Freescale Semiconductor
Technical Data

Document Number: MRF6S21140H
Rev. 5, 2/2010

RoHS

RF Power Field Effect Transistors

N-Channel Enhancement-Mode Lateral MOSFETs

MRF6S21140HR3
MRF6S21140HSR3

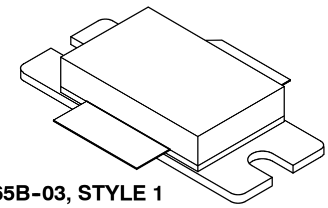
2110-2170 MHz, 30 W AVG., 28 V
2 x W-CDMA
LATERAL N-CHANNEL
RF POWER MOSFETs

Designed for W-CDMA base station applications with frequencies from 2110 to 2170 MHz. Suitable for TDMA, CDMA and multicarrier amplifier applications. To be used in Class AB for PCN-PCS/cellular radio and WLL applications.

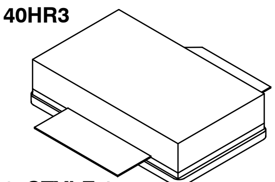
- Typical 2-carrier W-CDMA Performance: V_{DD} = 28 Volts, I_{DQ} = 1200 mA, P_{out} = 30 Watts Avg., f = 2112.5 MHz, Channel Bandwidth = 3.84 MHz, PAR = 8.5 dB @ 0.01% Probability on CCDF.
  Power Gain — 15.5 dB
  Drain Efficiency — 27.5%
  IM3 @ 10 MHz Offset — -37 dBc in 3.84 MHz Channel Bandwidth
  ACPR @ 5 MHz Offset — -41 dBc in 3.84 MHz Channel Bandwidth
- Capable of Handling 10:1 VSWR, @ 28 Vdc, 2140 MHz, 140 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
- Optimized for Doherty Applications
- RoHS Compliant
- In Tape and Reel. R3 Suffix = 250 Units per 56 mm, 13 inch Reel.



CASE 465B-03, STYLE 1
NI-880
MRF6S21140HR3



CASE 465C-02, STYLE 1
NI-880S
MRF6S21140HSR3

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 Case Temperature 80°C, 140 W CW Case Temperature 75°C, 30 W CW	$R_{\theta JC}$	 0.35 0.38	°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/D, *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)	2 (Minimum)
Machine Model (per EIA/JESD22-A115)	A (Minimum)
Charge Device Model (per JESD22-C101)	IV (Minimum)

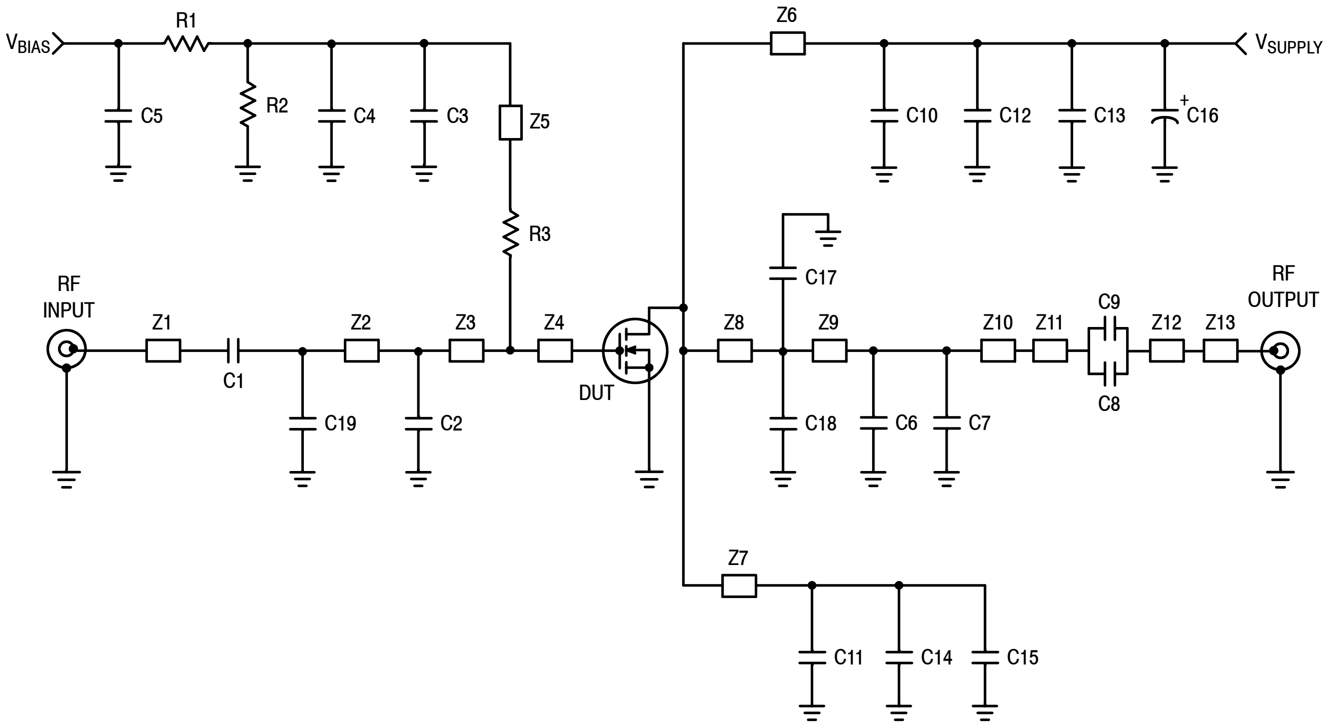
Table 4. Electrical Characteristics (T_A = 25°C unless otherwise noted)

