

RF Power Field Effect Transistors

N-Channel Enhancement-Mode Lateral MOSFETs

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

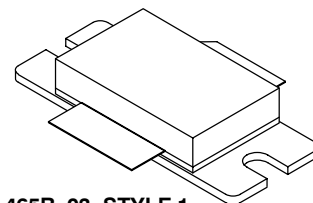
- Typical Single-Carrier W-CDMA Performance: $V_{DD} = 28$ Volts, $I_{DQ} = 1400$ mA, $P_{out} = 50$ Watts Avg., Full Frequency Band, 3GPP Test Model 1, 64 DPCH with 50% Clipping, Channel Bandwidth = 3.84 MHz, Input Signal PAR = 7.5 dB @ 0.01% Probability on CCDF.
Power Gain — 16 dB
Drain Efficiency — 31%
Device Output Signal PAR — 6.1 dB @ 0.01% Probability on CCDF
ACPR @ 5 MHz Offset — -37 dBc in 3.84 MHz Channel Bandwidth
- Capable of Handling 10:1 VSWR, @ 28 Vdc, 2140 MHz, 170 Watts CW Peak Tuned Output Power
- P_{out} @ 1 dB Compression Point ≥ 170 W CW

Features

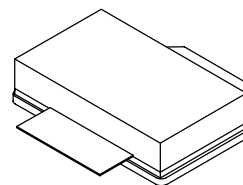
- 100% PAR Tested for Guaranteed Output Power Capability
- Characterized with Series Equivalent Large-Signal Impedance Parameters
- Internally Matched for Ease of Use
- Integrated ESD Protection
- Designed for Digital Predistortion Error Correction Systems
- RoHS Compliant
- In Tape and Reel. R3 Suffix = 250 Units per 56 mm, 13 inch Reel.

MRF7S21170HR3
MRF7S21170HSR3

2110-2170 MHz, 50 W AVG., 28 V
SINGLE W-CDMA
LATERAL N-CHANNEL
RF POWER MOSFETs



CASE 465B-03, STYLE 1
NI-880
MRF7S21170HR3



CASE 465C-02, STYLE 1
NI-880S
MRF7S21170HSR3

Table 1. Maximum Ratings

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DSS}	-0.5, +65	Vdc
Gate-Source Voltage	V_{GS}	-6.0, +10	Vdc
Operating Voltage	V_{DD}	32, +0	Vdc
Storage Temperature Range	T_{stg}	- 65 to +150	°C
Case Operating Temperature	T_C	150	°C
Operating Junction Temperature	T_J	200	°C

Table 2. Thermal Characteristics

Characteristic	Symbol	Value (1,2)	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$		°C/W
Case Temperature 80°C, 170 W CW		0.31	
Case Temperature 73°C, 25 W CW		0.36	

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.

Table 3. ESD Protection Characteristics

Test Methodology	Class
Human Body Model (per JESD22-A114)	1A (Minimum)
Machine Model (per EIA/JESD22-A115)	B (Minimum)
Charge Device Model (per JESD22-C101)	IV (Minimum)

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

Characteristic	Symbol	Min	Typ	Max	Unit
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Off Characteristics

Zero Gate Voltage Drain Leakage Current ($V_{DS} = 65\text{ Vdc}$, $V_{GS} = 0\text{ Vdc}$)	I_{DSS}	—	—	10	μAdc
Zero Gate Voltage Drain Leakage Current ($V_{DS} = 28\text{ Vdc}$, $V_{GS} = 0\text{ Vdc}$)	I_{DSS}	—	—	1	μAdc
Gate-Source Leakage Current ($V_{GS} = 5\text{ Vdc}$, $V_{DS} = 0\text{ Vdc}$)	I_{GSS}	—	—	500	nAdc

On Characteristics

Gate Threshold Voltage ($V_{DS} = 10\text{ Vdc}$, $I_D = 270\text{ }\mu\text{Adc}$)	$V_{GS(th)}$	1	2	3	Vdc
Gate Quiescent Voltage ⁽¹⁾ ($V_{DS} = 28\text{ Vdc}$, $I_D = 1400\text{ mAdc}$, Measured in Functional Test)	$V_{GS(Q)}$	2	2.8	4	Vdc
Drain-Source On-Voltage ($V_{GS} = 10\text{ Vdc}$, $I_D = 2.7\text{ Adc}$)	$V_{DS(on)}$	0.1	0.15	0.3	Vdc

Dynamic Characteristics ⁽²⁾

Reverse Transfer Capacitance ($V_{DS} = 28\text{ Vdc} \pm 30\text{ mV(rms)ac}$ @ 1 MHz, $V_{GS} = 0\text{ Vdc}$)	C_{rss}	—	0.9	—	pF
Output Capacitance ($V_{DS} = 28\text{ Vdc} \pm 30\text{ mV(rms)ac}$ @ 1 MHz, $V_{GS} = 0\text{ Vdc}$)	C_{oss}	—	703	—	pF

