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# RF Power Field Effect Transistors

## N-Channel Enhancement-Mode Lateral MOSFETs

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.

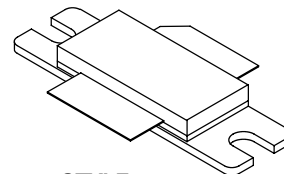
- Typical 2-carrier W-CDMA Performance:  $V_{DD} = 28$  Volts,  $I_{DQ} = 1050$  mA,  $P_{out} = 23$  Watts Avg.,  $f = 2167.5$  MHz, Channel Bandwidth = 3.84 MHz, PAR = 8.5 dB @ 0.01% Probability on CCDF.  
Power Gain — 13.5 dB  
Drain Efficiency — 26%  
IM3 @ 10 MHz Offset — -37 dBc in 3.84 MHz Channel Bandwidth  
ACPR @ 5 MHz Offset — -40 dBc in 3.84 MHz Channel Bandwidth
- Capable of Handling 10:1 VSWR, @ 28 Vdc, 2140 MHz, 100 Watts CW Output Power

### Features

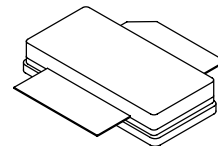
- Characterized with Series Equivalent Large-Signal Impedance Parameters
- Internally Matched for Ease of Use
- Qualified Up to a Maximum of 32  $V_{DD}$  Operation
- Integrated ESD Protection
- Lower Thermal Resistance Package
- Low Gold Plating Thickness on Leads, 40 $\mu$ m Nominal.
- RoHS Compliant
- In Tape and Reel. R3 Suffix = 250 Units per 56 mm, 13 inch Reel.

**MRF5S21100HR3**  
**MRF5S21100HSR3**

**2110-2170 MHz, 23 W AVG., 28 V**  
**2 x W-CDMA**  
**LATERAL N-CHANNEL**  
**RF POWER MOSFETs**



**CASE 465-06, STYLE 1**  
**NI-780**  
**MRF5S21100HR3**



**CASE 465A-06, STYLE 1**  
**NI-780S**  
**MRF5S21100HSR3**

**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 $^\circ\text{C}$	$P_D$	273 1.56	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 (1,2)	Unit
Thermal Resistance, Junction to Case Case Temperature 80 $^\circ\text{C}$ , 100 W CW Case Temperature 78 $^\circ\text{C}$ , 23 W CW	$R_{\theta JC}$	0.57 0.64	$^\circ\text{C}/\text{W}$

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** ( $T_A = 25^\circ\text{C}$  unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
<b>Off Characteristics</b>					
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 ( $V_{DS} = 28\text{ Vdc}$ , $V_{GS} = 0\text{ Vdc}$ )	$I_{DSS}$	—	—	1	$\mu\text{Adc}$
Gate-Source Leakage Current ( $V_{GS} = 5\text{ Vdc}$ , $V_{DS} = 0\text{ Vdc}$ )	$I_{GSS}$	—	—	0.5	$\mu\text{Adc}$

**On Characteristics (DC)**

Gate Threshold Voltage ( $V_{DS} = 10\text{ Vdc}$ , $I_D = 250\ \mu\text{Adc}$ )	$V_{GS(th)}$	2.5	2.8	3.5	Vdc
Gate Quiescent Voltage ( $V_{DS} = 28\text{ Vdc}$ , $I_D = 1050\text{ mAdc}$ )	$V_{GS(Q)}$	—	3.8	—	Vdc
Drain-Source On-Voltage ( $V_{GS} = 10\text{ Vdc}$ , $I_D = 2.5\text{ Adc}$ )	$V_{DS(on)}$	—	0.24	0.3	Vdc
Forward Transconductance ( $V_{DS} = 10\text{ Vdc}$ , $I_D = 2.5\text{ Adc}$ )	$g_{fs}$	—	6	—	S

