

# RF Power Field Effect Transistors

## N-Channel Enhancement-Mode Lateral MOSFETs

Designed for N-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.

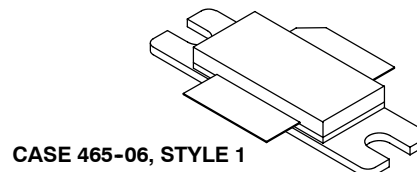
- Typical Single-Carrier N-CDMA Performance:  $V_{DD} = 28$  Volts,  $I_{DQ} = 1000$  mA,  $P_{out} = 19$  Watts Avg.,  $f = 1990$  MHz, IS-95 CDMA (Pilot, Sync, Paging, Traffic Codes 8 Through 13) Channel Bandwidth = 1.2288 MHz. PAR = 9.8 dB @ 0.01% Probability on CCDF.
  - Power Gain — 15 dB
  - Drain Efficiency — 21.5%
  - ACPR @ 885 kHz Offset — -54 dBc in 30 kHz Bandwidth
- Capable of Handling 10:1 VSWR, @ 28 Vdc, 1960 MHz, 120 Watts CW Output Power

### Features

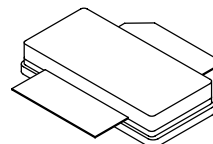
- Characterized with Series Equivalent Large-Signal Impedance Parameters
- Internally Matched for Ease of Use
- Qualified Up to a Maximum of 32  $V_{DD}$  Operation
- Integrated ESD Protection
- Designed for Lower Memory Effects and Wide Instantaneous Bandwidth Applications
- RoHS Compliant
- In Tape and Reel. R3 Suffix = 250 Units per 56 mm, 13 inch Reel.

**MRF6S19120HR3**  
**MRF6S19120HSR3**

**1930-1990 MHz, 19 W AVG., 28 V**  
**SINGLE N-CDMA**  
**LATERAL N-CHANNEL**  
**RF POWER MOSFETs**



**CASE 465-06, STYLE 1**  
**NI-780**  
**MRF6S19120HR3**



**CASE 465A-06, STYLE 1**  
**NI-780S**  
**MRF6S19120HSR3**

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**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
Storage Temperature Range	$T_{stg}$	-65 to +150	°C
Case Operating Temperature	$T_C$	150	°C
Operating Junction Temperature (1,2)	$T_J$	225	°C

**Table 2. Thermal Characteristics**

Characteristic	Symbol	Value (2,3)	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$		°C/W
Case Temperature 80°C, 120 W CW		0.43	
Case Temperature 73°C, 19 W CW		0.45	

1. Continuous use at maximum temperature will affect MTTF.
2. MTTF calculator available at <http://www.freescale.com/rf>. Select Software & Tools/Development Tools/Calculators to access MTTF calculators by product.
3. 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 Methodology	Class
Human Body Model (per JESD22-A114)	1A (Minimum)
Machine Model (per EIA/JESD22-A115)	A (Minimum)
Charge Device Model (per JESD22-C101)	IV (Minimum)

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

Characteristic	Symbol	Min	Typ	Max	Unit
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**Off Characteristics**

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 ( $V_{DS} = 10\text{ Vdc}$ , $I_D = 270\ \mu\text{Adc}$ )	$V_{GS(th)}$	1	2	3	Vdc
Gate Quiescent Voltage ( $V_{DD} = 28\text{ Vdc}$ , $I_D = 1000\text{ mAdc}$ Measured in Functional Test)	$V_{GS(Q)}$	2	2.8	4	Vdc
Drain-Source On-Voltage ( $V_{GS} = 10\text{ Vdc}$ , $I_D = 2.7\text{ Adc}$ )	$V_{DS(on)}$	—	0.21	0.3	Vdc

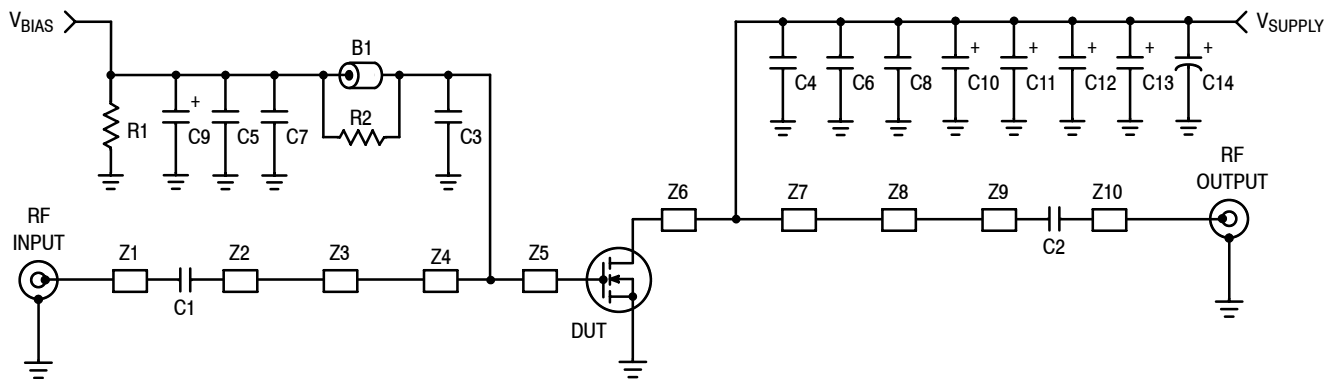
**Dynamic Characteristics** <sup>(1)</sup>

