RF Power Field Effect Transistor

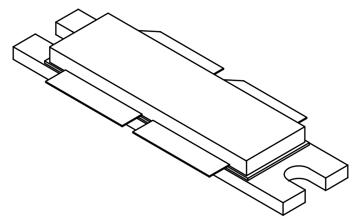
N-Channel Enhancement-Mode Lateral MOSFET

Designed for 802.16 WiBro and dual mode applications with frequencies from 2300 to 2400 MHz. Suitable for Class AB feedforward and predistortion systems.

- Typical 2-Carrier W-CDMA Performance: V_{DD} = 28 Volts, I_{DQ} = 1900 mA, P_{out} = 40 Watts Avg., Full Frequency Band, 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 @ 3.84 MHz Channel Bandwidth
  ACPR @ 5 MHz Offset — -41 dBc @ 3.84 MHz Channel Bandwidth
- Capable of Handling 10:1 VSWR, @ 28 Vdc, 2340 MHz, 190 Watts CW Output Power
- 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
- Lower Thermal Resistance Package
- Designed for Lower Memory Effects and Wide Instantaneous Bandwidth Applications
- Low Gold Plating Thickness on Leads, 40μ″ Nominal.
- Pb-Free and RoHS Compliant
- In Tape and Reel. R6 Suffix = 150 Units per 56 mm, 13 inch Reel.

MRF6P23190HR6

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



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

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
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	795 4.5	W W/°C
Storage Temperature Range	T_{stg}	- 65 to +150	°C
Operating Junction Temperature	T_J	200	°C

Table 2. Thermal Characteristics

Characteristic	Symbol	Value (1,2)	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. MTTF calculator available at http://www.freescale.com/rf. Select Tools/Software/Application Software/Calculators to access the 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.

NOTE - **CAUTION** - MOS devices are susceptible to damage from electrostatic charge. Reasonable precautions in handling and packaging MOS devices should be observed.

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)

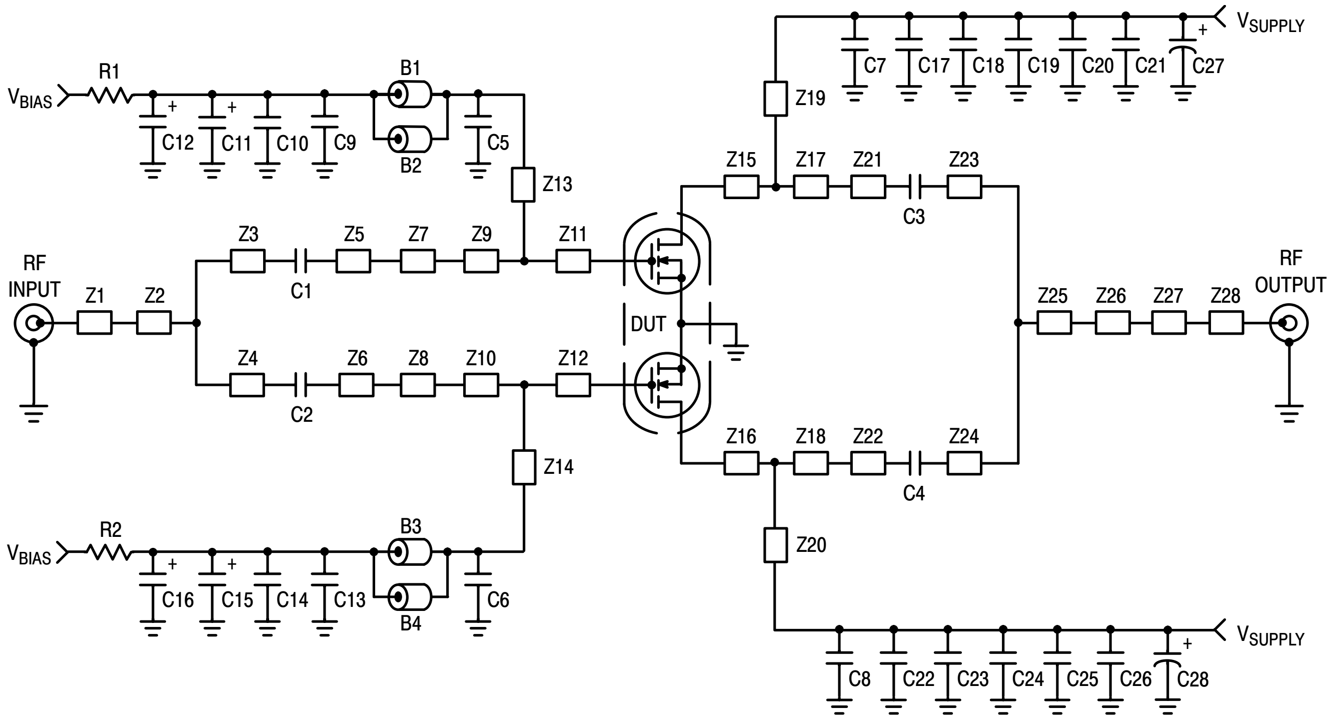
Table 4. Electrical Characteristics (T_C = 25°C unless otherwise noted)

