Freescale Semiconductor
Technical Data

Document Number: MRF6S9130H
Rev. 4, 5/2006

RoHS

RF Power Field Effect Transistors

N-Channel Enhancement-Mode Lateral 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 @ 880 MHz: V_{DD} = 28 Volts, I_{DQ} = 950 mA, P_{out} = 27 Watts Avg., Full Frequency Band, 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 — -48.1 dBc in 30 kHz Bandwidth

GSM Application

- Typical GSM Performance: V_{DD} = 28 Volts, I_{DQ} = 950 mA, P_{out} = 130 Watts, Full Frequency Band (921-960 MHz)
  Power Gain — 18 dB
  Drain Efficiency — 63%

GSM EDGE Application

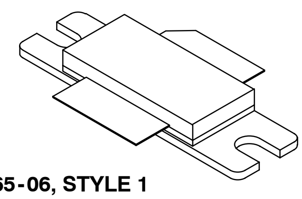
- Typical GSM EDGE Performance: V_{DD} = 28 Volts, I_{DQ} = 950 mA, P_{out} = 56 Watts Avg., Full Frequency Band (921-960 MHz)
  Power Gain — 18.5 dB
  Drain Efficiency — 44%
  Spectral Regrowth @ 400 kHz Offset = -63 dBc
  Spectral Regrowth @ 600 kHz Offset = -75 dBc
  EVM — 1.5% rms
- Capable of Handling 10:1 VSWR, @ 28 Vdc, 880 MHz, 130 Watts CW Output Power

Features

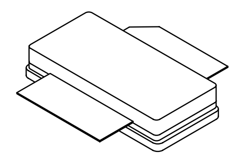
- Characterized with Series Equivalent Large-Signal Impedance Parameters
- Internally Matched for Ease of Use
- Qualified Up to a Maximum of 32 V_{DD} Operation
- Integrated ESD Protection
- Lower Thermal Resistance Package
- Low Gold Plating Thickness on Leads, 40µ″ Nominal.
- RoHS Compliant
- In Tape and Reel. R3 Suffix = 250 Units per 56 mm, 13 inch Reel.

MRF6S9130HR3
MRF6S9130HSR3

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



CASE 465-06, STYLE 1
NI-780
MRF6S9130HR3



CASE 465A-06, STYLE 1
NI-780S
MRF6S9130HSR3

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
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	389 2.2	W W/°C
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 (1,2)	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

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} = 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}	—	—	1	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_{DS} = 28 Vdc, I_D = 950 mAdc)	$V_{GS(Q)}$	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
Forward Transconductance (V_{DS} = 10 Vdc, I_D = 8 Adc)	g_{fs}	—	10	—	S
Dynamic Characteristics (3)					
Output Capacitance (V_{DS} = 28 Vdc ± 30 mV(rms)ac @ 1 MHz, V_{GS} = 0 Vdc)	C_{oss}	—	66	—	pF
Reverse Transfer Capacitance (V_{DS} = 28 Vdc ± 30 mV(rms)ac @ 1 MHz, V_{GS} = 0 Vdc)	C_{rss}	—	1.6	—	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

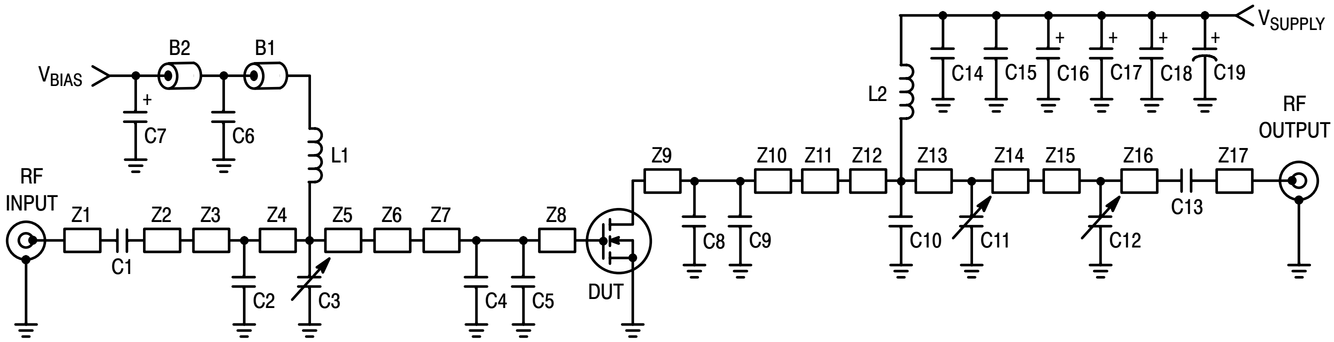
Characteristic	Symbol	Min	Typ	Max	Unit
Power Gain	G_{ps}	18	19.2	21	dB
Drain Efficiency	η_D	29	30.5	—	%
Adjacent Channel Power Ratio	ACPR	—	-48.1	-46	dBc
Input Return Loss	IRL	—	-30	-9	dB

