

# RF Power Field Effect Transistors

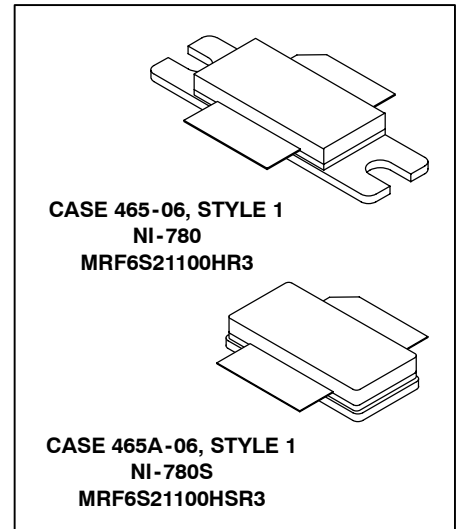
## N-Channel Enhancement-Mode Lateral MOSFETs

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 for  $V_{DD} = 28$  Volts,  $I_{DQ} = 950$  mA,  $P_{out} = 23$  Watts Avg., Full Frequency Band, Channel Bandwidth = 3.84 MHz, Peak/Avg. = 8.5 dB @ 0.01% Probability on CCDF.  
 Power Gain — 15.9 dB  
 Drain Efficiency — 27.6%  
 IM3 @ 10 MHz Offset — -37 dBc @ 3.84 MHz Channel Bandwidth  
 ACPR @ 5 MHz Offset — -39.5 dBc @ 3.84 MHz Channel Bandwidth
- Capable of Handling 10:1 VSWR, @ 28 Vdc, 2140 MHz, 100 Watts CW Output Power
- Characterized with Series Equivalent Large-Signal Impedance Parameters
- Internally Matched, Controlled Q, 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.
- In Tape and Reel. R3 Suffix = 250 Units per 56 mm, 13 inch Reel.

**MRF6S21100HR3**  
**MRF6S21100HSR3**

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



**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 $^\circ\text{C}$	$P_D$	388 2.2	W W/ $^\circ\text{C}$
Storage Temperature Range	$T_{stg}$	- 65 to +150	$^\circ\text{C}$
Operating Junction Temperature	$T_J$	200	$^\circ\text{C}$

**Table 2. Thermal Characteristics**

Characteristic	Symbol	Value (1)	Unit
Thermal Resistance, Junction to Case Case Temperature 80 $^\circ\text{C}$ , 100 W CW Case Temperature 77 $^\circ\text{C}$ , 23 W CW	$R_{\theta JC}$	0.45 0.52	$^\circ\text{C}/\text{W}$

1. Refer to AN1955/D, *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-G)	3A (Minimum)
Machine Model (per EIA/JESD22-A115-A)	A (Minimum)
Charge Device Model (per JESD22-C101-A)	IV (Minimum)

**Table 4. Electrical Characteristics** ( $T_C = 25^\circ\text{C}$  unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
<b>Off Characteristics</b>					
Zero Gate Voltage Drain Leakage Current ( $V_{DS} = 68\text{ Vdc}$ , $V_{GS} = 0\text{ Vdc}$ )	$I_{DSS}$	—	—	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 ( $V_{GS} = 5\text{ Vdc}$ , $V_{DS} = 0\text{ Vdc}$ )	$I_{GSS}$	—	—	1	$\mu\text{Adc}$

**On Characteristics**

Gate Threshold Voltage ( $V_{DS} = 10\text{ Vdc}$ , $I_D = 200\ \mu\text{Adc}$ )	$V_{GS(th)}$	1	2	3	Vdc
Gate Quiescent Voltage ( $V_{DS} = 28\text{ Vdc}$ , $I_D = 950\ \text{mAdc}$ )	$V_{GS(Q)}$	2	2.8	4	Vdc
Drain-Source On-Voltage ( $V_{GS} = 10\text{ Vdc}$ , $I_D = 2.2\ \text{Adc}$ )	$V_{DS(on)}$	—	0.21	0.3	Vdc
Forward Transconductance ( $V_{DS} = 10\text{ Vdc}$ , $I_D = 2\ \text{Adc}$ )	$g_{fs}$	—	5.3	—	S

