Freescale Semiconductor
Technical Data

Document Number: MRF7S21110H
Rev. 2, 3/2011

RF Power Field Effect Transistors

N-Channel Enhancement-Mode Lateral MOSFETs

Designed for CDMA base station applications with frequencies from 2110 to 2170 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.

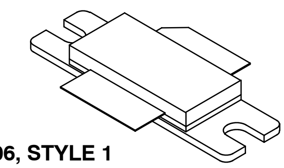
- Typical Single-Carrier W-CDMA Performance: V_{DD} = 28 Volts, I_{DQ} = 1100 mA, P_{out} = 33 Watts Avg., f = 2167.5 MHz, IQ Magnitude Clipping, Channel Bandwidth = 3.84 MHz, Input Signal PAR = 7.5 dB @ 0.01% Probability on CCDF.
  - Power Gain — 17.3 dB
  - Drain Efficiency — 32.5%
  - Device Output Signal PAR — 6.1 dB @ 0.01% Probability on CCDF
  - ACPR @ 5 MHz Offset — -38 dBc in 3.84 MHz Channel Bandwidth
- Capable of Handling 10:1 VSWR, @ 32 Vdc, 2140 MHz, 110 Watts CW Peak Tuned Output Power
- P_{out} @ 1 dB Compression Point ≃ 110 Watts CW

Features

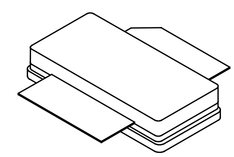
- 100% PAR Tested for Guaranteed Output Power Capability
- Characterized with Series Equivalent Large-Signal Impedance Parameters
- Internally Matched for Ease of Use
- Integrated ESD Protection
- Greater Negative Gate-Source Voltage Range for Improved Class C Operation
- Designed for Digital Predistortion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

MRF7S21110HR3
MRF7S21110HSR3

2110-2170 MHz, 33 W AVG., 28 V
SINGLE W-CDMA
LATERAL N-CHANNEL
RF POWER MOSFETs



CASE 465-06, STYLE 1
NI-780
MRF7S21110HR3



CASE 465A-06, STYLE 1
NI-780S
MRF7S21110HSR3

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, 109 W CW Case Temperature 78°C, 33 W CW	$R_{\theta JC}$	 0.37 0.41	°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.

Table 3. ESD Protection Characteristics

Test Methodology	Class
Human Body Model (per JESD22-A114)	1B (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)

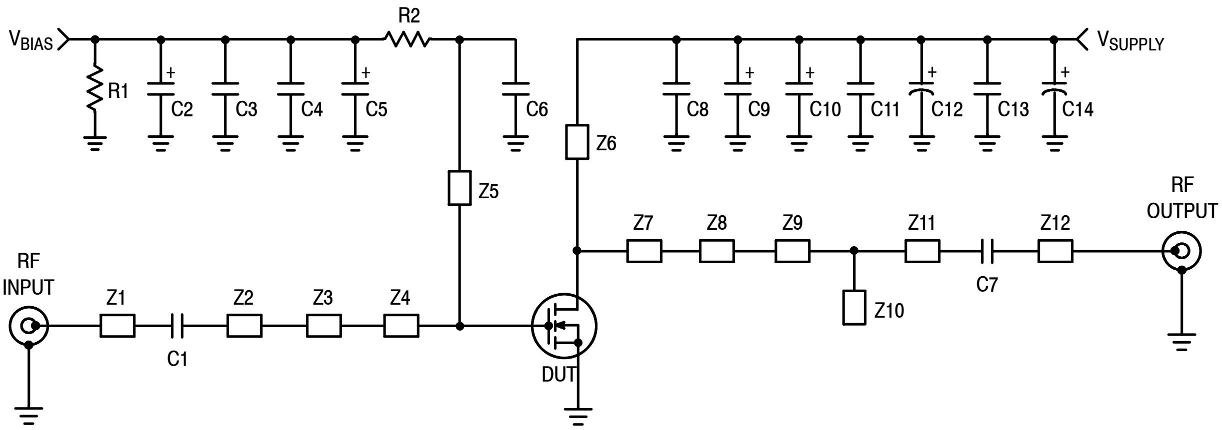
Characteristic	Symbol	Min	Typ	Max	Unit
Off Characteristics					
Zero Gate Voltage Drain Leakage Current (V_{DS} = 65 Vdc, V_{GS} = 0 Vdc)	I_{DSS}	—	—	10	μAdc
Zero Gate Voltage Drain Leakage Current (V_{DS} = 28 Vdc, V_{GS} = 0 Vdc)	I_{DSS}	—	—	1	μAdc
Gate-Source Leakage Current (V_{GS} = 5 Vdc, V_{DS} = 0 Vdc)	I_{GSS}	—	—	1	μAdc
On Characteristics					
Gate Threshold Voltage (V_{DS} = 10 Vdc, I_D = 270 μAdc)	$V_{GS(th)}$	1.2	2	2.7	Vdc
Gate Quiescent Voltage (V_{DD} = 28 Vdc, I_D = 1100 mAdc, Measured in Functional Test)	$V_{GS(Q)}$	2	2.7	3.5	Vdc
Drain-Source On-Voltage (V_{GS} = 10 Vdc, I_D = 2.7 Adc)	$V_{DS(on)}$	0.05	0.1	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}	—	7.95	—	pF
Output Equivalent Capacitance (V_{DS} = 28 Vdc ± 30 mV(rms)ac @ 1 MHz, V_{GS} = 0 Vdc)	C_{oss}	—	613	—	pF
Input Capacitance (V_{DS} = 28 Vdc, V_{GS} = 0 Vdc ± 30 mV(rms)ac @ 1 MHz)	C_{iss}	—	232	—	pF
Functional Tests (In Freescale Test Fixture, 50 ohm system) V_{DD} = 28 Vdc, I_{DQ} = 1100 mA, P_{out} = 33 W Avg., f = 2167.5 MHz, Single-Carrier W-CDMA, IQ Magnitude Clipping, Input Signal PAR = 7.5 dB @ 0.01% Probability on CCDF. ACPR measured in 3.84 MHz Channel Bandwidth @ ±5 MHz Offset.					
Power Gain	G_{ps}	16.5	17.3	19.5	dB
Drain Efficiency	η_D	31	32.5	39	%
Output Peak-to-Average Ratio @ 0.01% Probability on CCDF	PAR	5.7	6.1	6.5	dB
Adjacent Channel Power Ratio	ACPR	-48	-38	-35	dBc
Input Return Loss	IRL	—	-15	—	dB

