

RF Power Field Effect Transistors

N-Channel Enhancement-Mode Lateral MOSFETs

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, $I_{DQ} = 1300$ mA, $P_{out} = 33$ Watts Avg., Full Frequency Band, Channel Bandwidth = 3.84 MHz, Peak/Avg. = 8.5 dB @ 0.01% Probability on CCDF.
Power Gain — 12.5 dB
Efficiency — 25%
IM3 @ 10 MHz Offset — -37 dBc @ 3.84 MHz Channel Bandwidth
ACPR @ 5 MHz Offset — -39 dBc @ 3.84 MHz Channel Bandwidth
- Capable of Handling 10:1 VSWR, @ 28 Vdc, 2140 MHz, 125 Watts CW Output Power
- Characterized with Series Equivalent Large-Signal Impedance Parameters
- Internally Matched, Controlled Q, for Ease of Use
- Qualified Up to a Maximum of 32 V_{DD} Operation
- Integrated ESD Protection
- Lower Thermal Resistance Package
- Low Gold Plating Thickness on Leads, 40 μ ” Nominal.
- In Tape and Reel. R3 Suffix = 250 Units per 56 mm, 13 inch Reel.

MRF5S21150HR3
MRF5S21150HSR3

2170 MHz, 33 W AVG., 28 V
2 x W-CDMA
LATERAL N-CHANNEL
RF POWER MOSFETs

CASE 465B-03, STYLE 1
NI-880
MRF5S21150HR3

CASE 465C-02, STYLE 1
NI-880S
MRF5S21150HSR3

Table 1. Maximum Ratings

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DSS}	-0.5, +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	380 2.2	W 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	125	W

Table 2. Thermal Characteristics

Characteristic	Symbol	Value (1,2)	Unit
Thermal Resistance, Junction to Case Case Temperature 80 $^\circ\text{C}$, 100 W CW Case Temperature 75 $^\circ\text{C}$, 33 W CW	$R_{\theta JC}$	0.46 0.47	$^\circ\text{C}/\text{W}$

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/D, *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 Conditions	Class
Human Body Model	1 (Minimum)
Machine Model	M3 (Minimum)
Charge Device Model	C7 (Minimum)

Table 4. Electrical Characteristics ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
Off Characteristics					
Zero Gate Voltage Drain Leakage Current ($V_{DS} = 65\text{ Vdc}$, $V_{GS} = 0\text{ Vdc}$)	I_{DSS}	—	—	10	μA_{dc}
Zero Gate Voltage Drain Leakage Current ($V_{DS} = 28\text{ Vdc}$, $V_{GS} = 0\text{ Vdc}$)	I_{DSS}	—	—	1	μA_{dc}
Gate-Source Leakage Current ($V_{GS} = 5\text{ Vdc}$, $V_{DS} = 0\text{ Vdc}$)	I_{GSS}	—	—	1	μA_{dc}

On Characteristics

Gate Threshold Voltage ($V_{DS} = 10\text{ Vdc}$, $I_D = 360\ \mu\text{A}_{dc}$)	$V_{GS(th)}$	2.5	—	3.5	Vdc
Gate Quiescent Voltage ($V_{DS} = 28\text{ Vdc}$, $I_D = 1300\ \text{mA}_{dc}$)	$V_{GS(Q)}$	—	3.7	—	Vdc
Drain-Source On-Voltage ($V_{GS} = 10\text{ Vdc}$, $I_D = 3.6\ \text{A}_{dc}$)	$V_{DS(on)}$	—	0.26	0.3	Vdc
Forward Transconductance ($V_{DS} = 10\text{ Vdc}$, $I_D = 3.6\ \text{A}_{dc}$)	g_{fs}	—	9	—	S

