

# RF Power Field Effect Transistor

## N-Channel Enhancement-Mode Lateral MOSFET

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.

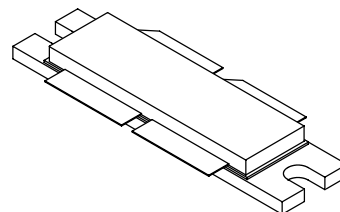
- Typical 2-Carrier W-CDMA Performance:  $V_{DD} = 28$  Volts,  $I_{DQ} = 1600$  mA,  $P_{out} = 38$  Watts Avg.,  $f = 1977.5$  MHz, Channel Bandwidth = 3.84 MHz, PAR = 8.5 dB @ 0.01% Probability on CCDF.  
Power Gain — 14 dB  
Drain Efficiency — 26%  
IM3 @ 10 MHz Offset — -37.5 dBc in 3.84 MHz Channel Bandwidth  
ACPR @ 5 MHz Offset — -41 dBc in 3.84 MHz Channel Bandwidth
- Capable of Handling 10:1 VSWR, @ 28 Vdc, 1960 MHz, 120 Watts CW Output Power

### Features

- 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
- Low Gold Plating Thickness on Leads, 40 $\mu$ " Nominal.
- RoHS Compliant
- In Tape and Reel. R6 Suffix = 150 Units per 56 mm, 13 inch Reel.

**MRF5P20180HR6**

**1930-1990 MHz, 38 W AVG., 28 V**  
**2 x W-CDMA**  
**LATERAL N-CHANNEL**  
**RF POWER MOSFET**



**CASE 375D-05, STYLE 1**  
**NI-1230**

ARCHIVE INFORMATION

ARCHIVE INFORMATION

**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 $^\circ\text{C}$	$P_D$	530 3.0	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	$^\circ\text{C}$
CW Operation @ $T_C = 25^\circ\text{C}$ Derate above 25 $^\circ\text{C}$	CW	185 1.2	W W/ $^\circ\text{C}$

**Table 2. Thermal Characteristics**

Characteristic	Symbol	Value (1,2)	Unit
Thermal Resistance, Junction to Case Case Temperature 77 $^\circ\text{C}$ , 120 W CW Case Temperature 72 $^\circ\text{C}$ , 38 W CW	$R_{\theta JC}$	0.33 0.35	$^\circ\text{C}/\text{W}$

1. MTF calculator available at <http://www.freescale.com/rf>. Select Software & Tools/Development Tools/Calculators to access MTF 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.

**Table 3. ESD Protection Characteristics**

Test Conditions	Class
Human Body Model	2 (Minimum)
Machine Model	M3 (Minimum)
Charge Device Model	C7 (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>					
Zero Gate Voltage Drain Leakage Current ( $V_{DS} = 65\text{ Vdc}$ , $V_{GS} = 0\text{ Vdc}$ )	$I_{DSS}$	—	—	10	$\mu\text{Adc}$
Zero Gate Voltage Drain Leakage Current ( $V_{DS} = 28\text{ Vdc}$ , $V_{GS} = 0$ )	$I_{DSS}$	—	—	1	$\mu\text{Adc}$
Gate-Source Leakage Current ( $V_{GS} = 5\text{ Vdc}$ , $V_{DS} = 0\text{ Vdc}$ )	$I_{GSS}$	—	—	1	$\mu\text{Adc}$

**On Characteristics**

Gate Threshold Voltage <sup>(1)</sup> ( $V_{DS} = 10\text{ Vdc}$ , $I_D = 200\ \mu\text{Adc}$ )	$V_{GS(th)}$	2.5	2.7	3.5	Vdc
Gate Quiescent Voltage <sup>(3)</sup> ( $V_{DS} = 28\text{ Vdc}$ , $I_D = 1600\text{ mAdc}$ )	$V_{GS(Q)}$	—	3.6	—	Vdc
Drain-Source On-Voltage <sup>(1)</sup> ( $V_{GS} = 10\text{ Vdc}$ , $I_D = 2\text{ Adc}$ )	$V_{DS(on)}$	—	0.26	0.3	Vdc
Forward Transconductance <sup>(1)</sup> ( $V_{DS} = 10\text{ Vdc}$ , $I_D = 2\text{ Adc}$ )	$g_{fs}$	—	5	—	S

