Freescale Semiconductor
Technical Data

Document Number: MRF8S23120H
Rev. 0, 11/2010

√RoHS

RF Power Field Effect Transistors

N-Channel Enhancement-Mode Lateral MOSFETs

MRF8S23120HR3
MRF8S23120HSR3

Designed for LTE base station applications with frequencies from 2300 to 2400 MHz. Can be used in Class AB and Class C for all typical cellular base station modulation formats.

- Typical Single-Carrier W-CDMA Performance: V_{DD} = 28 Volts, I_{DQ} = 800 mA, P_{out} = 28 Watts Avg., IQ Magnitude Clipping, Channel Bandwidth = 3.84 MHz, Input Signal PAR = 7.5 dB @ 0.01% Probability on CCDF.

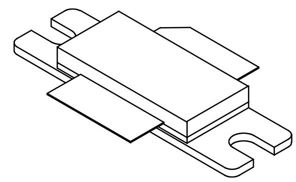
Frequency	G_{ps} (dB)	η_D (%)	Output PAR (dB)	ACPR (dBc)
2300 MHz	16.0	31.9	6.1	-37.1
2350 MHz	16.3	30.9	6.4	-37.9
2400 MHz	16.6	31.2	6.3	-37.5

- Capable of Handling 5:1 VSWR, @ 30 Vdc, 2350 MHz, 138 Watts CW (1) Output Power (2 dB Input Overdrive from Rated P_{out})
- Typical P_{out} @ 1 dB Compression Point ≃ 107 Watts CW

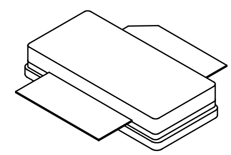
Features

- 100% PAR Tested for Guaranteed Output Power Capability
- Characterized with Series Equivalent Large-Signal Impedance Parameters and Common Source S-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
- Optimized for Doherty Applications
- RoHS Compliant
- In Tape and Reel. R3 Suffix = 250 Units, 56 mm Tape Width, 13 inch Reel.

2300-2400 MHz, 28 W AVG., 28 V
LTE
LATERAL N-CHANNEL
RF POWER MOSFETs



CASE 465-06, STYLE 1
NI-780
MRF8S23120HR3



CASE 465A-06, STYLE 1
NI-780S
MRF8S23120HSR3

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 (2,3)	T_J	225	°C
CW Operation @ T_C = 25°C Derate above 25°C	CW	109 0.52	W W/°C

Table 2. Thermal Characteristics

Characteristic	Symbol	Value (3,4)	Unit
Thermal Resistance, Junction to Case Case Temperature 76°C, 28 W CW, 28 Vdc, I_{DQ} = 800 mA, 2400 MHz Case Temperature 80°C, 120 W CW(1), 28 Vdc, I_{DQ} = 800 mA, 2400 MHz	$R_{\theta JC}$	 0.50 0.47	°C/W

1. Exceeds recommended operating conditions. See CW operation data in Maximum Ratings table.
2. Continuous use at maximum temperature will affect MTTF.
3. MTTF calculator available at http://www.freescale.com/rf. Select Software & Tools/Development Tools/Calculators to access MTTF calculators by product.
4. 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)	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} = 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 = 172 μAdc)	$V_{GS(th)}$	1.0	1.8	2.5	Vdc
Gate Quiescent Voltage (V_{DD} = 28 Vdc, I_D = 800 mAdc, Measured in Functional Test)	$V_{GS(Q)}$	1.8	2.6	3.3	Vdc
Drain-Source On-Voltage (V_{GS} = 10 Vdc, I_D = 1.72 Adc)	$V_{DS(on)}$	0.1	0.15	0.3	Vdc

Functional Tests (1) (In Freescale Test Fixture, 50 ohm system) V_{DD} = 28 Vdc, I_{DQ} = 800 mA, P_{out} = 28 W Avg., f = 2300 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.