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_{DS} = 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
Forward Transconductance(1) (V_{DS} = 10 Vdc, I_D = 2 Adc)	g_{fs}	—	5.3	—	S
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., f1 = 2300 MHz, f2 = 2310 MHz and f1 = 2390 MHz, f2 = 2400 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.

Characteristic	Symbol	Min	Typ	Max	Unit
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.

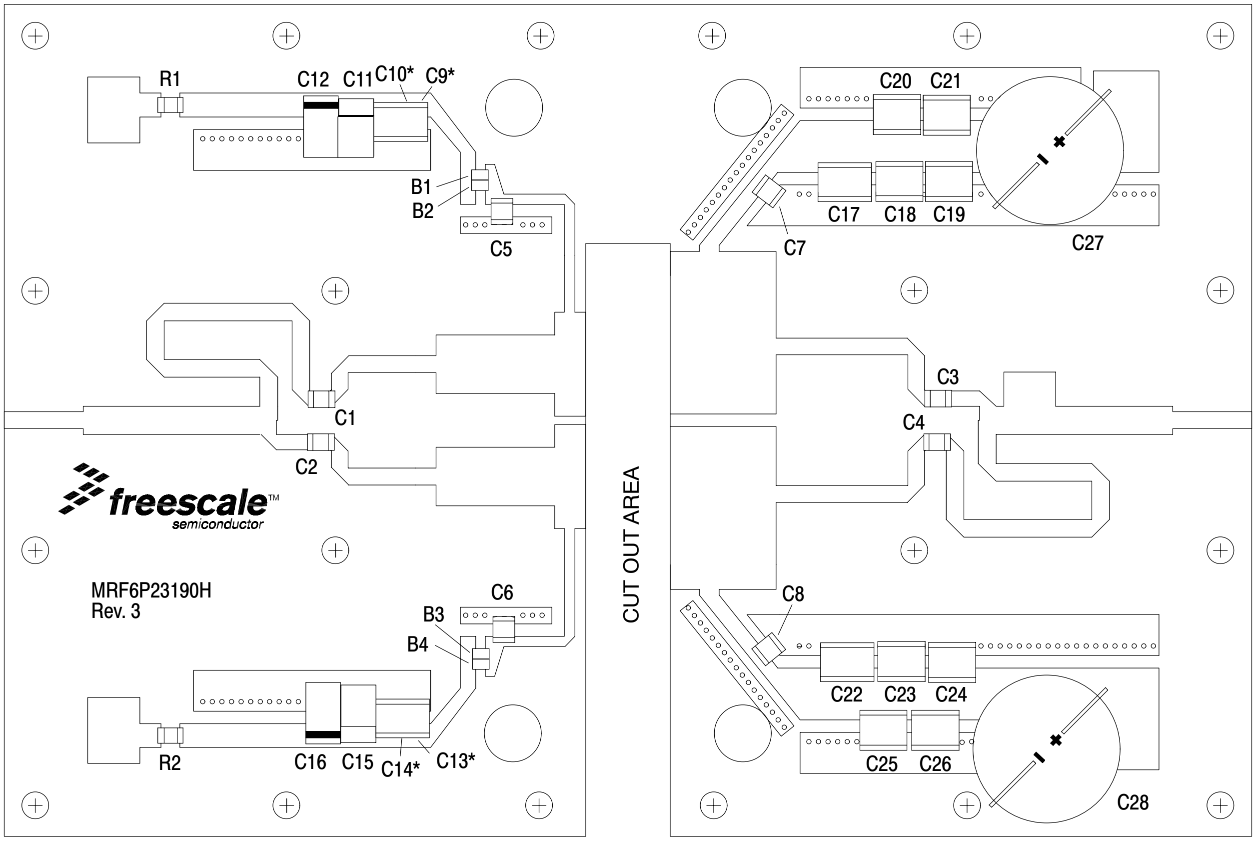


Z1, Z28	0.380″ x 0.081″ Microstrip	Z17, Z18	0.321″ x 0.782″ Microstrip
Z2	0.850″ x 0.135″ Microstrip	Z19, Z20	0.404″ x 0.074″ Microstrip
Z3	2.244″ x 0.081″ Microstrip	Z21, Z22	0.918″ x 0.081″ Microstrip
Z4	0.186″ x 0.074″ Microstrip	Z23	0.346″ x 0.081″ Microstrip
