

# RF Power Field Effect Transistors

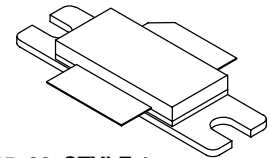
## N-Channel Enhancement-Mode Lateral MOSFETs

Designed for 802.16 WiBro and dual mode applications with frequencies from 2300 to 2400 MHz. Suitable for Class AB feedforward and predistortion systems.

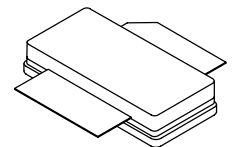
- Typical 2-Carrier W-CDMA Performance:  $V_{DD} = 28$  Volts,  $I_{DQ} = 1000$  mA,  $P_{out} = 20$  Watts Avg., Full Frequency Band, Channel Bandwidth = 3.84 MHz, PAR = 8.5 dB @ 0.01% Probability on CCDF.  
 Power Gain — 15.4 dB  
 Drain Efficiency — 23.5%  
 IM3 @ 10 MHz Offset — -37 dBc @ 3.84 MHz Channel Bandwidth  
 ACPR @ 5 MHz Offset — -40.5 dBc @ 3.84 MHz Channel Bandwidth
- Capable of Handling 10:1 VSWR, @ 28 Vdc, 2390 MHz, 100 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, 40 $\mu$ m Nominal.
- Pb-Free and RoHS Compliant
- In Tape and Reel. R3 Suffix = 250 Units per 56 mm, 13 inch Reel.

**MRF6S23100HR3**  
**MRF6S23100HSR3**

**2300-2400 MHz, 20 W AVG., 28 V**  
**2 x W-CDMA**  
**LATERAL N-CHANNEL**  
**RF POWER MOSFETs**



**CASE 465-06, STYLE 1**  
**NI-780**  
**MRF6S23100HR3**



**CASE 465A-06, STYLE 1**  
**NI-780S**  
**MRF6S23100HSR3**

**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 $^\circ\text{C}$	$P_D$	330 1.9	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	100	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 $^\circ\text{C}$ , 20 W CW	$R_{\theta JC}$	0.53 0.59	$^\circ\text{C}/\text{W}$

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, *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 Methodology	Class
Human Body Model (per JESD22-A114)	3A (Minimum)
Machine Model (per EIA/JESD22-A115)	A (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
<b>Off Characteristics</b>					
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 ( $V_{DS} = 10\text{ Vdc}$ , $I_D = 250\ \mu\text{Adc}$ )	$V_{GS(th)}$	1	2	3	Vdc
Gate Quiescent Voltage ( $V_{DS} = 28\text{ Vdc}$ , $I_D = 1000\ \text{mAdc}$ )	$V_{GS(Q)}$	2	2.8	4	Vdc
Drain-Source On-Voltage ( $V_{GS} = 10\text{ Vdc}$ , $I_D = 2.2\ \text{Adc}$ )	$V_{DS(on)}$	0.1	0.21	0.3	Vdc
Forward Transconductance ( $V_{DS} = 10\text{ Vdc}$ , $I_D = 2\ \text{Adc}$ )	$g_{fs}$	—	5.3	—	S

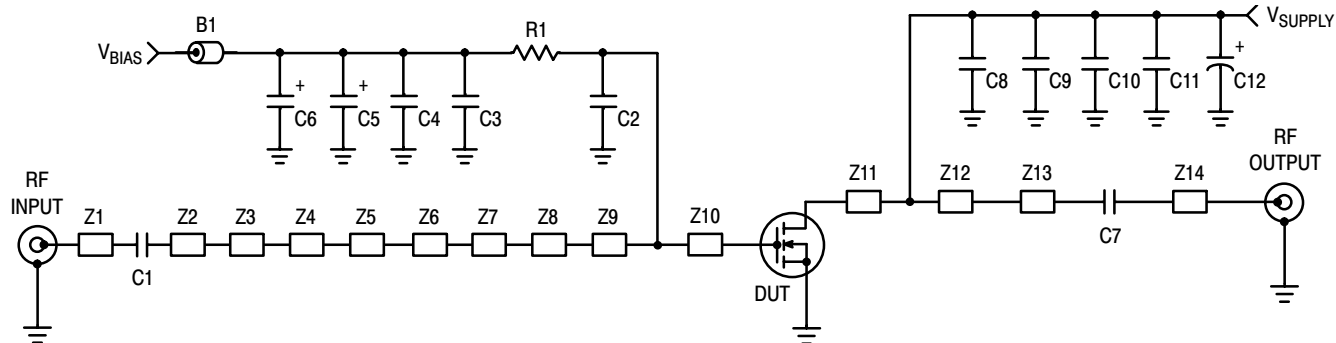
**Dynamic Characteristics** <sup>(1)</sup>

