

RF Power Field Effect Transistors

N-Channel Enhancement-Mode Lateral MOSFETs

RF Power transistors designed for applications operating at 1300 MHz. These devices are suitable for use in pulsed and CW applications.

- Typical Performance: $V_{DD} = 50$ Volts, $I_{DQ} = 100$ mA

Signal Type	P_{out} (W)	f (MHz)	G_{ps} (dB)	η_D (%)	IRL (dB)
Pulsed (200 μ sec, 10% Duty Cycle)	250 Peak	1300	22.7	57.0	-18

- Typical Performance: $V_{DD} = 50$ Volts, $I_{DQ} = 10$ mA, $T_C = 25^\circ\text{C}$

Signal Type	P_{out} (W)	f (MHz)	G_{ps} (dB)	η_D (%)	IRL (dB)
CW	230 CW	1300	21.0	55.0	-17

- Capable of Handling a Load Mismatch of 10:1 VSWR, @ 50 Vdc, 1300 MHz at all Phase Angles
 - 250 Watts Pulsed Peak Power, 10% Duty Cycle, 200 μ sec
- CW Capable

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
- Characterized from 20 V to 50 V for Extended Power Range
- Integrated ESD Protection
- Greater Negative Gate-Source Voltage Range for Improved Class C Operation
- RoHS Compliant
- In Tape and Reel. R3 Suffix = 250 Units, 56 mm Tape Width, 13 inch Reel. For R5 Tape and Reel options, see p. 12.

Table 1. Maximum Ratings

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DSS}	-0.5, +120	Vdc
Gate-Source Voltage	V_{GS}	-6.0, +10	Vdc
Storage Temperature Range	T_{stg}	- 65 to +150	$^\circ\text{C}$
Case Operating Temperature	T_C	150	$^\circ\text{C}$
Operating Junction Temperature (1,2)	T_J	225	$^\circ\text{C}$
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C	P_D	476 2.38	W W/ $^\circ\text{C}$

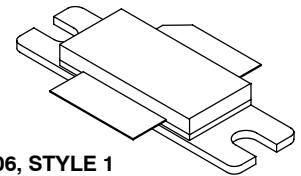
Table 2. Thermal Characteristics

Characteristic	Symbol	Value (2,3)	Unit
Thermal Resistance, Junction to Case Pulsed: Case Temperature 65°C , 250 W Pulsed, 200 μ sec Pulse Width, 10% Duty Cycle, 50 Vdc, $I_{DQ} = 100$ mA, 1300 MHz CW: Case Temperature 77°C , 235 W CW, 50 Vdc, $I_{DQ} = 10$ mA, 1300 MHz	$Z_{\theta JC}$ $R_{\theta JC}$	0.07 0.42	$^\circ\text{C}/\text{W}$

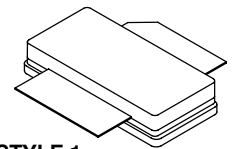
- Continuous use at maximum temperature will affect MTTF.
- MTTF calculator available at <http://www.freescale.com/rf>. Select Software & Tools/Development Tools/Calculators to access MTTF calculators by product.
- Refer to AN1955, *Thermal Measurement Methodology of RF Power Amplifiers*. Go to <http://www.freescale.com/rf>. Select Documentation/Application Notes - AN1955.

MRF6V13250HR3
MRF6V13250HSR3

1300 MHz, 250 W, 50 V
LATERAL N-CHANNEL
RF POWER MOSFETs



CASE 465-06, STYLE 1
NI-780
MRF6V13250HR3



CASE 465A-06, STYLE 1
NI-780S
MRF6V13250HSR3

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
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Off Characteristics

