RF Power Field Effect Transistor

N-Channel Enhancement-Mode Lateral MOSFET

Designed for N-CDMA base station applications with frequencies from 869 to 960 MHz. Suitable for multicarrier amplifier applications.

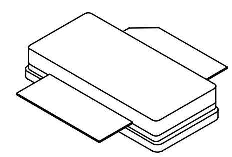
- Typical Single-Carrier N-CDMA Performance @ 880 MHz: V_{DD} = 28 Volts, I_{DQ} = 1500 mA, P_{out} = 33 Watts Avg., IS-95 CDMA (Pilot, Sync, Paging, Traffic Codes 8 Through 13). Channel Bandwidth = 1.2288 MHz. PAR = 9.8 dB @ 0.01% Probability on CCDF.
  Power Gain — 19.7 dB
  Drain Efficiency — 28.4%
  ACPR @ 750 kHz Offset — -46.8 dBc in 30 kHz Bandwidth
- Capable of Handling 10:1 VSWR, @ 28 Vdc, 880 MHz, 150 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, 40μ″ Nominal.
- RoHS Compliant
- In Tape and Reel. R3 Suffix = 250 Units per 56 mm, 13 inch Reel.

MRF5S9150HSR3

**880 MHz, 33 W AVG., 28 V
SINGLE N-CDMA
LATERAL N-CHANNEL
RF POWER MOSFET**



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

Table 1. Maximum Ratings

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DSS}	-0.5, +68	Vdc
Gate-Source Voltage	V_{GS}	-0.5, +15	Vdc
Storage Temperature Range	T_{stg}	- 65 to +150	°C
Case Operating Temperature	T_C	150	°C
Operating Junction Temperature	T_J	200	°C

Table 2. Thermal Characteristics

Characteristic	Symbol	Value (1)	Unit
Thermal Resistance, Junction to Case Case Temperature 80°C, 150 W CW Case Temperature 76°C, 33 W CW	$R_{\theta JC}$	 0.34 0.34	°C/W

Table 3. ESD Protection Characteristics

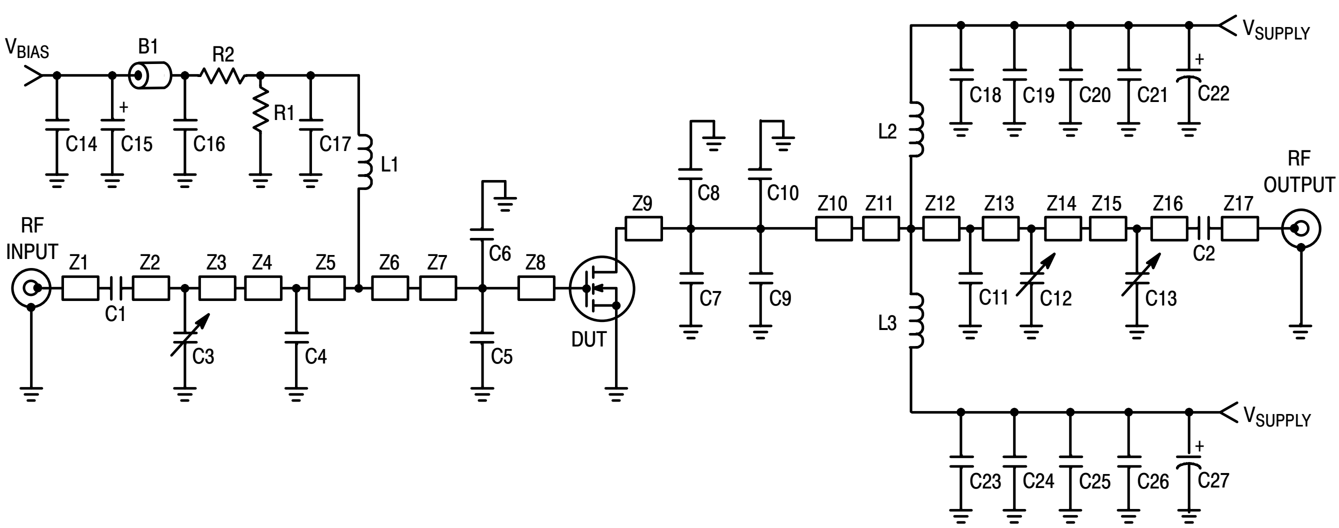
Test Methodology	Class
Human Body Model (per JESD22-A114)	1C (Minimum)
Machine Model (per EIA/JESD22-A115)	A (Minimum)
Charge Device Model (per JESD22-C101)	III (Minimum)