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 = 300 μAdc)	$V_{GS(th)}$	1	2	3	Vdc
Gate Quiescent Voltage (V_{DD} = 28 Vdc, I_D = 1200 mAdc, Measured in Functional Test)	$V_{GS(Q)}$	2	2.8	4	Vdc
Drain-Source On-Voltage (V_{GS} = 10 Vdc, I_D = 3 Adc)	$V_{DS(on)}$	0.1	0.21	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}	—	2	—	pF

Functional Tests (In Freescale Test Fixture, 50 ohm system) V_{DD} = 28 Vdc, I_{DQ} = 1200 mA, P_{out} = 30 W Avg., f1 = 2112.5 MHz, f2 = 2122.5 MHz, 2-carrier W-CDMA, 3.84 MHz Channel Bandwidth Carriers. ACPR measured in 3.84 MHz Channel Bandwidth @ ±5 MHz Offset. IM3 measured in 3.84 MHz Channel Bandwidth @ ±10 MHz Offset. PAR = 8.5 dB @ 0.01% Probability on CCDF.

Characteristic	Symbol	Min	Typ	Max	Unit
Power Gain	G_{ps}	14.5	15.5	17.5	dB
Drain Efficiency	η_D	26	27.5	—	%
Intermodulation Distortion	IM3	—	-37	-35	dBc
Adjacent Channel Power Ratio	ACPR	—	-41	-38	dBc
Input Return Loss	IRL	—	-15	-9	dB

1. Part is internally matched both on input and output.



Z1	0.250″ x 0.083″ Microstrip	Z8	0.531″ x 1.000″ Microstrip
Z2	1.177″ x 0.083″ Microstrip	Z9	0.308″ x 0.083″ Microstrip
Z3	0.443″ x 0.083″ Microstrip	Z10	0.987″ x 0.083″ Microstrip
Z4	0.276″ x 0.787″ Microstrip	Z11, Z12	0.070″ x 0.220″ Microstrip
Z5	0.786″ x 0.083″ Microstrip (quarter wave length for bias purpose)	Z13	0.160″ x 0.083″ Microstrip
Z6, Z7	0.833″ x 0.083″ Microstrip (quarter wave length for supply purpose)	PCB	Taconic TLX8-0300, 0.030″, ε_r = 2.55

Figure 1. MRF6S21140HR3(HSR3) Test Circuit Schematic

Table 5. MRF6S21140HR3(HSR3) Test Circuit Component Designations and Values

Part	Description	Part Number	Manufacturer
C1, C3, C8, C9, C10, C11	6.8 pF Chip Capacitors	ATC100B6R8CT500XT	ATC
C2	0.8 pF Chip Capacitor	ATC100B0R8BT500XT	ATC
C4	220 nF Chip Capacitor	VJ1812Y22YKXCAT	Vishay
C5, C12, C13, C14, C15	10 μF Chip Capacitors	C5750X5R1H106MT	TDK
C6, C19	0.2 pF Chip Capacitors	ATC100B0R2BT500XT	ATC
C7	0.5 pF Chip Capacitor	ATC100B0R5BT500XT	ATC
C16	220 μF, 63 V Electrolytic Capacitor, Radial	EMVY630ATR221MKE0S	Nippon Chemi-Con
C17, C18	0.1 pF Chip Capacitors	ATC100B0R1BT500XT	ATC
R1, R2	10 kΩ, 1/4 W Chip Resistors	CRCW12061002FKTA	Vishay
R3	10 Ω, 1/4 W Chip Resistor	CRCW120610R0FKTA	Vishay