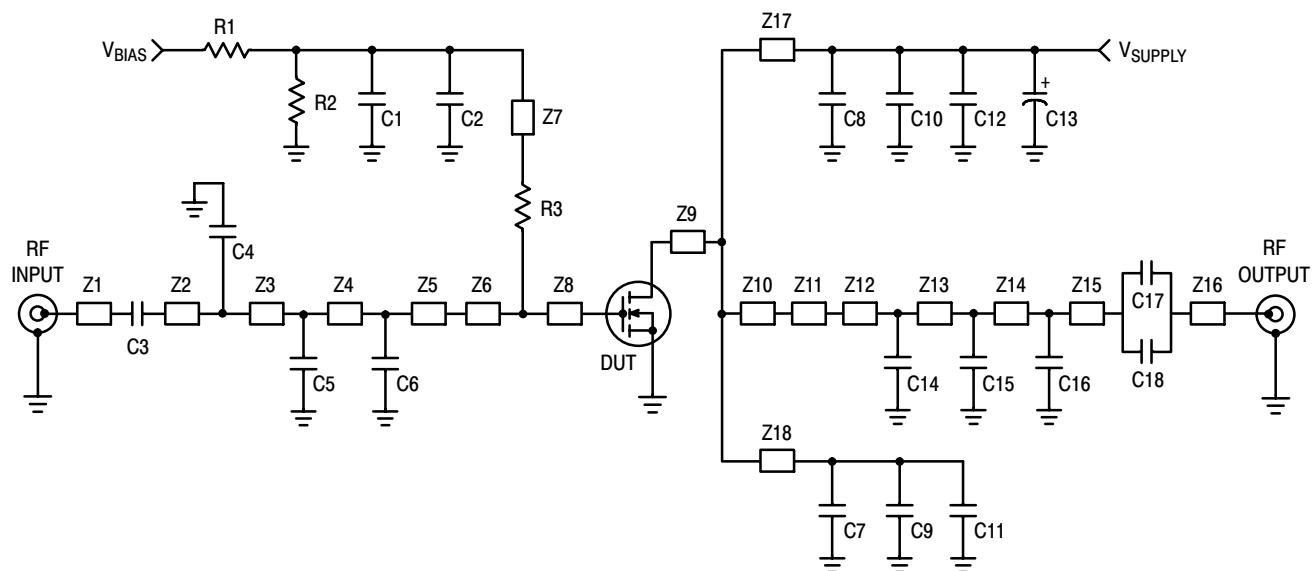
Functional Tests (In Freescale Test Fixture, 50 ohm system) $V_{DD} = 28\text{ Vdc}$, $I_{DQ} = 1400\text{ mA}$, $P_{out} = 50\text{ W Avg.}$, $f = 2112.5\text{ MHz}$ and $f = 2167.5\text{ MHz}$, Single-Carrier W-CDMA, 3GPP Test Model 1, 64 DPCH, 50% Clipping, $PAR = 7.5\text{ dB}$ @ 0.01% Probability on CCDF. ACPR measured in 3.84 MHz Channel Bandwidth @ $\pm 5\text{ MHz}$ Offset.

Power Gain	G_{ps}	15	16	18	dB
Drain Efficiency	η_D	29	31	—	%
Output Peak-to-Average Ratio @ 0.01% Probability on CCDF	PAR	5.7	6.1	—	dB
Adjacent Channel Power Ratio	ACPR	—	-37	-35	dBc
Input Return Loss	IRL	—	-15	-9	dB

Typical Performances (In Freescale Test Fixture, 50 ohm system) $V_{DD} = 28\text{ Vdc}$, $I_{DQ} = 1400\text{ mA}$, 2110-2170 MHz Bandwidth

Video Bandwidth (Tone Spacing from 100 kHz to VBW) $\Delta\text{IMD3} = \text{IMD3 @ VBW frequency} - \text{IMD3 @ } 100\text{ kHz} < 1\text{ dBc}$ (both sidebands)	VBW	—	25	—	MHz
Part-to-Part Phase Variation @ $P_{out} = 170\text{ W CW}$	$\Delta\Phi$	—	18	—	°
Gain Variation over Temperature	ΔG	—	0.015	—	dB/°C
Output Power Variation over Temperature	ΔP_{1dB}	—	0.01	—	dBm/°C

1. $V_{GG} = 2 \times V_{GS(Q)}$. Parameter measured on Freescale Test Fixture, due to resistive divider network on the board. Refer to Test Circuit schematic.
2. Part internally matched both on input and output.