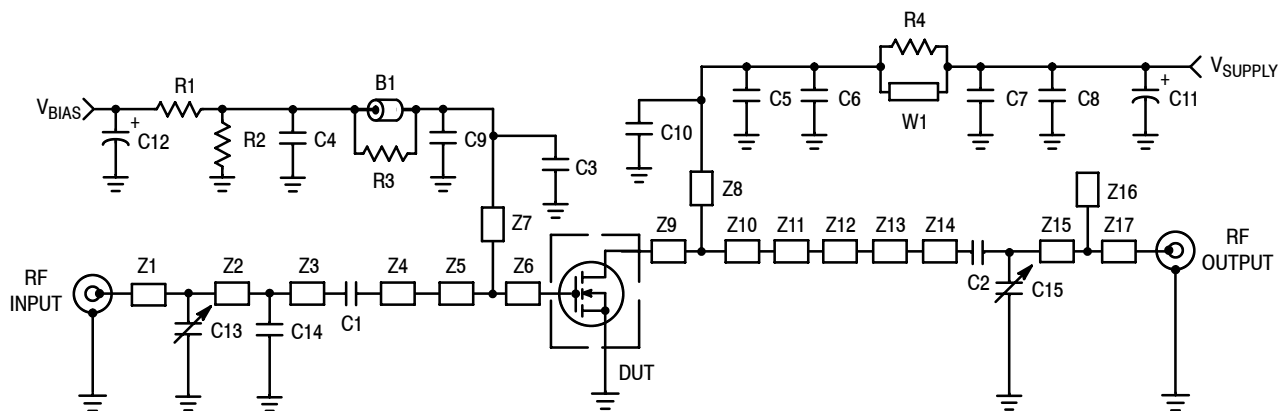
**Dynamic Characteristics (1)**

Reverse Transfer Capacitance ( $V_{DS} = 28\text{ Vdc} \pm 30\text{ mV(rms)ac}$ @ 1 MHz, $V_{GS} = 0\text{ Vdc}$ )	$C_{rss}$	—	2.14	—	pF
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**Functional Tests** (In Freescale Test Fixture, 50 ohm system)  $V_{DD} = 28\text{ Vdc}$ ,  $I_{DQ} = 1050\text{ mA}$ ,  $P_{out} = 23\text{ W Avg.}$ ,  $f_1 = 2157.5\text{ MHz}$ ,  $f_2 = 2167.5\text{ MHz}$ , 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 Bandwidth @  $\pm 10\text{ MHz}$  Offset. PAR = 8.5 dB @ 0.01% Probability on CCDF.

Power Gain	$G_{ps}$	12.5	13.5	—	dB
Drain Efficiency	$\eta_D$	24	26	—	%
Intermodulation Distortion	IM3	—	-37	-35	dBc
Adjacent Channel Power Ratio	ACPR	—	-40	-38	dBc
Input Return Loss	IRL	—	-16	-9	dB