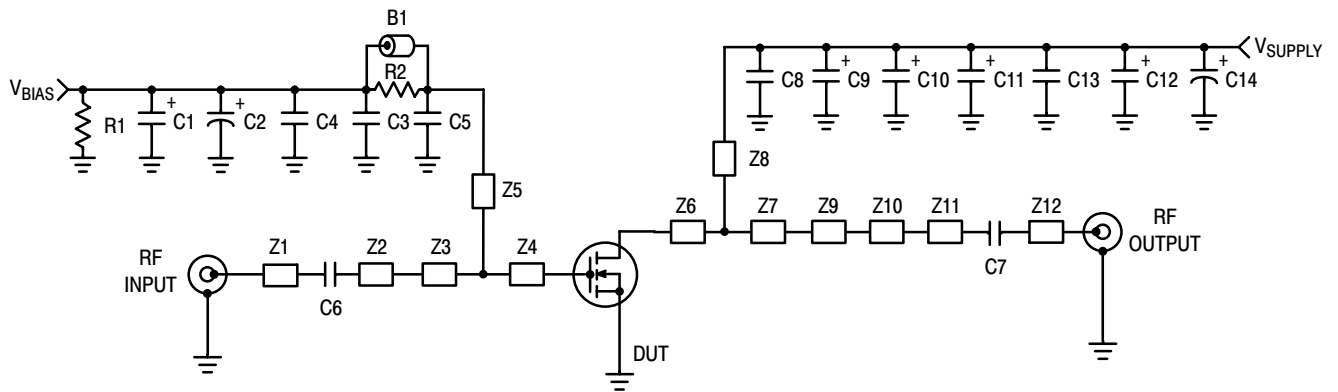
**Dynamic Characteristics** <sup>(1)</sup>

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
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**Functional Tests** (In Freescale Test Fixture, 50 ohm system)  $V_{DD} = 28\text{ Vdc}$ ,  $I_{DQ} = 950\ \text{mA}$ ,  $P_{out} = 23\ \text{W Avg.}$ ,  $f_1 = 2112.5\ \text{MHz}$ ,  $f_2 = 2122.5\ \text{MHz}$  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. Peak/Avg. = 8.5 dB @ 0.01% Probability on CCDF.

Power Gain	$G_{ps}$	15	15.9	17	dB
Drain Efficiency	$\eta_D$	26	27.6	—	%
Intermodulation Distortion	IM3	—	-37	-35	dBc
Adjacent Channel Power Ratio	ACPR	—	-39.5	-38	dBc
Input Return Loss	IRL	—	-16	-9	dB

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



Z1, Z12	1.250" x 0.084" Microstrip	Z7	0.320" x 0.880" Microstrip
Z2	1.070" x 0.084" Microstrip	Z8	0.120" x 0.820" Microstrip
Z3	0.330" x 0.800" Microstrip	Z9	0.035" x 0.320" Microstrip
Z4	0.093" x 0.800" Microstrip	Z10	0.335" x 0.200" Microstrip
Z5	1.255" x 0.040" Microstrip	Z11	0.650" x 0.084" Microstrip
Z6	0.160" x 0.880" Microstrip	PCB	Arlon GX-0300-55-22, 0.030", $\epsilon_r = 2.55$