Z1	0.250" x 0.083" Microstrip	Z11	0.060" x 0.076" Microstrip
Z2*	0.090" x 0.083" Microstrip	Z12*	0.129" x 0.083" Microstrip
Z3*	0.842" x 0.083" Microstrip	Z13*	0.436" x 0.083" Microstrip
Z4*	0.379" x 0.083" Microstrip	Z14*	0.490" x 0.083" Microstrip
Z5*	0.307" x 0.083" Microstrip	Z15*	0.275" x 0.083" Microstrip
Z6	0.119" x 0.787" Microstrip	Z16	0.230" x 0.083" Microstrip
Z7	1.160" x 0.080" Microstrip	Z17, Z18	0.900" x 0.080" Microstrip
Z8	0.156" x 0.787" Microstrip	PCB	Taconix TLX8-0300, 0.030", $\epsilon_r = 2.55$
Z9	0.770" x 0.880" Microstrip		
Z10	0.459" x 1.000" Microstrip		

* Variable for tuning

Figure 1. MRF7S21170HR3(HSR3) Test Circuit Schematic

Table 5. MRF7S21170HR3(HSR3) Test Circuit Component Designations and Values

Part	Description	Part Number	Manufacturer
C1	100 pF 100B Chip Capacitor	100B101JW500XT	ATC
C2, C3, C7, C8, C17, C18	6.8 pF 600B Chip Capacitors	600B6R8BT500XT	ATC
C4, C15	0.3 pF 700B Chip Capacitors	700B0R3BW500XT	ATC
C5	0.8 pF 600B Chip Capacitor	600B0R8BT500XT	ATC
C6	0.2 pF 700B Chip Capacitor	700B0R2BW500XT	ATC
C9, C10, C11, C12	10 μ F Chip Capacitors	C5750X5R1H106MT	TDK
C13	470 μ F, 63 V Electrolytic Capacitor, Radial	13661471	Philips
C14	0.4 pF 700B Chip Capacitor	700B0R4BW500XT	ATC
C16	0.1 pF 700B Chip Capacitor	700B0R1BW500XT	ATC
R1, R2	10 k Ω , 1/4 W Chip Resistors		
R3	10 Ω , 1/4 W Chip Resistor		