1. Part is internally matched both on input and output.

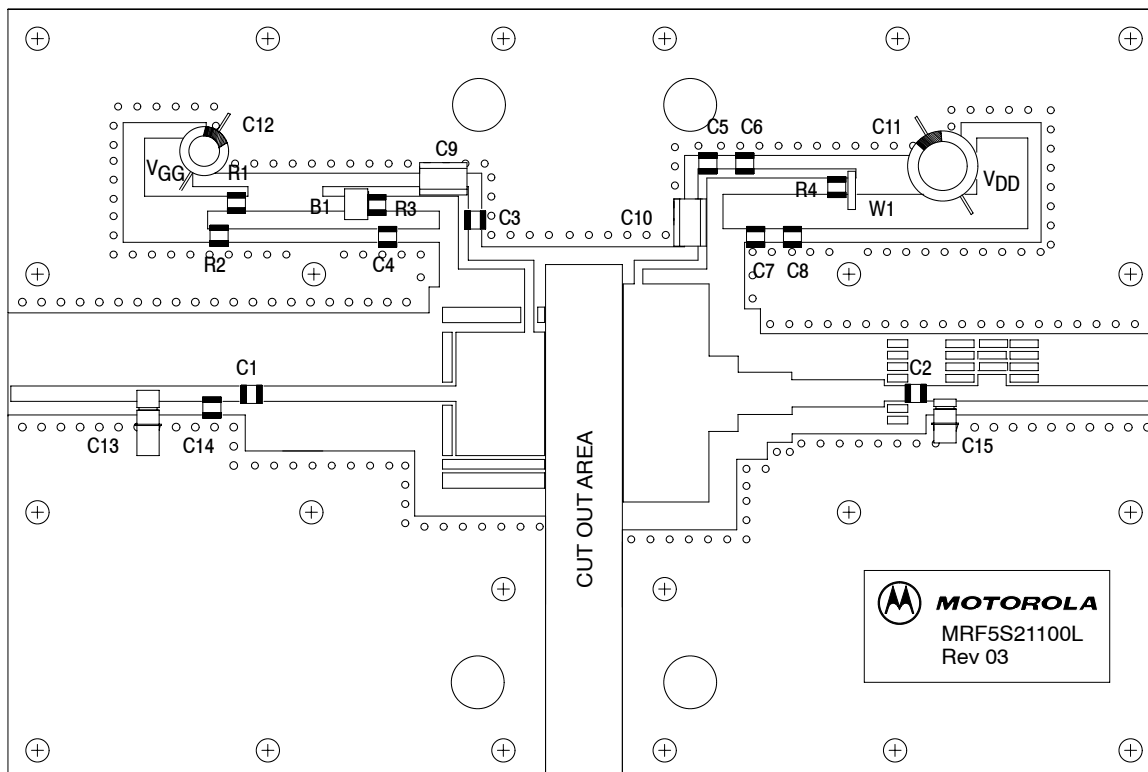


Z1	0.674" x 0.080" Microstrip	Z10	0.368" x 1.136" Microstrip
Z2	0.421" x 0.080" Microstrip	Z11	0.151" x 0.393" Microstrip
Z3	0.140" x 0.080" Microstrip	Z12	0.280" x 0.220" Microstrip
Z4	1.031" x 0.080" Microstrip	Z13	0.481" x 0.142" Microstrip
Z5	0.380" x 0.643" Microstrip	Z14	0.138" x 0.080" Microstrip
Z6	0.080" x 0.643" Microstrip	Z15	0.344" x 0.080" Microstrip
Z7	0.927" x 0.048" Microstrip	Z16	0.147" x 0.099" Microstrip
Z8	0.620" x 0.048" Microstrip	Z17	0.859" x 0.080" Microstrip
Z9	0.079" x 1.136" Microstrip	PCB	Arlon GX-0300-SS-22, 0.030", $\epsilon_r = 2.55$

