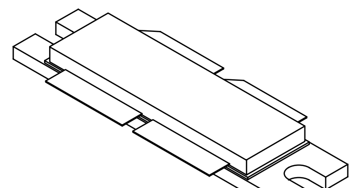
Document Number: MRF6P23190H
Rev. 3, 12/2008

RF Power Field Effect Transistor

N-Channel Enhancement-Mode Lateral MOSFET

MRF6P23190HR6

**2300-2400 MHz, 40 W AVG., 28 V
2 x W-CDMA
LATERAL N-CHANNEL
RF POWER MOSFET**



**CASE 375D-05, STYLE 1
NI-1230**

Designed for CDMA base station applications with frequencies from 2300 to 2400 MHz. Suitable for WiMAX, WiBro and multicarrier amplifier applications. To be used in Class AB and Class C for WLL applications.

- Typical 2-Carrier W-CDMA Performance: V_{DD} = 28 Volts, I_{DQ} = 1900 mA, P_{out} = 40 Watts Avg., f = 2390 MHz, Channel Bandwidth = 3.84 MHz, PAR = 8.5 dB @ 0.01% Probability on CCDF.
  - Power Gain — 14 dB
  - Drain Efficiency — 23.5%
  - IM3 @ 10 MHz Offset — -37.5 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, 2340 MHz, 190 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
- Designed for Lower Memory Effects and Wide Instantaneous Bandwidth Applications
- RoHS Compliant
- In Tape and Reel. R6 Suffix = 150 Units per 56 mm, 13 inch Reel.

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
CW Operation @ T_C = 25°C Derate above 25°C	CW	250 1.3	W W/°C

Table 2. Thermal Characteristics

Characteristic	Symbol	Value (2,3)	Unit
Thermal Resistance, Junction to Case Case Temperature 100°C, 160 W CW Case Temperature 83°C, 40 W CW	$R_{\theta JC}$	 0.22 0.24	°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.

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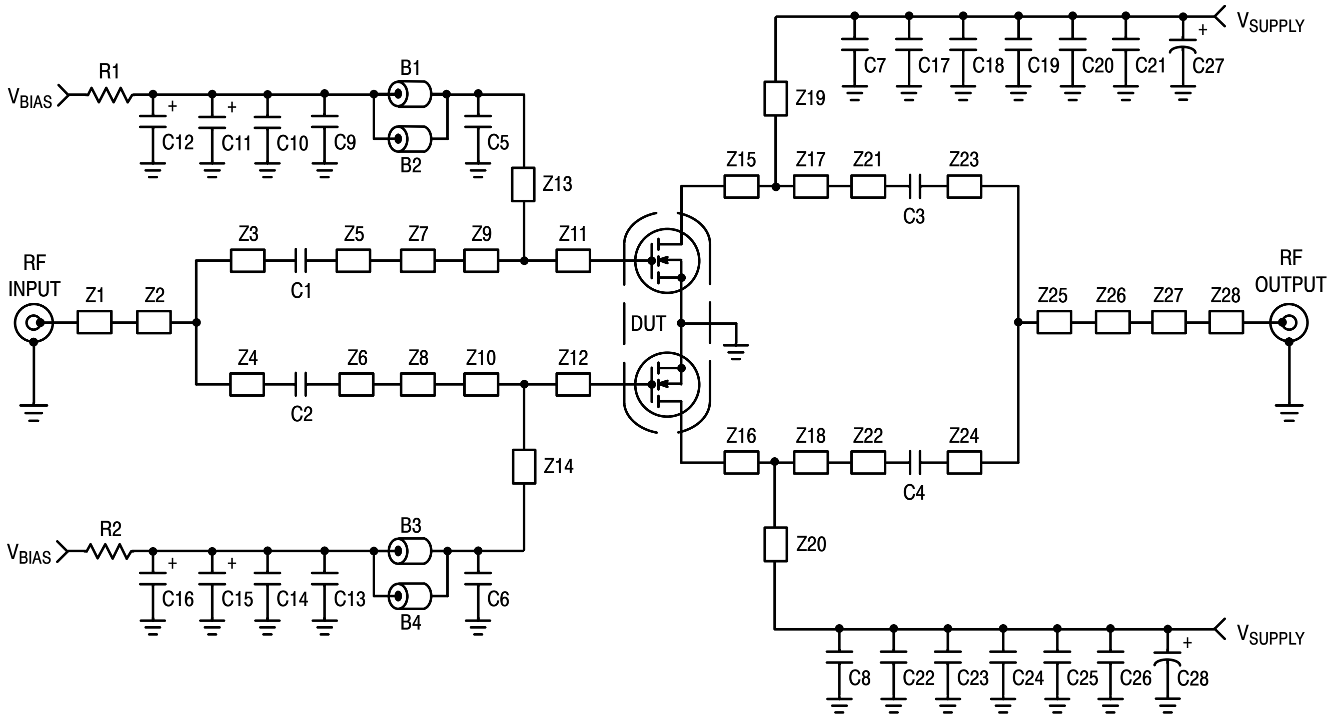
Table 3. ESD Protection Characteristics