Characteristic	Symbol	Min	Typ	Max	Unit
Power Gain	G_{ps}	14.5	16.0	17.5	dB
Drain Efficiency	η_D	29.0	31.9	—	%
Output Peak-to-Average Ratio @ 0.01% Probability on CCDF	PAR	5.7	6.1	—	dB
Adjacent Channel Power Ratio	ACPR	—	-37.1	-35.0	dBc
Input Return Loss	IRL	—	-12	-7	dB

Typical Broadband Performance (In Freescale Test Fixture, 50 ohm system) V_{DD} = 28 Vdc, I_{DQ} = 800 mA, P_{out} = 28 W Avg., 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.

Frequency	G_{ps} (dB)	η_D (%)	Output PAR (dB)	ACPR (dBc)	IRL (dB)
2300 MHz	16.0	31.9	6.1	-37.1	-12
2350 MHz	16.3	30.9	6.4	-37.9	-19
2400 MHz	16.6	31.2	6.3	-37.5	-18

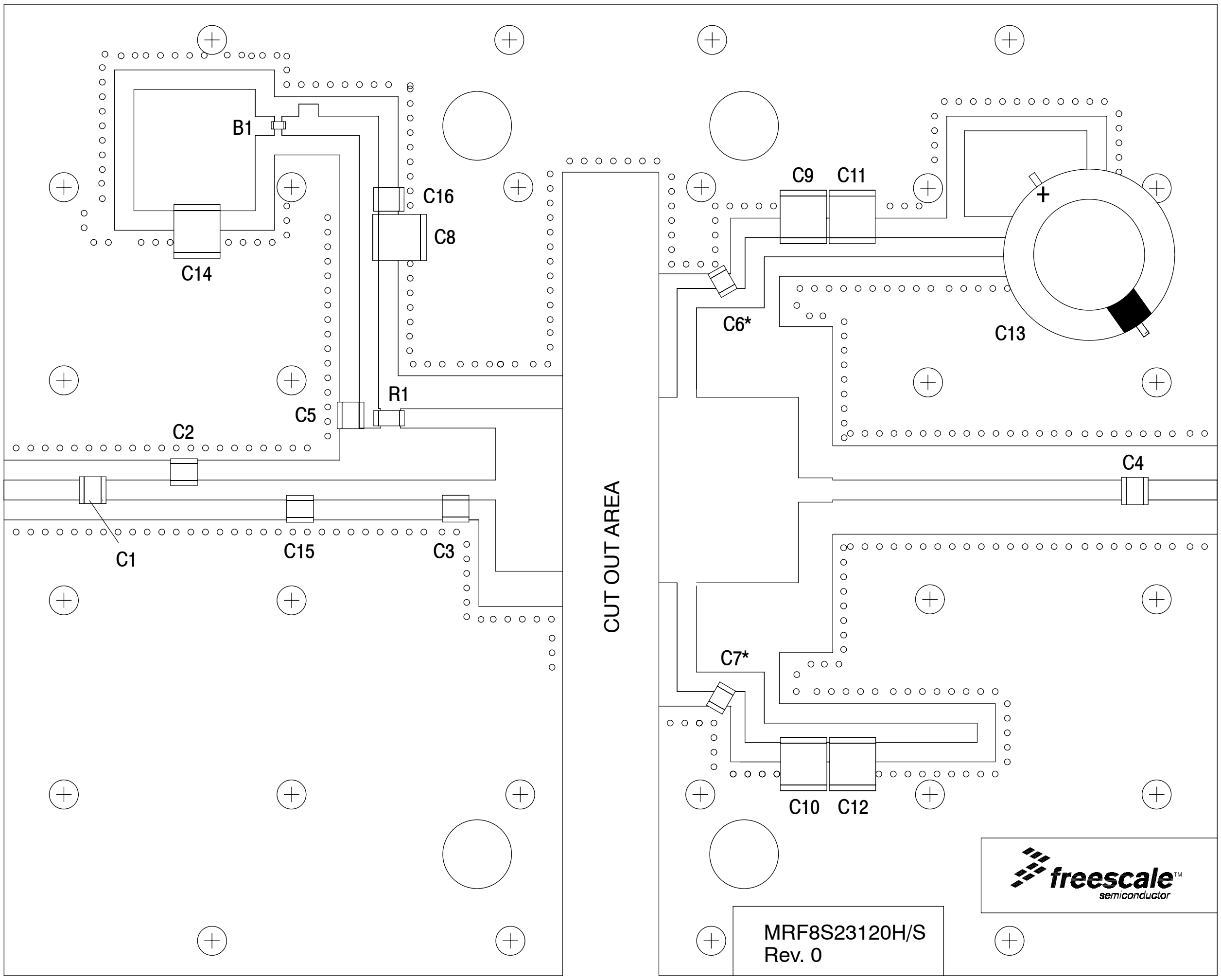
1. Part internally matched both on input and output.

