

# RF Power Field Effect Transistors

## N-Channel Enhancement-Mode Lateral MOSFETs

RF Power transistors designed for applications operating at frequencies between 965 and 1215 MHz. These devices are suitable for use in pulsed applications.

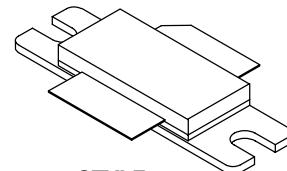
- Typical Pulsed Performance:  $V_{DD} = 50$  Volts,  $I_{DQ} = 200$  mA,  $P_{out} = 500$  Watts Peak (50 W Avg.),  $f = 1030$  MHz, Pulse Width = 128  $\mu$ sec, Duty Cycle = 10%
  - Power Gain — 19.7 dB
  - Drain Efficiency — 62%
- Capable of Handling 10:1 VSWR, @ 50 Vdc, 1030 MHz, 500 Watts Peak Power

### Features

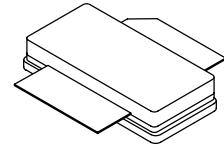
- Characterized with Series Equivalent Large-Signal Impedance Parameters
- Internally Matched for Ease of Use
- Qualified Up to a Maximum of 50  $V_{DD}$  Operation
- Integrated ESD Protection
- Greater Negative Gate-Source Voltage Range for Improved Class C Operation
- RoHS Compliant
- In Tape and Reel. R3 Suffix = 250 Units per 56 mm, 13 inch Reel.

**MRF6V12500HR3  
MRF6V12500HSR3**

**965 - 1215 MHz, 500 W, 50 V  
PULSED  
LATERAL N-CHANNEL  
RF POWER MOSFETs**



CASE 465-06, STYLE 1  
NI-780  
MRF6V12500HR3



CASE 465A-06, STYLE 1  
NI-780S  
MRF6V12500HSR3

**Table 1. Maximum Ratings**

Rating	Symbol	Value	Unit
Drain-Source Voltage	$V_{DSS}$	-0.5, +100	Vdc
Gate-Source Voltage	$V_{GS}$	-6.0, +10	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 Case Temperature 80°C, 500 W Pulsed, 128 $\mu$ sec Pulse Width, 10% Duty Cycle	$Z_{\theta JC}$	0.044	°C/W

- MTTF calculator available at <http://www.freescale.com/rf>. Select Software & Tools/Development Tools/Calculators to access MTTF calculators by product.
- 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)	2 (Minimum)
Machine Model (per EIA/JESD22-A115)	B (Minimum)
Charge Device Model (per JESD22-C101)	IV (Minimum)

