**Freescale Semiconductor**
Technical Data

RF Power Field Effect Transistor
N‑Channel Enhancement‑Mode Lateral MOSFET

Designed for W‑CDMA base station applications with frequencies from 2110 to 2170 MHz. Suitable for TDMA, CDMA and multicarrier amplifier applications. To be used in Class AB for PCN‑PCS/cellular radio and WLL applications.

- Typical 2‑Carrier W‑CDMA Performance: V_{DD} = 28 Volts, I_{DQ} = 2 x 950 mA, P_{out} = 44 Watts Avg., Full Frequency Band, Channel Bandwidth = 3.84 MHz, PAR = 8.5 dB @ 0.01% Probability on CCDF.
    Power Gain — 15.5 dB
    Drain Efficiency — 26.5%
    IM3 @ 10 MHz Offset — -37 dBc @ 3.84 MHz Channel Bandwidth
    ACPR @ 5 MHz Offset — -40 dBc @ 3.84 MHz Channel Bandwidth
- Capable of Handling 10:1 VSWR, @ 28 Vdc, 2140 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.

MRF6P21190HR6

**2170 MHz, 44 W AVG., 28 V
2 x W‑CDMA
LATERAL N‑CHANNEL
RF POWER MOSFET**
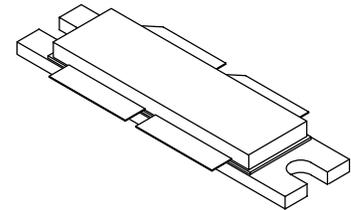
**CASE 375D‑05, STYLE 1
NI‑1230**

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	700 4	W W/°C
Storage Temperature Range	T_{stg}	- 65 to +150	°C
Operating Junction Temperature	T_J	200	°C
CW Operation	CW	190	W

Table 2. Thermal Characteristics

Characteristic	Symbol	Value (1,2)	Unit

Thermal Resistance, Junction to Case
    Case Temperature 80°C, 190 W CW
    Case Temperature 72°C, 44 W CW
	$R_{\theta JC}$	
		0.25
		0.27
			°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.

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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 = 250 µAdc)	$V_{GS(th)}$	1	2	3	Vdc
Gate Quiescent Voltage [3] (V_{DS} = 28 Vdc, I_D = 1900 mAdc)	$V_{GS(Q)}$	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} = 2 x 950 mA, P_{out} = 44 W Avg., f1 = 2112.5 MHz, f2 = 2122.5 MHz and f1 = 2157.5 MHz, f2 = 2167.5 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 Channel Bandwidth @ ±10 MHz Offset. PAR = 8.5 dB @ 0.01% Probability on CCDF.

Power Gain	G_{ps}	14.5	15.5	17.5	dB
Drain Efficiency	η_D	25	26.5	—	%
Intermodulation Distortion	IM3	—	-37	-35	dBc
Adjacent Channel Power Ratio	ACPR	—	-40	-38	dBc
Input Return Loss	IRL	—	-15	-9	dB