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

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} = 68 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}	—	—	500	nAdc
On Characteristics					
Gate Threshold Voltage (V_{DS} = 10 Vdc, I_D = 600 μAdc)	$V_{GS(th)}$	2	3	4	Vdc
Gate Quiescent Voltage (V_{DS} = 28 Vdc, I_D = 1500 mAdc, Measured in Functional Test)	$V_{GS(Q)}$	3	4	5	Vdc
Drain-Source On-Voltage (V_{GS} = 10 Vdc, I_D = 3.15 Adc)	$V_{DS(on)}$	0.1	0.2	0.3	Vdc
Dynamic Characteristics (1)					
Reverse Transfer Capacitance (V_{DS} = 28 Vdc ± 30 mV(rms)ac @ 1 MHz, V_{GS} = 0 Vdc)	C_{rss}	—	3.1	—	pF
Output Capacitance (V_{DS} = 28 Vdc ± 30 mV(rms)ac @ 1 MHz, V_{GS} = 0 Vdc)	C_{oss}	—	91.5	—	pF
Functional Tests (In Freescale Test Fixture, 50 ohm system) V_{DD} = 28 Vdc, I_{DQ} = 1500 mA, P_{out} = 33 W Avg. N-CDMA, f = 880 MHz, Single-Carrier N-CDMA, 1.2288 MHz Channel Bandwidth Carrier. ACPR measured in 30 kHz Channel Bandwidth @ ±750 kHz Offset. PAR = 9.8 dB @ 0.01% Probability on CCDF.					
Power Gain	G_{ps}	18.5	19.7	21.5	dB
Drain Efficiency	η_D	26.5	28.4	—	%
Adjacent Channel Power Ratio	ACPR	—	-46.8	-45	dBc
Input Return Loss	IRL	—	-20	-9	dB

1. Part internally input matched.



Z1	0.416″ x 0.080″ Microstrip	Z10	0.105″ x 0.630″ Microstrip
Z2	0.851″ x 0.080″ Microstrip	Z11	0.200″ x 0.630″ x 0.220″ Taper
Z3, Z17	0.410″ x 0.080″ Microstrip	Z12	0.236″ x 0.220″ Microstrip
Z4	0.055″ x 0.220″ Microstrip	Z13	0.195″ x 0.220″ Microstrip
Z5	0.434″ x 0.220″ Microstrip	Z14	0.059″ x 0.220″ Microstrip
Z6	0.200″ x 0.220″ x 0.630″ Taper	Z15	0.989″ x 0.080″ Microstrip
Z7	0.077″ x 0.630″ Microstrip	Z16	0.284″ x 0.080″ Microstrip
Z8	0.221″ x 0.630″ Microstrip	PCB	Arlon GX-0300-55-22, 0.030″, ε_r = 2.55
Z9	0.193″ x 0.630″ Microstrip		

Figure 1. MRF5S9150HSR3 Test Circuit Schematic

Table 5. MRF5S9150HSR3 Test Circuit Component Designations and Values

Part	Description	Part Number	Manufacturer
B1	Small Ferrite Bead	2743019447	Fair Rite
C1, C2, C17	47 pF Chip Capacitors	ATC100B470JT500XT	ATC
C3, C12	0.8-8.0 pF Variable Capacitors, Gigatrim	27291SL	Johanson
C4	13 pF Chip Capacitor	ATC100B130JT500XT	ATC
C5, C6	15 pF Chip Capacitors	ATC100B150JT500XT	ATC
C7, C8	12 pF Chip Capacitors	ATC100B120JT500XT	ATC
C9, C10	4.3 pF Chip Capacitors	ATC100B4R3JT500XT	ATC
C11	8.2 pF Chip Capacitor	ATC100B8R2JT500XT	ATC
C13	0.6-4.5 pF Variable Capacitor, Gigatrim	27271SL	Johanson
C14	22 pF Chip Capacitor	ATC100B220JT500XT	ATC
C15	1 μF, 50 V Tantalum Capacitor	T491C105K050AT	Kemit
C16	20K pF Chip Capacitor	CDR35BP203AKYM	Kemit
C18, C23	180 pF Chip Capacitors	ATC100B181JT500XT	ATC
C19, C20, C21, C24, C25, C26	10 μF, 50 V Chip Capacitors	GRM55DR61H106KA88B	Murata
C22, C27	470 μF, 63 V Electrolytic Capacitors	EMVY630GTR471MMH0S	Nippon Chemi-Con
L1, L2, L3	12.5 nH Inductors	A04T	Coilcraft
R1	180 kΩ, 1/4 W Chip Resistor	CRCW12061803FKEA	Vishay
R2	10 Ω, 1/4 W Chip Resistor	CRCW120610R0FKEA	Vishay

