

# RF Power Field Effect Transistors

## N-Channel Enhancement-Mode Lateral MOSFETs

Designed for PCN and PCS base station applications with frequencies from 1900 to 2000 MHz. Suitable for TDMA, CDMA and multicarrier amplifier applications.

- Typical 2-Carrier N-CDMA Performance:  $V_{DD} = 28$  Volts,  $I_{DQ} = 1000$  mA,  $P_{out} = 22$  Watts Avg.,  $f = 1987.5$  MHz, IS-95 (Pilot, Sync, Paging, Traffic Codes 8 Through 13) Channel Bandwidth = 1.2288 MHz. PAR = 9.8 dB @ 0.01% Probability on CCDF.
  - Power Gain — 13.9 dB
  - Drain Efficiency — 25.5%
  - IM3 @ 2.5 MHz Offset — -36.5 dBc in 1.2288 MHz Channel Bandwidth
  - ACPR @ 885 kHz Offset — -50.7 dBc in 30 kHz Channel Bandwidth
- Capable of Handling 10:1 VSWR, @ 28 Vdc, 1960 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.

**MRF5S19100HR3**  
**MRF5S19100HSR3**

**1930-1990 MHz, 22 W AVG., 28 V**  
**2 x N-CDMA**  
**LATERAL N-CHANNEL**  
**RF POWER MOSFETs**

**CASE 465-06, STYLE 1**  
**NI-780**  
**MRF5S19100HR3**

**CASE 465A-06, STYLE 1**  
**NI-780S**  
**MRF5S19100HSR3**

**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 $^\circ\text{C}$	$P_D$	269 1.54	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)	Unit
Thermal Resistance, Junction to Case Case Temperature 75 $^\circ\text{C}$ , 100 W CW Case Temperature 70 $^\circ\text{C}$ , 22 W CW	$R_{\theta JC}$	0.64 0.65	$^\circ\text{C}/\text{W}$

1. Refer to AN1955, *Thermal Measurement Methodology of RF Power Amplifiers*. Go to <http://www.freescale.com/rf>.  
 Select Documentation/Application Notes - AN1955.

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**Table 3. ESD Protection Characteristics**

Test Conditions	Class
Human Body Model	2 (Minimum)
Machine Model	M3 (Minimum)
Charge Device Model	C7 (Minimum)

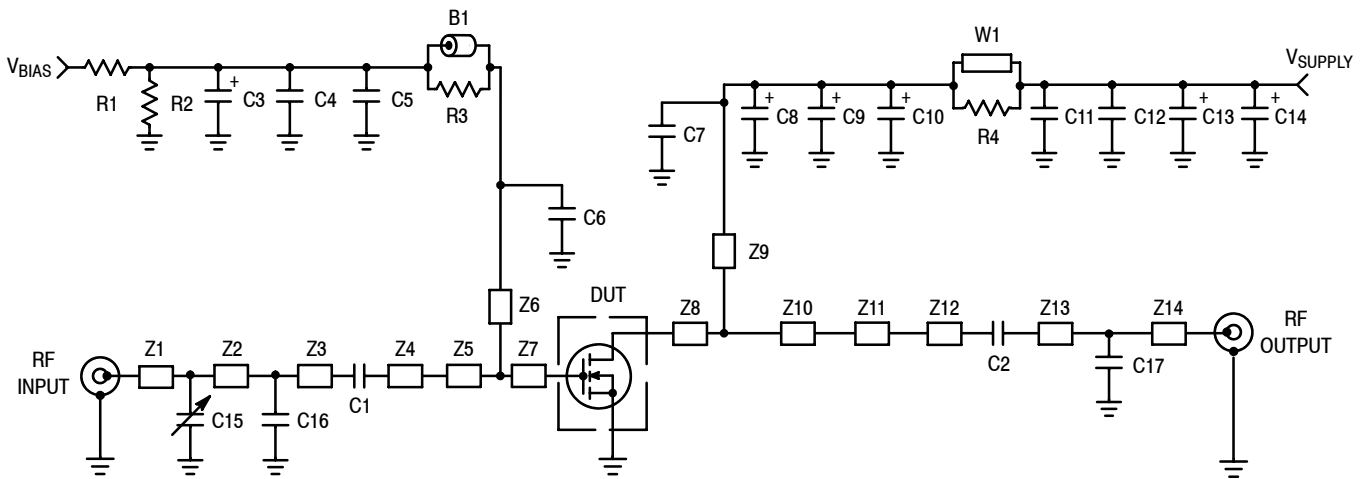
**Table 4. Electrical Characteristics** ( $T_A = 25^\circ\text{C}$  unless otherwise noted)

