Freescale Semiconductor
Technical Data

Document Number: MRFE6S9130H
Rev. 1, 12/2008

RoHS

RF Power Field Effect Transistors

N-Channel Enhancement-Mode Lateral MOSFETs

MRFE6S9130HR3
MRFE6S9130HSR3

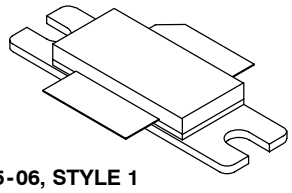
880 MHz, 27 W AVG., 28 V
SINGLE N-CDMA
LATERAL N-CHANNEL
RF POWER MOSFETs

Designed for N-CDMA, GSM and GSM EDGE base station applications with frequencies from 865 to 960 MHz. Suitable for multicarrier amplifier applications.

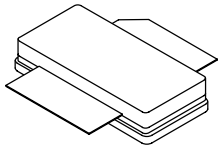
- Typical Single-Carrier N-CDMA Performance: V_{DD} = 28 Volts, I_{DQ} = 950 mA, P_{out} = 27 Watts Avg., f = 880 MHz, IS-95 CDMA (Pilot, Sync, Paging, Traffic Codes 8 Through 13) Channel Bandwidth = 1.2288 MHz. PAR = 9.8 dB @ 0.01% Probability on CCDF.
  Power Gain — 19.2 dB
  Drain Efficiency — 30.5%
  ACPR @ 750 kHz Offset — -47.6 dBc in 30 kHz Bandwidth
- Capable of Handling 10:1 VSWR, @ 32 Vdc, 880 MHz, 3 dB Overdrive, Designed for Enhanced Ruggedness

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
- RoHS Compliant
- In Tape and Reel. R3 Suffix = 250 Units per 56 mm, 13 inch Reel.



CASE 465-06, STYLE 1
NI-780
MRFE6S9130HR3



CASE 465A-06, STYLE 1
NI-780S
MRFE6S9130HSR3

Table 1. Maximum Ratings

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DSS}	-0.5, +66	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 Case Temperature 80°C, 130 W CW Case Temperature 75°C, 27 W CW	$R_{\theta JC}$	 0.45 0.51	°C/W

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.

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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)	A (Minimum)
Charge Device Model (per JESD22-C101)	IV (Minimum)

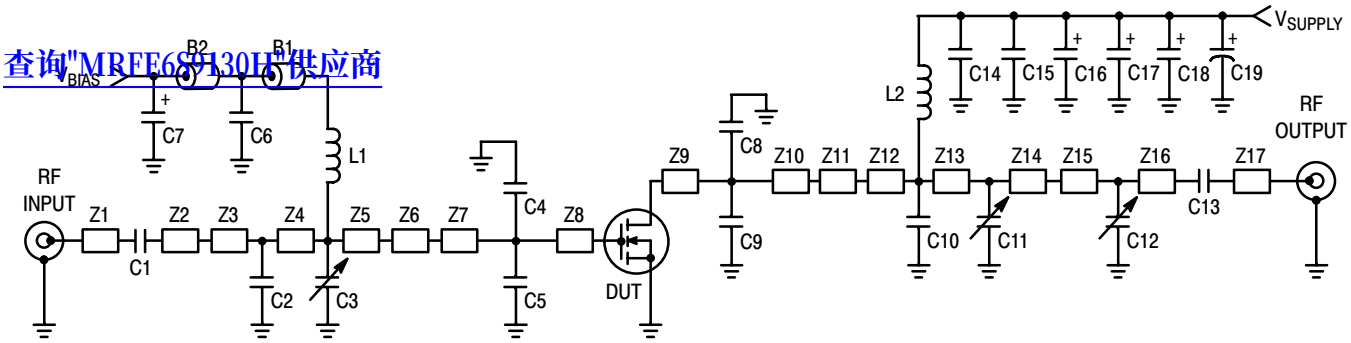
Table 4. Electrical Characteristics (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
Off Characteristics					
Zero Gate Voltage Drain Leakage Current (V_{DS} = 66 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}	—	—	10	μAdc
On Characteristics					
Gate Threshold Voltage (V_{DS} = 10 Vdc, I_D = 400 μAdc)	$V_{GS(th)}$	1	2.1	3	Vdc
Gate Quiescent Voltage (V_{DD} = 28 Vdc, I_D = 950 mAdc, Measured in Functional Test)	$V_{GS(Q)}$	2	2.9	4	Vdc
Drain-Source On-Voltage (V_{GS} = 10 Vdc, I_D = 2.74 Adc)	$V_{DS(on)}$	—	0.22	0.5	Vdc
Dynamic Characteristics (1)					
Reverse Transfer Capacitance (V_{DS} = 28 Vdc ± 30 mV(rms)ac @ 1 MHz, V_{GS} = 0 Vdc)	C_{rss}	—	1.6	—	pF
Output Capacitance (V_{DS} = 28 Vdc ± 30 mV(rms)ac @ 1 MHz, V_{GS} = 0 Vdc)	C_{oss}	—	66	—	pF