1. MTTF calculator available at http://www.freescale.com/rf. Select Tools/Software/Application Software/Calculators to access the MTTF calculators by product.
2. Refer to AN1955, *Thermal Measurement Methodology of RF Power Amplifiers.* Go to http://www.freescale.com/rf. Select Documentation/Application Notes - AN1955.
3. Part is internally matched on input.

(continued)

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

Characteristic	Symbol	Min	Typ	Max	Unit
Typical GSM EDGE Performances (In Freescale GSM EDGE Test Fixture, 50 ohm system) V_{DD} = 28 Vdc, I_{DQ} = 950 mA, P_{out} = 56 W Avg., 921 MHz<Frequency<960 MHz					
Power Gain	G_{ps}	—	18.5	—	dB
Drain Efficiency	η_D	—	44	—	%
Error Vector Magnitude	EVM	—	1.5	—	% rms
Spectral Regrowth at 400 kHz Offset	SR1	—	-63	—	dBc
Spectral Regrowth at 600 kHz Offset	SR2	—	-75	—	dBc
Typical CW Performances (In Freescale GSM Test Fixture, 50 ohm system) V_{DD} = 28 Vdc, I_{DQ} = 950 mA, P_{out} = 130 W, 921 MHz<Frequency<960 MHz					
Power Gain	G_{ps}	—	18	—	dB
Drain Efficiency	η_D	—	63	—	%
Input Return Loss	IRL	—	-12	—	dB
P_{out} @ 1 dB Compression Point, CW (f = 940 MHz)	P1dB	—	135	—	W



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 GX-0300-55-22, 0.030″, ε_r = 2.55	
Z6, Z11	0.200″ x 0.220″ x 0.620″ Taper		Z13	0.261″ x 0.220″ Microstrip				

Figure 1. MRF6S9130HR3(SR3) Test Circuit Schematic

Table 5. MRF6S9130HR3(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	100B470JP500X	ATC
C2	8.2 pF Chip Capacitor	100B8R2BP500X	ATC
C3, C11	0.8-8.0 pF Variable Capacitors, Gigatrim	27291SL	Johanson
C4, C5	12 pF Chip Capacitors	100B120JP500X	ATC
C6	20 K pF Chip Capacitor	200B203KP50X	ATC
C7, C16, C17, C18	10 μF, 35 V Tantalum Chip Capacitors	T491D106K035AS	Kemet
C8, C9	10 pF Chip Capacitors	100B7R5JP500X	ATC
C10	11 pF Chip Capacitor	100B110JP500X	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	SME63VB471M12X25LL	United Chemi-Con
L1, L2	12.5 nH Inductors	A04T-5	Coilcraft