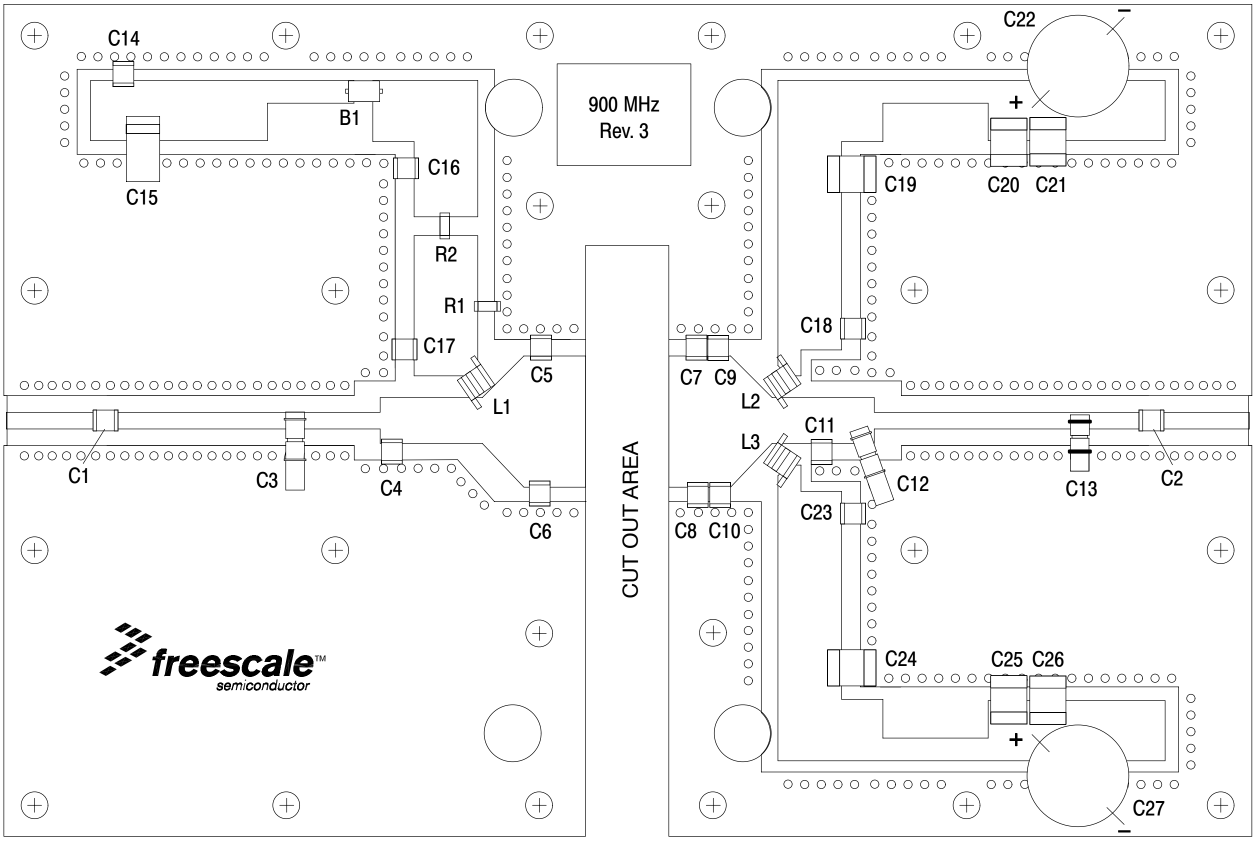


Figure 2. MRF5S9150HSR3 Test Circuit Component Layout

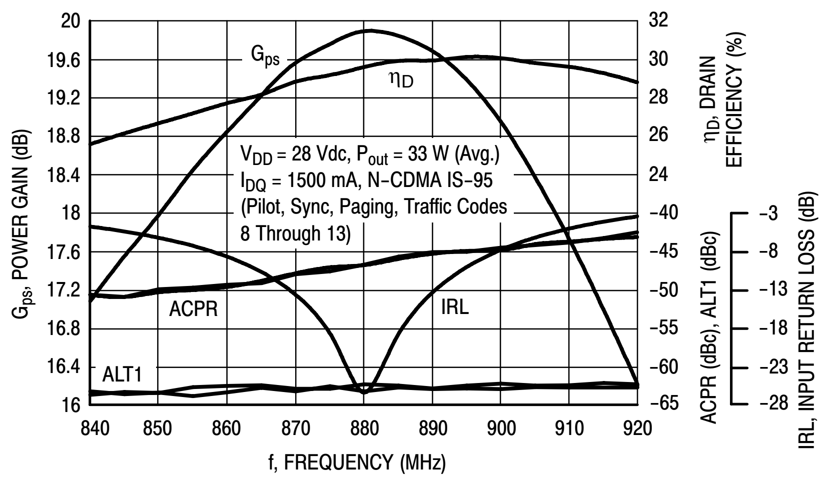


Figure 3. Single-Carrier N-CDMA