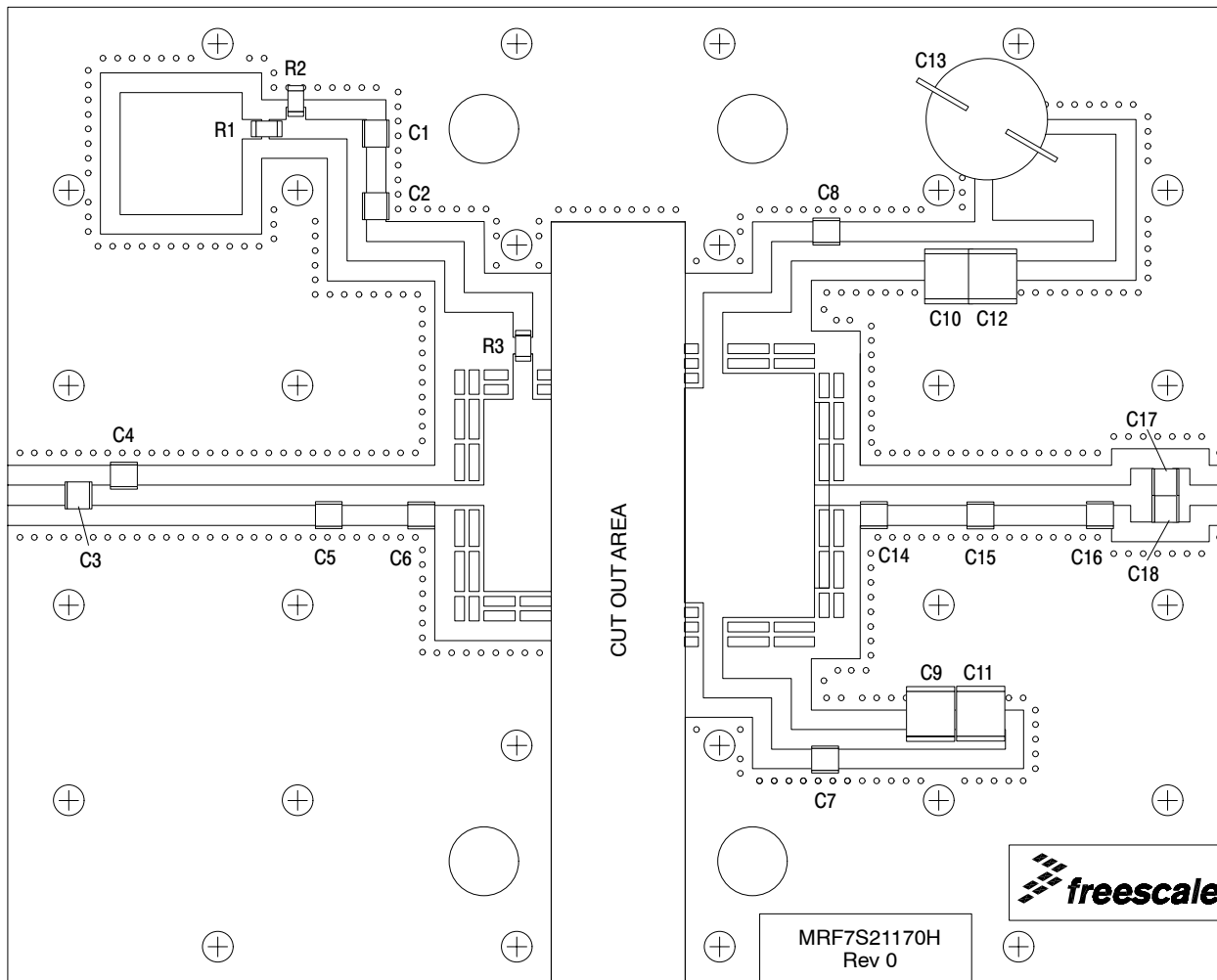


Figure 2. MRF7S21170HR3(HSR3) Test Circuit Component Layout

TYPICAL CHARACTERISTICS

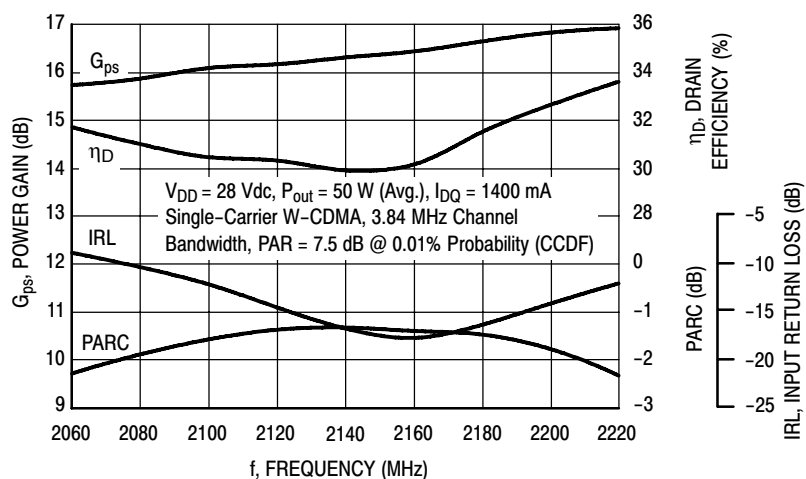


Figure 3. Output Peak-to-Average Ratio Compression (PARC) Broadband Performance @ $P_{out} = 50$ Watts Avg.

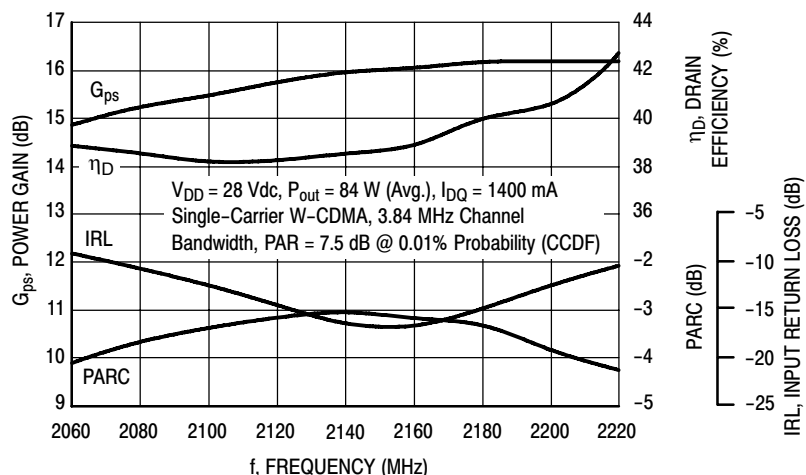


Figure 4. Output Peak-to-Average Ratio Compression (PARC) Broadband Performance @ $P_{out} = 84$ Watts Avg.