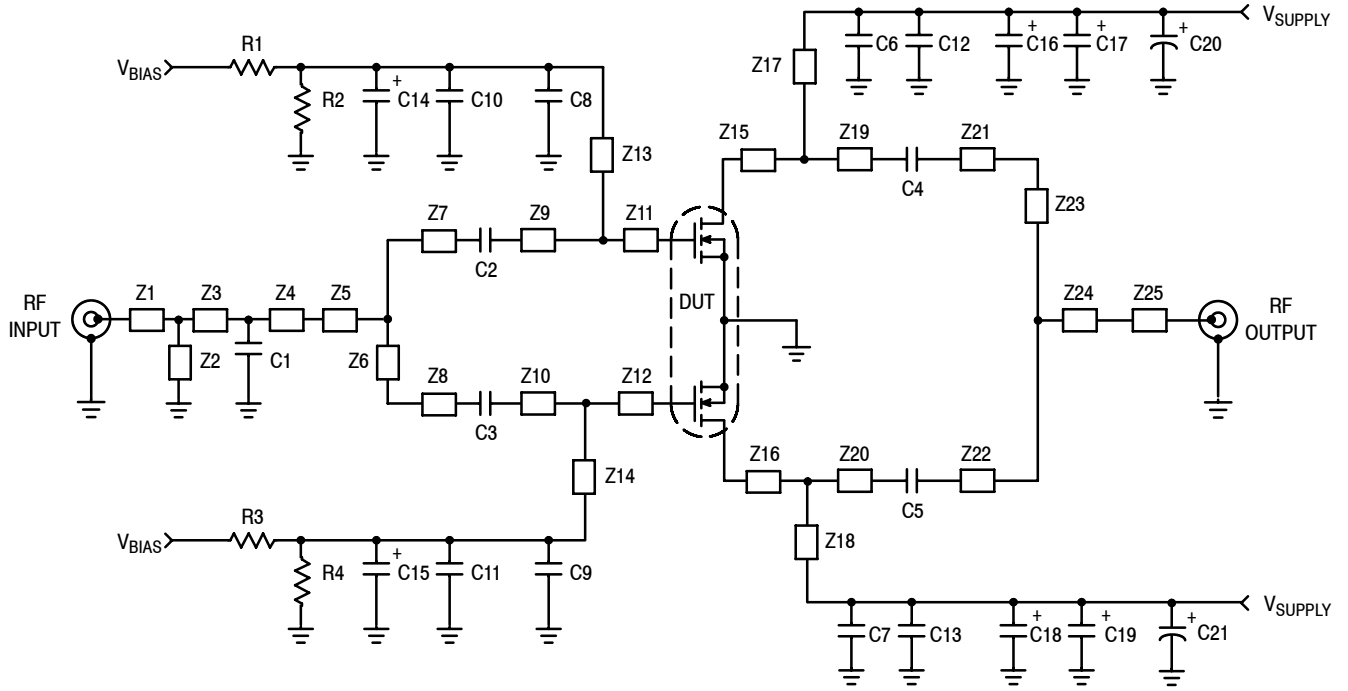
**Dynamic Characteristics** <sup>(1,2)</sup>

Reverse Transfer Capacitance ( $V_{DS} = 28\text{ Vdc} \pm 30\text{ mV(rms)ac}$ @ 1 MHz, $V_{GS} = 0\text{ Vdc}$ )	$C_{rss}$	—	1.7	—	pF
---	-----------	---	-----	---	----

**Functional Tests** <sup>(3)</sup> (In Freescale Test Fixture, 50 ohm system)  $V_{DD} = 28\text{ Vdc}$ ,  $I_{DQ} = 1600\text{ mA}$ ,  $P_{out} = 38\text{ W Avg.}$ ,  $f_1 = 1977.5\text{ MHz}$ ,  $f_2 = 1987.5\text{ MHz}$ , 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 Bandwidth @  $\pm 10\text{ MHz}$  Offset. PAR = 8.5 dB @ 0.01% Probability on CCDF.

