Document Number: MRF8P20161HS
Rev. 0, 10/2010

RoHS

RF Power Field Effect Transistor

N-Channel Enhancement-Mode Lateral MOSFET

MRF8P20161HSR3

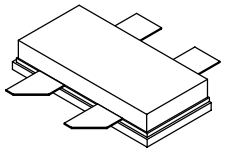
**1880-1920 MHz, 37 W AVG., 28 V
SINGLE W-CDMA
LATERAL N-CHANNEL
RF POWER MOSFET**

Designed for CDMA base station applications with frequencies from 1880 to 2025 MHz. Can be used in Class AB and Class C for all typical cellular base station modulation formats.

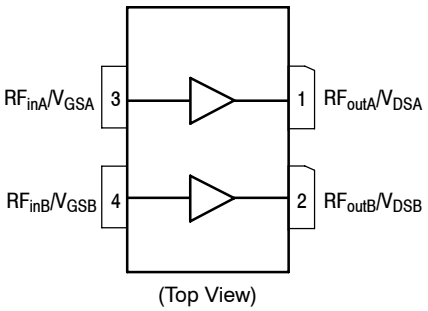
- Typical Doherty Single-Carrier W-CDMA Performance: V_{DD} = 28 Volts, I_{DQA} = 550 mA, V_{GSB} = 1.6 Vdc, P_{out} = 37 Watts Avg., IQ Magnitude Clipping, Channel Bandwidth = 3.84 MHz, Input Signal PAR = 9.9 dB @ 0.01% Probability on CCDF.

Frequency	G_{ps} (dB)	η_D (%)	Output PAR (dB)	ACPR (dBc)
1880 MHz	16.5	46.2	6.9	-27.9
1900 MHz	16.5	46.0	6.9	-29.1
1920 MHz	16.4	45.8	7.0	-30.4

- Capable of Handling 10:1 VSWR, @ 28 Vdc, 1900 MHz, 142 Watts CW Output Power (3 dB Input Overdrive from Rated P_{out})
- Typical P_{out} @ 3 dB Compression Point ≃ 147 Watts CW



**CASE 465H-02, STYLE 1
NI-780S-4**



(Top View)

Figure 1. Pin Connections

Features

- Production Tested in a Symmetrical Doherty Configuration
- 100% PAR Tested for Guaranteed Output Power Capability
- Characterized with Large-Signal Load-Pull 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
- RoHS Compliant
- In Tape and Reel. R3 Suffix = 250 Units, 32 mm Tape Width, 13 inch Reel.

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
CW Operation @ T_C = 25°C Derate above 25°C	CW	206 1.86	W W/°C

Table 2. Thermal Characteristics

Characteristic	Symbol	Value (2,3)	Unit
Thermal Resistance, Junction to Case Case Temperature 74°C, 37 W CW, 28 Vdc, I_{DQA} = 550 mA, V_{GSB} = 1.6 V, 1900 MHz Case Temperature 93°C, 160 W CW(4), 28 Vdc, I_{DQA} = 550 mA, V_{GSB} = 1.6 V, 1900 MHz	$R_{\theta JC}$	 0.76 0.53	°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.
4. Exceeds recommended operating conditions. See CW operation data in Maximum Ratings table.

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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 (1)					
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 (1)					
Gate Threshold Voltage (V_{DS} = 10 Vdc, I_D = 116 μAdc)	$V_{GS(th)}$	1.2	1.8	2.7	Vdc
Gate Quiescent Voltage (V_{DD} = 28 Vdc, I_{DA} = 550 mAdc, Measured in Functional Test)	$V_{GS(Q)}$	1.9	2.7	3.4	Vdc
Drain-Source On-Voltage (V_{GS} = 10 Vdc, I_D = 1.5 Adc)	$V_{DS(on)}$	0.05	0.27	0.4	Vdc
Functional Tests (2,3) (In Freescale Doherty Test Fixture, 50 ohm system) V_{DD} = 28 Vdc, I_{DQA} = 550 mA, V_{GSB} = 1.6 Vdc, P_{out} = 37 W Avg., f = 1920 MHz, Single-Carrier W-CDMA, IQ Magnitude Clipping, Input Signal PAR = 9.9 dB @ 0.01% Probability on CCDF. ACPR measured in 3.84 MHz Channel Bandwidth @ ±5 MHz Offset.					
Power Gain	G_{ps}	15.0	16.4	18.0	dB
Drain Efficiency	η_D	42.2	45.8	—	%
Output Peak-to-Average Ratio @ 0.01% Probability on CCDF	PAR	6.5	7.0	—	dB
Adjacent Channel Power Ratio	ACPR	—	-30.4	-27.3	dBc