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

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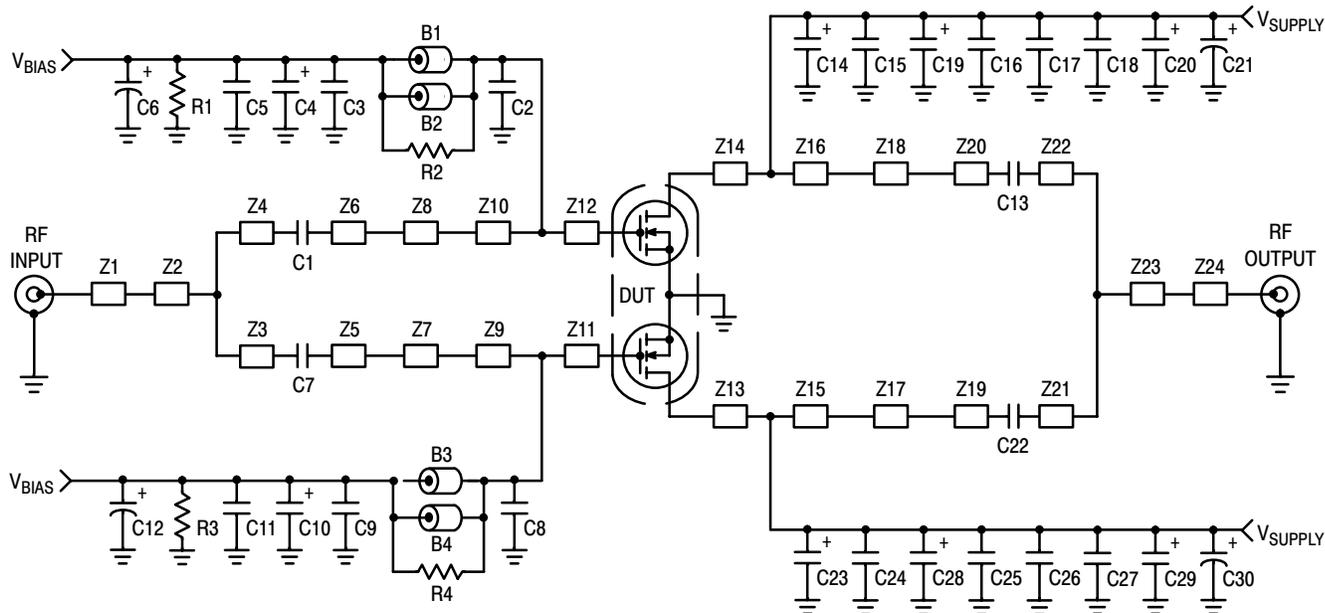
Z1	0.850″ x 0.067″ Microstrip	Z15, Z16	0.289″ x 0.712″ Microstrip
Z2	1.140″ x 0.114″ Microstrip	Z17, Z18	0.127″ x 0.200″ Microstrip
Z3	1.830″ x 0.067″ Microstrip	Z19, Z20	0.288″ x 0.067″ Microstrip
Z4	0.088″ x 0.067″ Microstrip	Z21	0.088″ x 0.067″ Microstrip
Z5, Z6	0.250″ x 0.067″ Microstrip	Z22	1.830″ x 0.067″ Microstrip
Z7, Z8	0.324″ x 0.178″ Microstrip	Z23	1.140″ x 0.114″ Microstrip
Z9, Z10	0.143″ x 0.655″ Microstrip	Z24	0.850″ x 0.066″ Microstrip
Z11, Z12	0.111″ x 0.655″ Microstrip	PCB	Taconic RF‐35, 0.030″, $\varepsilon_r = 3.5$
Z13, Z14	0.124″ x 0.712″ Microstrip		

Figure 1. MRF6P21190HR6 Test Circuit Schematic

Table 5. MRF6P21190HR6 Test Circuit Component Designations and Values

Part	Description	Part Number	Manufacturer
B1, B2, B3, B4	RF Beads	2743019447	Fair‐Rite
C1, C7	30 pF Chip Capacitors	100B300JP500X	ATC
C2, C8, C15, C24	6.8 pF Chip Capacitors	100B6R8CP500X	ATC
C3, C9, C18, C27	1k pF Chip Capacitors	100B102JP50X	ATC
C4, C10	1 µF, 50 V Tantalum Chip Capacitors	T491C105K050AS	Kemet
C5, C11, C17, C26	0.1 µF Chip Capacitors	CDR33BX104AKWS	Kemet
C6, C12	100 µF, 50 V Electrolytic Capacitors, Radial	MCR50V107M8X11	Multicomp
C13, C22	43 pF Chip Capacitors	100B430JP500X	ATC
C14, C19, C20, C23, C28, C29	22 µF, 35 V Tantalum Chip Capacitors	T491X226K035AS	Kemet
C16, C25	0.56 µF Chip Capacitors (1825)	C1825C564J5RAC	Kemet
C21, C30	470 µF, 63 V Electrolytic Capacitors, Radial	MCR63V477M13X26	Multicomp
R1, R3	1 kΩ, 1/4 W Chip Resistors (1206)	CRCW12061001F100	Vishay
R2, R4	12 Ω, 1/4 W Chip Resistors (1206)	CRCW120612R0F100	Vishay

