



# RF Power Field Effect Transistors

## N-Channel Enhancement-Mode Lateral MOSFETs

Designed for CDMA base station applications with frequencies from 2300 to 2400 MHz. Suitable for WiMAX, WiBro and multicarrier amplifier applications. To be used in Class AB and Class C for WLL applications.

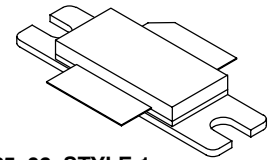
- Typical 2-Carrier W-CDMA Performance:  $V_{DD} = 28$  Volts,  $I_{DQ} = 1000$  mA,  $P_{out} = 20$  Watts Avg., Full Frequency Band, Channel Bandwidth = 3.84 MHz, PAR = 8.5 dB @ 0.01% Probability on CCDF.  
Power Gain — 15.4 dB  
Drain Efficiency — 23.5%  
IM3 @ 10 MHz Offset — -37 dBc @ 3.84 MHz Channel 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

### Features

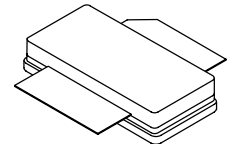
- Characterized with Series Equivalent Large-Signal Impedance Parameters
- Internally Matched for Ease of Use
- Qualified Up to a Maximum of 32  $V_{DD}$  Operation
- Integrated ESD Protection
- Lower Thermal Resistance Package
- Designed for Lower Memory Effects and Wide Instantaneous Bandwidth Applications
- Low Gold Plating Thickness on Leads, 40 $\mu$ m Nominal.
- 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	$^\circ\text{C}$
Case Operating Temperature	$T_C$	150	$^\circ\text{C}$
Operating Junction Temperature	$T_J$	200	$^\circ\text{C}$

**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.

**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

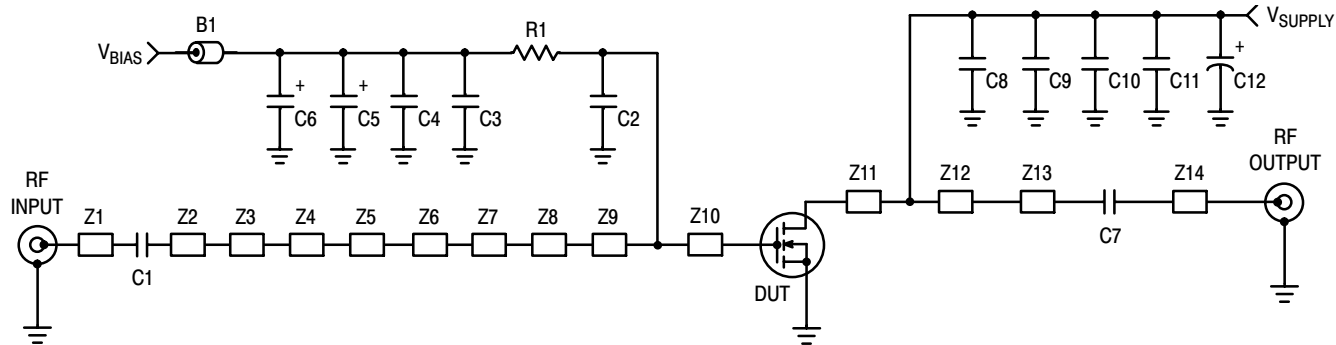
**Dynamic Characteristics** <sup>(1)</sup>