Functional Tests (In Freescale Test Fixture, 50 ohm system) V_{DD} = 28 Vdc, I_{DQ} = 950 mA, P_{out} = 27 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	19.2	21	dB
Drain Efficiency	η_D	29	30.5	—	%
Adjacent Channel Power Ratio	ACPR	—	-47.6	-46	dBc
Input Return Loss	IRL	—	-29	-9	dB

1. Part internally input matched.



Z1	0.383″ x 0.080″ Microstrip	Z7	0.220″ x 0.630″ Microstrip	Z14	0.045″ x 0.220″ Microstrip
Z2	1.250″ x 0.080″ Microstrip	Z8	0.077″ x 0.630″ Microstrip	Z15	0.755″ x 0.080″ Microstrip
Z3	0.190″ x 0.220″ Microstrip	Z9	0.146″ x 0.630″ Microstrip	Z16	0.496″ x 0.080″ Microstrip
Z4	0.127″ x 0.220″ Microstrip	Z10	0.152″ x 0.630″ Microstrip	Z17	0.384″ x 0.080″ Microstrip
Z5	0.173″ x 0.220″ Microstrip	Z12	0.184″ x 0.220″ Microstrip	PCB	Arlon CuClad 250GX-0300-55-22,
Z6, Z11	0.200″ x 0.220″ x 0.620″ Taper	Z13	0.261″ x 0.220″ Microstrip		0.030″, ε_r = 2.55

Figure 1. MRFE6S9130HR3(SR3) Test Circuit Schematic

Table 5. MRFE6S9130HR3(SR3) Test Circuit Component Designations and Values

Part	Description	Part Number	Manufacturer
B1, B2	Ferrite Beads, Short	2743019447	Fair Rite
C1, C13, C14	47 pF Chip Capacitors	ATC100B470JT500XT	ATC
C2	8.2 pF Chip Capacitor	ATC100B8R2BT500XT	ATC
C3, C11	0.8-8.0 pF Variable Capacitors, Gigatrim	27291SL	Johanson
C4, C5	12 pF Chip Capacitors	ATC100B120JT500XT	ATC
C6	20 K pF Chip Capacitor	ATC200B203KT50XT	ATC
C7, C16, C17, C18	10 μF, 35 V Tantalum Chip Capacitors	T491D106K035AT	Kemet
C8, C9	10 pF Chip Capacitors	ATC100B7R5JT500XT	ATC
C10	11 pF Chip Capacitor	ATC100B110JT500XT	ATC
C12	0.6-4.5 pF Variable Capacitor, Gigatrim	27271SL	Johanson
C15	0.56 μF, 50 V Chip Capacitor	C1825C564J5GAC	Kemet
C19	470 μF, 63 V Electrolytic Capacitor	ESME630ELL471MK25S	United Chemi-Con
L1, L2	12.5 nH Inductors	A04T-5	Coilcraft