Reverse Transfer Capacitance ( $V_{DS} = 28\text{ Vdc} \pm 30\ \text{mV(rms)ac}$ @ 1 MHz, $V_{GS} = 0\text{ Vdc}$ )	$C_{rss}$	—	1.5	—	pF
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**Functional Tests** (In Freescale Test Fixture, 50 ohm system)  $V_{DD} = 28\text{ Vdc}$ ,  $I_{DQ} = 1000\ \text{mA}$ ,  $P_{out} = 20\ \text{W Avg.}$ ,  $f_1 = 2300\ \text{MHz}$ ,  $f_2 = 2310\ \text{MHz}$  and  $f_1 = 2390\ \text{MHz}$ ,  $f_2 = 2400\ \text{MHz}$ , 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	$G_{ps}$	14	15.4	17	dB
Drain Efficiency	$\eta_D$	22.5	23.5	—	%
Intermodulation Distortion	IM3	-35	-37	—	dBc
Adjacent Channel Power Ratio	ACPR	-38	-40.5	—	dBc
Input Return Loss	IRL	—	-10	—	dB

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



Z1	0.725" x 0.080" Microstrip	Z9	0.329" x 0.756" Microstrip
Z2	0.240" x 0.080" Microstrip	Z10	0.083" x 0.756" Microstrip
Z3	0.110" x 0.240" Microstrip	Z11	0.092" x 0.800" Microstrip
Z4	0.140" x 0.080" Microstrip	Z12	0.436" x 0.800" Microstrip
Z5	0.167" x 0.500" Microstrip	Z13	0.974" x 0.080" Microstrip
Z6	0.130" x 0.080" Microstrip	Z14	0.727" x 0.080" Microstrip
Z7	0.250" x 0.611" Microstrip	PCB	Arlon GX-0300-5022, 0.030", $\epsilon_r = 2.5$
Z8	0.060" x 0.080" Microstrip		

**Figure 1. MRF6S23100HR3(HSR3) Test Circuit Schematic**

**Table 5. MRF6S23100HR3(HSR3) Test Circuit Component Designations and Values**

Part	Description	Part Number	Manufacturer
B1	Ferrite Bead	2743019447	Fair-Rite
C1, C2, C7, C8	5.6 pF Chip Capacitors, B Case	100B5R6CP500X	ATC
C3	0.01 $\mu$ F Chip Capacitor (1825)	C1825C103J1RAC	Kemet
C4, C9	2.2 $\mu$ F, 50 V Chip Capacitors (1825)	C1825C225J5RAC	Kemet
C5	22 $\mu$ F, 25 V Tantalum Capacitor	ECS-T1ED226R	Panasonic TE series
C6	47 $\mu$ F, 16 V Tantalum Capacitor	T491D476K016AS	Kemet
C10, C11	10 $\mu$ F, 50 V Chip Capacitors (2220)	GRM55DR61H106KA88B	Murata
C12	330 $\mu$ F, 63 V Electrolytic Capacitor	NACZF331M63V	Nippon
R1	10 $\Omega$ , 1/8 W Chip Resistor (1206)	CRC120610R0F100	Dale/Vishay

