

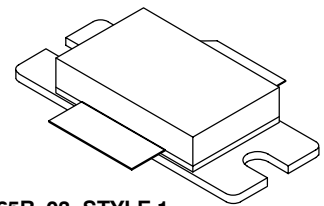
**The RF MOSFET Line**  
**RF Power Field Effect Transistors**  
**N-Channel Enhancement-Mode Lateral MOSFETs**

**MRF5S21130R3**  
**MRF5S21130SR3**

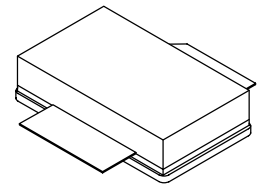
Designed for W-CDMA base station applications at frequencies from 2110 to 2170 MHz. Suitable for TDMA, CDMA and multicarrier amplifier applications. To be used in Class AB for PCN - PCS/cellular radio and WLL applications.

- Typical 2-carrier W-CDMA Performance for  $V_{DD} = 28$  Volts,  $I_{DQ} = 1200$  mA,  $f_1 = 2135$  MHz,  $f_2 = 2145$  MHz, Channel Bandwidth = 3.84 MHz, Adjacent Channels Measured over 3.84 MHz BW @  $f_1 - 5$  MHz and  $f_2 + 5$  MHz, Distortion Products Measured over a 3.84 MHz BW @  $f_1 - 10$  MHz and  $f_2 + 10$  MHz, Peak/Avg. = 8.5 dB @ 0.01% Probability on CCDF.
  - Output Power — 28 Watts Avg.
  - Power Gain — 13.5 dB
  - Efficiency — 26%
  - IM3 — -37 dBc
  - ACPR — -39 dBc
- Internally Matched, Controlled Q, for Ease of Use
- High Gain, High Efficiency and High Linearity
- Integrated ESD Protection
- Designed for Maximum Gain and Insertion Phase Flatness
- Capable of Handling 10:1 VSWR, @ 28 Vdc, 2140 MHz, 92 Watts CW Output Power
- Excellent Thermal Stability
- Characterized with Series Equivalent Large-Signal Impedance Parameters
- Qualified Up to a Maximum of 32  $V_{DD}$  Operation
- In Tape and Reel. R3 Suffix = 250 Units per 56 mm, 13 inch Reel.

**2170 MHz, 28 W AVG.,**  
**2 x W-CDMA, 28 V**  
**LATERAL N-CHANNEL**  
**RF POWER MOSFETs**



**CASE 465B-03, STYLE 1**  
**NI-880**  
**MRF5S21130R3**



**CASE 465C-02, STYLE 1**  
**NI-880S**  
**MRF5S21130SR3**

**MAXIMUM RATINGS**

Rating	Symbol	Value	Unit
Drain-Source Voltage	$V_{DSS}$	65	Vdc
Gate-Source Voltage	$V_{GS}$	-0.5, +15	Vdc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above $25^\circ\text{C}$	$P_D$	315 2	Watts $\text{W}/^\circ\text{C}$
Storage Temperature Range	$T_{stg}$	- 65 to +150	$^\circ\text{C}$
Operating Junction Temperature	$T_J$	200	$^\circ\text{C}$
CW Operation	CW	92	Watts

**THERMAL CHARACTERISTICS**

Characteristic	Symbol	Value (1,2)	Unit
Thermal Resistance, Junction to Case Case Temperature $80^\circ\text{C}$ , 92 W CW Case Temperature $80^\circ\text{C}$ , 28 W CW	$R_{\theta JC}$	0.54 0.56	$^\circ\text{C}/\text{W}$

- (1) MTTF calculator available at <http://www.motorola.com/semiconductors/rf>. Select Tools/Software/Application Software/Calculators to access the MTTF calculators by product.
- (2) Refer to AN1955/D, *Thermal Measurement Methodology of RF Power Amplifiers*. Go to <http://www.motorola.com/semiconductors/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.

