Freescale Semiconductor
Technical Data

Document Number: MRF7S19170H
Rev. 0, 10/2006

RoHS

RF Power Field Effect Transistors

N-Channel Enhancement-Mode Lateral MOSFETs

Designed for CDMA base station applications with frequencies from 1930 to 1990 MHz. Suitable for CDMA and multicarrier amplifier applications. To be used in Class AB and Class C for PCN-PCS/cellular radio and WLL applications.

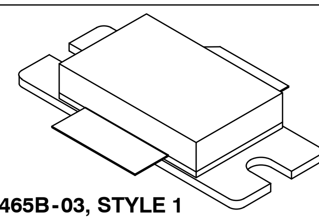
- Typical Single-Carrier W-CDMA Performance: V_{DD} = 28 Volts, I_{DQ} = 1400 mA, P_{out} = 50 Watts Avg., Full Frequency Band, 3GPP Test Model 1, 64 DPCH with 50% Clipping, Channel Bandwidth = 3.84 MHz, Input Signal PAR = 7.5 dB @ 0.01% Probability on CCDF.
  - Power Gain — 17.2 dB
  - Drain Efficiency — 32%
  - Device Output Signal PAR — 6.2 dB @ 0.01% Probability on CCDF
  - ACPR @ 5 MHz Offset — -37.5 dBc in 3.84 MHz Channel Bandwidth
- Capable of Handling 5:1 VSWR, @ 32 Vdc, 1960 MHz, 170 Watts CW Peak Tuned Output Power
- P_{out} @ 1 dB Compression Point ≥ 170 Watts CW

Features

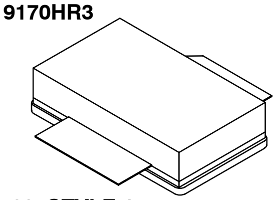
- 100% PAR Tested for Guaranteed Output Power Capability
- Characterized with Series Equivalent Large-Signal Impedance Parameters
- Internally Matched for Ease of Use
- Integrated ESD Protection
- Greater Negative Gate-Source Voltage Range for Improved Class C Operation
- Designed for Digital Predistortion Error Correction Systems
- RoHS Compliant
- In Tape and Reel. R3 Suffix = 250 Units per 56 mm, 13 inch Reel.

MRF7S19170HR3
MRF7S19170HSR3

1930-1990 MHz, 50 W AVG., 28 V
SINGLE W-CDMA
LATERAL N-CHANNEL
RF POWER MOSFETs



CASE 465B-03, STYLE 1
NI-880
MRF7S19170HR3



CASE 465C-02, STYLE 1
NI-880S
MRF7S19170HSR3

Table 1. Maximum Ratings

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DSS}	-0.5, +65	Vdc
Gate-Source Voltage	V_{GS}	-6.0, +10	Vdc
Operating Voltage	V_{DD}	32, +0	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 Case Temperature 80°C, 170 W CW Case Temperature 72°C, 25 W CW	$R_{\theta JC}$	 0.25 0.31	°C/W

1. Continuous use at maximum temperature will affect MTTF.
2. MTTF calculator available at http://www.freescale.com/rf. Select Tools/Software/Application Software/Calculators to access the 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.

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Table 3. ESD Protection Characteristics

Test Methodology	Class
Human Body Model (per JESD22-A114)	1A (Minimum)
Machine Model (per EIA/JESD22-A115)	B (Minimum)
Charge Device Model (per JESD22-C101)	IV (Minimum)