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)	III (Minimum)

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

Characteristic	Symbol	Min	Typ	Max	Unit
Off Characteristics [1]					
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 [1] (V_{DS} = 10 Vdc, I_D = 200 μAdc)	$V_{GS(th)}$	1	2	3	Vdc
Gate Quiescent Voltage [3] (V_{DD} = 28 Vdc, I_D = 1900 mAdc, Measured in Functional Test)	$V_{GS(Q)}$	2	2.8	4	Vdc
Drain-Source On-Voltage [1] (V_{GS} = 10 Vdc, I_D = 2.2 Adc)	$V_{DS(on)}$	0.1	0.21	0.3	Vdc
Dynamic Characteristics [1,2]					
Reverse Transfer Capacitance (V_{DS} = 28 Vdc ± 30 mV(rms)ac @ 1 MHz, V_{GS} = 0 Vdc)	C_{rss}	—	1.5	—	pF
Functional Tests [3] (In Freescale Test Fixture, 50 ohm system) V_{DD} = 28 Vdc, I_{DQ} = 1900 mA, P_{out} = 40 W Avg., f = 2390 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 Bandwidth @ ±10 MHz Offset. PAR = 8.5 dB @ 0.01% Probability on CCDF.					
Power Gain	G_{ps}	13	14	16	dB
Drain Efficiency	η_D	22	23.5	—	%
Intermodulation Distortion	IM3	—	-37.5	-35	dBc
Adjacent Channel Power Ratio	ACPR	—	-41	-38	dBc
Input Return Loss	IRL	—	-13	—	dB

1. Each side of device measured separately.
2. Part internally matched both on input and output.
3. Measurement made with device in push-pull configuration.