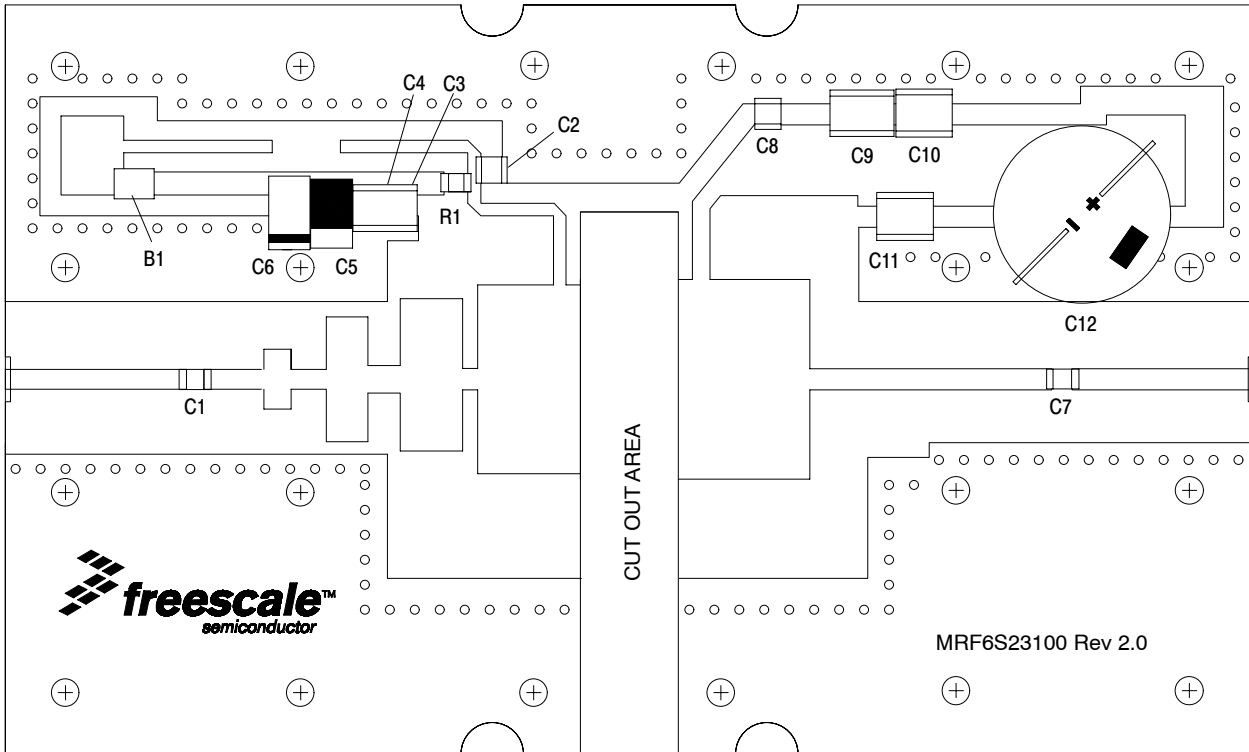


Figure 2. MRF6S23100HR3(HSR3) Test Circuit Component Layout

## TYPICAL CHARACTERISTICS

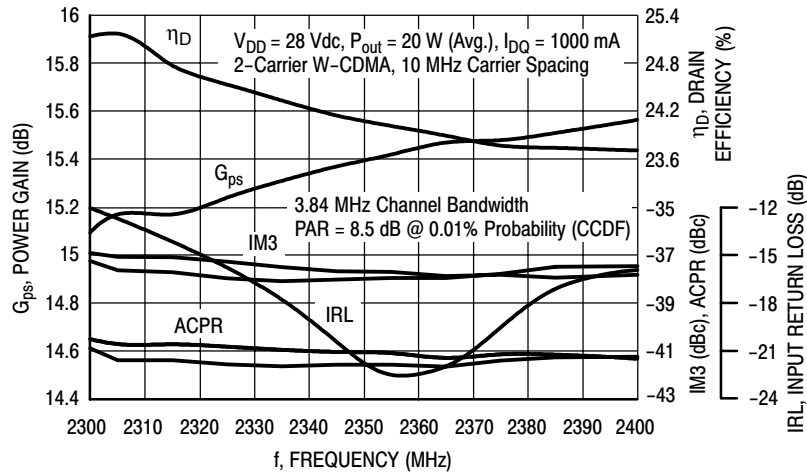


Figure 3. 2-Carrier W-CDMA Broadband Performance @  $P_{out} = 20$  Watts Avg.

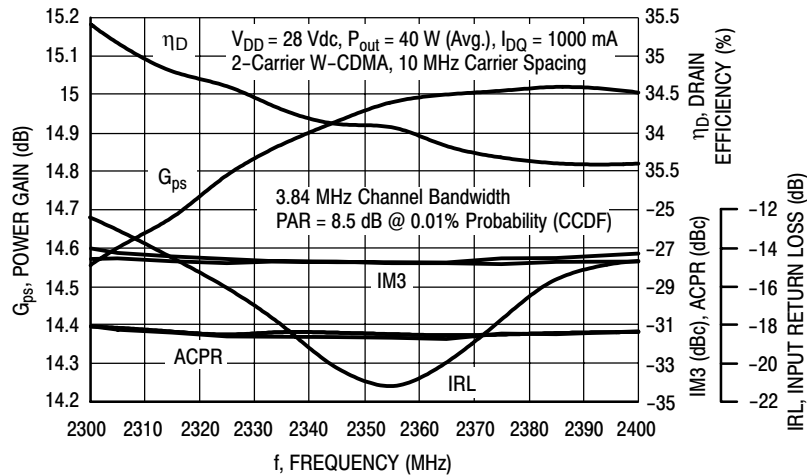


Figure 4. 2-Carrier W-CDMA Broadband Performance @  $P_{out} = 40$  Watts Avg.