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

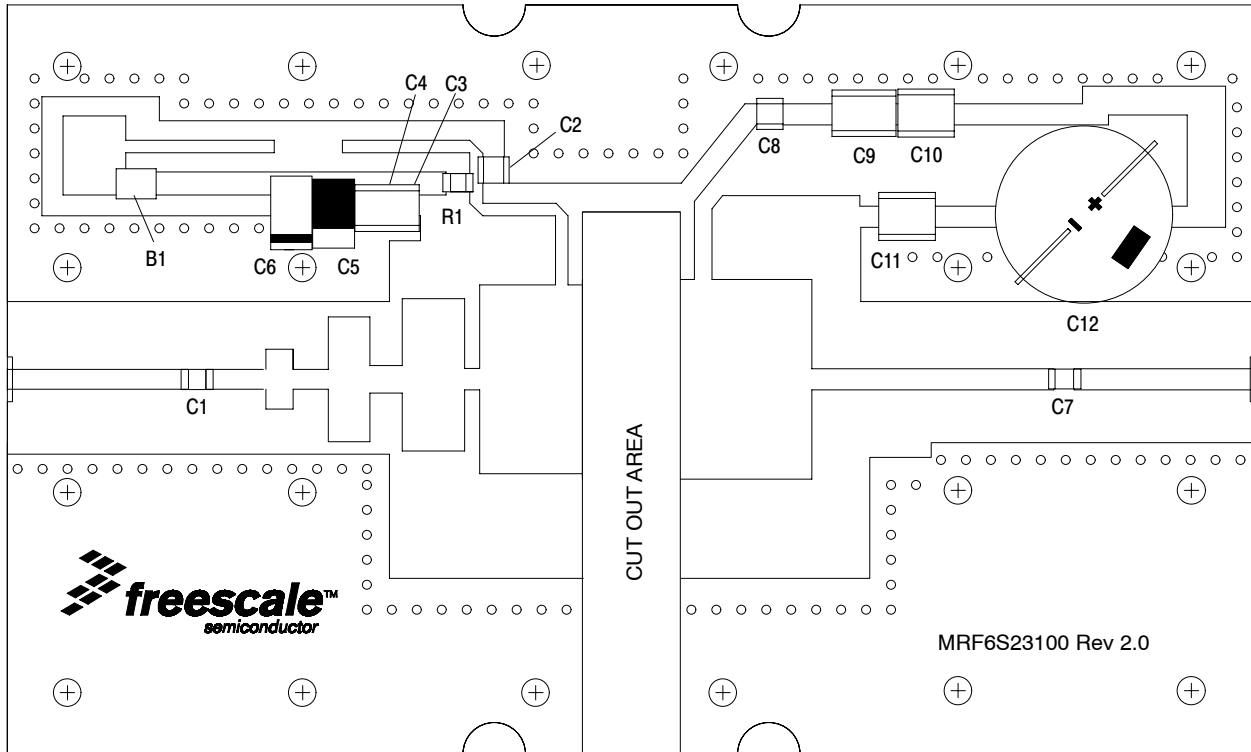


Figure 2. MRF6S23100HR3(HSR3) Test Circuit Component Layout

## TYPICAL CHARACTERISTICS

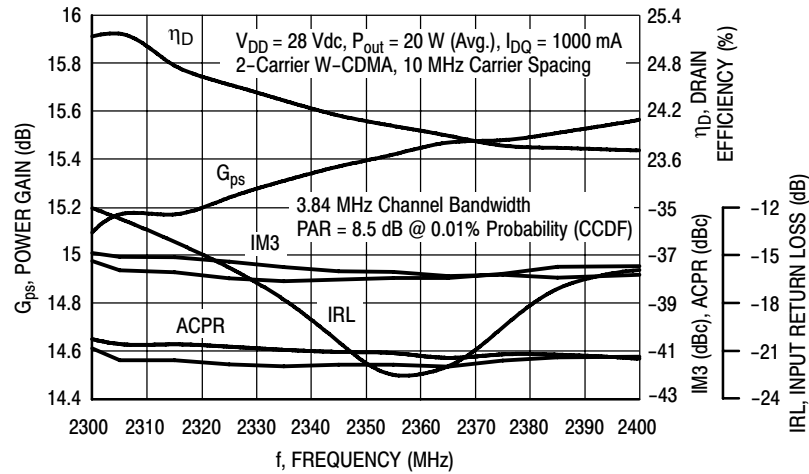


Figure 3. 2-Carrier W-CDMA Broadband Performance @  $P_{out} = 20$  Watts Avg.