**Figure 1. MRF6S21100HR3(SR3) Test Circuit Schematic**

**Table 5. MRF6S21100HR3(SR3) Test Circuit Component Designations and Values**

Part	Description	Part Number	Manufacturer
B1	Ferrite Bead	2743019447	Fair-Rite
C1	1.0 $\mu$ F, 50 V Tantalum Capacitor	T491C105M050	Kemet
C2	10 $\mu$ F, 50 V Electrolytic Capacitor	EEV-HB1H100P	Panasonic
C3	1000 pF 100B Chip Capacitor	100B102JCA500X	ATC
C4, C13	0.1 $\mu$ F 100B Chip Capacitors	CDR33BX104AKWS	Kemet
C5	5.1 pF Chip Capacitor	100B5R1JCA500X	ATC
C6, C7	15 pF Chip Capacitors	100B150JCA500X	ATC
C8	6.8 pF Chip Capacitors	100B6R8JCA500X	ATC
C9, C10, C11, C12	22 $\mu$ F, 35 V Tantalum Capacitors	T491X226K035AS4394	Kemet
C14	100 $\mu$ F, 50 V Electrolytic Capacitor	515D107M050BB6A	Vishay/Sprague
R1	1.0 k $\Omega$ , 1/8 W Chip Resistor		
R2	10 $\Omega$ , 1/8 W Chip Resistor		

