

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.

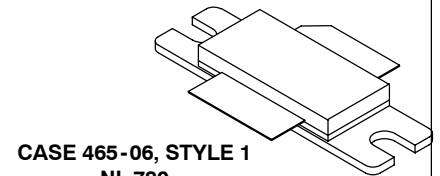
- Typical Single-Carrier N-CDMA Performance: $V_{DD} = 28$ Volts, $I_{DQ} = 1000$ mA, $P_{out} = 19$ Watts Avg., $f = 1990$ MHz, IS-95 CDMA (Pilot, Sync, Paging, Traffic Codes 8 Through 13) Channel Bandwidth = 1.2288 MHz. PAR = 9.8 dB @ 0.01% Probability on CCDF.
Power Gain — 15 dB
Drain Efficiency — 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

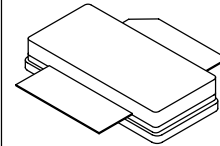
- Characterized with Series Equivalent Large-Signal Impedance Parameters
- Internally Matched for Ease of Use
- Qualified Up to a Maximum of 32 V_{DD} Operation
- Integrated ESD Protection
- Designed for Lower Memory Effects and Wide Instantaneous Bandwidth Applications
- RoHS Compliant
- In Tape and 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

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	$R_{\theta JC}$	0.43	°C/W
Case Temperature 80°C, 120 W CW		0.45	
Case Temperature 73°C, 19 W CW			

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	μAdc
Zero Gate Voltage Drain Leakage Current ($V_{DS} = 28\text{ Vdc}$, $V_{GS} = 0\text{ Vdc}$)	I_{DSS}	—	—	1	μAdc
Gate-Source Leakage Current ($V_{GS} = 5\text{ Vdc}$, $V_{DS} = 0\text{ Vdc}$)	I_{GSS}	—	—	1	μAdc

On Characteristics

Gate Threshold Voltage ($V_{DS} = 10\text{ Vdc}$, $I_D = 270\text{ }\mu\text{Adc}$)	$V_{GS(th)}$	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