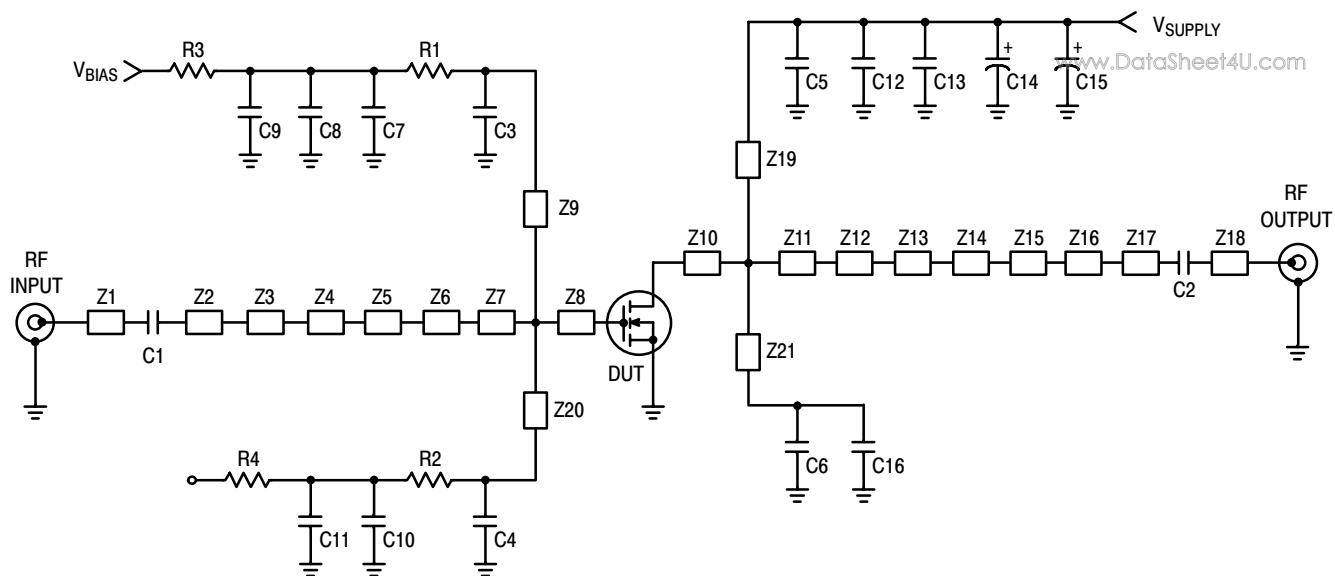
**Table 4. Electrical Characteristics** ( $T_A = 25^\circ\text{C}$  unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
<b>Off Characteristics</b>					
Gate-Source Leakage Current ( $V_{GS} = 5 \text{ Vdc}$ , $V_{DS} = 0 \text{ Vdc}$ )	$I_{GSS}$	—	—	10	$\mu\text{A dc}$
Drain-Source Breakdown Voltage ( $V_{GS} = 0 \text{ Vdc}$ , $I_D = 200 \text{ mA}$ )	$V_{(BR)DSS}$	110	—	—	$\text{Vdc}$
Zero Gate Voltage Drain Leakage Current ( $V_{DS} = 50 \text{ Vdc}$ , $V_{GS} = 0 \text{ Vdc}$ )	$I_{DSS}$	—	—	20	$\mu\text{A dc}$
Zero Gate Voltage Drain Leakage Current ( $V_{DS} = 90 \text{ Vdc}$ , $V_{GS} = 0 \text{ Vdc}$ )	$I_{DSS}$	—	—	200	$\mu\text{A dc}$
<b>On Characteristics</b>					
Gate Threshold Voltage ( $V_{DS} = 10 \text{ Vdc}$ , $I_D = 1.32 \text{ mA}$ )	$V_{GS(\text{th})}$	0.9	1.7	2.4	$\text{Vdc}$
Gate Quiescent Voltage ( $V_{DD} = 50 \text{ Vdc}$ , $I_D = 200 \text{ mA dc}$ , Measured in Functional Test)	$V_{GS(Q)}$	1.7	2.4	3.2	$\text{Vdc}$
Drain-Source On-Voltage ( $V_{GS} = 10 \text{ Vdc}$ , $I_D = 3.26 \text{ Adc}$ )	$V_{DS(\text{on})}$	—	0.25	—	$\text{Vdc}$
<b>Dynamic Characteristics (1)</b>					
Reverse Transfer Capacitance ( $V_{DS} = 50 \text{ Vdc} \pm 30 \text{ mV(rms)ac}$ @ 1 MHz, $V_{GS} = 0 \text{ Vdc}$ )	$C_{rss}$	—	0.2	—	$\text{pF}$
Output Capacitance ( $V_{DS} = 50 \text{ Vdc} \pm 30 \text{ mV(rms)ac}$ @ 1 MHz, $V_{GS} = 0 \text{ Vdc}$ )	$C_{oss}$	—	697	—	$\text{pF}$
Input Capacitance ( $V_{DS} = 50 \text{ Vdc}$ , $V_{GS} = 0 \text{ Vdc} \pm 30 \text{ mV(rms)ac}$ @ 1 MHz)	$C_{iss}$	—	1391	—	$\text{pF}$

**Functional Tests** (In Freescale Test Fixture, 50 ohm system)  $V_{DD} = 50 \text{ Vdc}$ ,  $I_{DQ} = 200 \text{ mA}$ ,  $P_{out} = 500 \text{ W Peak}$  (50 W Avg.),  $f = 1030 \text{ MHz}$ , Pulsed, 128  $\mu\text{sec}$  Pulse Width, 10% Duty Cycle

Power Gain	$G_{ps}$	18.5	19.7	22	dB
Drain Efficiency	$\eta_D$	58	62	—	%
Input Return Loss	IRL	—	-18	-9	dB