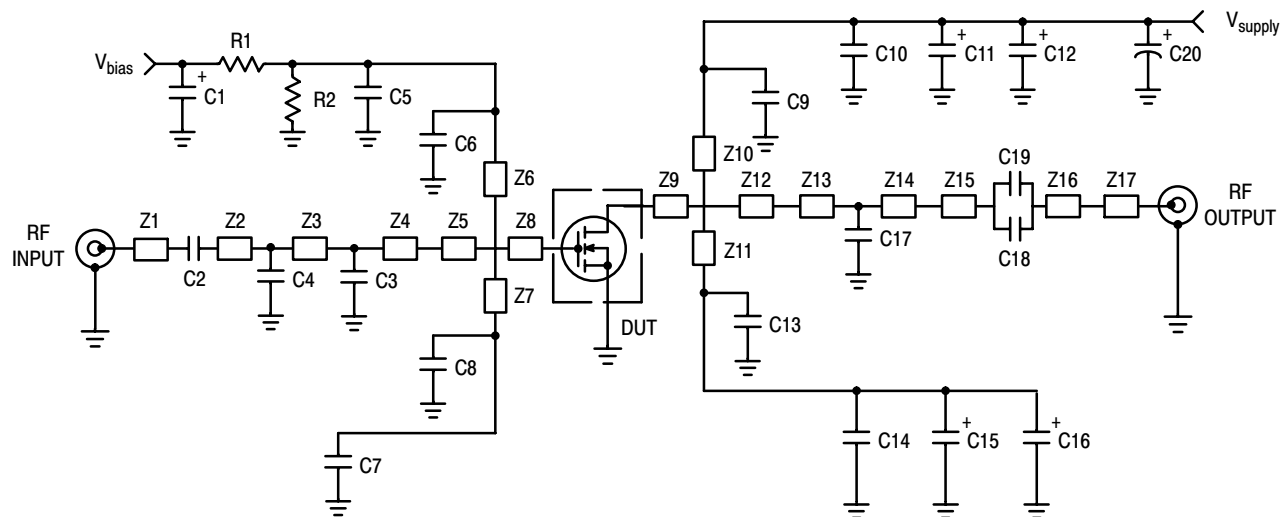
Dynamic Characteristics ⁽¹⁾

Reverse Transfer Capacitance ($V_{DS} = 28\text{ Vdc} \pm 30\ \text{mV(rms)ac}$ @ 1 MHz, $V_{GS} = 0\text{ Vdc}$)	C_{rss}	—	3.2	—	pF
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Functional Tests (In Freescale Test Fixture, 50 ohm system) $V_{DD} = 28\text{ Vdc}$, $I_{DQ} = 1300\ \text{mA}$, $P_{out} = 33\ \text{W Avg.}$, $f_1 = 2112.5\ \text{MHz}$, $f_2 = 2122.5\ \text{MHz}$ and $f_1 = 2157.5\ \text{MHz}$, $f_2 = 2167.5\ \text{MHz}$, 2-carrier W-CDMA, 3.84 MHz Channel Bandwidth Carriers. ACPR measured in 3.84 MHz Channel Bandwidth @ $\pm 5\ \text{MHz}$ Offset. IM3 measured in 3.84 MHz Bandwidth @ $\pm 10\ \text{MHz}$ Offset. Peak/Avg. = 8.5 dB @ 0.01% Probability on CCDF.

Power Gain	G_{ps}	11	12.5	—	dB
Drain Efficiency	η_D	23	25	—	%
Intermodulation Distortion	IM3	—	-37	-35	dBc
Adjacent Channel Power Ratio	ACPR	—	-39	-37	dBc
Input Return Loss	IRL	—	-12	-9	dB