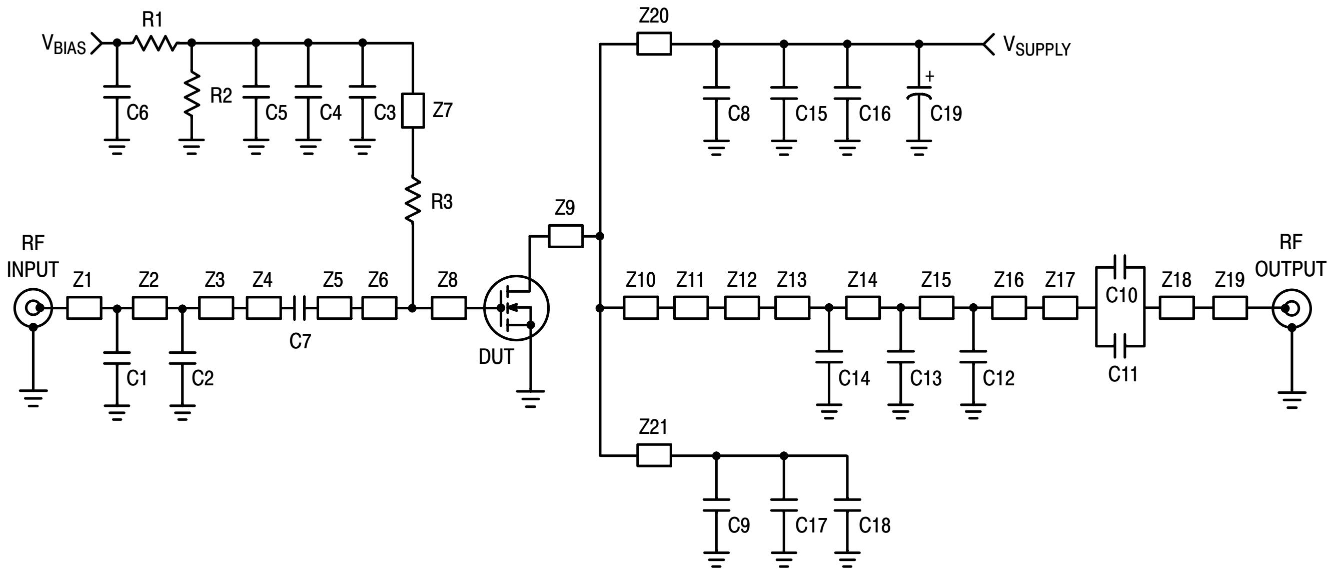
Table 4. Electrical Characteristics (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
Off Characteristics					
Zero Gate Voltage Drain Leakage Current (V_{DS} = 65 Vdc, V_{GS} = 0 Vdc)	I_{DSS}	—	—	10	μAdc
Zero Gate Voltage Drain Leakage Current (V_{DS} = 28 Vdc, V_{GS} = 0 Vdc)	I_{DSS}	—	—	1	μAdc
Gate-Source Leakage Current (V_{GS} = 5 Vdc, V_{DS} = 0 Vdc)	I_{GSS}	—	—	1	μAdc
On Characteristics					
Gate Threshold Voltage (V_{DS} = 10 Vdc, I_D = 372 μAdc)	$V_{GS(th)}$	1.2	2	2.7	Vdc
Gate Quiescent Voltage (V_{DS} = 28 Vdc, I_D = 1400 mAdc)	$V_{GS(Q)}$	—	2.7	—	Vdc
Fixture Gate Quiescent Voltage (1) (V_{DS} = 28 Vdc, I_D = 1400 mAdc, Measured in Functional Test)	$V_{GG(Q)}$	4	5.4	7.6	Vdc
Drain-Source On-Voltage (V_{GS} = 10 Vdc, I_D = 3.72 Adc)	$V_{DS(on)}$	0.1	0.15	0.3	Vdc
Dynamic Characteristics (2)					
Reverse Transfer Capacitance (V_{DS} = 28 Vdc ± 30 mV(rms)ac @ 1 MHz, V_{GS} = 0 Vdc)	C_{rss}	—	0.9	—	pF
Output Capacitance (V_{DS} = 28 Vdc ± 30 mV(rms)ac @ 1 MHz, V_{GS} = 0 Vdc)	C_{oss}	—	703	—	pF
Functional Tests (In Freescale Test Fixture, 50 ohm system) V_{DD} = 28 Vdc, I_{DQ} = 1400 mA, P_{out} = 50 W Avg., f = 1932.5 MHz and f = 1987.5 MHz, Single-Carrier W-CDMA, 3GPP Test Model 1, 64 DPCH, 50% Clipping, PAR = 7.5 dB @ 0.01% Probability on CCDF. ACPR measured in 3.84 MHz Channel Bandwidth @ ±5 MHz Offset.					
Power Gain	G_{ps}	16	17.2	19	dB
Drain Efficiency	η_D	29	32	—	%
Output Peak-to-Average Ratio @ 0.01% Probability on CCDF	PAR	5.7	6.2	—	dB
Adjacent Channel Power Ratio	ACPR	—	-37.5	-35	dBc
Input Return Loss	IRL	—	-16	-9	dB

1. V_{GG} = 2 x $V_{GS(Q)}$. Parameter measured on Freescale Test Fixture, due to resistive divider network on the board. Refer to Test Circuit schematic.
2. Part internally matched both on input and output.

Table 4. Electrical Characteristics (T_C = 25°C unless otherwise noted) **— continued**

Characteristic	Symbol	Min	Typ	Max	Unit
Typical Performances (In Freescale Test Fixture, 50 ohm system) V_{DD} = 28 Vdc, I_{DQ} = 1400 mA, 1930-1990 MHz Bandwidth					
Video Bandwidth (Tone Spacing from 100 kHz to VBW) ΔIMD3 = IMD3 @ VBW frequency - IMD3 @ 100 kHz <1 dBc (both sidebands)	VBW	—	25	—	MHz
Gain Flatness in 60 MHz Bandwidth @ P_{out} = 170 W CW	G_F	—	0.5	—	dB
Deviation from Linear Phase in 60 MHz Bandwidth @ P_{out} = 170 W CW	Φ	—	2.06	—	°
Group Delay @ P_{out} = 170 W CW, f = 1960 MHz	Delay	—	4.7	—	ns
Part-to-Part Insertion Phase Variation @ P_{out} = 170 W CW, f = 1960 MHz	ΔΦ	—	16	—	°
Gain Variation over Temperature	ΔG	—	0.015	—	dB/°C
Output Power Variation over Temperature	ΔP1dB	—	0.01	—	dBm/°C



Z1*	0.588″ x 0.083″ Microstrip	Z12	0.060″ x 0.420″ Microstrip
Z2*	0.146″ x 0.083″ Microstrip	Z13*	0.197″ x 0.083″ Microstrip
Z3*	0.068″ x 0.083″ Microstrip	Z14*	0.332″ x 0.083″ Microstrip
Z4	0.865″ x 0.098″ Microstrip	Z15*	0.158″ x 0.083″ Microstrip
Z5	0.154″ x 0.098″ Microstrip	Z16*	0.572″ x 0.083″ Microstrip
Z6	0.271″ x 0.787″ Microstrip	Z17, Z18	0.063″ x 0.220″ Microstrip
Z7	1.410″ x 0.080″ Microstrip	Z19	0.160″ x 0.083″ Microstrip
Z8	0.194″ x 0.787″ Microstrip	Z20, Z21	1.120″ x 0.080″ Microstrip
Z9	0.115″ x 1.360″ Microstrip	PCB	Taconic TLX-0300, 0.030″, ε_r = 2.5
Z10	0.230″ x 1.360″ Microstrip		* Variable for tuning
Z11	0.185″ x 1.120″ Microstrip		