Power Gain	$G_{ps}$	12.5	14	—	dB
Drain Efficiency	$\eta_D$	23	26	—	%
Intermodulation Distortion	IM3	—	-37.5	-35	dBc
Adjacent Channel Power Ratio	ACPR	—	-41	-38	dBc
Input Return Loss	IRL	—	-16	-9	dB

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

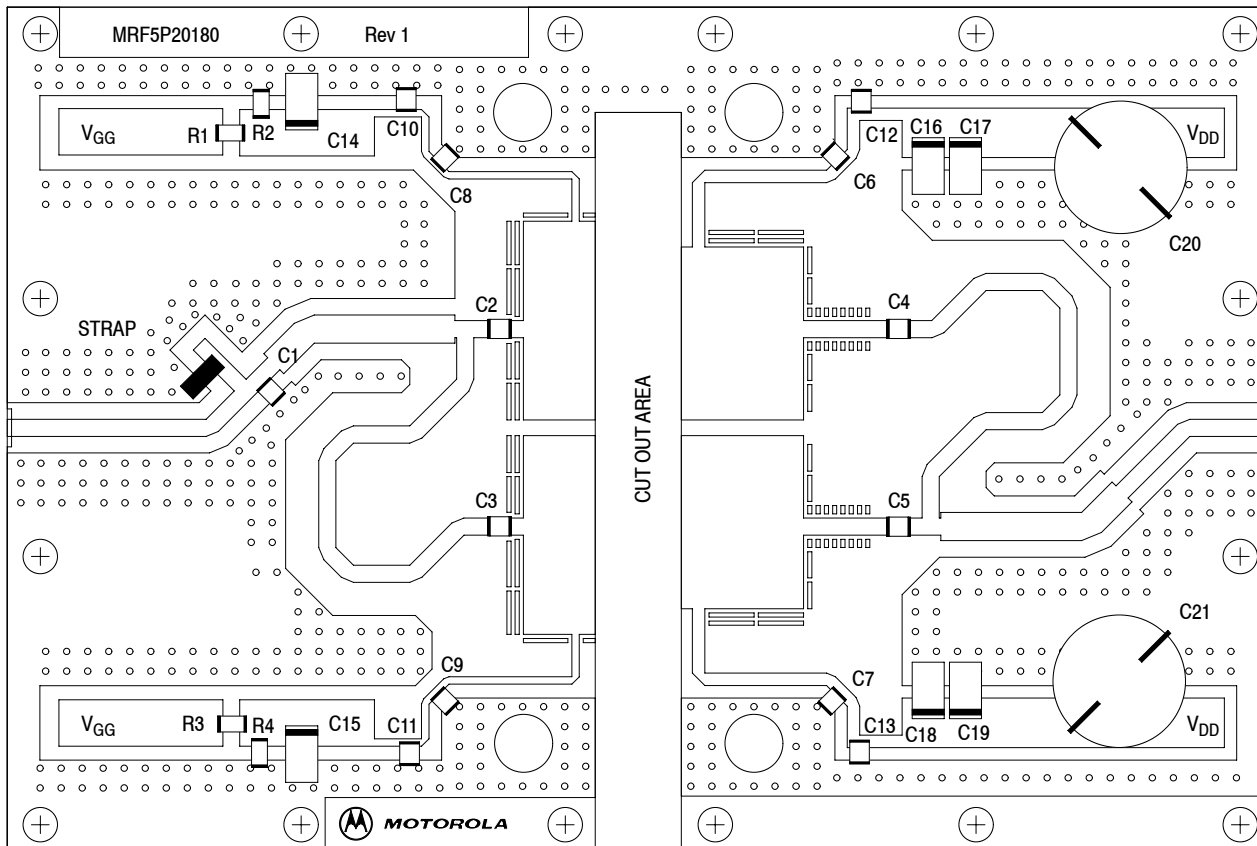


Z1	0.081" x 1.126" Microstrip	Z11, Z12	0.341" x 0.945" Microstrip
Z2	0.079" x 0.138" Microstrip	Z13, Z14	0.035" x 0.913" Microstrip
Z3	0.081" x 0.091" Microstrip	Z15, Z16	0.581" x 0.823" Microstrip
Z4	0.081" x 0.117" Microstrip	Z17, Z18	0.059" x 1.057" Microstrip
Z5, Z24	0.134" x 0.874" Microstrip	Z19, 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. MRF5P20180HR6 Test Circuit Schematic

Table 5. MRF5P20180HR6 Test Circuit Component Designations and Values

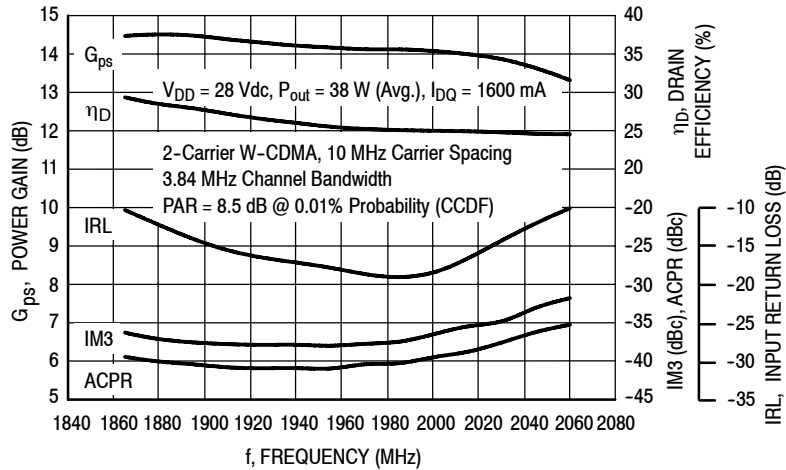
Part	Description	Part Number	Manufacturer