# Freescale Semiconductor, Inc.

## ESD PROTECTION CHARACTERISTICS

Test Conditions	Class
Human Body Model	2 (Minimum)
Machine Model	M4 (Minimum)
Charge Device Model	C7 (Minimum)

## ELECTRICAL CHARACTERISTICS (T<sub>C</sub> = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
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### OFF CHARACTERISTICS

Zero Gate Voltage Drain Leakage Current (V <sub>DS</sub> = 65 Vdc, V <sub>GS</sub> = 0 Vdc)	I <sub>DSS</sub>	—	—	10	μA <sub>dc</sub>
Zero Gate Voltage Drain Leakage Current (V <sub>DS</sub> = 28 Vdc, V <sub>GS</sub> = 0 Vdc)	I <sub>DSS</sub>	—	—	1	μA <sub>dc</sub>
Gate-Source Leakage Current (V <sub>GS</sub> = 5 Vdc, V <sub>DS</sub> = 0 Vdc)	I <sub>GSS</sub>	—	—	1	μA <sub>dc</sub>

### ON CHARACTERISTICS

Gate Threshold Voltage (V <sub>DS</sub> = 10 Vdc, I <sub>D</sub> = 300 μA <sub>dc</sub> )	V <sub>GS(th)</sub>	2.5	2.7	3.5	Vdc
Gate Quiescent Voltage (V <sub>DS</sub> = 28 Vdc, I <sub>D</sub> = 1200 mA <sub>dc</sub> )	V <sub>GS(Q)</sub>	—	3.7	—	Vdc
Drain-Source On-Voltage (V <sub>GS</sub> = 10 Vdc, I <sub>D</sub> = 3 A <sub>dc</sub> )	V <sub>DS(on)</sub>	—	0.26	0.3	Vdc
Forward Transconductance (V <sub>DS</sub> = 10 Vdc, I <sub>D</sub> = 3 A <sub>dc</sub> )	g <sub>fs</sub>	—	7.5	—	S

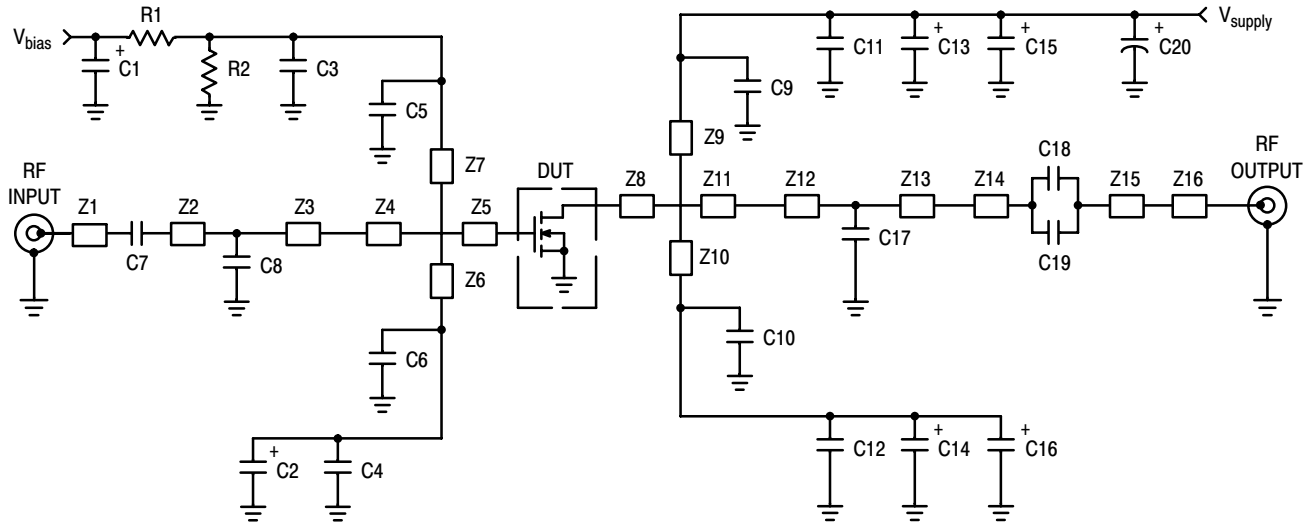
### DYNAMIC CHARACTERISTICS (1)

Reverse Transfer Capacitance (V <sub>DS</sub> = 28 Vdc ± 30 mV(rms) <sub>ac</sub> @ 1 MHz, V <sub>GS</sub> = 0 Vdc)	C <sub>rss</sub>	—	2.6	—	pF
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**FUNCTIONAL TESTS** (In Motorola Test Fixture, 50 ohm system) 2-carrier W-CDMA, 3.84 MHz Channel Bandwidth Carriers, ACPR and IM3 measured in 3.84 MHz Bandwidth. Peak/Avg. = 8.5 dB @ 0.01% Probability on CCDF.

