

# RF Power Field Effect Transistors

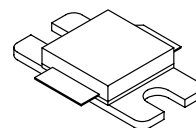
## N-Channel Enhancement-Mode Lateral MOSFETs

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.

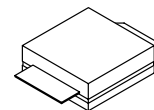
- Typical 2-carrier W-CDMA Performance:  $V_{DD} = 28$  Volts,  $I_{DQ} = 450$  mA,  $P_{out} = 11.5$  Watts Avg., Full Frequency Band, Channel Bandwidth = 3.84 MHz, PAR = 8.5 dB @ 0.01% Probability on CCDF.  
 Power Gain — 16 dB  
 Drain Efficiency — 27.7%  
 IM3 @ 10 MHz Offset — -37 dBc @ 3.84 MHz Channel Bandwidth  
 ACPR @ 5 MHz Offset — -40 dBc @ 3.84 MHz Channel Bandwidth
- Capable of Handling 10:1 VSWR, @ 28 Vdc, 2140 MHz, 50 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
- Designed for Lower Memory Effects and Wide Instantaneous Bandwidth Applications
- Low Gold Plating Thickness on Leads, 40 $\mu$ " Nominal.
- In Tape and Reel. R3 Suffix = 250 Units per 32 mm, 13 inch Reel.

**MRF6S21050LR3**  
**MRF6S21050LSR3**

**2170 MHz, 11.5 W AVG., 28 V**  
**2 x W-CDMA**  
**LATERAL N-CHANNEL**  
**RF POWER MOSFETs**



**CASE 465E-04, STYLE 1**  
**NI-400**  
**MRF6S21050LR3**



**CASE 465F-04, STYLE 1**  
**NI-400S**  
**MRF6S21050LSR3**

**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 @ $T_C = 25^\circ\text{C}$ Derate above 25 $^\circ\text{C}$	$P_D$	151 0.86	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	50	W

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

**Table 2. Thermal Characteristics**

Characteristic	Symbol	Value (1,2)	Unit
Thermal Resistance, Junction to Case Case Temperature 80°C, 50 W CW Case Temperature 76°C, 12 W CW	$R_{\theta JC}$	1.16 1.28	°C/W

**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** ( $T_C = 25^\circ\text{C}$  unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
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**Off Characteristics**

Zero Gate Voltage Drain Leakage Current ( $V_{DS} = 68 \text{ Vdc}$ , $V_{GS} = 0 \text{ Vdc}$ )	$I_{DSS}$	—	—	10	$\mu\text{Adc}$
Zero Gate Voltage Drain Leakage Current ( $V_{DS} = 28 \text{ Vdc}$ , $V_{GS} = 0 \text{ Vdc}$ )	$I_{DSS}$	—	—	1	$\mu\text{Adc}$
Gate-Source Leakage Current ( $V_{GS} = 5 \text{ Vdc}$ , $V_{DS} = 0 \text{ Vdc}$ )	$I_{GSS}$	—	—	1	$\mu\text{Adc}$

**On Characteristics**

Gate Threshold Voltage ( $V_{DS} = 10 \text{ Vdc}$ , $I_D = 200 \mu\text{Adc}$ )	$V_{GS(th)}$	1	2	3	Vdc
Gate Quiescent Voltage ( $V_{DS} = 28 \text{ Vdc}$ , $I_D = 450 \text{ mAdc}$ )	$V_{GS(Q)}$	2	2.9	4	Vdc
Drain-Source On-Voltage ( $V_{GS} = 10 \text{ Vdc}$ , $I_D = 1.1 \text{ Adc}$ )	$V_{DS(on)}$	—	0.21	0.3	Vdc
Forward Transconductance ( $V_{DS} = 10 \text{ Vdc}$ , $I_D = 1 \text{ Adc}$ )	$g_{fs}$	—	5.3	—	S