C1	1.8 pF 100B Chip Capacitor	ATC100B1R8BT500XT	ATC
C2, C3, C4, C5, C6, C7	10 pF 100B Chip Capacitors	ATC100B100GT500XT	ATC
C8, C9	6.8 pF 100B Chip Capacitors	ATC100B6R8CT500XT	ATC
C10, C11, C12, C13	10 nF 200B Chip Capacitors	ATC200B103MT500XT	ATC
C14, C15, C16, C17, C18, C19	22 $\mu$ F, 35 V Tantalum Capacitors	TAJE226M035S	AVX
C20, C21	220 $\mu$ F, 63 V Electrolytic Capacitors	EMVY630GTR221MLH0S	Nippon Chemi-Con
R1, R2, R3, R4	10 k $\Omega$ , 1/4 W Chip Resistors	CRCW12061002FKEA	Vishay



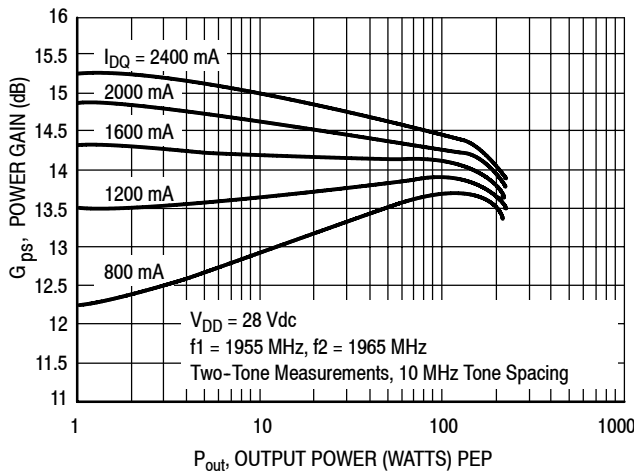
Freescall has begun the transition of marking Printed Circuit Boards (PCBs) with the Freescall Semiconductor signature/logo. PCBs may have either Motorola or Freescall markings during the transition period. These changes will have no impact on form, fit or function of the current product.