Typical Broadband Performance (3) (In Freescale Doherty Test Fixture, 50 ohm system) V_{DD} = 28 Vdc, I_{DQA} = 550 mA, V_{GSB} = 1.6 Vdc, P_{out} = 37 W Avg., Single-Carrier W-CDMA, IQ Magnitude Clipping, Input Signal PAR = 9.9 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)
1880 MHz	16.5	46.2	6.9	-27.9
1900 MHz	16.5	46.0	6.9	-29.1
1920 MHz	16.4	45.8	7.0	-30.4

1. Each side of device measured separately.
2. Part internally matched both on input and output.
3. Measurement made with device in a Symmetrical Doherty configuration.

(continued)

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

Characteristic	Symbol	Min	Typ	Max	Unit
Typical Performance (1) (In Freescale Doherty Test Fixture, 50 ohm system) V_{DD} = 28 Vdc, I_{DQA} = 550 mA, V_{GSB} = 1.6 Vdc, 1880–1920 MHz Bandwidth					
P_{out} @ 1 dB Compression Point, CW	P1dB	—	97	—	W
P_{out} @ 3 dB Compression Point, CW	P3dB	—	147	—	W
IMD Symmetry @ 30 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}	—	55	—	MHz
VBW Resonance Point (IMD Third Order Intermodulation Inflection Point)	VBW_{res}	—	65	—	MHz
Gain Flatness in 40 MHz Bandwidth @ P_{out} = 37 W Avg.	G_F	—	0.1	—	dB
Gain Variation over Temperature (–30°C to +85°C)	ΔG	—	0.01	—	dB/°C
Output Power Variation over Temperature (–30°C to +85°C)	ΔP1dB	—	0.009	—	dB/°C