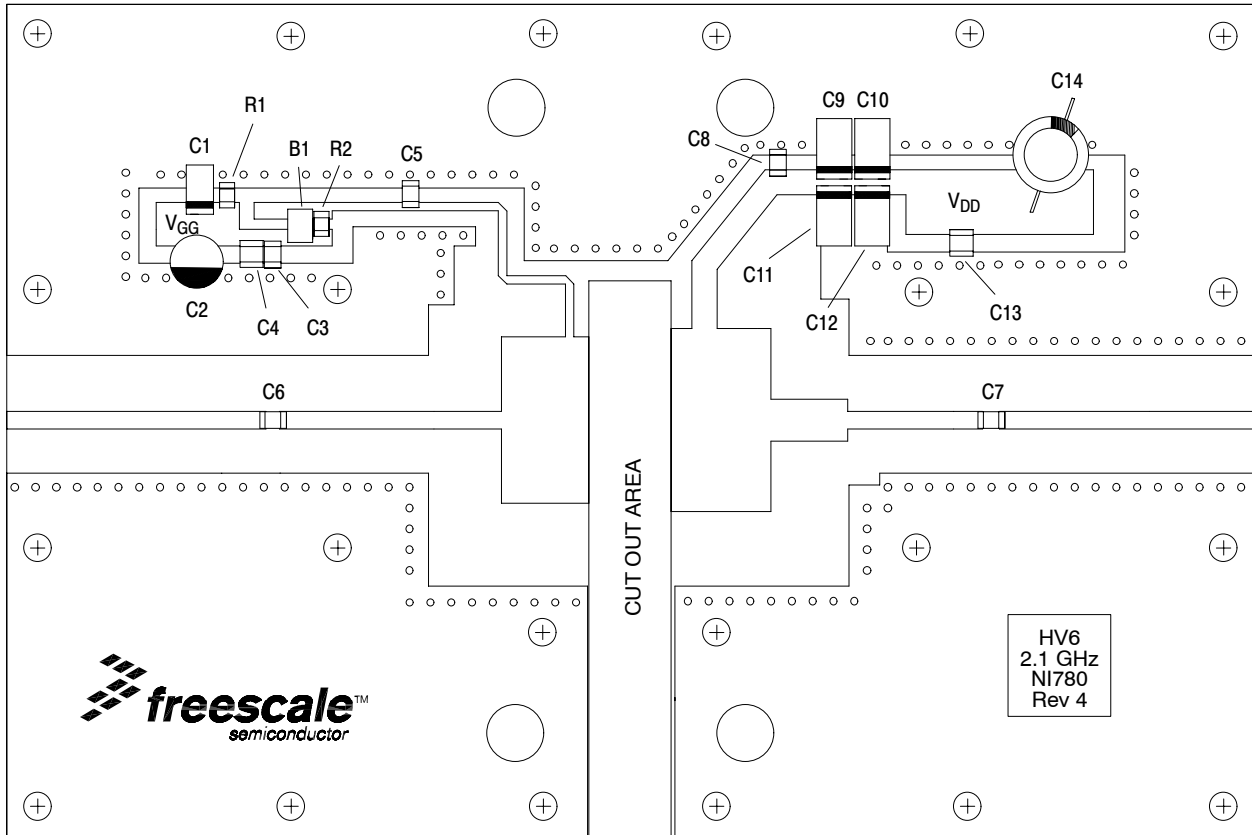


Figure 2. MRF6S21100HR3(SR3) Test Circuit Component Layout

## TYPICAL CHARACTERISTICS

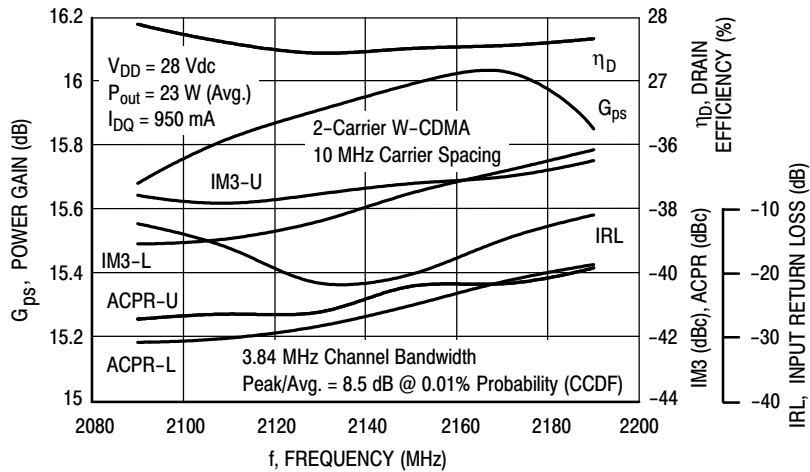


Figure 3. 2-Carrier W-CDMA Broadband Performance

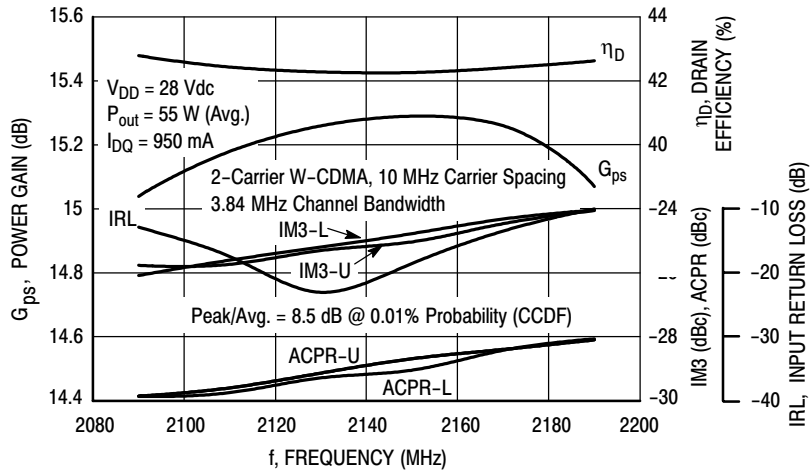