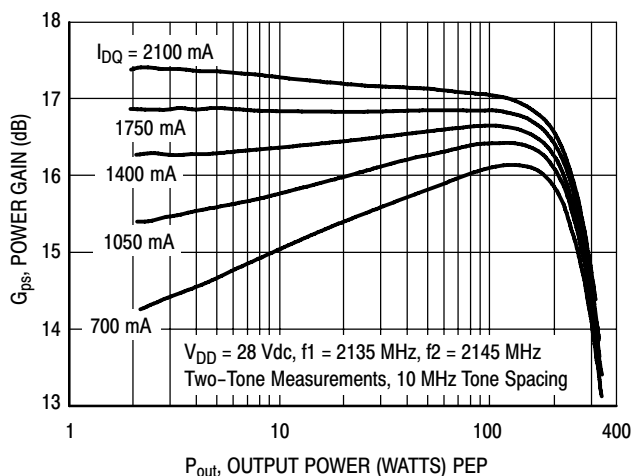


Figure 5. Two-Tone Power Gain versus Output Power

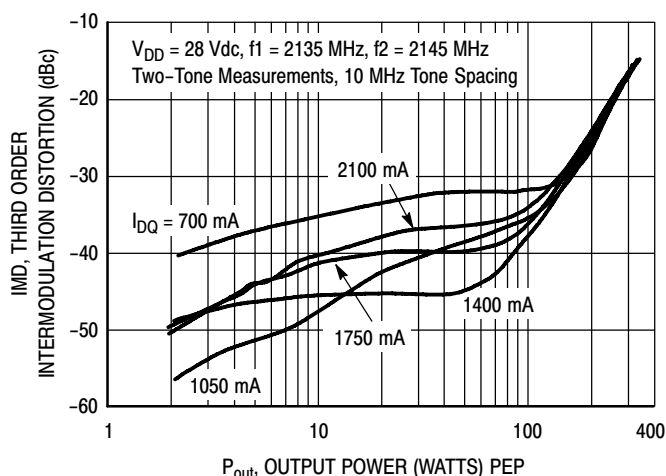


Figure 6. Third Order Intermodulation Distortion versus Output Power

TYPICAL CHARACTERISTICS

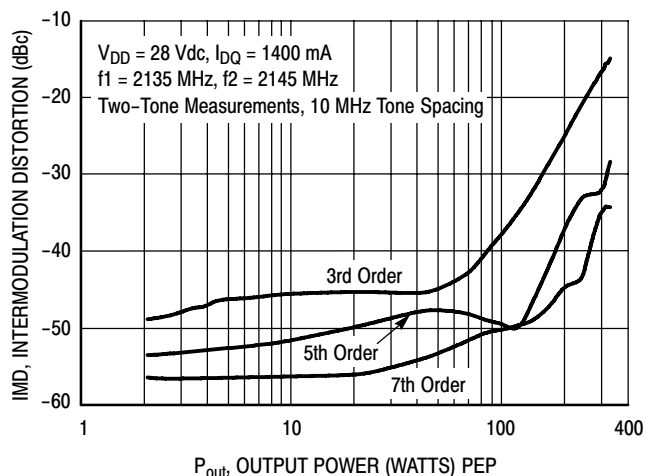


Figure 7. Intermodulation Distortion Products versus Output Power

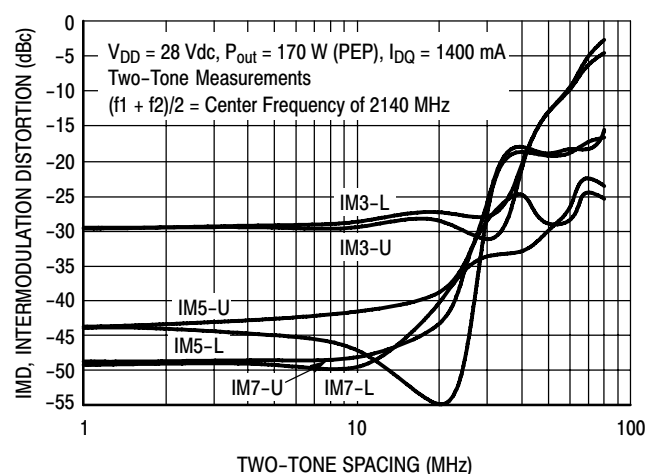


Figure 8. Intermodulation Distortion Products versus Tone Spacing

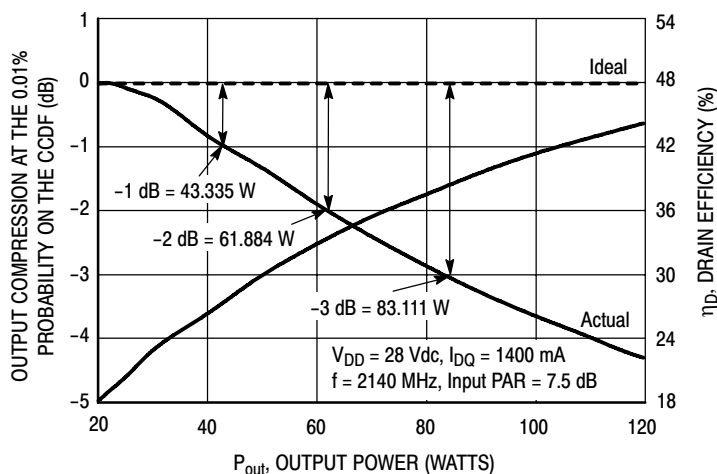


Figure 9. Output Peak-to-Average Ratio Compression (PARC) versus Output Power