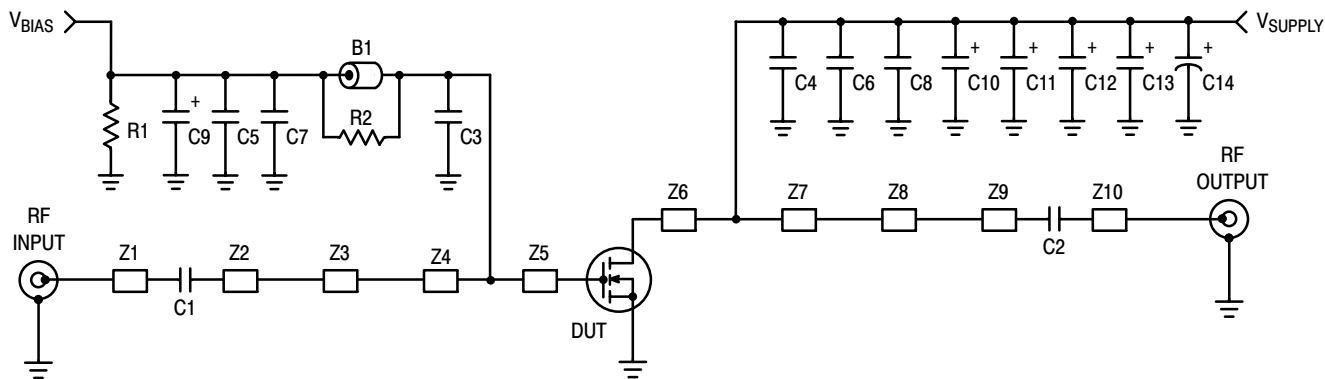
Dynamic Characteristics ⁽¹⁾

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	η_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 μ F Chip Capacitors	C1825C100J5RAC	Kemet
C9	10 μ F, 35 V Tantalum Chip Capacitor	T491X106K035AT	Kemet
C10, C11	10 μ F, 35 V Tantalum Chip Capacitors	GRM55DR61H106KA88L	Murata
C12, C13	22 μ F, 50 V Tantalum Chip Capacitors	T491C105K022AT	Kemet
C14	470 μ F, 63 V Electrolytic Capacitor, Radial	EMVY630GTR471MLN0S	Nippon Chemi - Con
R1	560 K Ω , 1/4 W Chip Resistor	CRCW12065603FKEA	Vishay
R2	10 Ω , 1/4 W Chip Resistor	CRCW120610R0FKEA	Vishay