**Figure 2. MRF5P20180HR6 Test Circuit Component Layout**

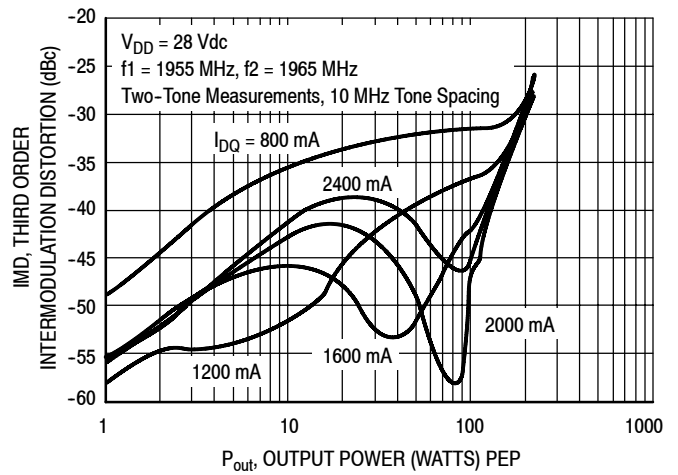
### TYPICAL CHARACTERISTICS



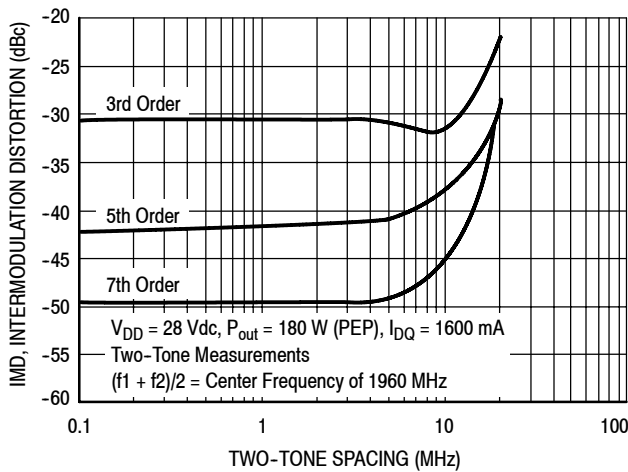
**Figure 3. 2-Carrier W-CDMA Broadband Performance @ P<sub>out</sub> = 38 Watts Avg.**



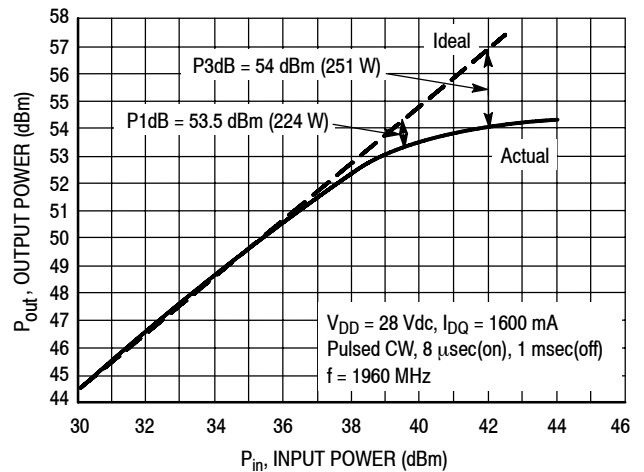
**Figure 4. Two-Tone Power Gain versus Output Power**