Broadband Performance @ P_{out} = 33 Watts Avg.

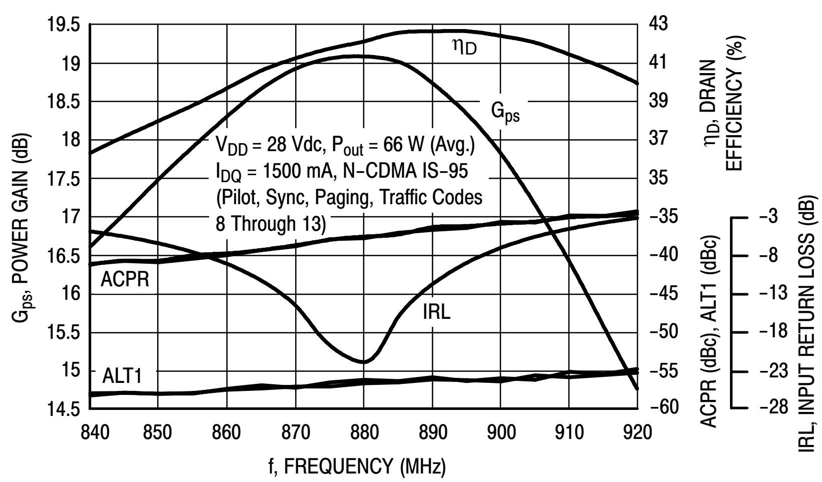


Figure 4. Single-Carrier N-CDMA Broadband Performance @ P_{out} = 66 Watts Avg.