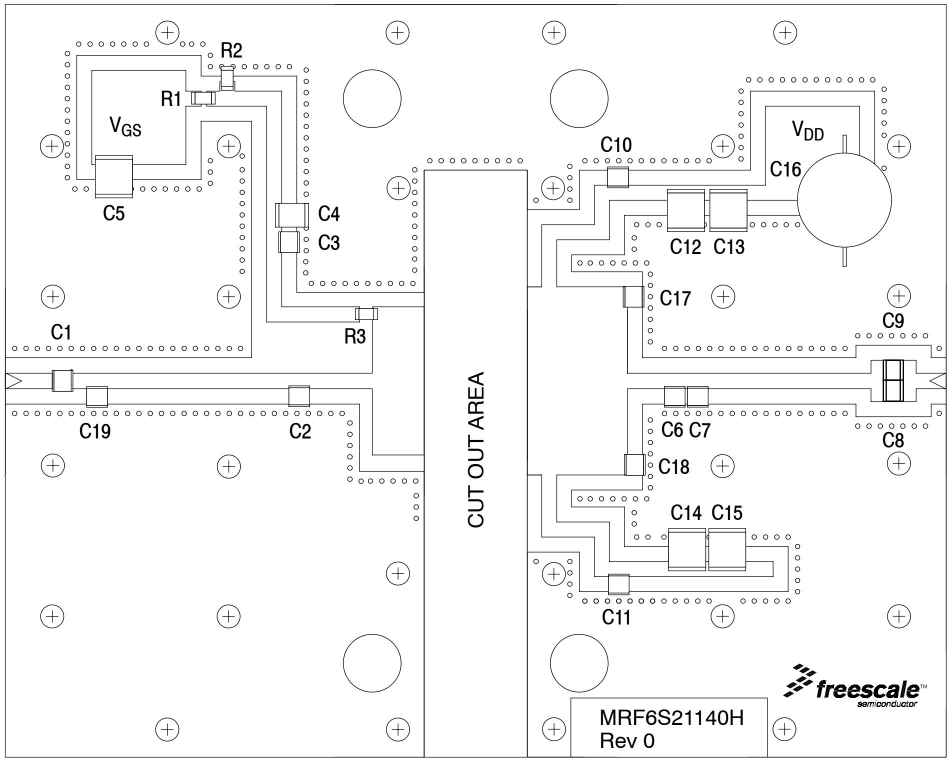


Figure 2. MRF6S21140HR3(HSR3) Test Circuit Component Layout

TYPICAL CHARACTERISTICS

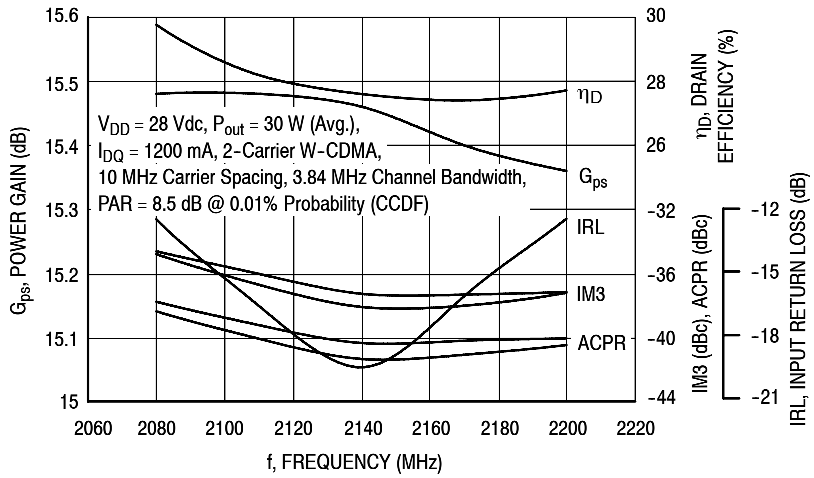


Figure 3. 2-Carrier W-CDMA Broadband Performance @ P_{out} = 30 Watts Avg.

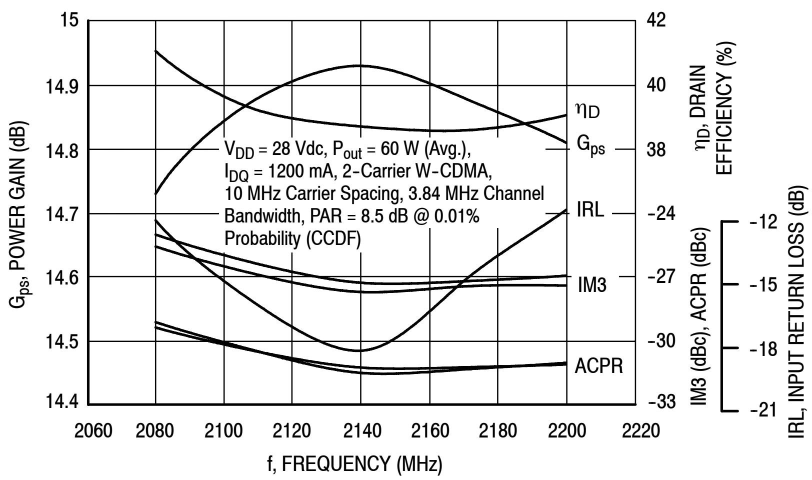


Figure 4. 2-Carrier W-CDMA Broadband Performance @ P_{out} = 60 Watts Avg.