Z5, Z6	0.614″ x 0.081″ Microstrip	Z24	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 GX-0300-5022, 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 (0805)	2508051107Y0	Fair-Rite
C1, C2, C3, C4	5.1 pF 100B Chip Capacitors	100B5R1CP500X	ATC
C5, C6, C7, C8	5.6 pF 100B Chip Capacitors	100B5R6CP500X	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	ECS-T1ED226R	Panasonic TE series
C12, C16	47 μF, 16 V Tantalum Capacitors	T491D476K016AS	Kemet
C18, C19, C20, C21, C23, C24, C25, C26	10 μF, 50 V Chip Capacitors (2220)	GRM55DR61H106KA88B	Murata
C27, C28	330 μF, 63 V Electrolytic Capacitors	NACZF331M63V	Nippon
R1, R2	240 Ω, 1/8 W Chip Resistors (1206)		



*Stacked.

Figure 2. MRF6P23190HR6 Test Circuit Component Layout

TYPICAL CHARACTERISTICS

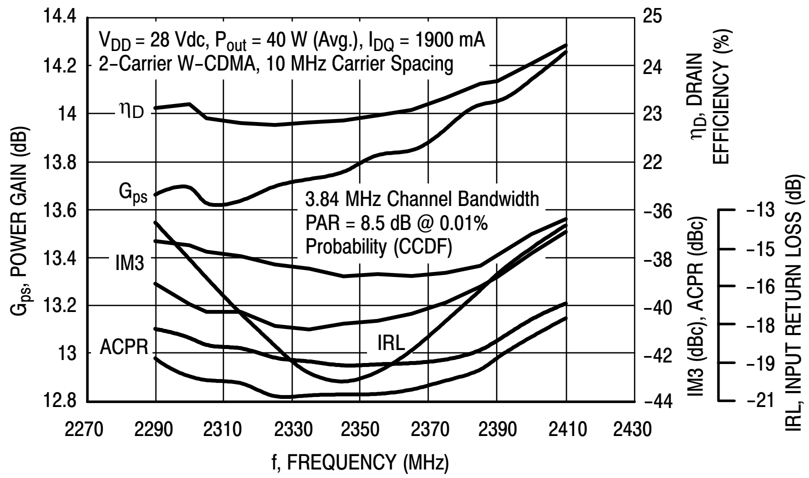


Figure 3. 2-Carrier W-CDMA Broadband Performance @ P_{out} = 40 Watts Avg.