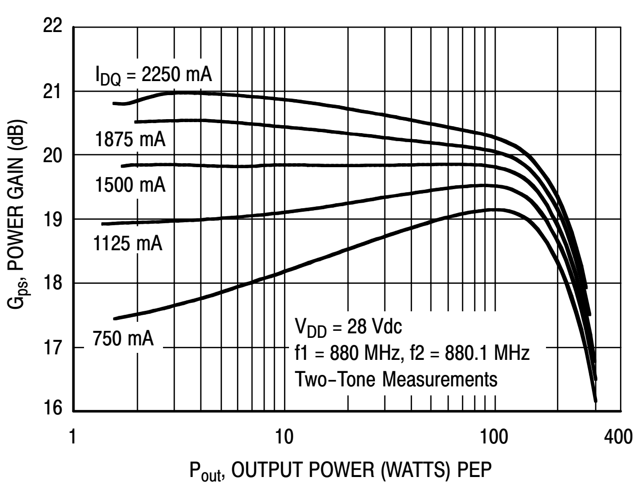


Figure 5. Two-Tone Power Gain versus Output Power

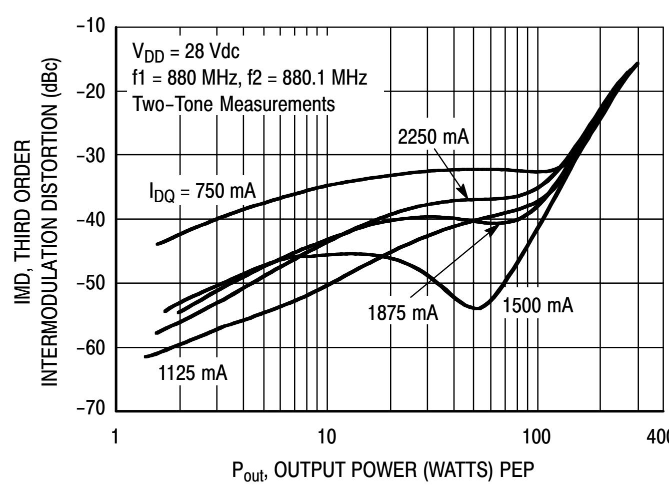


Figure 6. Third Order Intermodulation Distortion versus Output Power

TYPICAL CHARACTERISTICS

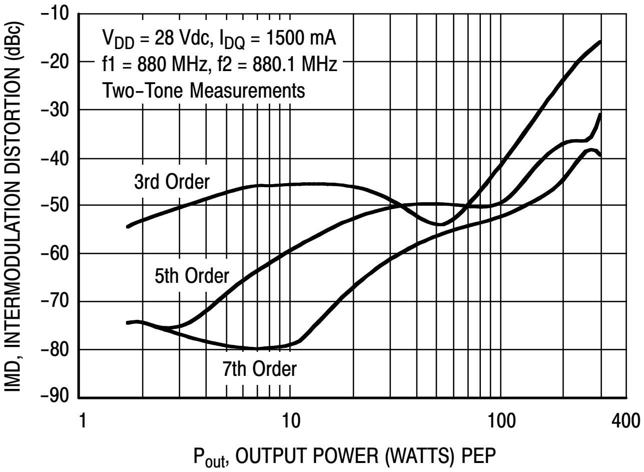


Figure 7. Intermodulation Distortion Products versus Output Power

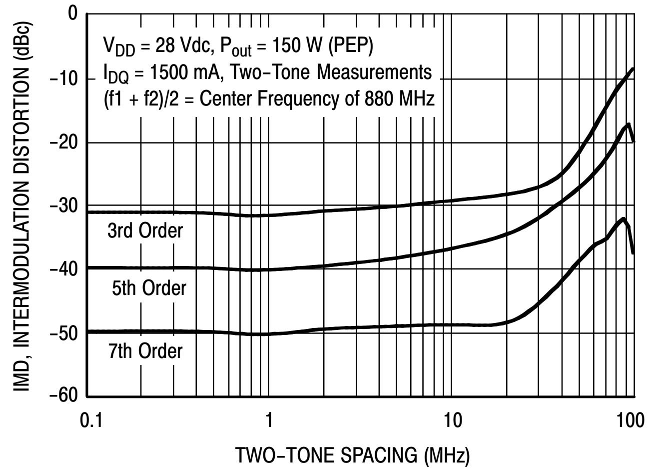


Figure 8. Intermodulation Distortion Products versus Tone Spacing