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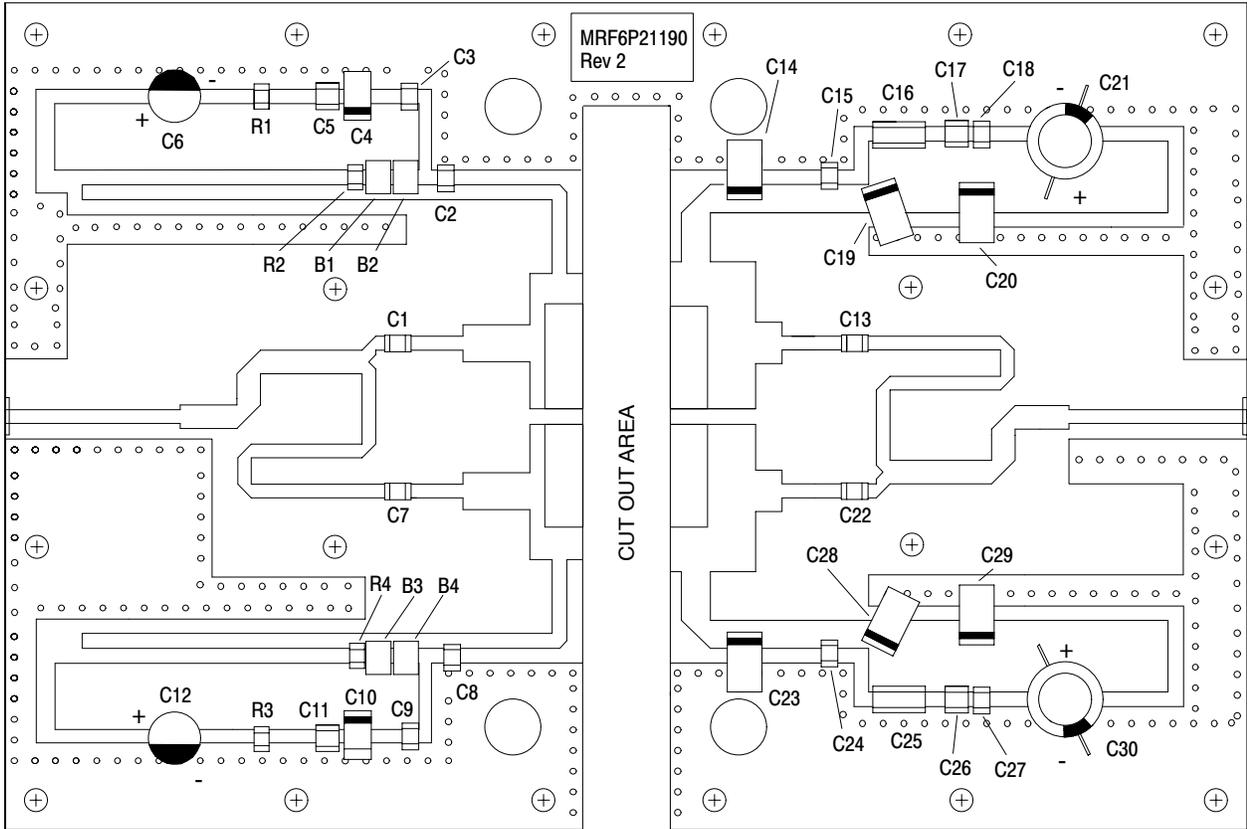
Freescale has begun the transition of marking Printed Circuit Boards (PCBs) with the Freescale Semiconductor signature/logo. PCBs may have either Motorola or Freescale markings during the transition period. These changes will have no impact on form, fit or function of the current product.

