. :eescale Semiconductor
Technical Data

Document Number: MD7P19130H
Rev. 2, 8/2010

RoHS

RF Power Field Effect Transistors

N-Channel Enhancement-Mode Lateral MOSFETs

MD7P19130HR3
MD7P19130HSR3

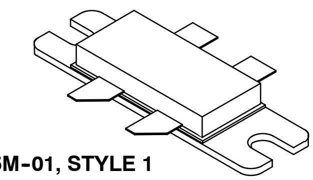
Designed for CDMA base station applications with frequencies from 1930 to 1990 MHz. Suitable for CDMA and multicarrier amplifier applications. To be used in Class AB and Class C for PCN-PCS/cellular radio and WLL applications.

- Typical Single-Carrier W-CDMA Performance: V_{DD} = 28 Volts, I_{DQ} = 1250 mA, P_{out} = 40 Watts Avg., f = 1987.5 MHz, IQ Magnitude Clipping, Channel Bandwidth = 3.84 MHz, Input Signal PAR = 7.5 dB @ 0.01% Probability on CCDF.
  Power Gain — 20 dB
  Drain Efficiency — 30%
  Device Output Signal PAR — 6 dB @ 0.01% Probability on CCDF
  ACPR @ 5 MHz Offset — -36 dBc in 3.84 MHz Channel Bandwidth
- Capable of Handling 10:1 VSWR, @ 32 Vdc, 1960 MHz, 130 Watts CW Output Power
- P_{out} @ 1 dB Compression Point ≃ 130 Watts CW

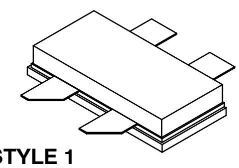
Features

- 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
- RoHS Compliant
- In Tape and Reel. R3 Suffix = 250 Units per 56 mm, 13 inch Reel.

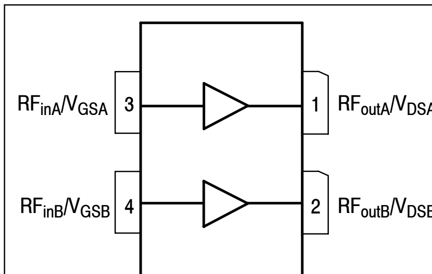
1930-1990 MHz, 40 W AVG., 28 V
SINGLE W-CDMA
LATERAL N-CHANNEL
RF POWER MOSFETs



CASE 465M-01, STYLE 1
NI-780-4
MD7P19130HR3



CASE 465H-02, STYLE 1
NI-780S-4
MD7P19130HSR3



(Top View)

Figure 1. Pin Connections

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

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.

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, 40 W CW	$R_{\theta JC}$	 0.31 0.36	°C/W

Table 3. ESD Protection Characteristics

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

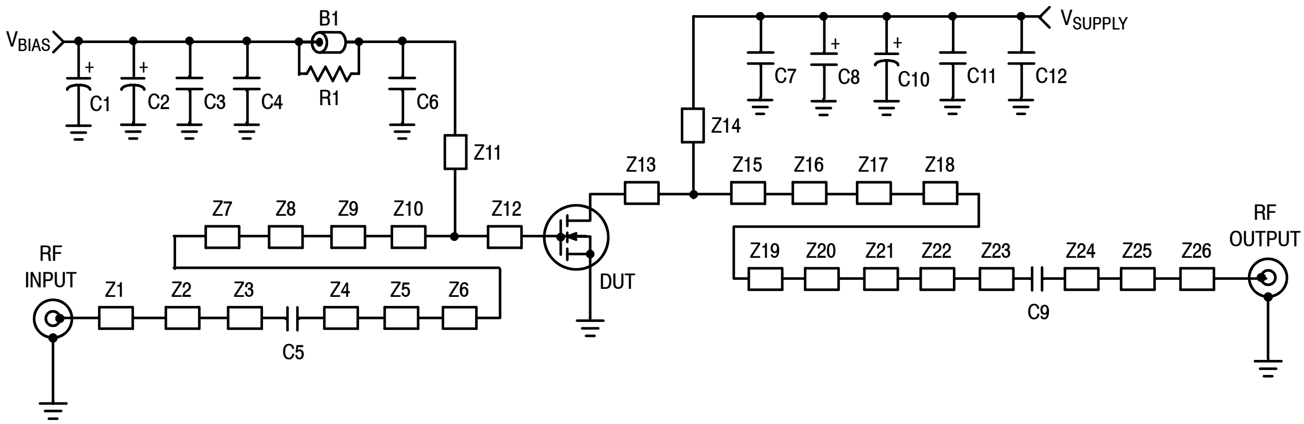
Characteristic	Symbol	Min	Typ	Max	Unit
Off Characteristics (3)					
Zero Gate Voltage Drain Leakage Current (V_{DS} = 65 Vdc, V_{GS} = 0 Vdc)	I_{DSS}	—	—	10	μAdc
Zero Gate Voltage Drain Leakage Current (V_{DS} = 28 Vdc, V_{GS} = 0 Vdc)	I_{DSS}	—	—	1	μAdc
Gate-Source Leakage Current (V_{GS} = 5 Vdc, V_{DS} = 0 Vdc)	I_{GSS}	—	—	1	μAdc
On Characteristics (3)					
Gate Threshold Voltage (V_{DS} = 10 Vdc, I_D = 316 μAdc)	$V_{GS(th)}$	1.2	2	2.7	Vdc
Gate Quiescent Voltage (V_{DD} = 28 Vdc, I_D = 1250 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 = 3.16 Adc)	$V_{DS(on)}$	0.1	0.2	0.3	Vdc
Dynamic Characteristics (3,4)					
Reverse Transfer Capacitance (V_{DS} = 28 Vdc ± 30 mV(rms)ac @ 1 MHz, V_{GS} = 0 Vdc)	C_{rss}	—	1.2	—	pF
Output Capacitance (V_{DS} = 28 Vdc ± 30 mV(rms)ac @ 1 MHz, V_{GS} = 0 Vdc)	C_{oss}	—	586	—	pF
Input Capacitance (V_{DS} = 28 Vdc, V_{GS} = 0 Vdc ± 30 mV(rms)ac @ 1 MHz)	C_{iss}	—	348	—	pF
Functional Tests (3) (In Freescale Test Fixture, 50 ohm system) V_{DD} = 28 Vdc, I_{DQ} = 1250 mA, P_{out} = 40 W Avg., f = 1987.5 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}	18.5	20	21.5	dB
Drain Efficiency	η_D	27	30	—	%
Output Peak-to-Average Ratio @ 0.01% Probability on CCDF	PAR	5.6	6	—	dB
Adjacent Channel Power Ratio	ACPR	—	-36	-32.5	dBc
Input Return Loss	IRL	—	-16	-7	dB