Gate-Source Leakage Current ($V_{GS} = 5\text{ Vdc}$, $V_{DS} = 0\text{ Vdc}$)	I_{GSS}	—	—	1	μAdc
Drain-Source Breakdown Voltage ($V_{GS} = 0\text{ Vdc}$, $I_D = 50\text{ mA}$)	$V_{(BR)DSS}$	120	—	—	Vdc
Zero Gate Voltage Drain Leakage Current ($V_{DS} = 50\text{ Vdc}$, $V_{GS} = 0\text{ Vdc}$)	I_{DSS}	—	—	10	μAdc
Zero Gate Voltage Drain Leakage Current ($V_{DS} = 90\text{ Vdc}$, $V_{GS} = 0\text{ Vdc}$)	I_{DSS}	—	—	20	μAdc

On Characteristics

Gate Threshold Voltage ($V_{DS} = 10\text{ Vdc}$, $I_D = 640\text{ }\mu\text{Adc}$)	$V_{GS(th)}$	1.0	1.8	2.7	Vdc
Gate Quiescent Voltage ($V_{DD} = 50\text{ Vdc}$, $I_D = 100\text{ mAdc}$, Measured in Functional Test)	$V_{GS(Q)}$	2.0	2.4	3.0	Vdc
Drain-Source On-Voltage ($V_{GS} = 10\text{ Vdc}$, $I_D = 1.58\text{ Adc}$)	$V_{DS(on)}$	0.1	0.25	0.3	Vdc

Dynamic Characteristics ⁽¹⁾

Reverse Transfer Capacitance ($V_{DS} = 50\text{ Vdc} \pm 30\text{ mV(rms)ac}$ @ 1 MHz, $V_{GS} = 0\text{ Vdc}$)	C_{rss}	—	1.2	—	pF
Output Capacitance ($V_{DS} = 50\text{ Vdc} \pm 30\text{ mV(rms)ac}$ @ 1 MHz, $V_{GS} = 0\text{ Vdc}$)	C_{oss}	—	58	—	pF
Input Capacitance ($V_{DS} = 50\text{ Vdc}$, $V_{GS} = 0\text{ Vdc} \pm 30\text{ mV(rms)ac}$ @ 1 MHz)	C_{iss}	—	340	—	pF

Functional Tests (In Freescale Test Fixture, 50 ohm system) $V_{DD} = 50\text{ Vdc}$, $I_{DQ} = 100\text{ mA}$, $P_{out} = 250\text{ W Peak}$ (25 W Avg.), $f = 1300\text{ MHz}$ Pulsed, 200 μsec Pulse Width, 10% Duty Cycle

Power Gain	G_{ps}	21.5	22.7	24.0	dB
Drain Efficiency	η_D	53.5	57.0	—	%
Input Return Loss	IRL	—	-18	-9	dB

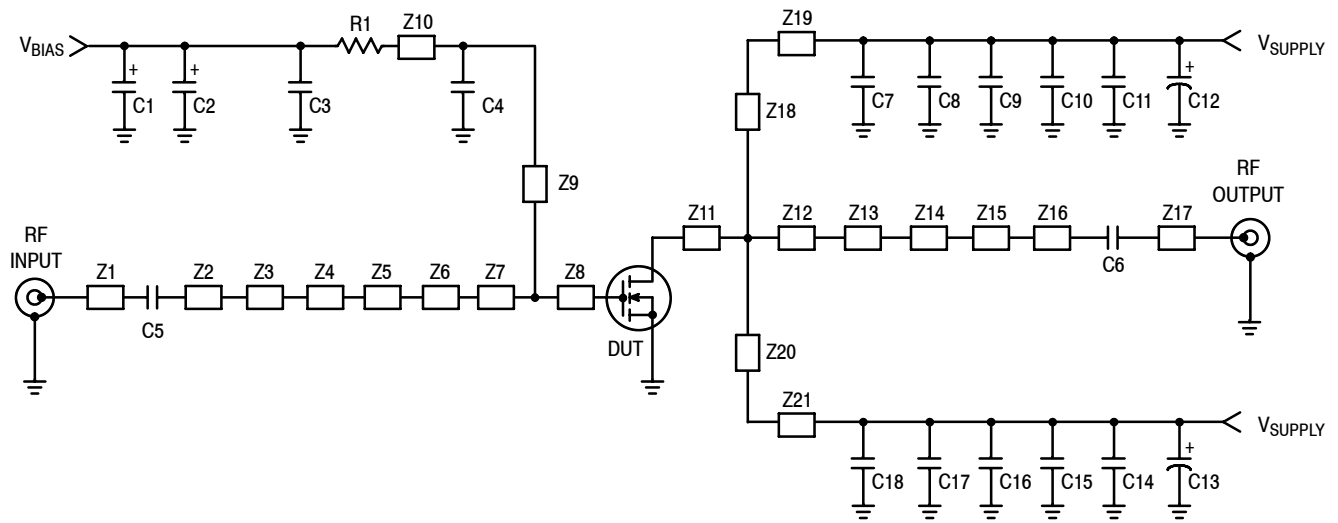
Typical Performance (In Freescale Test Fixture, 50 ohm system) $V_{DD} = 50\text{ Vdc}$, $I_{DQ} = 10\text{ mA}$, $P_{out} = 230\text{ W CW}$, $f = 1300\text{ MHz}$, $T_C = 25^\circ\text{C}$