Reverse Transfer Capacitance ( $V_{DS} = 28\text{ Vdc} \pm 30\text{ mV(rms)ac}$ @ 1 MHz, $V_{GS} = 0\text{ Vdc}$ )	$C_{rss}$	—	1.95	—	pF
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**Functional Tests** (In Freescale Test Fixture, 50 ohm system)  $V_{DD} = 28\text{ Vdc}$ ,  $I_{DQ} = 1000\text{ mA}$ ,  $P_{out} = 19\text{ W Avg. N-CDMA}$ ,  $f = 1990\text{ MHz}$ , Single-Carrier N-CDMA, 1.2288 MHz Channel Bandwidth Carrier. ACPR measured in 30 kHz Channel Bandwidth @  $\pm 885\text{ kHz}$  Offset. PAR = 9.8 dB @ 0.01% Probability on CCDF.

Power Gain	$G_{ps}$	14	15	17	dB
Drain Efficiency	$\eta_D$	20	21.5	—	%
Adjacent Channel Power Ratio	ACPR	—	-54	-48	dBc
Input Return Loss	IRL	—	-13	-9	dB

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



Z1	1.242" x 0.084" Microstrip	Z7	0.387" x 1.098" Microstrip
Z2	0.839" x 0.084" Microstrip	Z8	0.169" x 0.316" Microstrip
Z3	0.230" x 0.180" Microstrip	Z9	0.781" x 0.084" Microstrip
Z4	0.320" x 1.100" Microstrip	Z10	1.228" x 0.084" Microstrip
Z5	0.093" x 1.100" Microstrip	PCB	Arlon CuClad 250GX-0300-55-22, 0.030", $\epsilon_r = 2.55$
Z6	0.160" x 1.098" Microstrip		

**Figure 1. MRF6S19120HR3(SR3) Test Circuit Schematic**

**Table 5. MRF6S19120HR3(SR3) Test Circuit Component Designations and Values**

Part	Description	Part Number	Manufacturer
B1	Short RF Bead	2743019447	Fair-Rite
C1, C2	10 pF Chip Capacitors	ATC100B100JT500XT	ATC
C3, C4	5.1 pF Chip Capacitors	ATC100B5R1CT500XT	ATC
C5, C6	1.0 nF Chip Capacitors	ATC100B102JT500XT	ATC
C7, C8	0.1 $\mu$ F Chip Capacitors	C1825C100J5RAC	Kemet
C9	10 $\mu$ F, 35 V Tantalum Chip Capacitor	T491X106K035AT	Kemet
C10, C11	10 $\mu$ F, 35 V Tantalum Chip Capacitors	GRM55DR61H106KA88L	Murata
C12, C13	22 $\mu$ F, 50 V Tantalum Chip Capacitors	T491C105K022AT	Kemet
C14	470 $\mu$ F, 63 V Electrolytic Capacitor, Radial	EMVY630GTR471MLN0S	Nippon Chemi-Con
R1	560 K $\Omega$ , 1/4 W Chip Resistor	CRCW12065603FKEA	Vishay
R2	10 $\Omega$ , 1/4 W Chip Resistor	CRCW120610R0FKEA	Vishay