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 ( $V_{GS} = 5\text{ Vdc}$ , $V_{DS} = 0\text{ Vdc}$ )	$I_{GSS}$	—	—	1	$\mu\text{Adc}$
<b>On Characteristics (DC)</b>					
Gate Threshold Voltage ( $V_{DS} = 10\text{ Vdc}$ , $I_D = 240\ \mu\text{Adc}$ )	$V_{GS(th)}$	—	2.7	—	Vdc
Gate Quiescent Voltage ( $V_{DS} = 28\text{ Vdc}$ , $I_D = 1000\ \text{mAdc}$ )	$V_{GS(Q)}$	—	3.7	—	Vdc
Drain-Source On-Voltage ( $V_{GS} = 10\text{ Vdc}$ , $I_D = 2.4\ \text{Adc}$ )	$V_{DS(on)}$	—	0.26	—	Vdc
Forward Transconductance ( $V_{DS} = 10\text{ Vdc}$ , $I_D = 2.4\ \text{Adc}$ )	$g_{fs}$	—	6.3	—	S
<b>Dynamic Characteristics</b>					
Reverse Transfer Capacitance (1) ( $V_{DS} = 28\text{ Vdc}$ , $V_{GS} = 0$ , $f = 1.0\ \text{MHz}$ )	$C_{rss}$	—	2.2	—	pF

**Functional Tests** (In Freescale Test Fixture, 50 ohm system)  $V_{DD} = 28\text{ Vdc}$ ,  $I_{DQ} = 1000\ \text{mA}$ ,  $P_{out} = 22\ \text{W Avg.}$ ,  $f_1 = 1987.5\ \text{MHz}$ ,  $f_2 = 1990\ \text{MHz}$ , 2-Carrier N-CDMA, 1.2288 MHz Channel Bandwidth Carriers. ACPR measured in 30 kHz Bandwidth @  $\pm 885\ \text{kHz}$  Offset. IM3 measured in 1.2288 MHz Channel Bandwidth @  $\pm 2.5\ \text{MHz}$  Offset. PAR = 9.8 dB @ 0.01% Probability on CCDF.

Power Gain	$G_{ps}$	12.5	13.9	—	dB
Drain Efficiency	$\eta_D$	24	25.5	—	%
Intermodulation Distortion	IM3	—	-36.5	-35	dBc
Adjacent Channel Power Ratio	ACPR	—	-50.7	-48	dBc
Input Return Loss	IRL	—	-13	-9	dB