(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} = 800 mA, 2300-2400 MHz Bandwidth					
P_{out} @ 1 dB Compression Point, CW	P1dB	—	107	—	W
IMD Symmetry @ 84 W PEP, P_{out} where IMD Third Order Intermodulation ≅ 30 dBc (Delta IMD Third Order Intermodulation between Upper and Lower Sidebands > 2 dB)	IMD_{sym}	—	13	—	MHz
VBW Resonance Point (IMD Third Order Intermodulation Inflection Point)	VBW_{res}	—	62	—	MHz
Gain Flatness in 100 MHz Bandwidth @ P_{out} = 28 W Avg.	G_F	—	0.6	—	dB
Gain Variation over Temperature (-30°C to +85°C)	ΔG	—	0.002	—	dB/°C
Output Power Variation over Temperature (-30°C to +85°C) [1]	ΔP1dB	—	0.008	—	dB/°C

1. Exceeds recommended operating conditions. See CW operation data in Maximum Ratings table.



*C6 and C7 are mounted vertically.

Figure 1. MRF8S23120HR3(HSR3) Test Circuit Component Layout

Table 5. MRF8S23120HR3(HSR3) Test Circuit Component Designations and Values

Part	Description	Part Number	Manufacturer
B1	Ferrite Bead	MPZ2012S300A	TDK
C1, C4	5.6 pF Chip Capacitors	ATC100B5R6CT500XT	ATC
C2, C15	0.5 pF Chip Capacitors	ATC100B0R5BT500XT	ATC
C3	1.8 pF Chip Capacitor	ATC100B1R5BT500XT	ATC
C5, C6, C7	8.2 pF Chip Capacitors	ATC100B8R2CT500XT	ATC
C8	3.3 μF, 100 V Chip Capacitor	C5750X7R2A335MT	TDK
C9, C10, C11, C12, C14	10 μF, 50 V Chip Capacitors	C5750X7R1H106KT	TDK
C13	470 μF, 63 V Electrolytic Capacitor	MCGPR63V477M13X26-RH	Multicomp
C16	330 nF, 100 V Chip Capacitor	C3225JB2A334KT	TDK
R1	4.75 Ω, 1/4 W Chip Resistor	CRCW12064R75FNEA	Vishay
PCB	0.030″, ε_r = 2.55	AD255A	Arlon