Figure 1. MRF7S19170HR3(HSR3) Test Circuit Schematic

Table 5. MRF7S19170HR3(HSR3) Test Circuit Component Designations and Values

Part	Description	Part Number	Manufacturer
C1, C2	1.8 pF Chip Capacitors	100B1R8BW	ATC
C3, C8, C9, C10, C11	8.2 pF Chip Capacitors	100B8R2CW	ATC
C4	100 pF Chip Capacitor	100B101JW	ATC
C5	100 nF Chip Capacitor	200B104MW	ATC
C6, C15, C16, C17, C18	10 μF Chip Capacitors	C5750X5R1H106MT	TDK
C7	0.5 pF Chip Capacitor	100B0R5BW	ATC
C12	1.5 pF Chip Capacitor	100B1R5BW	ATC
C13	0.3 pF Chip Capacitor	100B0R3BW	ATC
C14	0.8 pF Chip Capacitor	100B0R8BW	ATC
C19	470 μF, 63 V Electrolytic Capacitor, Axial	516D477M063PS7B	Sprague
R1, R2	10 kΩ, 1/4 W Chip Resistors	CRCW12061001FKTA	Vishay
R3	10 Ω, 1/4 W Chip Resistor	CRCW120610R0FKTA	Vishay

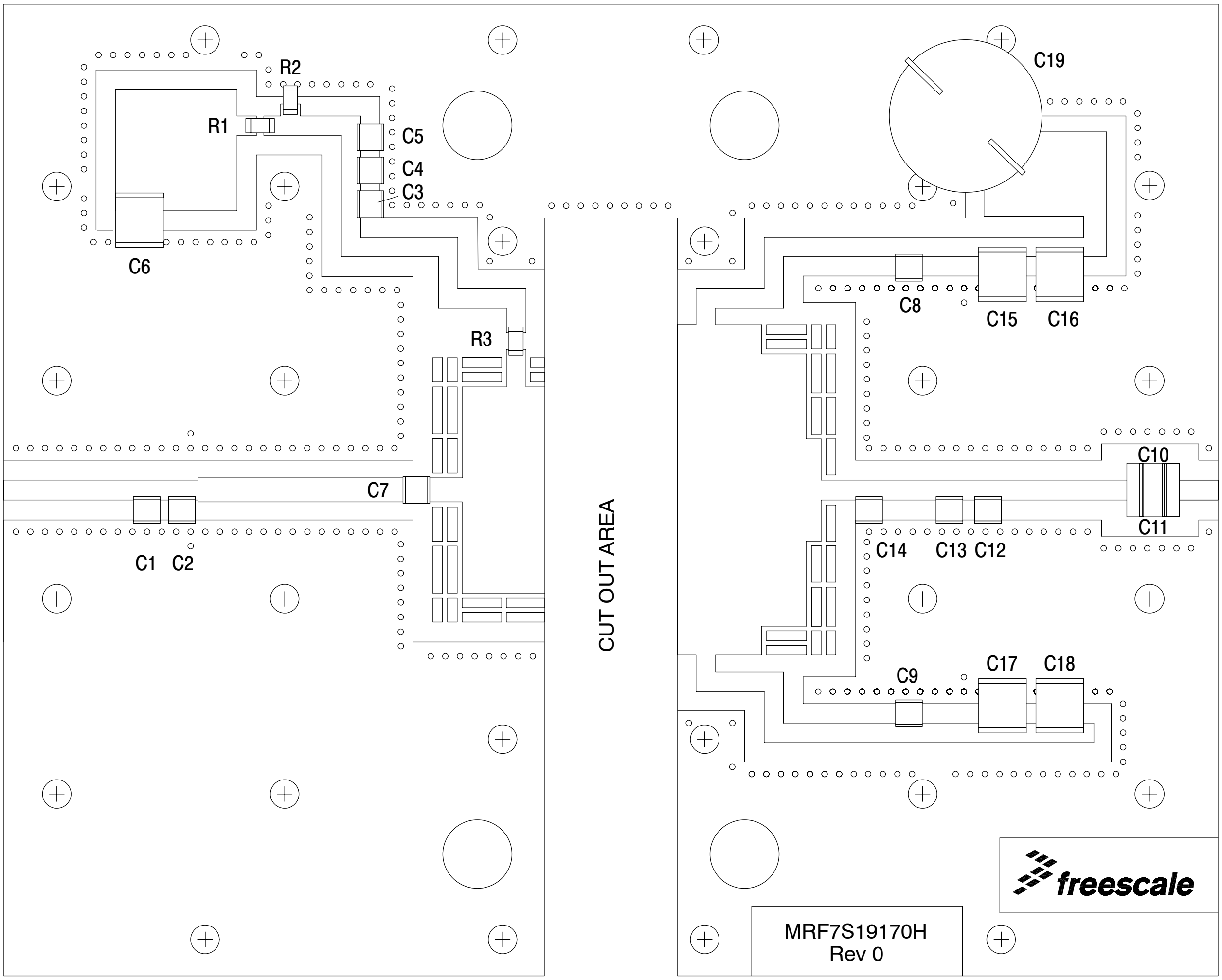


Figure 2. MRF7S19170HR3(HSR3) Test Circuit Component Layout

TYPICAL CHARACTERISTICS

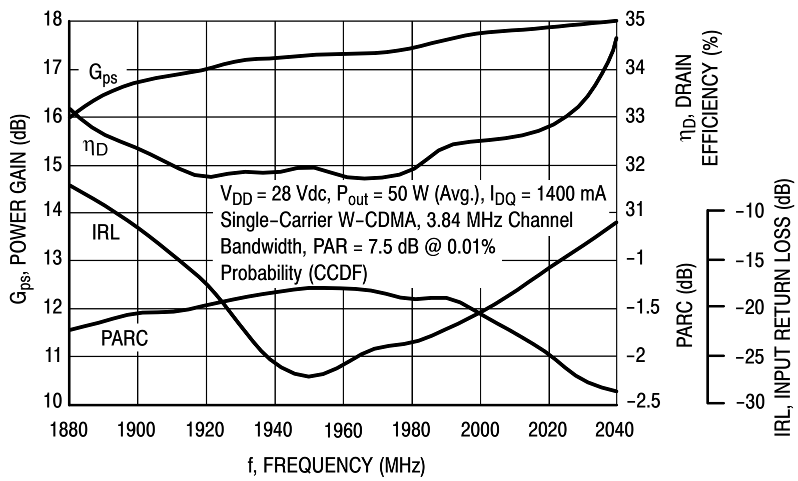


Figure 3. Output Peak-to-Average Ratio Compression (PARC) Broadband Performance @ P_{out} = 50 Watts Avg.

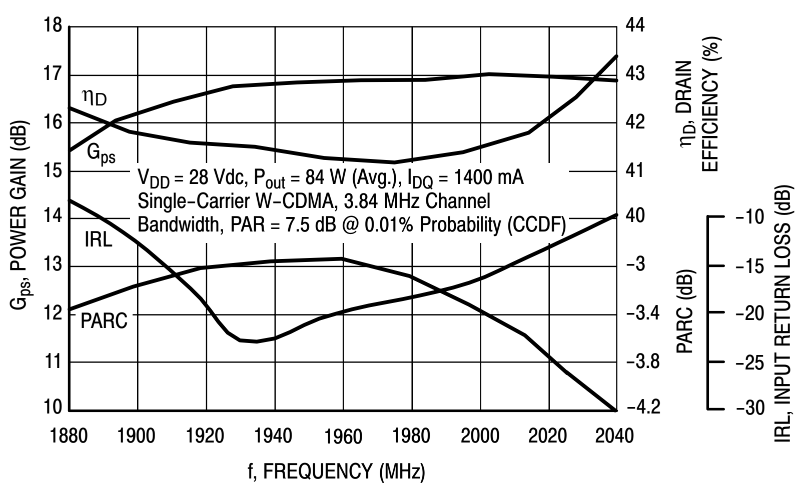


Figure 4. Output Peak-to-Average Ratio Compression (PARC) Broadband Performance @ P_{out} = 84 Watts Avg.