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

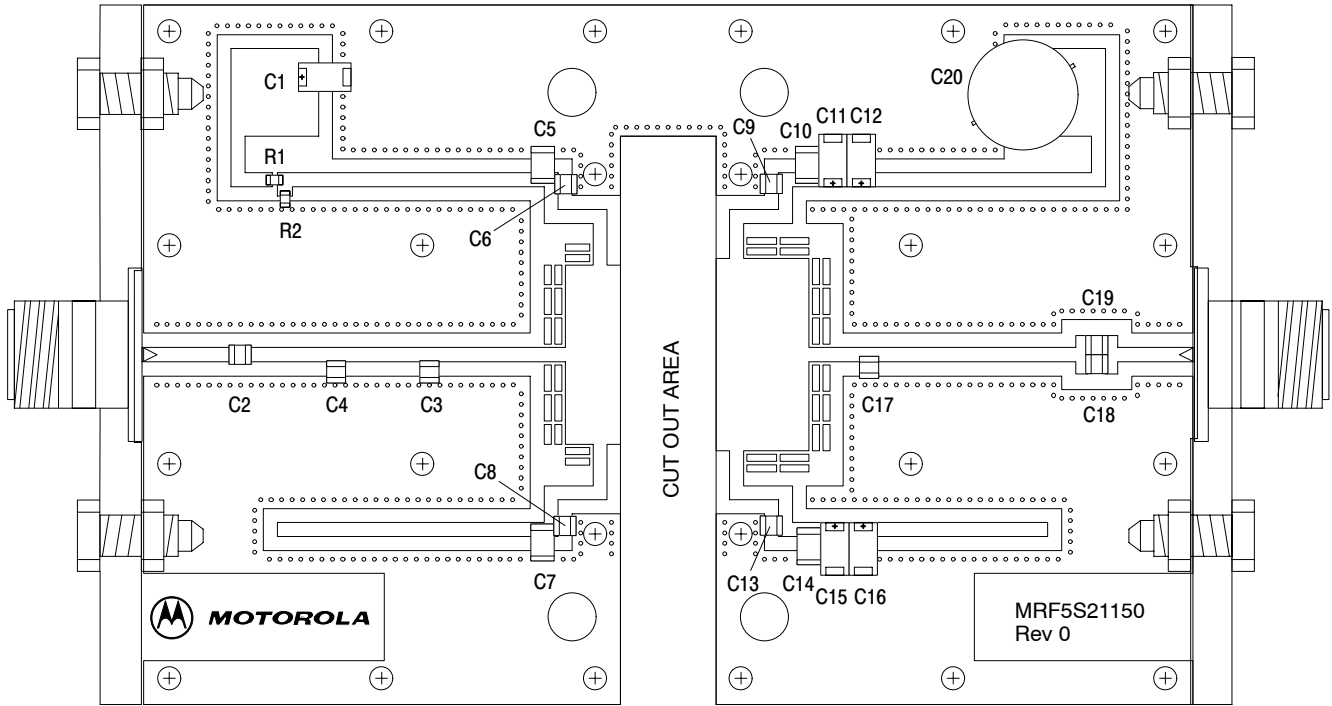


Z1	0.500" x 0.083" Microstrip	Z10, Z11	0.709" x 0.083" Microstrip
Z2	0.505" x 0.083" Microstrip	Z12	0.415" x 1.100" Microstrip
Z3	0.536" x 0.083" Microstrip	Z13	0.874" x 0.083" Microstrip
Z4	0.776" x 0.083" Microstrip	Z14	1.182" x 0.083" Microstrip
Z5	0.119" x 1.024" Microstrip	Z15, Z16	0.070" x 0.220" Microstrip
Z6, Z7	0.749" x 0.083" Microstrip	Z17	0.430" x 0.083" Microstrip
Z8	0.117" x 1.024" Microstrip	PCB	Taconic TLX8, 0.030", $\epsilon_r = 2.55$
Z9	0.117" x 1.100" Microstrip		

Figure 1. MRF5S21150HR3(HSR3) Test Circuit Schematic

Table 5. MRF5S21150HR3(HSR3) Test Circuit Component Designations and Values

Part	Description	Part Number	Manufacturer
C1	22 μ F, 35 V Tantalum Capacitor	TAJE226M035R	AVX
C2, C6, C8, C9, C13, C18, C19	6.8 pF 100B Chip Capacitors	100B6R8CW	ATC
C3, C4	1.8 pF 100B Chip Capacitors	100B1R8BW	ATC
C5, C7, C10, C14	220 nF Chip Capacitors (1812)	1812Y224KXA	Vishay - Vitramon
C11, C12, C15, C16	10 μ F, 35 V Tantalum Capacitors	293D1106X9035D	Vishay - Sprague
C17	0.3 pF Chip Capacitor	100B0R3BW	ATC
C20	470 μ F, 63 V Electrolytic Capacitor, Radial	13661471	Philips
R1, R2	10 k Ω , 1/4 W Chip Resistors		



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. MRF5S21150HR3(HSR3) Test Circuit Component Layout

TYPICAL CHARACTERISTICS

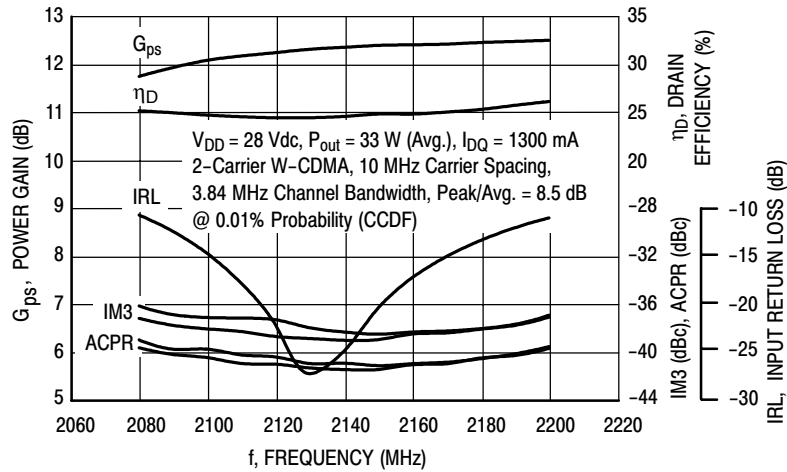


Figure 3. 2-Carrier W-CDMA Broadband Performance @ $P_{out} = 33$ Watts Avg.