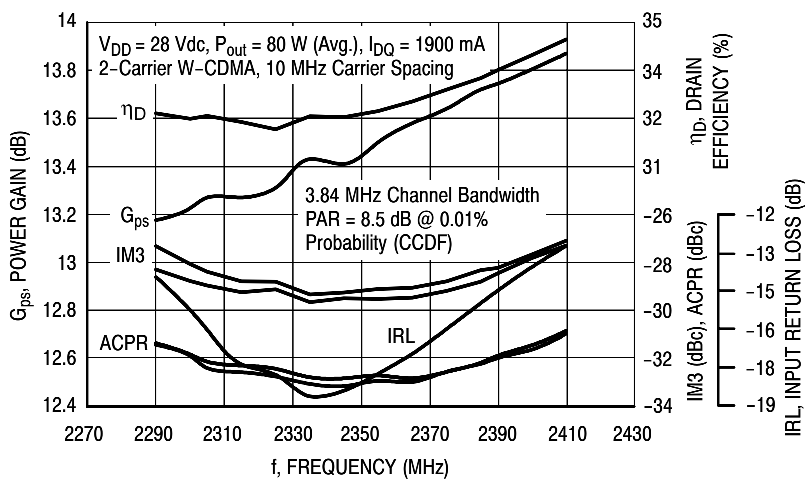


Figure 4. 2-Carrier W-CDMA Broadband Performance @ P_{out} = 80 Watts Avg.