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



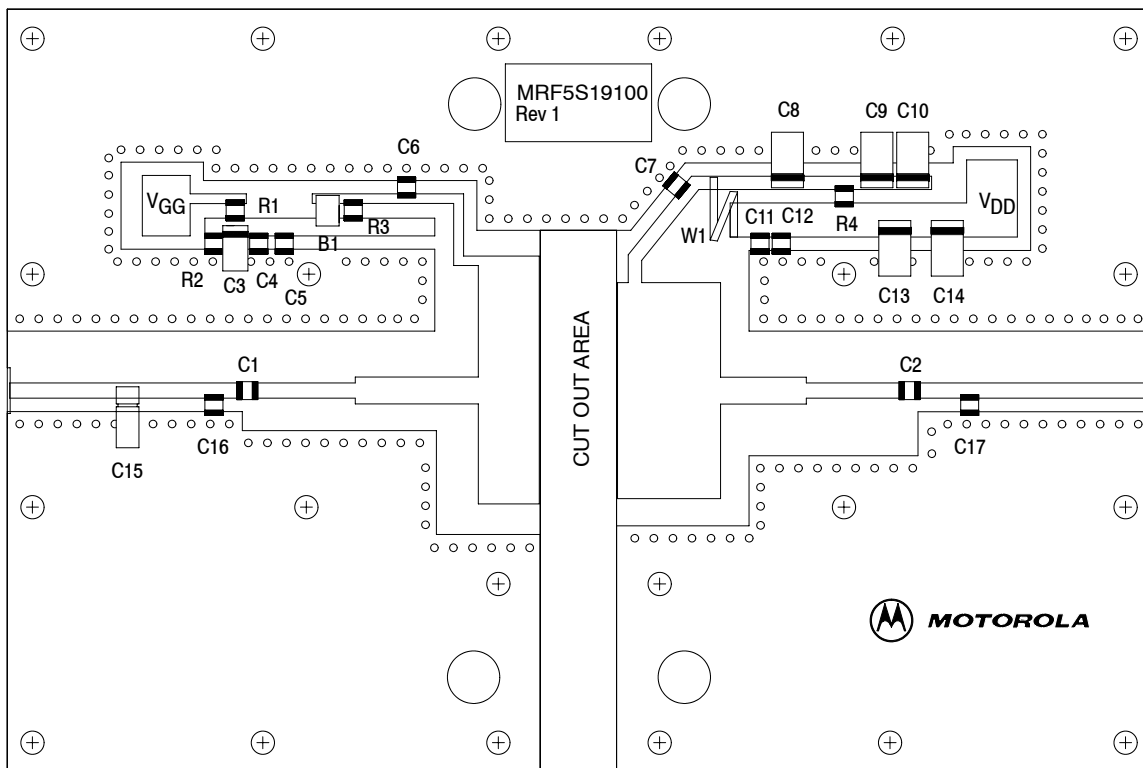
Z1, Z3	0.140" x 0.080" Microstrip	Z9	0.590" x 0.071" Microstrip
Z2	0.450" x 0.080" Microstrip	Z10	0.450" x 1.133" Microstrip
Z4	0.525" x 0.080" Microstrip	Z11	0.450" x 0.141" Microstrip
Z5	0.636" x 0.141" Microstrip	Z12	0.490" x 0.080" Microstrip
Z6	0.650" x 0.050" Microstrip	Z13	0.085" x 0.080" Microstrip
Z7	0.320" x 1.299" Microstrip	Z14	1.124" x 0.080" Microstrip
Z8	0.091" x 1.133" Microstrip	PCB	Arlon GX-0300-55-22, 0.030", $\epsilon_r = 2.55$

Figure 1. MRF5S19100HR3(HSR3) Test Circuit Schematic

Table 5. MRF5S19100HR3(HSR3) Test Circuit Component Designations and Values

Part	Description	Part Number	Manufacturer
B1	Short RF Bead	2743019447	Fair-Rite
C1	22 pF Chip Capacitor	ATC100B220CT500XT	ATC
C2	10 pF Chip Capacitor	ATC100B100CT500XT	ATC
C3	1 $\mu$ F, 50 V Tantalum Capacitor	T494C105J050AT	Kemet
C4, C12	0.1 $\mu$ F Chip Capacitors	CDR33BX104AKYS	Kemet
C5, C11	1K pF Chip Capacitors	ATC100B102JT500XT	ATC
C6	2.7 pF Chip Capacitor	ATC100B2R7BT500XT	ATC
C7	4.3 pF Chip Capacitor	ATC100B4R3JT500XT	ATC
C8	10 $\mu$ F, 35 V Tantalum Capacitor	T494D106J035AT	Kemet
C9, C10, C13, C14	22 $\mu$ F, 35 V Tantalum Capacitors	T494X226J035AT	Kemet
C15	0.6 – 4.5 Gigatrim Variable Capacitor	272715L	Johanson
C16	2.2 pF Chip Capacitor	ATC100B2R2BT500XT	ATC
C17*	0.3 pF Chip Capacitor	ATC100B0R3BT500XT	ATC
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
W1	1 turn 14 gauge wire		

\* Need for part will vary from fixture to fixture.