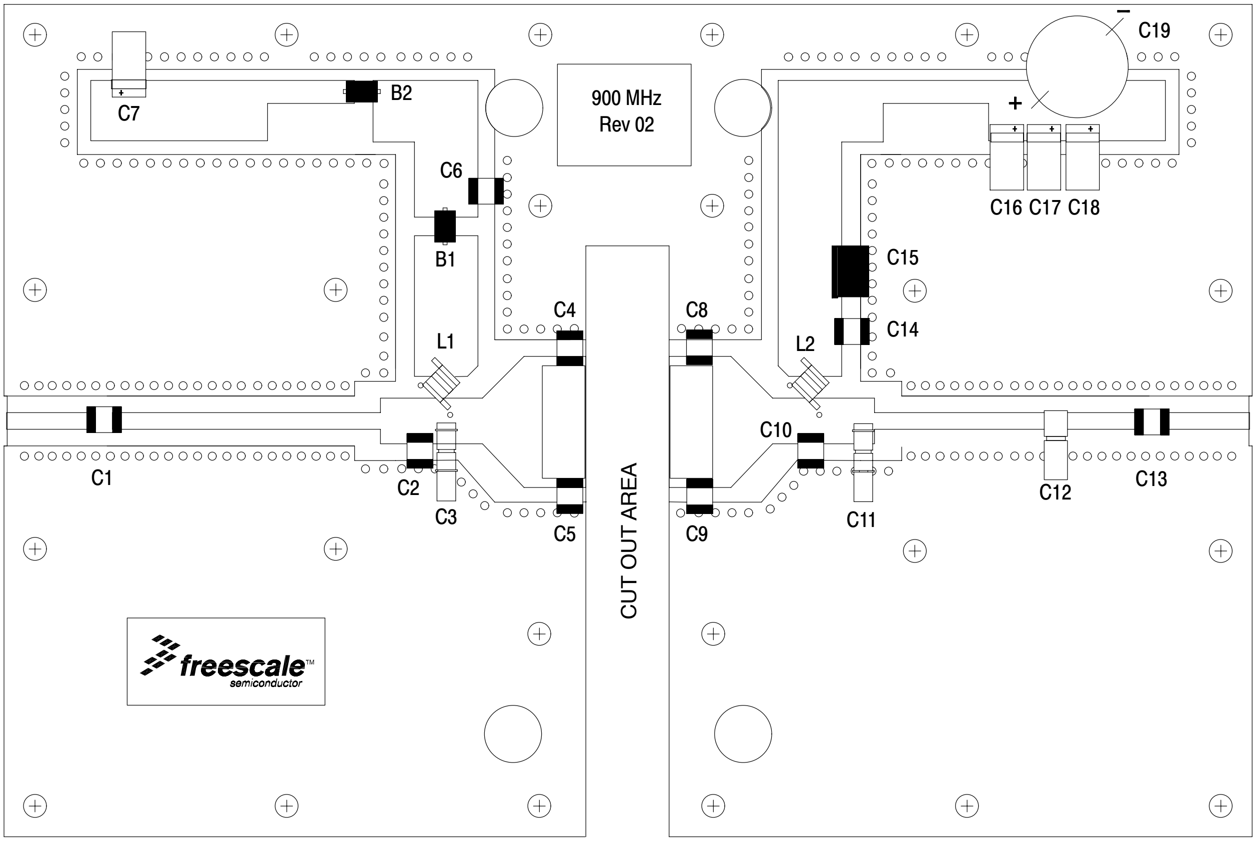


Figure 2. MRF6S9130HR3(SR3) Test Circuit Component Layout

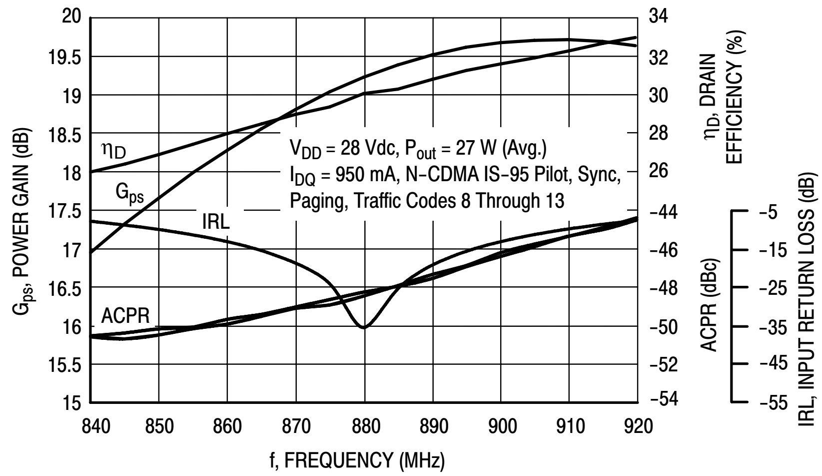


Figure 3. Single-Carrier N-CDMA Broadband Performance @ P_{out} = 27 Watts Avg.