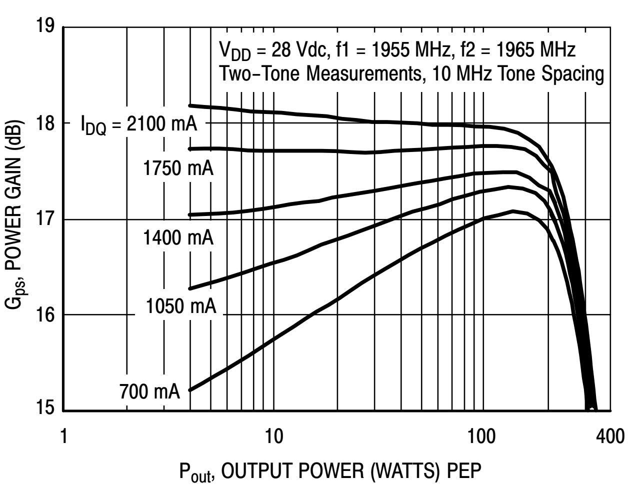


Figure 5. Two-Tone Power Gain versus Output Power

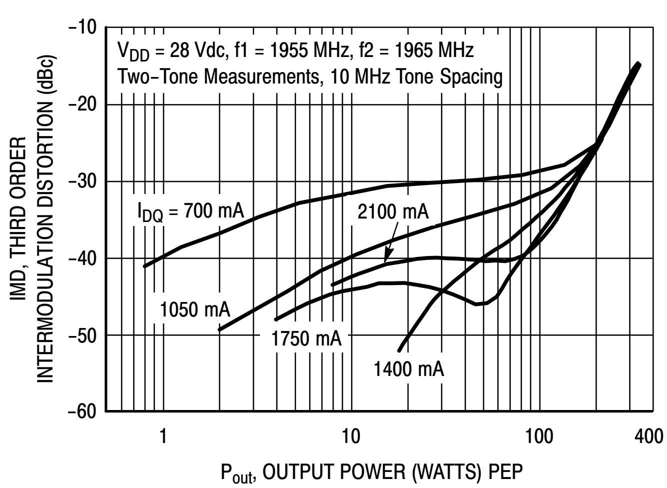


Figure 6. Third Order Intermodulation Distortion versus Output Power

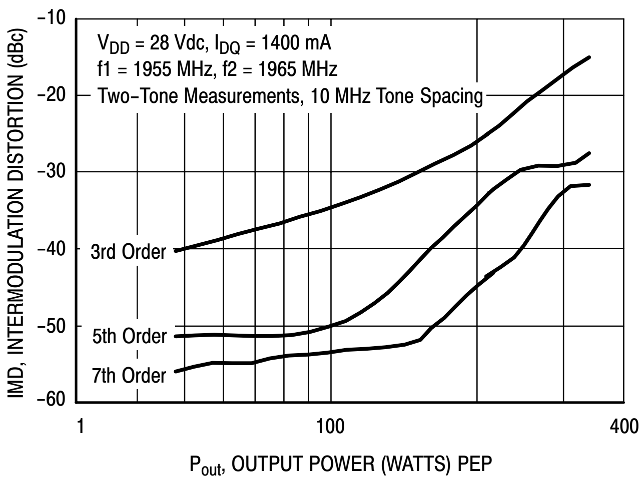


Figure 7. Intermodulation Distortion Products versus Output Power

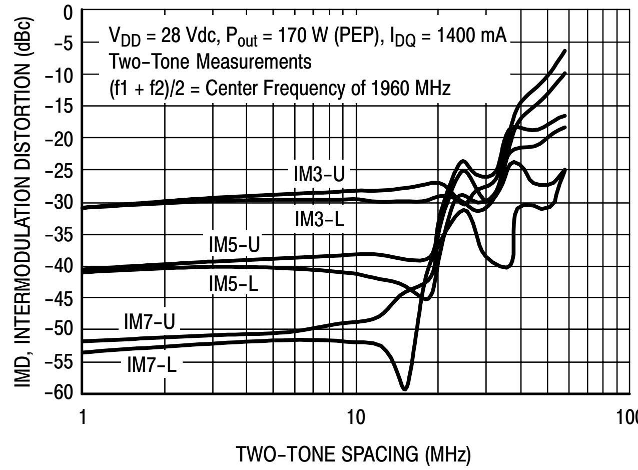


Figure 8. Intermodulation Distortion Products versus Tone Spacing