1. Part internally matched both on input and output.

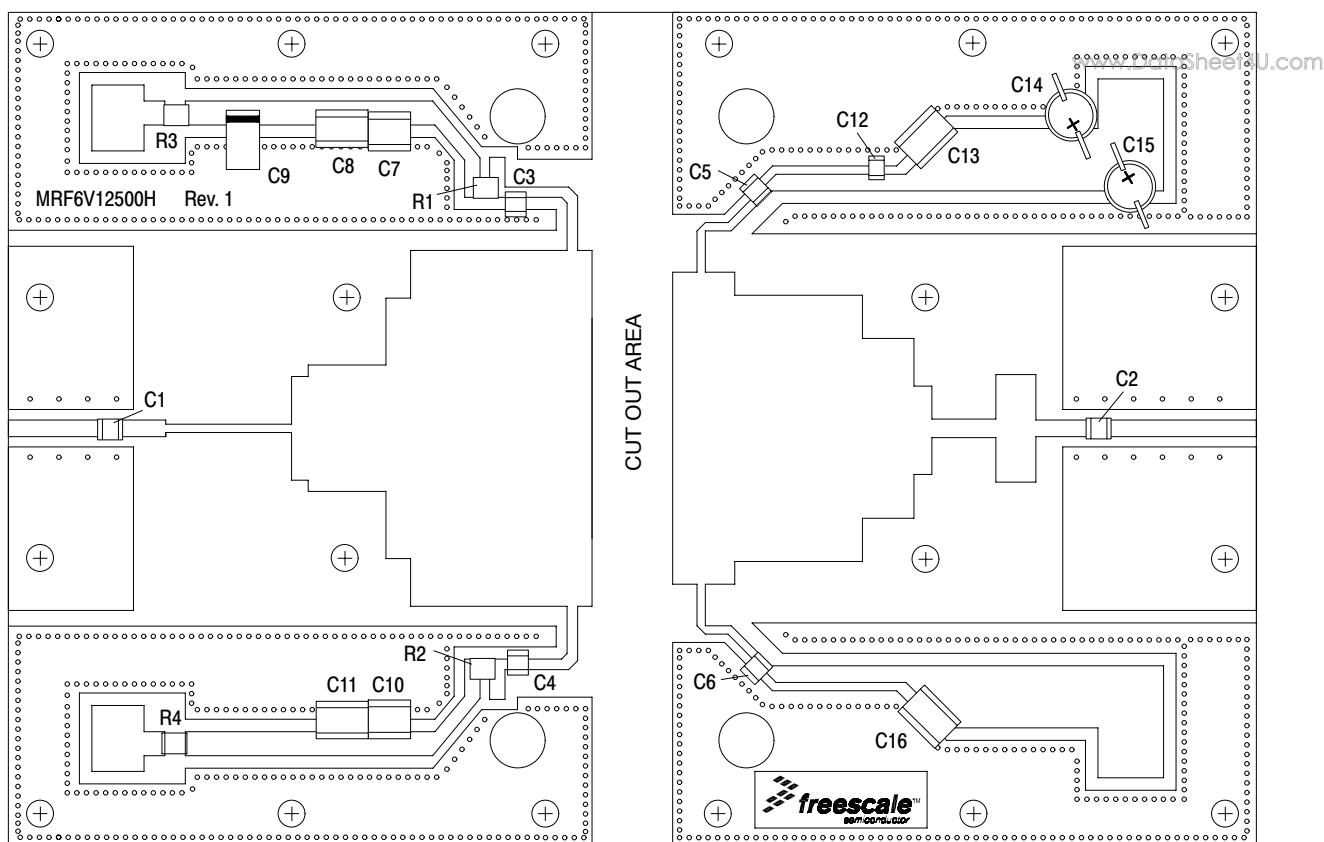


Z1	0.457" x 0.080" Microstrip	Z11	0.161" x 1.500" Microstrip
Z2	0.250" x 0.080" Microstrip	Z12	0.613" x 1.281" Microstrip
Z3	0.605" x 0.040" Microstrip	Z13	0.248" x 0.865" Microstrip
Z4	0.080" x 0.449" Microstrip	Z14	0.087" x 0.425" Microstrip
Z5	0.374" x 0.608" Microstrip	Z15	0.309" x 0.090" Microstrip
Z6	0.118" x 1.252" Microstrip	Z16	0.193" x 0.516" Microstrip
Z7	0.778" x 1.710" Microstrip	Z17	0.279" x 0.080" Microstrip
Z8	0.095" x 1.710" Microstrip	Z18	0.731" x 0.080" Microstrip
Z9, Z20	0.482" x 0.050" Microstrip	Z19, Z21	0.507" x 0.040" Microstrip
Z10	0.138" x 1.500" Microstrip	PCB	Arlon CuClad 250GX-0300-55-22, 0.030", $\epsilon_r = 2.55$