1. MTTF calculator available at http://www.freescale.com/rf. Select Software & Tools/Development Tools/Calculators to access 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. Measurement made with device in single-ended configuration.
4. 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} = 1250 mA, 1930-1990 MHz Bandwidth					
P_{out} @ 1 dB Compression Point, CW	P1dB	—	130	—	W
Gain Flatness in 60 MHz Bandwidth @ P_{out} = 40 W Avg.	G_F	—	0.3	—	dB
Average Deviation from Linear Phase in 60 MHz Bandwidth @ P_{out} = 130 W CW	Φ	—	0.5	—	°
Average Group Delay @ P_{out} = 130 W CW, f = 1960 MHz	Delay	—	2.3	—	ns
Part-to-Part Insertion Phase Variation @ P_{out} = 130 W CW, f = 1960 MHz, Six Sigma Window	ΔΦ	—	80	—	°
Gain Variation over Temperature (-30°C to +85°C)	ΔG	—	0.016	—	dB/°C
Output Power Variation over Temperature (-30°C to +85°C)	ΔP1dB	—	0.01	—	dB/°C



Z1	0.582″ x 0.110″ Microstrip	Z15	0.203″ x 0.957″ Microstrip
Z2	0.140″ x 0.284″ Microstrip	Z16	0.271″ x 0.930″ Microstrip
Z3	0.066″ x 0.080″ Microstrip	Z17	0.010″ x 0.540″ Microstrip
Z4	0.127″ x 0.080″ Microstrip	Z18	0.042″ x 0.205″ Microstrip
Z5	0.042″ x 0.237″ Microstrip	Z19	0.471″ x 0.080″ Microstrip
Z6	0.095″ x 0.375″ Microstrip	Z20	0.024″ x 0.241″ Microstrip
Z7	0.330″ x 0.320″ Microstrip	Z21	0.057″ x 0.349″ Microstrip
Z8	0.438″ x 0.530″ Microstrip	Z22	0.781″ x 0.311″ Microstrip
Z9	0.311″ x 0.741″ Microstrip	Z23	0.271″ x 0.080″ Microstrip
Z10	0.025″ x 0.814″ Microstrip	Z24	0.024″ x 0.095″ Microstrip
Z11	0.049″ x 0.254″ Microstrip	Z25	0.134″ x 0.190″ Microstrip
Z12	0.078″ x 0.814″ Microstrip	Z26	0.511″ x 0.080″ Microstrip
Z13	0.134″ x 0.957″ Microstrip	PCB	Arlon CuClad 250GX-0300-55-22, 0.030″, ε_r = 2.55
Z14	0.150″ x 0.276″ Microstrip		