Figure 1. MRF5S21100HR3(SR3) Test Circuit Schematic

Table 5. MRF5S21100HR3(SR3) Test Circuit Component Designations and Values

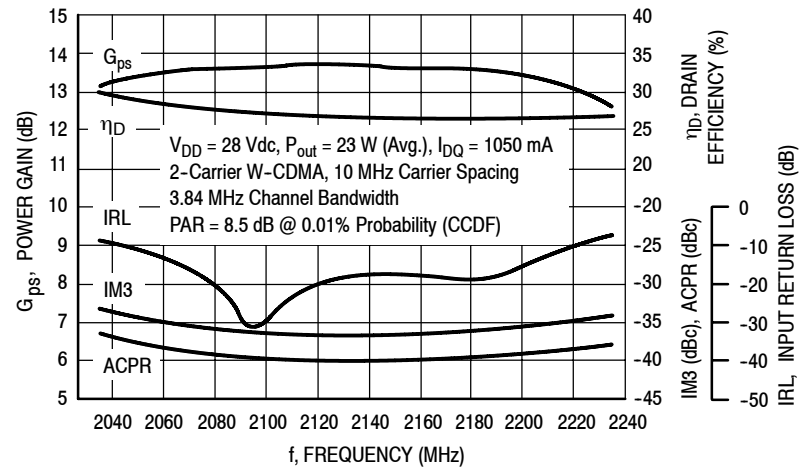
Part	Description	Part Number	Manufacturer
B1	Short RF Bead	2743019447	Fair-Rite
C1, C2	8.2 pF Chip Capacitors	ATC100B8R2CT500XT	ATC
C3	5.6 pF Chip Capacitor	ATC100B5R6CT500XT	ATC
C4	0.1 $\mu$ F Chip Capacitor	C1210C104J5RAC	Kemet
C5, C7	7.5 pF Chip Capacitors	ATC100B7R5JT500XT	ATC
C6	1.2 pF Chip Capacitor	ATC100B1R2BT500XT	ATC
C8	1K pF Chip Capacitor	ATC100B102JT500XT	ATC
C9, C10	0.56 $\mu$ F Chip Capacitors	C1825C564J5RAC	Kemet
C11	470 $\mu$ F, 63 V Electrolytic Capacitor	EKME630ELL471MK25S	Multicomp
C12	100 $\mu$ F, 50 V Electrolytic Capacitor	MCHT101M1HB-1017-RH	Multicomp
C13	0.6-4.5 pF Gigatrim Variable Capacitor	27271SL	Johanson
C14	2.7 pF Chip Capacitor	ATC100B2R7CT500XT	ATC
C15	0.4-2.5 pF Gigatrim Variable Capacitor	27271SL	Johanson
R1	1 k $\Omega$ , 1/4 W Chip Resistor	CRCW12061001FKEA	Vishay
R2	560 k $\Omega$ , 1/4 W Chip Resistor	CRCW12065600FKEA	Vishay
R3, R4	12 $\Omega$ , 1/4 W Chip Resistors	CRCW120612R0FKEA	Vishay



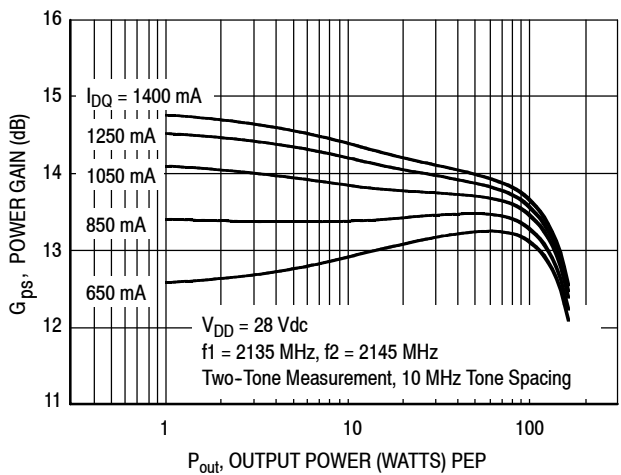
Freescale has begun the transition of marking Printed Circuit Boards (PCBs) with the Freescale Semiconductor signature/logo. PCBs may have either Motorola or Freescale markings during the transition period. These changes will have no impact on form, fit or function of the current product.