**Figure 2. MRF6P21190HR6 Test Circuit Component Layout**

TYPICAL CHARACTERISTICS
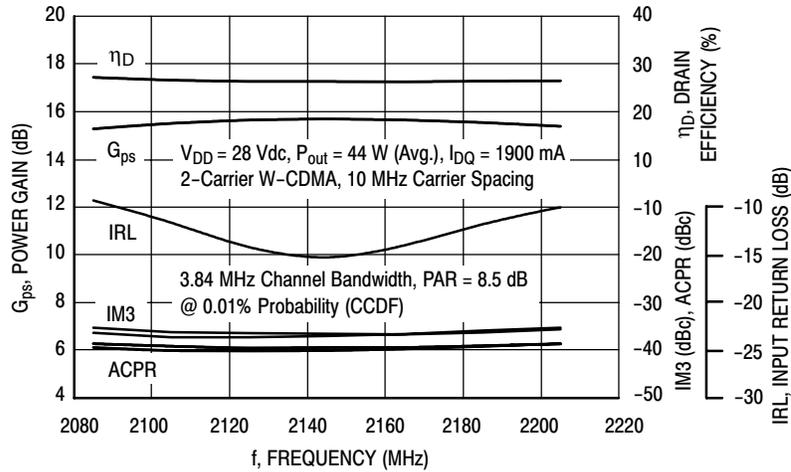
**Figure 3. 2‑Carrier W‑CDMA Broadband Performance @ P_out = 44 Watts Avg.**
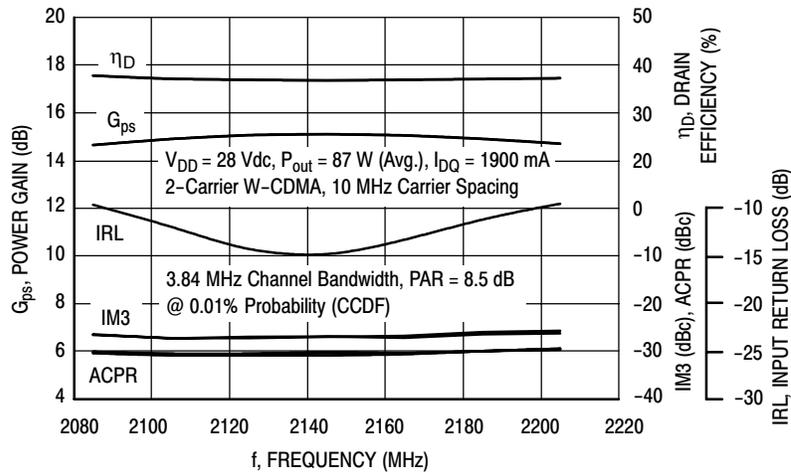
Figure 4. 2‑Carrier W‑CDMA Broadband Performance @ P_out = 87 Watts Avg.
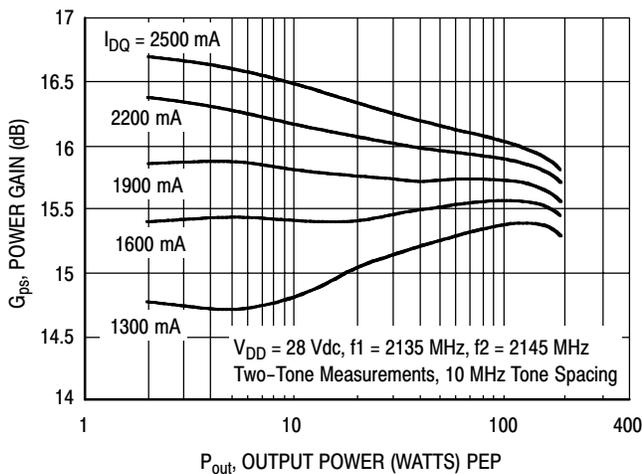
Figure 5. Two‑Tone Power Gain versus Output Power
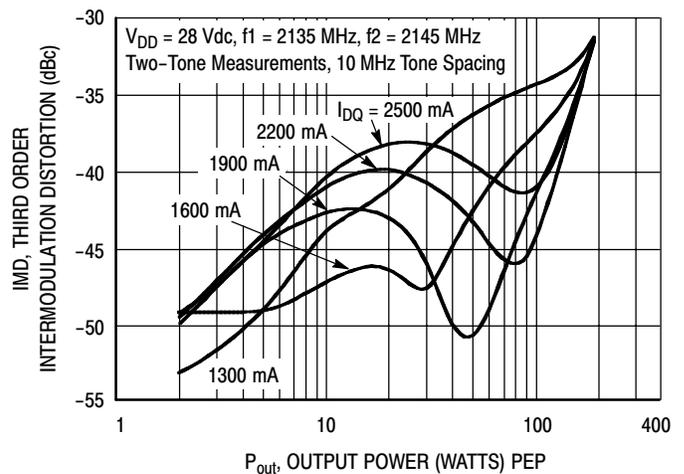
Figure 6. Third Order Intermodulation Distortion versus Output Power