Common-Source Amplifier Power Gain (V <sub>DD</sub> = 28 Vdc, P <sub>out</sub> = 28 W Avg., I <sub>DQ</sub> = 1200 mA, f <sub>1</sub> = 2112.5 MHz, f <sub>2</sub> = 2122.5 MHz and f <sub>1</sub> = 2157.5 MHz, f <sub>2</sub> = 2167.5 MHz)	G <sub>ps</sub>	12	13.5	—	dB
Drain Efficiency (V <sub>DD</sub> = 28 Vdc, P <sub>out</sub> = 28 W Avg., I <sub>DQ</sub> = 1200 mA, f <sub>1</sub> = 2112.5 MHz, f <sub>2</sub> = 2122.5 MHz and f <sub>1</sub> = 2157.5 MHz, f <sub>2</sub> = 2167.5 MHz)	η	24	26	—	%
Third Order Intermodulation Distortion (V <sub>DD</sub> = 28 Vdc, P <sub>out</sub> = 28 W Avg., I <sub>DQ</sub> = 1200 mA, f <sub>1</sub> = 2112.5 MHz, f <sub>2</sub> = 2122.5 MHz and f <sub>1</sub> = 2157.5 MHz, f <sub>2</sub> = 2167.5 MHz; IM3 measured over 3.84 MHz BW at f <sub>1</sub> -10 MHz and f <sub>2</sub> +10 MHz referenced to carrier channel power.)	IM3	—	-37	-35	dBc
Adjacent Channel Power Ratio (V <sub>DD</sub> = 28 Vdc, P <sub>out</sub> = 28 W Avg., I <sub>DQ</sub> = 1200 mA, f <sub>1</sub> = 2112.5 MHz, f <sub>2</sub> = 2122.5 MHz and f <sub>1</sub> = 2157.5 MHz, f <sub>2</sub> = 2167.5 MHz; ACPR measured over 3.84 MHz at f <sub>1</sub> -5 MHz and f <sub>2</sub> +5 MHz.)	ACPR	—	-39	-37	dBc
Input Return Loss (V <sub>DD</sub> = 28 Vdc, P <sub>out</sub> = 28 W Avg., I <sub>DQ</sub> = 1200 mA, f <sub>1</sub> = 2112.5 MHz, f <sub>2</sub> = 2122.5 MHz and f <sub>1</sub> = 2157.5 MHz, f <sub>2</sub> = 2167.5 MHz)	IRL	—	-12	-9	dB

(1) Part is internally matched both on input and output.



Z1	0.500" x 0.083" Microstrip	Z9, Z10	0.709" x 0.083" Microstrip
Z2	0.995" x 0.083" Microstrip	Z11	0.415" x 1.000" Microstrip
Z3	0.905" x 0.083" Microstrip	Z12	0.531" x 0.083" Microstrip
Z4	0.159" x 1.024" Microstrip	Z13	0.994" x 0.083" Microstrip
Z5	0.117" x 1.024" Microstrip	Z14, Z15	0.070" x 0.220" Microstrip
Z6, Z7	0.749" x 0.083" Microstrip	Z16	0.430" x 0.083" Microstrip
Z8	0.117" x 1.000" Microstrip	PCB	Taconic TLX8, 0.030", $\epsilon_r = 2.55$