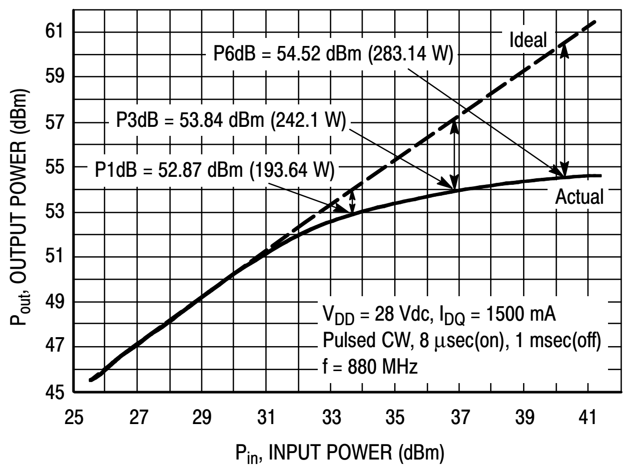


Figure 9. Pulse CW Output Power versus Input Power

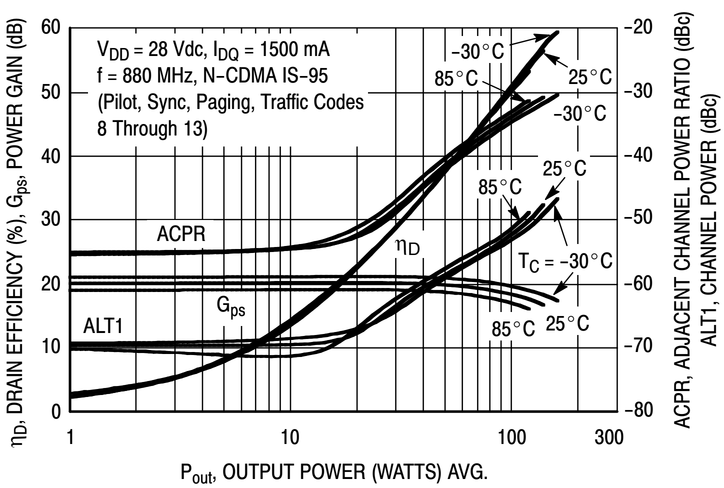


Figure 10. Single-Carrier N-CDMA ACPR, ALT1, Power Gain and Drain Efficiency versus Output Power

TYPICAL CHARACTERISTICS

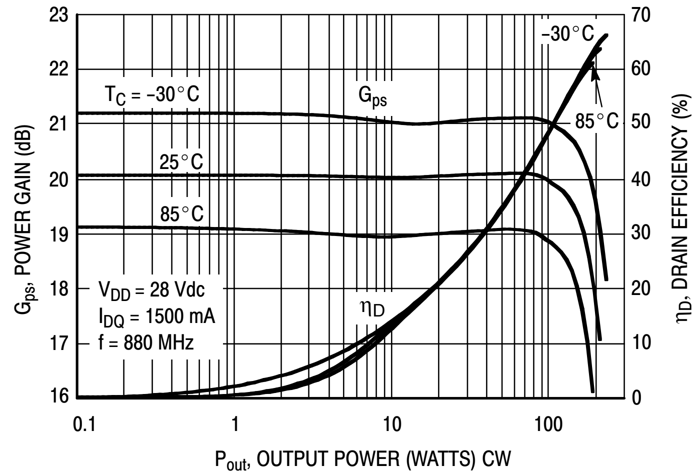


Figure 11. Power Gain and Drain Efficiency versus CW Output Power

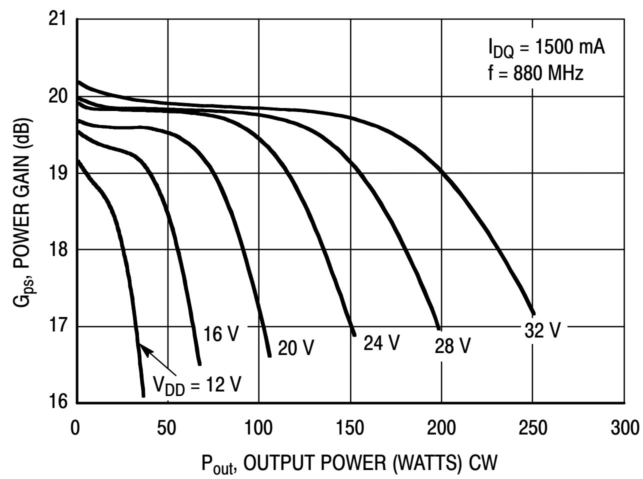
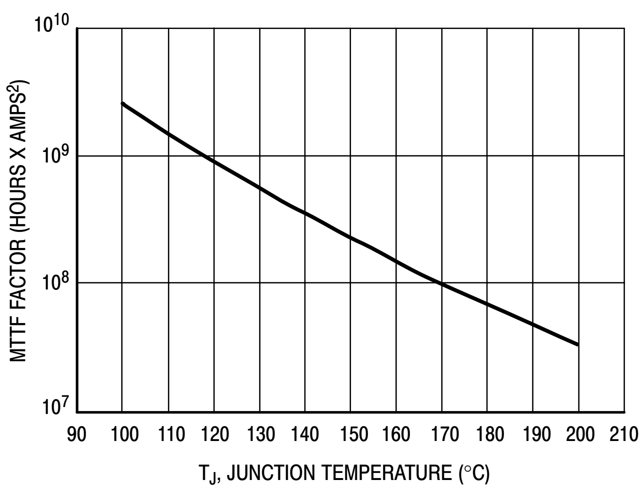