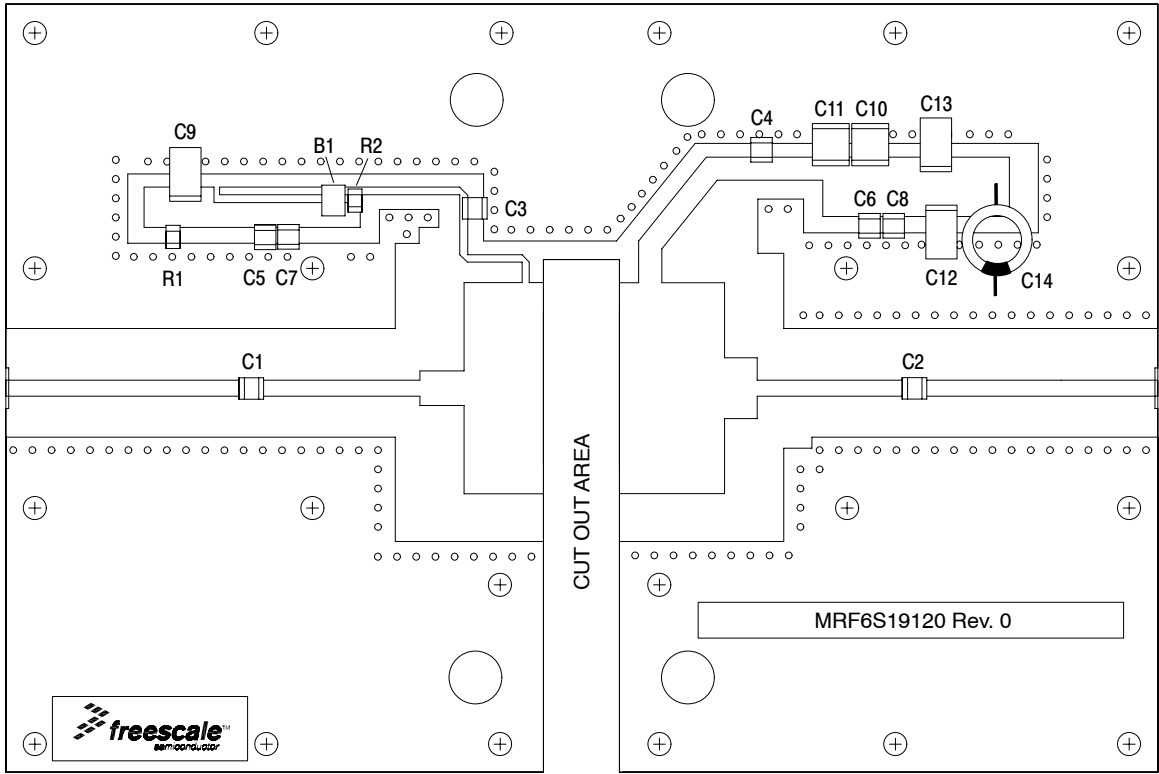


Figure 2. MRF6S19120HR3(SR3) Test Circuit Component Layout

TYPICAL CHARACTERISTICS

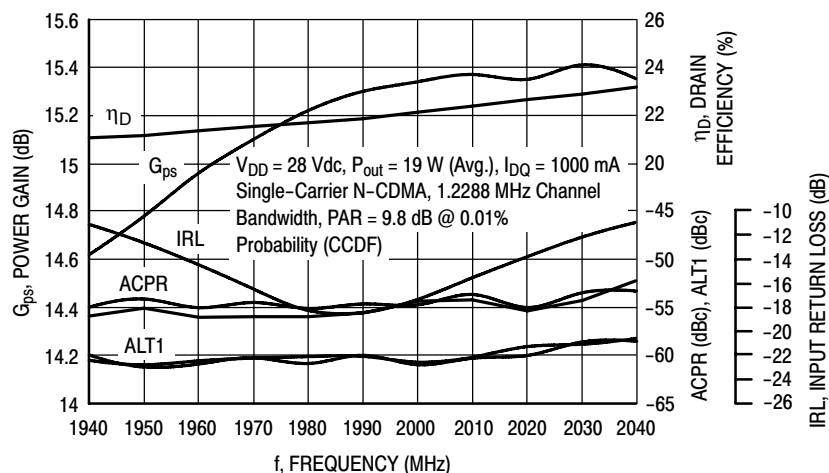
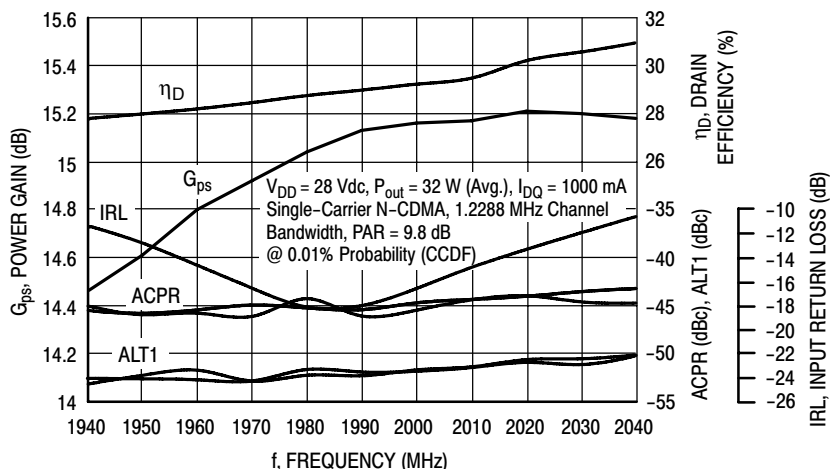
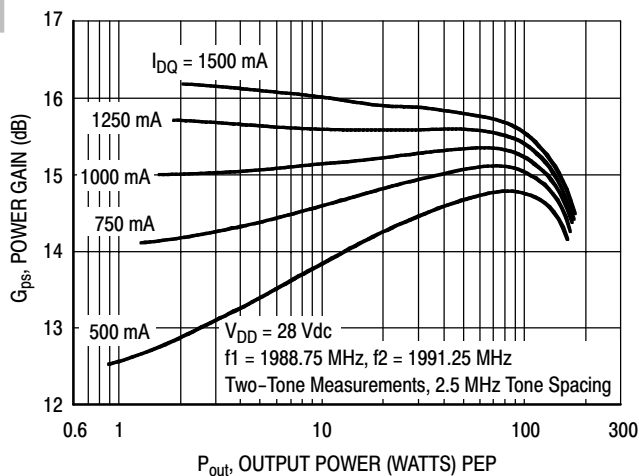
Figure 3. 2-Carrier N-CDMA Broadband Performance @ $P_{out} = 19$ Watts Avg.Figure 4. 2-Carrier N-CDMA Broadband Performance @ $P_{out} = 32$ Watts Avg.