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V_{DD} = 28 Vdc, P_{out} = 190 W (PEP), I_{DQ} = 1900 mA
Two−Tone Measurements, Center Frequency = 2140 MHz

3rd Order

5th Order

7th Order
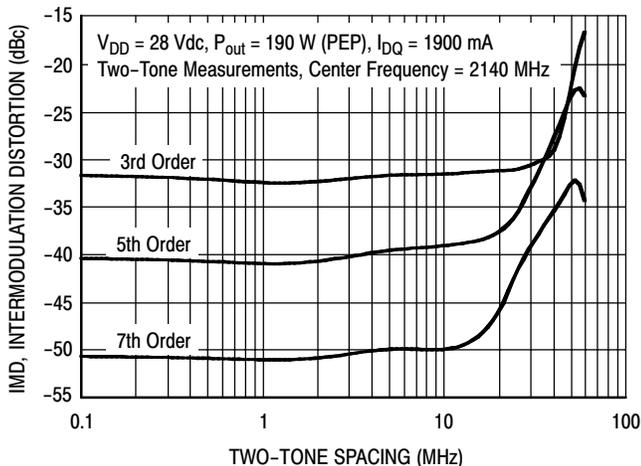
**Figure 7. Intermodulation Distortion Products
versus Tone Spacing**

P3dB = 54.45 dBm (279 W)

Ideal

P1dB = 53.7 dBm (233 W)

Actual

V_{DD} = 28 Vdc, I_{DQ} = 1900 mA
Pulsed CW, 8 μsec(on), 1 msec(off)
f = 2140 MHz
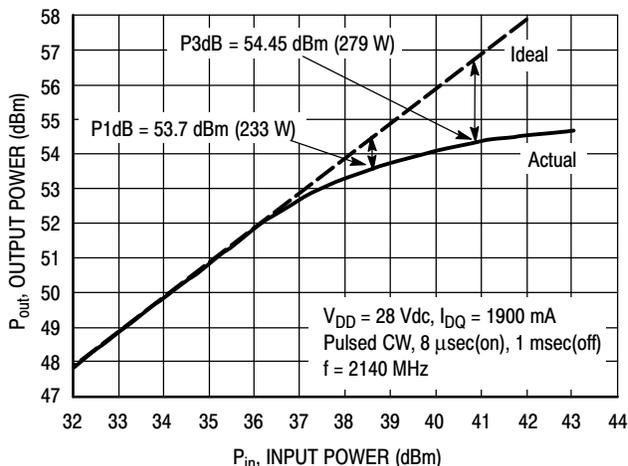
**Figure 8. Pulse CW Output Power versus
Input Power**

V_{DD} = 28 Vdc, I_{DQ} = 1900 mA
f1 = 2135 MHz, f2 = 2145 MHz
2−Carrier W−CDMA, 10 MHz
Carrier Spacing, 3.84 MHz Channel Bandwidth
PAR = 8.5 dB @ 0.01% Probability (CCDF)

η_D
IM3
ACPR
G_{ps}
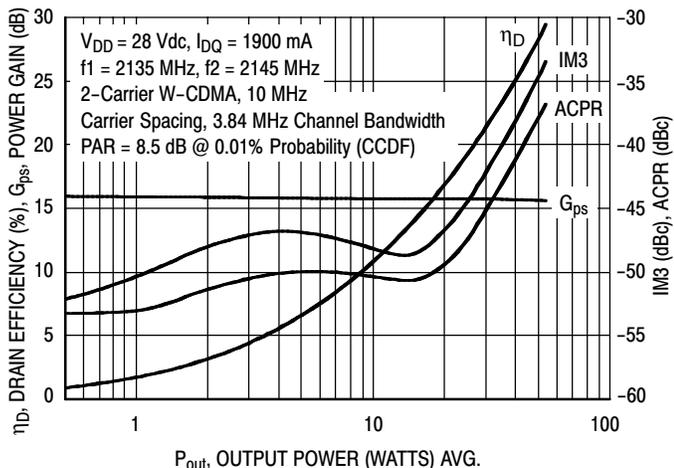
**Figure 9. 2-Carrier W-CDMA ACPR, IM3,
Power Gain and Drain Efficiency
versus Output Power**