1. Measurement made with device in a Symmetrical Doherty configuration.

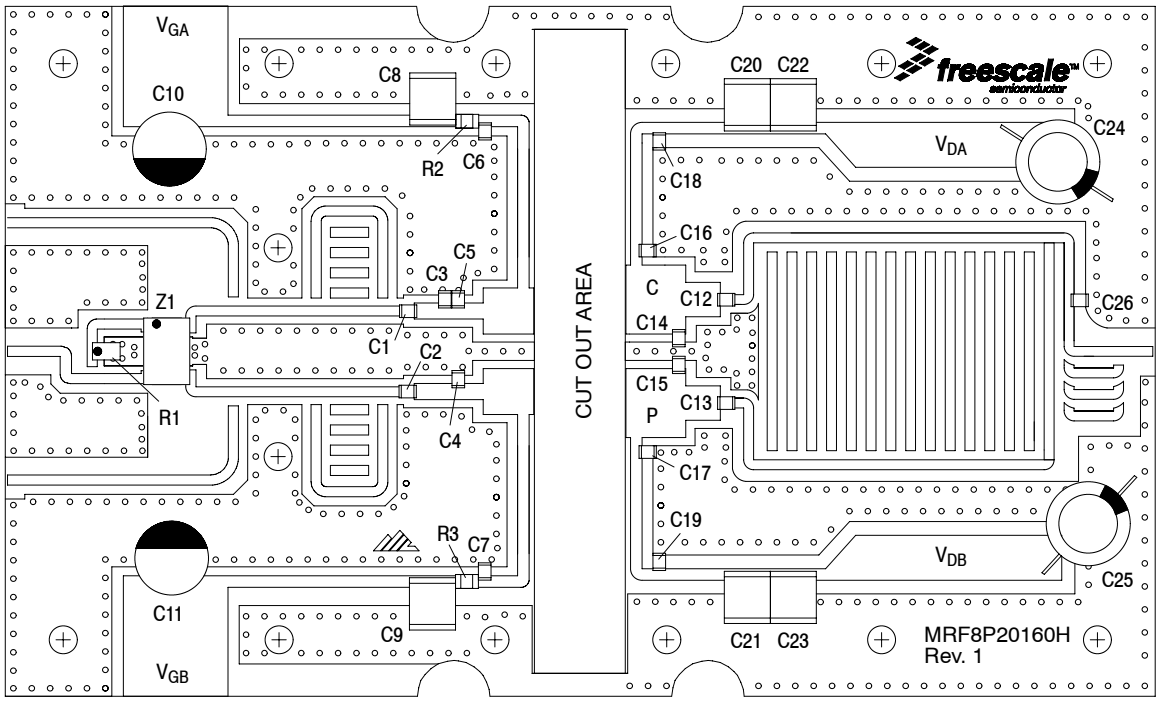


Figure 2. MRF8P20161HSR3 Test Circuit Component Layout

Table 5. MRF8P20161HSR3 Test Circuit Component Designations and Values

Part	Description	Part Number	Manufacturer
C1, C2, C12, C13	10 pF Chip Capacitors	ATC600F100JT250XT	ATC
C3	0.3 pF Chip Capacitor	ATC600F0R3BT250XT	ATC
C4, C5	1.1 pF Chip Capacitors	ATC600F1R1BT250XT	ATC
C6, C7, C18, C19	12 pF Chip Capacitors	ATC600F120JT250XT	ATC
C8, C9, C20, C21, C22, C23	10 μF, 50 V Chip Capacitors	GRM55DR61H106KA88L	Murata
C10, C11	22 μF, 35 V Tantalum Capacitors	T491X226K035AT	Kemet
C14, C15	2.0 pF Chip Capacitors	ATC600F2R0BT250XT	ATC
C16, C17	2.2 pF Chip Capacitors	ATC600F2R2BT250XT	ATC
C24, C25	220 μF, 50 V Electrolytic Capacitors	227CKS505M	Illinois Cap
C26	0.8 pF Chip Capacitor	ATC600F0R8BT250XT	ATC
R1	50 Ω, 4 W Chip Resistor	CW12010T0050GBK	ATC
R2, R3	8.25 Ω, 1/4 W Chip Resistors	CRCW12068R25FKEA	Vishay
Z1	1900 MHz Band 90°, 3 dB Chip Hybrid Coupler	GCS351-HYB1900	Soshin
PCB	0.020″, ε_r = 3.5	RO4350B	Rogers

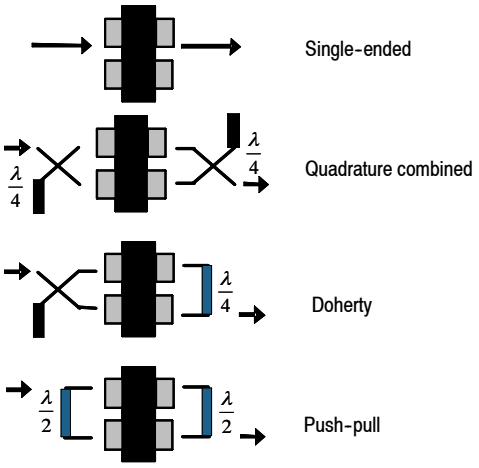


Figure 3. Possible Circuit Topologies

TYPICAL CHARACTERISTICS

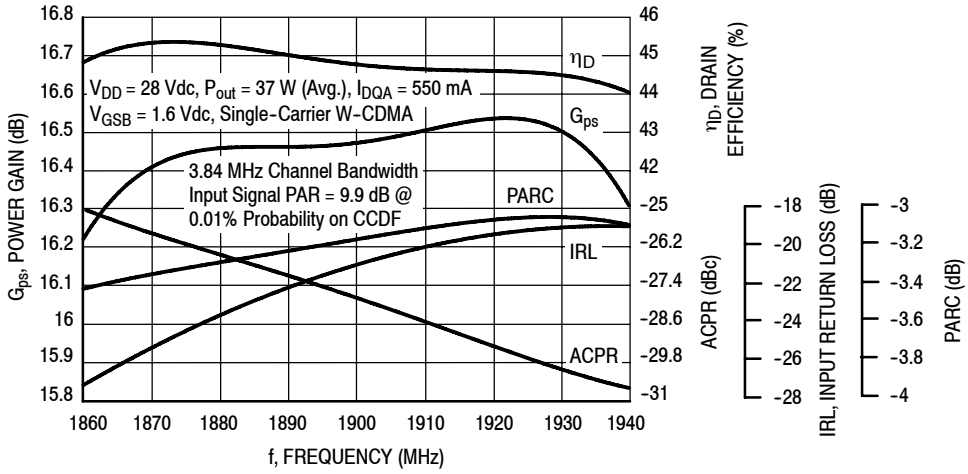


Figure 4. Output Peak-to-Average Ratio Compression (PARC) Broadband Performance @ P_{out} = 37 Watts Avg.