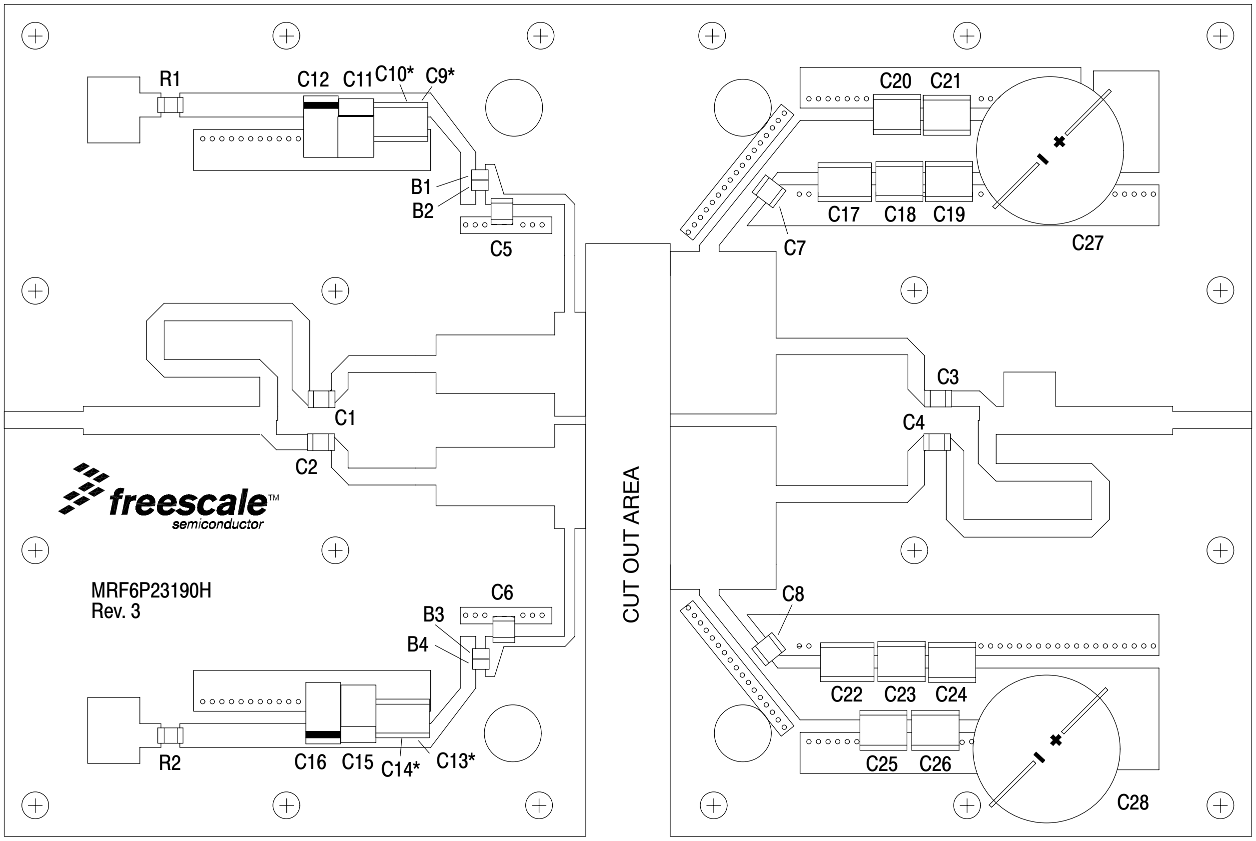


Z1, Z28	0.380″ x 0.081″ Microstrip	Z17, Z18	0.321″ x 0.782″ Microstrip
Z2	0.850″ x 0.135″ Microstrip	Z19, Z20	0.404″ x 0.074″ Microstrip
Z3	2.244″ x 0.081″ Microstrip	Z21, Z22	0.918″ x 0.081″ Microstrip
Z4	0.186″ x 0.074″ Microstrip	Z23	0.346″ x 0.081″ Microstrip
Z5, Z6	0.614″ x 0.081″ Microstrip	Z24	2.103″ x 0.081″ Microstrip
Z7, Z8	0.570″ x 0.282″ Microstrip	Z25	0.037″ x 0.135″ Microstrip
Z9, Z10	0.072″ x 0.500″ Microstrip	Z26	0.250″ x 0.300″ Microstrip
Z11, Z12	0.078″ x 0.500″ Microstrip	Z27	0.563″ x 0.135″ Microstrip
Z13, Z14	0.861″ x 0.050″ Microstrip	PCB	Arlon CuClad 250GX-0300-55-22, 0.030″, ε_r = 2.55
Z15, Z16	0.187″ x 0.782″ Microstrip		

Figure 1. MRF6P23190HR6 Test Circuit Schematic

Table 5. MRF6P23190HR6 Test Circuit Component Designations and Values

Part	Description	Part Number	Manufacturer
B1, B2, B3, B4	Ferrite Beads	2508051107Y0	Fair-Rite
C1, C2, C3, C4	5.1 pF Chip Capacitors	ATC100B5R1CT500XT	ATC
C5, C6, C7, C8	5.6 pF Chip Capacitors	ATC100B5R6CT500XT	ATC
C9, C13	0.01 μF, 100 V Chip Capacitors	C1825C103J1RAC	Kemet
C10, C14, C17, C22	2.2 μF, 50 V Chip Capacitors	C1825C225J5RAC	Kemet
C11, C15	22 μF, 25 V Tantalum Capacitors	T491D226K025AT	Kemet
C12, C16	47 μF, 16 V Tantalum Capacitors	T491D476K016AT	Kemet
C18, C19, C20, C21, C23, C24, C25, C26	10 μF, 50 V Chip Capacitors	GRM55DR61H106KA88B	Murata
C27, C28	330 μF, 63 V Electrolytic Capacitors	NACZF331M63V	Nippon
R1, R2	240 Ω, 1/4 W Chip Resistors	CRCW12062400FKEA	Vishay



*Stacked.

Figure 2. MRF6P23190HR6 Test Circuit Component Layout

TYPICAL CHARACTERISTICS

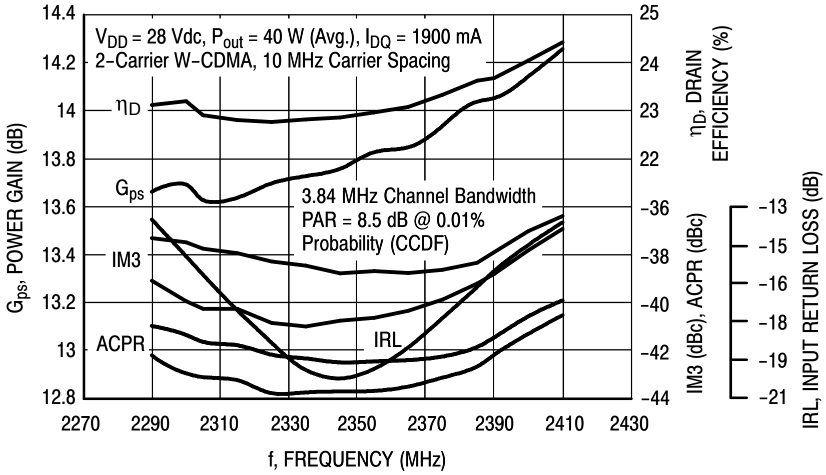


Figure 3. 2-Carrier W-CDMA Broadband Performance @ P_{out} = 40 Watts Avg.