G_{ps}

η_D

V_{DD} = 28 Vdc
I_{DQ} = 1900 mA
f = 2140 MHz
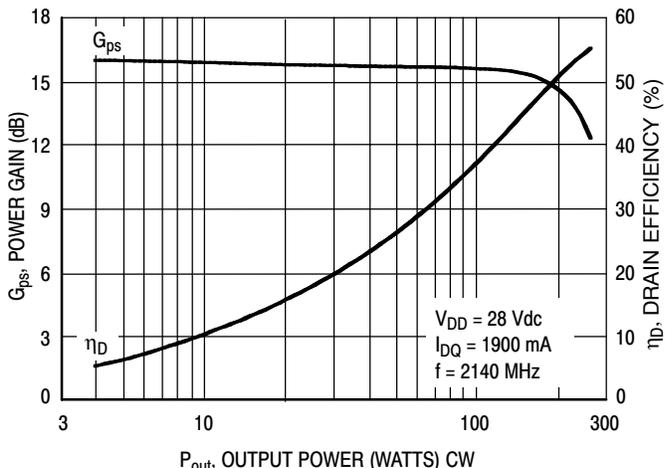
**Figure 10. Power Gain and Drain Efficiency
versus CW Output Power**

V_{DD} = 28 V

24 V

20 V

I_{DQ} = 1900 mA
f = 2140 MHz

16 V

12 V
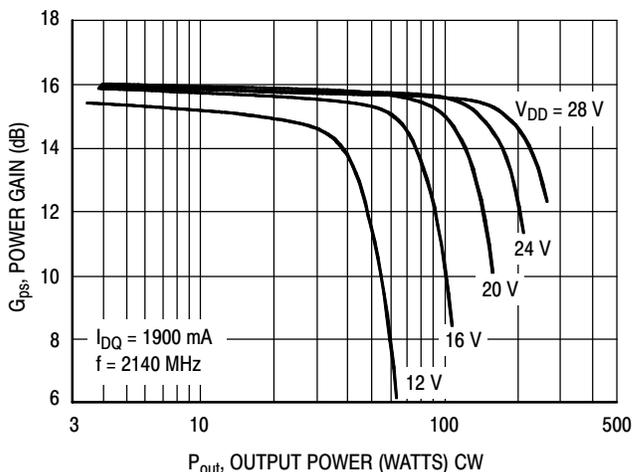
Figure 11. Power Gain versus Output Power

MRF6P21190HR6
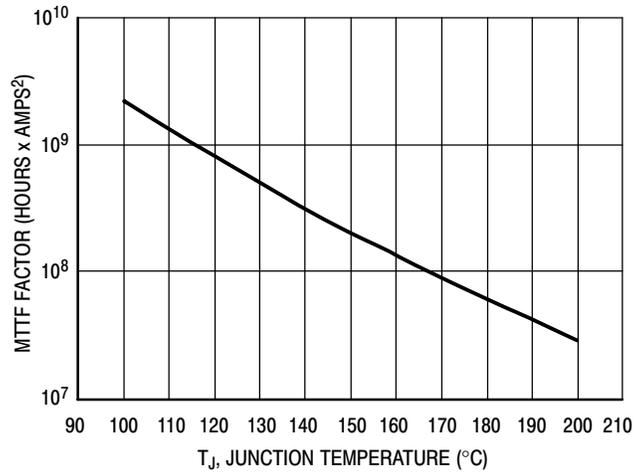
This above graph displays calculated MTTF in hours x ampere^2 drain current. Life tests at elevated temperatures have correlated to better than $\pm 10\%$ of the theoretical prediction for metal failure. Divide MTTF factor by I_D^2 for MTTF in a particular application.