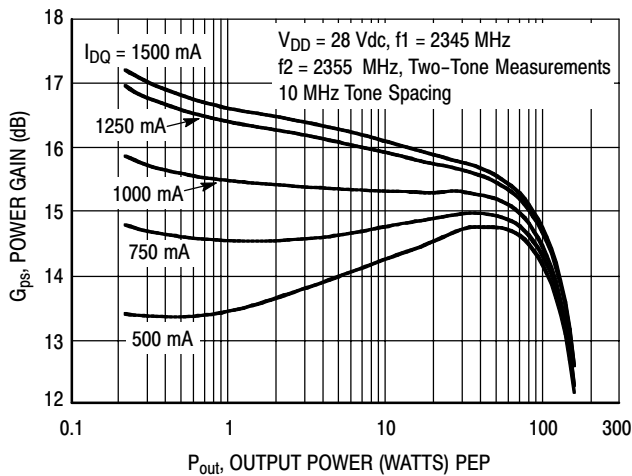


Figure 5. Two-Tone Power Gain versus Output Power

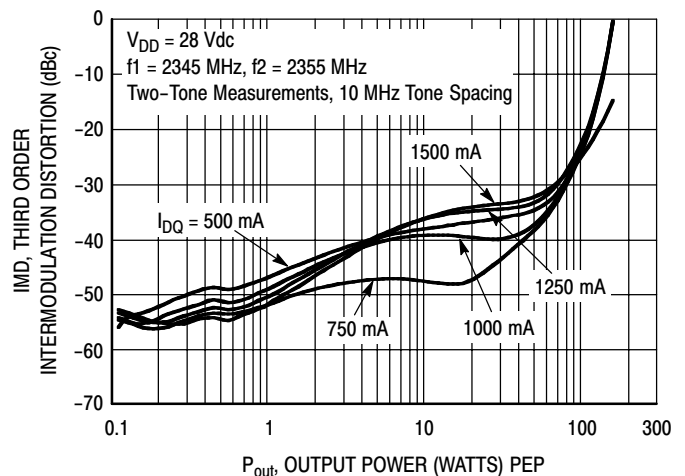
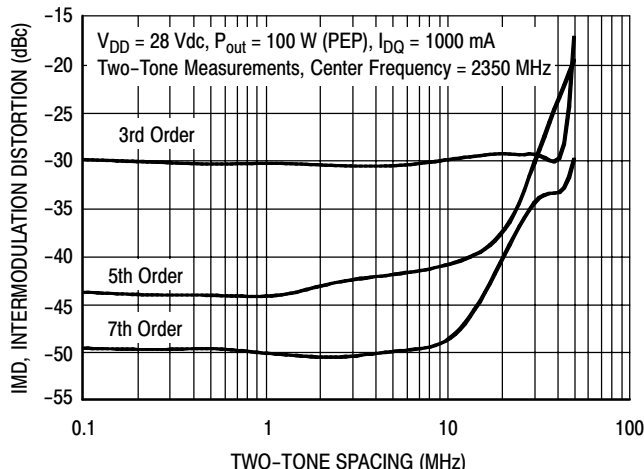


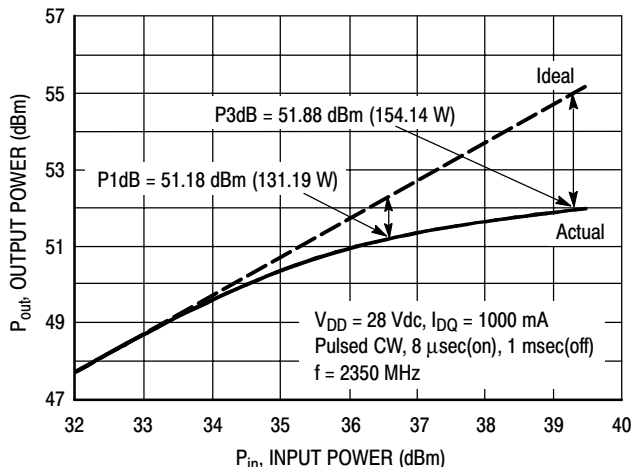
Figure 6. Third Order Intermodulation Distortion versus Output Power