Figure 5. Two-Tone Power Gain versus Output Power

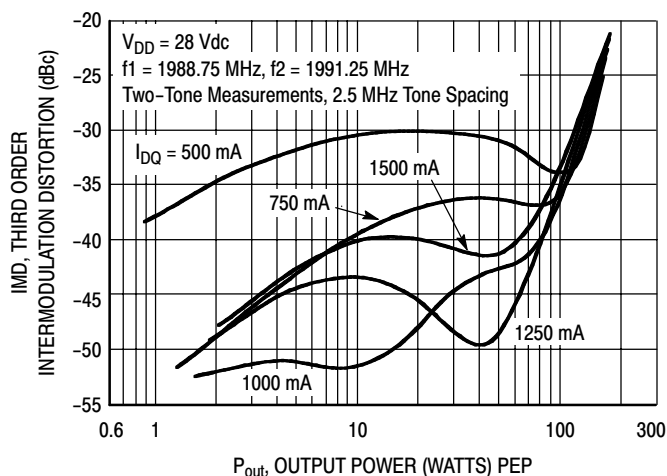


Figure 6. Third Order Intermodulation Distortion versus Output Power

TYPICAL CHARACTERISTICS

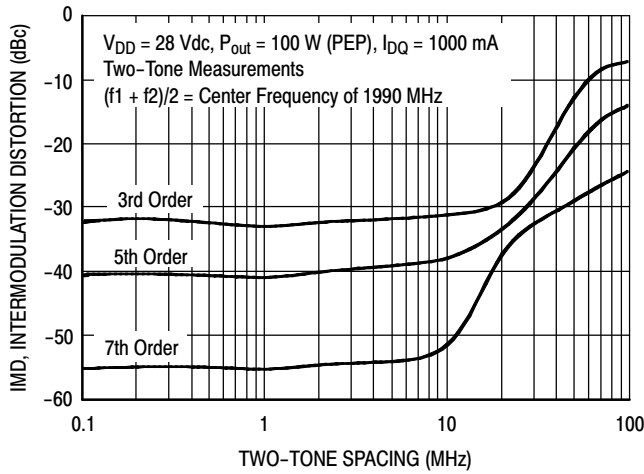


Figure 7. Intermodulation Distortion Products versus Tone Spacing

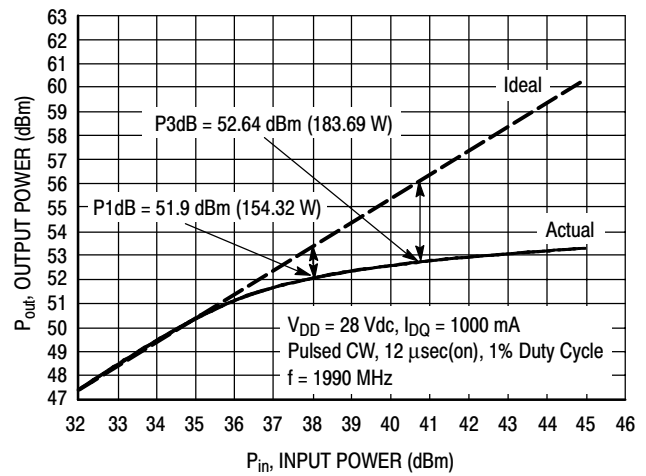


Figure 8. Pulsed CW Output Power versus Input Power

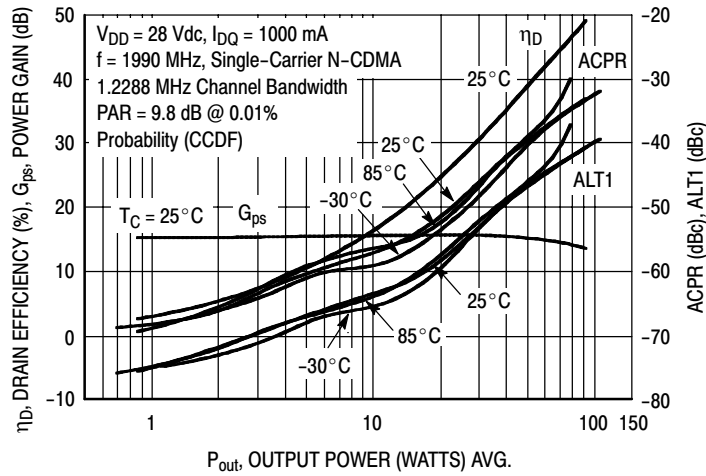


Figure 9. Single-Carrier N-CDMA ACPR, ALT1, Power Gain and Drain Efficiency versus Output Power