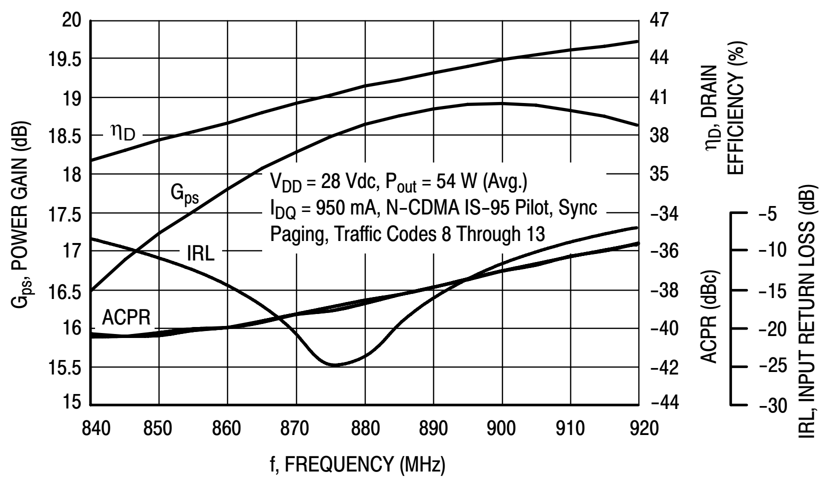


Figure 4. Single-Carrier N-CDMA Broadband Performance @ P_{out} = 54 Watts Avg.