1. Part internally matched both on input and output.

(continued)

Table 4. Electrical Characteristics (T_A = 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} = 1100 mA, 2110–2170 MHz Bandwidth					
Video Bandwidth @ 90 W PEP P_{out} where IM3 = –30 dBc (Tone Spacing from 100 kHz to VBW) ΔIMD3 = IMD3 @ VBW frequency – IMD3 @ 100 kHz <1 dBc (both sidebands)	VBW	—	10	—	MHz
Gain Flatness in 60 MHz Bandwidth @ P_{out} = 33 W Avg.	G_F	—	0.325	—	dB
Average Deviation from Linear Phase in 60 MHz Bandwidth @ P_{out} = 110 W CW	Φ	—	0.772	—	°
Average Group Delay @ P_{out} = 110 W CW, f = 2140 MHz	Delay	—	1.9	—	ns
Part–to–Part Insertion Phase Variation @ P_{out} = 110 W CW, f = 2140 MHz, Six Sigma Window	ΔΦ	—	39.7	—	°
Gain Variation over Temperature (–30°C to +85°C)	ΔG	—	0.011	—	dB/°C
Output Power Variation over Temperature (–30°C to +85°C)	ΔP1dB	—	0.028	—	dB/°C



Z1	1.280″ x 0.084″ Microstrip	Z8	0.370″ x 0.201″ Microstrip
Z2	0.856″ x 0.084″ Microstrip	Z9	0.386″ x 0.084″ Microstrip
Z3	0.240″ x 0.280″ Microstrip	Z10	0.196″ x 0.242″ Microstrip
Z4	0.420″ x 0.880″ Microstrip	Z11	0.105″ x 0.084″ Microstrip
Z5	0.950″ x 0.0395″ Microstrip	Z12	1.267″ x 0.084″ Microstrip
Z6	0.526″ x 0.0940″ Microstrip	PCB	Arlon CuClad 250GX-0300-55-22, 0.030″, ε_r = 2.55
Z7	0.480″ x 1.050″ Microstrip		

Figure 1. MRF7S21110HR3(HSR3) Test Circuit Schematic

Table 5. MRF7S21110HR3(HSR3) Test Circuit Component Designations and Values

Part	Description	Part Number	Manufacturer
C1	15 pF, Chip Capacitor	ATC100B150JT500XT	ATC
C2	47 μF, 16 V Tantalum Capacitor	T491D476K016AT	Kemet
C3	8.2 pF, Chip Capacitor	ATC100B8R2CT500XT	ATC
C4, C13	2.2 μF, 50 V Chip Capacitors	C1825C225J5RAC	Kemet
C5	1 μF, 50 V Tantalum Capacitor	T491C105K050AT	Kemet
C6	5.1 pF Chip Capacitor	ATC100B5R1CT500XT	ATC
C7	16 pF Chip Capacitor	ATC100B160JT500XT	ATC
C8	6.8 pF Chip Capacitor	ATC100B6R8BT500XT	ATC
C9, C10	22 μF, 35 V Tantalum Capacitors	T491X226K035AT	Kemet
C11	0.1 μF Chip Capacitor	C1206C104K5RAC	Kemet
C12	100 μF, 50 V Electrolytic Capacitor	MCR63V477M13X26	Multicomp
C14	470 μF, 63 V Electrolytic Capacitor	MCR50V107M8X11	Multicomp
R1	1 KΩ, 1/4 W Chip Resistor	CRCW12061001FKEA	Vishay
R2	10 Ω, 1/3 W Chip Resistor	CRCW121010R0FKEA	Vishay