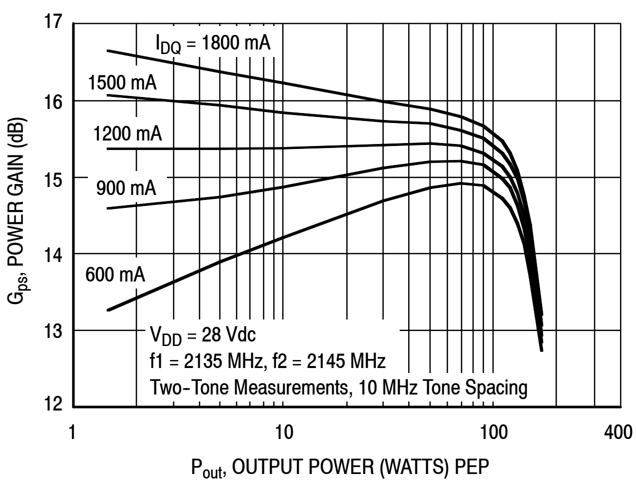


Figure 5. Two-Tone Power Gain versus Output Power

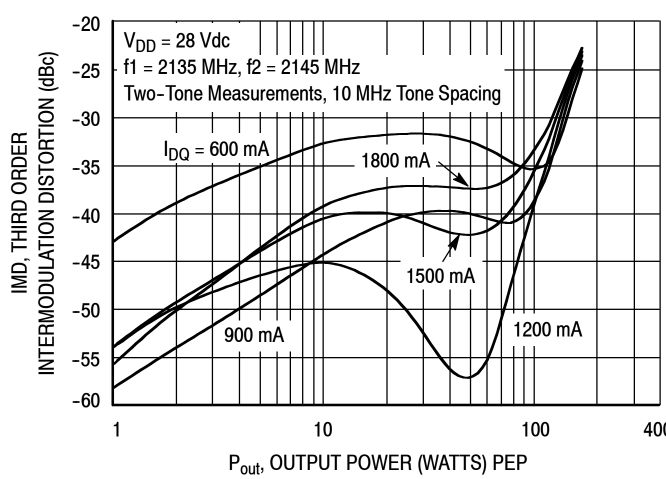


Figure 6. Third Order Intermodulation Distortion versus Output Power

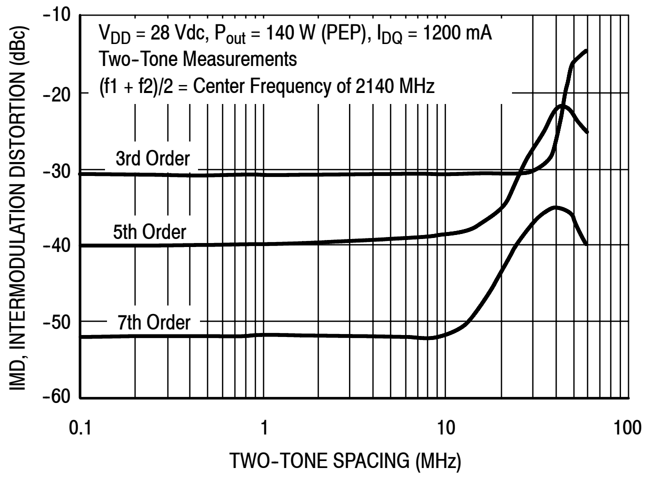


Figure 7. Intermodulation Distortion Products versus Tone Spacing

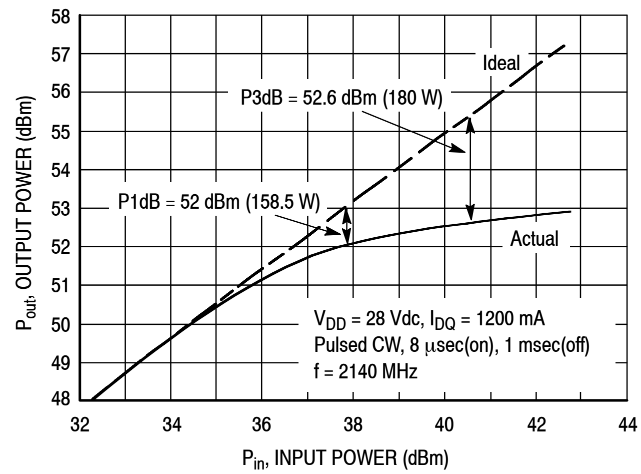


Figure 8. Pulsed CW Output Power versus Input Power

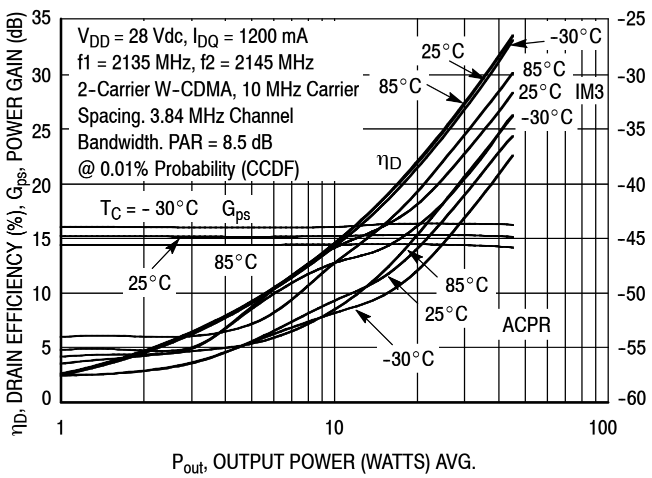


Figure 9. 2-Carrier W-CDMA ACPR, IM3, Power Gain and Drain Efficiency versus Output Power