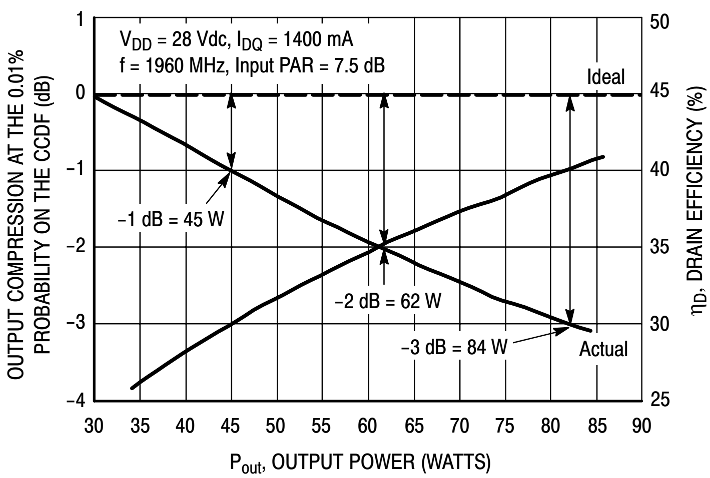


Figure 9. Output Peak-to-Average Ratio Compression (PARC) versus Output Power

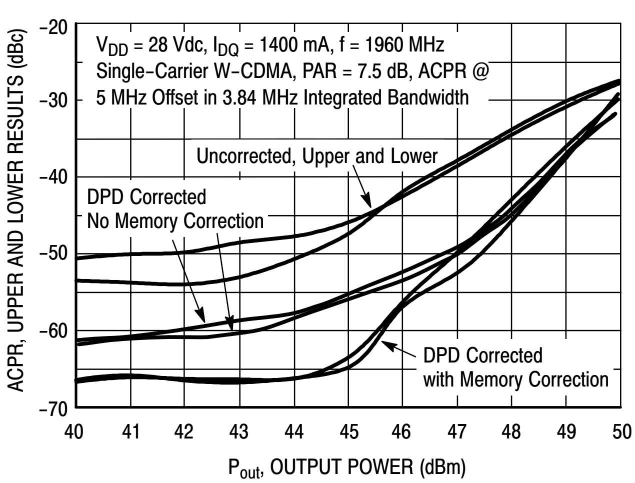


Figure 10. Digital Predistortion Correction versus ACPR and Output Power

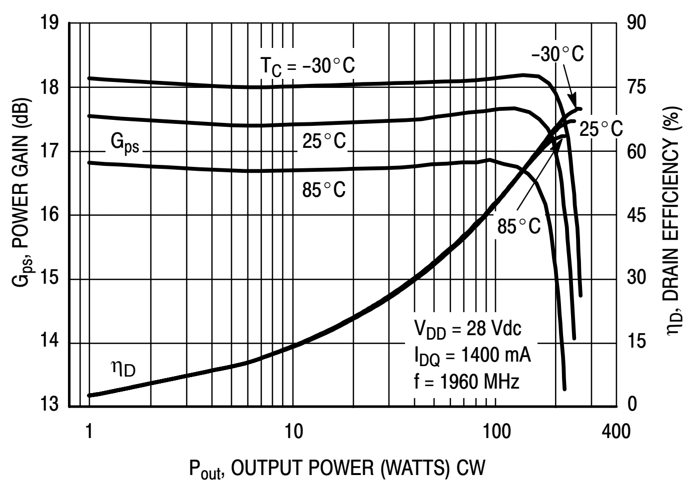


Figure 11. Power Gain and Drain Efficiency versus CW Output Power

TYPICAL CHARACTERISTICS

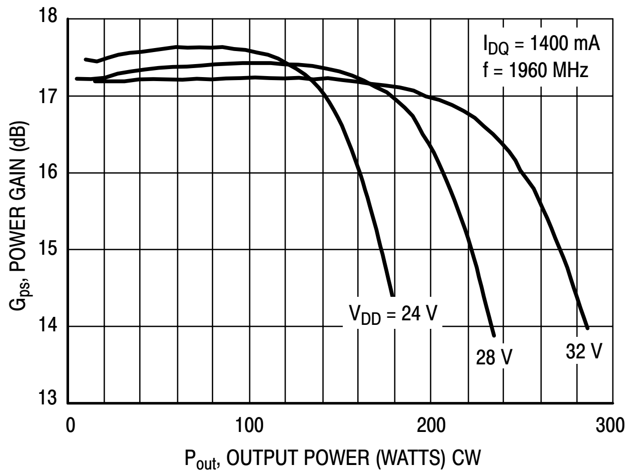
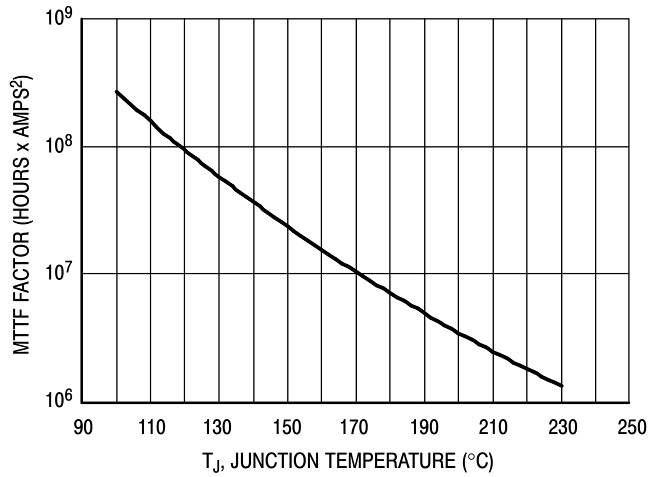