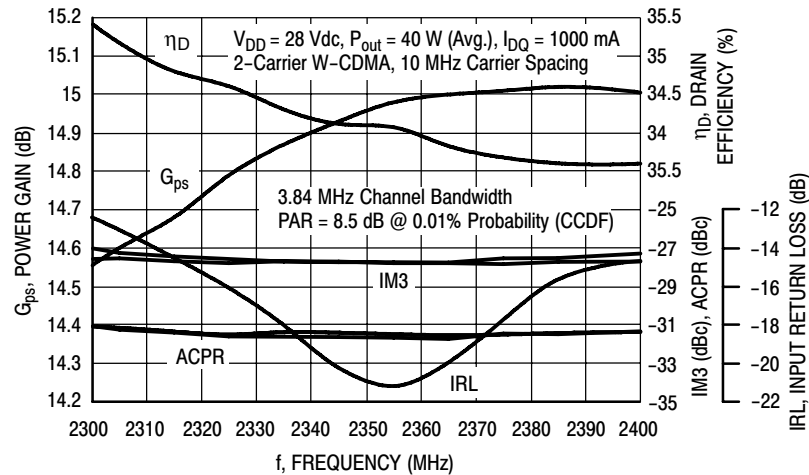


Figure 4. 2-Carrier W-CDMA Broadband Performance @  $P_{out} = 40$  Watts Avg.

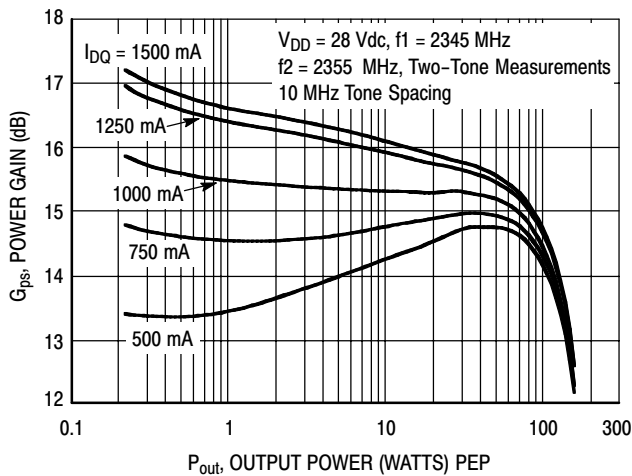


Figure 5. Two-Tone Power Gain versus Output Power

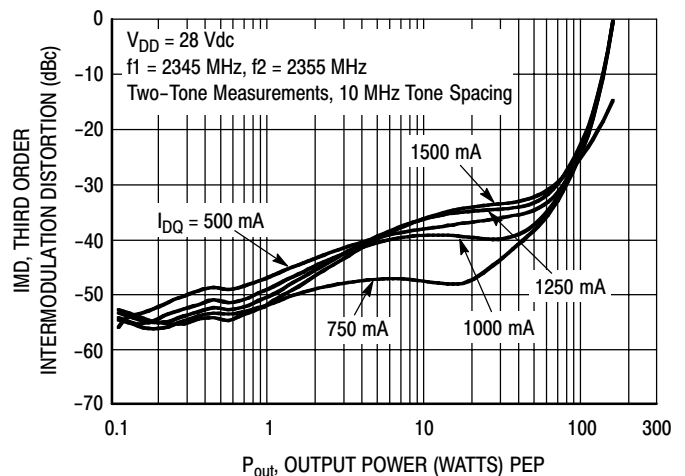
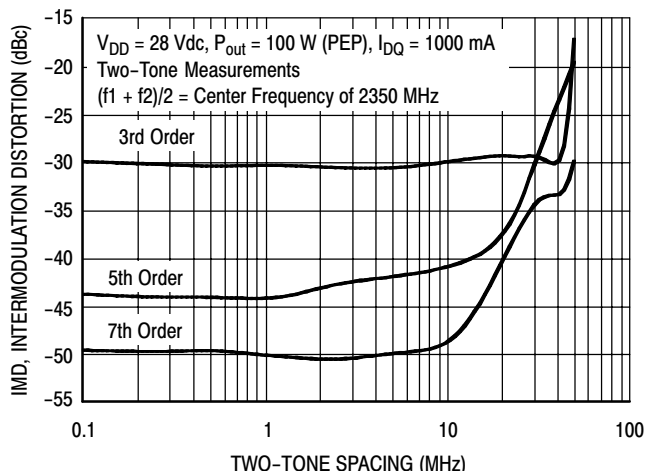