**Figure 2. MRF5S21100HR3(SR3) Test Circuit Component Layout**

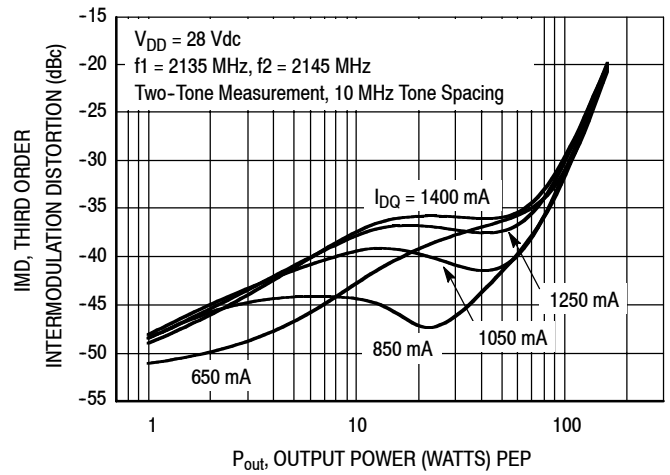
### TYPICAL CHARACTERISTICS



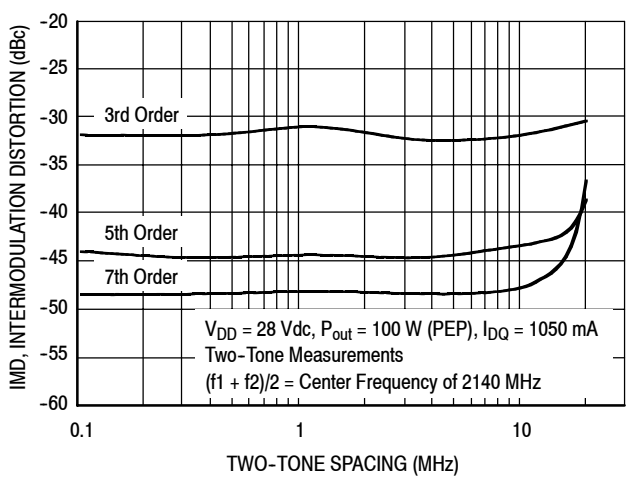
**Figure 3. 2-Carrier W-CDMA Broadband Performance**



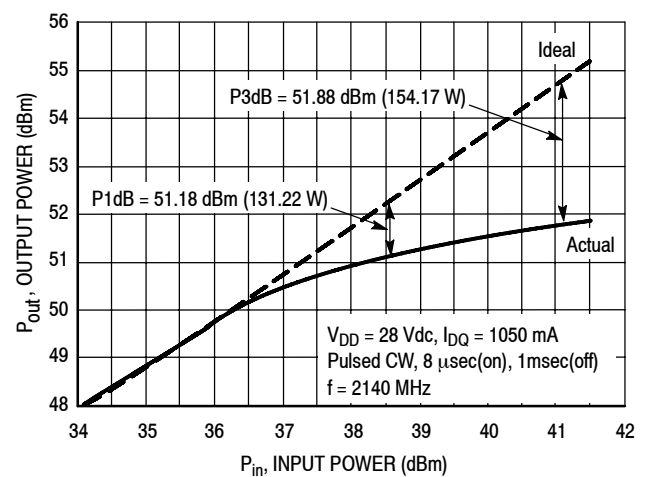
**Figure 4. Two-Tone Power Gain versus Output Power**



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



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

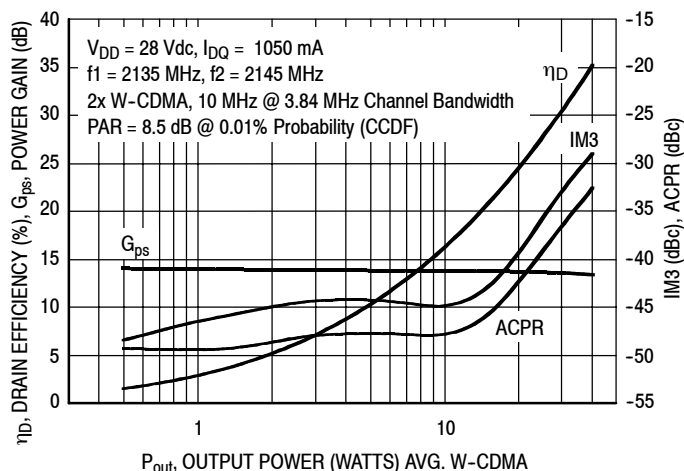


**Figure 7. Pulse CW Output Power versus Input Power**

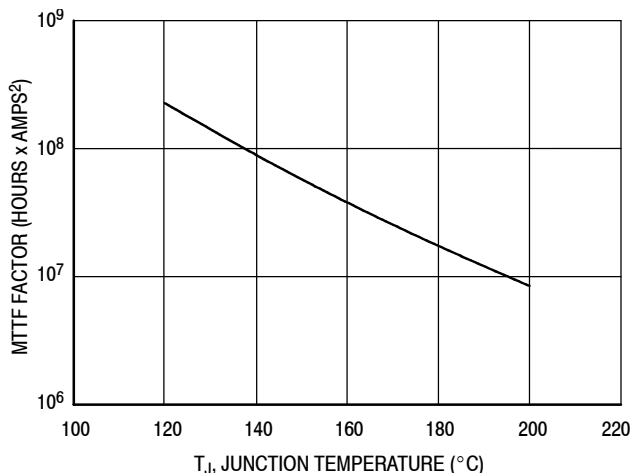
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### TYPICAL CHARACTERISTICS