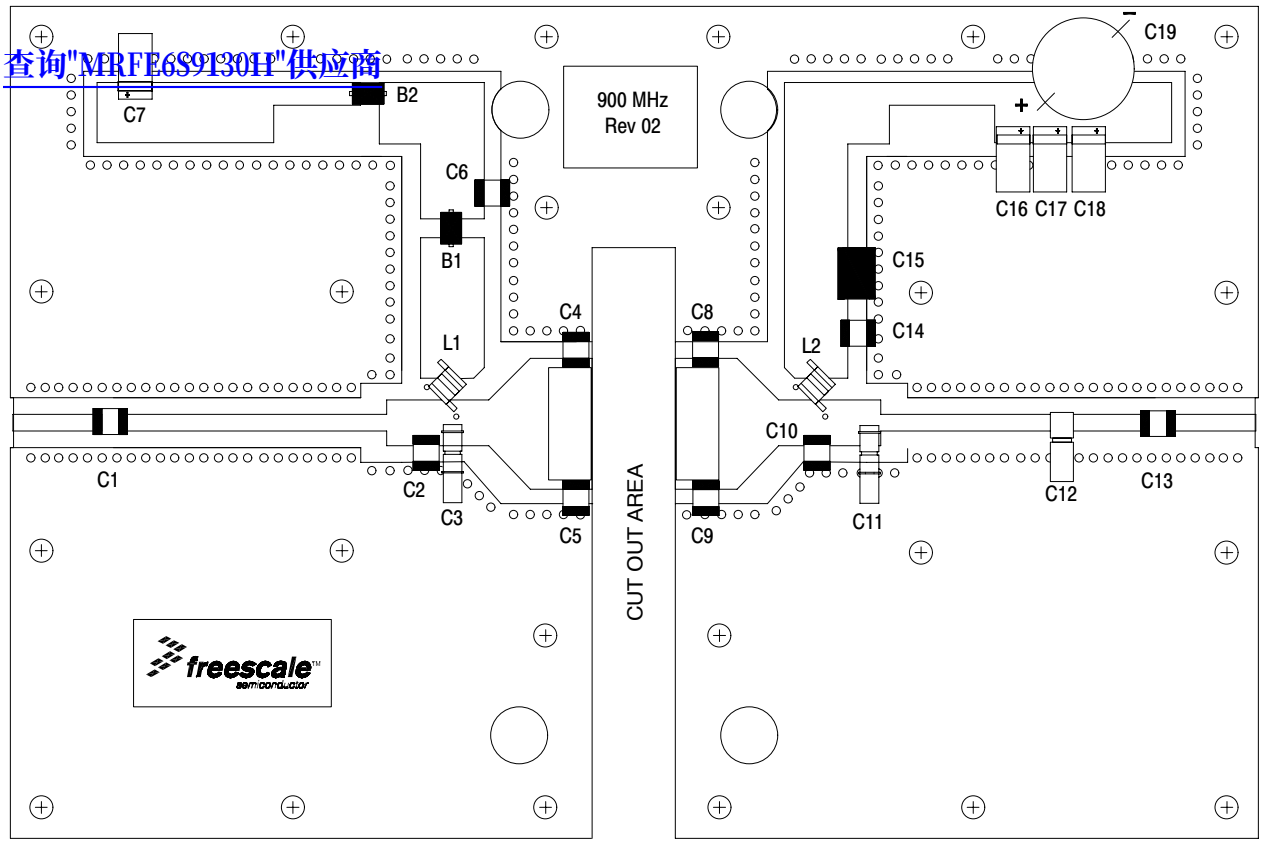


Figure 2. MRFE6S9130HR3(SR3) Test Circuit Component Layout

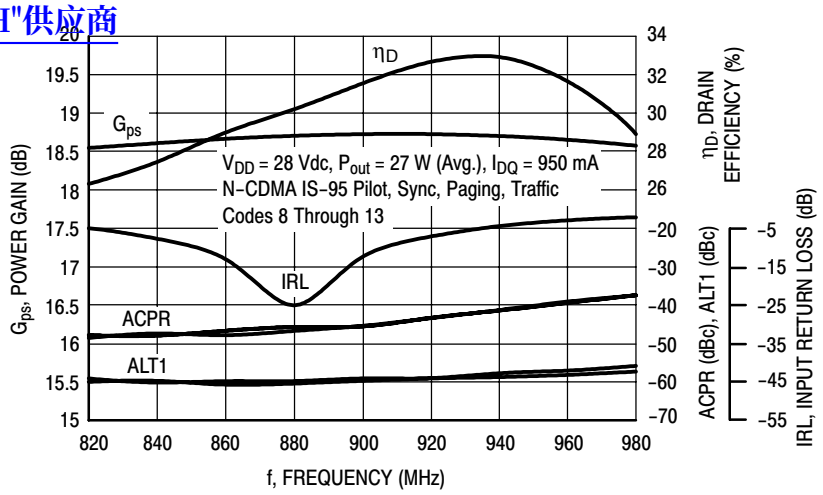


Figure 3. Single-Carrier N-CDMA Broadband Performance @ P_{out} = 27 Watts Avg.