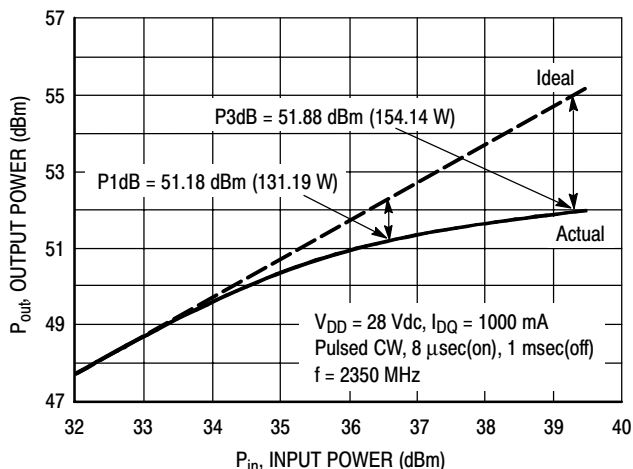
Figure 6. Third Order Intermodulation Distortion versus Output Power

MRF6S23100HR3 MRF6S23100HSR3

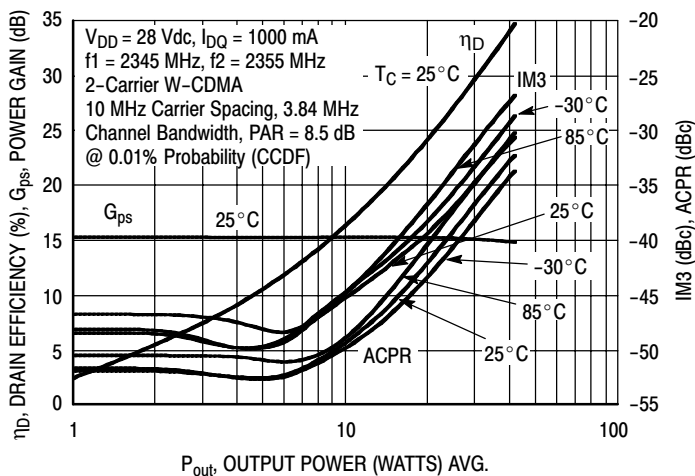
## TYPICAL CHARACTERISTICS



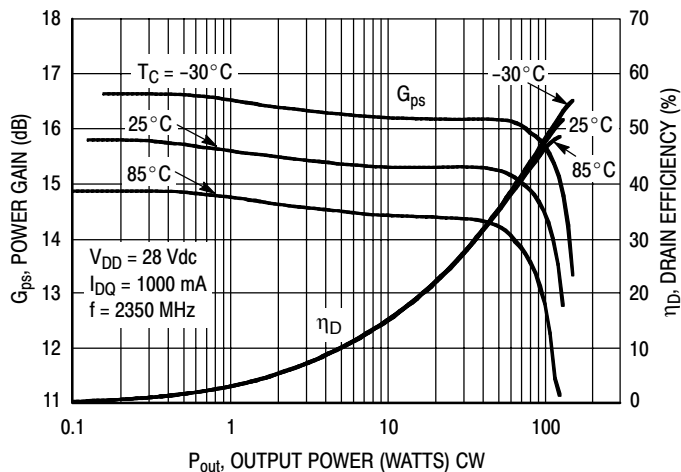
**Figure 7. Intermodulation Distortion Products versus Tone Spacing**