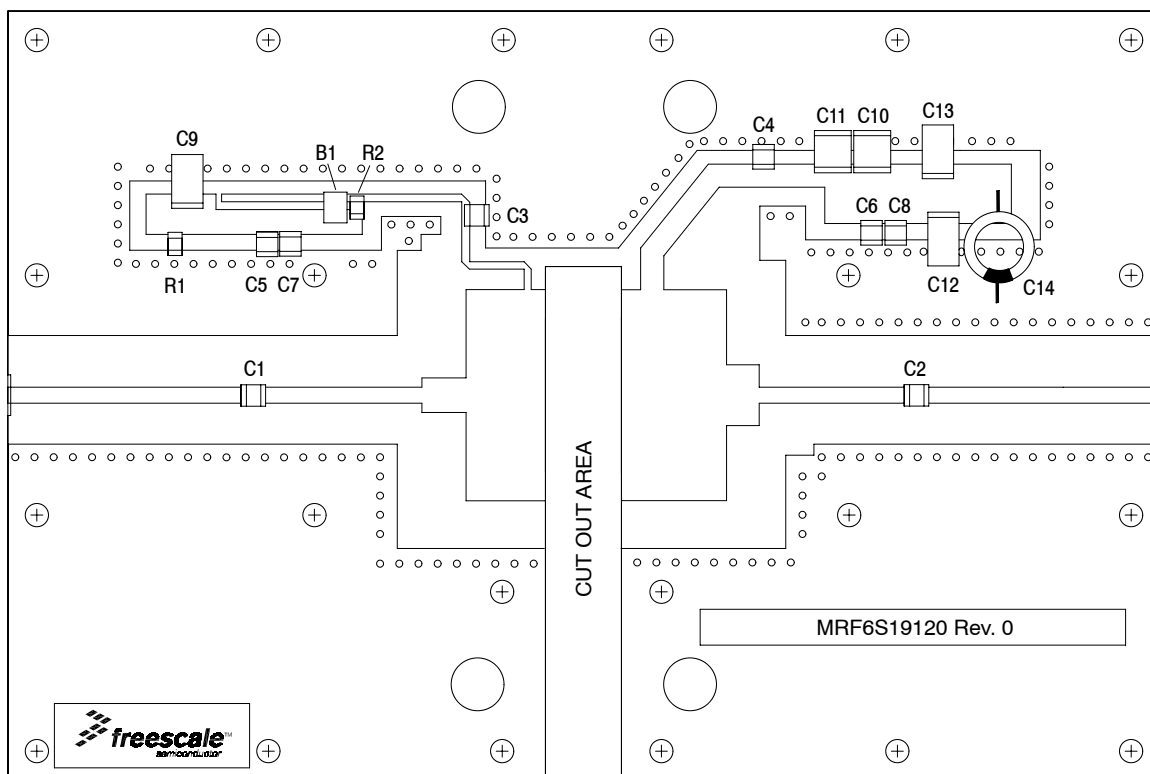


Figure 2. MRF6S19120HR3(SR3) Test Circuit Component Layout

### TYPICAL CHARACTERISTICS

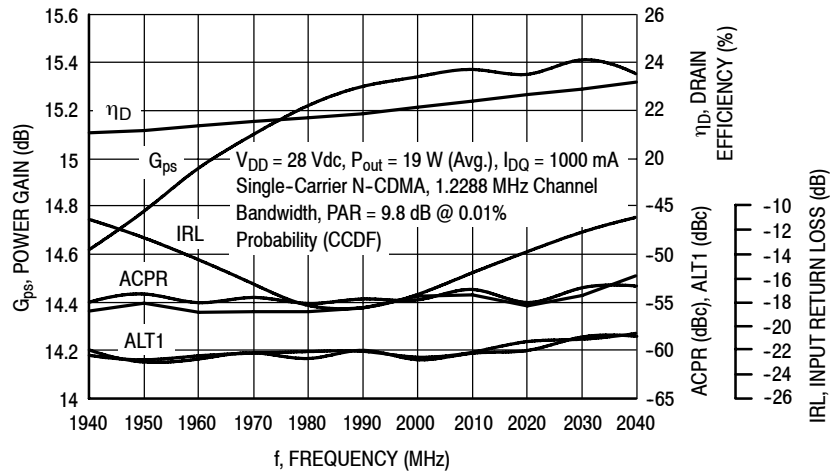


Figure 3. 2-Carrier N-CDMA Broadband Performance @  $P_{out} = 19$  Watts Avg.

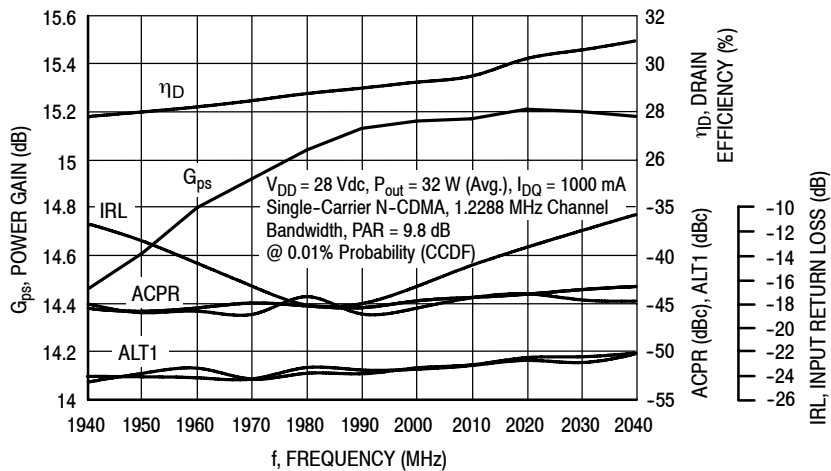


Figure 4. 2-Carrier N-CDMA Broadband Performance @  $P_{out} = 32$  Watts Avg.