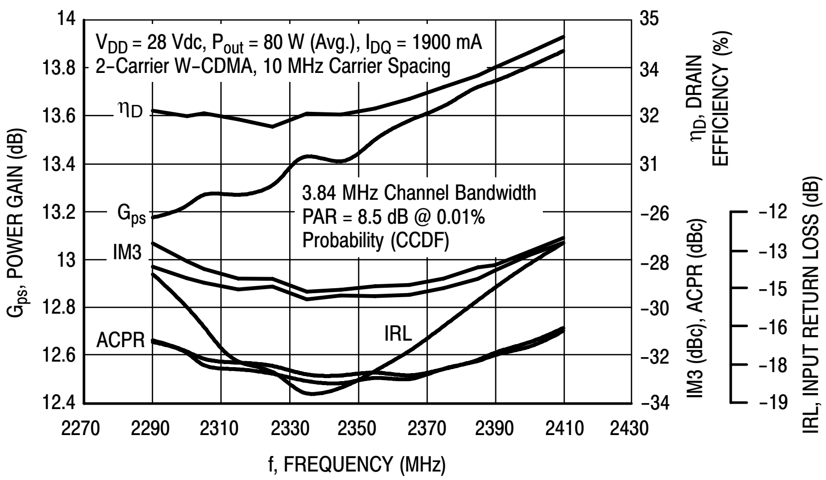


Figure 4. 2-Carrier W-CDMA Broadband Performance @ P_{out} = 80 Watts Avg.