Figure 4. 2-Carrier W-CDMA Broadband Performance

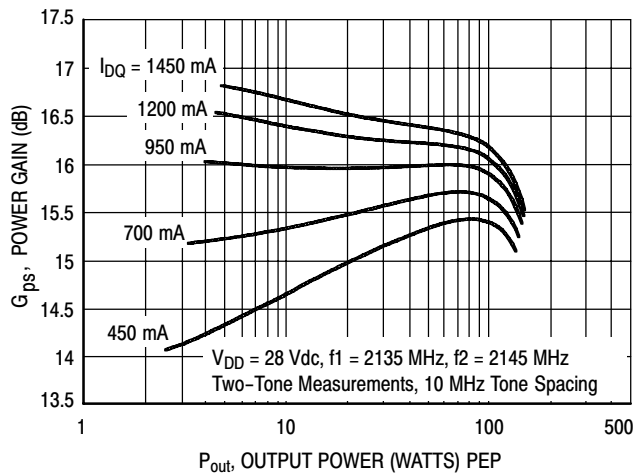


Figure 5. Two-Tone Power Gain versus Output Power

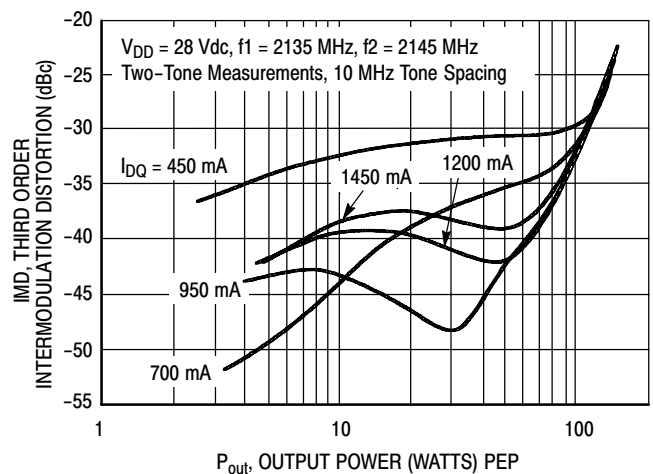
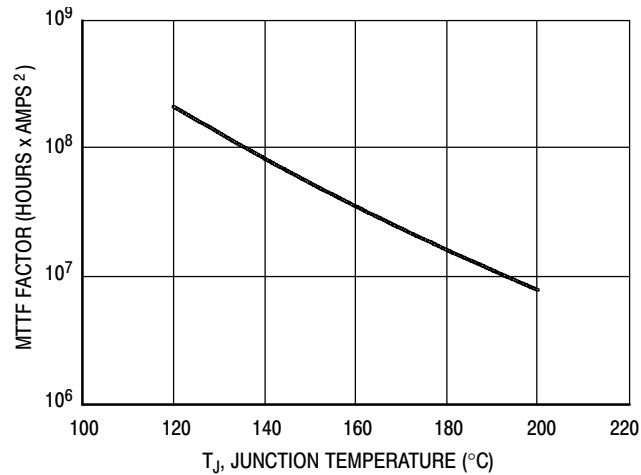