Figure 2. MD7P19130HR3(HSR3) Test Circuit Schematic

Table 5. MD7P19130HR3(HSR3) Test Circuit Component Designations and Values

Part	Description	Part Number	Manufacturer
B1	Short Ferrite Bead	2743019447 ROP50	Fair-Rite
C1	47 μF, 50 V Electrolytic Capacitor	476KXM063M	Illinois Cap.
C2	100 μF, 50 V Electrolitic Capacitor	T491C105K050AT	Kemet
C3	1.0 μF Chip Capacitor	ATC100B102JT50XT	ATC
C4, C12	0.1 μF Chip Capacitors	CDR33BX104AKYS	Kemet
C5, C9	11 pF Chip Capacitors	ATC100B110JT500XT	ATC
C6	13 pF Chip Capacitor	ATC100B130JT500XT	ATC
C7	8.2 pF Chip Capacitor	ATC100B8R2JT500XT	ATC
C8	22 μF, 35 V Tantalum Capacitor	T491C226K035AT	Kemet
C10	470 μF, 63 V Electrolytic Capacitor	477KXM063M	Illinois Cap.
C11	10 μF, 50 V Chip Capacitor	GRM55DR61H106KA88B	Murata
R1	10 Ω, 1/4 W Chip Resistor	CRCW120610R0FKEA	Vishay