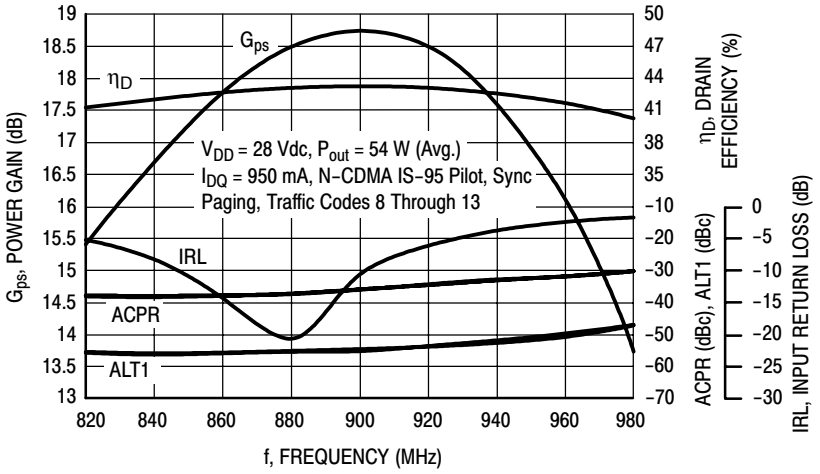


Figure 4. Single-Carrier N-CDMA Broadband Performance @ P_{out} = 54 Watts Avg.