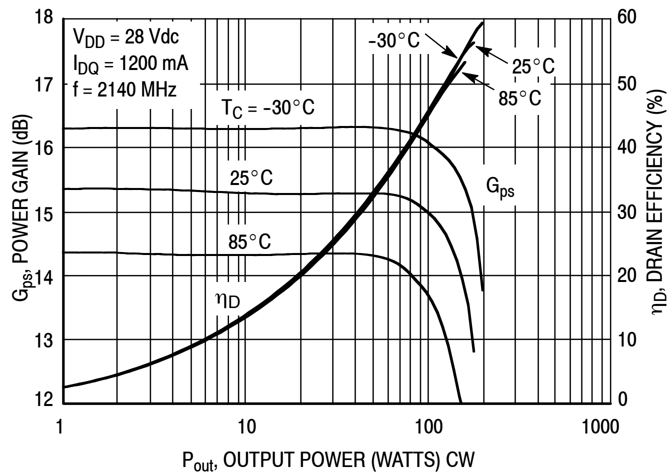


Figure 10. Power Gain and Drain Efficiency versus CW Output Power

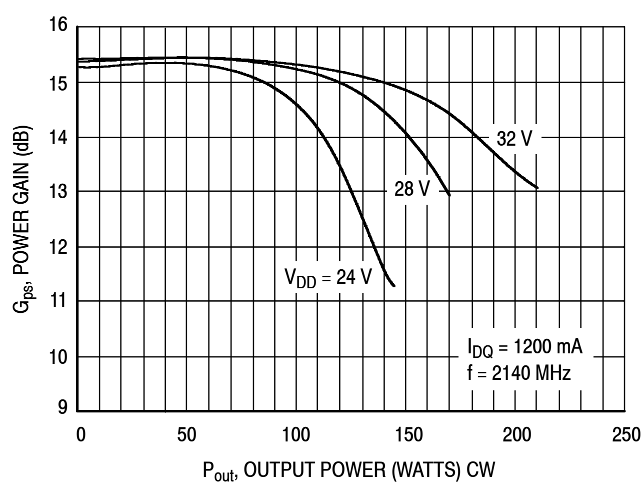
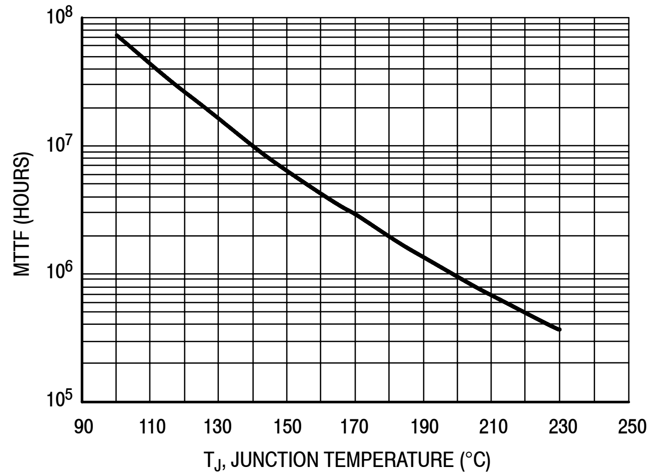


Figure 11. Power Gain versus Output Power

TYPICAL CHARACTERISTICS



This above graph displays calculated MTTF in hours when the device is operated at V_{DD} = 28 Vdc, P_{out} = 30 W Avg., and η_D = 27.5%.

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

Figure 12. MTTF versus Junction Temperature

W-CDMA TEST SIGNAL

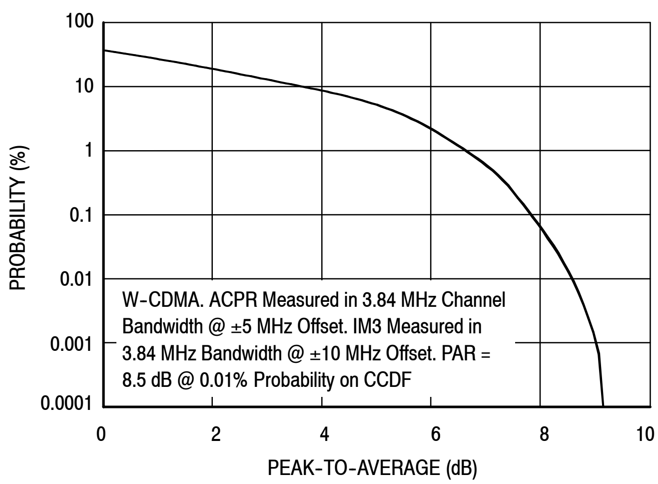


Figure 13. CCDF W-CDMA 3GPP, Test Model 1, 64 DPCH, 67% Clipping, Single-Carrier Test Signal