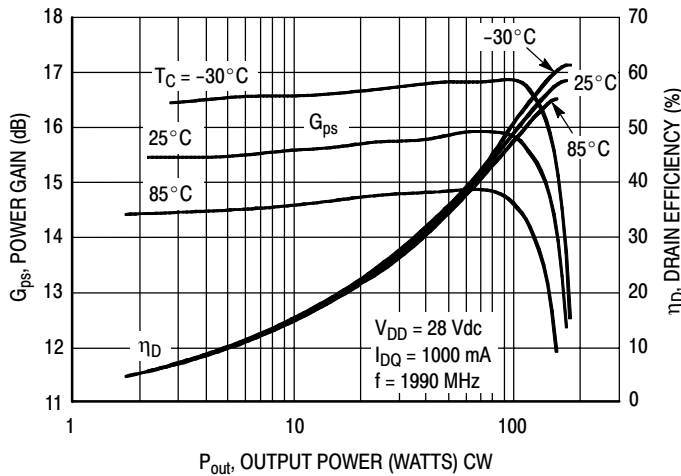


Figure 10. Power Gain and Drain Efficiency versus CW Output Power

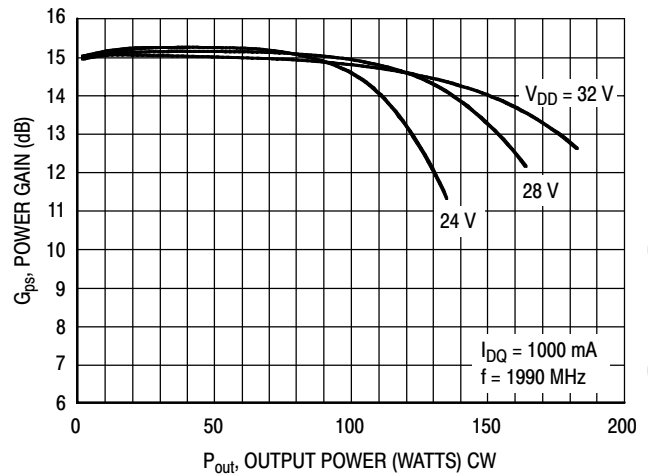
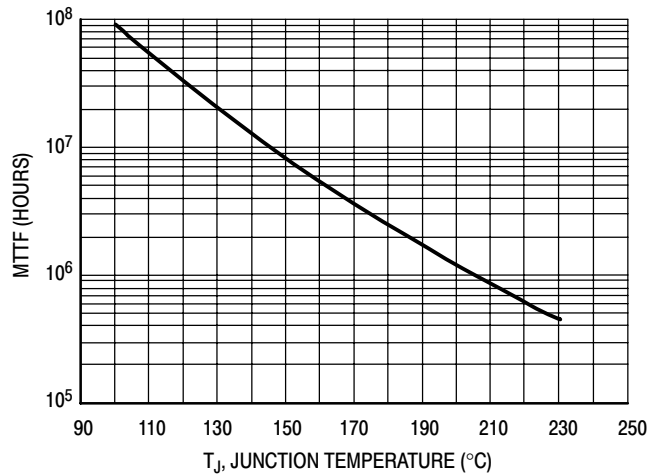