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. MRF5S19100HR3(HSR3) Test Circuit Component Layout**

### TYPICAL CHARACTERISTICS

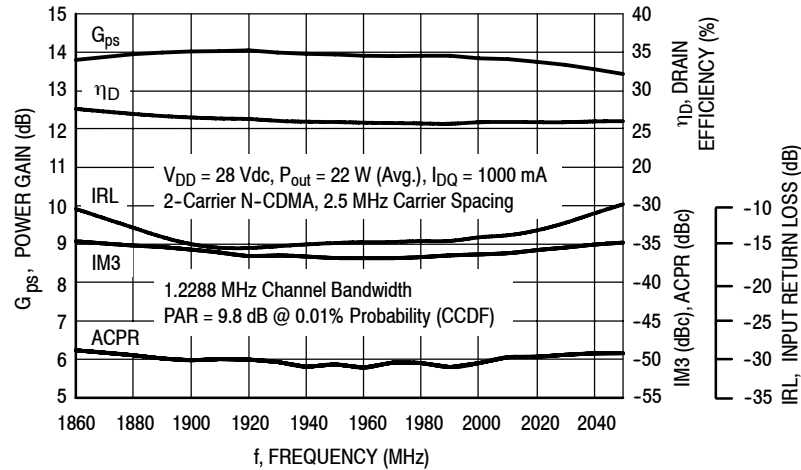


Figure 3. 2-Carrier N-CDMA Broadband Performance

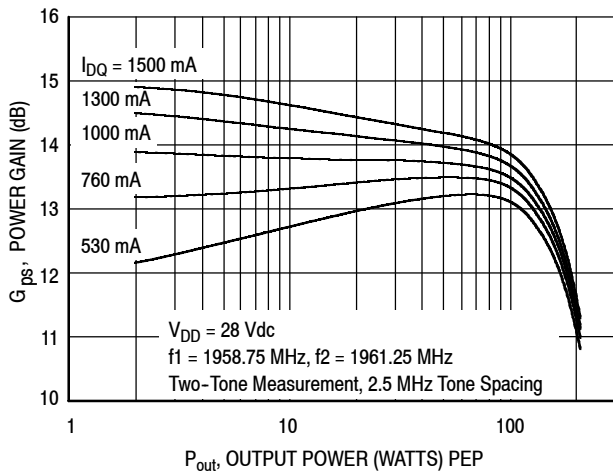


Figure 4. Two-Tone Power Gain versus Output Power

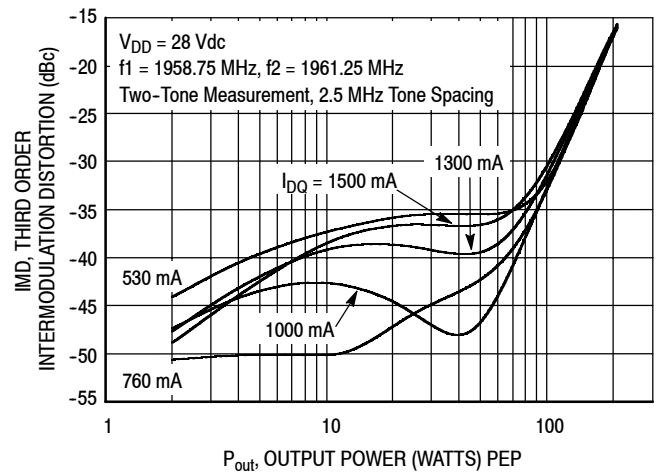


Figure 5. Third Order Intermodulation Distortion versus Output Power