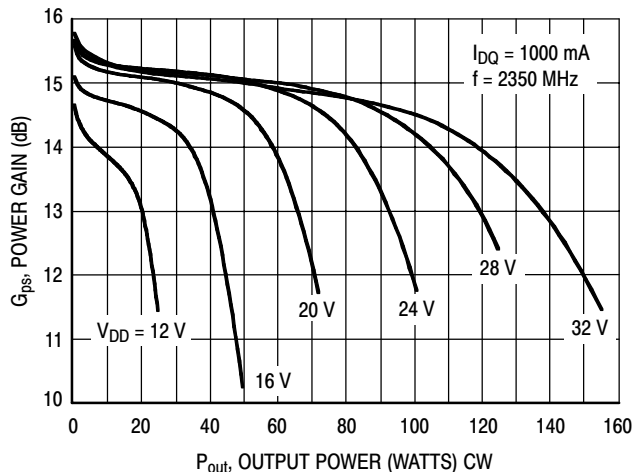
**Figure 8. Pulse CW Output Power versus Input Power**



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



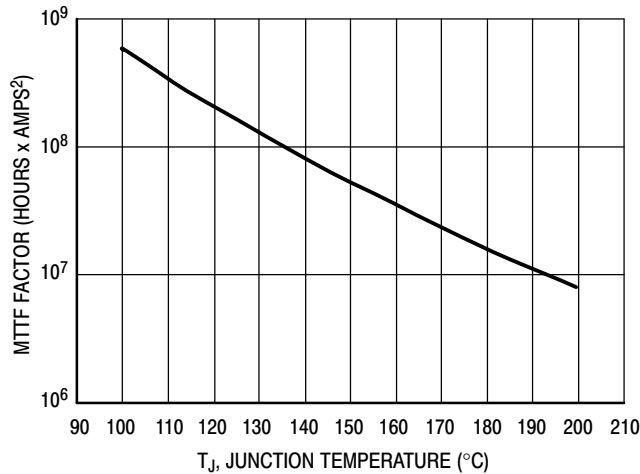
**Figure 10. Power Gain and Drain Efficiency versus CW Output Power**



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

MRF6S23100HR3 MRF6S23100HSR3

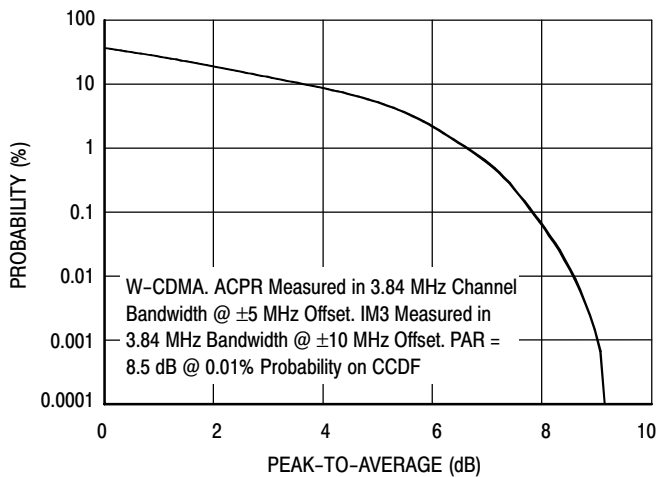
## TYPICAL CHARACTERISTICS



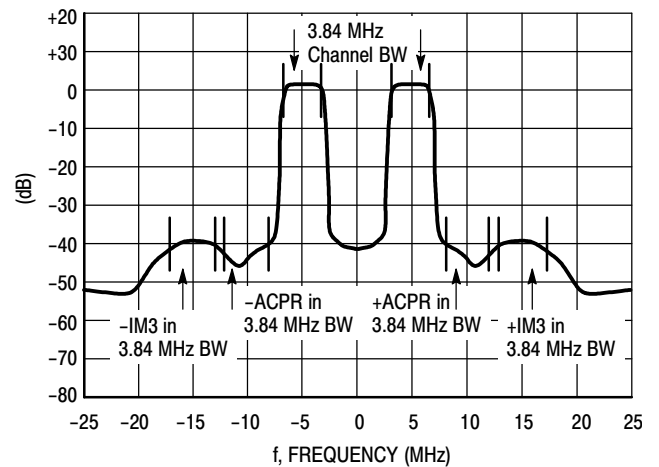
This above graph displays calculated MTTF in hours x ampere<sup>2</sup> drain current. Life tests at elevated temperatures have correlated to better than  $\pm 10\%$  of the theoretical prediction for metal failure. Divide MTTF factor by  $I_D^2$  for MTTF in a particular application.