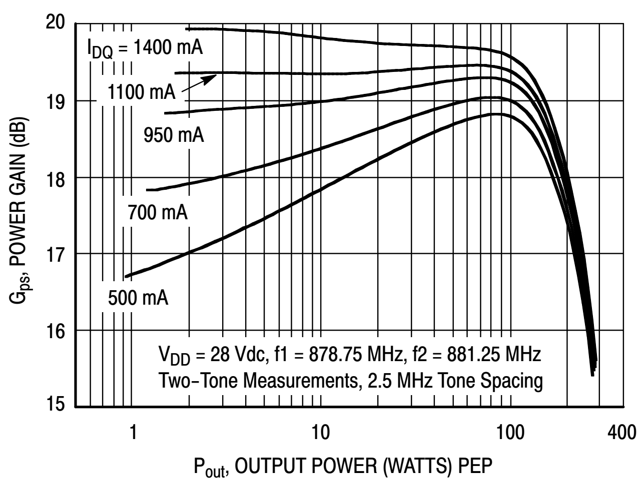


Figure 5. Two-Tone Power Gain versus Output Power

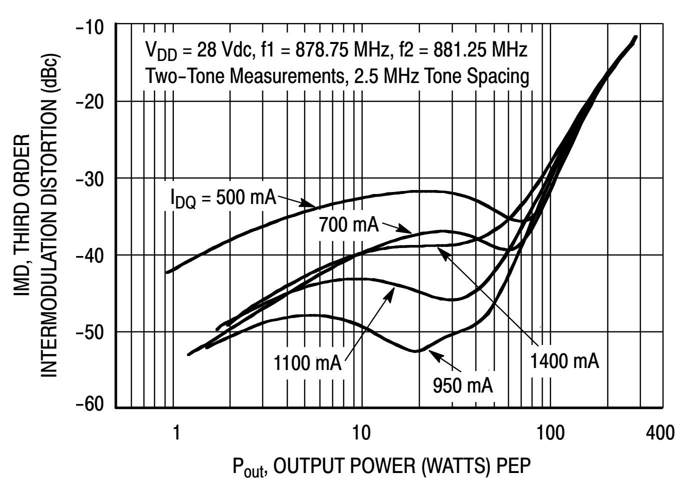


Figure 6. Third Order Intermodulation Distortion versus Output Power

TYPICAL CHARACTERISTICS

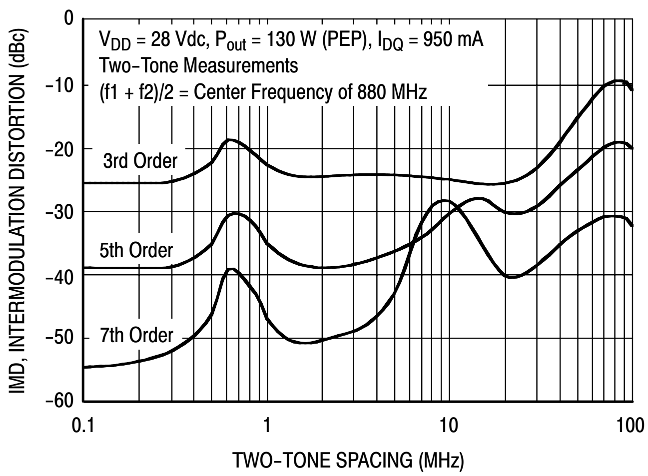


Figure 7. Intermodulation Distortion Products versus Tone Spacing

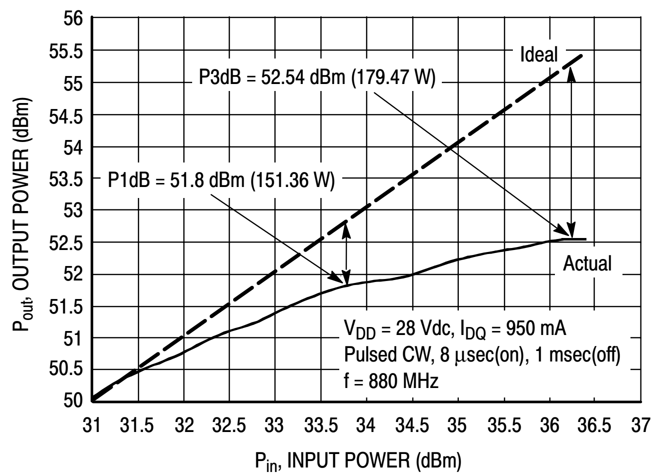


Figure 8. Pulse CW Output Power versus Input Power

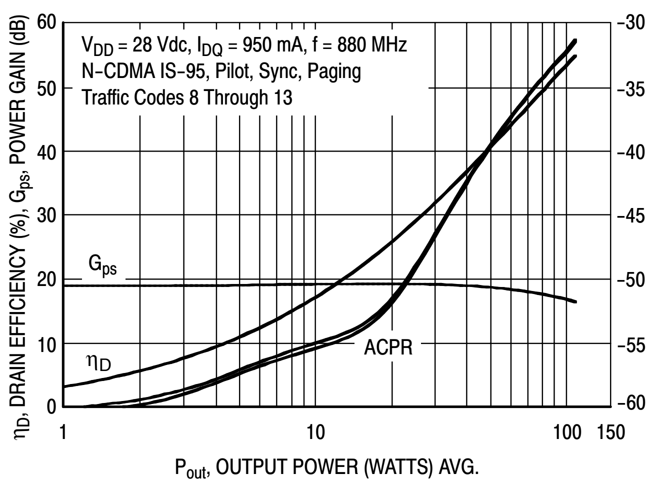


Figure 9. Single-Carrier N-CDMA ACPR, Power Gain and Drain Efficiency versus Output Power