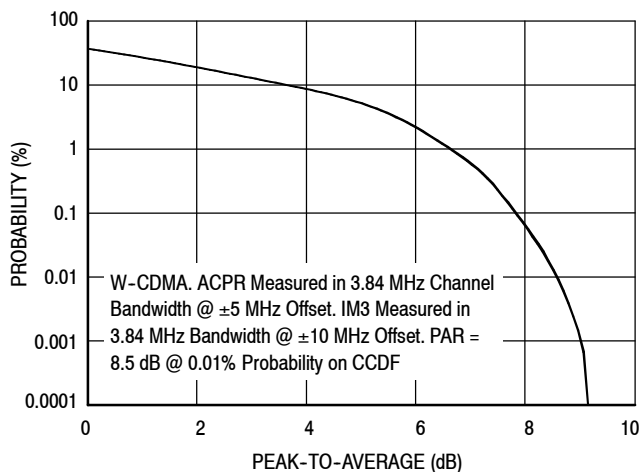
**Figure 8. 2-Carrier W-CDMA ACPR, IM3, Power Gain and Drain Efficiency versus Output Power**



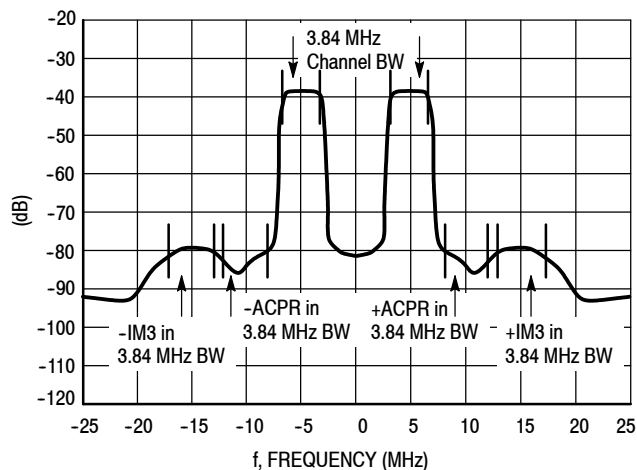
This above graph displays calculated MTTF in hours x ampere<sup>2</sup> drain current. Life tests at elevated temperatures have correlated to better than ±10% of the theoretical prediction for metal failure. Divide MTTF factor by  $I_D^2$  for MTTF in a particular application.