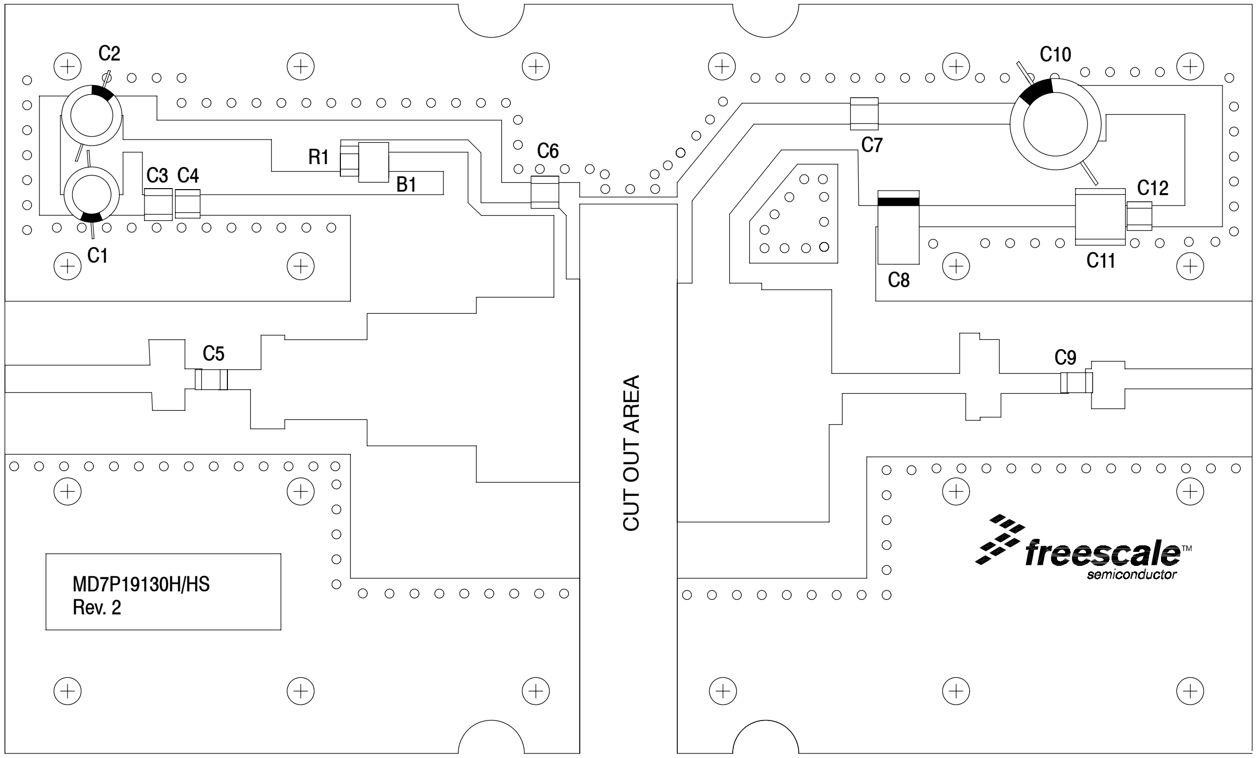


Figure 3. MD7P19130HR3(HSR3) Test Circuit Component Layout

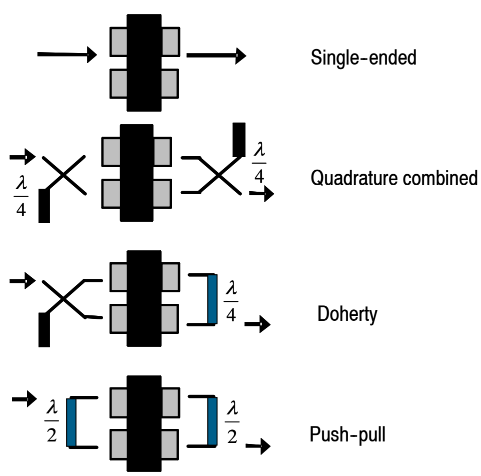


Figure 4. Possible Circuit Topologies

TYPICAL CHARACTERISTICS

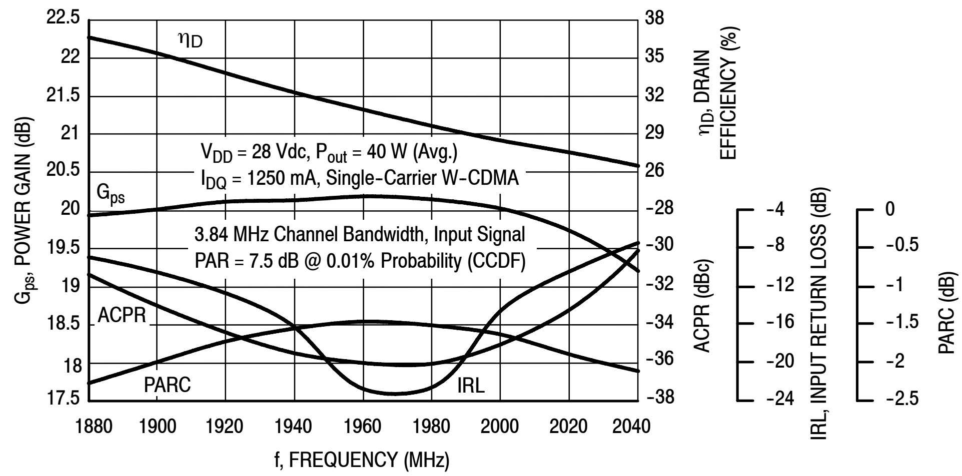


Figure 5. Output Peak-to-Average Ratio Compression (PARC) Broadband Performance @ P_{out} = 40 Watts Avg.

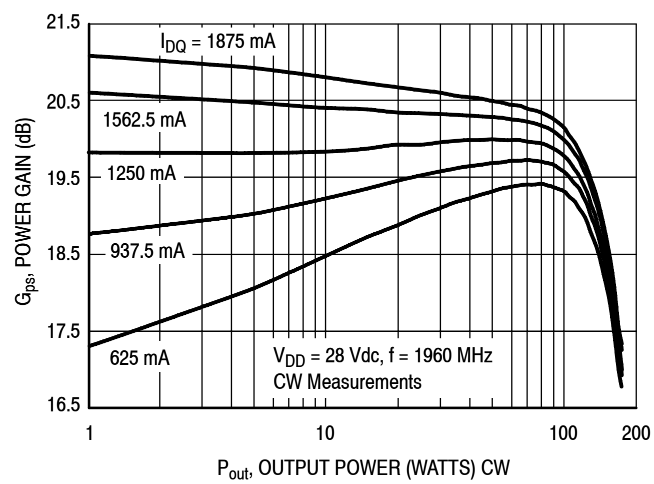


Figure 6. CW Power Gain versus Output Power

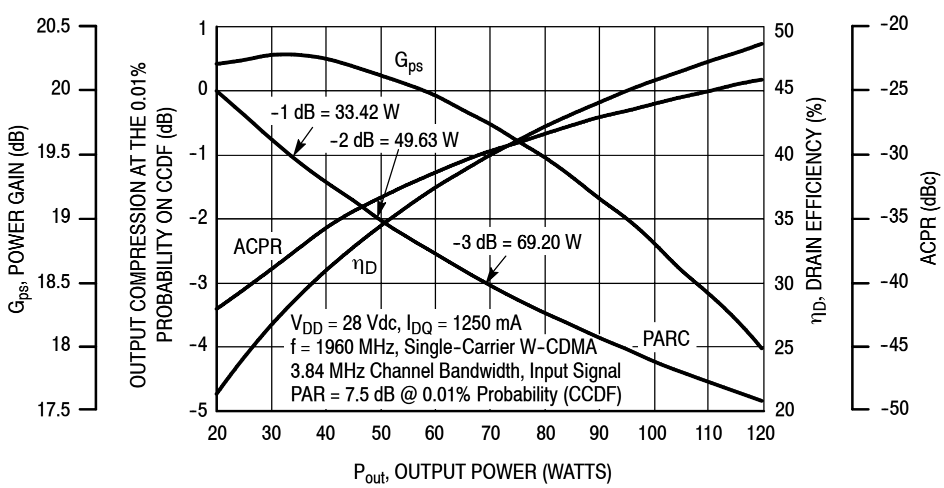


Figure 7. Output Peak-to-Average Ratio Compression (PARC) versus Output Power

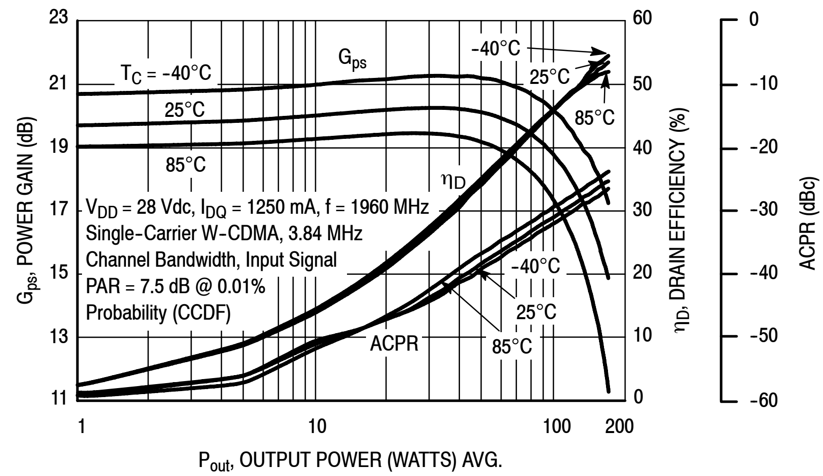


Figure 8. Single-Carrier W-CDMA Power Gain, Drain Efficiency and ACPR versus Output Power