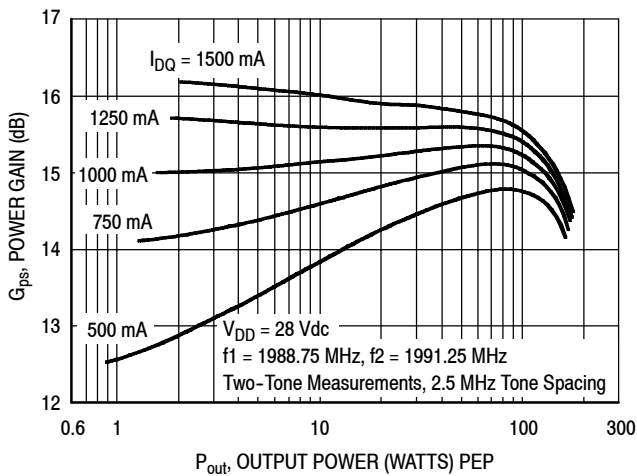


Figure 5. Two-Tone Power Gain versus Output Power

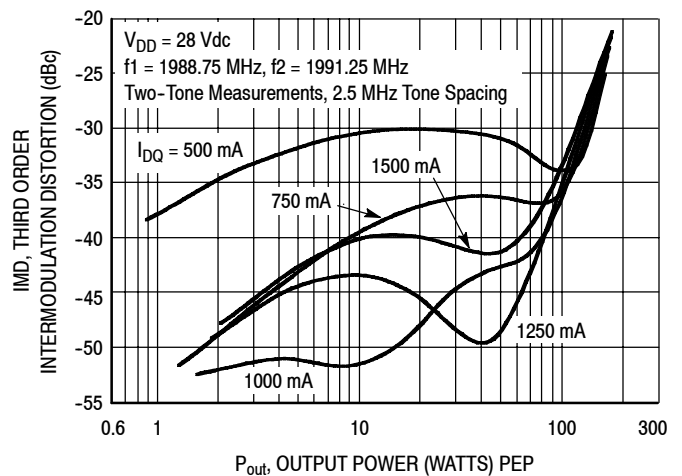
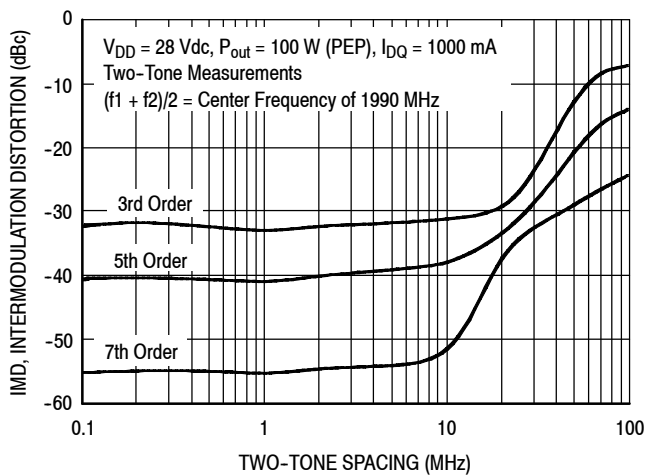
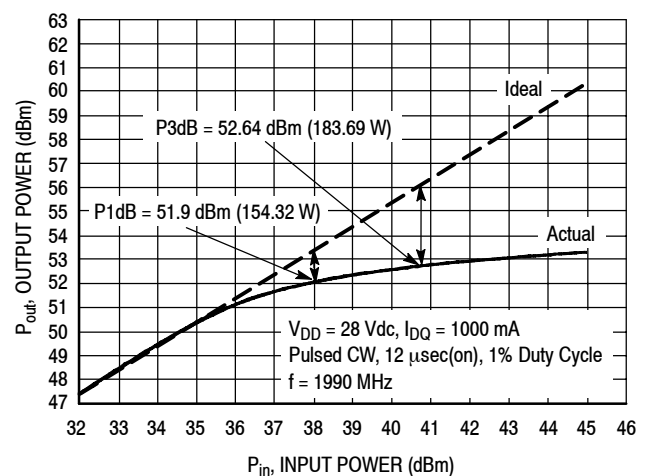