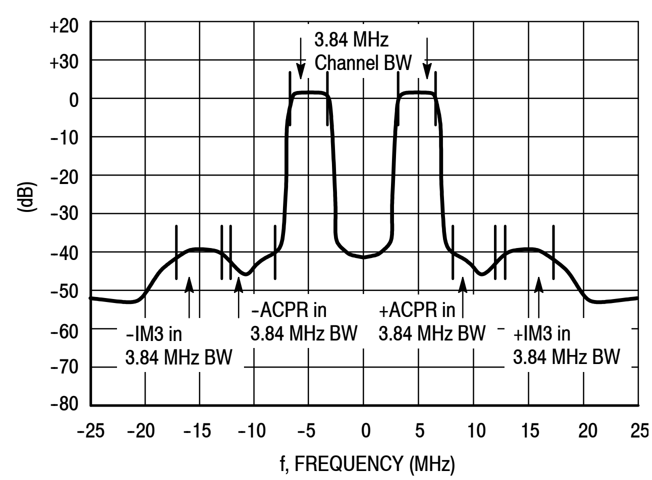
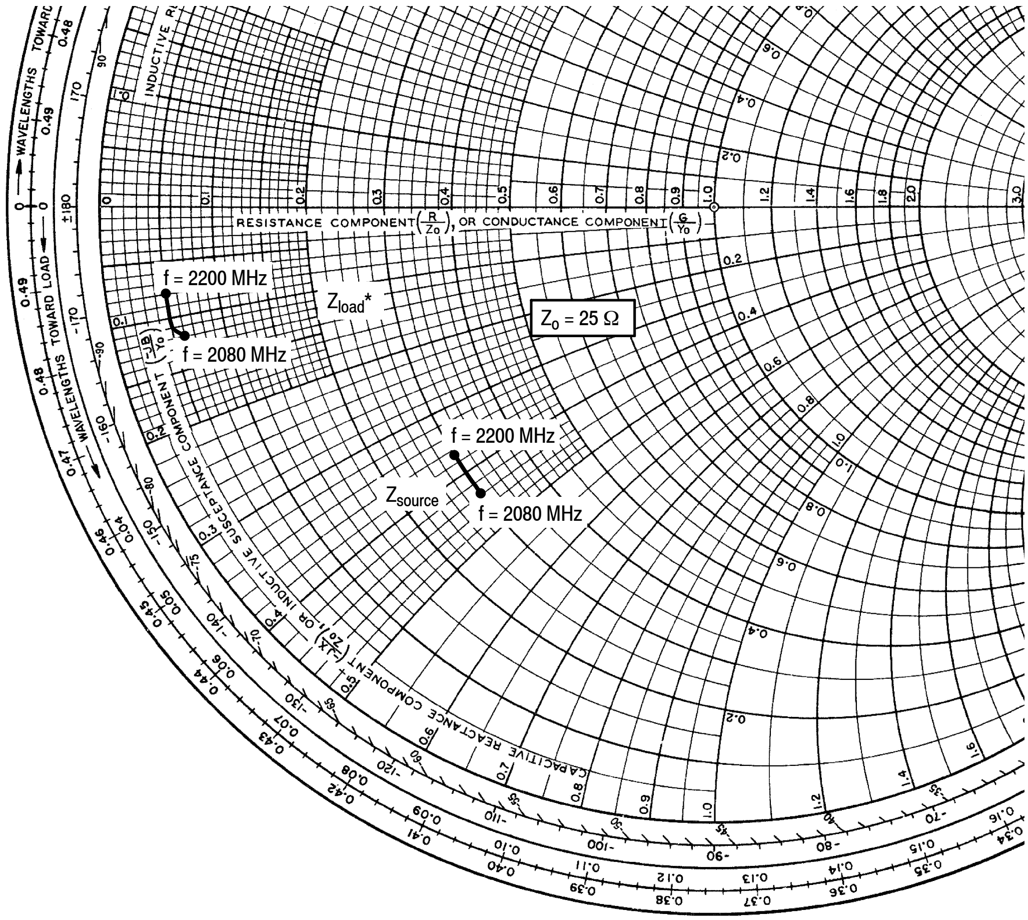


Figure 14. 2-Carrier W-CDMA Spectrum



V_{DD} = 28 Vdc, I_{DQ} = 1200 mA, P_{out} = 30 W Avg.

f MHz	Z_{source} Ω	Z_{load} Ω
2080	7.53 – j10.99	1.40 – j3.03
2110	7.57 – j10.67	1.37 – j2.78
2140	7.58 – j10.23	1.34 – j2.52
2170	7.51 – j9.73	1.32 – j2.28
2200	7.44 – j9.32	1.31 – j2.06

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

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

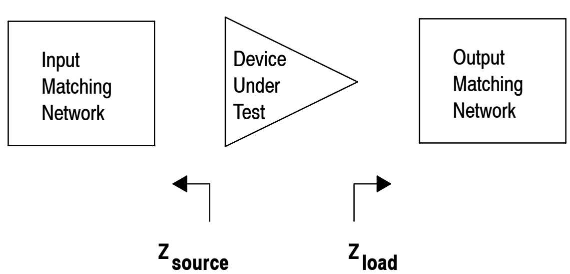
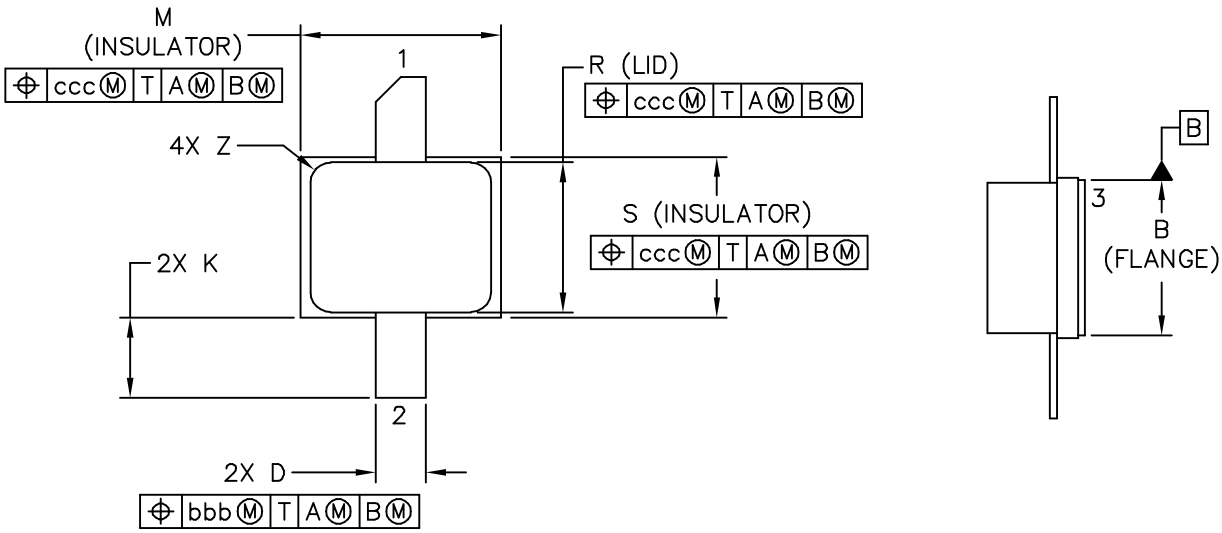
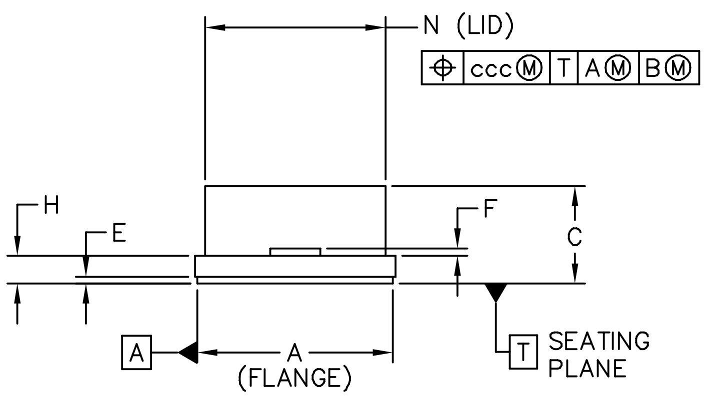