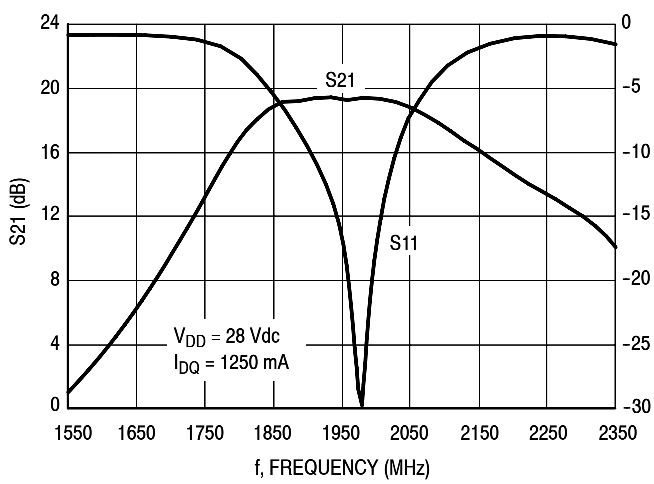
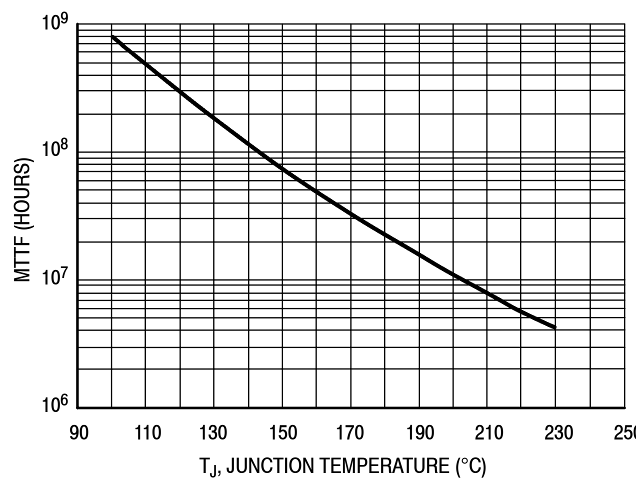


Figure 9. Broadband Frequency Response



This above graph displays calculated MTTF in hours when the device is operated at V_{DD} = 28 Vdc, P_{out} = 40 W Avg., and η_D = 30%.

