12. MTTF Factor versus Junction Temperature**

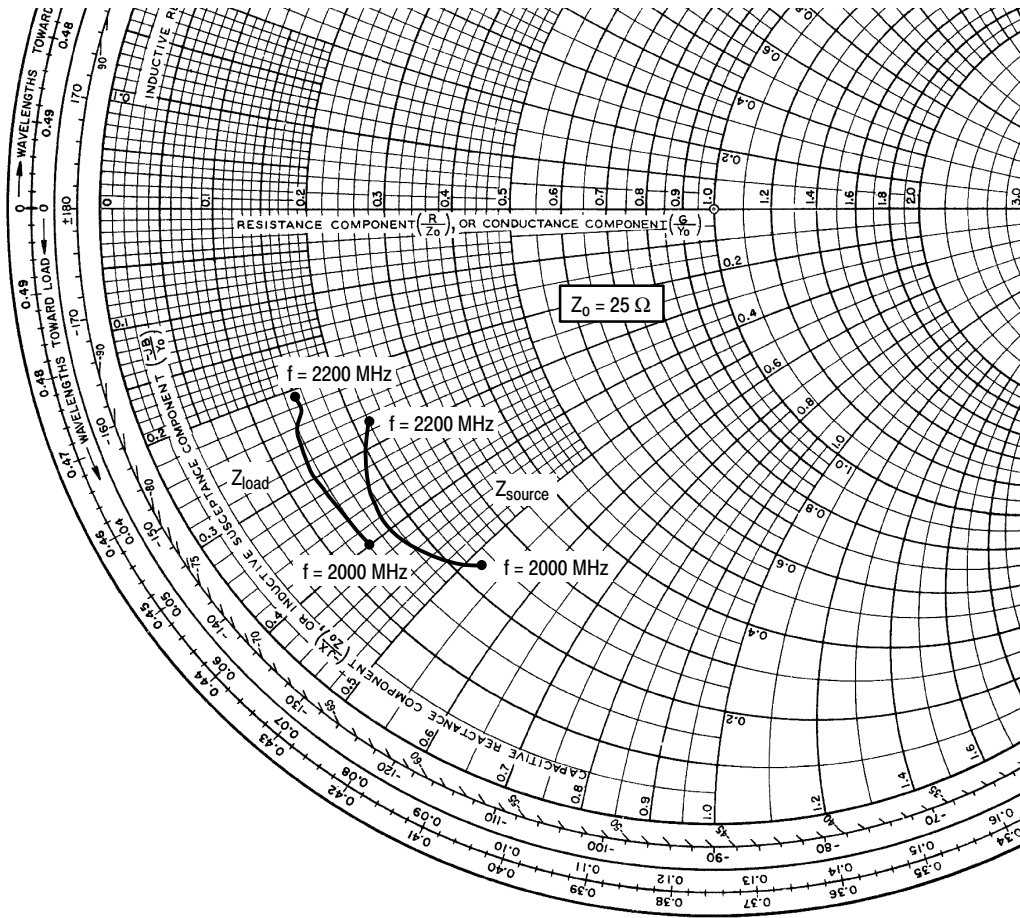
## W-CDMA TEST SIGNAL



**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	$Z_{source}$ $\Omega$	$Z_{load}$ $\Omega$
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.