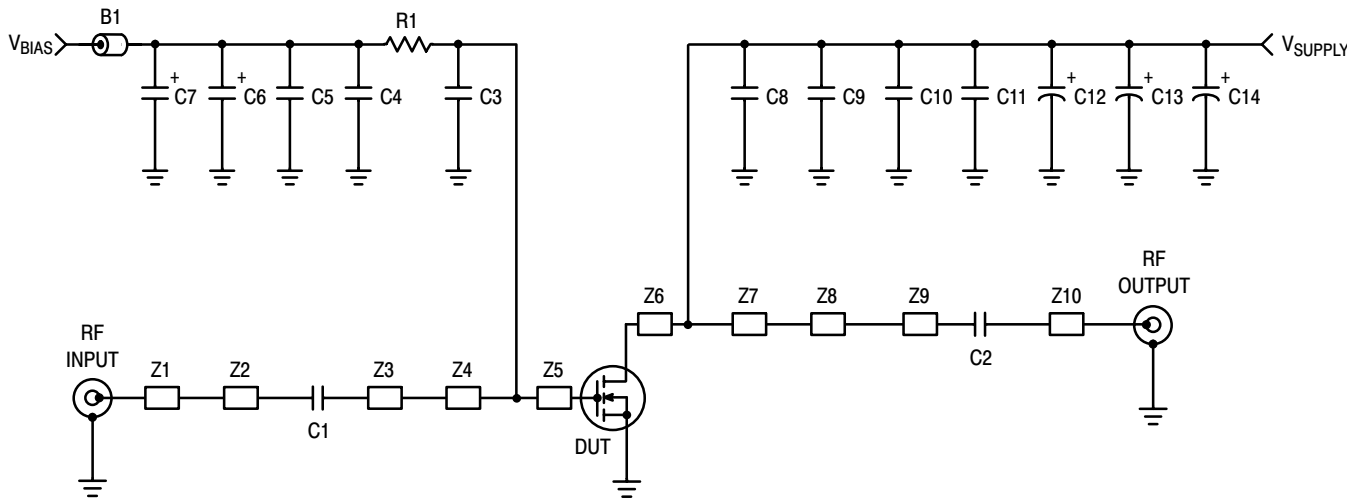
**Dynamic Characteristics** <sup>(3)</sup>

Reverse Transfer Capacitance ( $V_{DS} = 28 \text{ Vdc} \pm 30 \text{ mV(rms)ac}$ @ 1 MHz, $V_{GS} = 0 \text{ Vdc}$ )	$C_{rss}$	—	0.75	—	pF
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**Functional Tests** (In Freescale Test Fixture, 50 ohm system)  $V_{DD} = 28 \text{ Vdc}$ ,  $I_{DQ} = 450 \text{ mA}$ ,  $P_{out} = 11.5 \text{ W Avg.}$ ,  $f_1 = 2112.5 \text{ MHz}$ ,  $f_2 = 2122.5 \text{ MHz}$  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. PAR = 8.5 dB @ 0.01% Probability on CCDF.

Power Gain	$G_{ps}$	15	16	18	dB
Drain Efficiency	$\eta_D$	26	27.7	—	%
Intermodulation Distortion	IM3	—	-37	-35	dBc
Adjacent Channel Power Ratio	ACPR	—	-40	-38	dBc
Input Return Loss	IRL	—	-15	-9	dB

1. MTF calculator available at <http://www.freescale.com/rf>. Select Tools/Software/Application Software/Calculators to access the MTF 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.
3. Part is internally matched both on input and output.