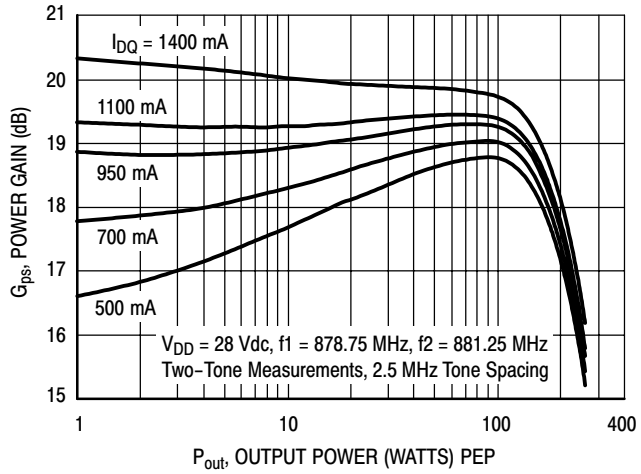


Figure 5. Two-Tone Power Gain versus Output Power

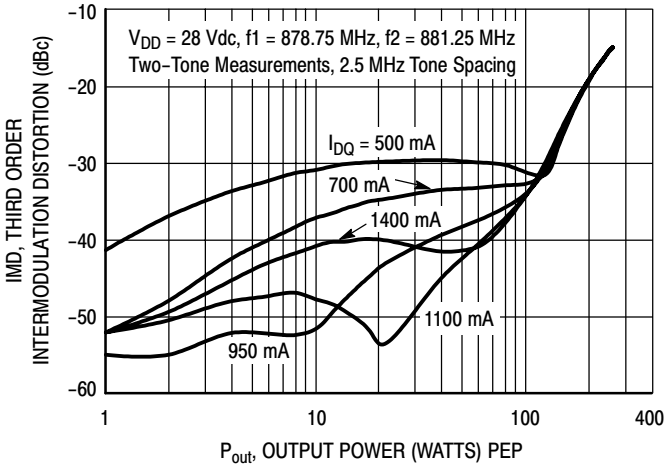


Figure 6. Third Order Intermodulation Distortion versus Output Power

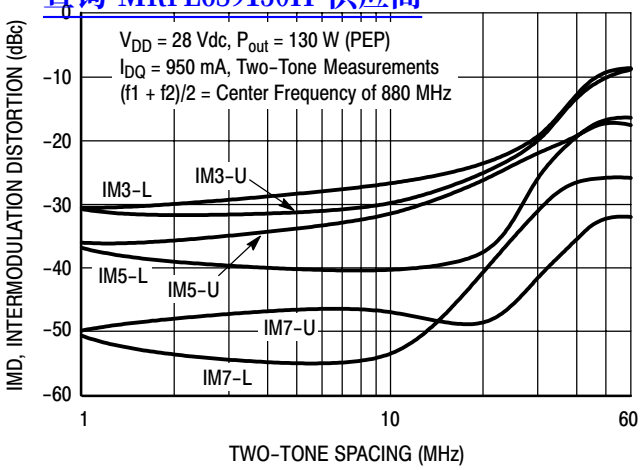


Figure 7. Intermodulation Distortion Products versus Tone Spacing

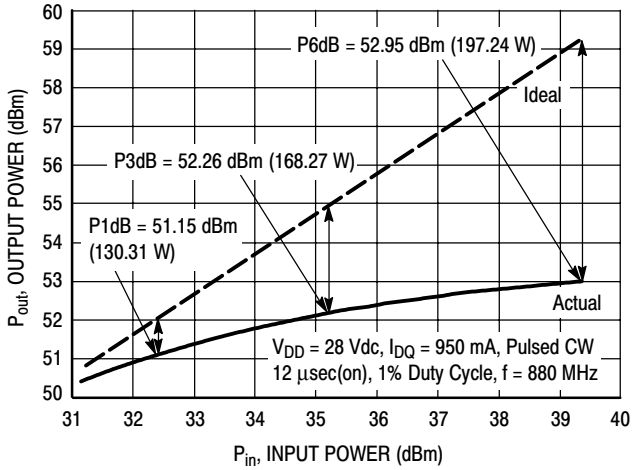


Figure 8. Pulsed CW Output Power versus Input Power

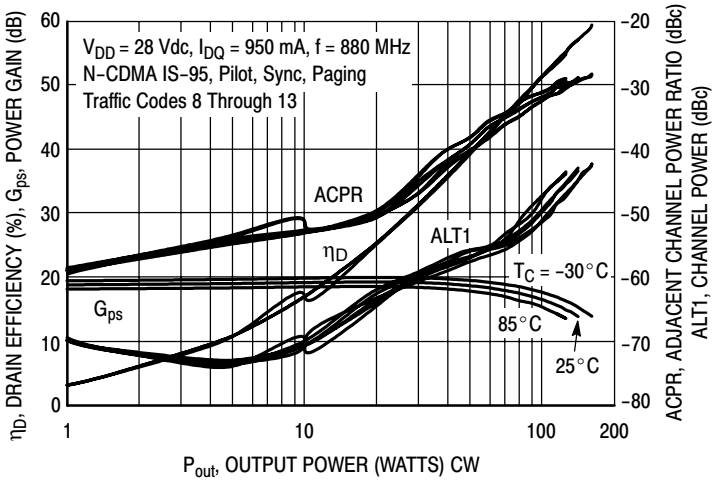


Figure 9. Single-Carrier N-CDMA ACPR, ALT1, Power Gain and Drain Efficiency versus Output Power