TYPICAL CHARACTERISTICS

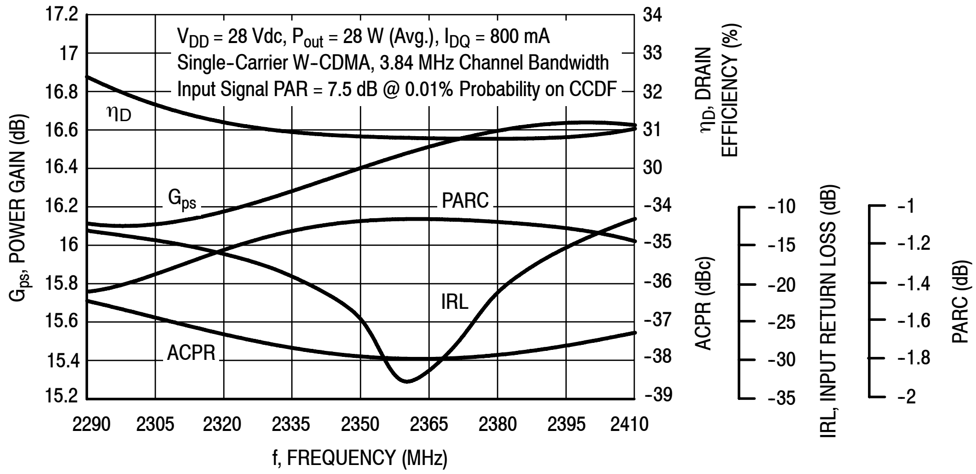


Figure 2. Output Peak-to-Average Ratio Compression (PARC) Broadband Performance @ P_{out} = 28 Watts Avg.