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

### W-CDMA TEST SIGNAL



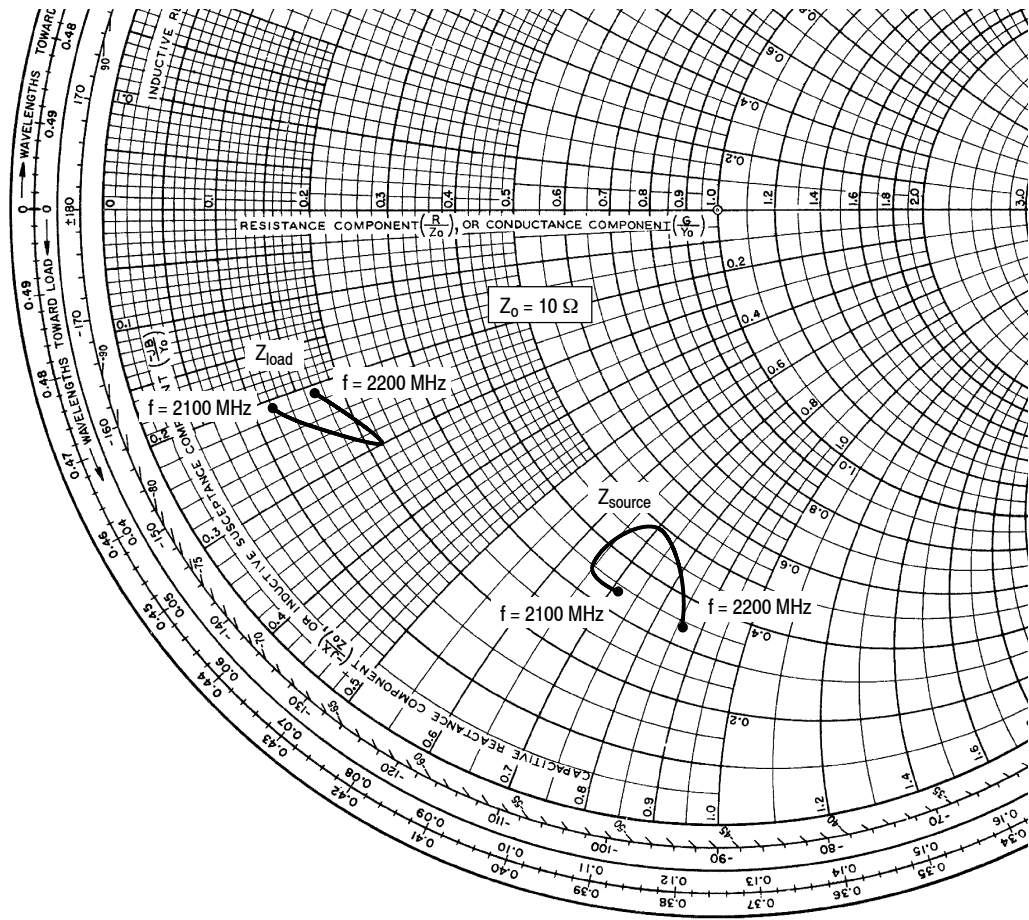
**Figure 10. CCDF W-CDMA 3GPP, Test Model 1, 64 DPCH, 67% Clipping, Single Carrier Test Signal**



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

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$V_{DD} = 28 \text{ Vdc}$ ,  $I_{DQ} = 1050 \text{ mA}$ ,  $P_{out} = 23 \text{ W Avg.}$

f MHz	Z <sub>source</sub> Ω	Z <sub>load</sub> Ω
2100	3.4 - j7.2	1.2 - j2.1
2120	3.4 - j6.5	1.4 - j2.3
2160	4.9 - j7.0	2.2 - j3.0
2200	3.4 - j8.6	1.7 - j2.1

Z<sub>source</sub> = Test circuit impedance as measured from gate to ground.

Z<sub>load</sub> = Test circuit impedance as measured from drain to ground.

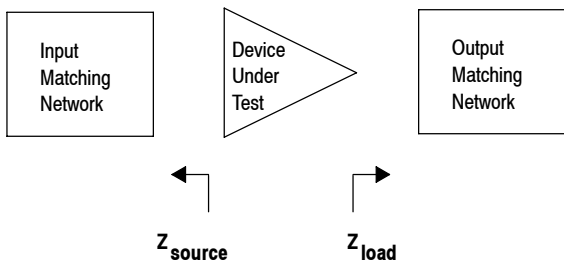
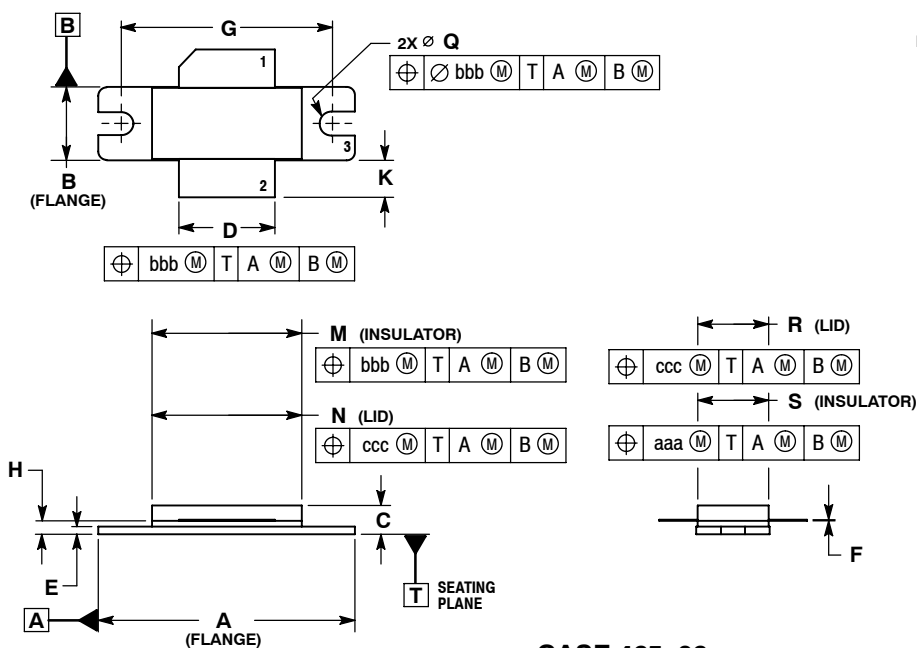