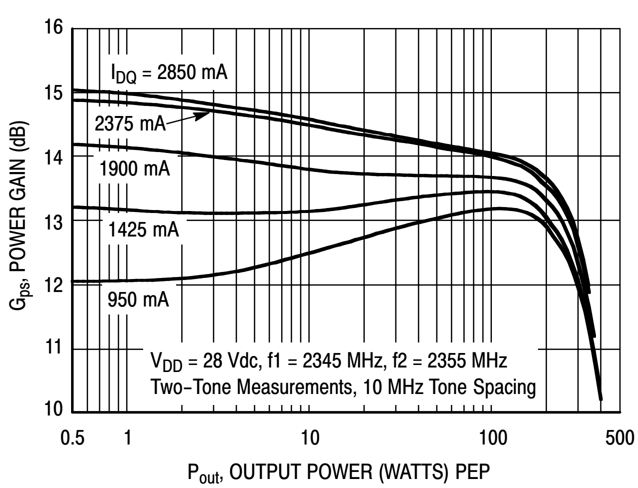


Figure 5. Two-Tone Power Gain versus Output Power

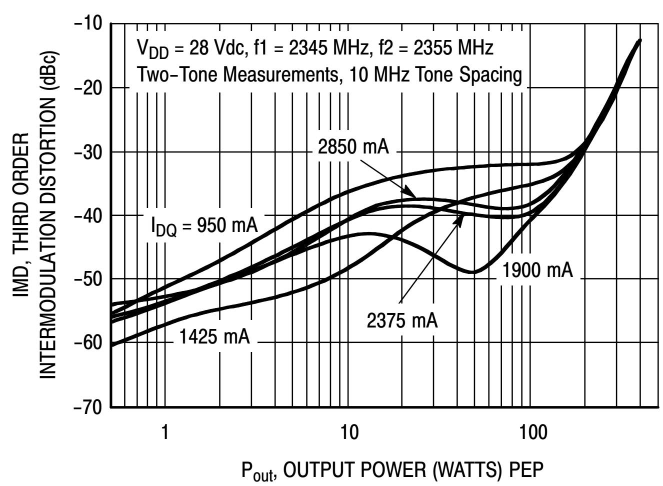


Figure 6. Third Order Intermodulation Distortion versus Output Power

TYPICAL CHARACTERISTICS

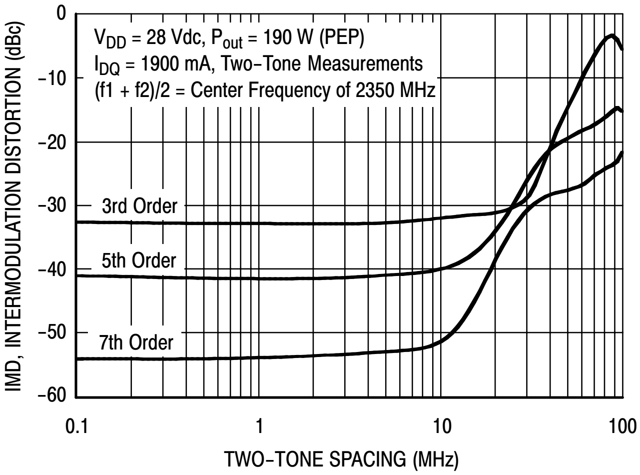


Figure 7. Intermodulation Distortion Products versus Tone Spacing

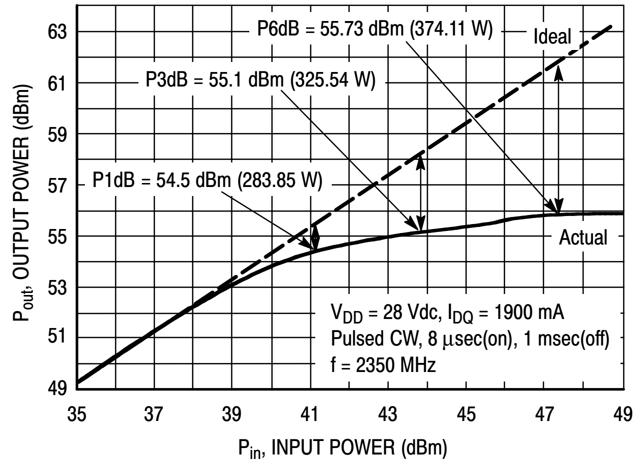


Figure 8. Pulse CW Output Power versus Input Power

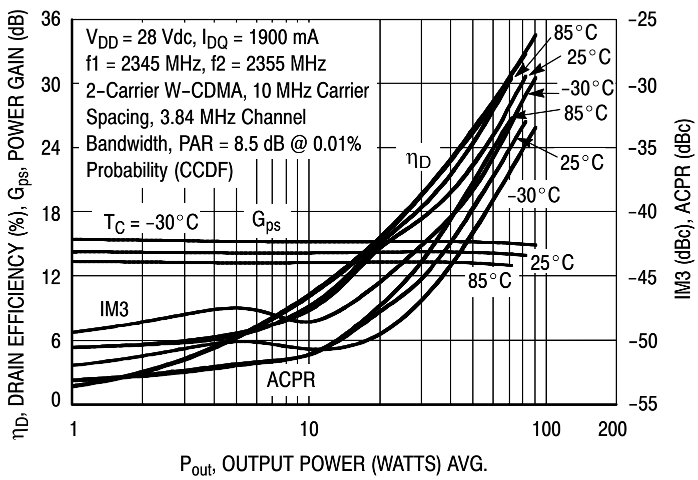


Figure 9. 2-Carrier W-CDMA ACPR, IM3, Power Gain and Drain Efficiency versus Output Power