Figure 6. Third Order Intermodulation Distortion versus Output Power



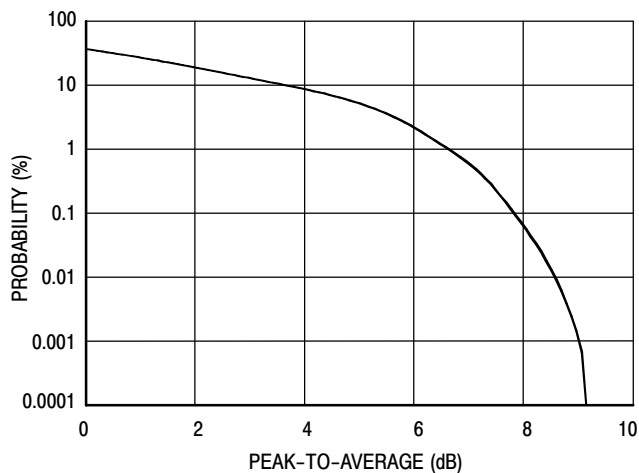
## TYPICAL CHARACTERISTICS



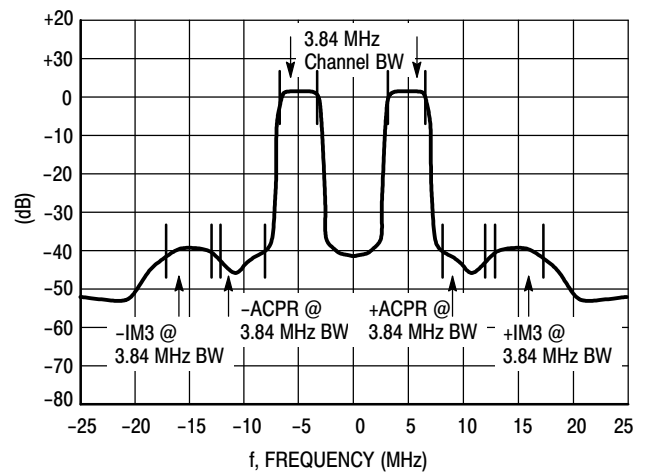
This above graph displays calculated MTTF in hours x ampere<sup>2</sup> drain current. Life tests at elevated temperatures have correlated to better than  $\pm 10\%$  of the theoretical prediction for metal failure. Divide MTTF factor by  $I_D^2$  for MTTF in a particular application.

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

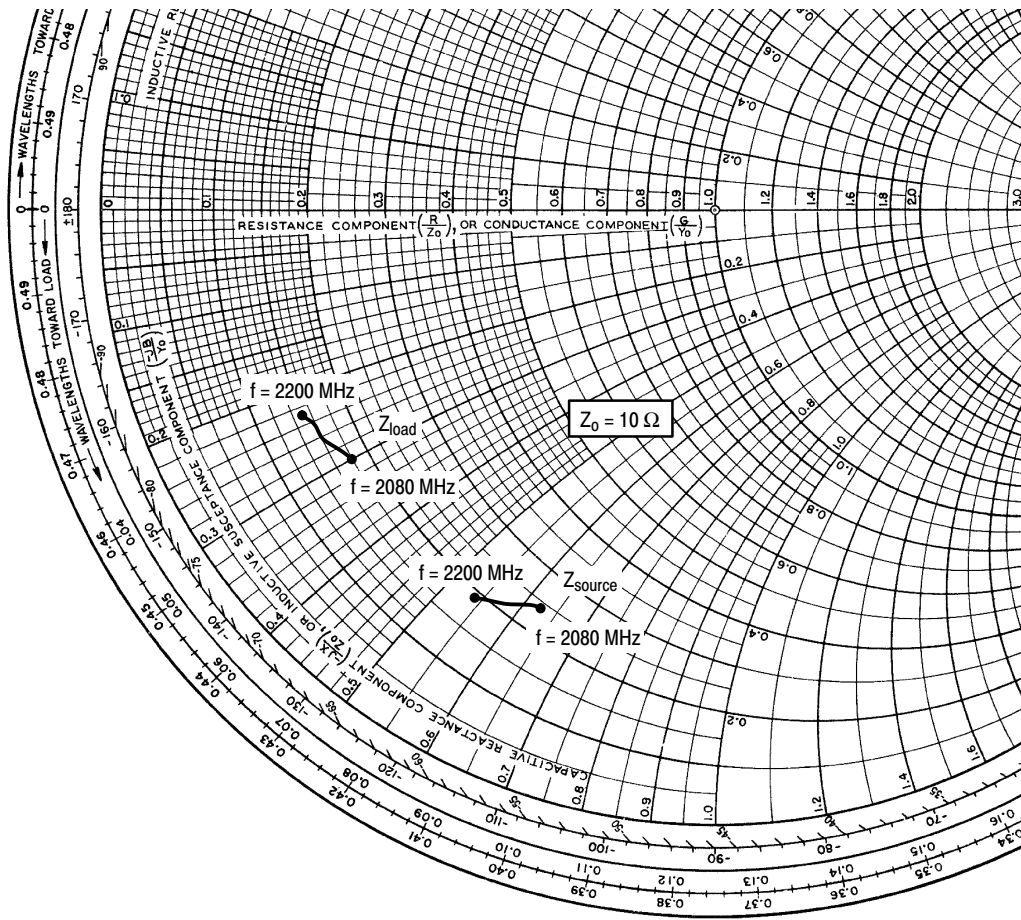
## TYPICAL CHARACTERISTICS W-CDMA TEST SIGNAL



**Figure 13. CCDF W-CDMA 3GPP, Test Model 1, 64 DPCH, 67% Clipping, Single-Carrier Test Signal**



**Figure 14. 2-Carrier W-CDMA Spectrum**



$V_{DD} = 28 \text{ Vdc}$ ,  $I_{DQ} = 950 \text{ mA}$ ,  $P_{out} = 23 \text{ W Avg.}$