Figure 6. Third Order Intermodulation Distortion versus Output Power

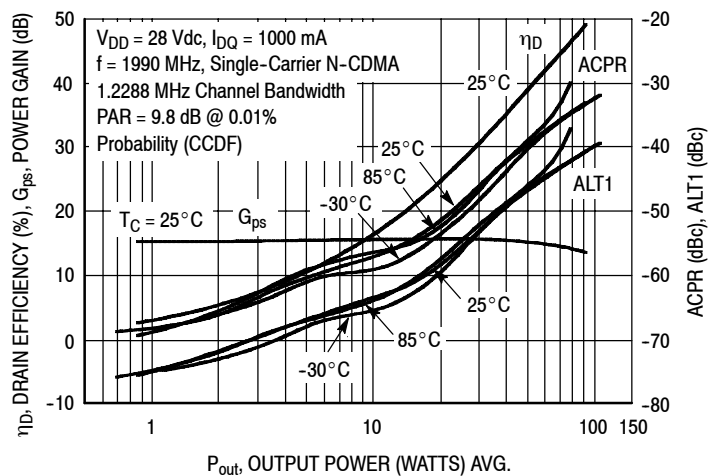
### TYPICAL CHARACTERISTICS



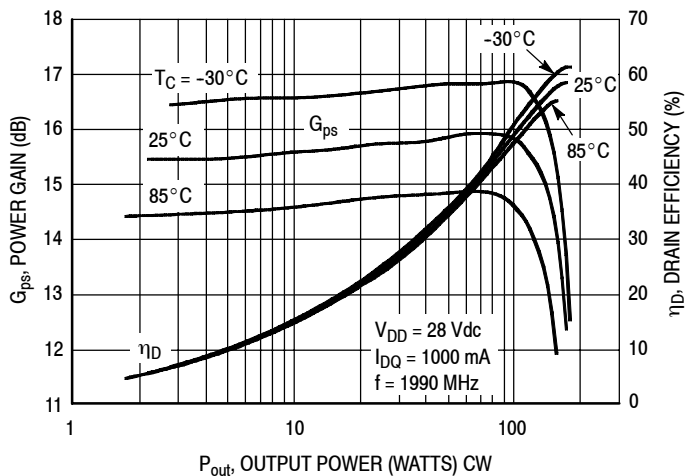
**Figure 7. Intermodulation Distortion Products versus Tone Spacing**



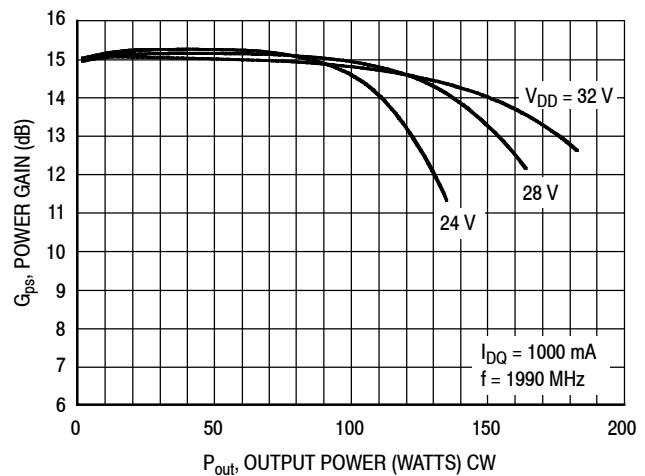
**Figure 8. Pulsed CW Output Power versus Input Power**