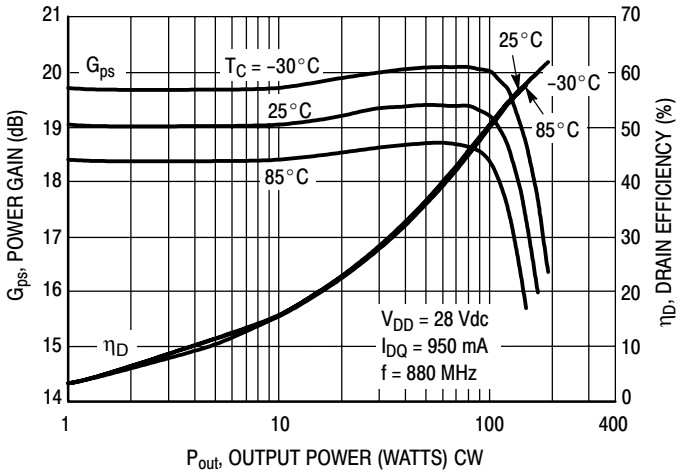


Figure 10. Power Gain and Drain Efficiency versus CW Output Power

TYPICAL CHARACTERISTICS

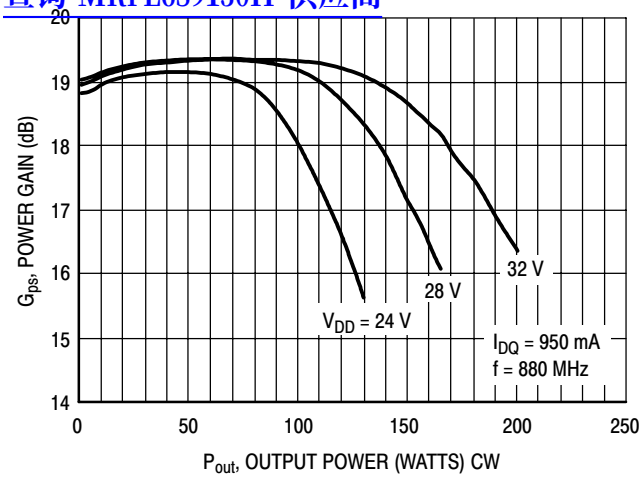
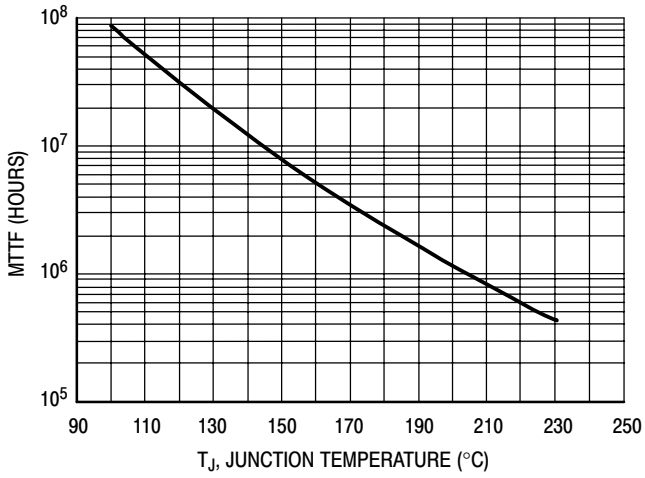


Figure 11. Power Gain versus Output Power



This above graph displays calculated MTTF in hours when the device is operated at V_{DD} = 28 Vdc, P_{out} = 27 W Avg., and η_D = 30.5%.