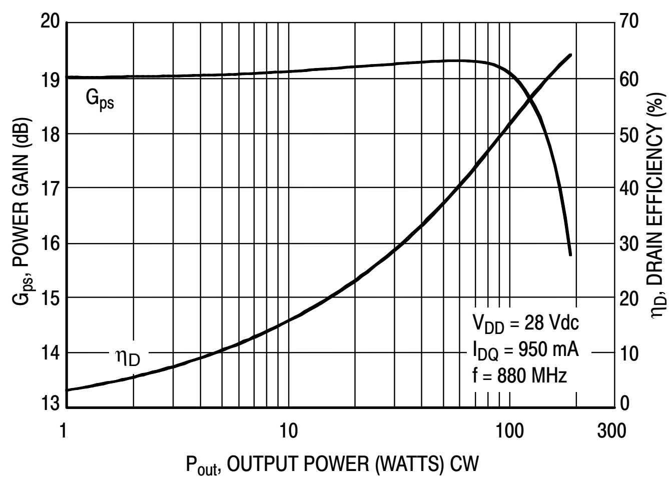


Figure 10. Power Gain and Drain Efficiency versus CW Output Power

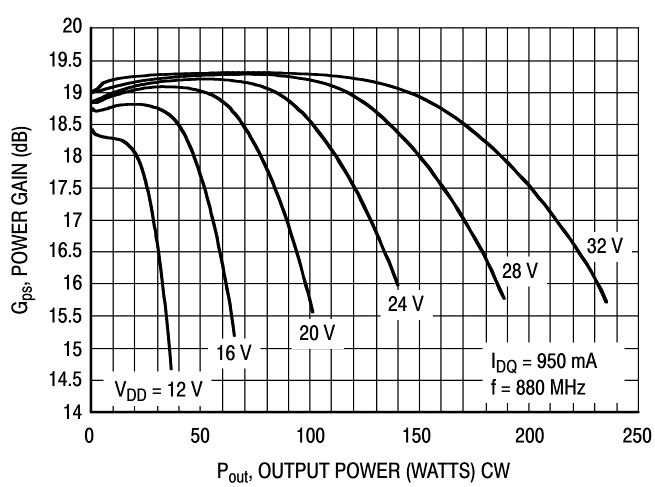
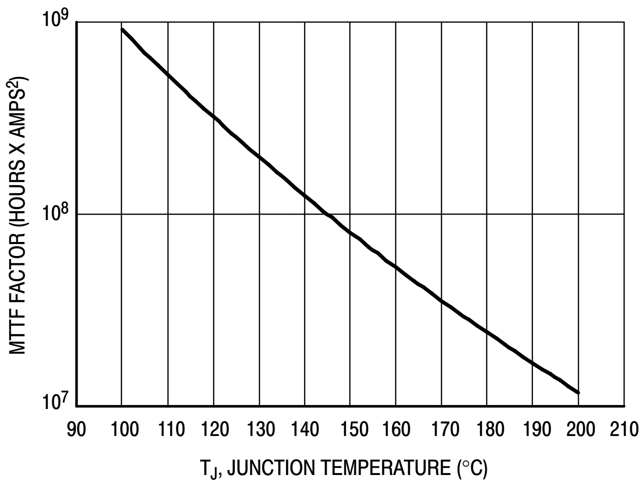


Figure 11. Power Gain versus Output Power

TYPICAL CHARACTERISTICS



This above graph displays calculated MTTF in hours 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 12. MTTF Factor versus Junction Temperature