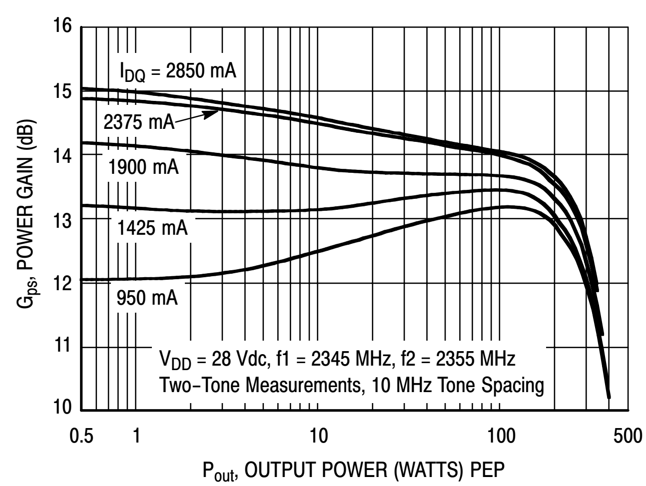


Figure 5. Two-Tone Power Gain versus Output Power

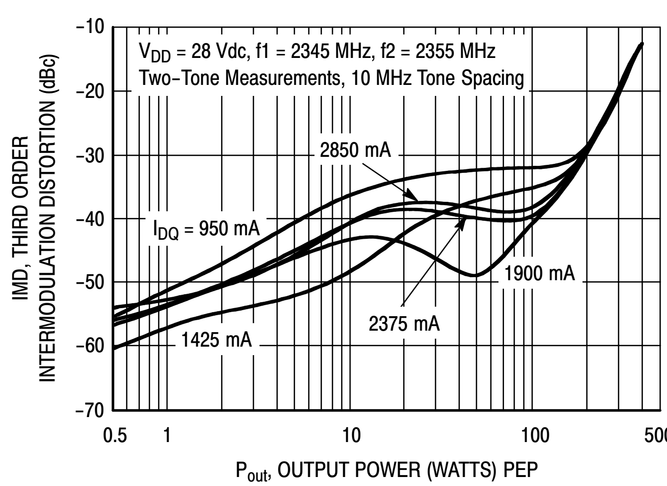


Figure 6. Third Order Intermodulation Distortion versus Output Power

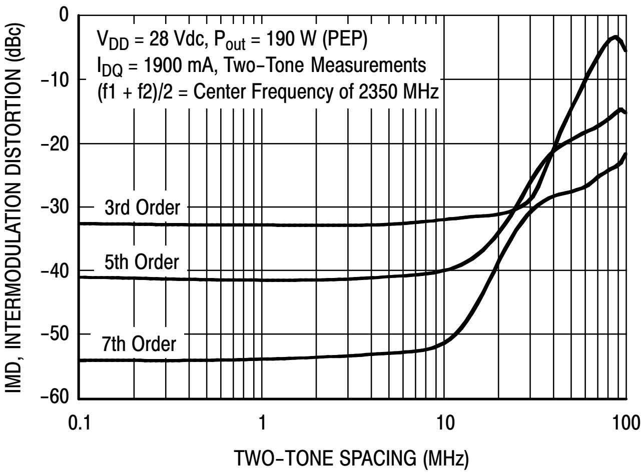


Figure 7. Intermodulation Distortion Products versus Tone Spacing

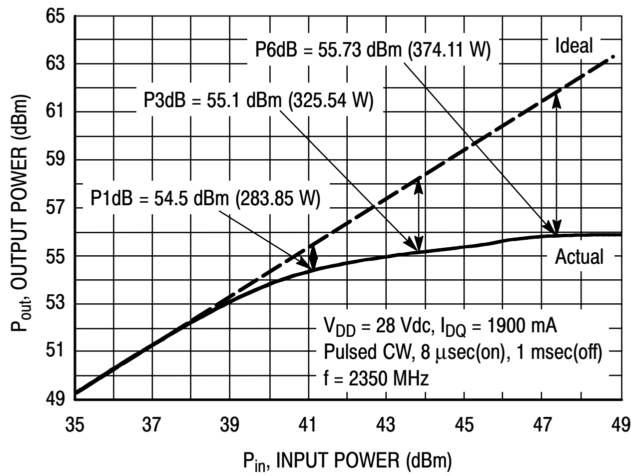


Figure 8. Pulsed CW Output Power versus Input Power

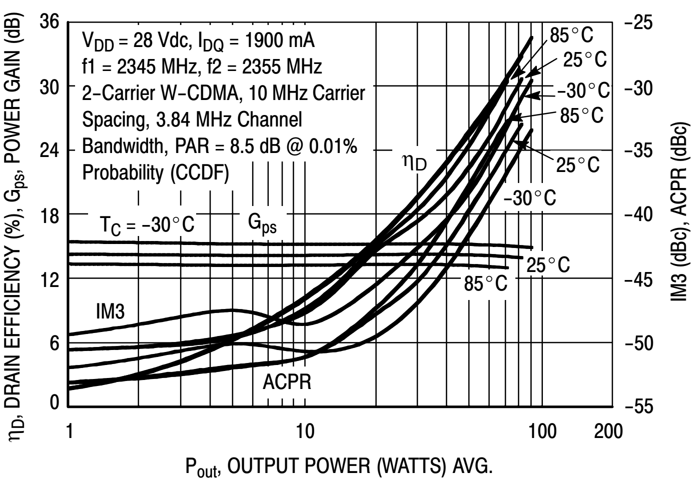


Figure 9. 2-Carrier W-CDMA ACPR, IM3, Power Gain and Drain Efficiency versus Output Power