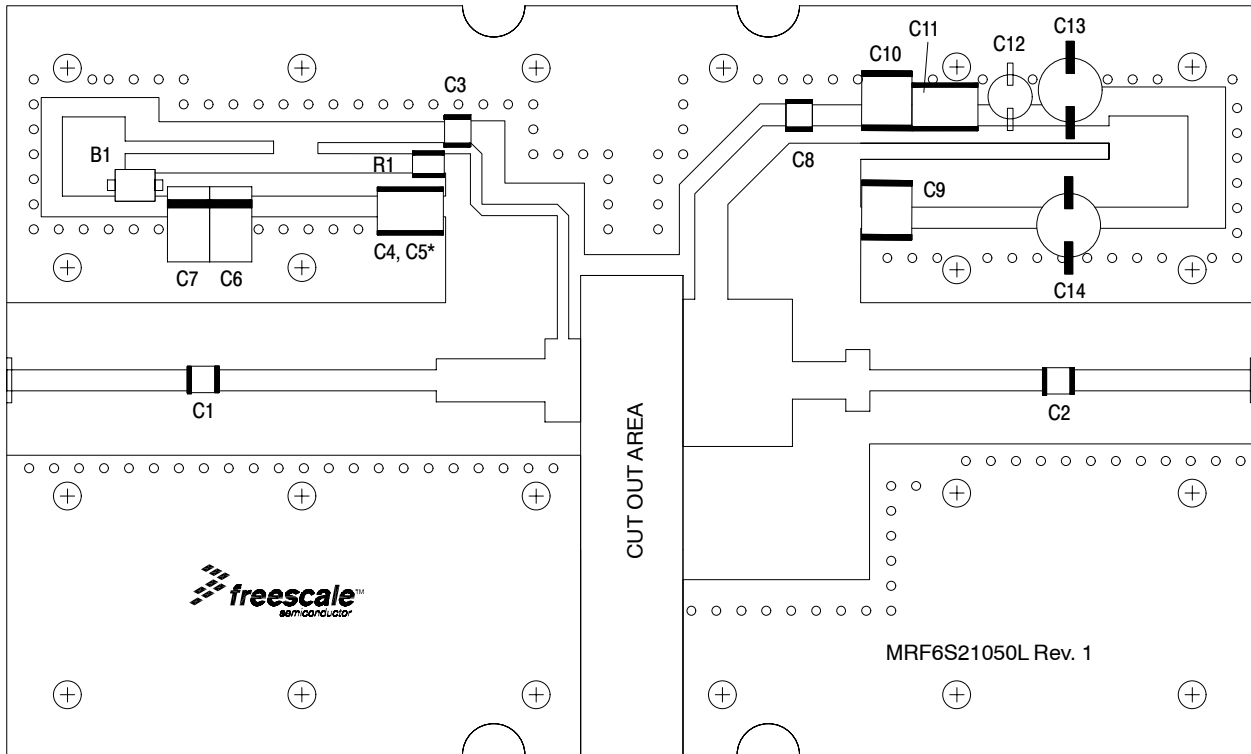


Z1, Z10	0.750" x 0.084" Microstrip	Z6	0.113" x 0.590" Microstrip
Z2	0.905" x 0.084" Microstrip	Z7	0.325" x 0.590" Microstrip
Z3	0.435" x 0.173" Microstrip	Z8	0.214" x 0.150" Microstrip
Z4	0.073" x 0.333" Microstrip	Z9	0.723" x 0.084" Microstrip
Z5	0.070" x 0.333" Microstrip	PCB	Arlon GX-0300-5022, 0.030", $\epsilon_r = 2.5$

**Figure 1. MRF6S21050LR3 (LSR3) Test Circuit Schematic**

**Table 5. MRF6S21050LR3 (LSR3) Test Circuit Component Designations and Values**

Part	Description	Part Number	Manufacturer
B1	Bead, Surface Mount	2743019447	Fair-Rite
C1, C2, C3, C8	6.8 pF Chip Capacitors	100B6R8CP500X	ATC
C4	0.01 $\mu$ F Chip Capacitor (1825)	C1825C103J1RAC	Kemet
C5, C11	2.2 $\mu$ F, 50 V Chip Capacitors (1825)	C1825C225J5RAC	Kemet
C6	22 $\mu$ F, 25 V Tantalum Capacitor	ECS-T1ED226R	Panasonic TE Series
C7	47 $\mu$ F, 16 V Tantalum Capacitor	T491D476K016AS	Kemet
C9, C10	10 $\mu$ F, 50 V Chip Capacitors (2220)	GRM55DR61H106KA88B	Murata
C12	47 $\mu$ F, 50 V Electrolytic Capacitor	MVK50VC47RM8X10TP	Nippon
C13, C14	220 $\mu$ F, 50 V Electrolytic Capacitors	MVY50VC221MJ10TP	Nippon
R1	3.3 $\Omega$ , 1/4 W Chip Resistor (1210)	ERJ-14YJ3R3U	Dale/Vishay



\* C4 on bottom, C5 on top.