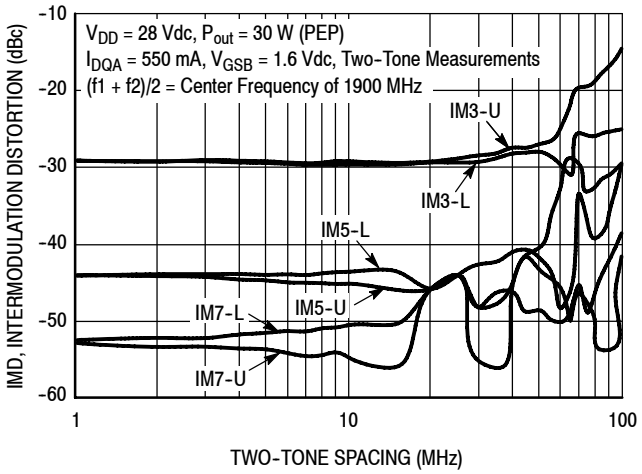


Figure 5. Intermodulation Distortion Products versus Two-Tone Spacing

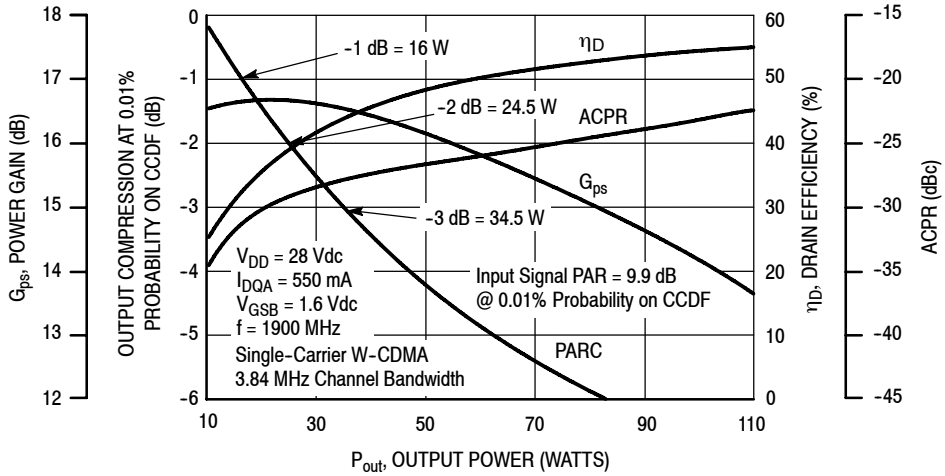


Figure 6. Output Peak-to-Average Ratio Compression (PARC) versus Output Power

TYPICAL CHARACTERISTICS

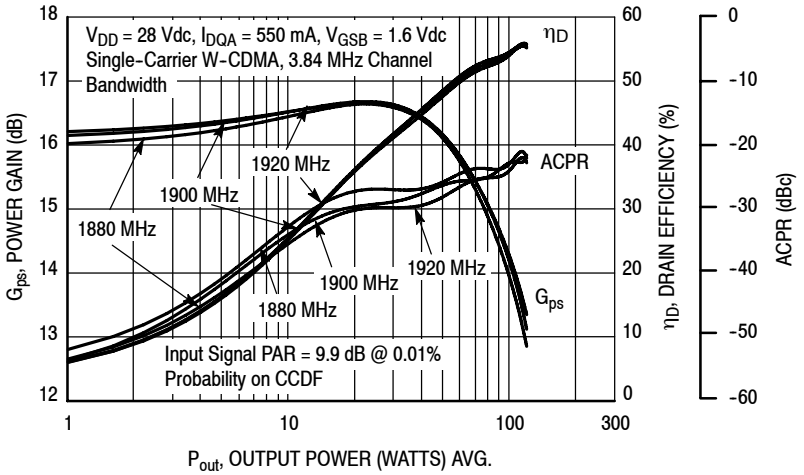


Figure 7. Single-Carrier W-CDMA Power Gain, Drain Efficiency and ACPR versus Output Power