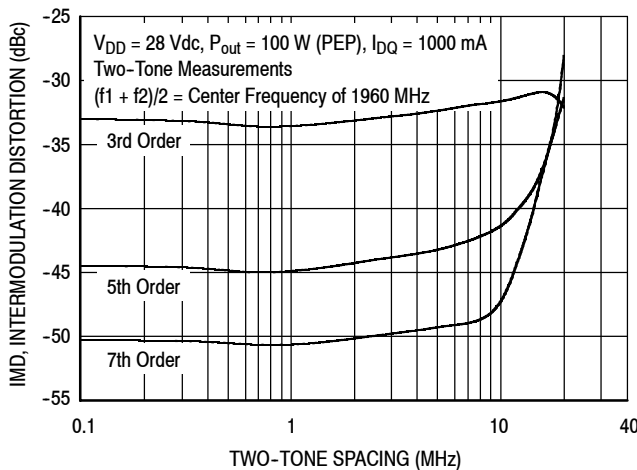


Figure 6. Intermodulation Distortion Products versus Tone Spacing

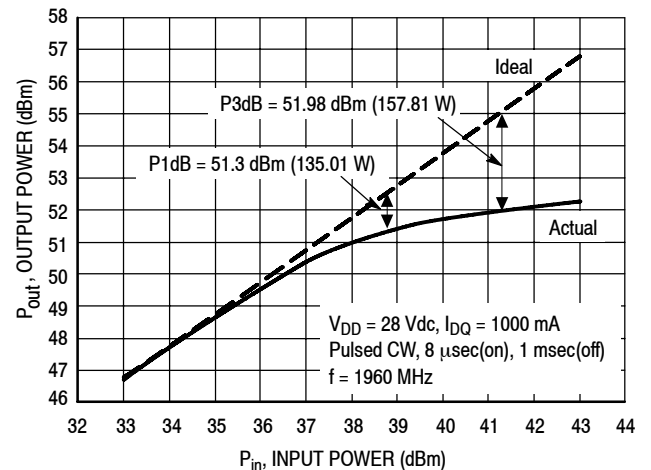
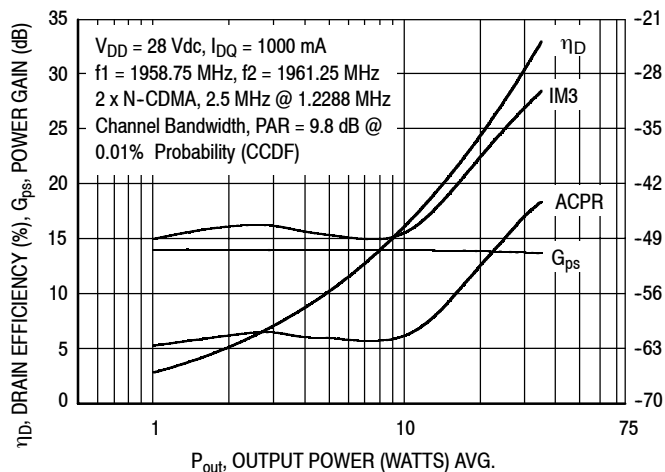


Figure 7. Pulse CW Output Power versus Input Power

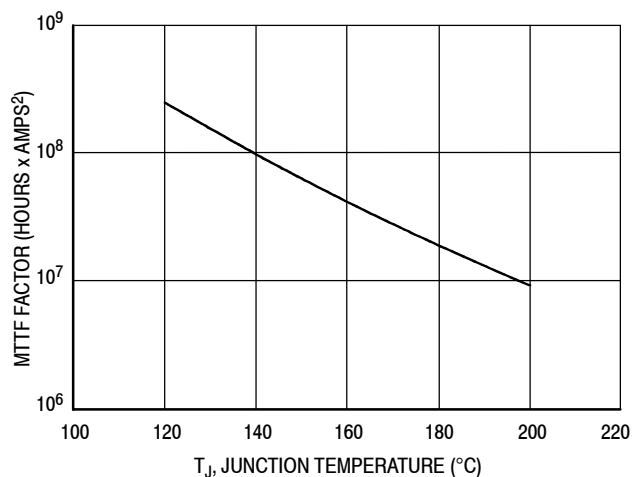
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### TYPICAL CHARACTERISTICS