Figure 12. Power Gain versus Output Power



This above graph displays calculated MTTF in hours x ampere^2 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 13. MTTF Factor versus Junction Temperature

W-CDMA TEST SIGNAL

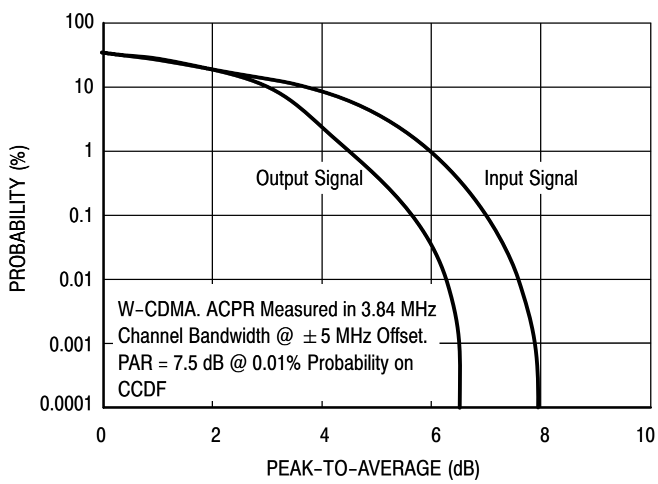


Figure 14. CCDF W-CDMA 3GPP, Test Model 1, 64 DPCH, 50% Clipping, Single-Carrier Test Signal

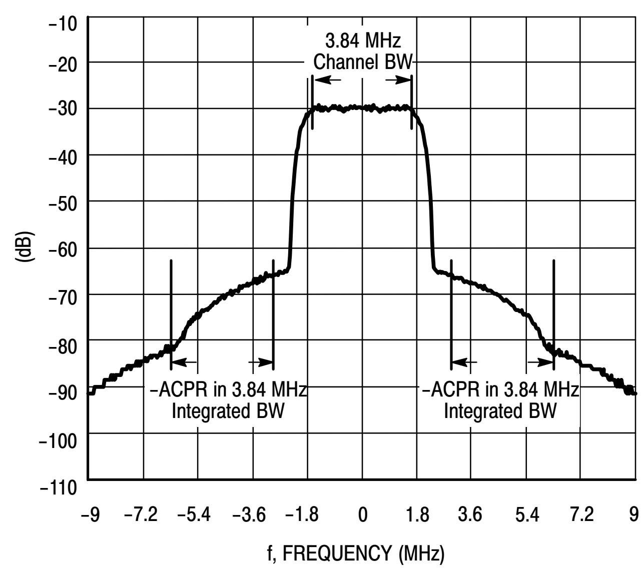
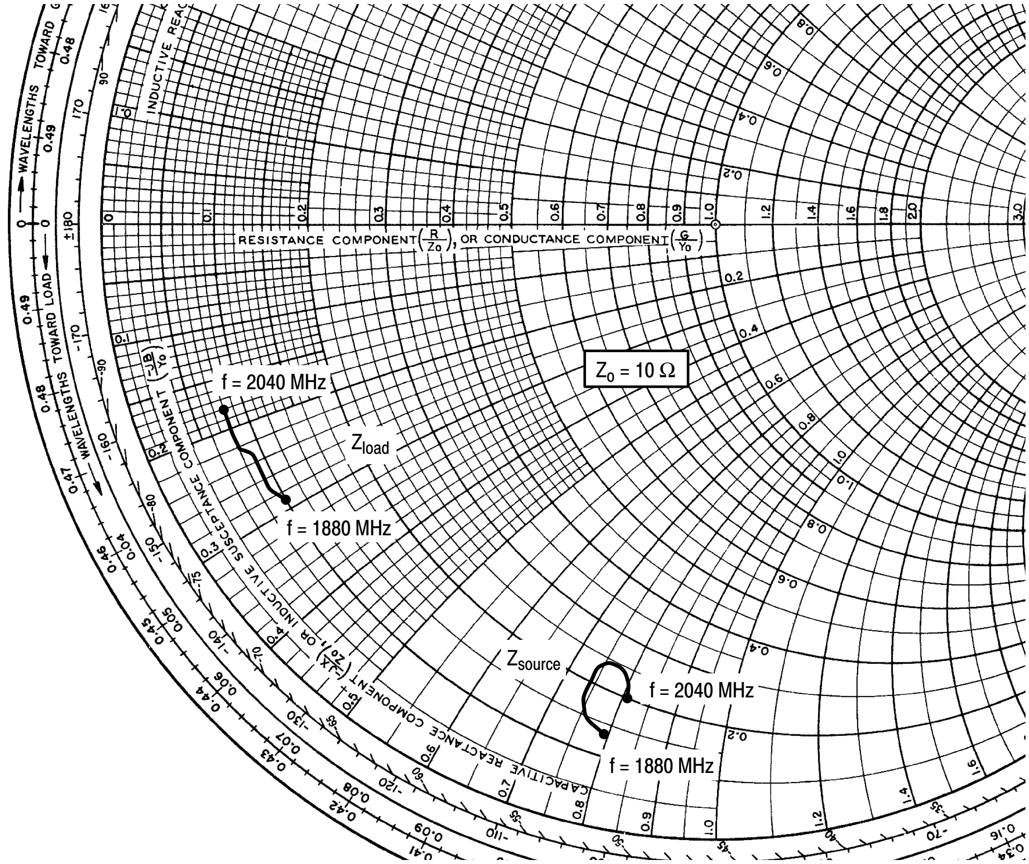