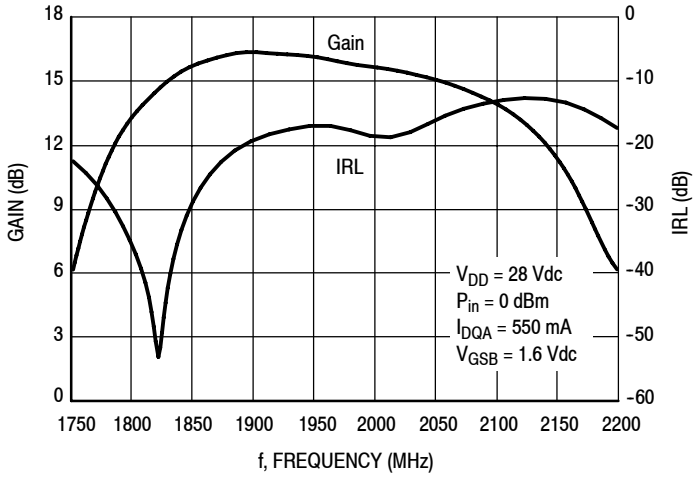


Figure 8. Broadband Frequency Response

W-CDMA TEST SIGNAL

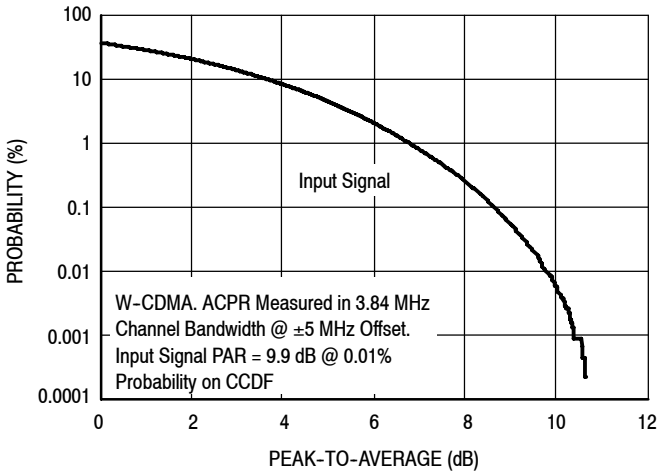


Figure 9. CCDF W-CDMA IQ Magnitude Clipping, Single-Carrier Test Signal

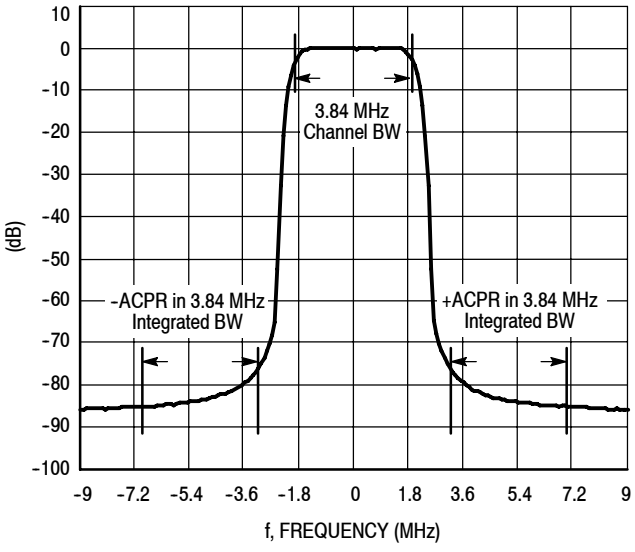


Figure 10. Single-Carrier W-CDMA Spectrum

V_{DD} = 28 Vdc, I_{DQA} = 550 mA

f MHz	Max P_{out} (1) Watts	Max P_{out} (1) dBm	Z_{source} Ω	Z_{load} Ω
1880	103	50.1	8.74 – j9.81	2.08 – j5.64
1930	108	50.3	13.6 – j9.01	2.29 – j5.66
1990	107	50.3	17.6 + j0.07	1.52 – j5.96
2025	105	50.2	14.6 + j4.42	1.75 – j5.54

(1) Maximum output power measurement reflects pulsed 1 dB gain compression.