**Figure 2. MRF6S21050LR3(LSR3) Test Circuit Component Layout**

## TYPICAL CHARACTERISTICS

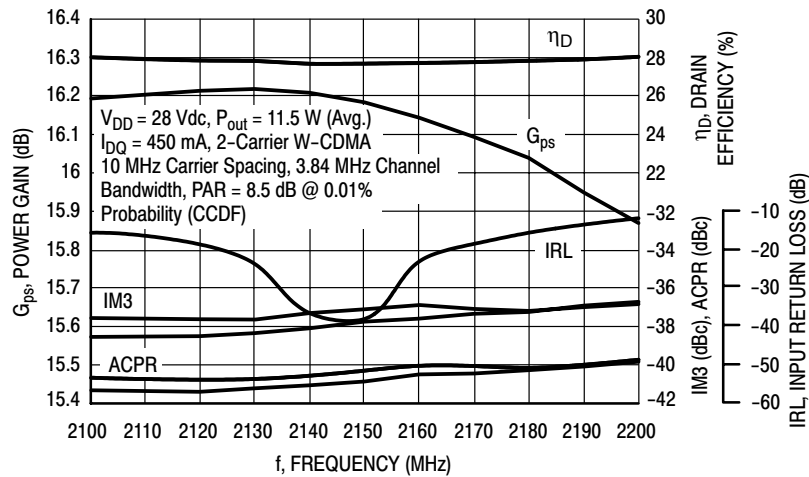


Figure 3. 2-Carrier W-CDMA Broadband Performance @  $P_{out} = 11.5$  Watts

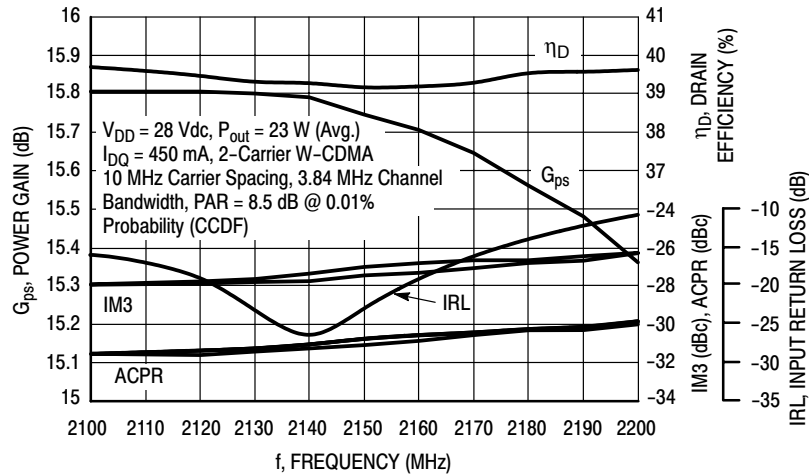


Figure 4. 2-Carrier W-CDMA Broadband Performance @  $P_{out} = 23$  Watts

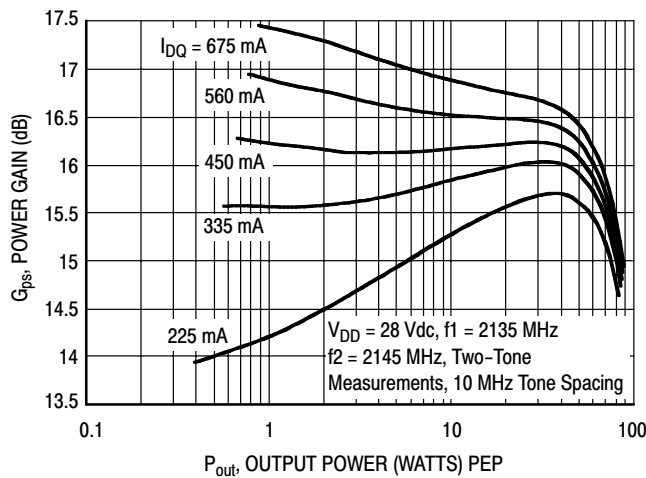


Figure 5. Two-Tone Power Gain versus Output Power

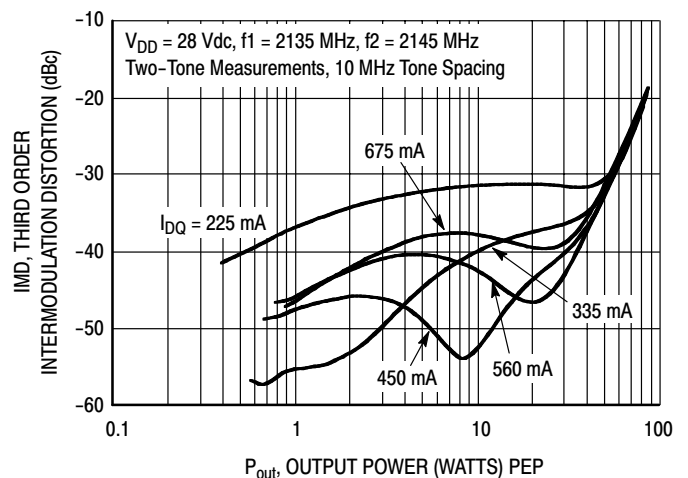
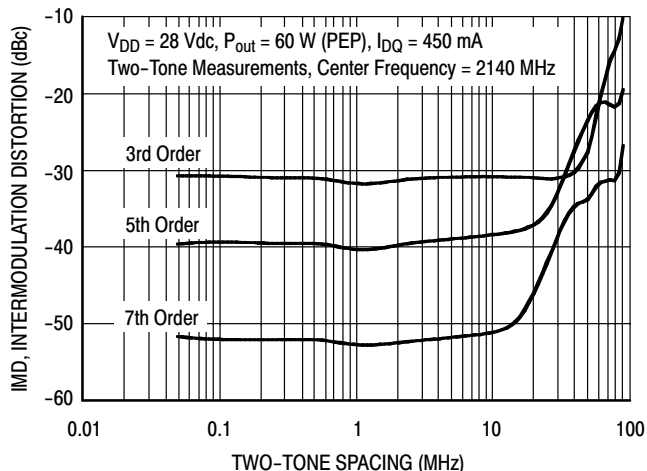
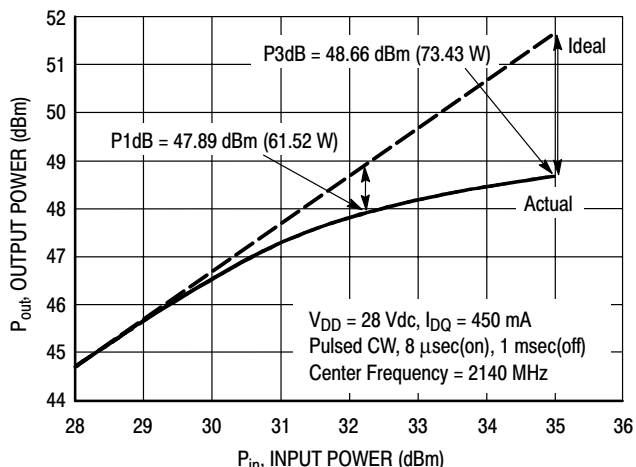