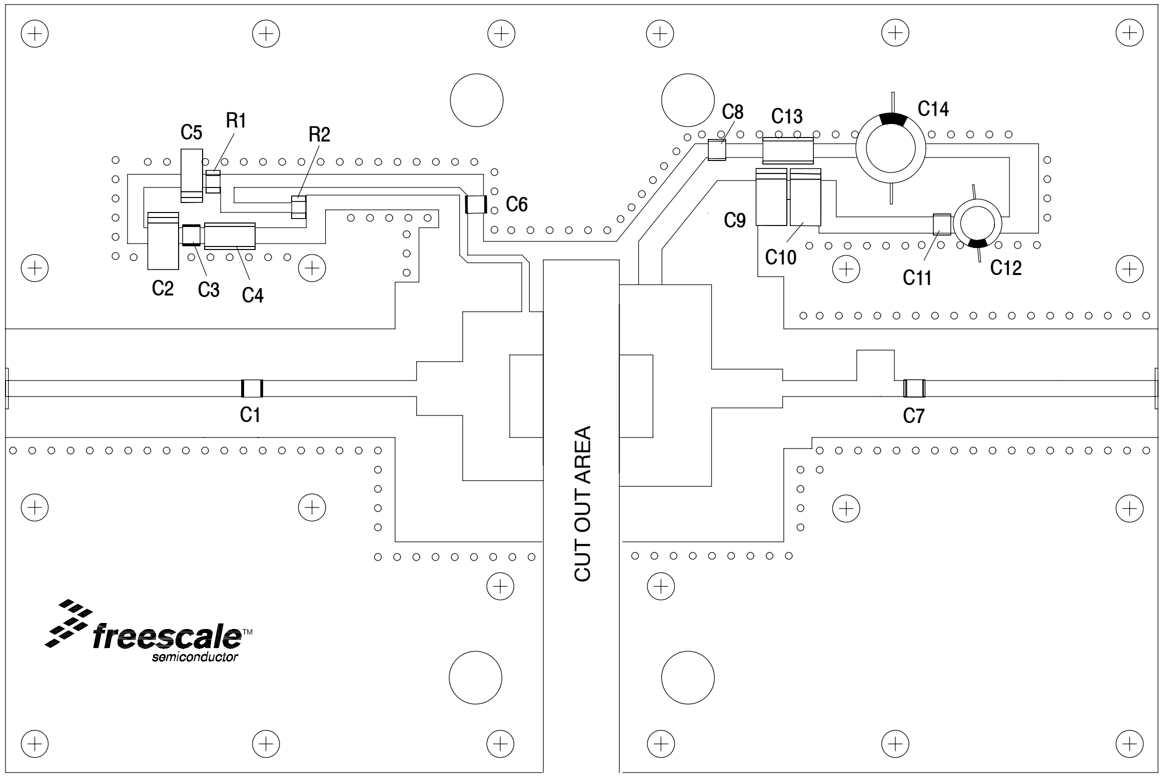


Figure 2. MRF7S21110HR3(HSR3) Test Circuit Component Layout

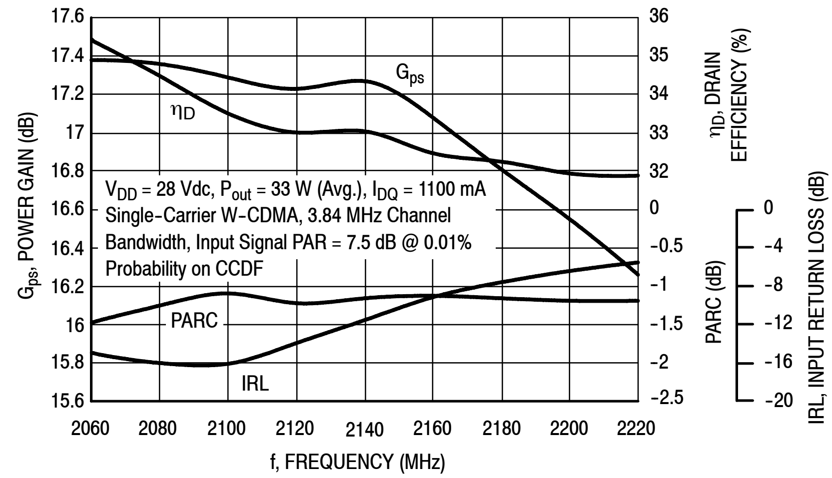


Figure 3. Output Peak-to-Average Ratio Compression (PARC) Broadband Performance @ P_{out} = 33 Watts Avg.

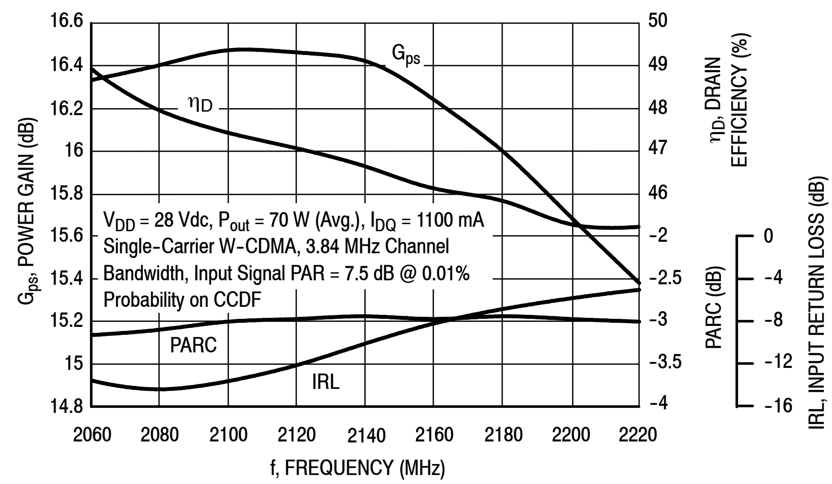


Figure 4. Output Peak-to-Average Ratio Compression (PARC) Broadband Performance @ P_{out} = 70 Watts Avg.