f MHz	$Z_{source}$ $\Omega$	$Z_{load}$ $\Omega$
2080	$2.44 - j6.3$	$1.83 - j3.0$
2110	$2.25 - j6.1$	$1.74 - j2.8$
2140	$2.09 - j5.8$	$1.61 - j2.6$
2170	$1.98 - j5.6$	$1.59 - j2.5$
2200	$1.85 - j5.4$	$1.52 - j2.3$

$Z_{source}$  = Test circuit impedance as measured from gate to ground.

$Z_{load}$  = Test circuit impedance as measured from drain to ground.

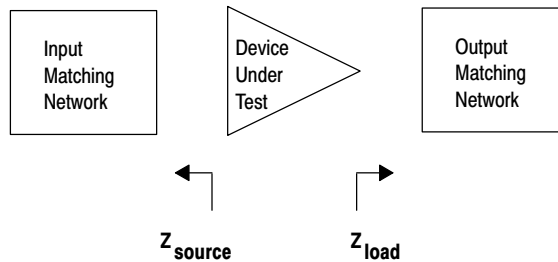


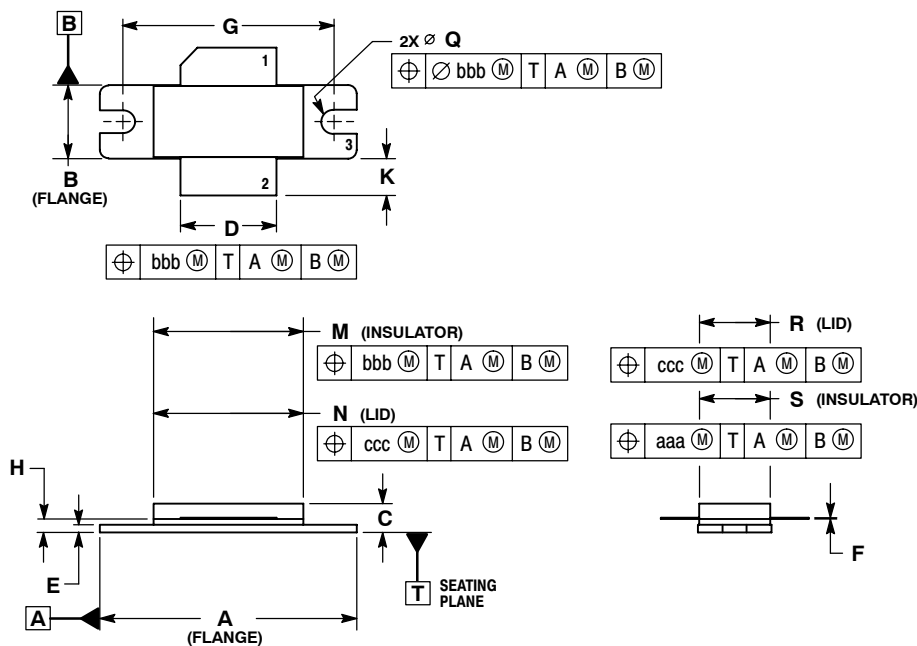
Figure 15. Series Equivalent Source and Load Impedance