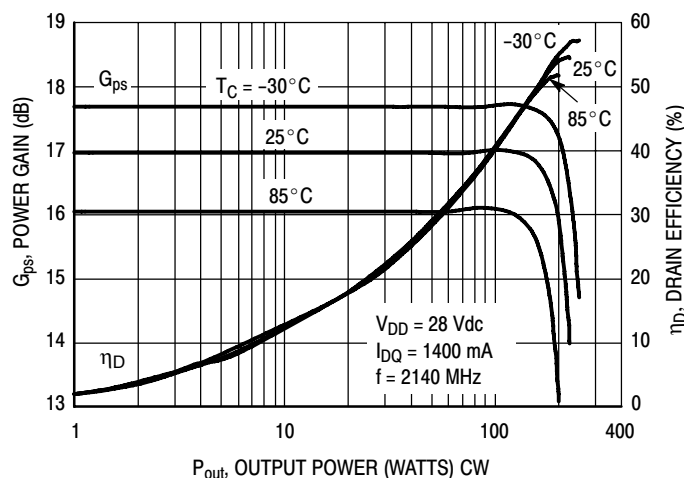


Figure 10. Power Gain and Drain Efficiency versus CW Output Power

TYPICAL CHARACTERISTICS

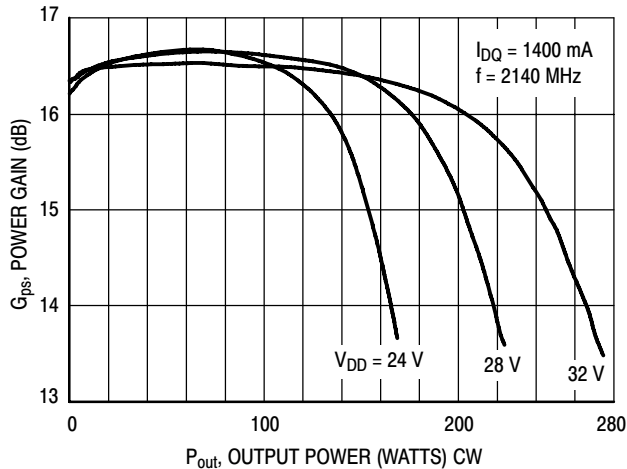
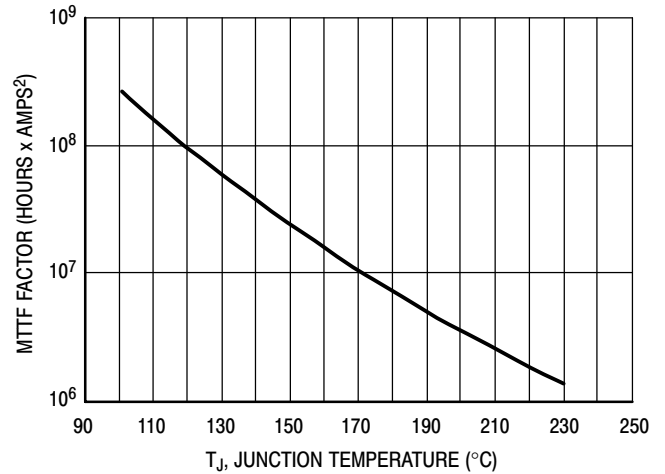


Figure 11. Power Gain versus Output Power



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 12. MTTF Factor versus Junction Temperature

W-CDMA TEST SIGNAL

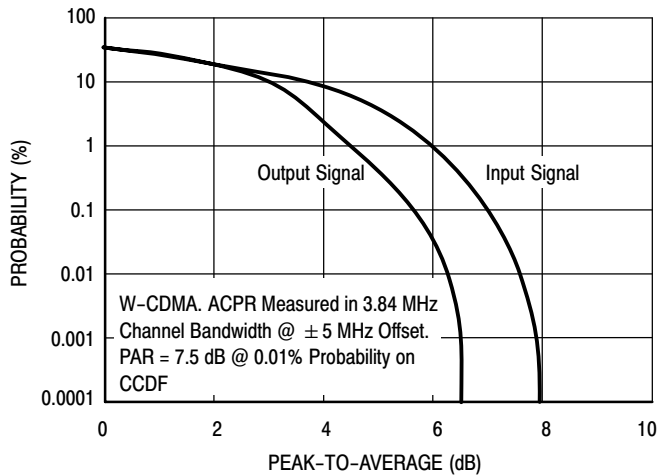


Figure 13. CCDF W-CDMA 3GPP, Test Model 1, 64 DPCH, 50% Clipping, Single-Carrier Test Signal