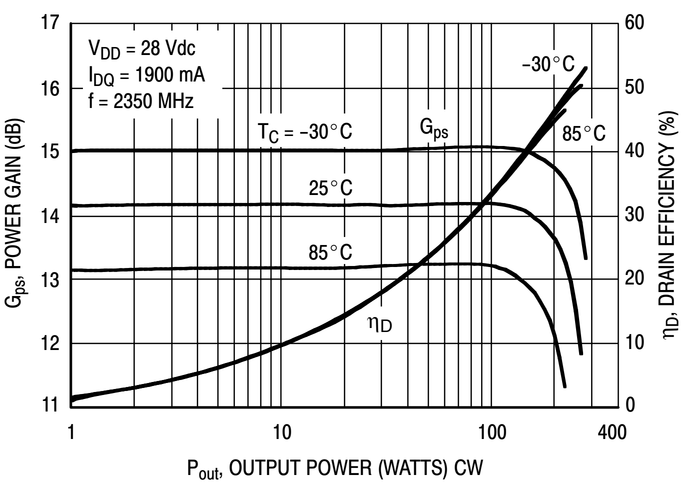


Figure 10. Power Gain and Drain Efficiency versus CW Output Power

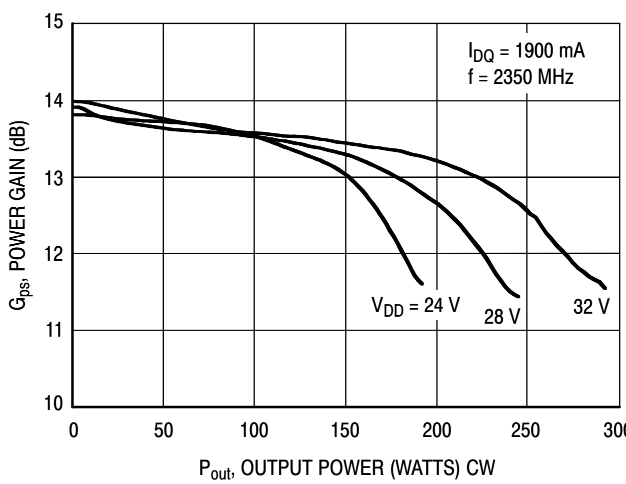
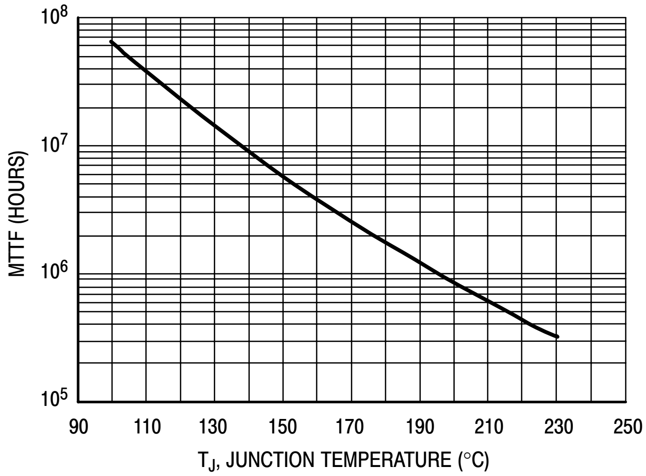


Figure 11. Power Gain versus Output Power

TYPICAL CHARACTERISTICS



This above graph displays calculated MTTF in hours when the device is operated at V_{DD} = 28 Vdc, P_{out} = 40 W Avg., and η_D = 23.5%.

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

Figure 12. MTTF versus Junction Temperature

W-CDMA TEST SIGNAL

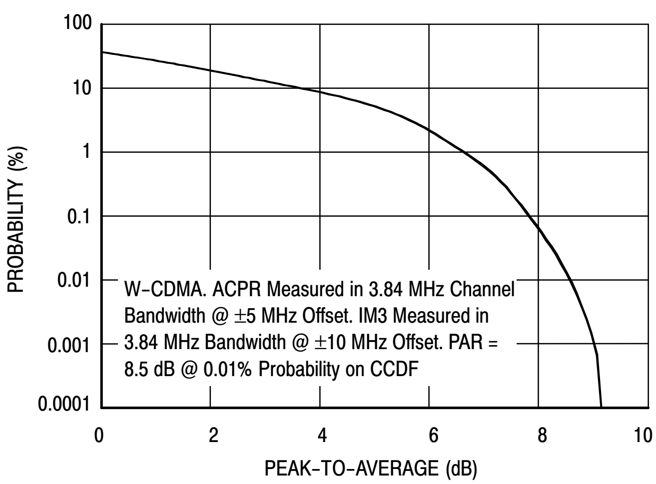


Figure 13. CCDF W-CDMA 3GPP, Test Model 1, 64 DPCH, 67% Clipping, Single-Carrier Test Signal