**Figure 9. Single-Carrier N-CDMA ACPR, ALT1, Power Gain and Drain Efficiency versus Output Power**



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

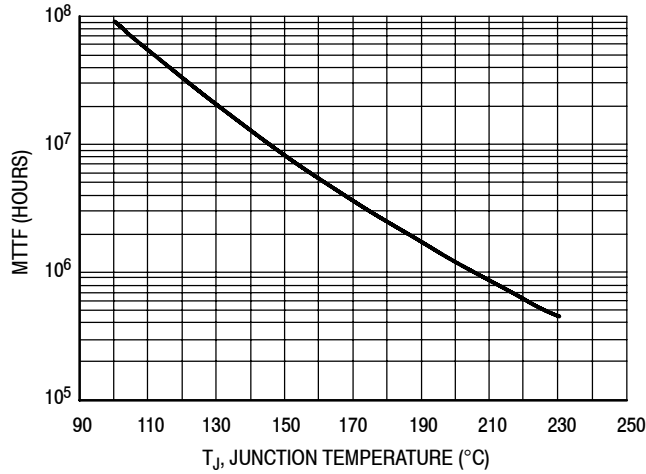


**Figure 11. Power Gain versus Output Power**

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### TYPICAL CHARACTERISTICS

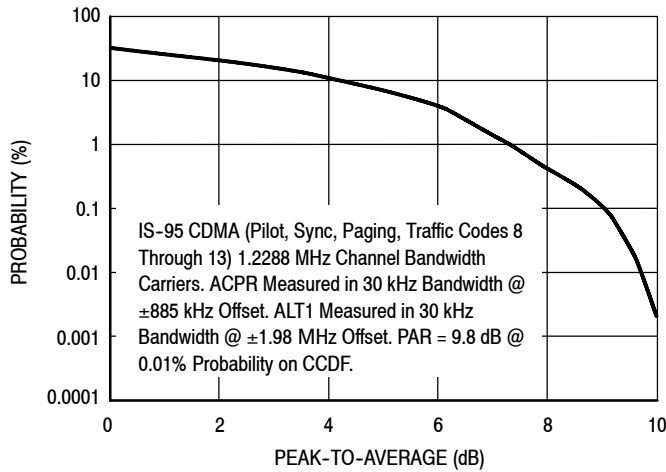


This above graph displays calculated MTTF in hours when the device is operated at  $V_{DD} = 28$  Vdc,  $P_{out} = 19$  W Avg., and  $\eta_D = 21.5\%$ .

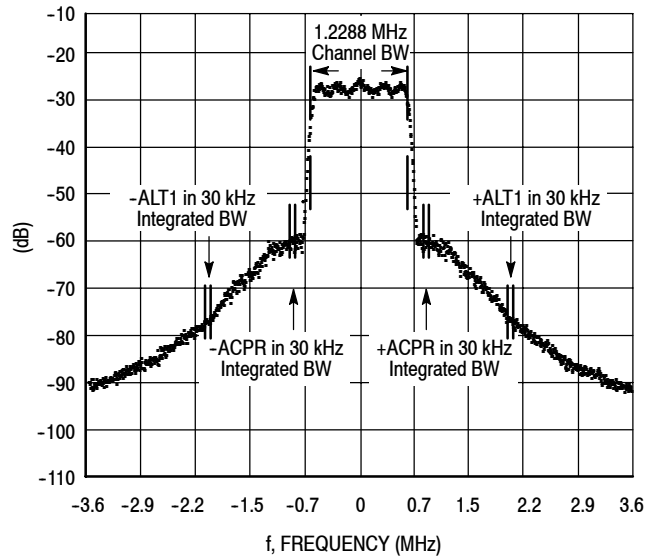
MTTF calculator available at <http://www.freescale.com/rf>. Select Software & Tools/Development Tools/Calculators to access MTTF calculators by product.