Figure 12. Power Gain versus Output Power



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

N-CDMA TEST SIGNAL

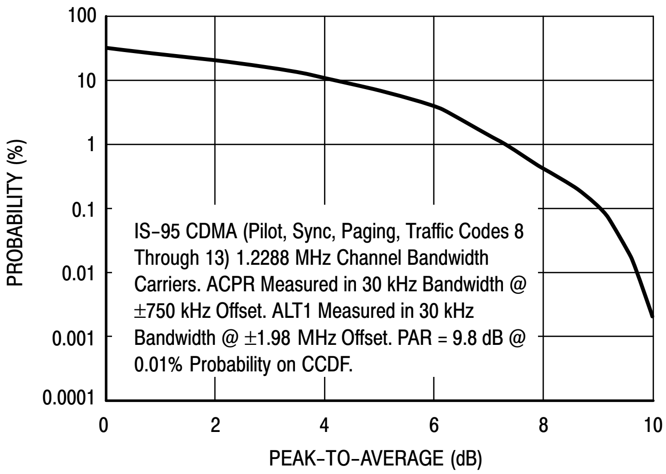


Figure 14. Single-Carrier CCDF N-CDMA

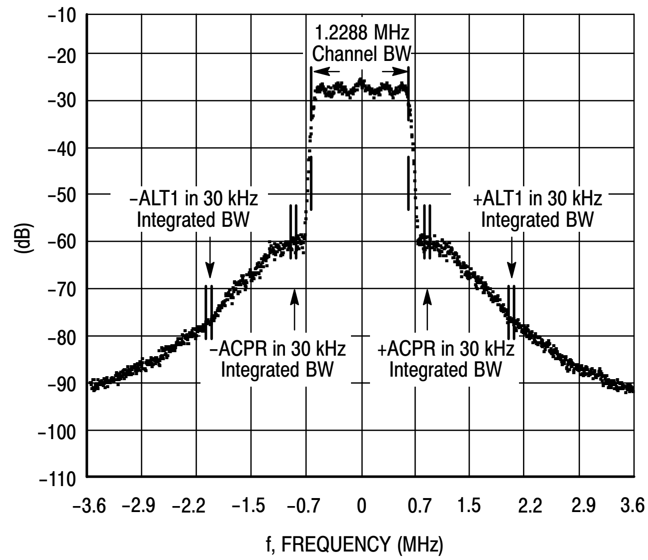
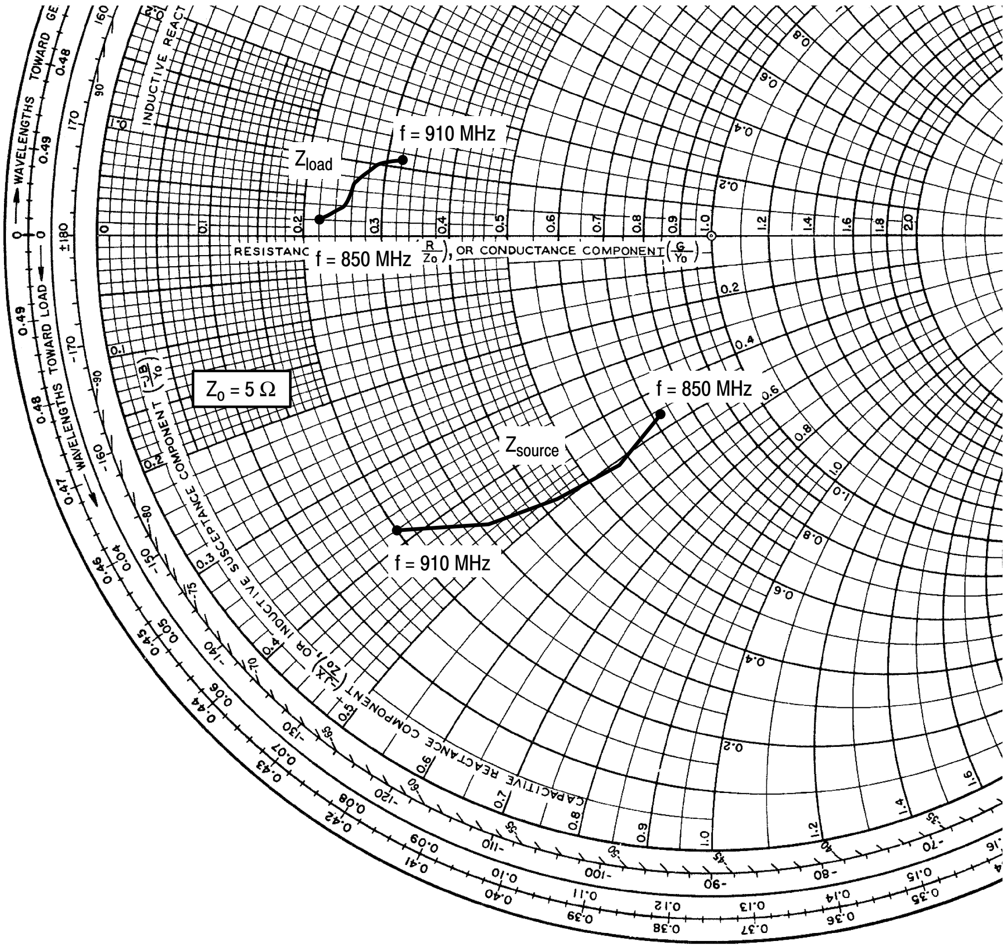