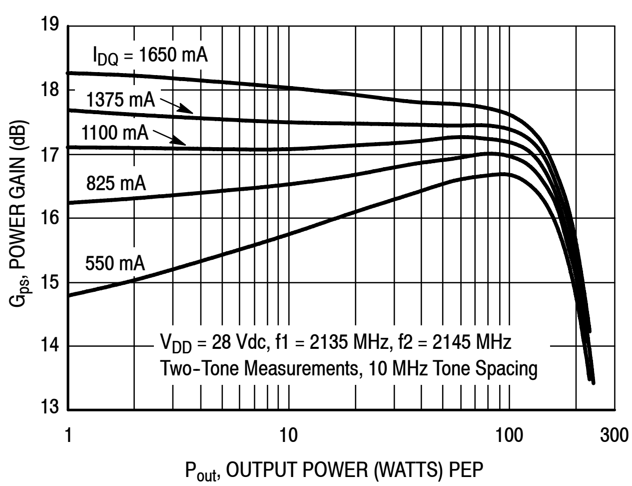


Figure 5. Two-Tone Power Gain versus Output Power

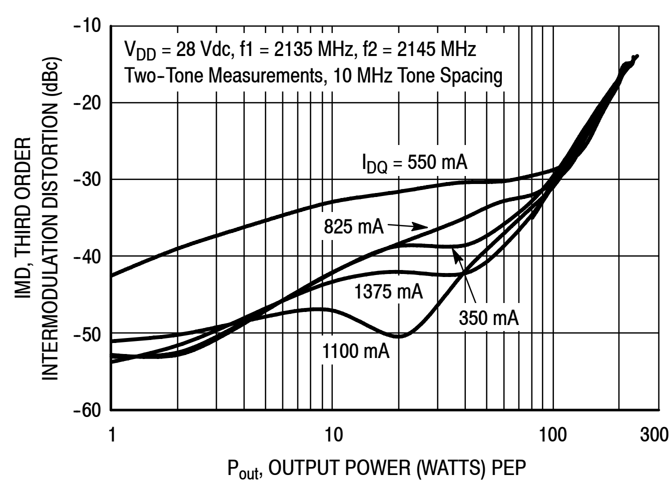


Figure 6. Third Order Intermodulation Distortion versus Output Power

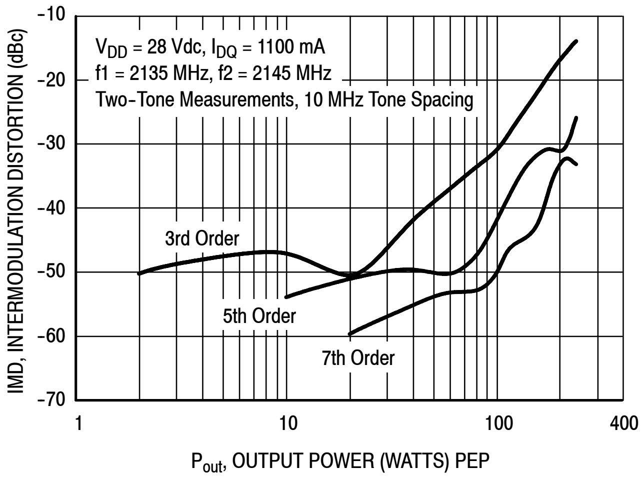


Figure 7. Intermodulation Distortion Products versus Output Power

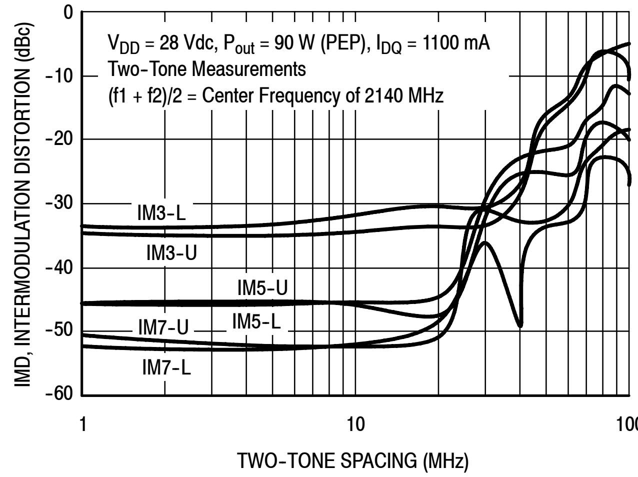


Figure 8. Intermodulation Distortion Products versus Tone Spacing

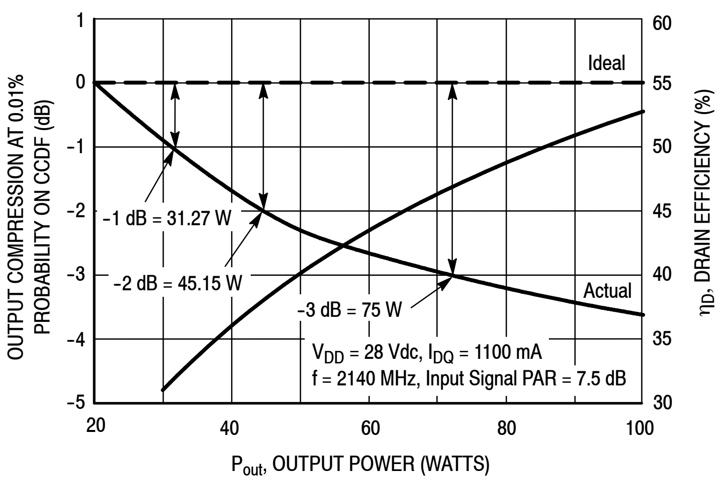