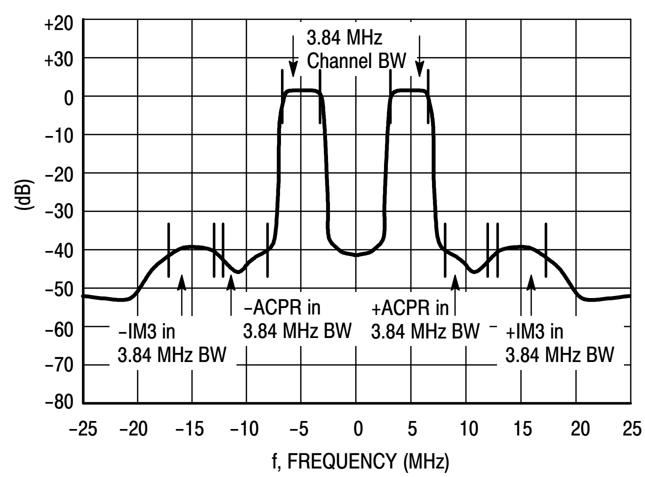
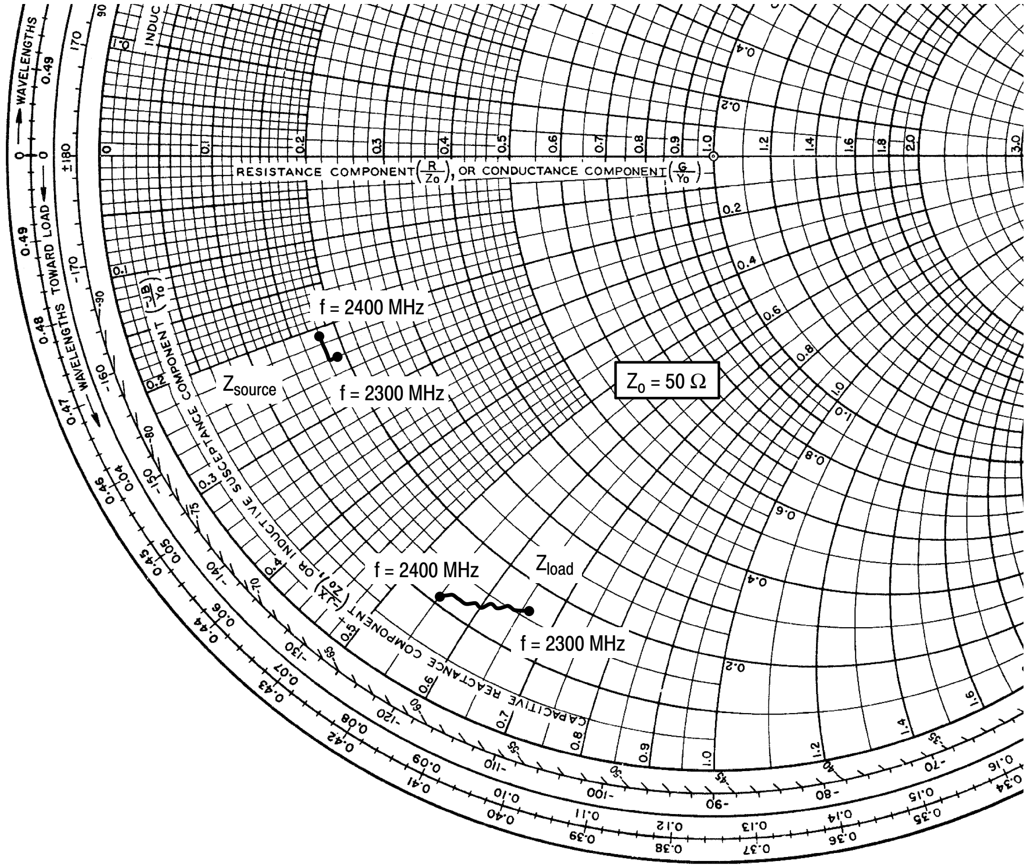


Figure 14. 2-Carrier W-CDMA Spectrum



V_{DD} = 28 Vdc, I_{DQ} = 1900 mA, P_{out} = 40 W Avg.

f MHz	Z_{source} Ω	Z_{load} Ω
2300	9.31 - j12.12	7.89 - j32.78
2310	9.27 - j11.93	7.61 - j32.19
2320	9.24 - j11.75	7.35 - j31.62
2330	9.21 - j11.57	7.10 - j31.06
2340	9.18 - j11.40	6.86 - j30.53
2350	9.16 - j11.23	6.64 - j30.01
2360	9.14 - j11.06	6.43 - j29.51
2370	9.13 - j10.90	6.23 - j29.02
2380	9.12 - j10.75	6.04 - j28.55
2390	9.11 - j10.59	5.86 - j28.09
2400	9.11 - j10.45	5.68 - j27.64

Z_{source} = Test circuit impedance as measured from gate to gate, balanced configuration.

Z_{load} = Test circuit impedance as measured from drain to drain, balanced configuration.