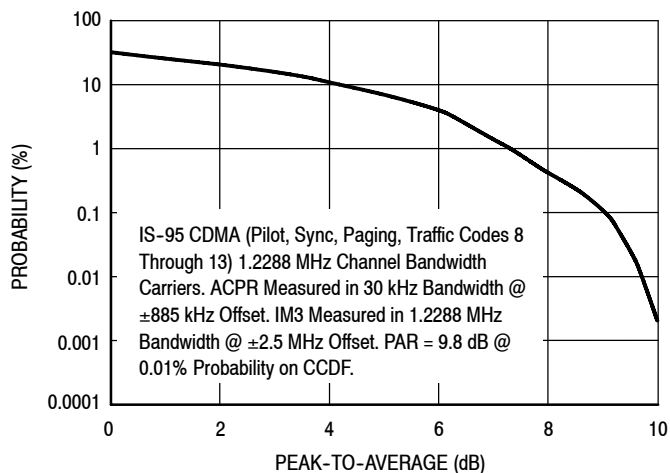
**Figure 8. 2-Carrier N-CDMA ACPR, IM3, Power Gain and Drain Efficiency versus Output Power**



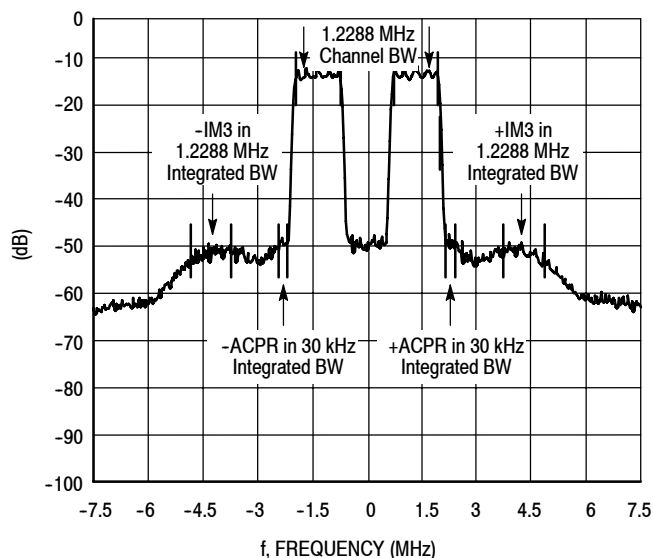
This above graph displays calculated MTTF in hours x ampere<sup>2</sup> drain current. Life tests at elevated temperatures have correlated to better than ±10% of the theoretical prediction for metal failure. Divide MTTF factor by  $I_{DQ}^2$  for MTTF in a particular application.