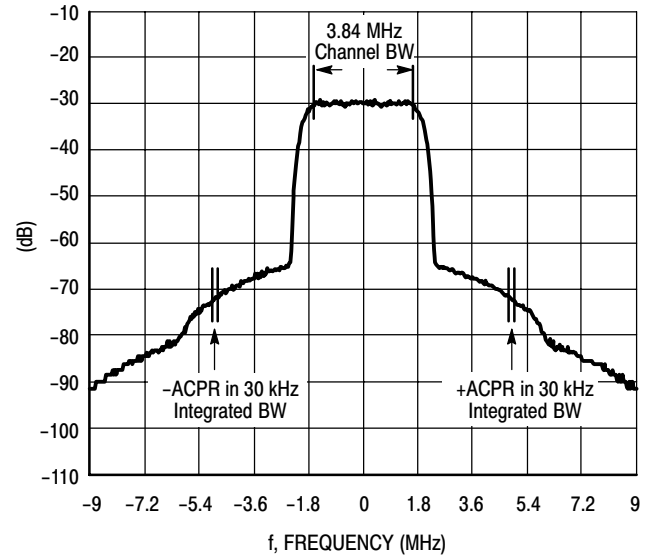
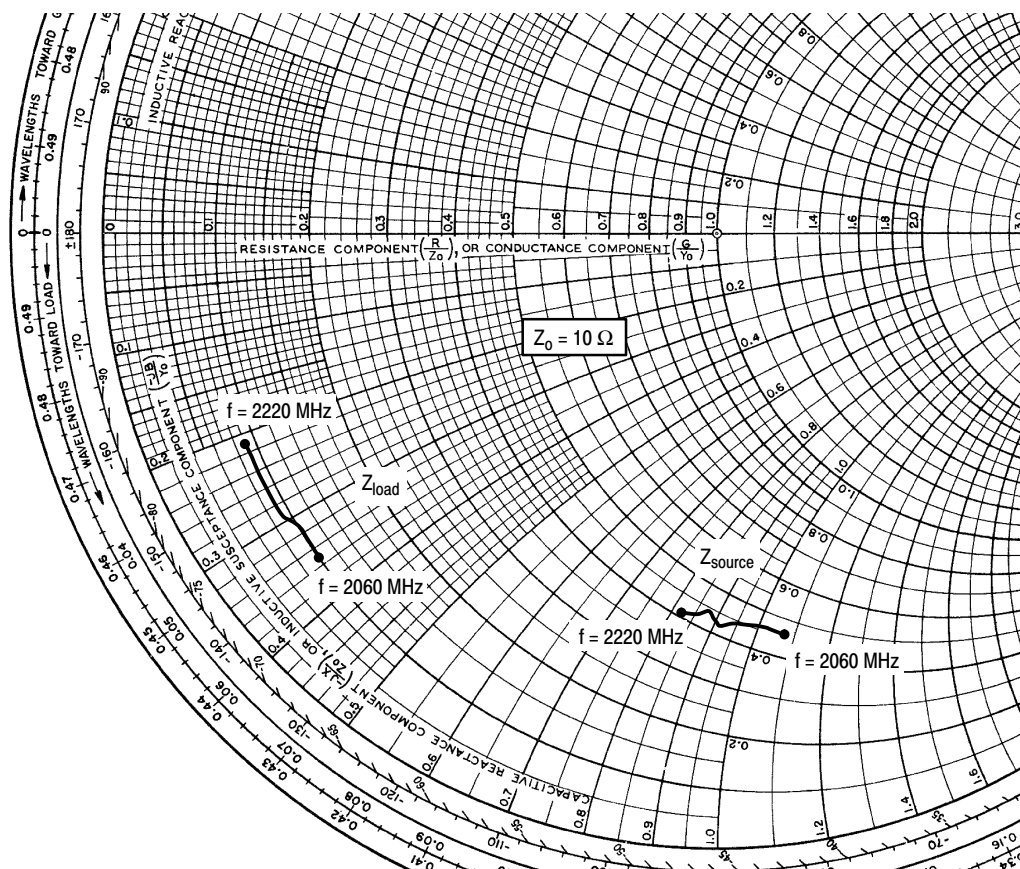


Figure 14. Single-Carrier W-CDMA Spectrum



$V_{DD} = 28 \text{ Vdc}$, $I_{DQ} = 1400 \text{ mA}$, $P_{out} = 50 \text{ W Avg.}$

f MHz	Z_{source} Ω	Z_{load} Ω
2060	$4.57 - j10.70$	$1.02 - j3.54$
2080	$4.57 - j10.38$	$0.99 - j3.34$
2100	$4.57 - j10.06$	$0.96 - j3.14$
2120	$4.52 - j9.72$	$0.93 - j2.94$
2140	$4.40 - j9.42$	$0.92 - j2.76$
2160	$4.15 - j9.12$	$0.91 - j2.59$
2180	$4.44 - j8.82$	$0.89 - j2.42$
2200	$4.19 - j8.53$	$0.88 - j2.25$
2220	$4.12 - j8.23$	$0.88 - j2.09$