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

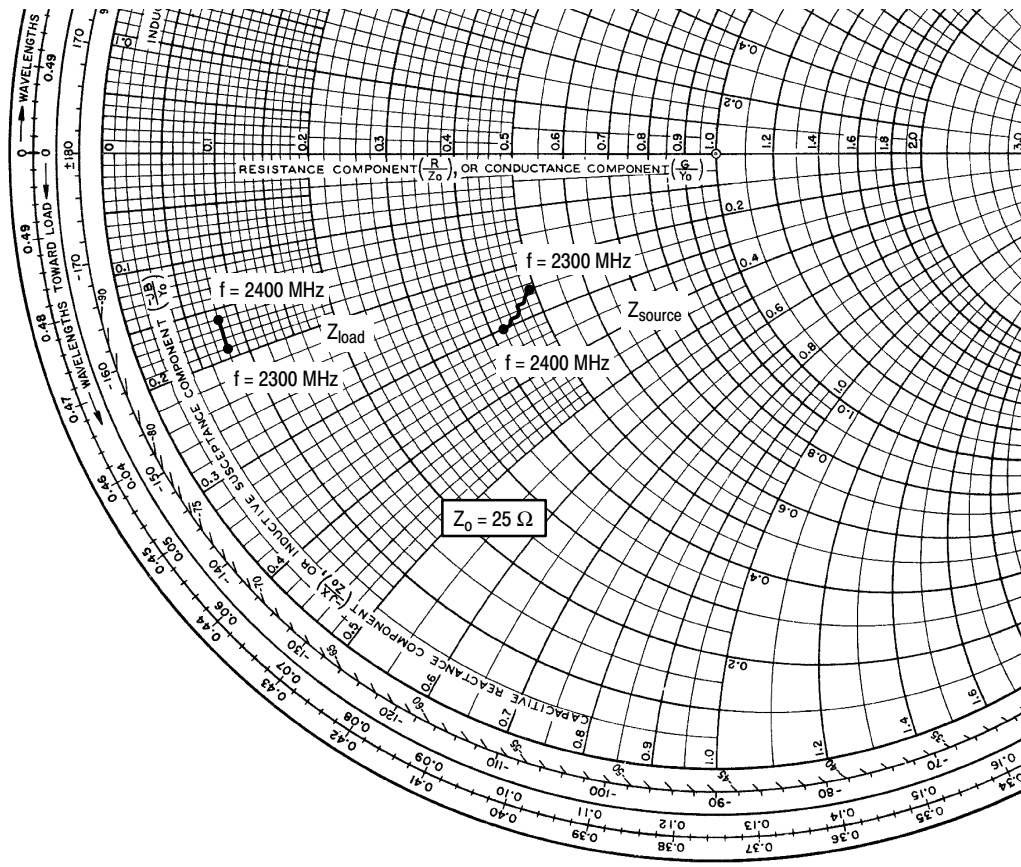
## W-CDMA TEST SIGNAL



**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.

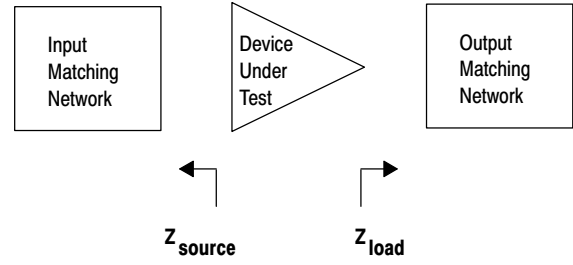


Figure 15. Series Equivalent Source and Load Impedance

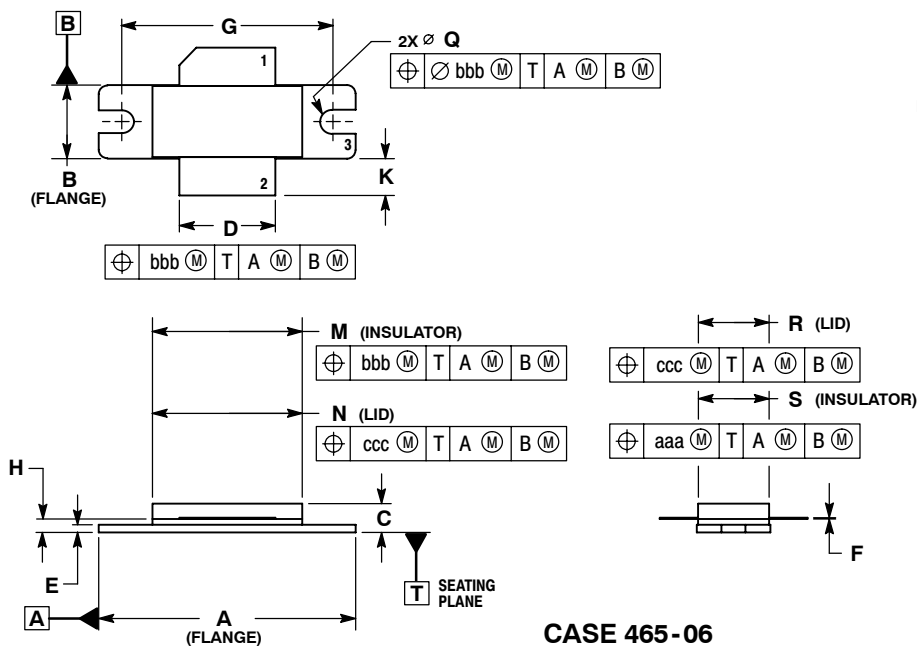
MRF6S23100HR3 MRF6S23100HSR3