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

Figure 10. MTTF versus Junction Temperature

W-CDMA TEST SIGNAL

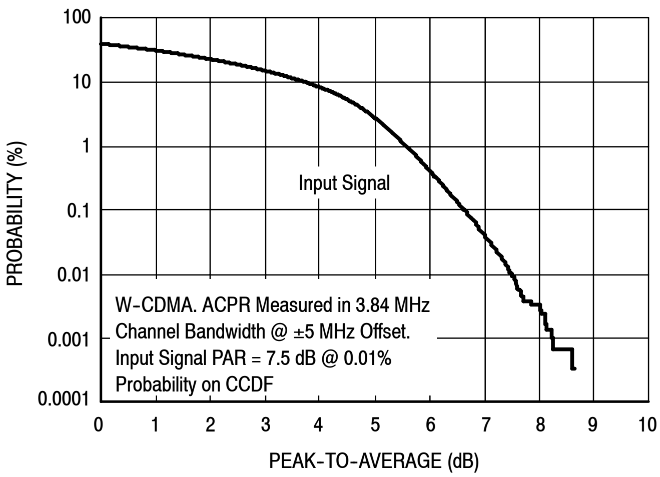


Figure 11. CCDF W-CDMA IQ Magnitude Clipping, Single-Carrier Test Signal

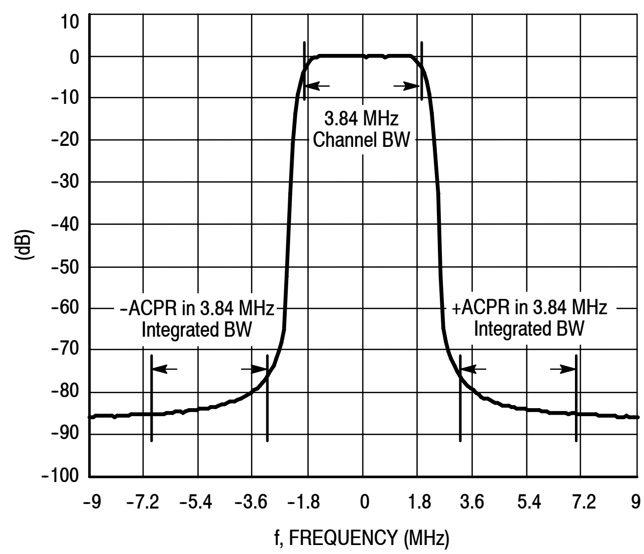
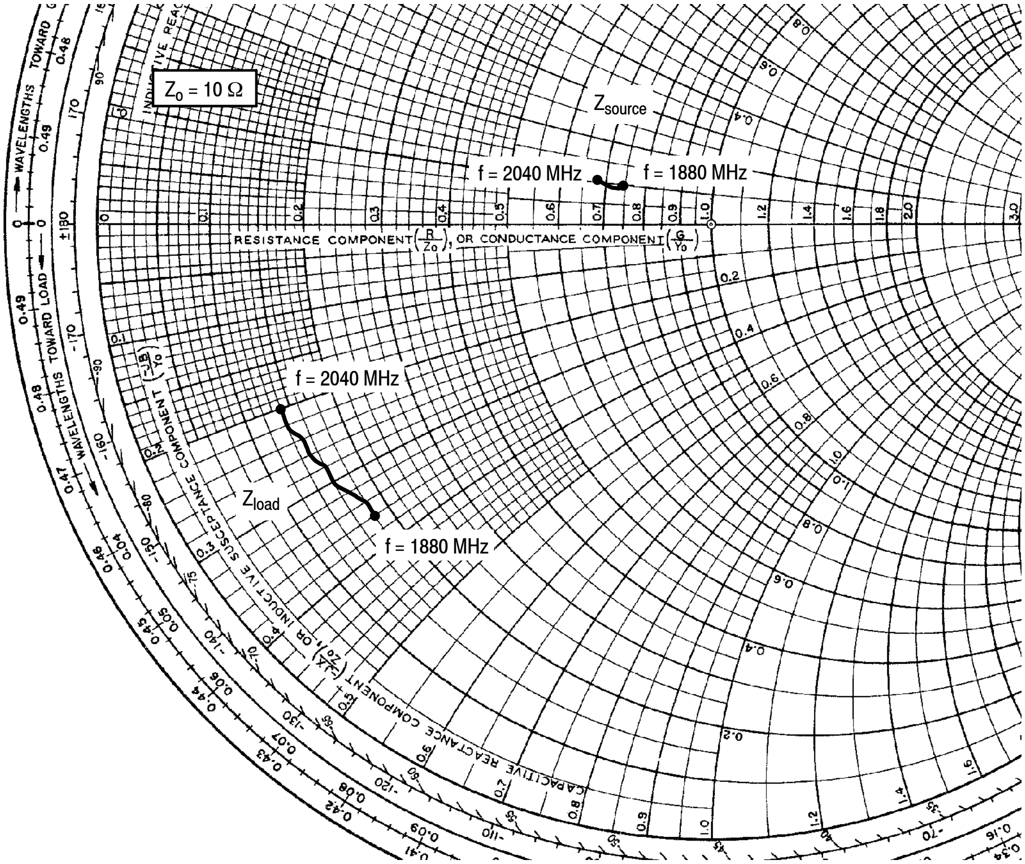


Figure 12. Single-Carrier W-CDMA Spectrum



V_{DD} = 28 Vdc, I_{DQ} = 1250 mA, P_{out} = 40 W Avg.

f MHz	Z_{source} Ω	Z_{load} Ω
1880	7.37 + j1.00	1.84 - j3.56
1900	7.33 + j0.96	1.78 - j3.37
1920	7.27 + j0.93	1.72 - j3.17
1940	7.19 + j0.90	1.64 - j2.98
1960	7.07 + j0.89	1.55 - j2.79
1980	6.93 + j0.97	1.48 - j2.55
2000	6.89 + j1.04	1.46 - j2.36
2020	6.83 + j1.07	1.44 - j2.20
2040	6.75 + j1.12	1.40 - j2.02

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

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

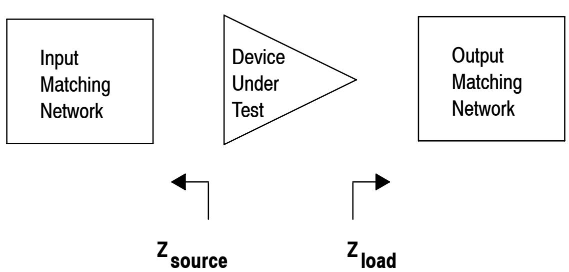
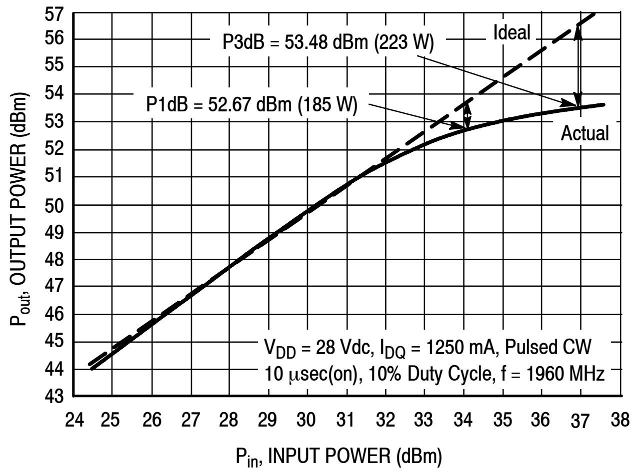