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# NOTES

# NOTES

## PACKAGE DIMENSIONS

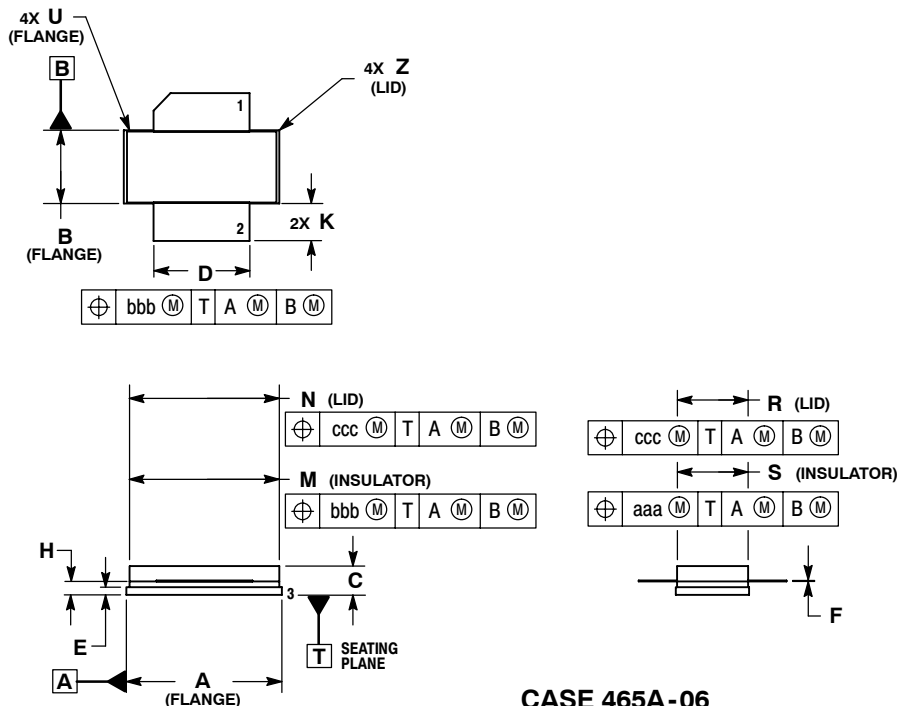


- NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M-1994.
  2. CONTROLLING DIMENSION: INCH.
  3. DELETED
  4. DIMENSION H IS MEASURED 0.030 (0.762) AWAY FROM PACKAGE BODY.

DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	1.335	1.345	33.91	34.16
B	0.380	0.390	9.65	9.91
C	0.125	0.170	3.18	4.32
D	0.495	0.505	12.57	12.83
E	0.035	0.045	0.89	1.14
F	0.003	0.006	0.08	0.15
G	1.100	BSC	27.94	BSC
H	0.057	0.067	1.45	1.70
K	0.170	0.210	4.32	5.33
M	0.774	0.786	19.66	19.96
N	0.772	0.788	19.60	20.00
Q	Ø 0.118	Ø 0.138	Ø 3.00	Ø 3.51
R	0.365	0.375	9.27	9.53
S	0.365	0.375	9.27	9.52
aaa	0.005	REF	0.127	REF
bbb	0.010	REF	0.254	REF
ccc	0.015	REF	0.381	REF

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

**CASE 465-06  
 ISSUE F  
 NI-780  
 MRF6S21100HR3**



- 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.

DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.805	0.815	20.45	20.70
B	0.380	0.390	9.65	9.91
C	0.125	0.170	3.18	4.32
D	0.495	0.505	12.57	12.83
E	0.035	0.045	0.89	1.14
F	0.003	0.006	0.08	0.15
H	0.057	0.067	1.45	1.70
K	0.170	0.210	4.32	5.33
M	0.774	0.786	19.61	20.02
N	0.772	0.788	19.61	20.02
R	0.365	0.375	9.27	9.53
S	0.365	0.375	9.27	9.52
U	---	0.040	---	1.02
Z	---	0.030	---	0.76
aaa	0.005	REF	0.127	REF
bbb	0.010	REF	0.254	REF
ccc	0.015	REF	0.381	REF

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

**CASE 465A-06  
 ISSUE F  
 NI-780S  
 MRF6S21100HSR3**

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