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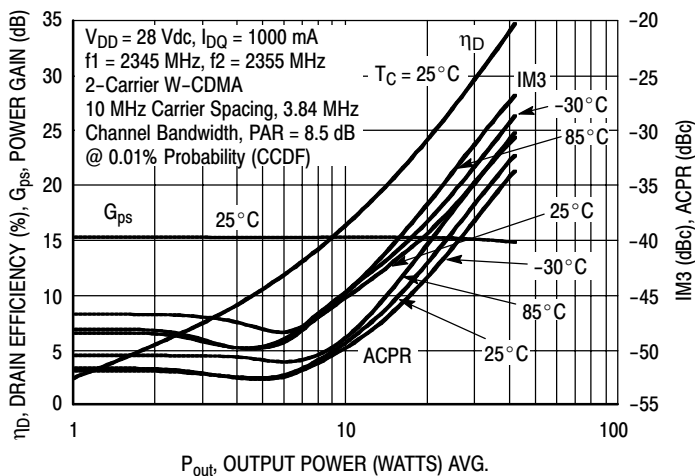
## TYPICAL CHARACTERISTICS



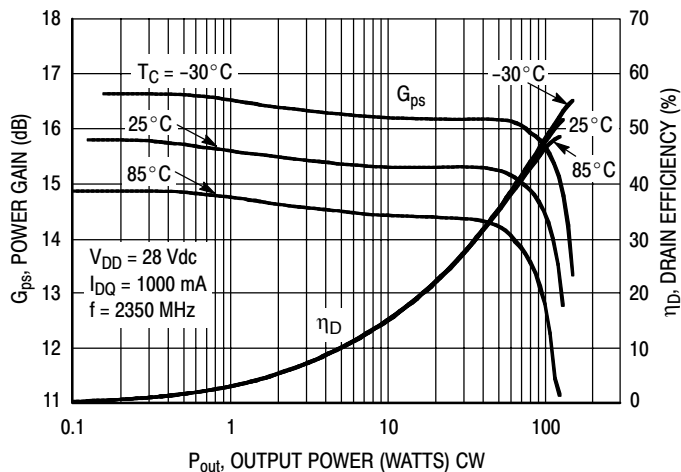
**Figure 7. Intermodulation Distortion Products versus Tone Spacing**



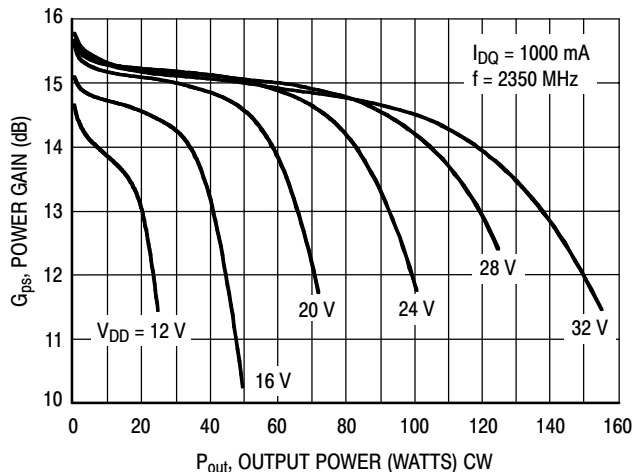
**Figure 8. Pulse CW Output Power versus Input Power**



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



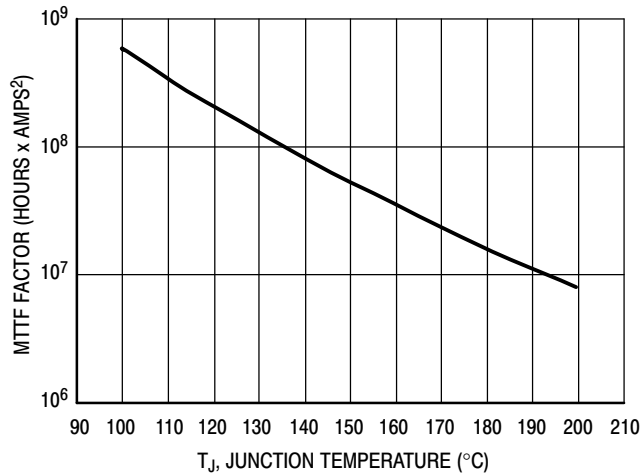
**Figure 10. Power Gain and Drain Efficiency versus CW Output Power**