Figure 1. MRF5S21130 Test Circuit Schematic

Table 1. MRF5S21130 Test Circuit Component Designations and Values

Part	Description	Value, P/N or DWG	Manufacturer
C1, C2, C13, C14, C15, C16	10 $\mu$ F, 35 V Tantalum Capacitors	293D1106X9035D	Vishay - Sprague
C3, C4, C11, C12	220 nF Chip Capacitors (1812)	1812Y224KXA	Vishay - Vitramon
C5, C6, C7, C9, C10, C18, C19	6.8 pF 100B Chip Capacitors	100B6R8CW	ATC
C8	0.1 pF 100B Chip Capacitor	100B0R1BW	ATC
C17	0.5 pF 100B Chip Capacitor	100B0R5BW	ATC
C20	220 $\mu$ F, 63 V Electrolytic Capacitor, Radial	13668221	Philips
R1, R2	1 k $\Omega$ , 1/4 W Chip Resistors		

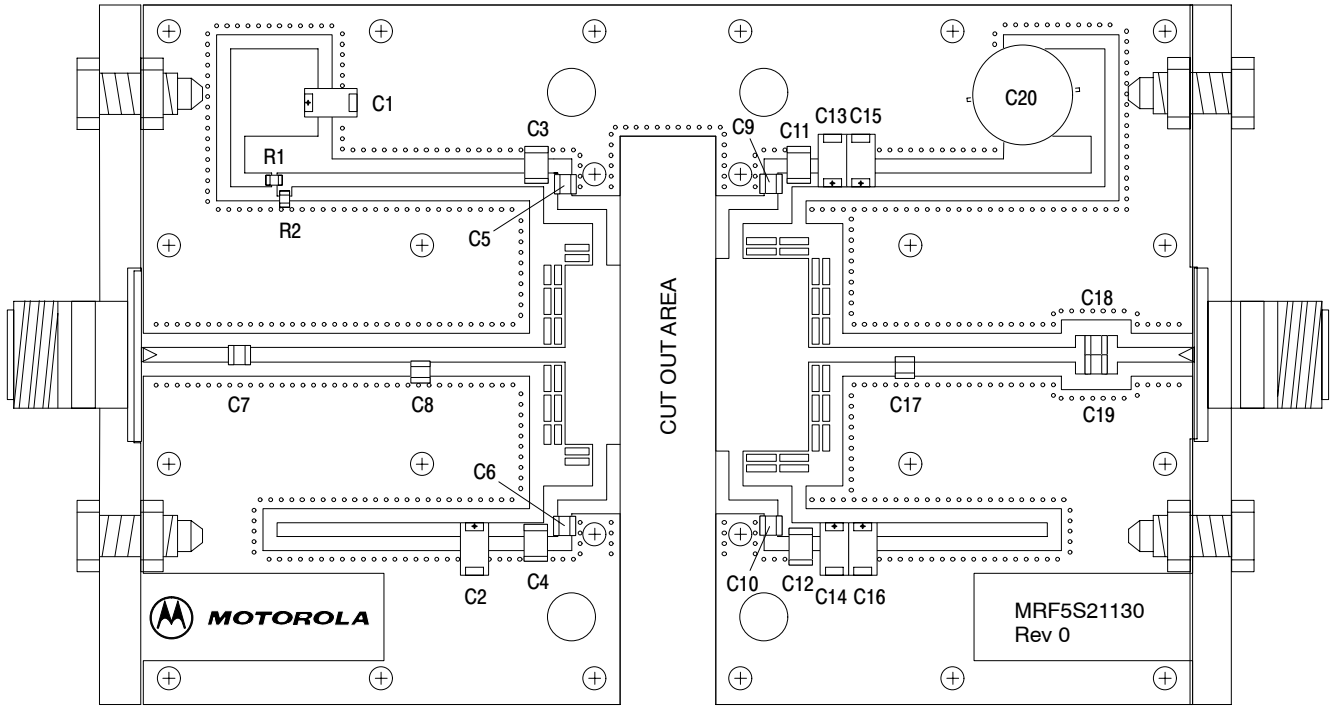


Figure 2. MRF5S21130 Test Circuit Component Layout

# Freescale Semiconductor, Inc.

## TYPICAL CHARACTERISTICS

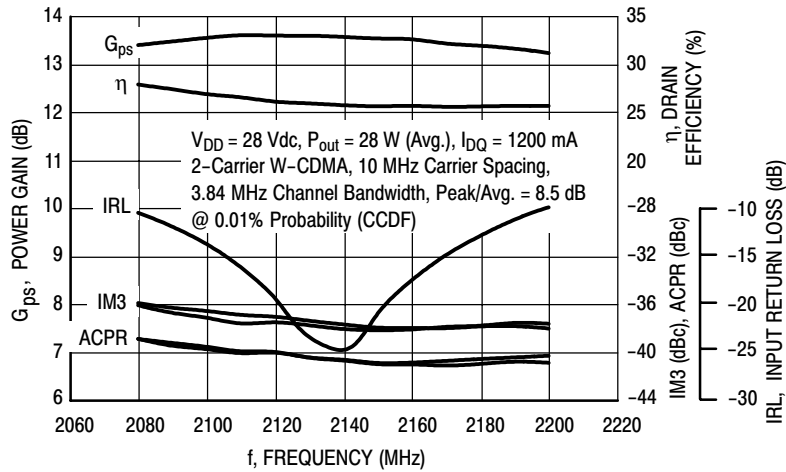


Figure 3. 2-Carrier W-CDMA Broadband Performance