Figure 9. Output Peak-to-Average Ratio Compression (PARC) versus Output Power

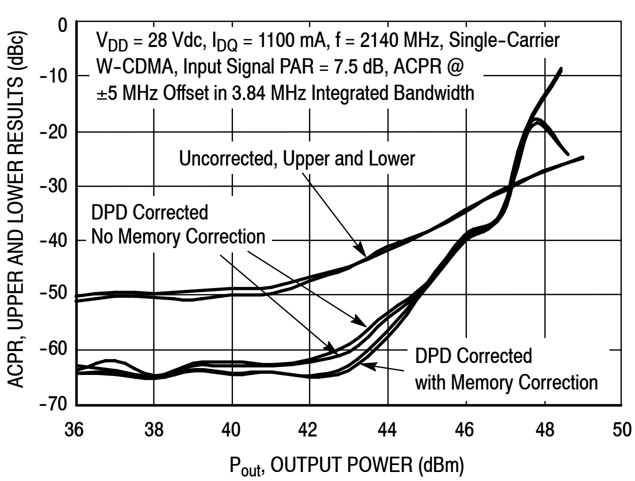


Figure 10. Digital Predistortion Correction versus ACPR and Output Power

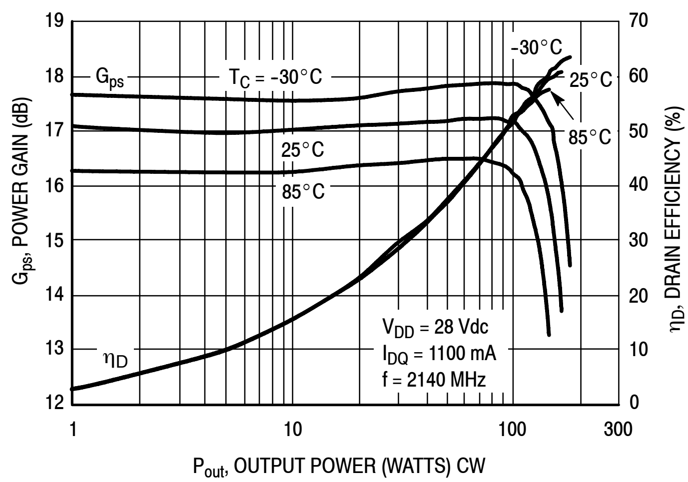


Figure 11. Power Gain and Drain Efficiency versus CW Output Power

TYPICAL CHARACTERISTICS

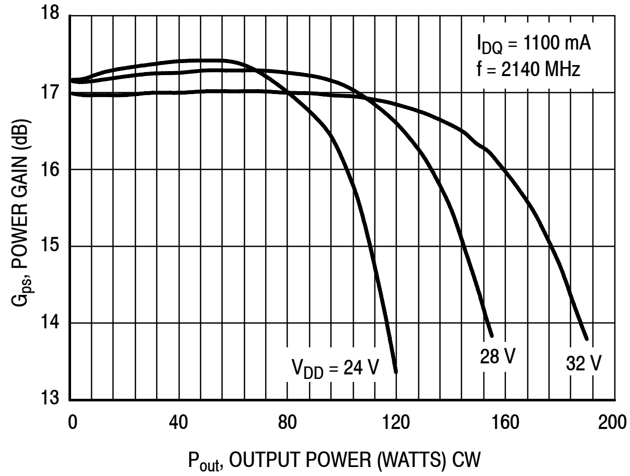


Figure 12. Power Gain versus Output Power

W-CDMA TEST SIGNAL

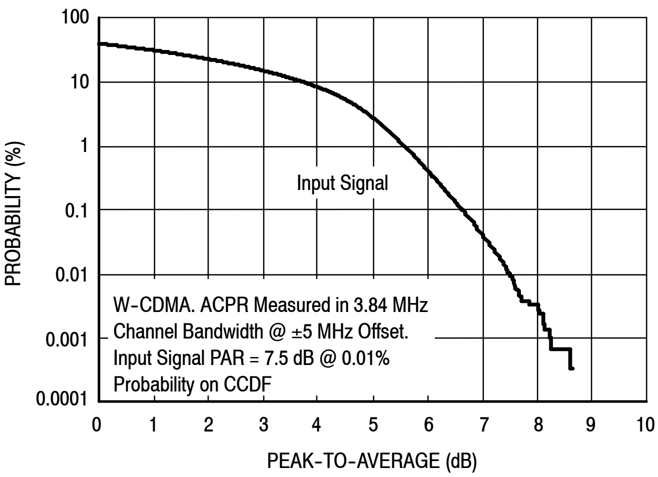


Figure 13. CCDF W-CDMA IQ Magnitude Clipping, Single-Carrier Test Signal