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

MRF6S23100HR3 MRF6S23100HSR3

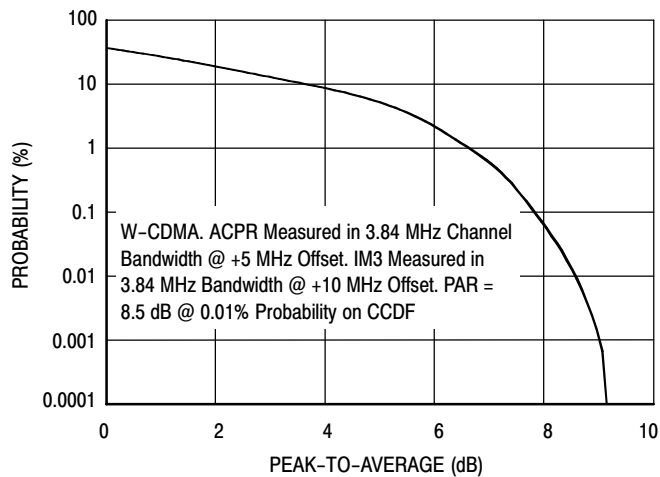
## TYPICAL CHARACTERISTICS



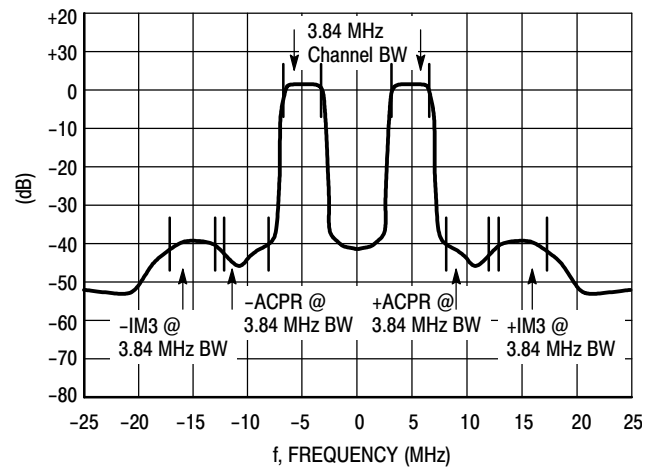
This above graph displays calculated MTTF in hours x ampere<sup>2</sup> drain current. Life tests at elevated temperatures have correlated to better than  $\pm 10\%$  of the theoretical prediction for metal failure. Divide MTTF factor by  $I_D^2$  for MTTF in a particular application.