Figure 6. Third Order Intermodulation Distortion versus Output Power

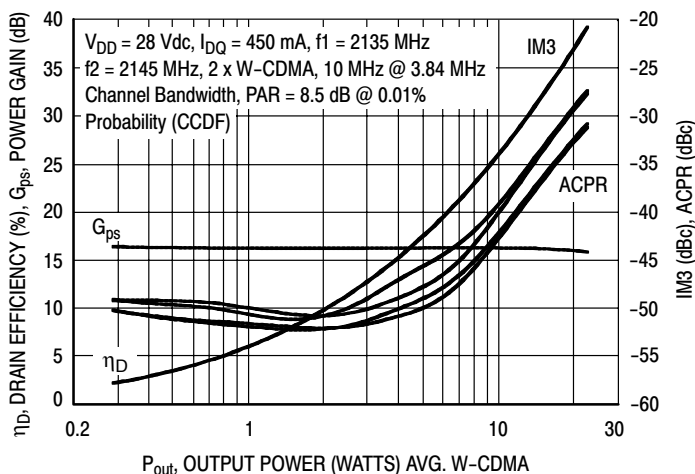
## TYPICAL CHARACTERISTICS



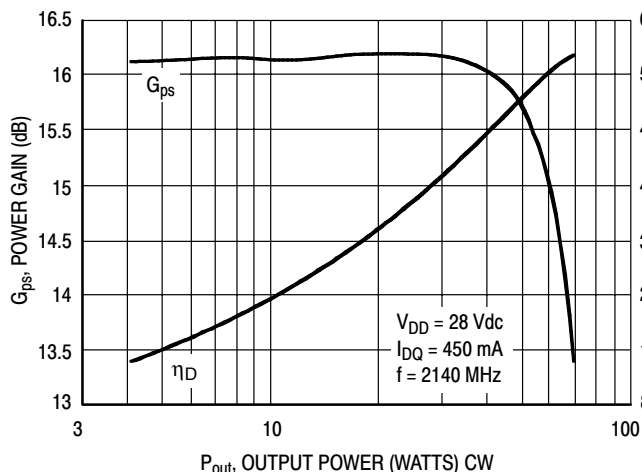
**Figure 7. Intermodulation Distortion Products versus Tone Spacing**



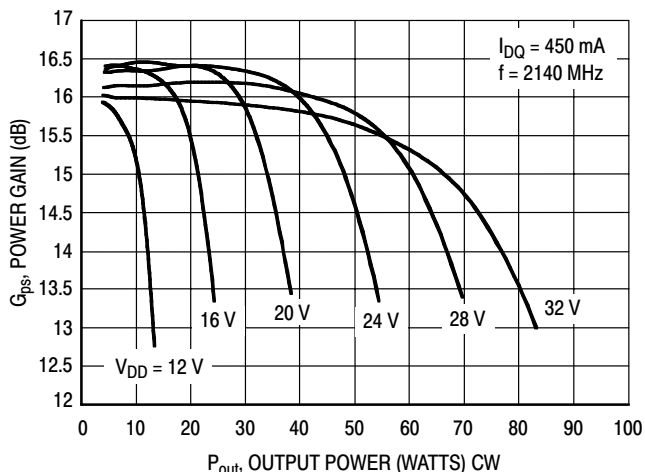
**Figure 8. Pulse CW Output Power versus Input Power**