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

### N-CDMA TEST SIGNAL



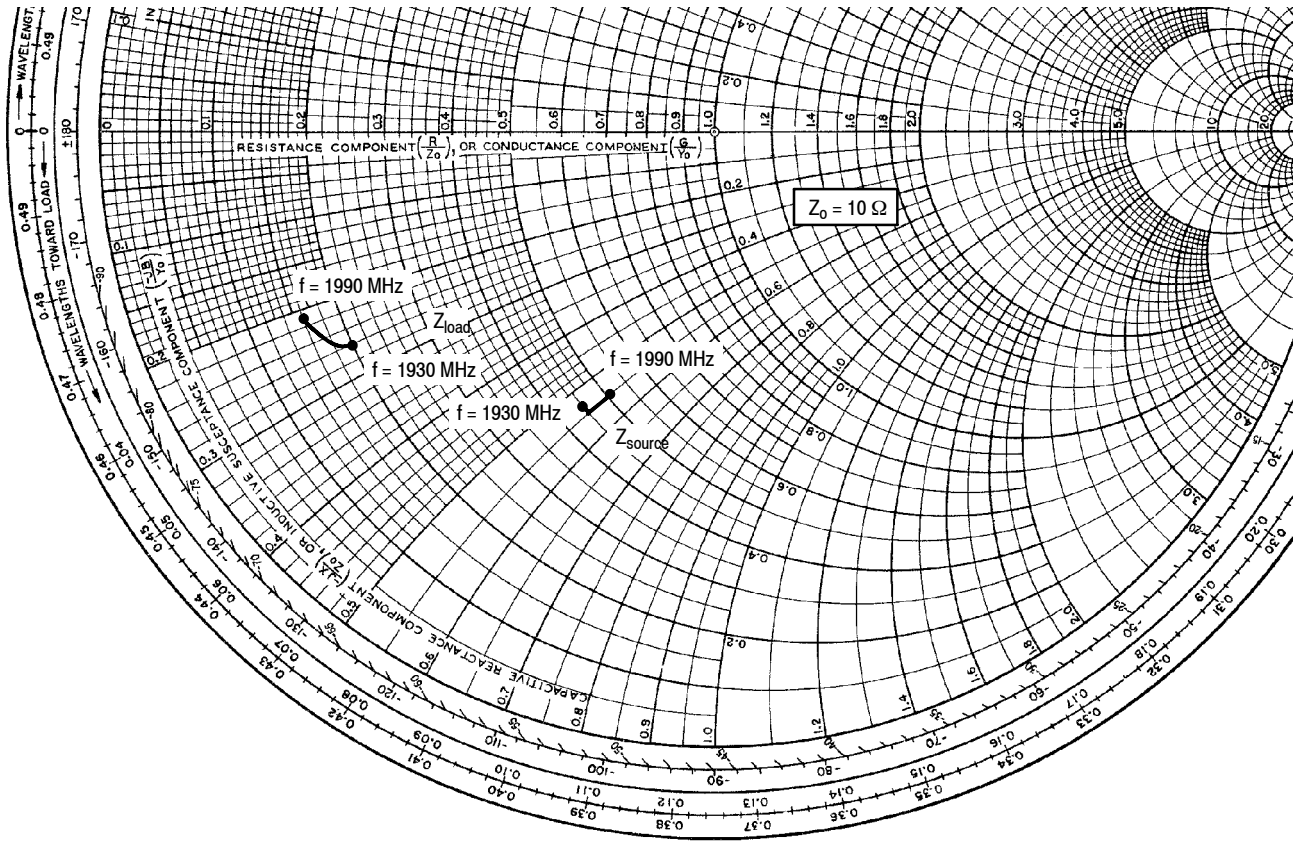
**Figure 10. 2-Carrier CCDF N-CDMA**



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

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$V_{DD} = 28 \text{ Vdc}$ ,  $I_{DQ} = 1000 \text{ mA}$ ,  $P_{out} = 22 \text{ W Avg.}$

f MHz	$Z_{source}$ $\Omega$	$Z_{load}$ $\Omega$
1930	$4.45 - j5.32$	$1.98 - j2.58$
1960	$4.53 - j5.40$	$1.83 - j2.55$
1990	$5.12 - j5.45$	$1.60 - j2.15$

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

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

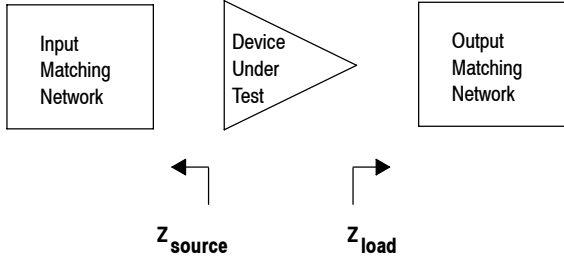
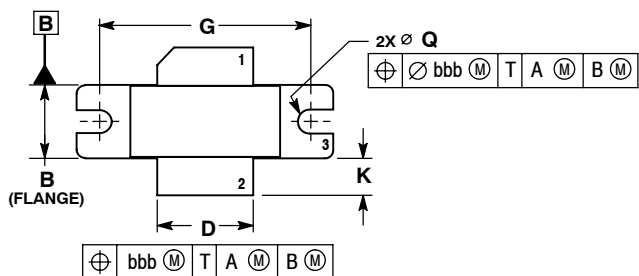