Figure 1. MRF6V12500HR3(HSR3) Test Circuit Schematic

Table 5. MRF6V12500HR3(HSR3) Test Circuit Component Designations and Values

Part	Description	Part Number	Manufacturer
C1, C2	5.1 pF Chip Capacitors	ATC100B5R1CT500XT	ATC
C3, C4, C5, C6	33 pF Chip Capacitors	ATC100B330JT500XT	ATC
C7, C10	10 $\mu$ F, 50 V Chip Capacitors	GRM55DR61H106KA88L	Murata
C8, C11, C13, C16	2.2 $\mu$ F, 100 V Chip Capacitors	2225X7R225KT3AB	ATC
C9	22 $\mu$ F, 25 V Chip Capacitor	TPSD226M025R0200	AVX
C12	1 $\mu$ F, 100 V Chip Capacitor	GRM31CR72A105KA01L	Murata
C14, C15	470 $\mu$ F, 63 V Electrolytic Capacitors	MCGP63V477M13X26-RH	Multicomp
R1, R2	56 $\Omega$ , 1/4 W Chip Resistors	CRCW120656R0FKEA	Vishay
R3, R4	0 $\Omega$ , 3 A Chip Resistors	CRCW12060000Z0EA	Vishay

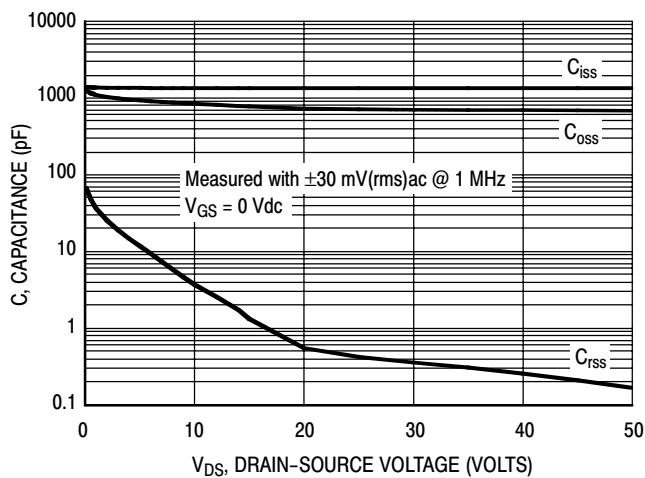


**Figure 2. MRF6V12500HR3(HSR3) Test Circuit Component Layout**

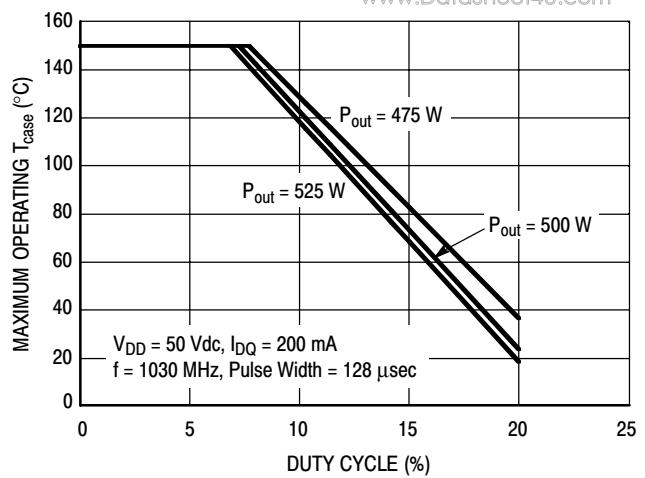
### MRF6V12500HR3 MRF6V12500HSR3

## TYPICAL CHARACTERISTICS

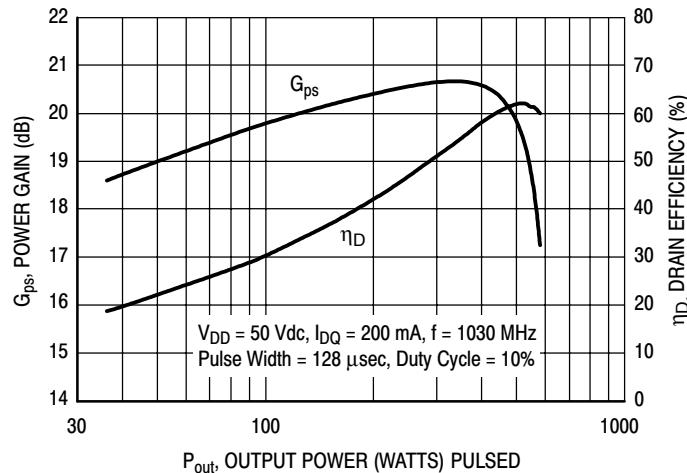
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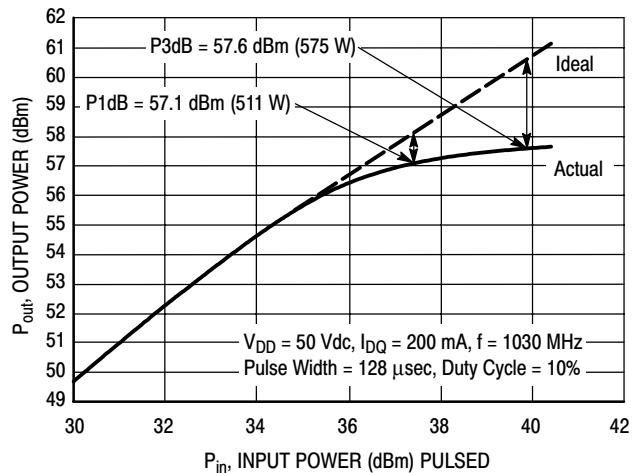
**Figure 3. Capacitance versus Drain-Source Voltage**



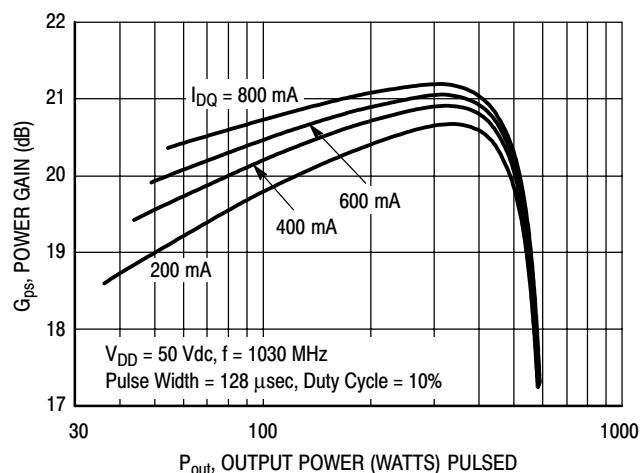
**Figure 4. Safe Operating Area**



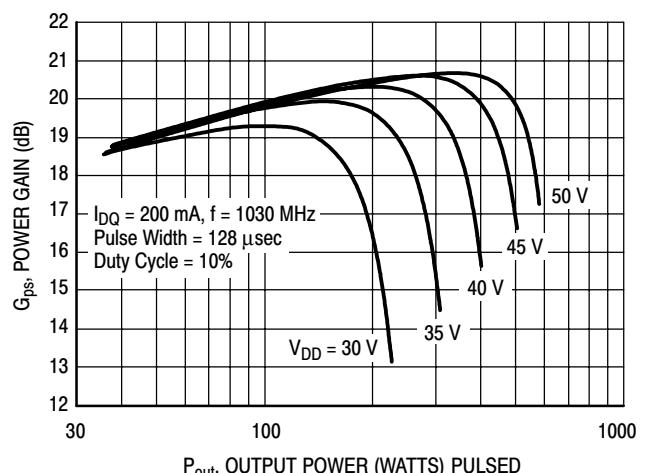
**Figure 5. Pulsed Power Gain and Drain Efficiency versus Output Power**



**Figure 6. Pulsed Output Power versus Input Power**



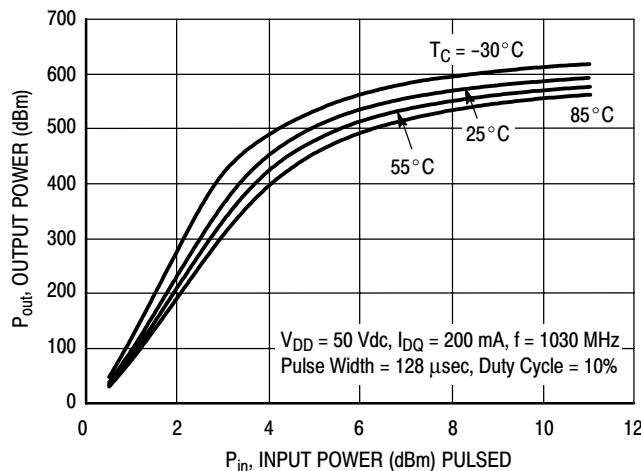
**Figure 7. Pulsed Power Gain versus Output Power**