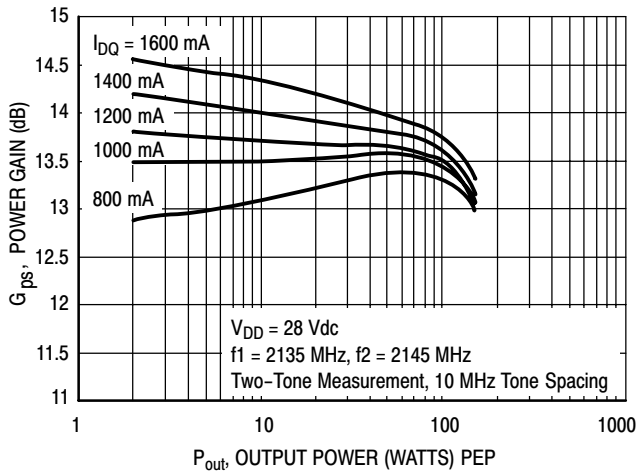


Figure 4. Two-Tone Power Gain versus Output Power

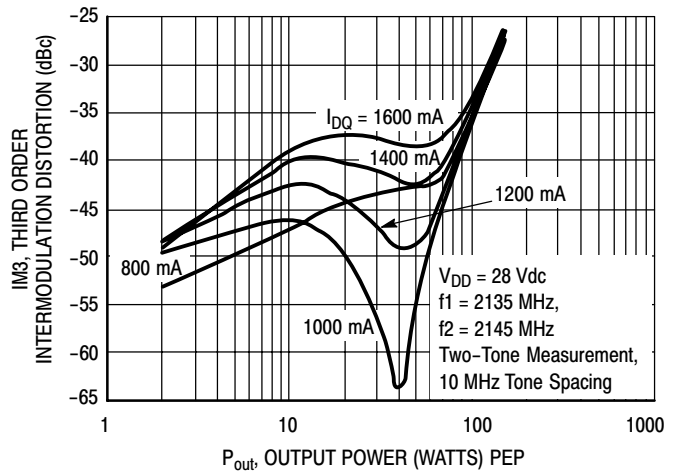


Figure 5. Third Order Intermodulation Distortion versus Output Power

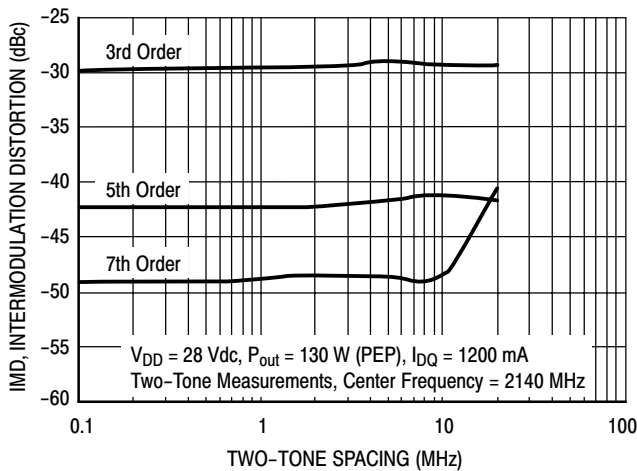


Figure 6. Intermodulation Distortion Products versus Tone Spacing

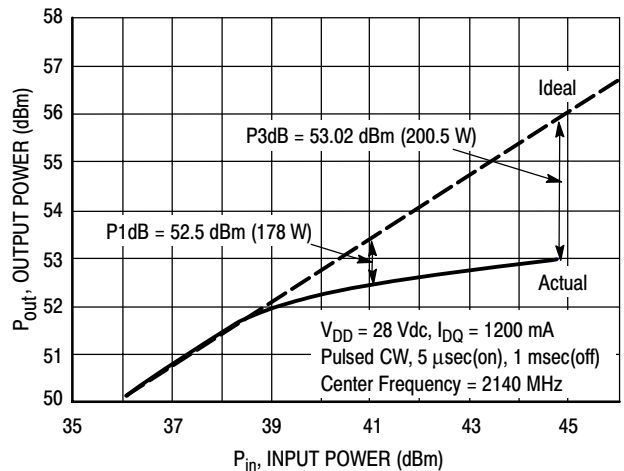
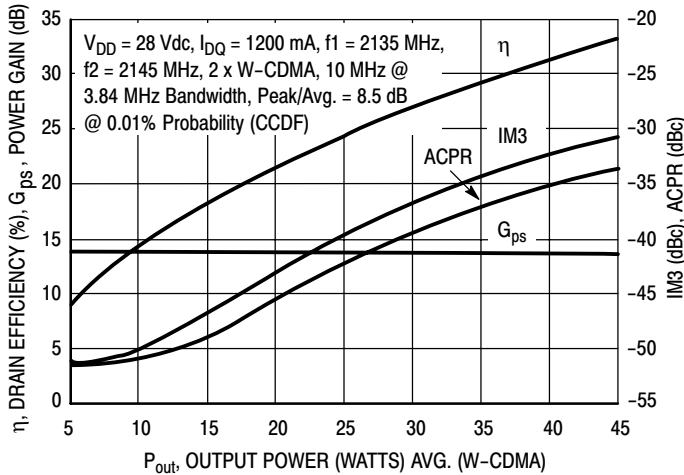
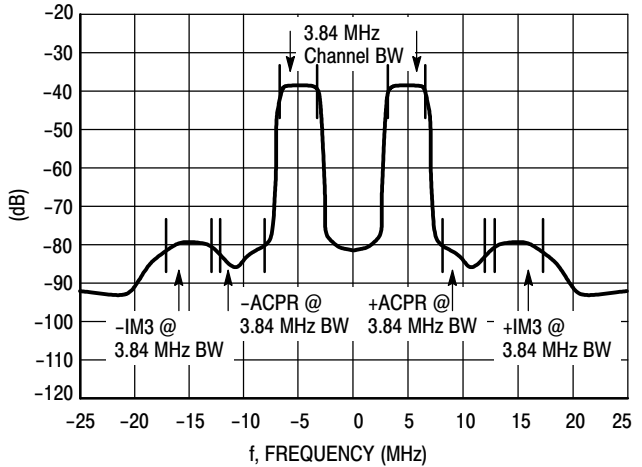