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

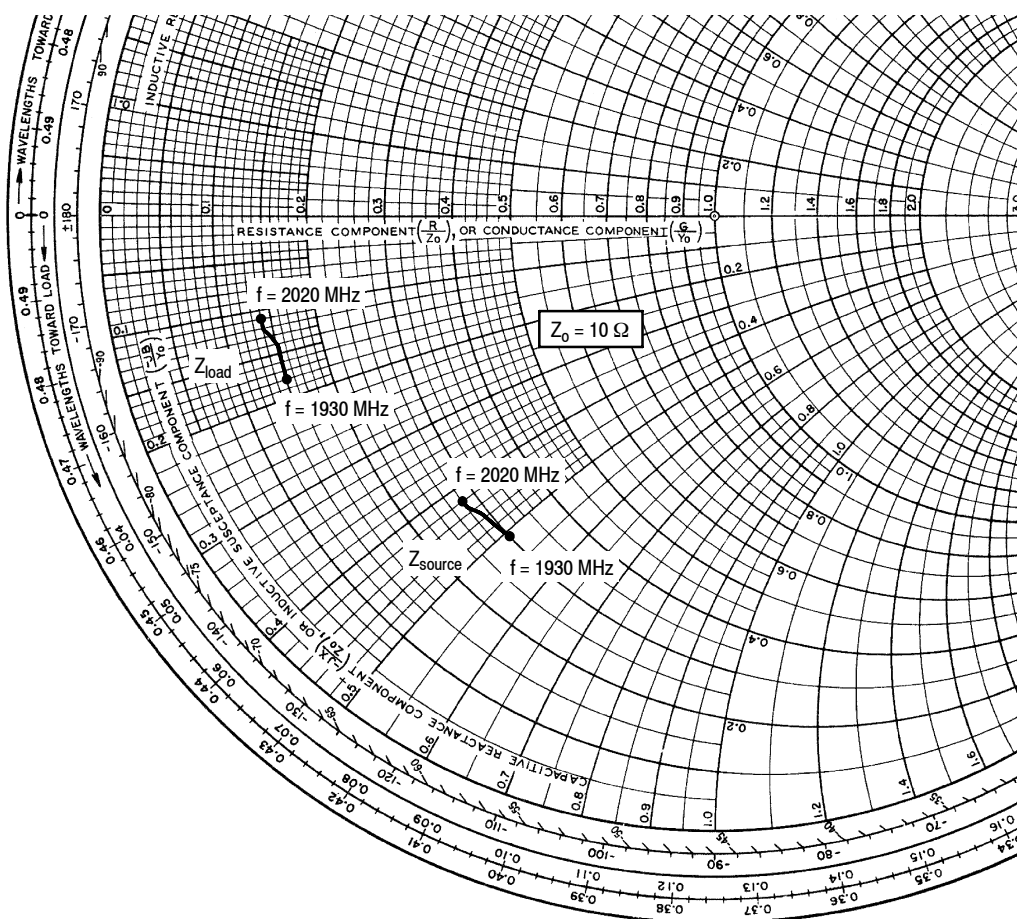
### N-CDMA TEST SIGNAL



**Figure 13. Single-Carrier CCDF N-CDMA**



**Figure 14. Single-Carrier N-CDMA Spectrum**



$V_{DD} = 28 \text{ Vdc}$ ,  $I_{DQ} = 1000 \text{ mA}$ ,  $P_{out} = 19 \text{ W Avg.}$

f MHz	Z <sub>source</sub> Ω	Z <sub>load</sub> Ω
1930	3.03 - j5.14	1.52 - j1.77
1960	2.94 - j4.54	1.51 - j1.37
1990	2.75 - j4.34	1.38 - j1.20
2020	2.75 - j4.18	1.41 - j1.11

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.

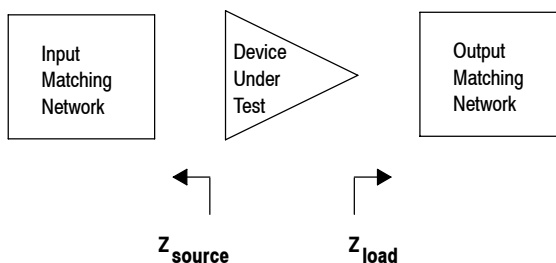
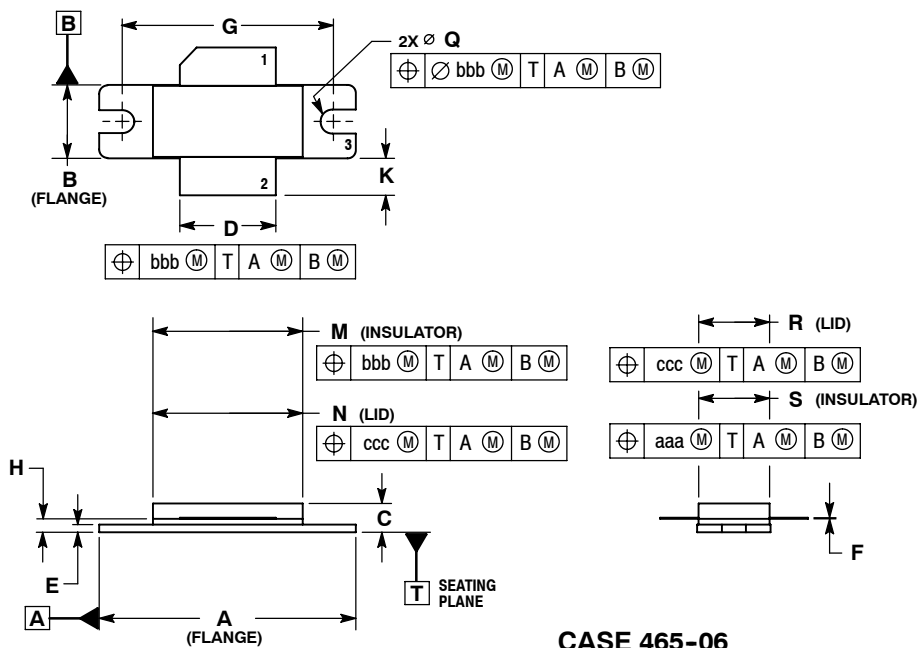