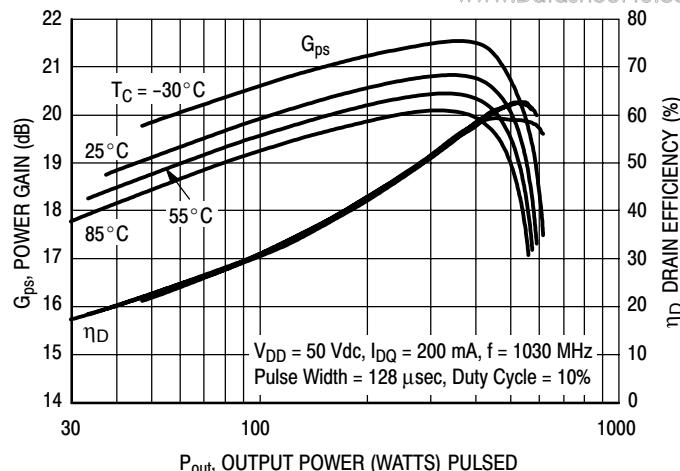
**Figure 8. Pulsed Power Gain versus Output Power**

## TYPICAL CHARACTERISTICS

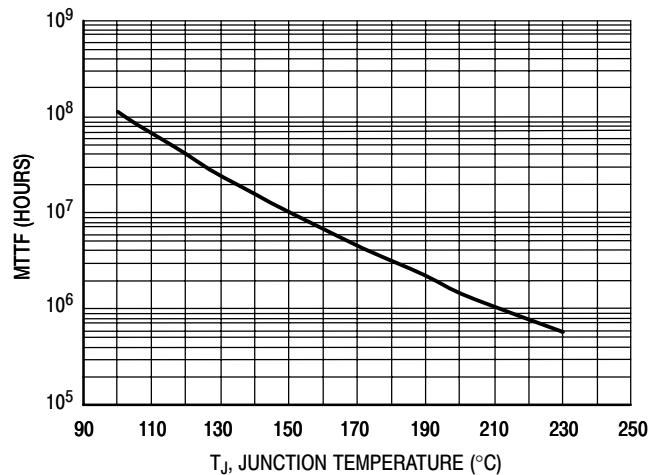
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**Figure 9. Pulsed Output Power versus Input Power**