Figure 15. Series Equivalent Source and Load Impedance

PACKAGE DIMENSIONS





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TITLE: NI−200S STRAIGHT LEAD	DOCUMENT NO: 98ARH98343A	REV: E
	CASE NUMBER: 458B−03	22 MAR 2005
	STANDARD: NON−JEDEC	

NOTES:

1. CONTROLLING DIMENSION: INCH

2. INTERPRET DIMENSIONS AND TOLERANCES PER ASME Y14.5M—1994.

3. DELETED.

4. DIMENSION "H" TO BE MEASURED .030 (0.762) FROM PACKAGE BODY.

STYLE 1:
PIN 1: DRAIN
PIN 2: GATE
PIN 3: SOURCE

DIM	INCH		MILLIMETER		DIM	INCH		MILLIMETER	
	MIN	MAX	MIN	MAX		MIN	MAX	MIN	MAX
A	.180	.190	4.572	4.83	Z	—	R .020	—	R 0.508
B	.140	.150	3.556	3.81	bbb	.010		0.254	
C	.082	.116	2.083	2.946	ccc	.015		0.381	
D	.047	.053	1.194	1.346	—	—	—	—	—
E	.004	.010	0.102	0.254	—	—	—	—	—
F	.004	.006	0.102	0.152	—	—	—	—	—
H	.025	.031	0.635	0.787	—	—	—	—	—
K	.060	.110	1.524	2.794	—	—	—	—	—
M	.197	.203	5.004	5.156	—	—	—	—	—
N	.177	.183	4.496	4.648	—	—	—	—	—
R	.147	.153	3.734	3.886	—	—	—	—	—
S	.157	.163	3.988	4.14	—	—	—	—	—

MECHANICAL OUTLINE

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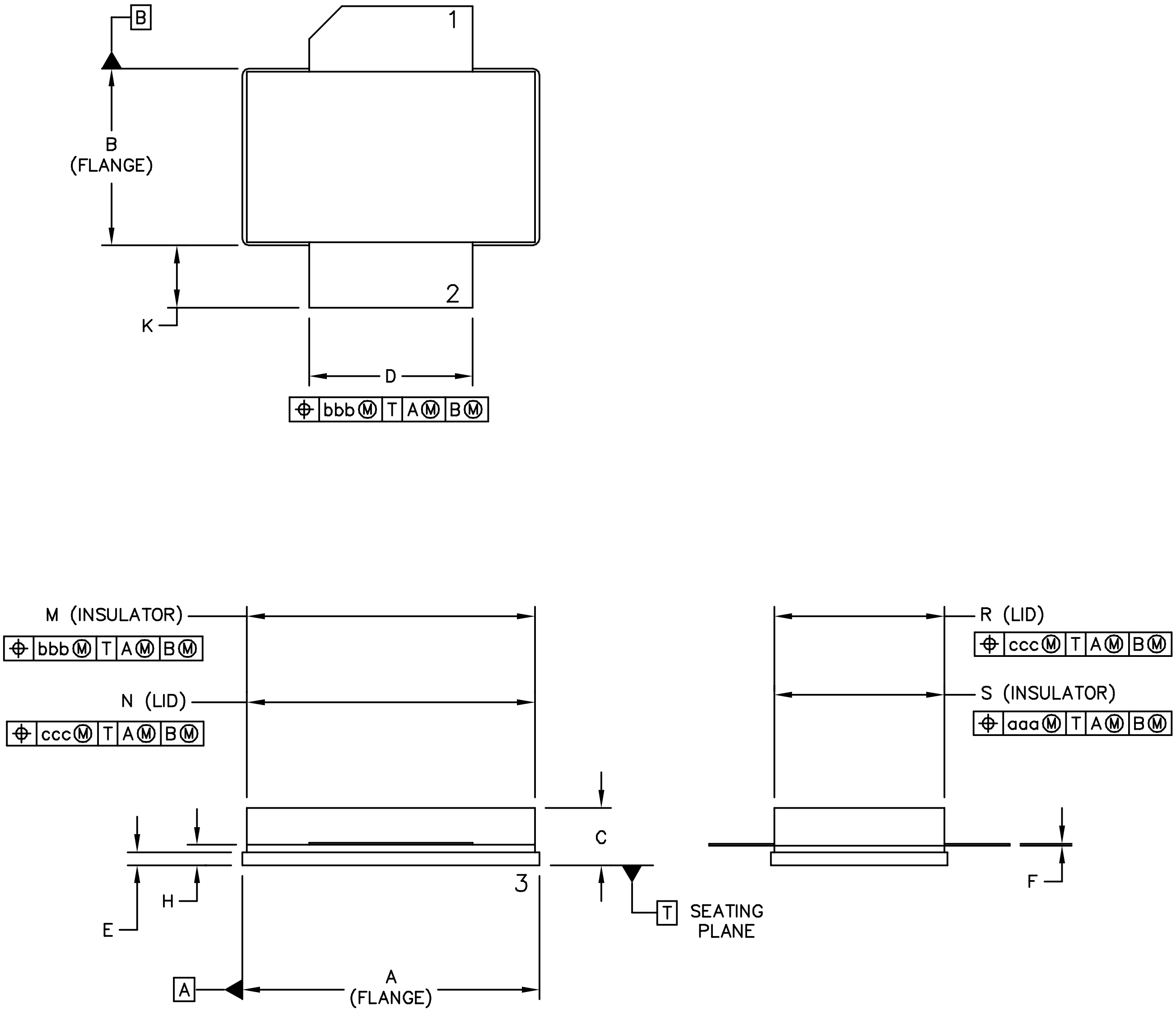