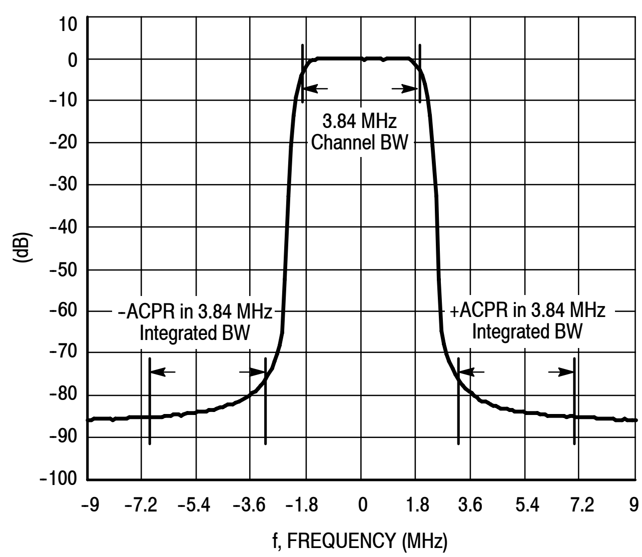
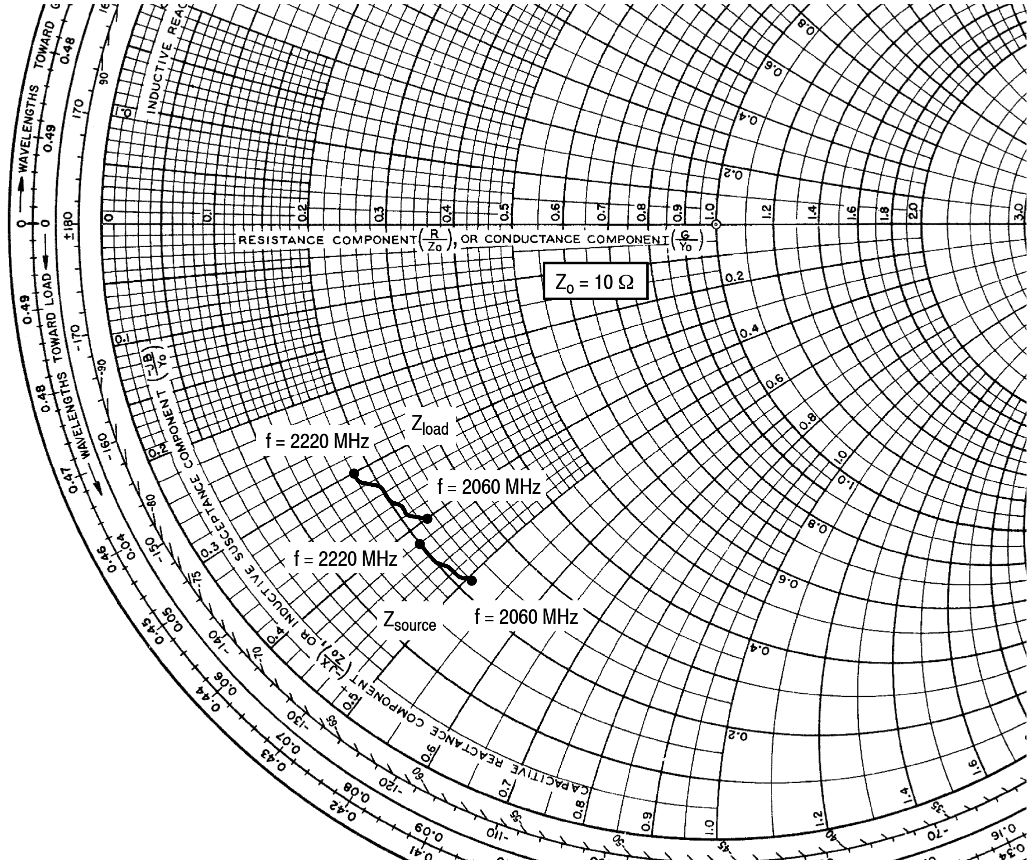


Figure 14. Single-Carrier W-CDMA Spectrum



V_{DD} = 28 Vdc, I_{DQ} = 1100 mA, P_{out} = 33 W Avg.

f MHz	Z_{source} Ω	Z_{load} Ω
2060	2.2 - j5.1	2.3 - j4.0
2080	2.2 - j5.0	2.2 - j3.9
2100	2.1 - j4.9	2.1 - j3.8
2120	2.1 - j4.8	2.1 - j3.7
2140	2.1 - j4.7	2.0 - j3.5
2160	2.0 - j4.5	2.0 - j3.4
2180	2.0 - j4.4	2.0 - j3.3
2200	2.0 - j4.3	1.8 - j3.1
2220	2.0 - j4.2	1.8 - j3.0