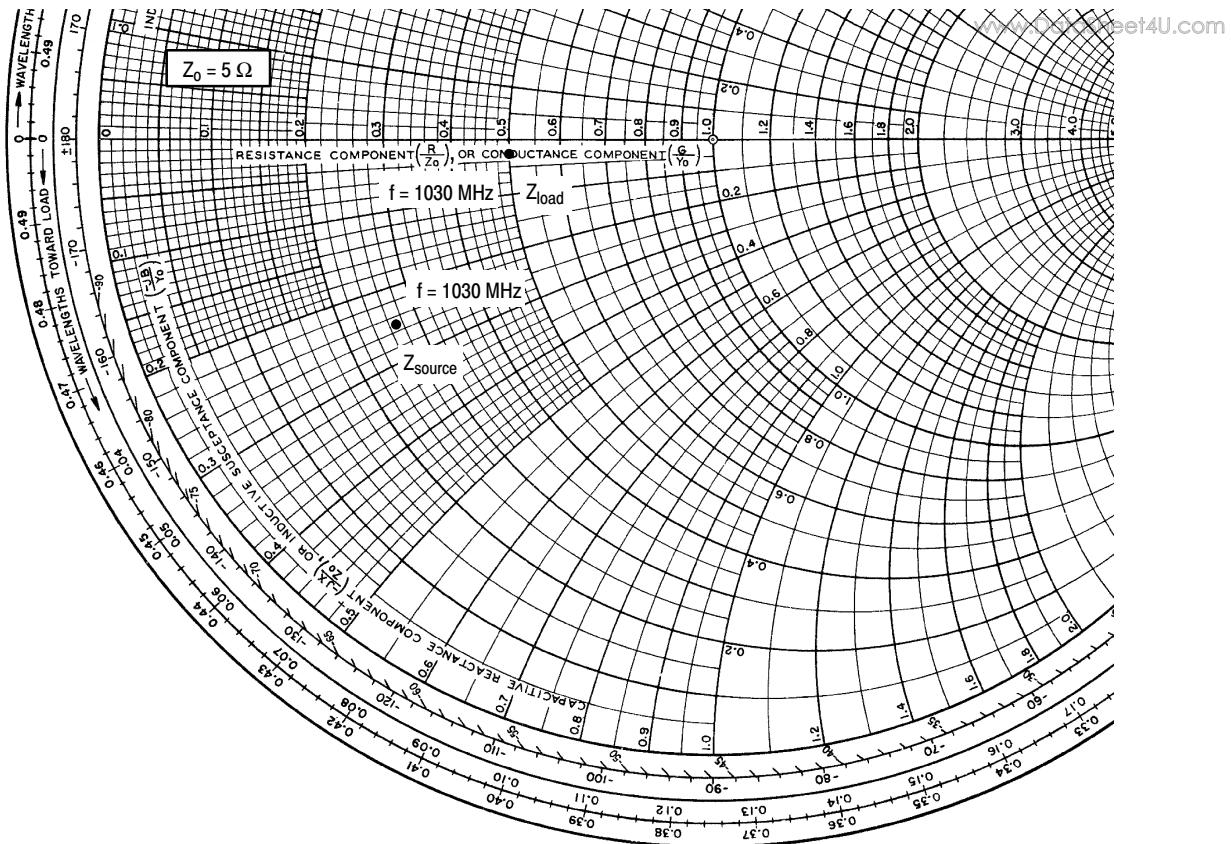
**Figure 10. Pulsed Power Gain and Drain Efficiency versus Output Power**



This above graph displays calculated MTTF in hours when the device is operated at  $V_{DD} = 50$  Vdc,  $P_{out} = 500$  W Peak, Pulse Width = 128  $\mu$ sec, Duty Cycle = 10%, and  $\eta_D = 62\%$ .

MTTF calculator available at <http://www.freescale.com/rf>. Select Software & Tools/Development Tools/Calculators to access MTTF calculators by product.

**Figure 11. MTTF versus Junction Temperature**



$V_{DD} = 50 \text{ Vdc}$ ,  $I_{DQ} = 200 \text{ mA}$ ,  $P_{out} = 500 \text{ W Peak}$

$f$ MHz	$Z_{\text{source}}$ $\Omega$	$Z_{\text{load}}$ $\Omega$
1030	$1.36 - j1.27$	$2.50 - j0.17$

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

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

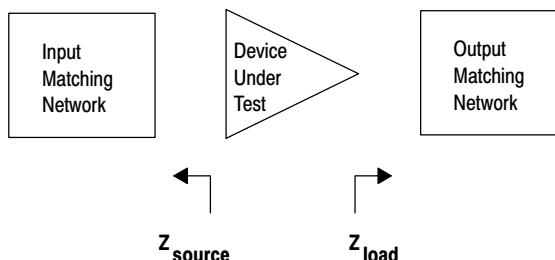
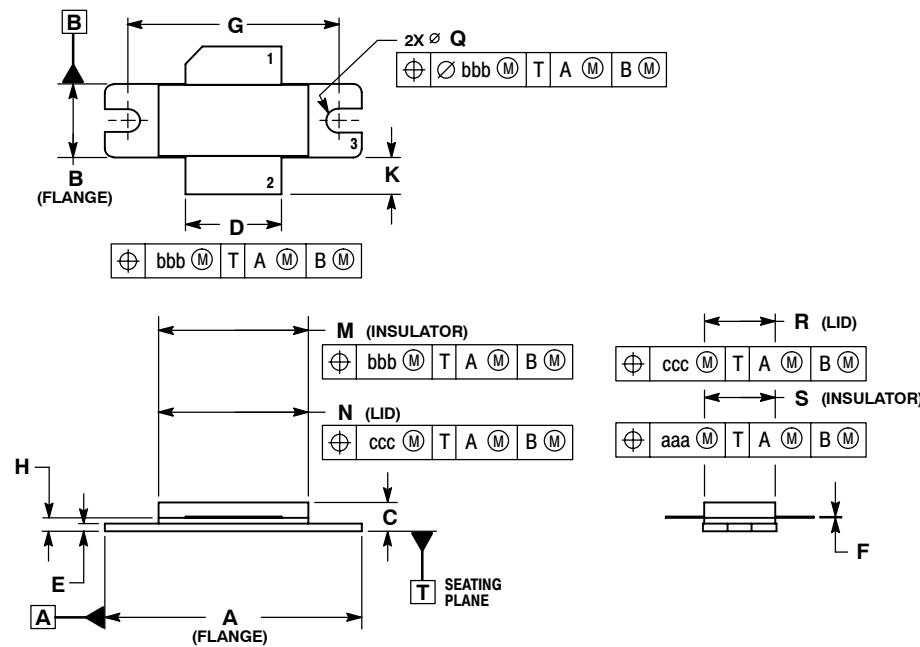