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



**Figure 6. Intermodulation Distortion Products versus Tone Spacing**

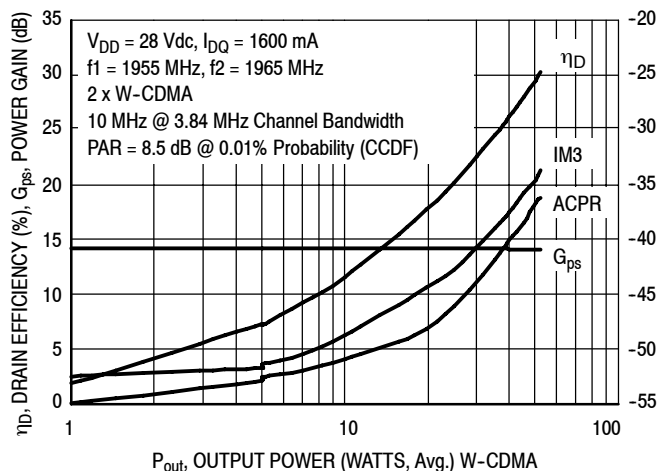


**Figure 7. Pulse CW Output Power versus Input Power**

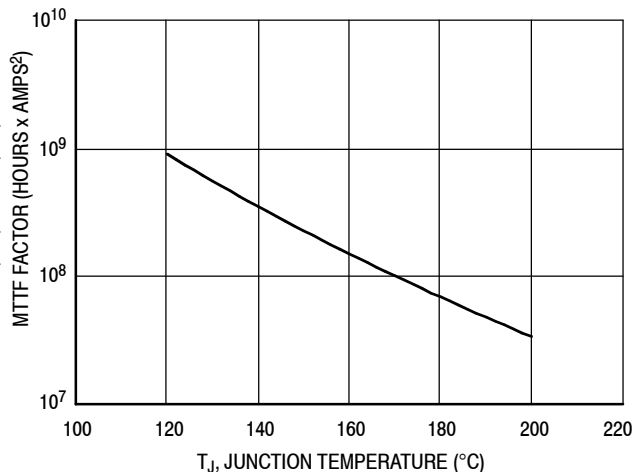
ARCHIVE INFORMATION

ARCHIVE INFORMATION

## TYPICAL CHARACTERISTICS



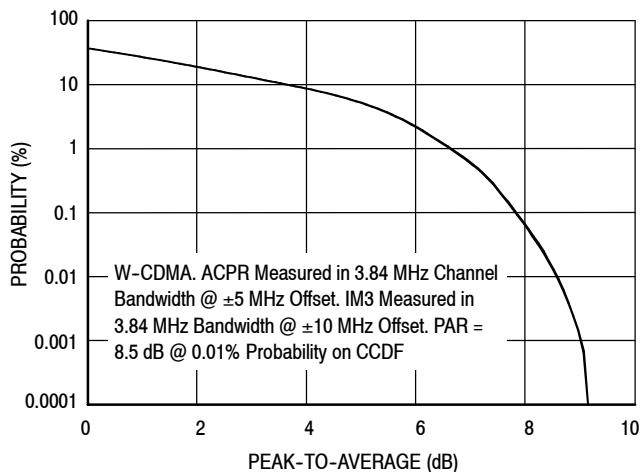
**Figure 8. 2-Carrier W-CDMA ACPR, IM3, Power Gain and Drain Efficiency versus Output Power**



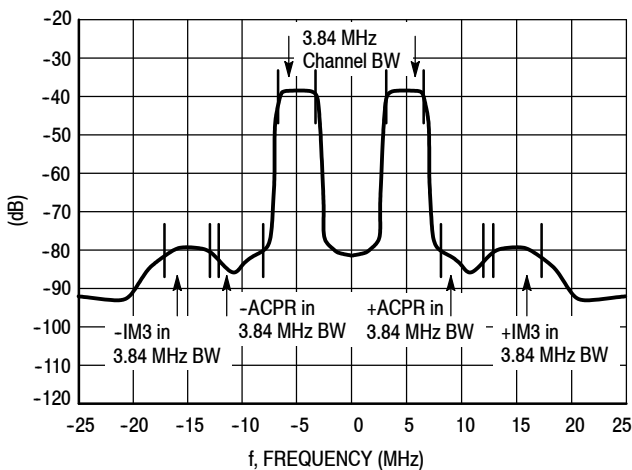
This above graph displays calculated MTTF in hours x ampere<sup>2</sup> drain current. Life tests at elevated temperatures have correlated to better than  $\pm 10\%$  of the theoretical prediction for metal failure. Divide MTTF factor by  $I_D^2$  for MTTF in a particular application.