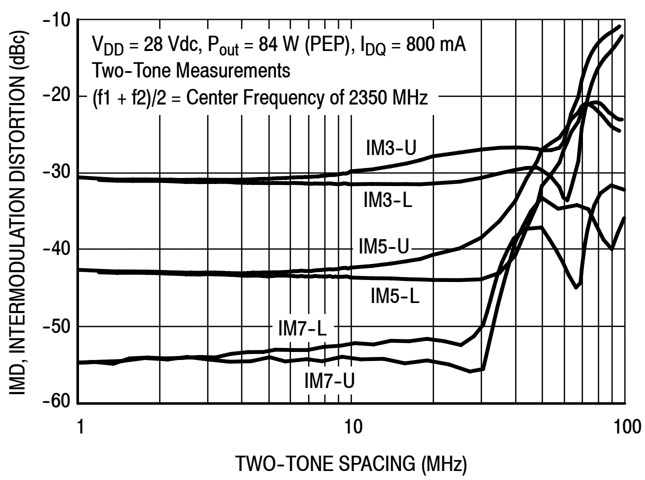


Figure 3. Intermodulation Distortion Products versus Two-Tone Spacing

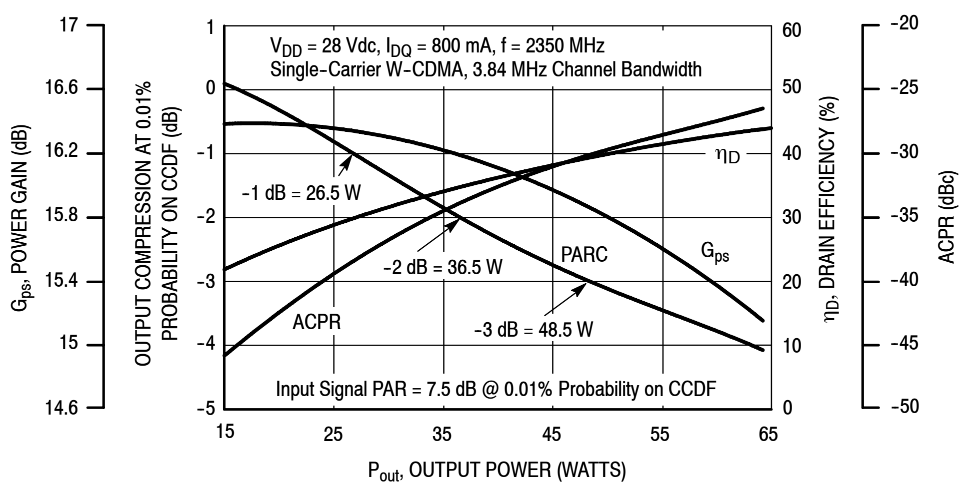


Figure 4. Output Peak-to-Average Ratio Compression (PARC) versus Output Power

TYPICAL CHARACTERISTICS

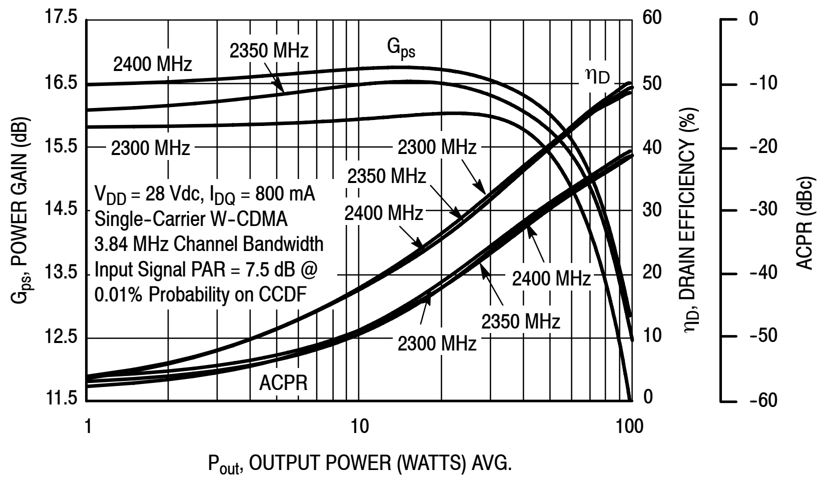


Figure 5. Single-Carrier W-CDMA Power Gain, Drain Efficiency and ACPR versus Output Power