Figure 7. Pulse CW Output Power versus Input Power

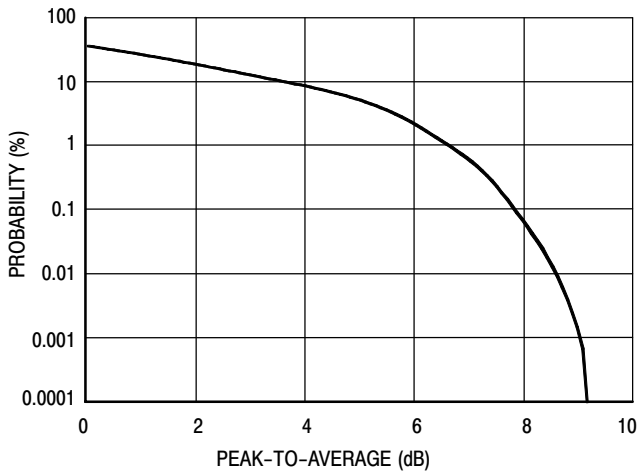
## TYPICAL CHARACTERISTICS



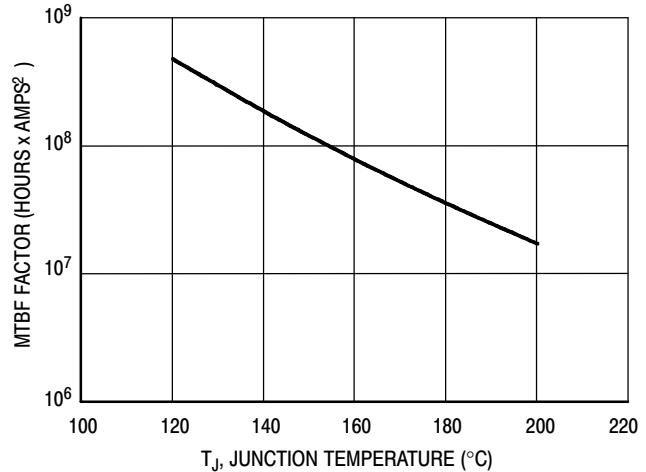
**Figure 8. 2-Carrier W-CDMA ACPR, IM3, Power Gain and Drain Efficiency versus Output Power**



**Figure 9. 2-Carrier W-CDMA Spectrum**

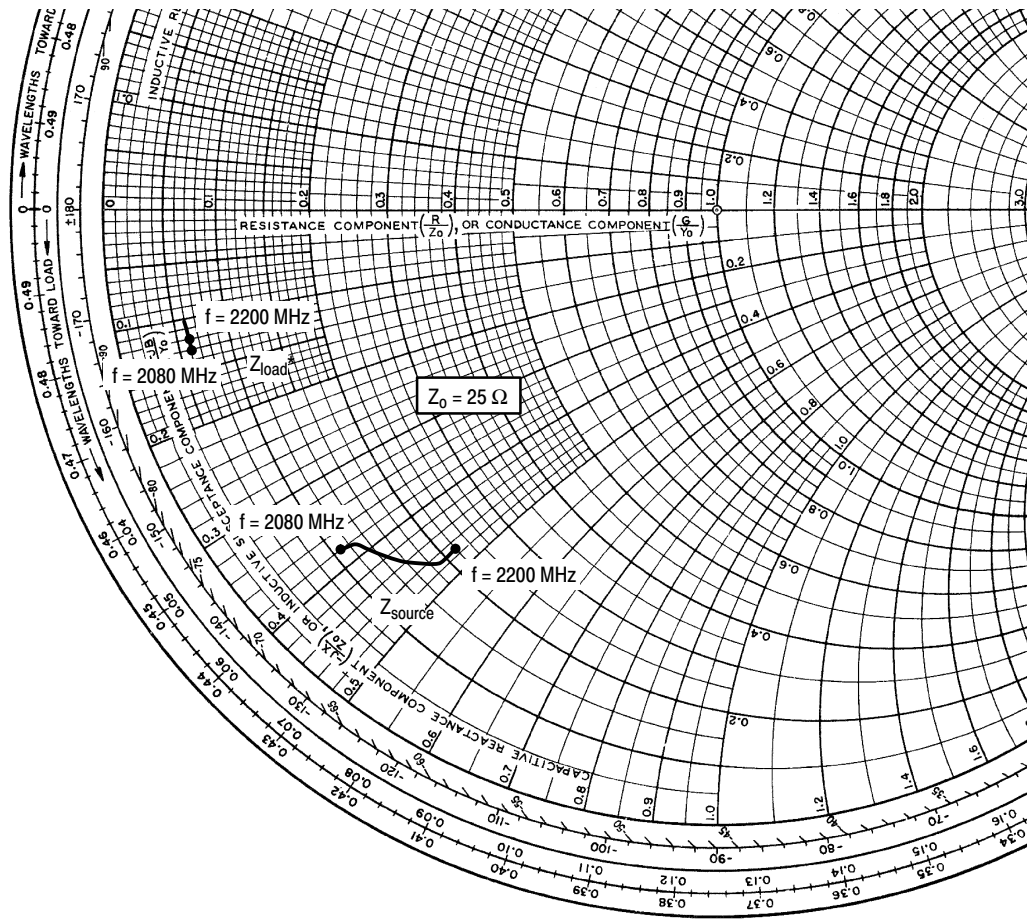


**Figure 10. CCDF W-CDMA 3GPP, Test Model 1, 64 DPCH, 67% Clipping, Single Carrier Test Signal**



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

**Figure 11. MTBF Factor versus Junction Temperature**



$V_{DD} = 28 \text{ Vdc}$ ,  $I_{DQ} = 1200 \text{ mA}$ ,  $P_{out} = 28 \text{ W Avg.}$