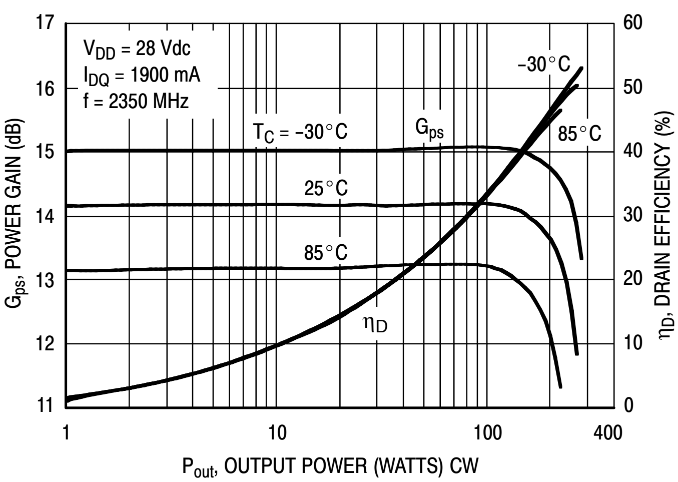


Figure 10. Power Gain and Drain Efficiency versus CW Output Power

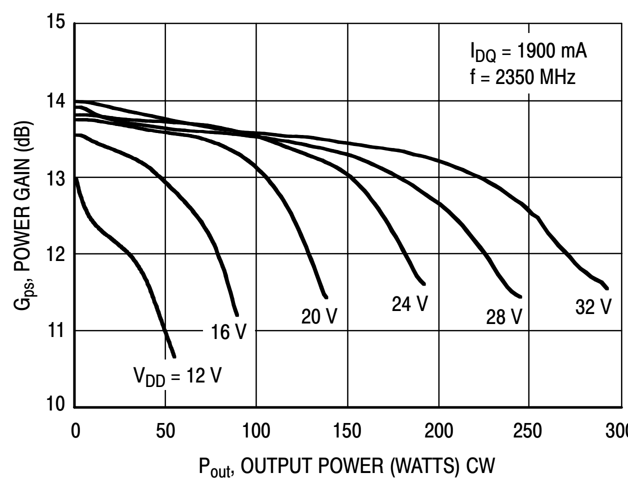
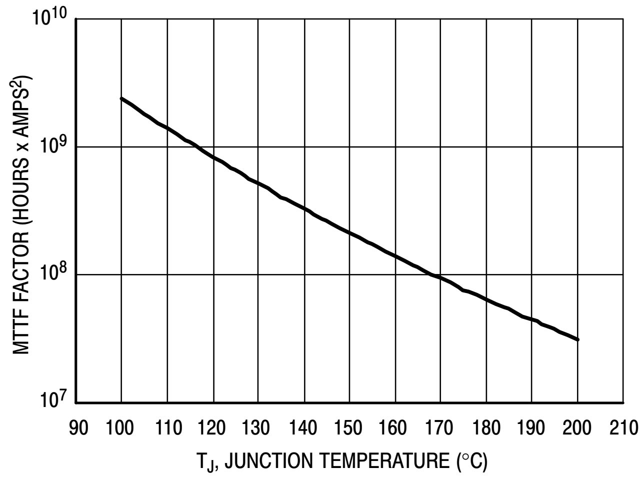


Figure 11. Power Gain versus Output Power

TYPICAL CHARACTERISTICS



This above graph displays calculated MTTF in hours x ampere² drain current. Life tests at elevated temperatures have correlated to better than ±10% of the theoretical prediction for metal failure. Divide MTTF factor by I_D^2 for MTTF in a particular application.

Figure 12. MTTF Factor versus Junction Temperature

W-CDMA TEST SIGNAL

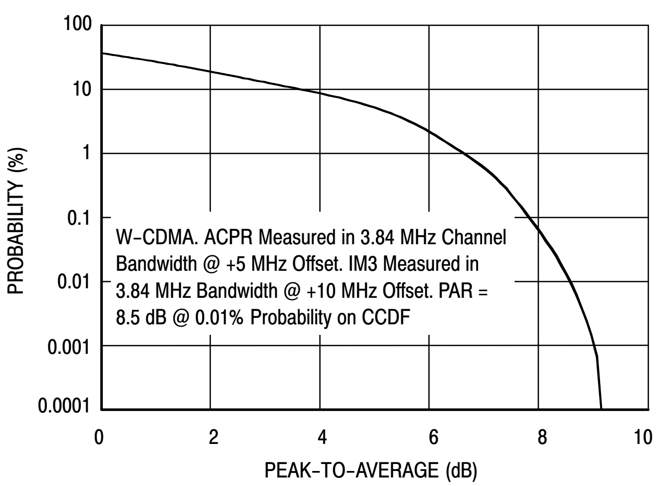


Figure 13. CCDF W-CDMA 3GPP, Test Model 1, 64 DPCH, 67% Clipping, Single-Carrier Test Signal