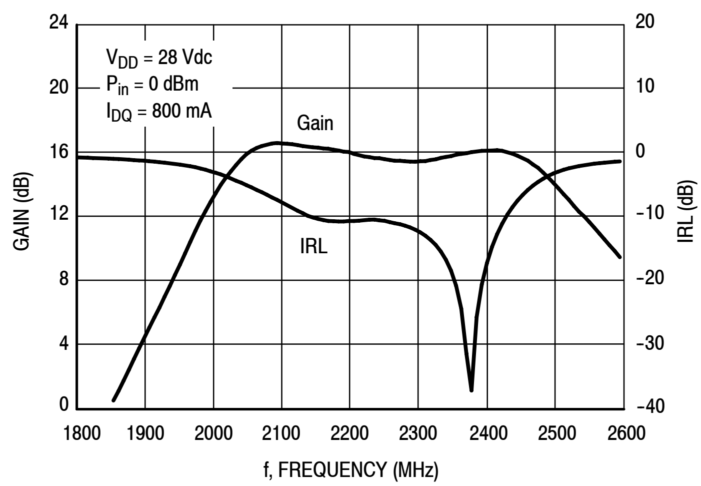


Figure 6. Broadband Frequency Response

W-CDMA TEST SIGNAL

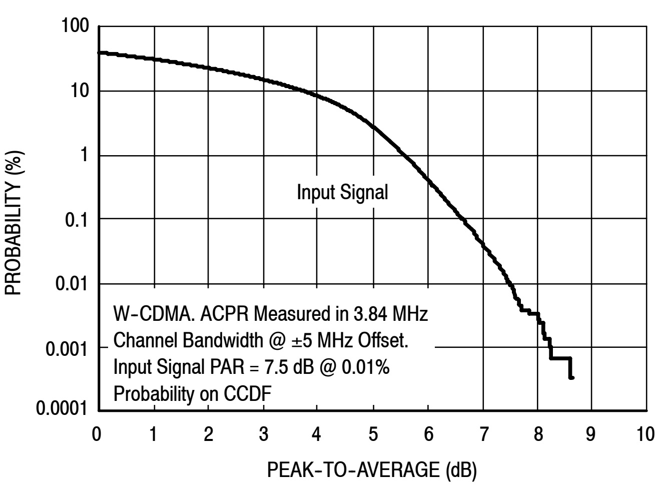


Figure 7. CCDF W-CDMA IQ Magnitude Clipping, Single-Carrier Test Signal

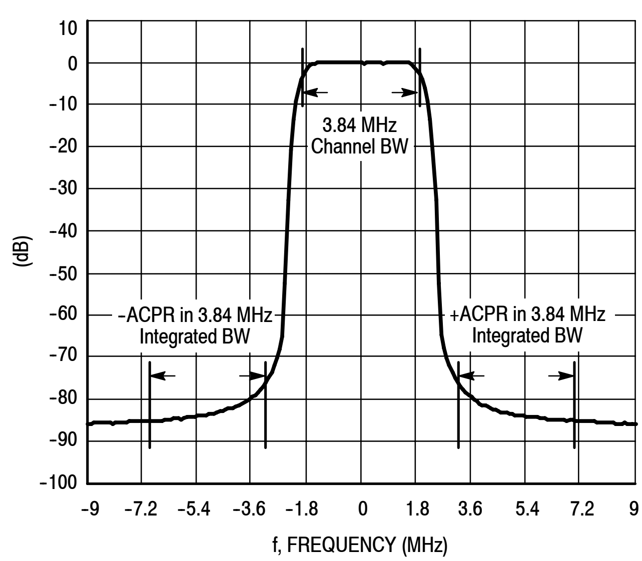


Figure 8. Single-Carrier W-CDMA Spectrum

V_{DD} = 28 Vdc, I_{DQ} = 800 mA, P_{out} = 28 W Avg.

f MHz	Z_{source} Ω	Z_{load} Ω
2290	8.41 - j0.97	1.86 - j4.43
2305	8.58 - j0.55	1.83 - j4.28
2320	8.78 - j0.14	1.80 - j4.14
2335	8.99 + j0.29	1.77 - j4.01
2350	9.21 + j0.72	1.74 - j3.88
2365	9.45 + j1.17	1.72 - j3.77
2380	9.71 + j1.62	1.69 - j3.66
2395	9.99 + j2.10	1.66 - j3.54
2410	10.28 + j2.60	1.65 - j3.43

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

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

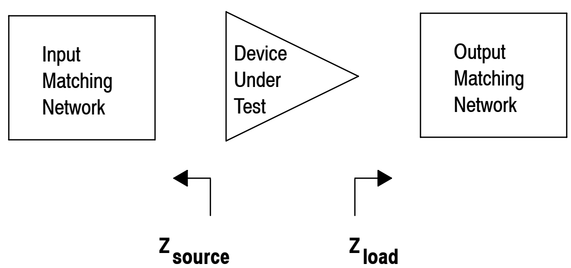
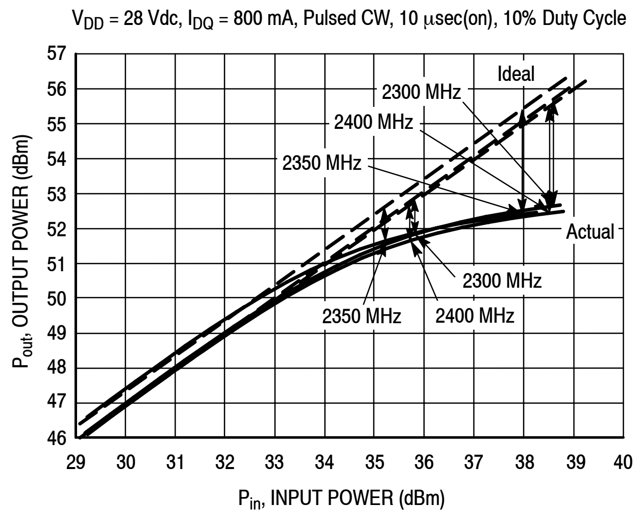