N-CDMA TEST SIGNAL

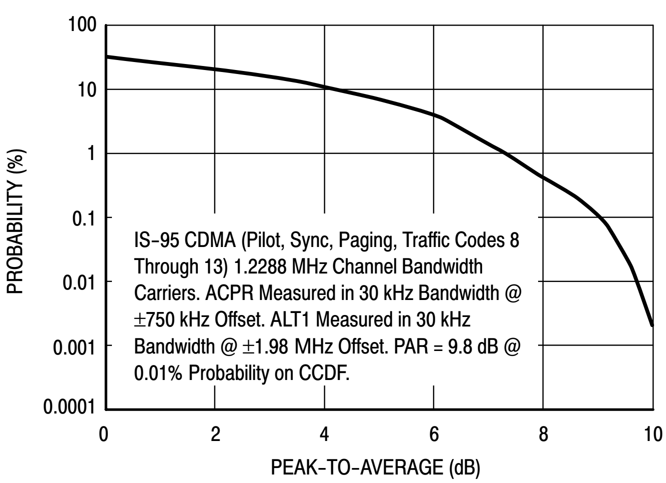


Figure 13. Single-Carrier CCDF N-CDMA

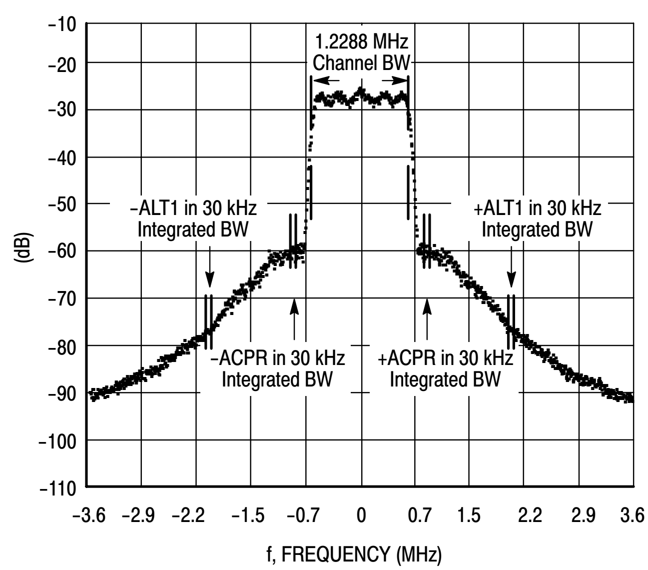
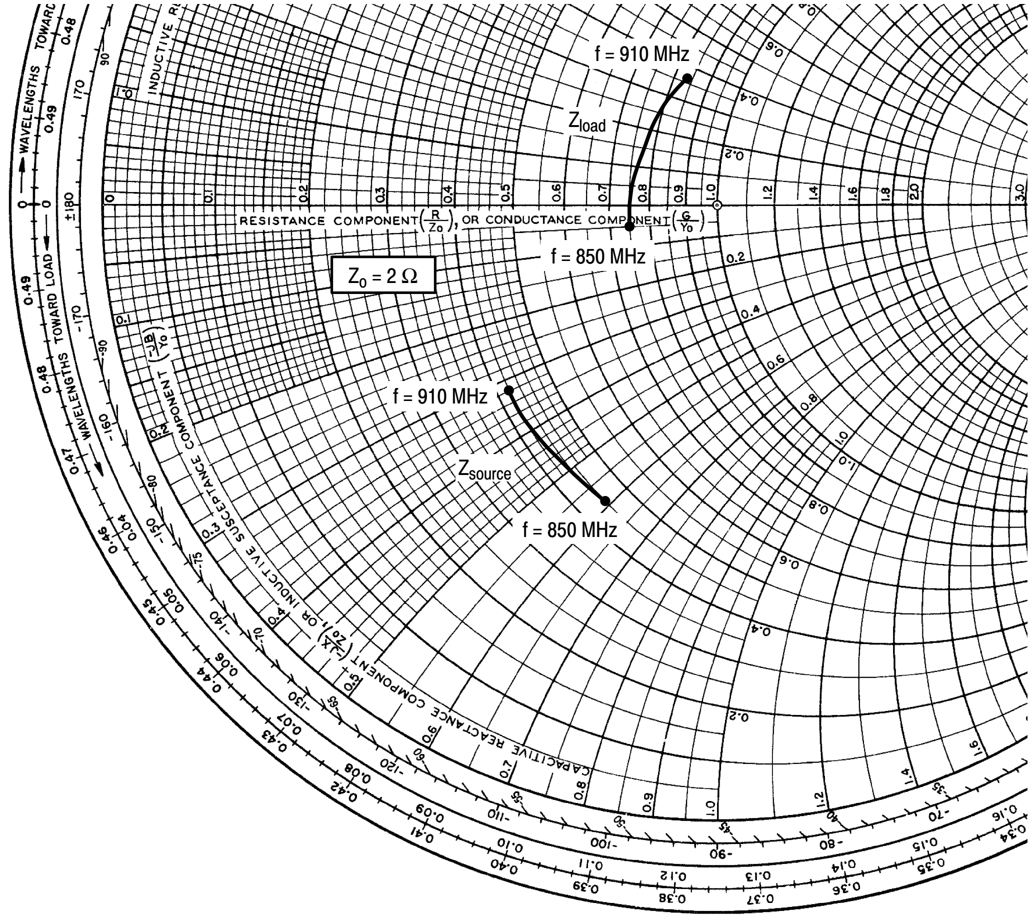


Figure 14. Single-Carrier N-CDMA Spectrum



V_{DD} = 28 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.