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

Figure 12. MTTF versus Junction Temperature

N-CDMA TEST SIGNAL

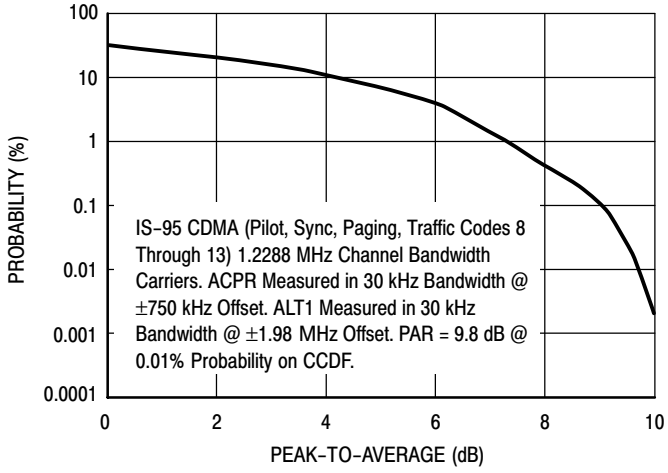


Figure 13. Single-Carrier CCDF N-CDMA

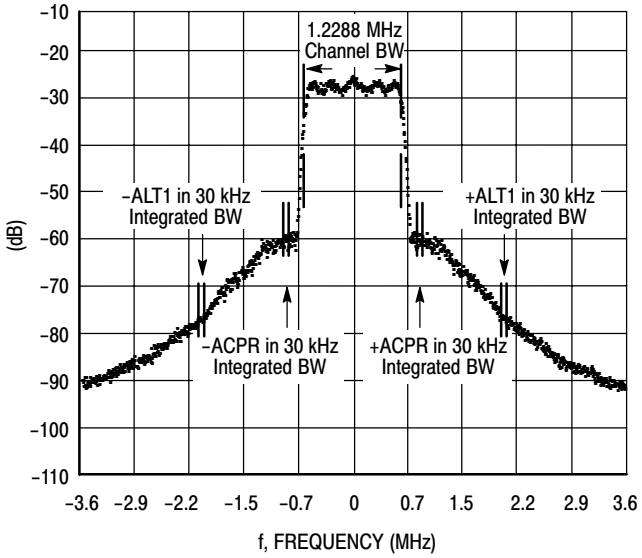
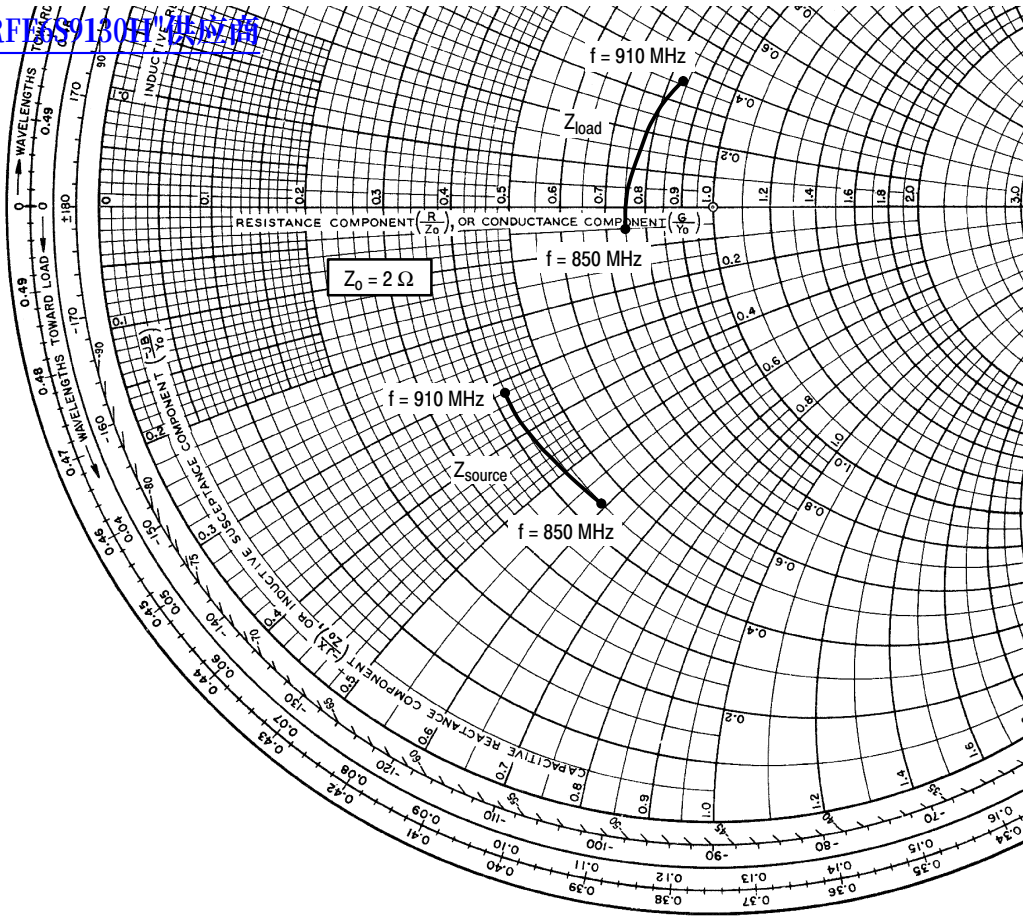


Figure 14. Single-Carrier N-CDMA Spectrum



V_{DD} = 28 Vdc, I_{DQ} = 950 mA, P_{out} = 27 W Avg.

f MHz	Z_{source} Ω	Z_{load} Ω
850	0.89 - j1.18	1.50 - j0.09
865	0.87 - j1.03	1.52 + j0.11
880	0.85 - j0.89	1.55 + j0.31
895	0.83 - j0.75	1.60 + j0.51
910	0.84 - j0.64	1.68 + j0.71

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

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

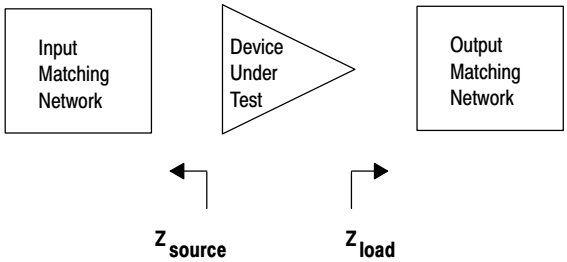
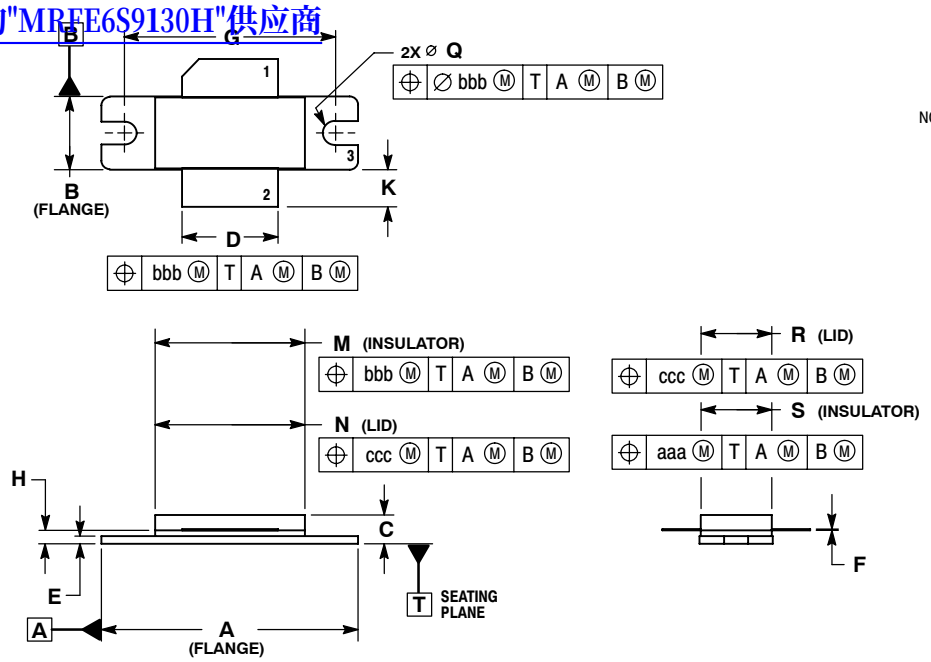