Figure 13. Series Equivalent Source and Load Impedance

ALTERNATIVE PEAK TUNE LOAD PULL CHARACTERISTICS



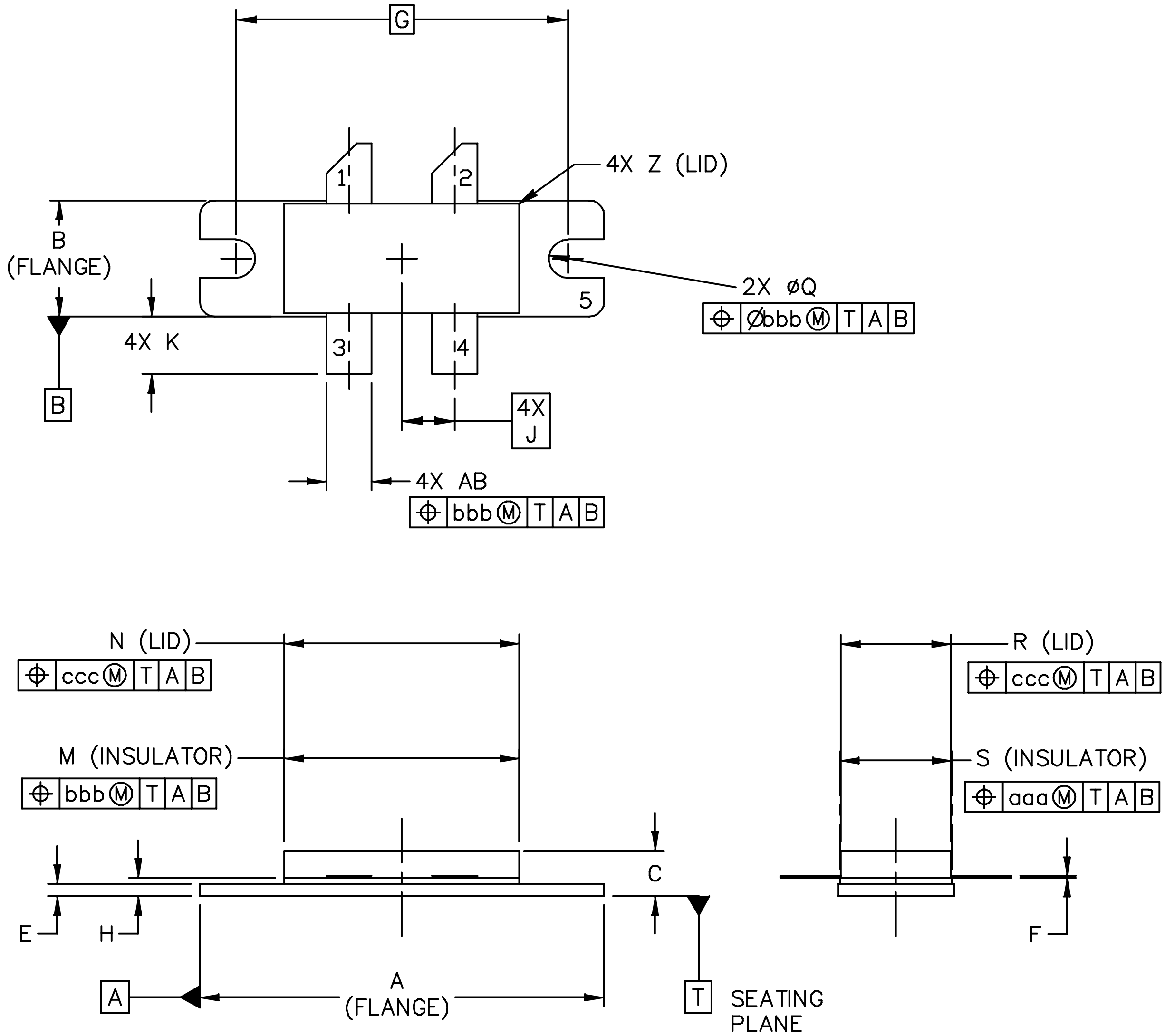
NOTE: Load Pull Test Fixture Tuned for Peak P1dB Output Power @ 28 V

Test Impedances per Compression Level

	Z_{source} Ω	Z_{load} Ω
P1dB	7.15 - j1.86	0.84 - j2.99

Figure 14. Pulsed CW Output Power versus Input Power @ 28 V

PACKAGE DIMENSIONS



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NOTES:

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2. CONTROLLING DIMENSION: INCH.
3. 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	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	U		.040		1.02
E	.035	.045	0.89	1.14	Z		.030		0.76
F	.003	.006	0.08	0.15	AB	.145	.155	3.68	3.94
G	1.100 BSC		27.94 BSC						
H	.057	.067	1.45	1.7	aaa	.005		0.127	
J	.175 BSC		4.44 BSC		bbb	.010		0.254	
K	.170	.210	4.32	5.33	ccc	.015		0.381	
M	.774	.786	19.61	20.02					
N	.772	.788	19.61	20.02					
Q	ø.118	ø.138	ø3	ø3.51					

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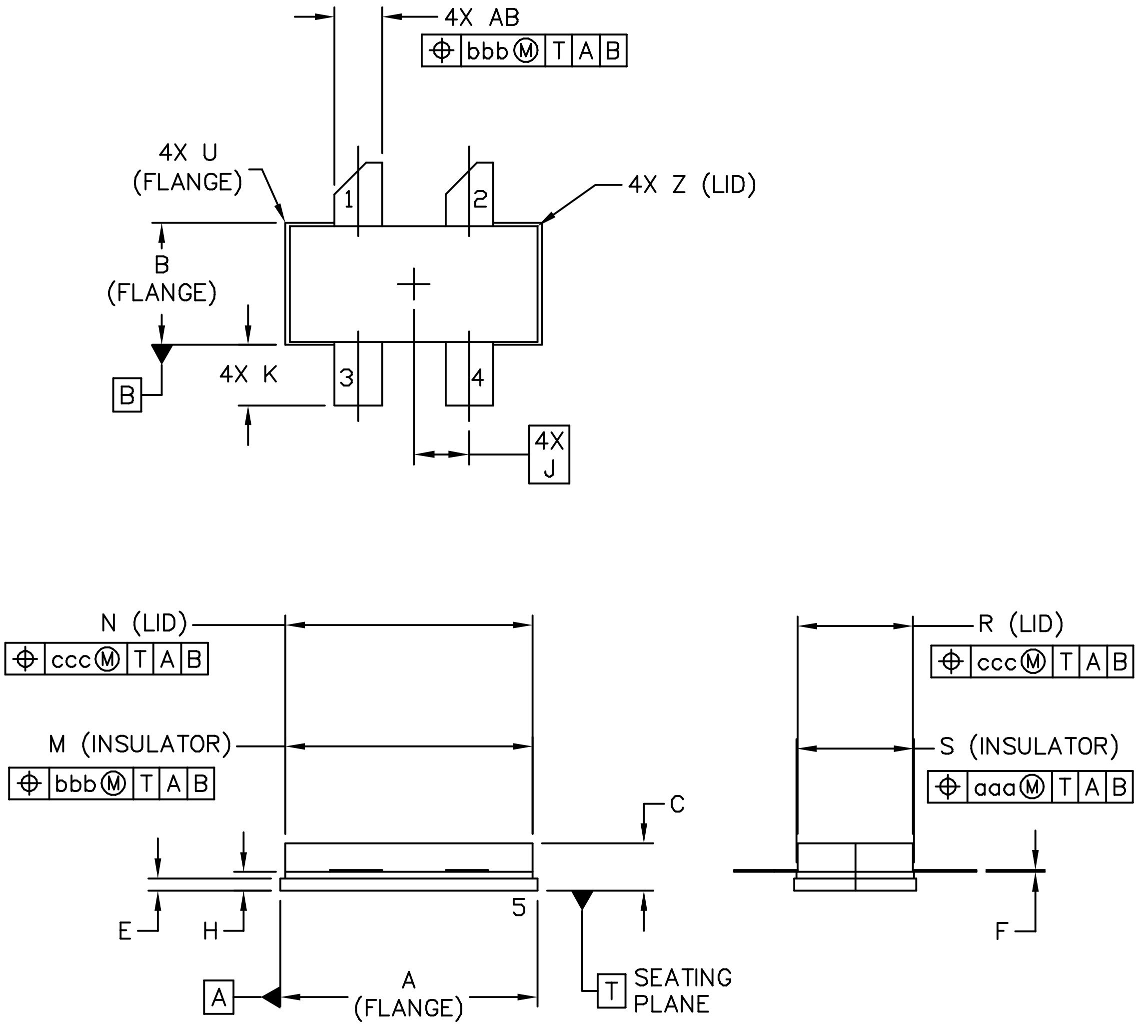

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3. DELETED

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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27 MAR 2007

STANDARD: NON-JEDEC

PRODUCT DOCUMENTATION 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, 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	May 2008	• Initial Release of Data Sheet
1	Dec. 2008	• Corrected the pin order in Fig. 1, Pin Connections, to match the Mechanical Outline pin order, p. 1
2	Aug. 2010	• Modified data sheet to reflect RF Test Reduction described in Product and Process Change Notification number, PCN13628, p. 1, 2 • Updated Fig. 14, CCDF W-CDMA IQ Magnitude Clipping, Single-Carrier Test Signal, to better represent production test signal, p. 8 • Updated Fig. 15, Single-Carrier W-CDMA Spectrum, to better represent production test signal, p. 8 • Added Electromigration MTTF Calculator and RF High Power Model availability to Product Software, p. 15

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