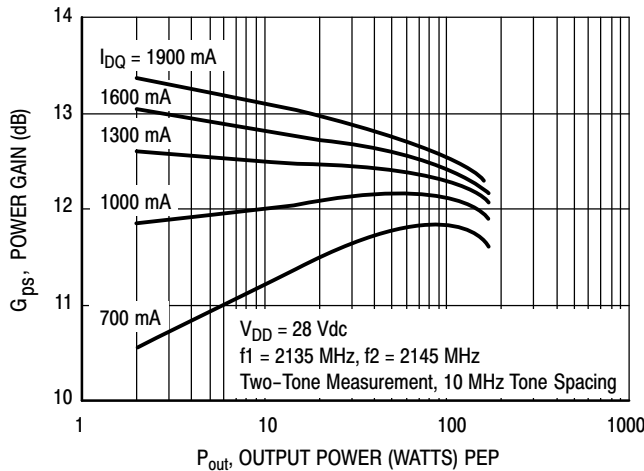


Figure 4. Two-Tone Power Gain versus Output Power

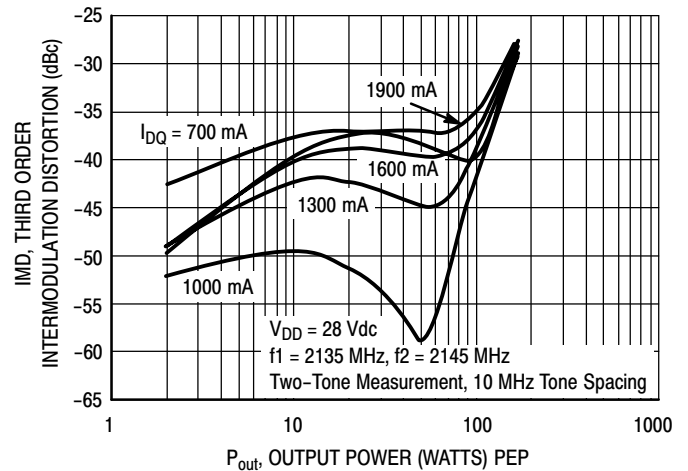


Figure 5. Third Order Intermodulation Distortion versus Output Power

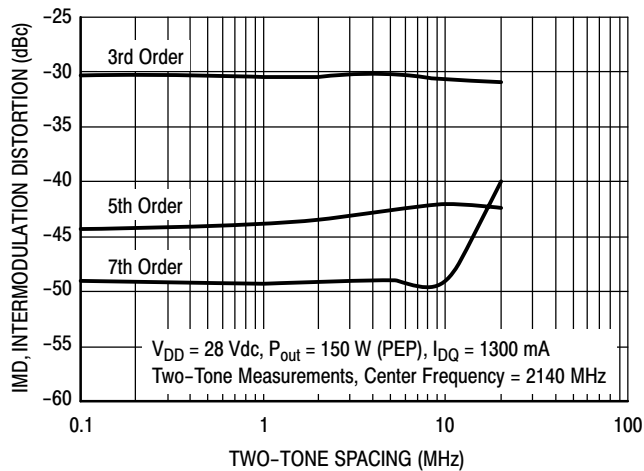


Figure 6. Intermodulation Distortion Products versus Tone Spacing

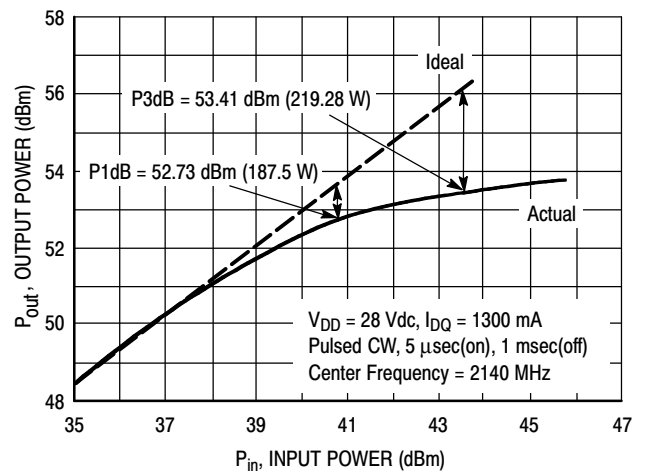


Figure 7. Pulse CW Output Power versus Input Power

MRF5S21150HR3 MRF5S21150HSR3

TYPICAL CHARACTERISTICS

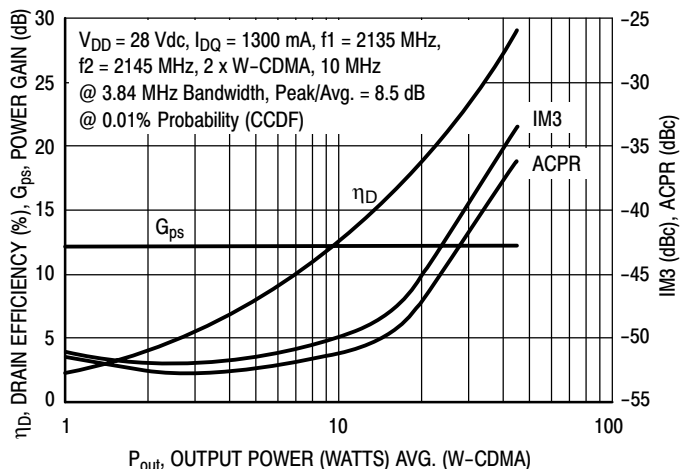


Figure 8. 2-Carrier W-CDMA ACPR, IM3, Power Gain and Drain Efficiency versus Output Power