**Figure 9. MTTF Factor versus Junction Temperature**

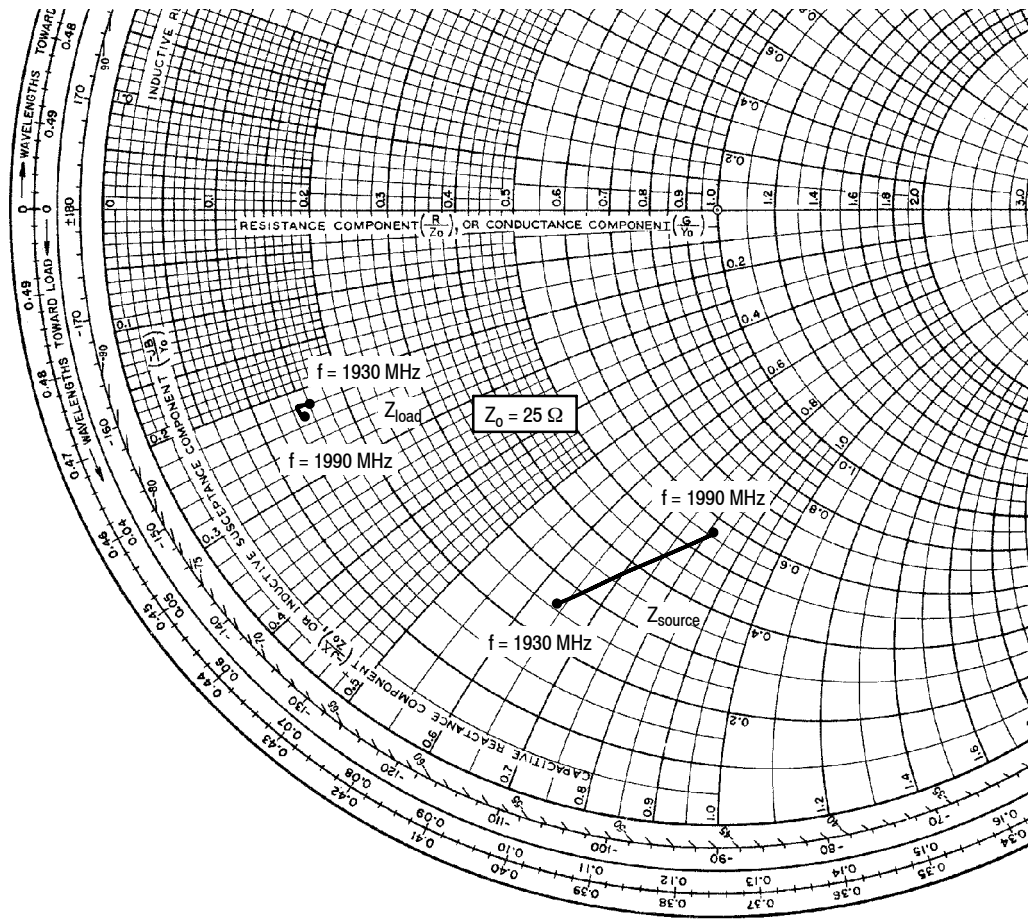
## W-CDMA TEST SIGNAL



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



**Figure 11. 2-Carrier W-CDMA Spectrum**



$V_{DD} = 28\text{ V}$ ,  $I_{DQ} = 1600\text{ mA}$ ,  $P_{out} = 38\text{ W Avg.}$

f MHz	Z <sub>source</sub> Ω	Z <sub>load</sub> Ω
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<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.