Figure 9. Series Equivalent Source and Load Impedance

ALTERNATIVE PEAK TUNE LOAD PULL CHARACTERISTICS



NOTE: Load Pull Test Fixture Tuned for Peak P1dB Output Power @ 28 V

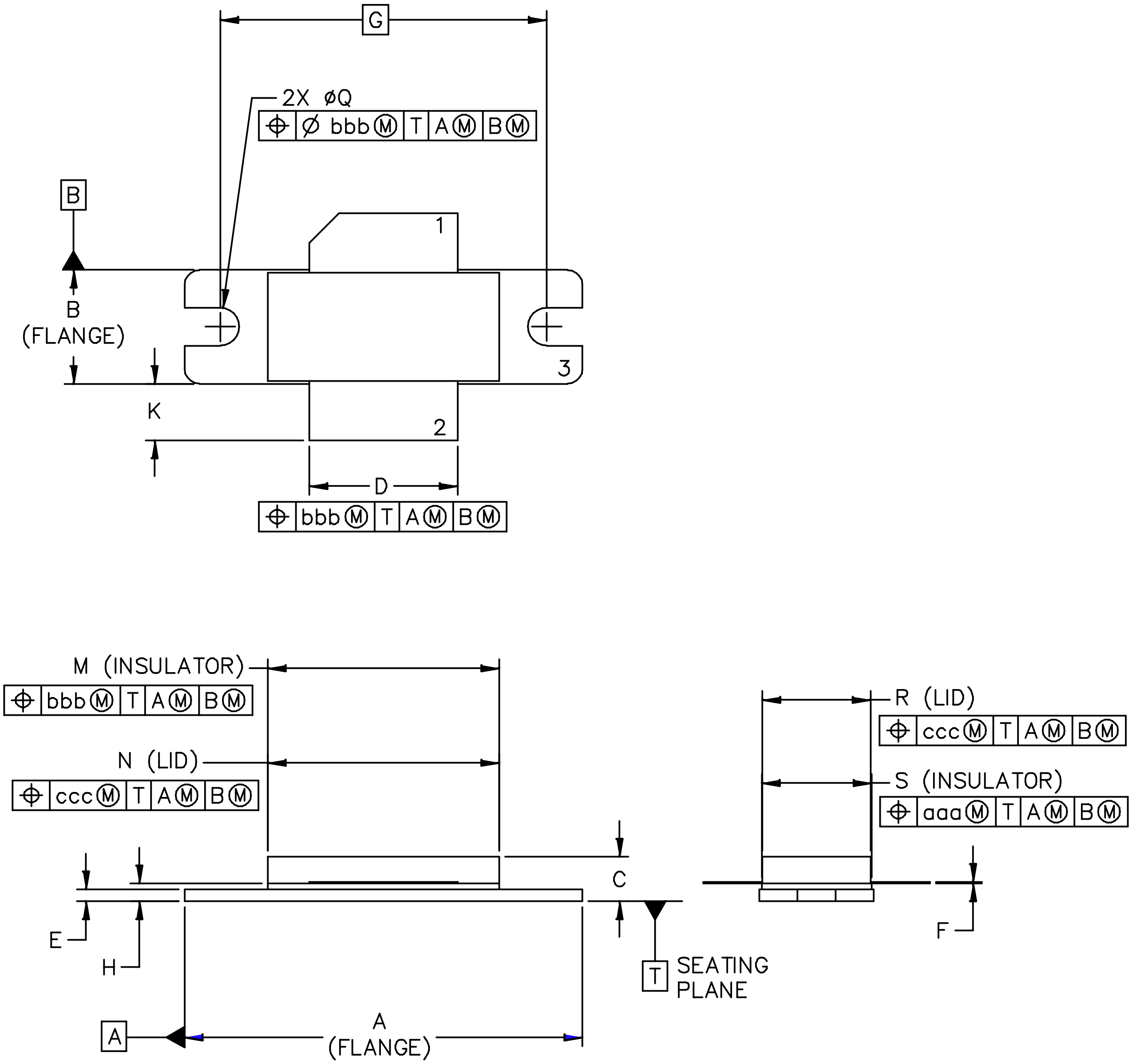
f (MHz)	P1dB		P3dB	
	Watts	dBm	Watts	dBm
2300	152	51.8	185	52.7
2350	150	51.8	181	52.6
2400	147	51.7	177	52.5