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

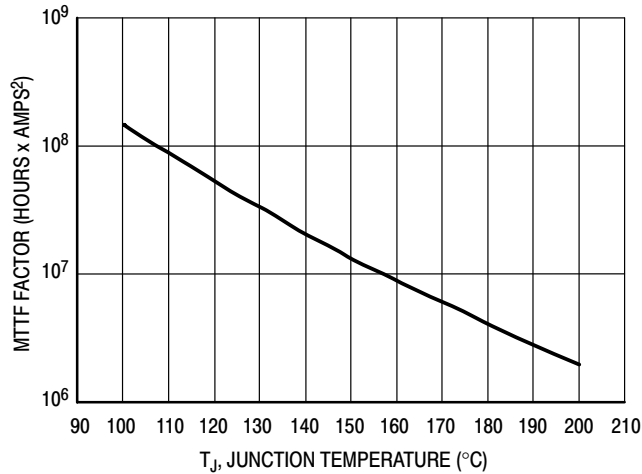


**Figure 10. Power Gain and Drain Efficiency versus CW Output Power**



**Figure 11. Power Gain versus Output Power**

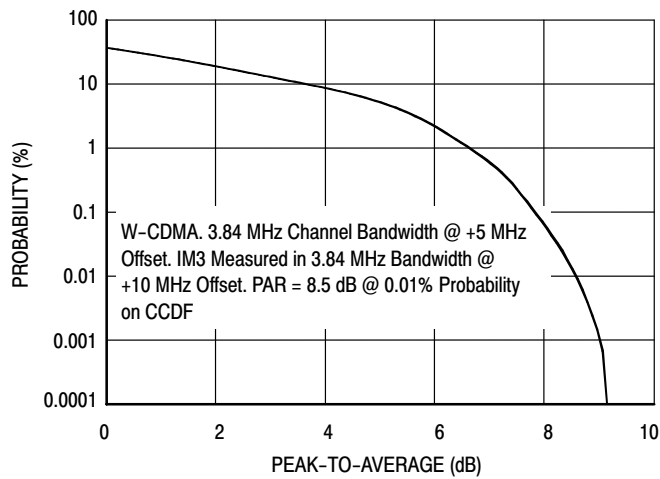
## TYPICAL CHARACTERISTICS



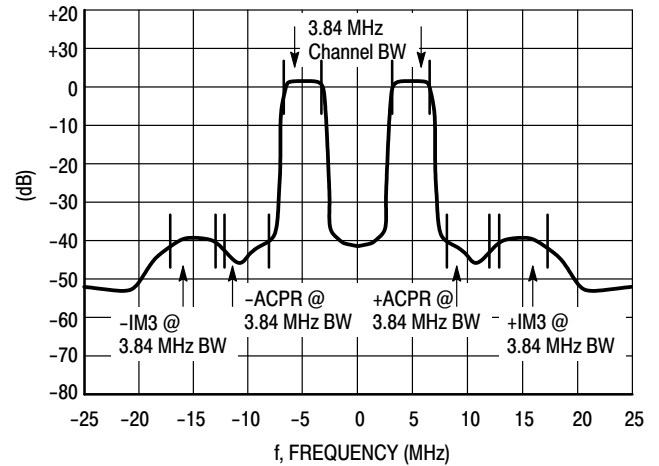
This above graph displays calculated MTTF in hours x ampere<sup>2</sup> drain current. Life tests at elevated temperatures have correlated to better than  $\pm 10\%$  of the theoretical prediction for metal failure. Divide MTTF factor by  $I_D^2$  for MTTF in a particular application.