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

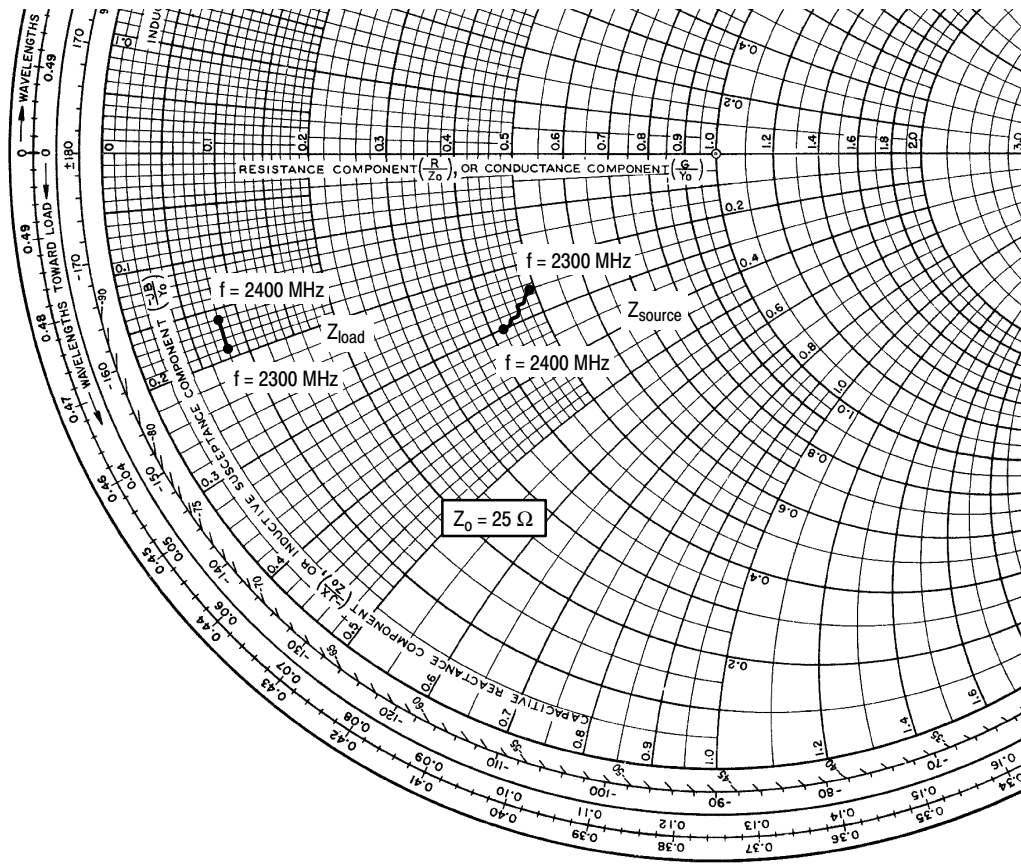
## W-CDMA TEST SIGNAL



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



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



$V_{DD} = 28 \text{ Vdc}$ ,  $I_{DQ} = 1000 \text{ mA}$ ,  $P_{out} = 20 \text{ W Avg.}$

f MHz	Z <sub>source</sub> Ω	Z <sub>load</sub> Ω
2300	12.20 - j6.20	2.06 - j4.69
2310	12.06 - j6.40	2.04 - j4.62
2320	11.91 - j6.56	2.02 - j4.55
2330	11.76 - j6.71	2.01 - j4.48
2340	11.60 - j6.86	1.99 - j4.42
2350	11.44 - j7.00	1.97 - j4.35
2360	11.27 - j7.13	1.96 - j4.28
2370	11.10 - j7.22	1.94 - j4.22
2380	10.92 - j7.34	1.93 - j4.15
2390	10.73 - j7.46	1.91 - j4.09
2400	10.55 - j7.53	1.90 - j4.02

Z<sub>source</sub> = Test circuit impedance as measured from gate to ground.

Z<sub>load</sub> = Test circuit impedance as measured from drain to ground.