Test Impedances per Compression Level

f (MHz)		Z_{source} Ω	Z_{load} Ω
2300	P1dB	4.03 - j5.45	2.24 + j0.08
2350	P1dB	4.63 - j6.15	2.21 + j0.35
2400	P1dB	5.57 - j5.96	2.36 + j0.47

Figure 10. Pulsed CW Output Power versus Input Power @ 28 V

PACKAGE DIMENSIONS



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TITLE: NI–780	DOCUMENT NO: 98ASB15607C	REV: G
	CASE NUMBER: 465–06	31 MAR 2005
	STANDARD: NON–JEDEC	

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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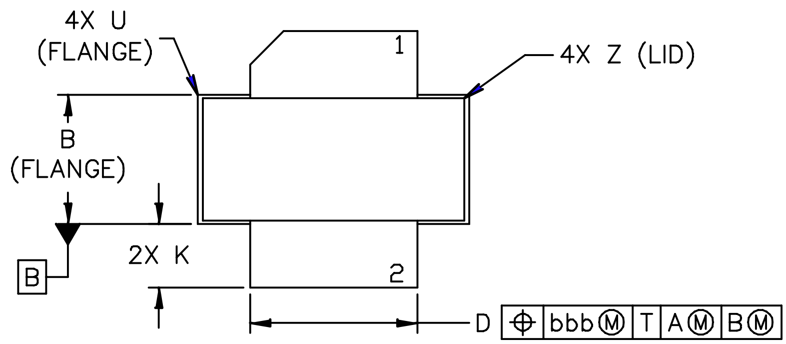

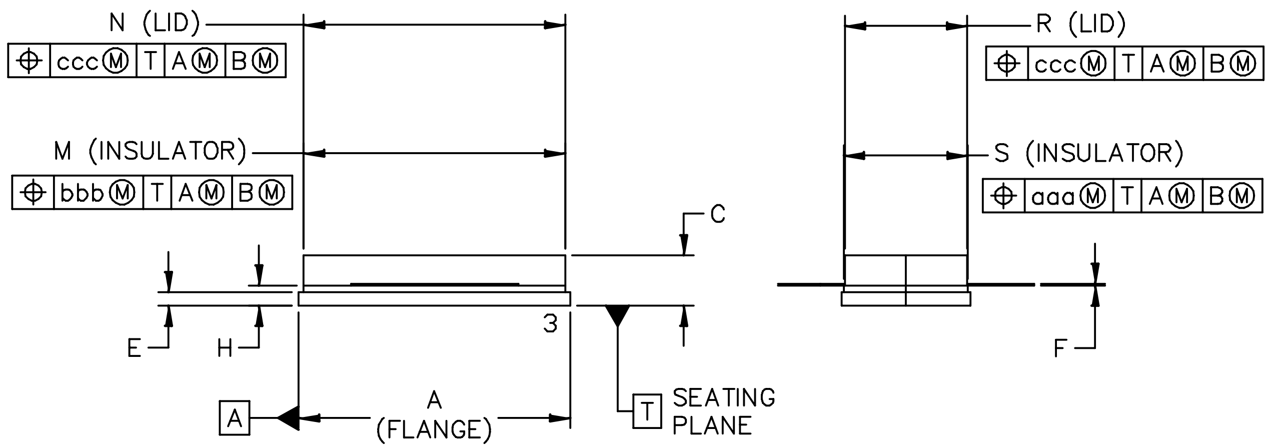

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NOTES:

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2. CONTROLLING DIMENSION: INCH.

3. DELETED

4. 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	.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
- .s2p File

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	Nov. 2010	• Initial Release of Data Sheet

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