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

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

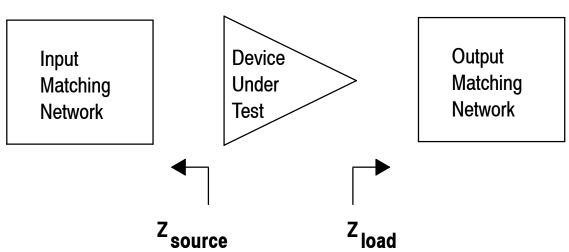
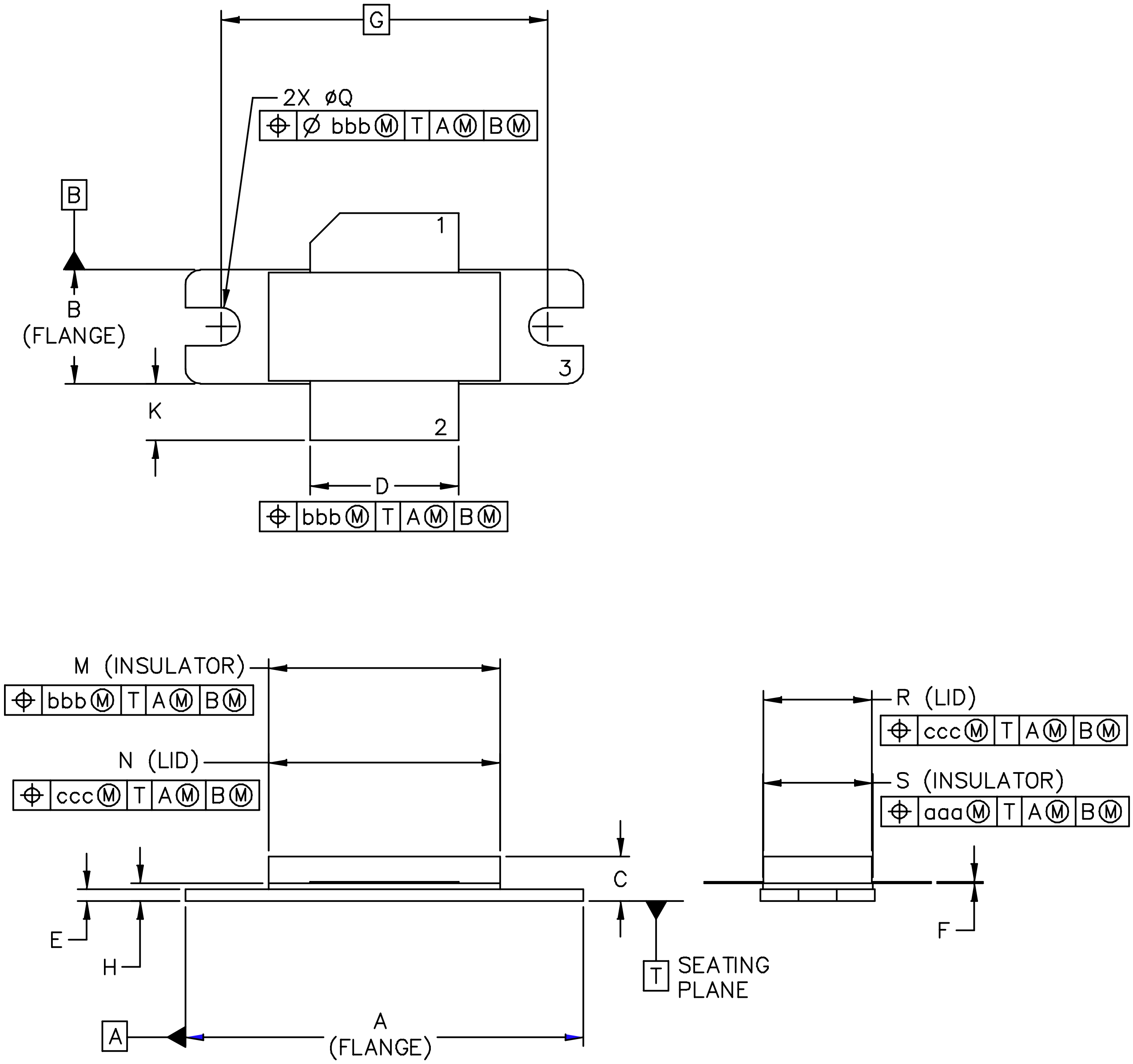


Figure 15. Series Equivalent Source and Load Impedance

PACKAGE DIMENSIONS



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NOTES:

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M—1994.
2. CONTROLLING DIMENSION: INCH.
3. DELETED
4. DIMENSION H IS MEASURED .030 (.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	1.335	—	1.345	33.91	—	34.16	R	.365	—	.375	9.27	—	9.53
B	.380	—	.390	9.65	—	9.91	S	.365	—	.375	9.27	—	9.52
C	.125	—	.170	3.18	—	4.32	aaa	—	.005	—	—	0.127	—
D	.495	—	.505	12.57	—	12.83	bbb	—	.010	—	—	0.254	—
E	.035	—	.045	0.89	—	1.14	ccc	—	.015	—	—	0.381	—
F	.003	—	.006	0.08	—	0.15	—	—	—	—	—	—	—
G	1.100 BSC			27.94 BSC			—	—	—	—	—	—	—
H	.057	—	.067	1.45	—	1.7	—	—	—	—	—	—	—
K	.170	—	.210	4.32	—	5.33	—	—	—	—	—	—	—
M	.774	—	.786	19.66	—	19.96	—	—	—	—	—	—	—
N	.772	—	.788	19.6	—	20	—	—	—	—	—	—	—
Q	ø.118	—	ø.138	ø3	—	ø3.51	—	—	—	—	—	—	—