# NOTES

# NOTES

## PACKAGE DIMENSIONS

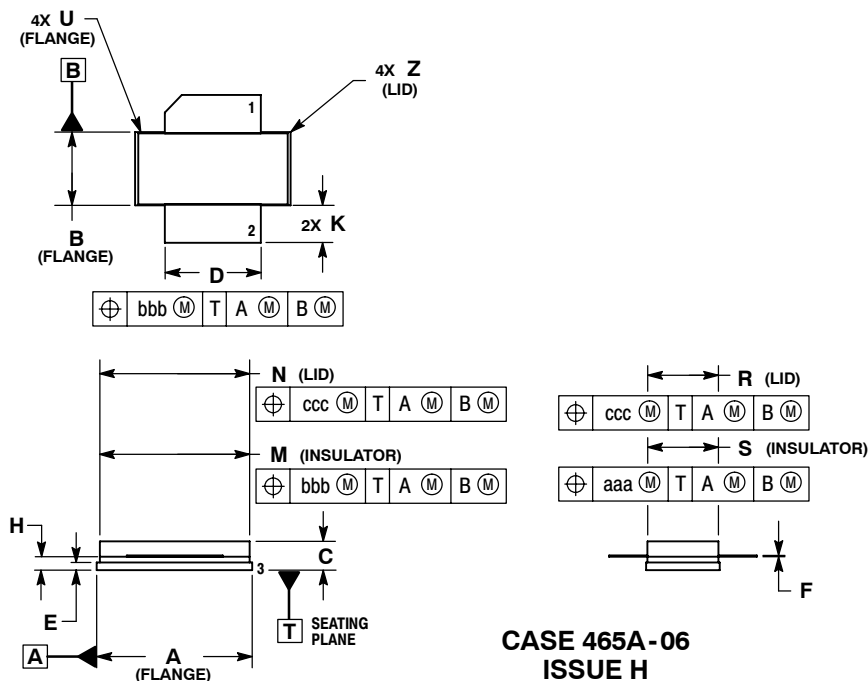


- NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M-1994.
  2. CONTROLLING DIMENSION: INCH.
  3. DELETED
  4. DIMENSION H IS MEASURED 0.030 (0.762) AWAY FROM PACKAGE BODY.

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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