Figure 12. Series Equivalent Source and Load Impedance

## PACKAGE DIMENSIONS

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**CASE 465-06  
ISSUE G  
NI-780  
MRF6V12500HR3**

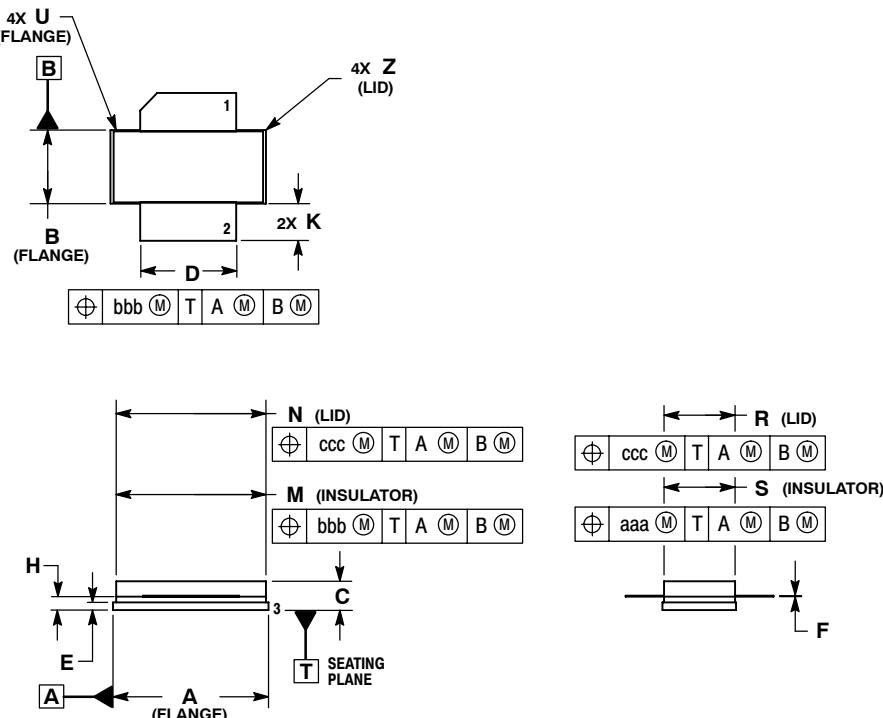
**NOTES:**

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 0.118	Ø 0.138	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:**

1. DRAIN
2. GATE
3. SOURCE



**CASE 465A-06  
ISSUE H  
NI-780S  
MRF6V12500HSR3**

**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:**

1. DRAIN
2. GATE
3. SOURCE

**MRF6V12500HR3 MRF6V12500HSR3**

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## PRODUCT DOCUMENTATION, TOOLS AND SOFTWARE

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Refer to the following documents, tools and software to aid your design process.

### Application Notes

- AN1955: Thermal Measurement Methodology of RF Power Amplifiers

### Engineering Bulletins

- EB212: Using Data Sheet Impedances for RF LDMOS Devices

### Software

- Electromigration MTTF Calculator

For Software and Tools, do a Part Number search at <http://www.freescale.com>, and select the “Part Number” link. Go to the Software & Tools tab on the part’s Product Summary page to download the respective tool.

## REVISION HISTORY

The following table summarizes revisions to this document.

Revision	Date	Description
0	Sept. 2009	• Initial Release of Data Sheet

MRF6V12500HR3 MRF6V12500HSR3

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