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	CASE NUMBER: 465C−02	09 JUN 2005
	STANDARD: NON−JEDEC	

NOTES:

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M–1994.
2. CONTROLLING DIMENSION: INCH.
3. DIMENSION H IS MEASURED .030 (0.762) AWAY FROM PACKAGE BODY.

STYLE 1: PIN 1. DRAIN
2. GATE
3. SOURCE

DIM	INCH			MILLIMETER			DIM	INCH			MILLIMETER		
	MIN		MAX	MIN		MAX		MIN		MAX	MIN		MAX
A	.905	–	.915	22.99	–	23.24	aaa	–	.007	–	–	0.178	–
B	.535	–	.545	13.6	–	13.8	bbb	–	.010	–	–	0.254	–
C	.147	–	.200	3.73	–	5.08	ccc	–	.015	–	–	0.381	–
D	.495	–	.505	12.57	–	12.83	–	–	–	–	–	–	–
E	.035	–	.045	0.89	–	1.14	–	–	–	–	–	–	–
F	.003	–	.006	0.08	–	0.15	–	–	–	–	–	–	–
H	.057		.067	1.45		1.7	–	–	–	–	–	–	–
K	.170	–	.210	4.32	–	5.33	–	–	–	–	–	–	–
M	.872	–	.888	22.15	–	22.55	–	–	–	–	–	–	–
N	.871	–	.889	19.3	–	22.6	–	–	–	–	–	–	–
R	.515	–	.525	13.1	–	13.3	–	–	–	–	–	–	–
S	.515	–	.525	13.1	–	13.3	–	–	–	–	–	–	–

	MECHANICAL OUTLINE	PRINT VERSION NOT TO SCALE
TITLE: NI–880S	DOCUMENT NO: 98ARB18660C	REV: D
	CASE NUMBER: 465C–02	09 JUN 2005
	STANDARD: NON–JEDEC	

PRODUCT DOCUMENTATION, TOOLS AND SOFTWARE

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

Software

- Electromigration MTTF Calculator
- RF High Power Model

For Software and Tools, do a Part Number search at http://www.freescale.com, and select the "Part Number" link. Go to the Software & Tools tab on the part's Product Summary page to download the respective tool.

REVISION HISTORY

The following table summarizes revisions to this document.

Revision	Date	Description
4	May 2007	• Removed Lower Thermal Resistance and Low Gold Plating bullets from Features section as functionality is standard, p. 1 • Removed "Designed for Lower Memory Effects and Wide Instantaneous Bandwidth Applications" bullet as functionality is standard, p. 1 • Added "Optimized for Doherty Applications" bullet to Features section, 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 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 $V_{GS(Q)}$ 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 Part Numbers in Table 5, Component Designations and Values, to RoHS compliant part numbers, p. 3 • Adjusted scale for Fig. 5, Two-Tone Power Gain versus Output Power, to better match the device's capabilities, p. 5 • 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 $Amps^2$ and listed operating characteristics and location of MTTF calculator for device, p. 7 • Added Product Documentation and Revision History, p. 10
5	Feb. 2010	• Modified data sheet to reflect RF Test Reduction described in Product and Process Change Notification number, PCN13232, p. 1, 2 • Added On Characteristic $V_{DS(on)}$ Min value, p. 2 • Added Electromigration MTTF Calculator and RF High Power Model availability to Product Software, p. 13

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Japan:
Freescale Semiconductor Japan Ltd.
Headquarters
ARCO Tower 15F
1-8-1, Shimo-Meguro, Meguro-ku,
Tokyo 153-0064
Japan
0120 191014 or +81 3 5437 9125
support.japan@freescale.com

Asia/Pacific:
Freescale Semiconductor China Ltd.
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Document Number: MRF6S21140H
Rev. 5, 2/2010