f MHz	$Z_{source}$ $\Omega$	$Z_{load}$ $\Omega$
2080	$2.87 - j9.49$	$1.51 - j2.97$
2110	$3.13 - j9.86$	$1.52 - j2.54$
2140	$4.05 - j10.90$	$1.59 - j2.68$
2170	$4.80 - j11.75$	$1.62 - j2.70$
2200	$5.55 - j11.87$	$1.54 - j3.13$

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

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

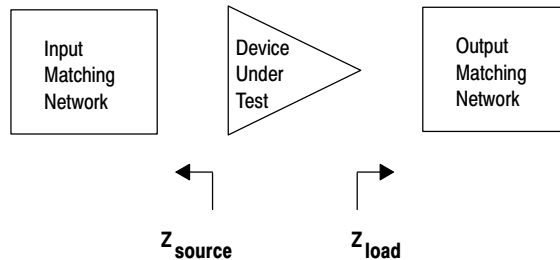


Figure 12. Series Equivalent Input and Output Impedance

**NOTES**



**NOTES**

**NOTES**

# Freescale Semiconductor, Inc.

## PACKAGE DIMENSIONS

**NOTES:**

- DIMENSIONING AND TOLERANCING PER ANSI Y14.5M-1994.
- CONTROLLING DIMENSION: INCH.
- DIMENSION H IS MEASURED 0.030 (0.762) AWAY FROM PACKAGE BODY.
- DELETED

DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	1.335	1.345	33.91	34.16
B	0.535	0.545	13.6	13.8
C	0.147	0.200	3.73	5.08
D	0.495	0.505	12.57	12.83
E	0.035	0.045	0.89	1.14
F	0.003	0.006	0.08	0.15
G	1.100 BSC		27.94 BSC	
H	0.057	0.067	1.45	1.70
K	0.170	0.210	4.32	5.33
M	0.872	0.888	22.15	22.55
N	0.871	0.889	19.30	22.60
Q	∅ 0.118	∅ 0.138	∅ 3.00	∅ 3.51
R	0.515	0.525	13.10	13.30
S	0.515	0.525	13.10	13.30
aaa	0.007 REF		0.178 REF	
bbb	0.010 REF		0.254 REF	
ccc	0.015 REF		0.381 REF	

**STYLE 1:**  
 PIN 1. DRAIN  
 2. GATE  
 3. SOURCE

**CASE 465B-03  
 ISSUE B  
 NI-880  
 MRF5S21130R3**

**NOTES:**

- DIMENSIONING AND TOLERANCING PER ANSI Y14.5M-1994.
- CONTROLLING DIMENSION: INCH.
- DIMENSION H IS MEASURED 0.030 (0.762) AWAY FROM PACKAGE BODY.

DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.905	0.915	22.99	23.24
B	0.535	0.545	13.60	13.80
C	0.147	0.200	3.73	5.08
D	0.495	0.505	12.57	12.83
E	0.035	0.045	0.89	1.14
F	0.003	0.006	0.08	0.15
H	0.057	0.067	1.45	1.70
K	0.170	0.210	4.32	5.33
M	0.872	0.888	22.15	22.55
N	0.871	0.889	19.30	22.60
R	0.515	0.525	13.10	13.30
S	0.515	0.525	13.10	13.30
aaa	0.007 REF		0.178 REF	
bbb	0.010 REF		0.254 REF	
ccc	0.015 REF		0.381 REF	

**STYLE 1:**  
 PIN 1. DRAIN  
 2. GATE  
 3. SOURCE

**CASE 465C-02  
 ISSUE A  
 NI-880S  
 MRF5S21130SR3**

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