Figure 15. Series Equivalent Source and Load Impedance

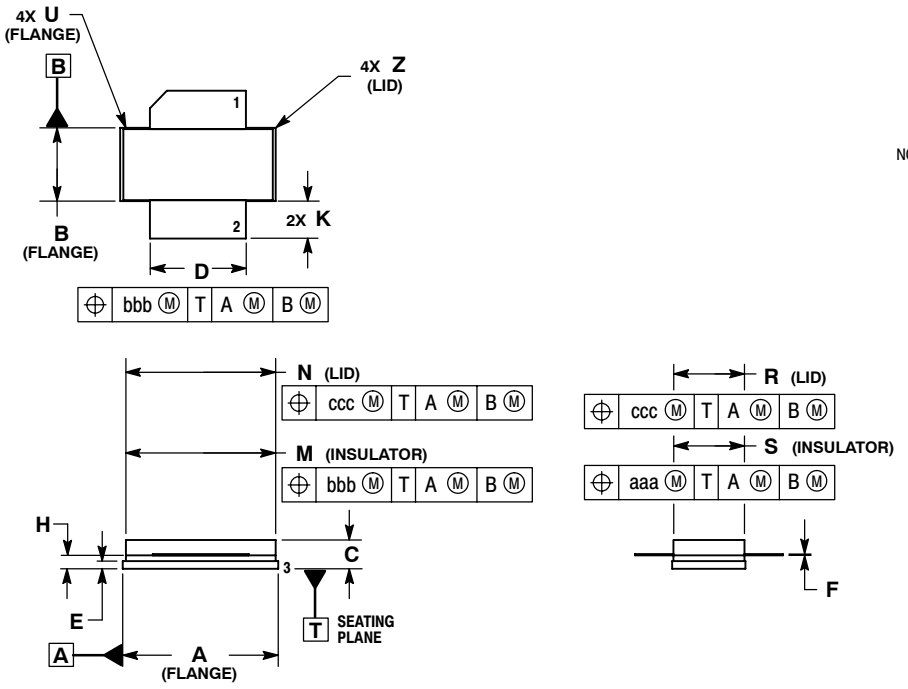


NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M–1994.
2. CONTROLLING DIMENSION: INCH.
3. DELETED
4. DIMENSION H IS MEASURED 0.030 (0.762) AWAY FROM PACKAGE BODY.

	INCHES		MILLIMETERS	
DIM	MIN	MAX	MIN	MAX
A	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	⌀.118	⌀.138	⌀3.00	⌀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
2. GATE
3. SOURCE

CASE 465-06
ISSUE G
NI-780
MRFE6S9130HR3



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3. DELETED
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	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
MRFE6S9130HSR3

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	April 2007	• Initial Release of Data Sheet
1	Dec. 2008	• Updated Full Frequency Band in Typical Performance bullet to f = 880 MHz to match actual production test, p. 1 • Operating Junction Temperature increased from 200°C to 225°C in Maximum Ratings table and 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 $V_{GS(Q)}$, On Characteristics table, p. 2 • Updated PCB information to show more specific material details, Fig. 1, Test Circuit Schematic, p. 3

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Document Number: MRFE6S9130H
Rev. 1, 12/2008