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

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

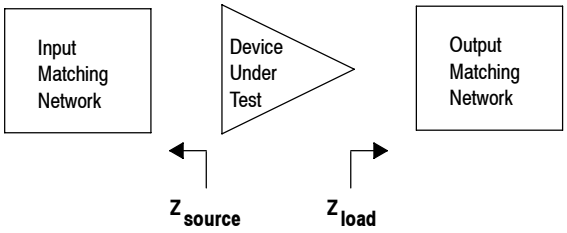


Figure 11. Carrier Side Load Pull Performance — Maximum P1dB Tuning

V_{DD} = 28 Vdc, I_{DQA} = 550 mA

f MHz	Max Eff. (1) %	Z_{source} Ω	Z_{load} Ω
1880	62.7	8.74 – j9.81	3.61 – j2.84
1930	66.2	13.6 – j9.01	3.84 – j4.10
1990	63.5	17.6 + j0.07	3.02 – j5.11
2025	64.1	14.6 + j4.42	3.30 – j4.36

(1) Maximum efficiency measurement reflects pulsed 1 dB gain compression.

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

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

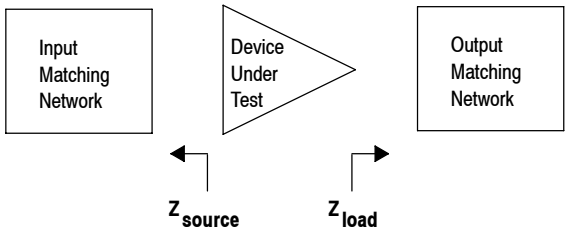
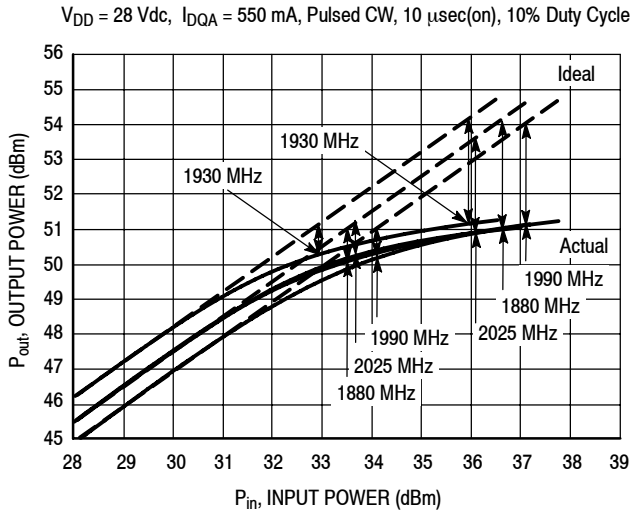


Figure 12. Carrier Side Load Pull Performance — Maximum Efficiency Tuning

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
1880	102	50.1	126	51.0
1930	108	50.3	130	51.1
1990	105	50.2	129	51.1
2025	105	50.2	124	50.9