Figure 11. Power Gain versus Output Power

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

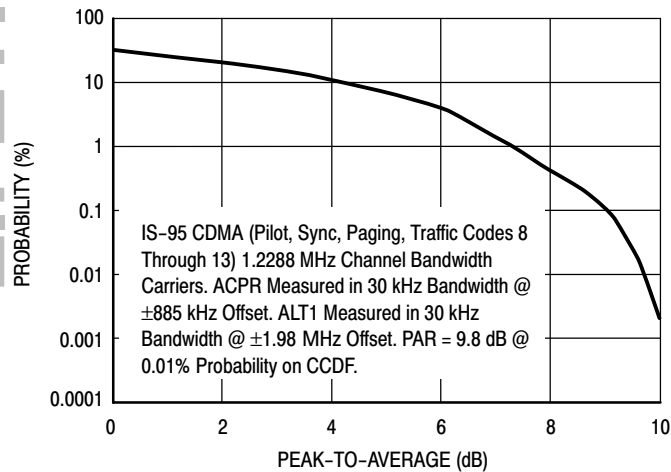


Figure 13. Single-Carrier CCDF N-CDMA

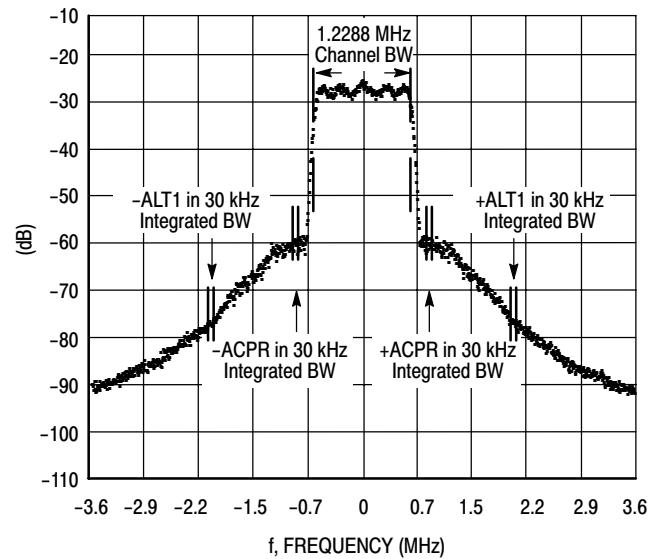
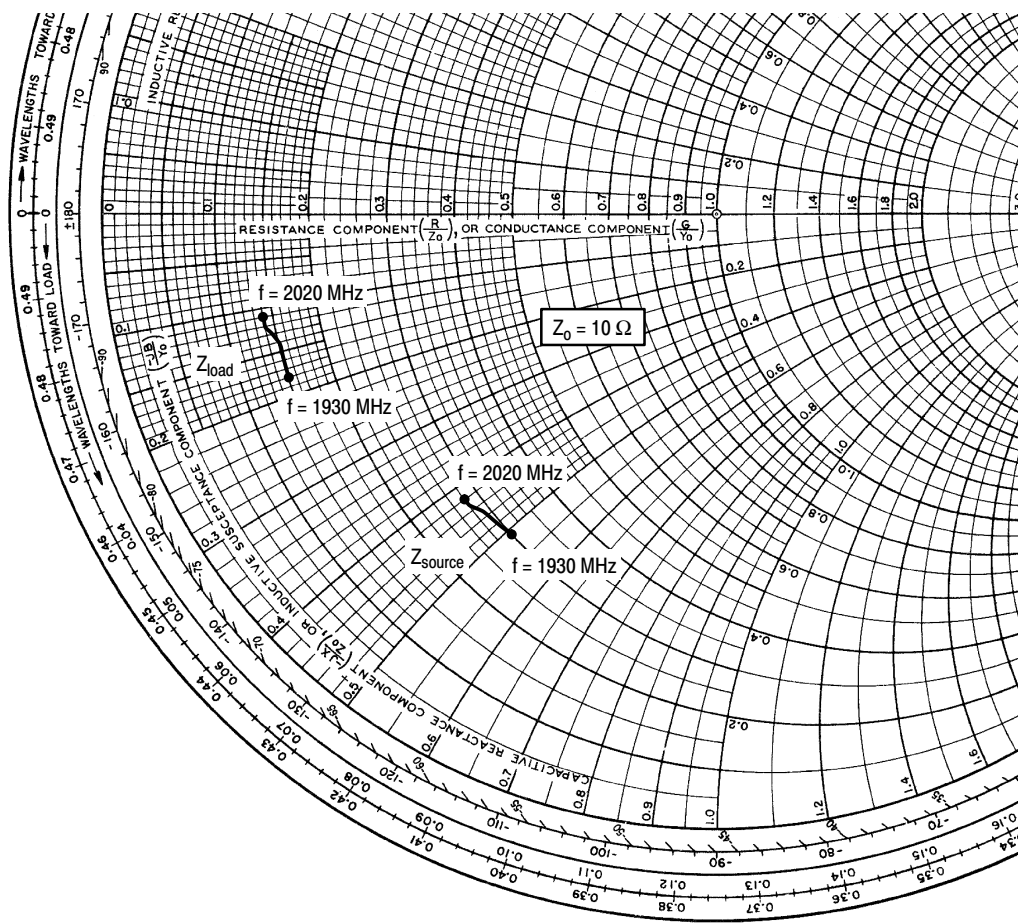