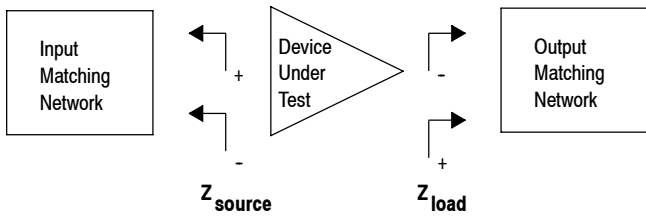
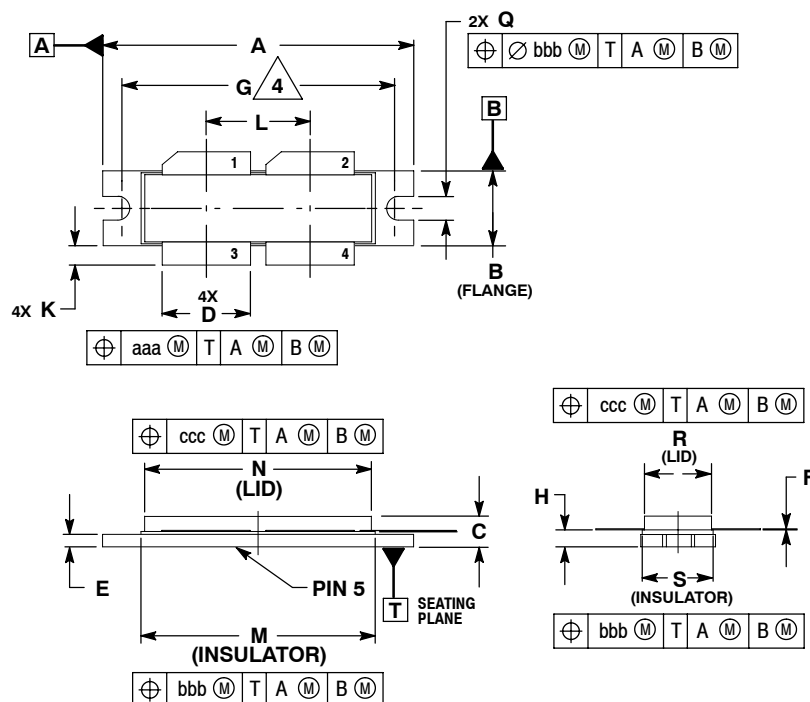


Figure 12. Series Equivalent Source and Load Impedance

### 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



## REVISION HISTORY

The following table summarizes revisions to this document.

Revision	Date	Description
2	Oct. 2008	<ul style="list-style-type: none"> <li>• Modified data sheet to reflect RF Test Reduction described in Product and Process Change Notification number, PCN12779, p. 1, 2</li> <li>• Updated Part Numbers in Table 5, Component Designations and Values, to RoHS compliant part numbers, p. 3</li> <li>• Added Revision History, p. 9</li> <li>• Data sheet archived. Part no longer manufactured.</li> </ul>

ARCHIVE INFORMATION

ARCHIVE INFORMATION

**How to Reach Us:****Home Page:**

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

**Web Support:**

<http://www.freescale.com/support>

**USA/Europe or Locations Not Listed:**

Freescale Semiconductor, Inc.  
Technical Information Center, EL516  
2100 East Elliot Road  
Tempe, Arizona 85284  
1-800-521-6274 or +1-480-768-2130  
[www.freescale.com/support](http://www.freescale.com/support)

**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)  
[www.freescale.com/support](http://www.freescale.com/support)

**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 China Ltd.  
Exchange Building 23F  
No. 118 Jianguo Road  
Chaoyang District  
Beijing 100022  
China  
+86 10 5879 8000  
[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 +1-303-675-2140  
Fax: +1-303-675-2150  
[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. 2008. All rights reserved.