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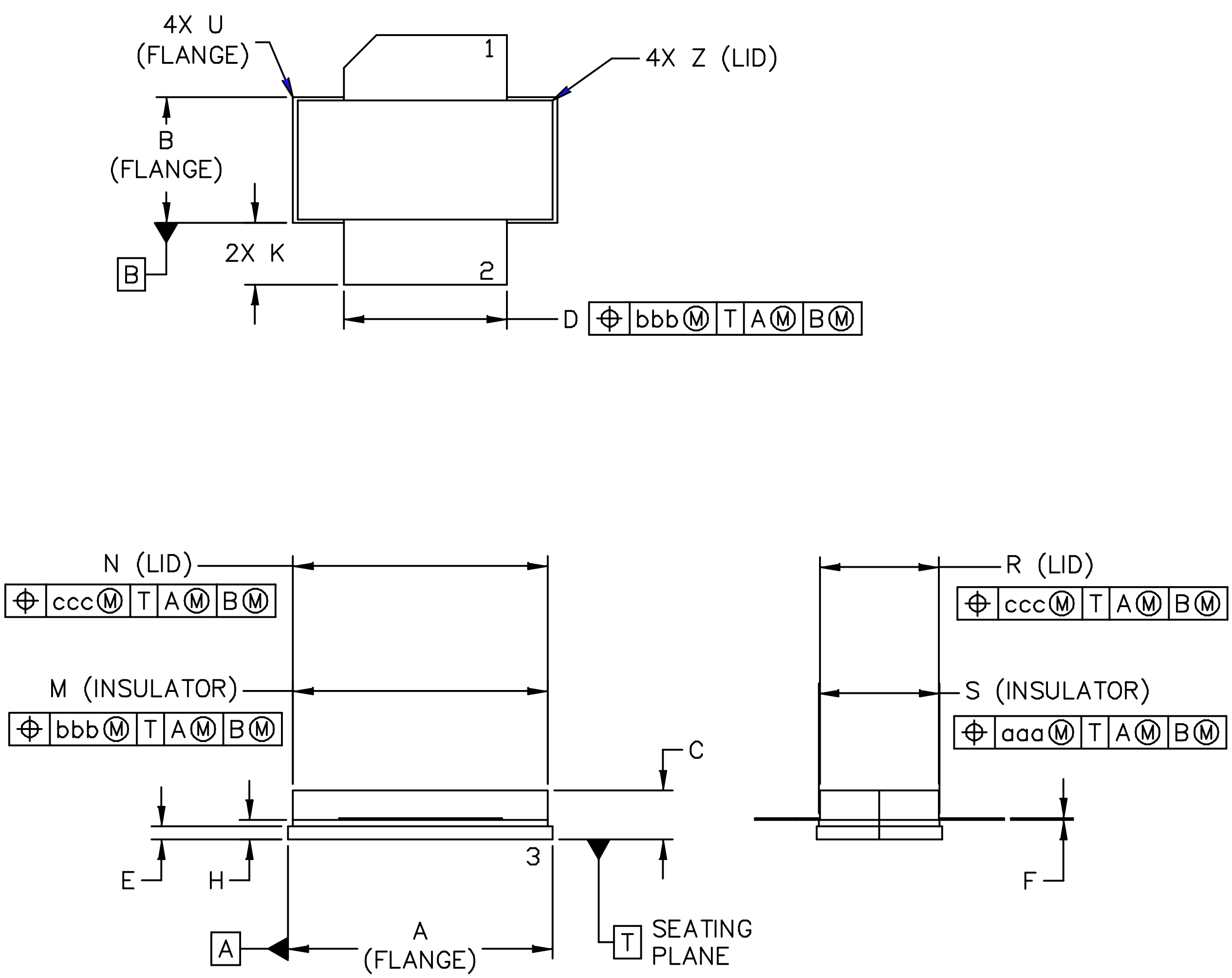

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STYLE 1:
PIN 1. DRAIN
2. GATE
3. SOURCE

DIM	INCH			MILLIMETER			DIM	INCH			MILLIMETER		
	MIN		MAX	MIN		MAX		MIN		MAX	MIN		MAX
A	.805	—	.815	20.45	—	20.7	U	—	—	.040	—	—	1.02
B	.380	—	.390	9.65	—	9.91	Z	—	—	.030	—	—	0.76
C	.125	—	.170	3.18	—	4.32	aaa	—	.005	—	—	0.127	—
D	.495	—	.505	12.57	—	12.83	bbb	—	.010	—	—	0.254	—
E	.035	—	.045	0.89	—	1.14	ccc	—	.015	—	—	0.381	—
F	.003	—	.006	0.08	—	0.15	—	—	—	—	—	—	—
H	.057	—	.067	1.45	—	1.7	—	—	—	—	—	—	—
K	.170	—	.210	4.32	—	5.33	—	—	—	—	—	—	—
M	.774	—	.786	19.61	—	20.02	—	—	—	—	—	—	—
N	.772	—	.788	19.61	—	20.02	—	—	—	—	—	—	—
R	.365	—	.375	9.27	—	9.53	—	—	—	—	—	—	—
S	.365	—	.375	9.27	—	9.52	—	—	—	—	—	—	—

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PRODUCT DOCUMENTATION AND SOFTWARE

Refer to the following documents and software 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, 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
0	Sept. 2007	• Initial Release of Data Sheet
1	July 2008	• Added Input Signal in front of PAR for consistency throughout data sheet p. 2, 6, 7, 8 • Corrected Table 4, Typical Performances, Output Power Variation over Temperature value from 0.276 to 0.028, p. 3 • Updated Fig. 14, CCDF W-CDMA 3GPP, Test Model 1, 64 DPCH, 50% Clipping, Single-Carrier Test Signal, to better represent production test signal, p. 8
2	Mar. 2011	• Modified data sheet to reflect RF Test Reduction described in Product and Process Change Notification number, PCN13628, p. 1, 2 • Fig. 13, MTTF versus Junction Temperature removed, p. 8. Refer to the device’s MTTF Calculator available at freescale.com/RFpower. Go to Design Resources > Software and Tools. • Fig. 14, CCDF W-CDMA IQ Magnitude Clipping, Single-Carrier Test Signal and Fig. 15, Single-Carrier W-CDMA Spectrum updated to show the undistorted input test signal, p. 8 (renumbered as Figs. 13 and 14 respectively after Fig. 13 removed) • Added Electromigration MTTF Calculator and RF High Power Model availability to Product Software, p. 14

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Document Number: MRF7S21110H
Rev. 2, 3/2011