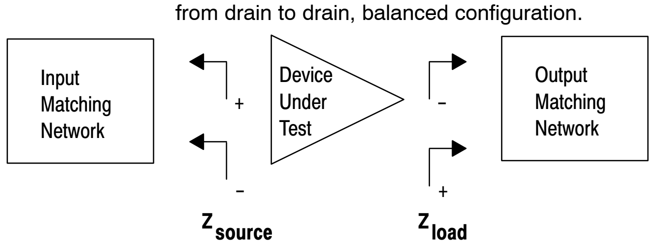
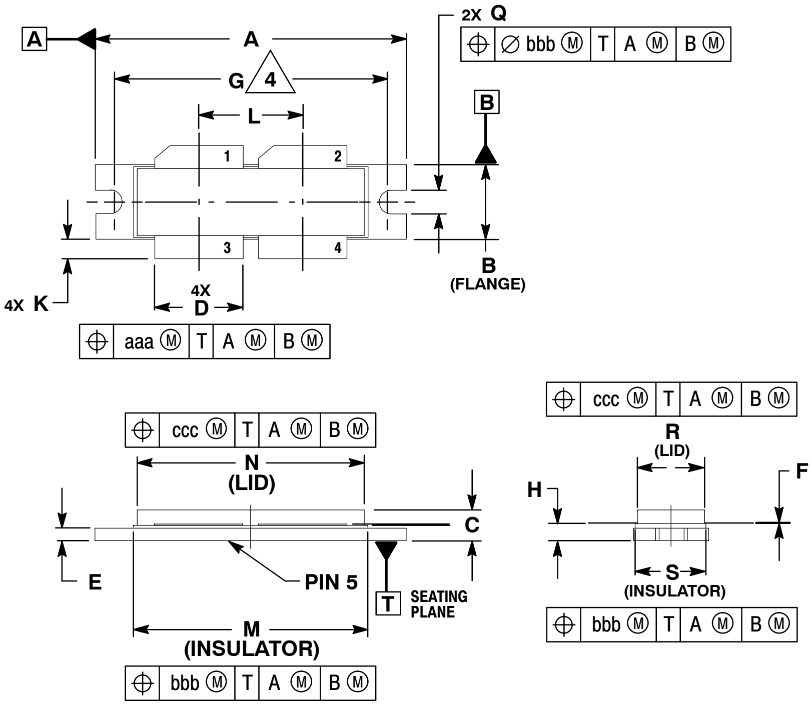


Figure 15. Series Equivalent Source and Load Impedance

PACKAGE DIMENSIONS



NOTES:
1. INTERPRET DIMENSIONS AND TOLERANCES PER ASME Y14.5M-1994.
2. CONTROLLING DIMENSION: INCH.
3. DIMENSION H IS MEASURED 0.030 (0.762) AWAY FROM PACKAGE BODY.
4. RECOMMENDED BOLT CENTER DIMENSION OF 1.52 (38.61) BASED ON M3 SCREW.

	INCHES		MILLIMETERS	
DIM	MIN	MAX	MIN	MAX
A	1.615	1.625	41.02	41.28
B	0.395	0.405	10.03	10.29
C	0.150	0.200	3.81	5.08
D	0.455	0.465	11.56	11.81
E	0.062	0.066	1.57	1.68
F	0.004	0.007	0.10	0.18
G	1.400 BSC		35.56 BSC	
H	0.082	0.090	2.08	2.29
K	0.117	0.137	2.97	3.48
L	0.540 BSC		13.72 BSC	
M	1.219	1.241	30.96	31.52
N	1.218	1.242	30.94	31.55
Q	0.120	0.130	3.05	3.30
R	0.355	0.365	9.01	9.27
S	0.365	0.375	9.27	9.53
aaa	0.013 REF		0.33 REF	
bbb	0.010 REF		0.25 REF	
ccc	0.020 REF		0.51 REF	

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

CASE 375D-05
ISSUE E
NI-1230

PRODUCT DOCUMENTATION

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

REVISION HISTORY

The following table summarizes revisions to this document.

Revision	Date	Description
2	Mar. 2007	• Removed Lower Thermal Resistance and Low Gold Plating bullets from Features section as functionality is standard, p. 1 • Removed Total Device Dissipation from Max Ratings table as data was redundant (information already provided in Thermal Characteristics table), p. 1 • Added maximum CW operation limitation and derating values to the Maximum Rating table to prevent a 200°C+ hot wire operating condition, p. 1 • Corrected V_{DS} to V_{DD} in the RF test condition voltage callout for $V_{GS(Q)}$, 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 • 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
3	Dec. 2008	• Modified data sheet to reflect RF Test Reduction described in Product and Process Change Notification number, PCN13232, p. 1, 2 • Operating Junction Temperature increased from 200°C to 225°C in Maximum Ratings table, related “Continuous use at maximum temperature will affect MTTF” footnote added, p. 1 • Updated PCB information to show more specific material details, Fig. 1, Test Circuit Schematic, p. 3 • Updated Part Numbers in Table 5, Component Designations and Values, to latest RoHS compliant part numbers, p. 3

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