Figure 15. Single-Carrier N-CDMA Spectrum



V_{DD} = 28 Vdc, I_{DQ} = 1500 mA, P_{out} = 33 W Avg.

f MHz	Z_{source} Ω	Z_{load} Ω
850	3.61 - j2.30	1.12 + j0.09
865	2.85 - j2.54	1.24 + j0.22
880	2.13 - j2.47	1.31 + j0.36
895	1.53 - j2.27	1.46 + j0.48
910	1.02 - j1.90	1.61 + j0.53

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

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

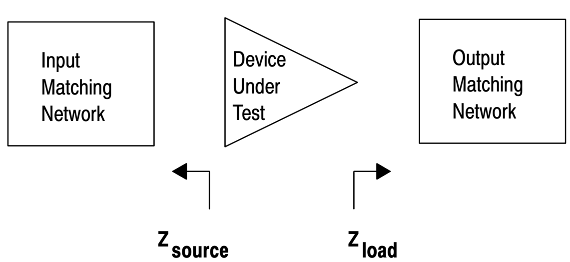
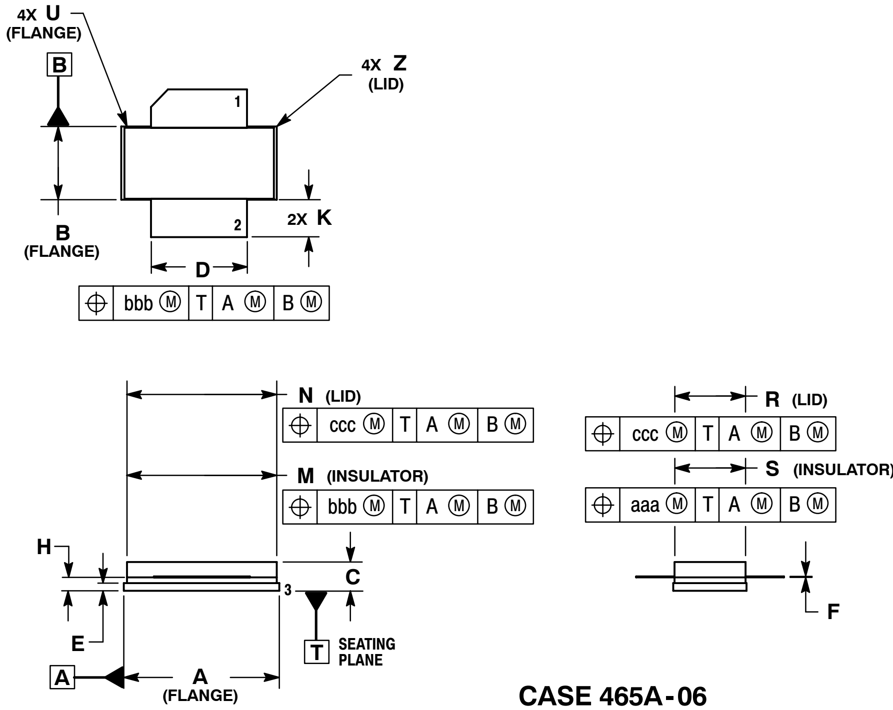


Figure 16. Series Equivalent Source and Load Impedance

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.

	INCHES		MILLIMETERS	
DIM	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 H
NI-780S
MRF5S9150HSR3

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
3	Mar. 2009	• Data sheet revised to reflect part status change (see Rev. 2 for MRF5S9150HR3 data sheet), p. 1, 3-4 • Updated Part Numbers in Table 5, Component Designations and Values, to RoHS compliant part numbers, p. 3 • Added Revision History, p. 11

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