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

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

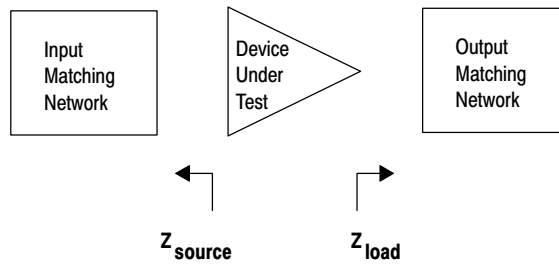
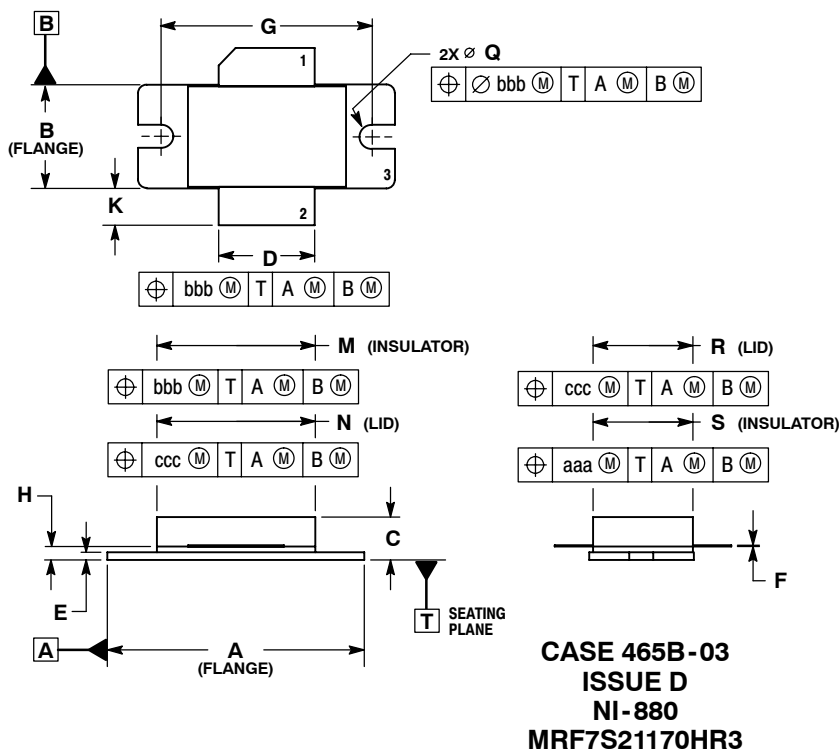


Figure 15. Series Equivalent Source and Load Impedance

NOTES

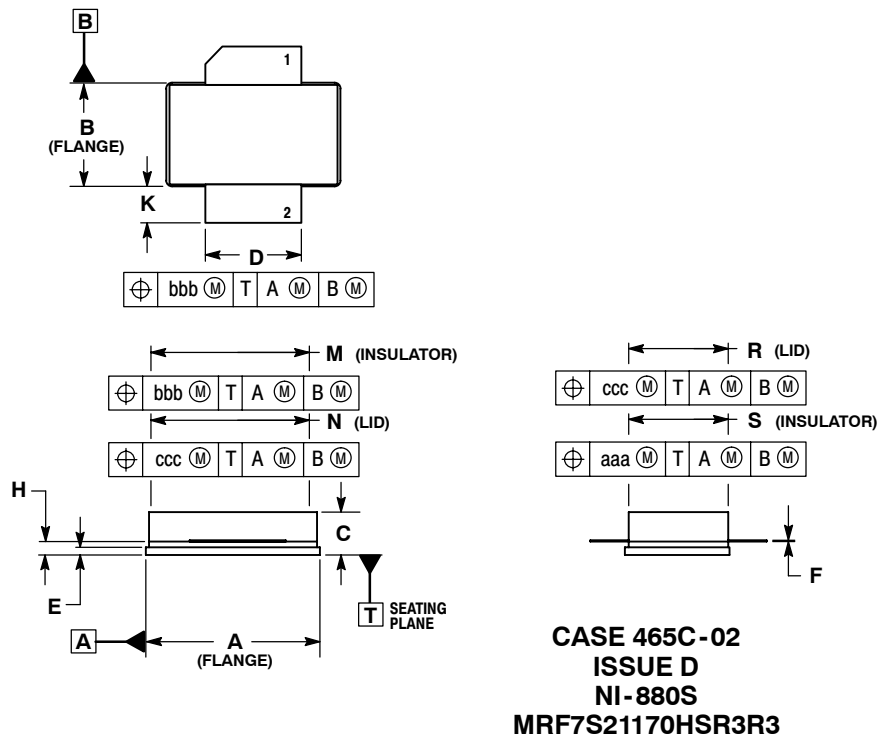
PACKAGE DIMENSIONS



- NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M-1994.
 2. CONTROLLING DIMENSION: INCH.
 3. DIMENSION H IS MEASURED 0.030 (0.762) AWAY FROM PACKAGE BODY.
 4. 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	
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	$\varnothing .118$	$\varnothing .138$	$\varnothing 3.00$	$\varnothing 3.51$
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



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 3. 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

MRF7S21170HR3 MRF7S21170HSR3

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