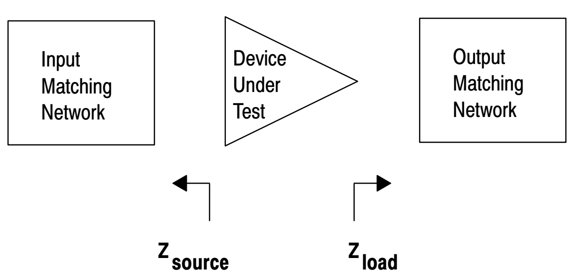
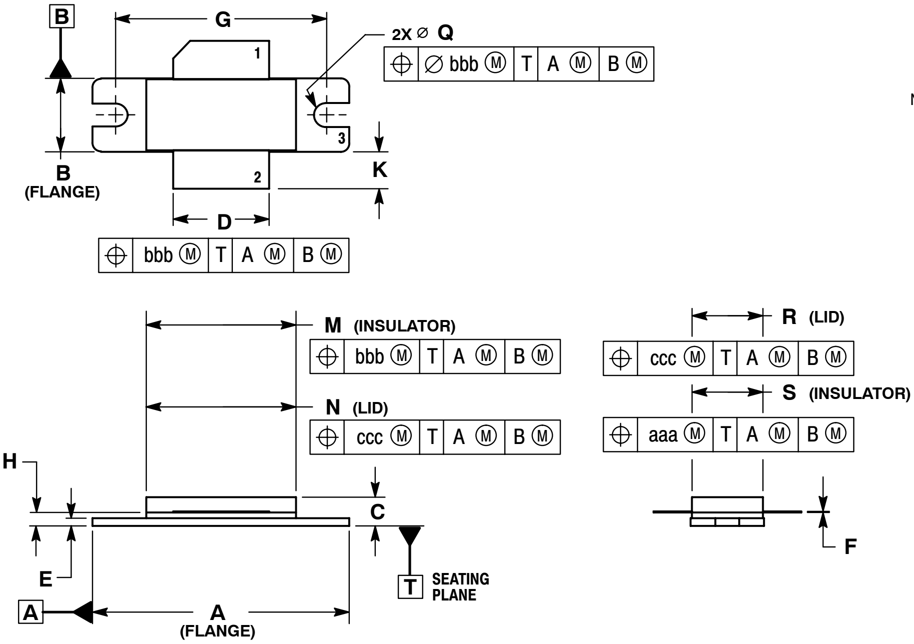


Figure 15. Series Equivalent Source and Load Impedance

NOTES

PACKAGE DIMENSIONS

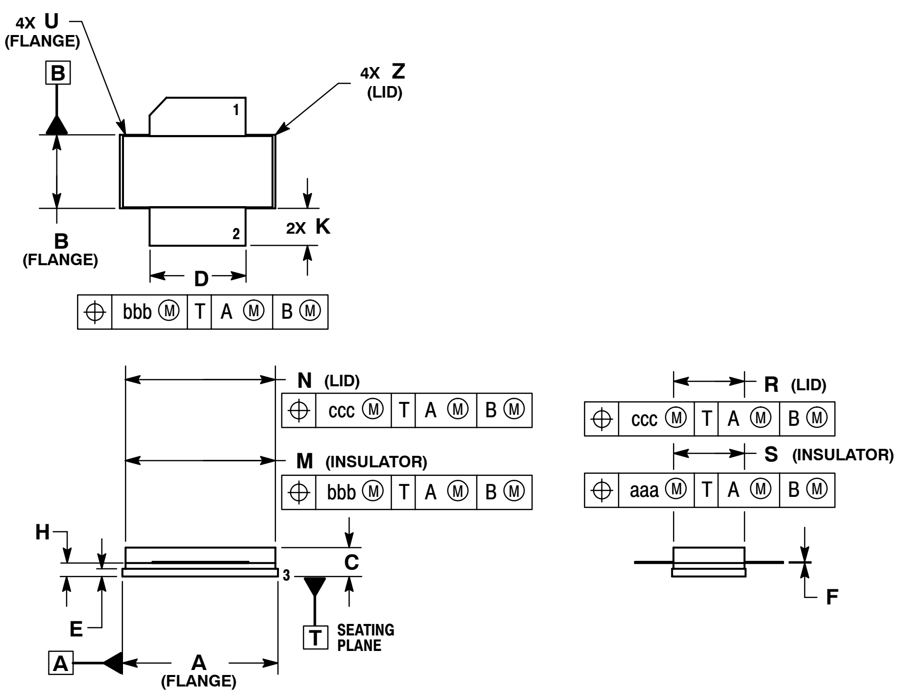


NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M-1994.
2. CONTROLLING DIMENSION: INCH.
3. DELETED
4. DIMENSION H IS MEASURED 0.030 (0.762) AWAY FROM PACKAGE BODY.

DIM	INCHES MIN	INCHES MAX	MILLIMETERS MIN	MILLIMETERS 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
MRF6S9130HR3



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3. DELETED
4. DIMENSION H IS MEASURED 0.030 (0.762) AWAY FROM PACKAGE BODY.

DIM	INCHES MIN	INCHES MAX	MILLIMETERS MIN	MILLIMETERS 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
MRF6S9130HSR3

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