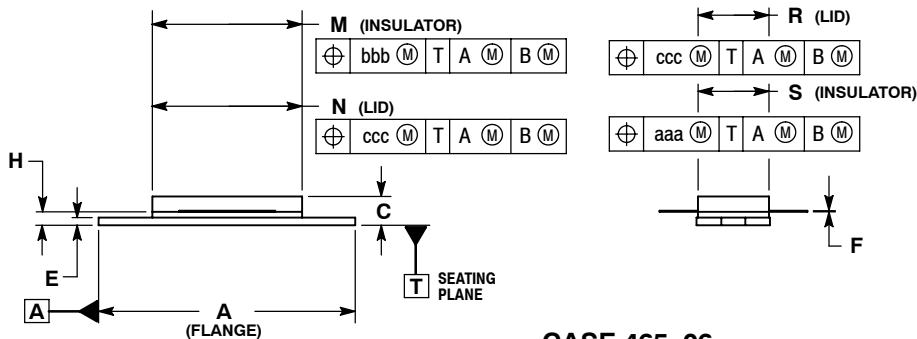
Figure 12. Series Equivalent Source and Load Impedance

### PACKAGE DIMENSIONS



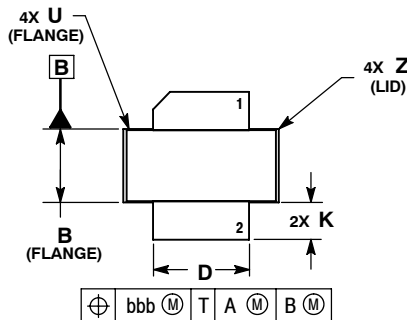
- NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M-1994.
  2. CONTROLLING DIMENSION: INCH.
  3. DELETED
  4. DIMENSION H IS MEASURED 0.030 (0.762) AWAY FROM PACKAGE BODY.

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 1.18	Ø 1.38	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	



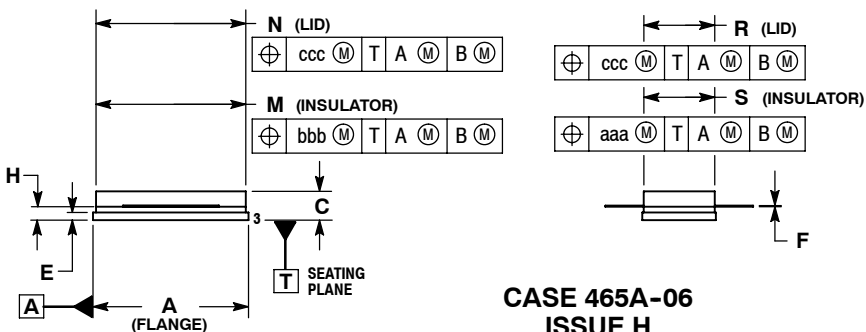
**CASE 465-06  
ISSUE G  
NI-780  
MRF5S19100HR3**

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



- 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	



**CASE 465A-06  
ISSUE H  
NI-780S  
MRF5S19100HSR3**

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

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## PRODUCT DOCUMENTATION

Refer to the following documents to aid your design process.

### Application Notes

- AN1955: Thermal Measurement Methodology of RF Power Amplifiers

### Engineering Bulletins

- EB212: Using Data Sheet Impedances for RF LDMOS Devices

## REVISION HISTORY

The following table summarizes revisions to this document.

Revision	Date	Description
5	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 Product Documentation and Revision History, p. 9</li> <li>• Data sheet archived. Part no longer manufactured.</li> </ul>

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