Figure 15. Single-Carrier W-CDMA Spectrum



V_{DD} = 28 Vdc, I_{DQ} = 1400 mA, P_{out} = 50 W CW Avg.

f MHz	Z_{source} Ω	Z_{load} Ω
1880	1.338 - j7.859	0.967 - j2.868
1900	1.515 - j7.609	0.942 - j2.725
1920	1.743 - j7.432	0.920 - j2.585
1940	2.007 - j7.352	0.893 - j2.449
1960	2.249 - j7.393	0.865 - j2.313
1980	2.410 - j7.553	0.841 - j2.192
2000	2.411 - j7.788	0.820 - j2.073
2020	2.244 - j7.995	0.802 - j1.957
2040	1.966 - j8.101	0.779 - j1.834

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

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

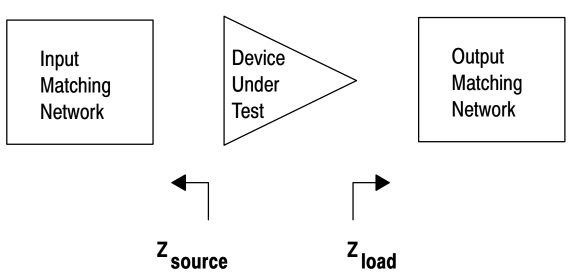
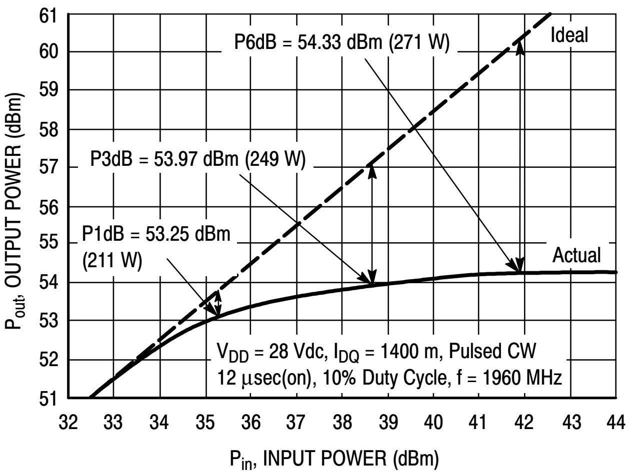