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

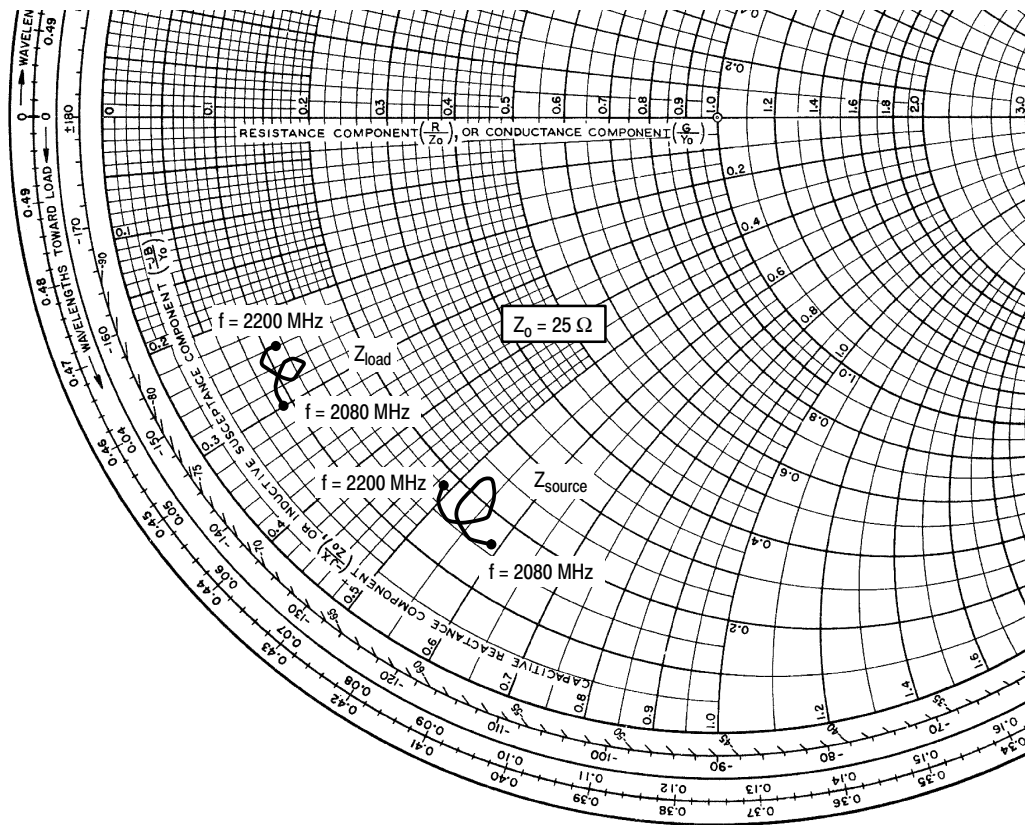
## W-CDMA TEST SIGNAL



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



**Figure 14. 2-Carrier W-CDMA Spectrum**



$V_{DD} = 28 \text{ Vdc}$ ,  $I_{DQ} = 450 \text{ mA}$ ,  $P_{out} = 11.5 \text{ W Avg.}$

f MHz	$Z_{source}$ $\Omega$	$Z_{load}$ $\Omega$
2080	4.09 - j14.65	2.36 - j7.52
2090	3.74 - j13.95	2.25 - j7.11
2100	3.95 - j13.36	2.40 - j6.78
2110	4.44 - j13.00	2.68 - j6.59
2120	5.03 - j12.89	2.99 - j6.52
2130	5.55 - j13.05	3.26 - j6.64
2140	5.76 - j13.26	3.32 - j6.68
2150	5.57 - j13.70	3.20 - j6.87
2160	4.86 - j13.92	2.82 - j6.93
2170	4.04 - j13.61	2.44 - j6.70
2180	3.69 - j12.91	2.33 - j6.29
2190	3.91 - j12.44	2.49 - j6.05
2200	4.41 - j12.32	2.77 - j5.96