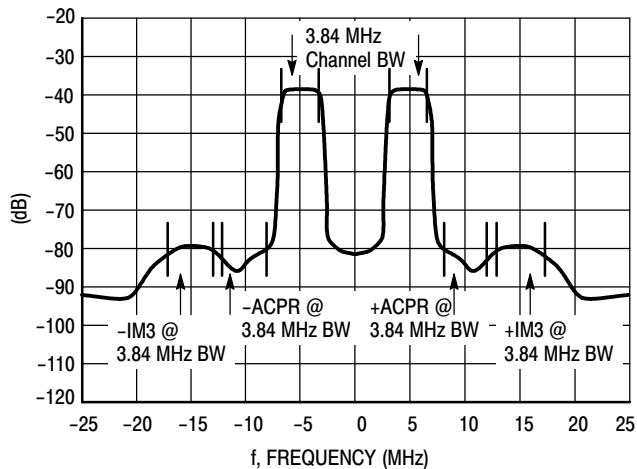


Figure 9. 2-Carrier W-CDMA Spectrum

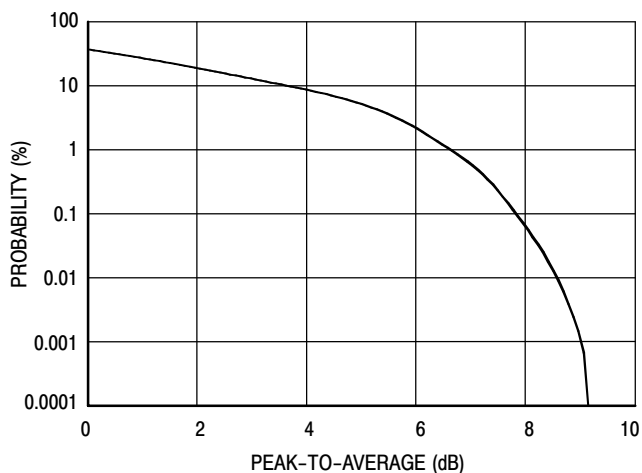
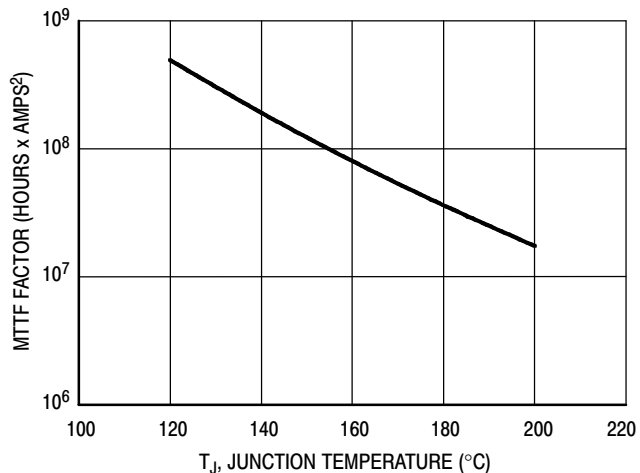
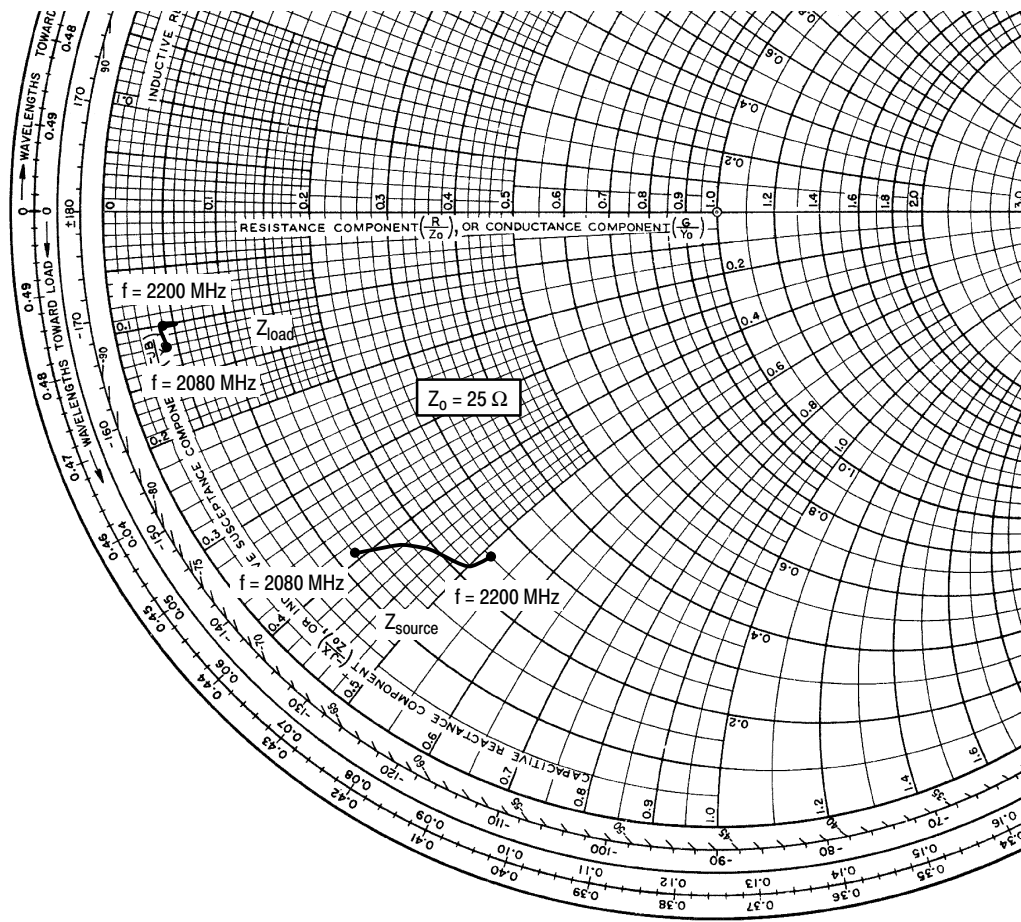


Figure 10. CCDF W-CDMA 3GPP, Test Model 1, 64 DPCH, 67% Clipping, Single Carrier Test Signal



This above graph displays calculated MTTF in hours x ampere² 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 11. MTTF Factor versus Junction Temperature



$V_{DD} = 28 \text{ Vdc}$, $I_{DQ} = 1300 \text{ mA}$, $P_{out} = 33 \text{ W Avg.}$

f MHz	Z_{source} Ω	Z_{load} Ω
2080	$3.05 - j9.66$	$1.02 - j2.94$
2110	$3.97 - j10.31$	$1.09 - j2.51$
2140	$4.70 - j11.03$	$1.16 - j2.46$
2170	$5.45 - j12.41$	$1.16 - j2.58$
2200	$6.18 - j13.04$	$1.02 - j2.55$

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

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

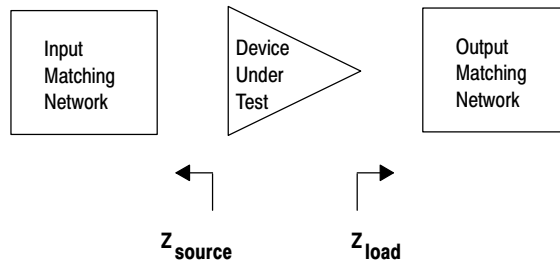


Figure 12. Series Equivalent Source and Load Impedance

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