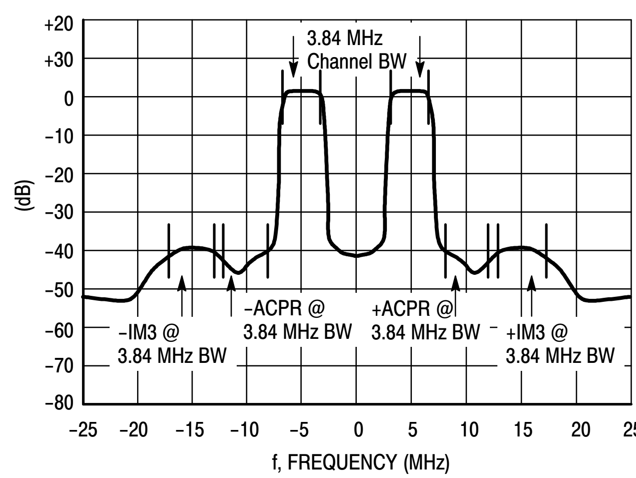
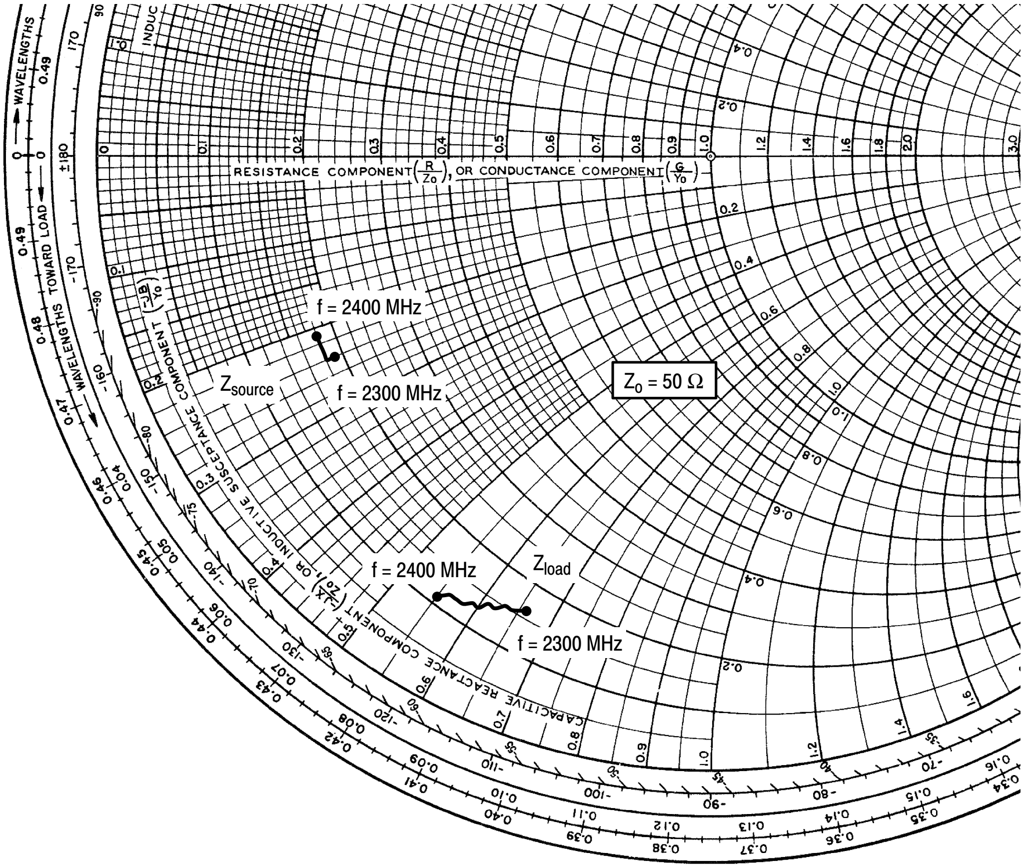


Figure 14. 2-Carrier W-CDMA Spectrum



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.