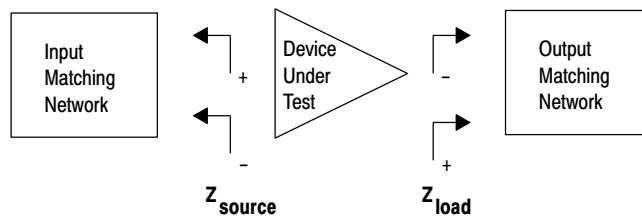


Figure 15. Series Equivalent Source and Load Impedance



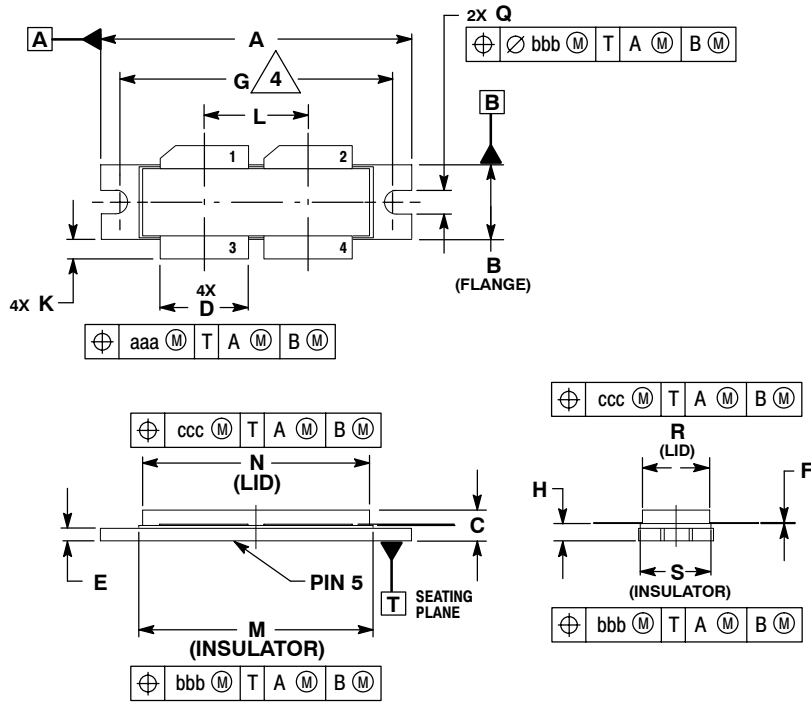


# NOTES



# 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:
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](http://www.freescale.com)

### **E-mail:**

[support@freescale.com](mailto: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](mailto: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](mailto: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](mailto: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](mailto:support.asia@freescale.com)

### **For Literature Requests Only:**

Freescale Semiconductor Literature Distribution Center  
P.O. Box 5405  
Denver, Colorado 80217  
1-800-441-2447 or 303-675-2140  
Fax: 303-675-2150  
[LDCForFreescaleSemiconductor@hibbertgroup.com](mailto:LDCForFreescaleSemiconductor@hibbertgroup.com)

Information in this document is provided solely to enable system and software implementers to use Freescale Semiconductor products. There are no express or implied copyright licenses granted hereunder to design or fabricate any integrated circuits or integrated circuits based on the information in this document.

Freescale Semiconductor reserves the right to make changes without further notice to any products herein. Freescale Semiconductor makes no warranty, representation or guarantee regarding the suitability of its products for any particular purpose, nor does Freescale Semiconductor assume any liability arising out of the application or use of any product or circuit, and specifically disclaims any and all liability, including without limitation consequential or incidental damages. "Typical" parameters that may be provided in Freescale Semiconductor data sheets and/or specifications can and do vary in different applications and actual performance may vary over time. All operating parameters, including "Typicals", must be validated for each customer application by customer's technical experts. Freescale Semiconductor does not convey any license under its patent rights nor the rights of others. Freescale Semiconductor products are not designed, intended, or authorized for use as components in systems intended for surgical implant into the body, or other applications intended to support or sustain life, or for any other application in which the failure of the Freescale Semiconductor product could create a situation where personal injury or death may occur. Should Buyer purchase or use Freescale Semiconductor products for any such unintended or unauthorized application, Buyer shall indemnify and hold Freescale Semiconductor and its officers, employees, subsidiaries, affiliates, and distributors harmless against all claims, costs, damages, and expenses, and reasonable attorney fees arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized use, even if such claim alleges that Freescale Semiconductor was negligent regarding the design or manufacture of the part.

Freescale™ and the Freescale logo are trademarks of Freescale Semiconductor, Inc. All other product or service names are the property of their respective owners.  
© Freescale Semiconductor, Inc. 2005. All rights reserved.