Figure 15. Series Equivalent Source and Load Impedance

### PACKAGE DIMENSIONS

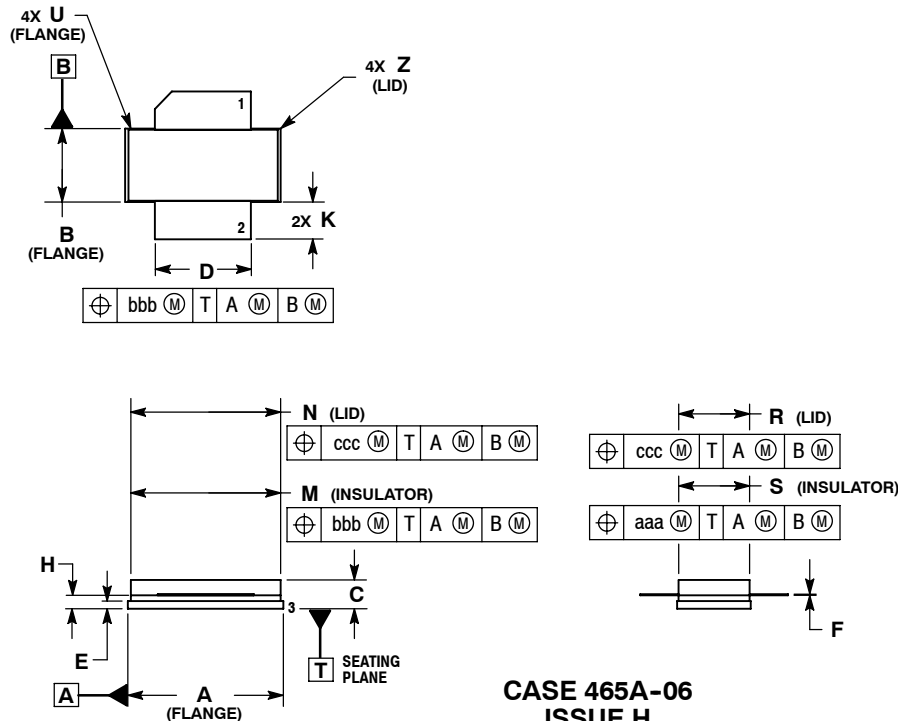


- NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M-1994.
  2. CONTROLLING DIMENSION: INCH.
  3. DELETED
  4. DIMENSION H IS MEASURED 0.030 (0.762) AWAY FROM PACKAGE BODY.

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 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:
1. DRAIN
  2. GATE
  3. SOURCE

**CASE 465-06  
ISSUE G  
NI-780  
MRF6S19120HR3**



- 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:
1. DRAIN
  2. GATE
  5. SOURCE

**CASE 465A-06  
ISSUE H  
NI-780S  
MRF6S19120HSR3**

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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
2	Dec. 2008	<ul style="list-style-type: none"> <li>• Changed "Full Frequency Band" to "f = 1990 MHz" to match functional tests, p. 1</li> <li>• Removed Lower Thermal Resistance and Low Gold Plating bullets from Features section as functionality is standard, p. 1</li> <li>• Removed Total Device Dissipation from Max Ratings table as data was redundant (information already provided in Thermal Characteristics table), p. 1</li> <li>• Operating Junction Temperature increased from 200°C to 225°C in Maximum Ratings table, related "Continuous use at maximum temperature will affect MTTF" footnote added, p. 1</li> <li>• Corrected <math>V_{DS}</math> to <math>V_{DD}</math> in the RF test condition voltage callout for <math>V_{GS(Q)}</math>, and added "Measured in Functional Test", On Characteristics table, p. 2</li> <li>• Removed Forward Transconductance from On Characteristics table as it no longer provided usable information, p. 2</li> <li>• Updated PCB information to show more specific material details, Fig. 1, Test Circuit Schematic, p. 3</li> <li>• Updated Part Numbers in Table 5, Component Designations and Values, to latest RoHS compliant part numbers, p. 3</li> <li>• Removed lower voltage tests from Fig. 11, Power Gain versus Output Power, due to fixed tuned fixture limitations, p. 6</li> <li>• Replaced Fig. 12, MTTF versus Junction Temperature with updated graph. Removed Amps<sup>2</sup> and listed operating characteristics and location of MTTF calculator for device, p. 7</li> <li>• Updated ALT1 Bandwidth and Offset in Fig. 13, Single-Carrier CCDF N-CDMA, p. 7</li> <li>• Updated -ALT1 and +ALT1 Bandwidths in Fig. 14, Single-Carrier N-CDMA Spectrum, p. 7</li> <li>• Added Product Documentation and Revision History, p. 10</li> </ul>
	Dec. 2010	<ul style="list-style-type: none"> <li>• Data sheet archived. Parts no longer manufactured.</li> </ul>

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