**Figure 12. MTTF Factor versus Junction Temperature**

W‑CDMA TEST SIGNAL

W–CDMA. 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
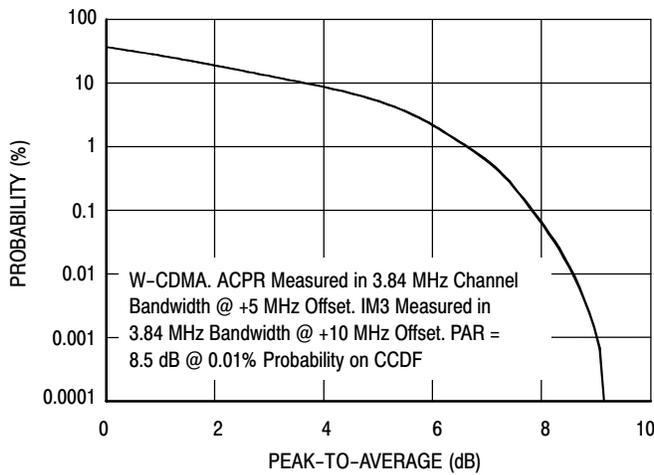
Figure 13. CCDF W‑CDMA 3GPP, Test Model 1, 64 DPCH, 67% Clipping, Single‑Carrier Test Signal
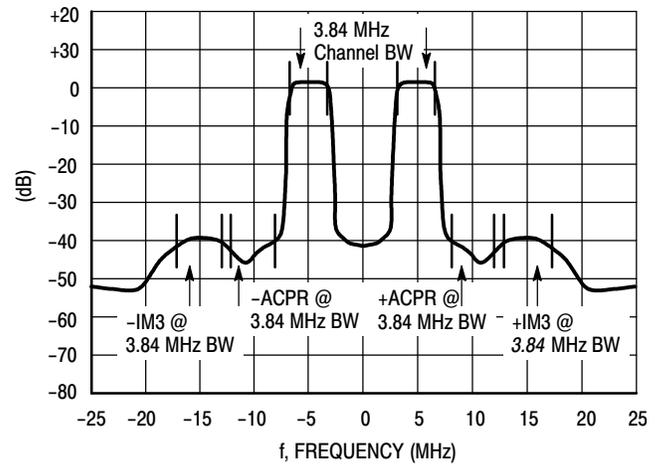
Figure 14. 2-Carrier W-CDMA Spectrum

MRF6P21190HR6
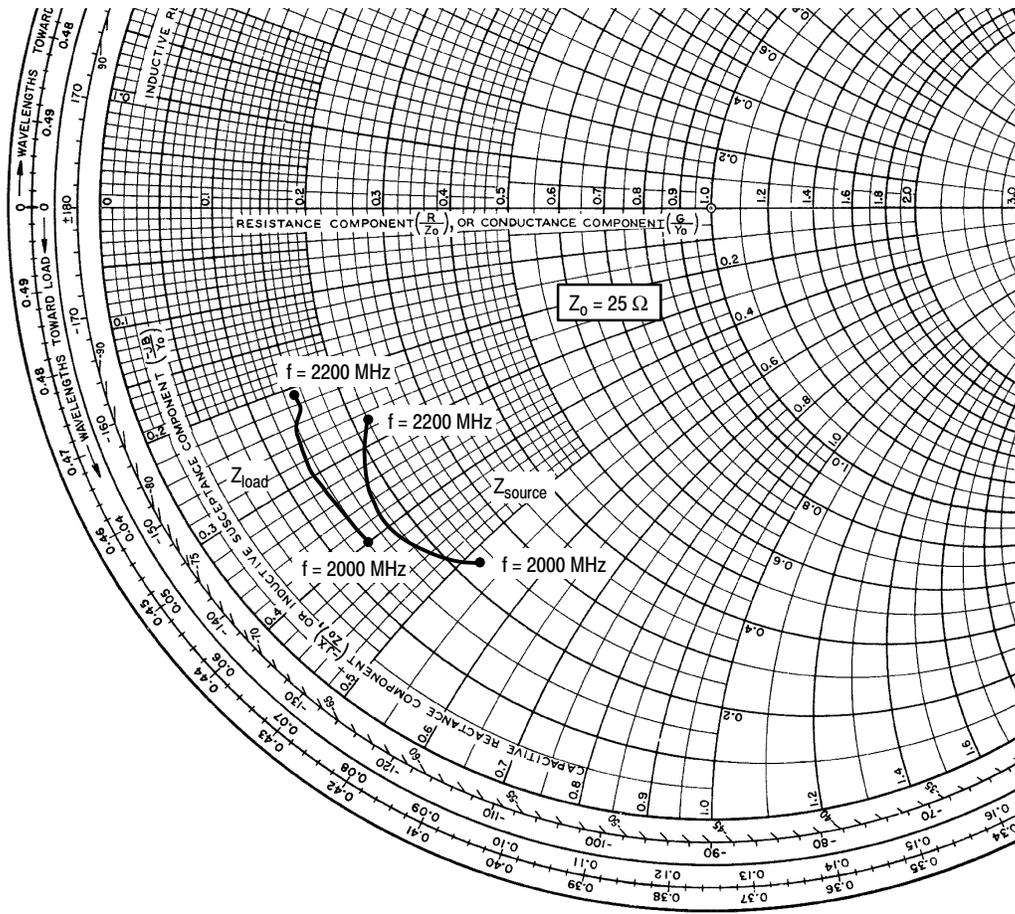
V_{DD} = 28 Vdc, I_{DQ} = 1900 mA, P_{out} = 44 W Avg.