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

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

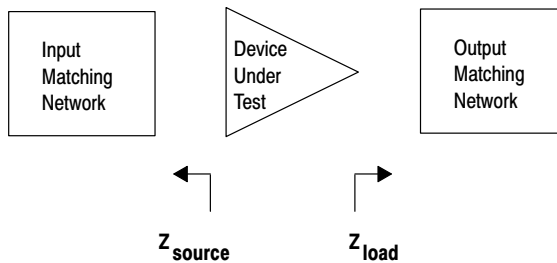


Figure 15. Series Equivalent Source and Load Impedance

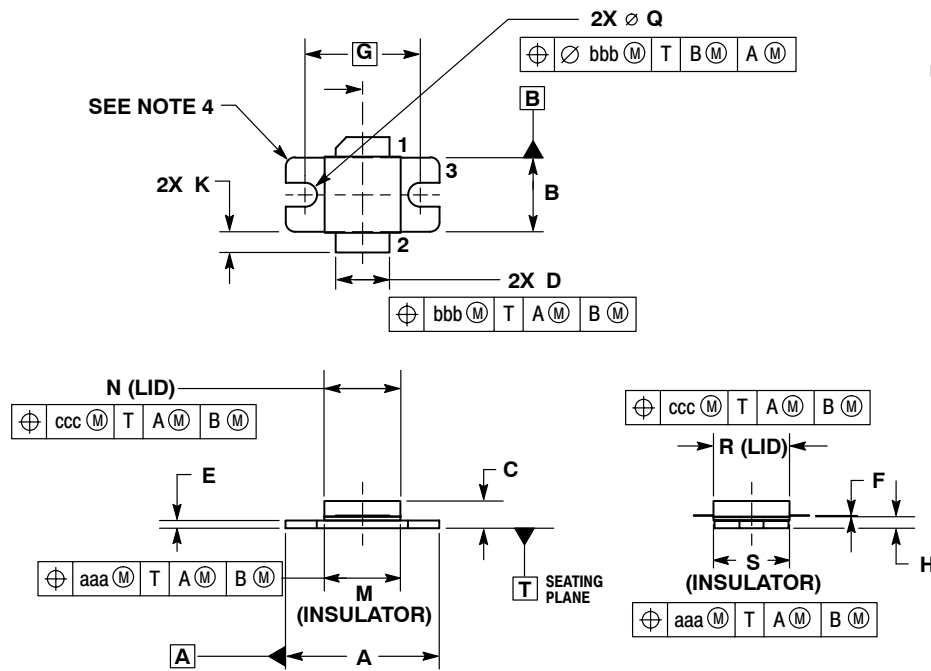




# NOTES

# NOTES

## PACKAGE DIMENSIONS



### NOTES:

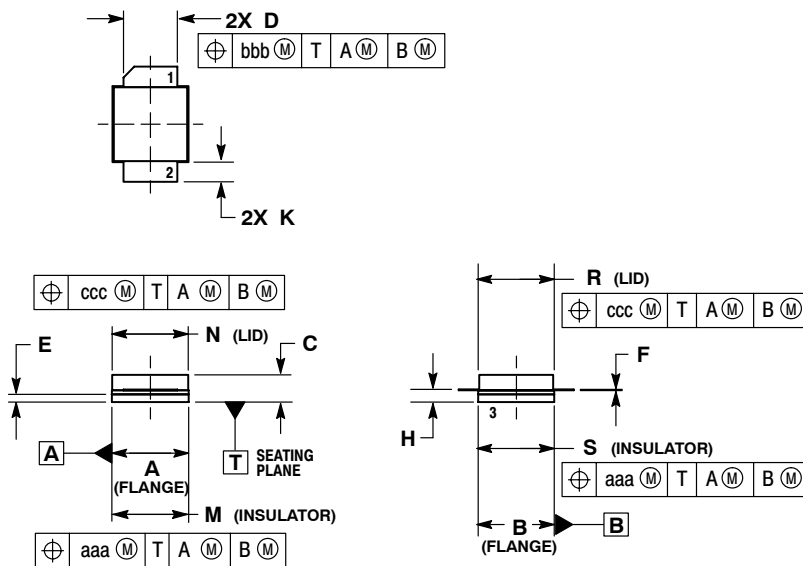
1. CONTROLLING DIMENSION: INCH.
2. INTERPRET DIMENSIONS AND TOLERANCES PER ASME Y14.5M, 1994.
3. DIMENSION H IS MEASURED 0.030 (0.762) AWAY FROM PACKAGE BODY.
4. INFORMATION ONLY: CORNER BREAK (4X) TO BE  $.060 \pm .005$  ( $1.52 \pm 0.13$ ) RADIUS OR  $.06 \pm .005$  ( $1.52 \pm 0.13$ ) x 45° CHAMFER.

DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	.795	.805	20.19	20.44
B	.380	.390	9.65	9.9
C	.125	.163	3.17	4.14
D	.275	.285	6.98	7.24
E	.035	.045	0.89	1.14
F	.004	.006	0.10	0.15
G	.600 BSC		15.24 BSC	
H	.057	.067	1.45	1.7
K	.092	.122	2.33	3.1
M	.395	.405	10	10.3
N	.395	.405	10	10.3
Q	$\varnothing$ .120	$\varnothing$ .130	$\varnothing$ 3.05	$\varnothing$ 3.3
R	.395	.405	10	10.3
S	.395	.405	10	10.3
aaa	.005 BSC		0.127 BSC	
bbb	.010 BSC		0.254 BSC	
ccc	.015 BSC		0.381 BSC	

### STYLE 1:

- PIN 1. DRAIN
- GATE
- SOURCE

**CASE 465E-04  
ISSUE E  
NI-400  
MRF6S21050LR3**



### NOTES:

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DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
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K	.092	.122	2.34	3.10
M	.395	.405	10.03	10.29
N	.395	.405	10.03	10.29
R	.395	.405	10.03	10.29
S	.395	.405	10.03	10.29
aaa	.005 REF		0.127 REF	
bbb	.010 REF		0.254 REF	
ccc	.015 REF		0.38 REF	

### STYLE 1:

- PIN 1. DRAIN
- GATE
- SOURCE

**CASE 465F-04  
ISSUE C  
NI-400S  
MRF6S21050LSR3**

MRF6S21050LR3 MRF6S21050LSR3

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