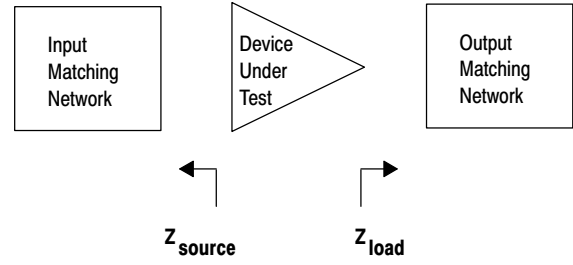


Figure 15. Series Equivalent Source and Load Impedance

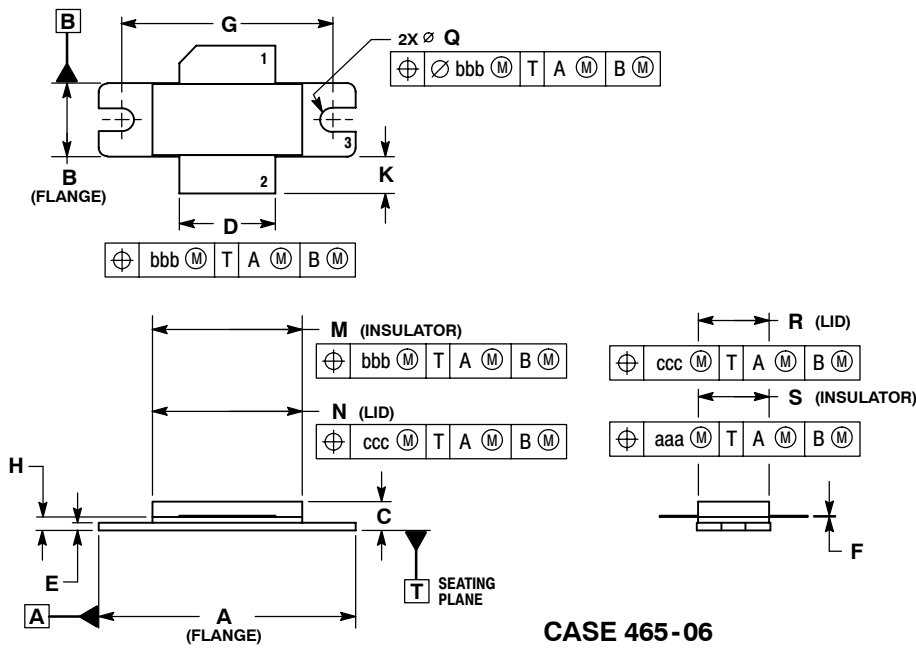
MRF6S23100HR3 MRF6S23100HSR3



# NOTES

# NOTES

## PACKAGE DIMENSIONS

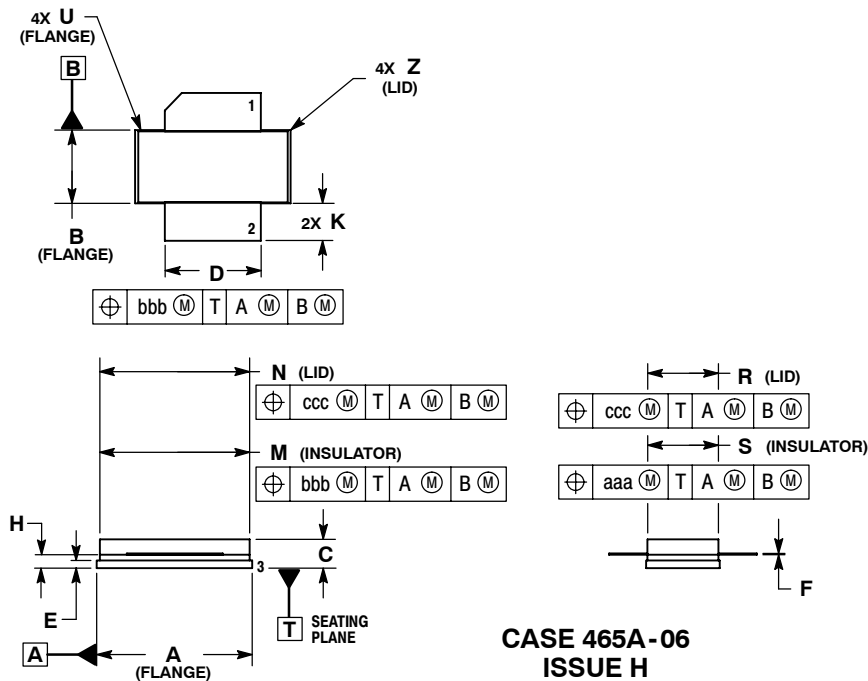


- NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M-1994.
  2. CONTROLLING DIMENSION: INCH.
  3. DELETED
  4. DIMENSION H IS MEASURED 0.030 (0.762) AWAY FROM PACKAGE BODY.

DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	1.335	1.345	33.91	34.16
B	0.380	0.390	9.65	9.91
C	0.125	0.170	3.18	4.32
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	0.774	0.786	19.66	19.96
N	0.772	0.788	19.60	20.00
Q	Ø 1.118	Ø 1.138	Ø 3.00	Ø 3.51
R	0.365	0.375	9.27	9.53
S	0.365	0.375	9.27	9.52
aaa	0.005 REF		0.127 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 465-06  
 ISSUE G  
 NI-780  
 MRF6S23100HR3**



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

DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.805	0.815	20.45	20.70
B	0.380	0.390	9.65	9.91
C	0.125	0.170	3.18	4.32
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	0.774	0.786	19.61	20.02
N	0.772	0.788	19.61	20.02
R	0.365	0.375	9.27	9.53
S	0.365	0.375	9.27	9.52
U	---	0.040	---	1.02
Z	---	0.030	---	0.76
aaa	0.005 REF		0.127 REF	
bbb	0.010 REF		0.254 REF	
ccc	0.015 REF		0.381 REF	

- STYLE 1:  
 PIN 1. DRAIN  
 2. GATE  
 5. SOURCE

**CASE 465A-06  
 ISSUE H  
 NI-780S  
 MRF6S23100HSR3**

**MRF6S23100HR3 MRF6S23100HSR3**

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