Figure 14. Single-Carrier N-CDMA Spectrum



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

f MHz	Z_{source} Ω	Z_{load} 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_{source} = Test circuit impedance as measured from gate to ground.

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

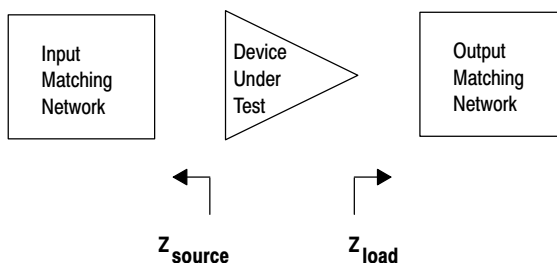
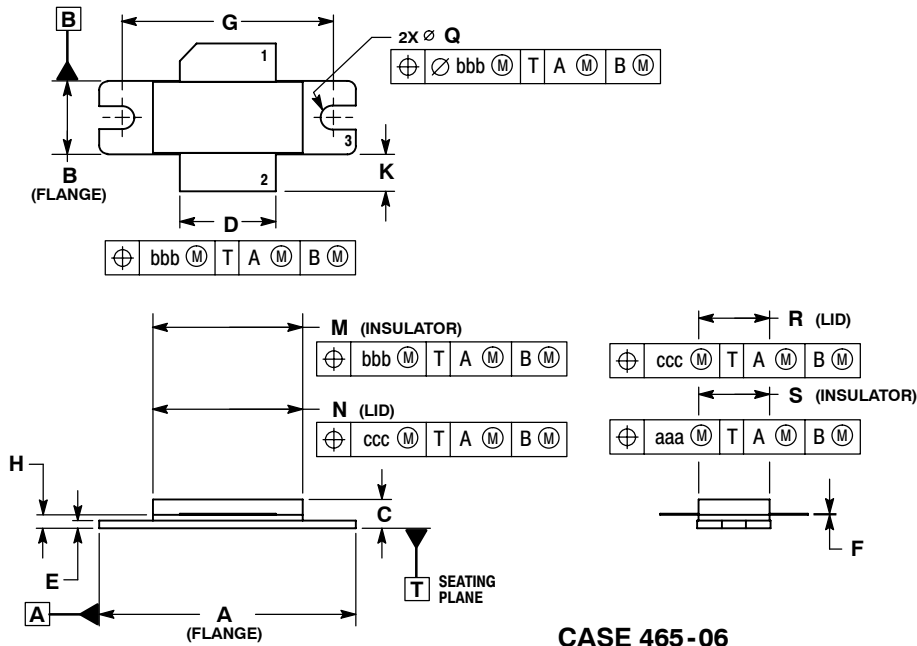