Figure 12. Series Equivalent Source and Load Impedance

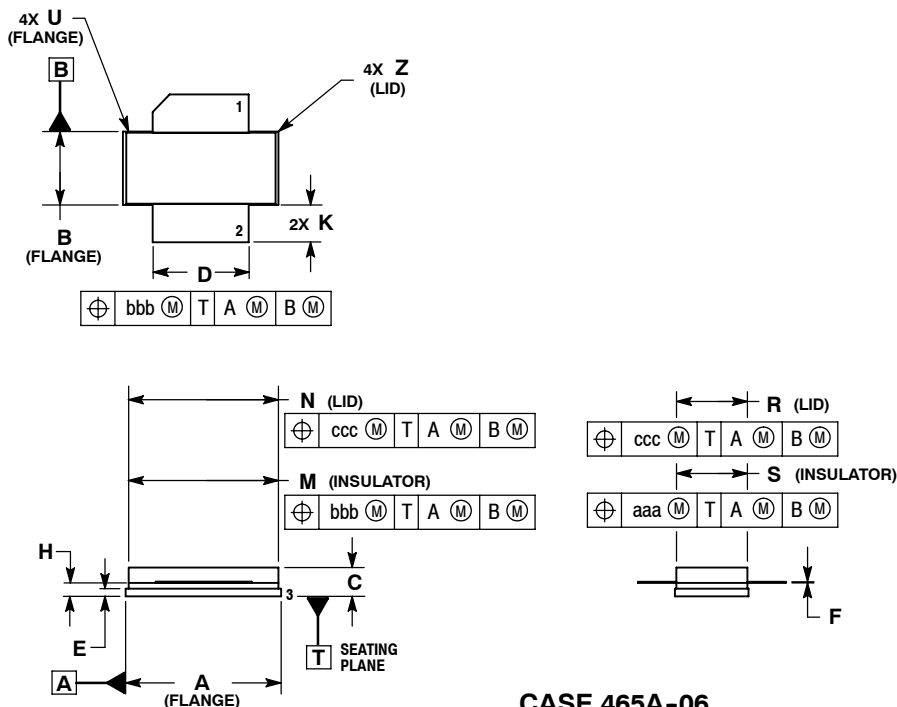


### PACKAGE DIMENSIONS



- NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M-1994.
  2. CONTROLLING DIMENSION: INCH.
  3. DELETED
  4. DIMENSION H IS MEASURED 0.030 (0.762) AWAY FROM PACKAGE BODY.

**CASE 465-06**  
**ISSUE G**  
**NI-780**  
**MRF5S21100HR3**



- NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M-1994.
  2. CONTROLLING DIMENSION: INCH.
  3. DELETED
  4. DIMENSION H IS MEASURED 0.030 (0.762) AWAY FROM PACKAGE BODY.

**CASE 465A-06**  
**ISSUE H**  
**NI-780S**  
**MRF5S21100HSR3**

- STYLE 1:
- PIN 1. DRAIN
  - GATE
  - SOURCE

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## REVISION HISTORY

The following table summarizes revisions to this document.

Revision	Date	Description
4	Dec. 2010	<ul style="list-style-type: none"> <li>• Data sheet revised to reflect part status change, p. 1, including use of applicable overlay.</li> <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. Parts no longer manufactured.</li> </ul>

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