f MHz	Z_{source} Ω	Z_{load} Ω
2000	5.63 - j12.88	3.43 - j10.06
2110	4.36 - j10.02	3.22 - j7.13
2140	4.56 - j8.49	3.39 - j6.07
2170	5.11 - j7.41	3.76 - j5.45
2200	5.42 - j6.67	3.69 - j5.16

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.
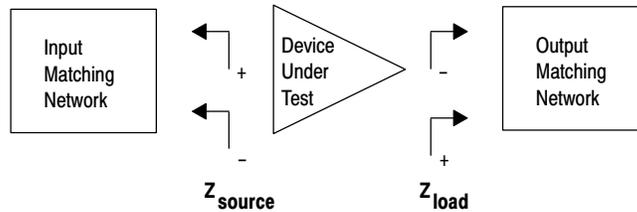
Figure 15. Series Equivalent Source and Load Impedance

NOTES

NOTES

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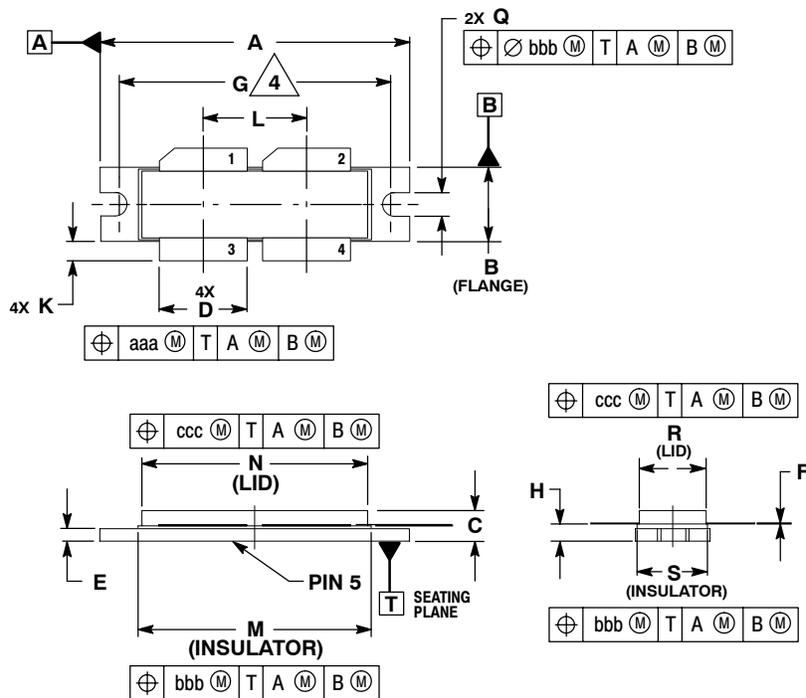
NOTES:
1. INTERPRET DIMENSIONS AND TOLERANCES PER ASME Y14.5M–1994.
2. CONTROLLING DIMENSION: INCH.
3. DIMENSION H IS MEASURED 0.030 (0.762) AWAY FROM PACKAGE BODY.
4. RECOMMENDED BOLT CENTER DIMENSION OF 1.52 (38.61) BASED ON M3 SCREW.

DIM	INCHES		MILLIMETERS	
	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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How to Reach Us:

Home Page:
www.freescale.com

E-mail:
support@freescale.com

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
2 Dai King Street
Tai Po Industrial Estate
Tai Po, N.T., Hong Kong
+800 2666 8080
support.asia@freescale.com

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