Figure 15. Series Equivalent Source and Load Impedance

PACKAGE DIMENSIONS

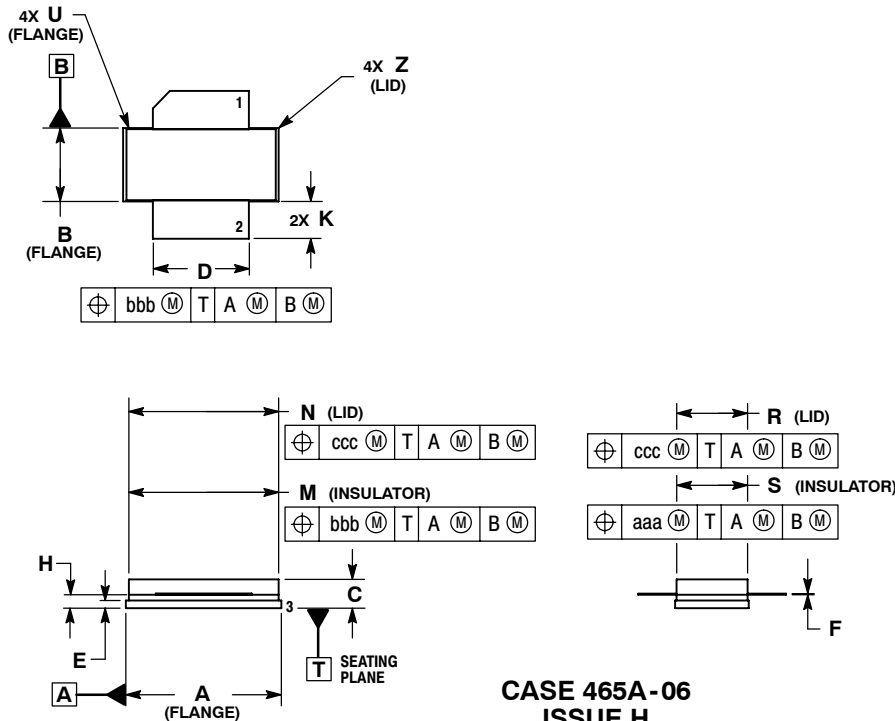


**CASE 465-06
ISSUE G
NI-780
MRF6S19120HR3**

- 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	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	$\varnothing$ 0.118	$\varnothing$ 0.138	$\varnothing$ 3.00	$\varnothing$ 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
 - GATE
 - SOURCE



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

- 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
 - GATE
 - SOURCE

MRF6S19120HR3 MRF6S19120HSR3

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	• Changed "Full Frequency Band" to "f = 1990 MHz" to match functional tests, p. 1 • Removed Lower Thermal Resistance and Low Gold Plating bullets from Features section as functionality is standard, p. 1 • Removed Total Device Dissipation from Max Ratings table as data was redundant (information already provided in Thermal Characteristics table), p. 1 • 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 • Corrected V_{DS} to V_{DD} in the RF test condition voltage callout for $V_{GS(Q)}$, and added "Measured in Functional Test", On Characteristics table, p. 2 • Removed Forward Transconductance from On Characteristics table as it no longer provided usable information, p. 2 • Updated PCB information to show more specific material details, Fig. 1, Test Circuit Schematic, p. 3 • Updated Part Numbers in Table 5, Component Designations and Values, to latest RoHS compliant part numbers, p. 3 • Removed lower voltage tests from Fig. 11, Power Gain versus Output Power, due to fixed tuned fixture limitations, p. 6 • Replaced Fig. 12, MTTF versus Junction Temperature with updated graph. Removed Amps² and listed operating characteristics and location of MTTF calculator for device, p. 7 • Updated ALT1 Bandwidth and Offset in Fig. 13, Single-Carrier CCDF N-CDMA, p. 7 • Updated -ALT1 and +ALT1 Bandwidths in Fig. 14, Single-Carrier N-CDMA Spectrum, p. 7 • Added Product Documentation and Revision History, p. 10

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