Figure 16. Series Equivalent Source and Load Impedance

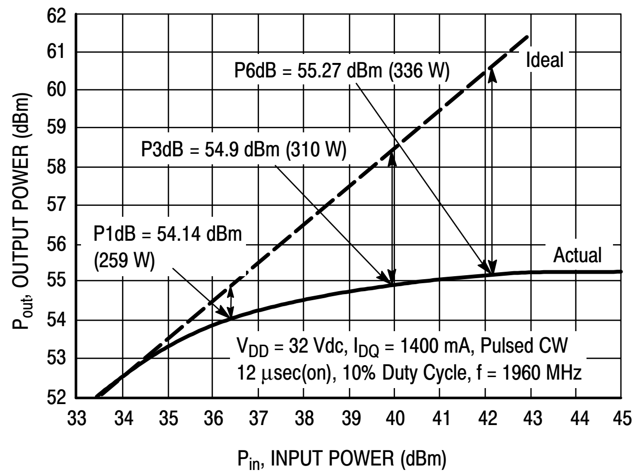


NOTE: Measured in a Peak Tuned Load Pull Fixture

Test Impedances per Compression Level

	Z_{source} Ω	Z_{load} Ω
P3dB	2.34 - j9.24	0.79 - j2.94

Figure 17. Pulsed CW Output Power versus Input Power



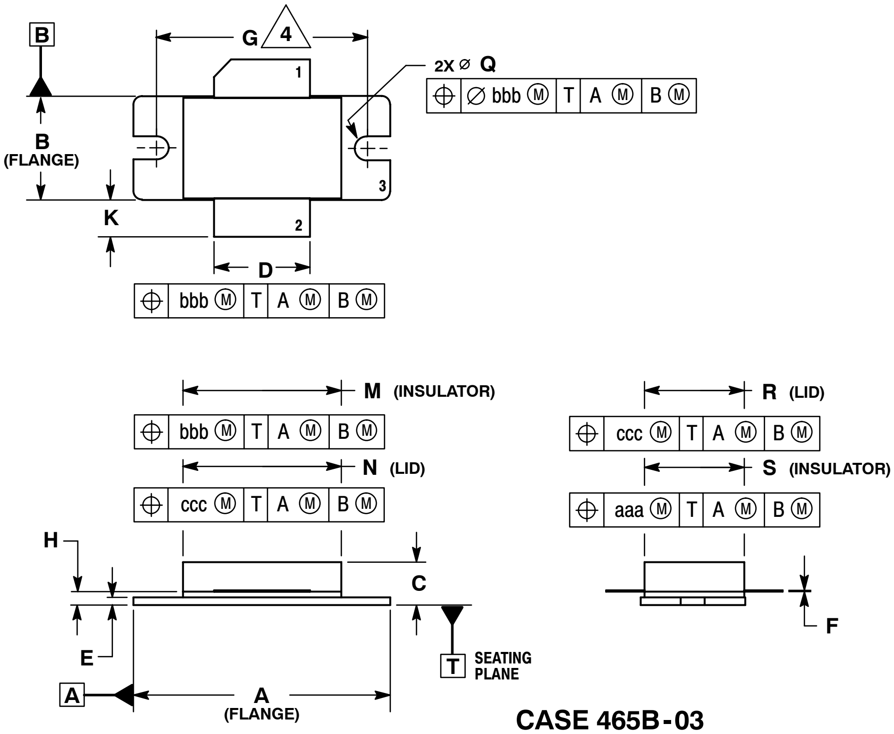
NOTE: Measured in a Peak Tuned Load Pull Fixture

Test Impedances per Compression Level

	Z_{source} Ω	Z_{load} Ω
P3dB	2.34 - j9.24	0.79 - j2.94

Figure 18. Pulsed CW Output Power versus Input Power

PACKAGE DIMENSIONS

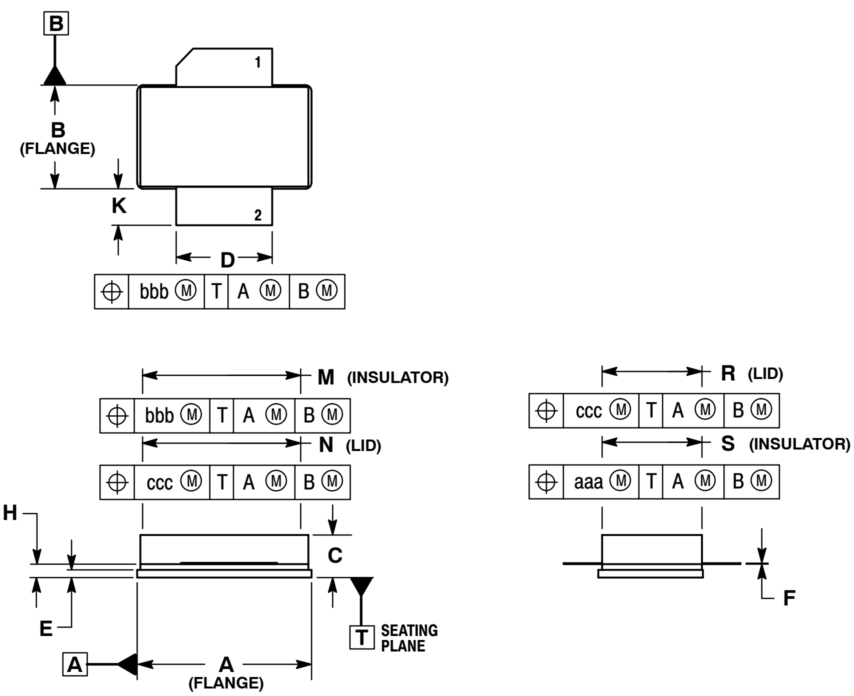


NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M-1994.
2. CONTROLLING DIMENSION: INCH.
3. DIMENSION H IS MEASURED 0.030 (0.762) AWAY FROM PACKAGE BODY.
4. RECOMMENDED BOLT CENTER DIMENSION OF 1.16 (29.57) BASED ON M3 SCREW.

	INCHES		MILLIMETERS	
DIM	MIN	MAX	MIN	MAX
A	1.335	1.345	33.91	34.16
B	0.535	0.545	13.6	13.8
C	0.147	0.200	3.73	5.08
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	0.175	0.205	4.44	5.21
M	0.872	0.888	22.15	22.55
N	0.871	0.889	19.30	22.60
Q	Ø.118	Ø.138	Ø3.00	Ø3.51
R	0.515	0.525	13.10	13.30
S	0.515	0.525	13.10	13.30
aaa	0.007 REF		0.178 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 465B-03
ISSUE D
NI-880
MRF7S19170H



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	INCHES		MILLIMETERS	
DIM	MIN	MAX	MIN	MAX
A	0.905	0.915	22.99	23.24
B	0.535	0.545	13.60	13.80
C	0.147	0.200	3.73	5.08
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	0.872	0.888	22.15	22.55
N	0.871	0.889	19.30	22.60
R	0.515	0.525	13.10	13.30
S	0.515	0.525	13.10	13.30
aaa	0.007 REF		0.178 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 465C-02
ISSUE D
NI-880S
MRF7S19170HS

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
0	Oct. 2006	• Initial Release of Data Sheet

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