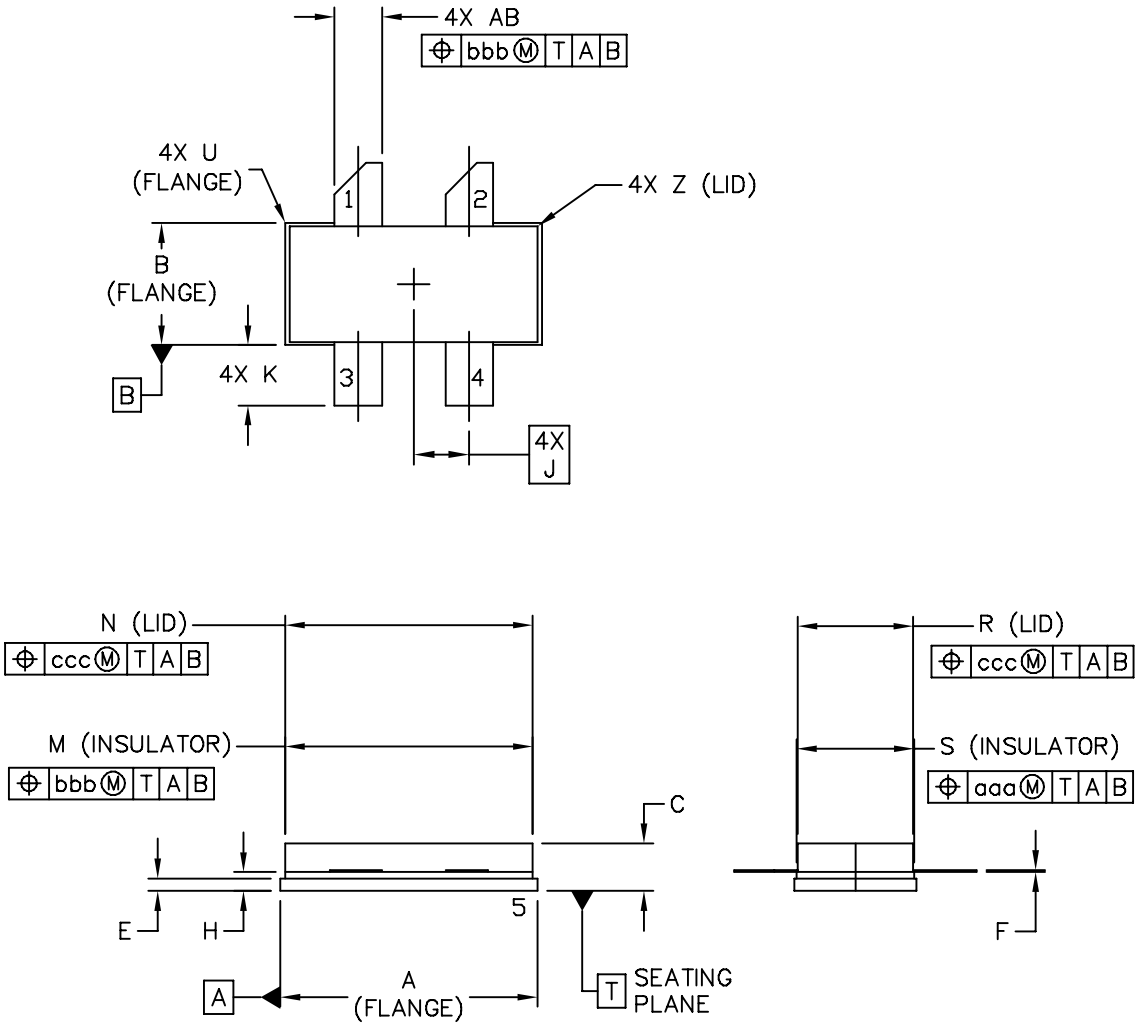
Test Impedances per Compression Level

f (MHz)		Z_{source} Ω	Z_{load} Ω
1880	P1dB	8.74 - j9.81	2.08 - j5.64
1930	P1dB	13.6 - j9.01	2.29 - j5.66
1990	P1dB	17.6 + j0.07	1.52 - j5.96
2025	P1dB	14.6 + j4.42	1.75 - j5.54

Figure 13. Pulsed CW Output Power versus Input Power @ 28 V

NOTE: Measurement made on the Class AB, carrier side of the device.

PACKAGE DIMENSIONS



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TITLE: NI 780S-4	DOCUMENT NO: 98ASA10718D	REV: A
	CASE NUMBER: 465H-02	27 MAR 2007
	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 (0.762) AWAY FROM PACKAGE BODY.

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

DIM	INCH MIN	INCH MAX	MILLIMETER MIN	MILLIMETER MAX	DIM	INCH MIN	INCH MAX	MILLIMETER MIN	MILLIMETER 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	AB	.145	.155	3.68	3.94
E	.035	.045	0.89	1.14					
F	.003	.006	0.08	0.15	aaa		.005		0.127
H	.057	.067	1.45	1.7	bbb		.010		0.254
J	.175 BSC		4.44 BSC		ccc		.015		0.381
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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NI 780S–4	CASE NUMBER: 465H–02	27 MAR 2007
	STANDARD: NON–JEDEC	

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
- .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	Oct. 2010	• Initial Release of Data Sheet

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