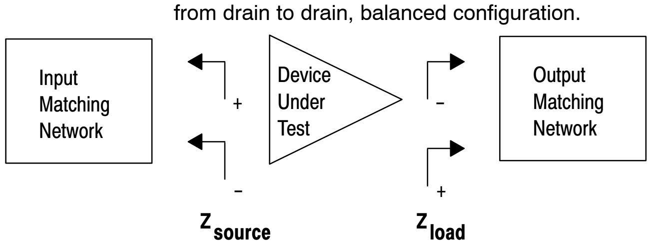
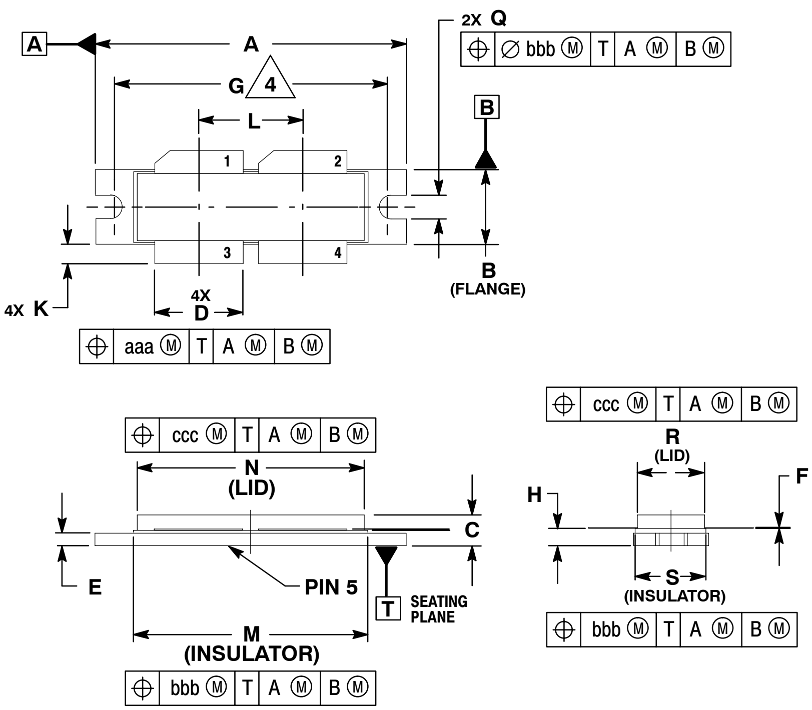


Figure 15. Series Equivalent Source and Load Impedance

NOTES

NOTES

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

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USA/Europe or Locations Not Listed:
Freescale Semiconductor
Technical Information Center, CH370
1300 N. Alma School Road
Chandler, Arizona 85224
+1-800-521-6274 or +1-480-768-2130
support@freescale.com

Europe, Middle East, and Africa:
Freescale Halbleiter Deutschland GmbH
Technical Information Center
Schatzbogen 7
81829 Muenchen, Germany
+44 1296 380 456 (English)
+46 8 52200080 (English)
+49 89 92103 559 (German)
+33 1 69 35 48 48 (French)
support@freescale.com

Japan:
Freescale Semiconductor Japan Ltd.
Headquarters
ARCO Tower 15F
1-8-1, Shimo-Meguro, Meguro-ku,
Tokyo 153-0064
Japan
0120 191014 or +81 3 5437 9125
support.japan@freescale.com

Asia/Pacific:
Freescale Semiconductor Hong Kong Ltd.
Technical Information Center
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