Power Gain	G_{ps}	—	21.0	—	dB
Drain Efficiency	η_D	—	55.0	—	%
Input Return Loss	IRL	—	-17	—	dB

Load Mismatch (In Freescale Application Test Fixture, 50 ohm system) $V_{DD} = 50\text{ Vdc}$, $I_{DQ} = 100\text{ mA}$, $P_{out} = 250\text{ W Peak}$ (25 W Avg.), $f = 1300\text{ MHz}$, Pulsed, 200 μsec Pulse Width, 10% Duty Cycle

VSWR 10:1 at all Phase Angles	Ψ	No Degradation in Output Power
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1. Part internally input matched.



Z1	0.447" x 0.063" Microstrip
Z2	0.030" x 0.084" Microstrip
Z3	0.120" x 0.063" Microstrip
Z4	0.855" x 0.293" Microstrip
Z5	0.369" x 0.825" Microstrip
Z6	0.203" x 0.516" Microstrip
Z7	0.105" x 0.530" Microstrip
Z8	0.105" x 0.530" Microstrip
Z9*	0.116" x 0.050" Microstrip
Z10	0.122" x 0.050" Microstrip

Z11	0.162" x 1.160" Microstrip
Z12	0.419" x 1.160" Microstrip
Z13	0.468" x 0.994" Microstrip
Z14	0.131" x 0.472" Microstrip
Z15	0.264" x 0.222" Microstrip
Z16	0.500" x 0.111" Microstrip
Z17	0.291" x 0.063" Microstrip
Z18, Z20	0.105" x 0.388" Microstrip
Z19*, Z21*	0.854" x 0.052" Microstrip

*Line length includes microstrip bends.

Figure 1. MRF6V13250HR3(HSR3) Test Circuit Schematic — 1300 MHz

Table 5. MRF6V13250HR3(HSR3) Test Circuit Component Designations and Values — 1300 MHz

Part	Description	Part Number	Manufacturer
C1, C2	22 μ F, 35 V Tantalum Capacitors	T491X226K035AT	Kemet
C3, C11, C14	0.1 μ F, 50 V Chip Capacitors	CDR33BX104AKWS	AVX
C4, C6, C7, C18	100 pF Chip Capacitors	ATC800B101JT500XT	ATC
C5	4.7 pF Chip Capacitor	ATC100B4R7CT500XT	ATC
C8, C17	1000 pF Chip Capacitors	ATC100B102JT50XT	ATC
C9, C16	1000 pF Chip Capacitors	ATC700B102FT50XT	ATC
C10, C15	10K pF Chip Capacitors	ATC200B103KT50XT	ATC
C12, C13	470 μ F, 63 V Electrolytic Capacitors	MCGPR63V477M13X26-RH	Multicom
R1	15 Ω , 1/4 W Chip Resistor	CRCW120615R0FKEA	Vishay
PCB	0.030", $\epsilon_r = 3.50$	RO4350B	Rogers

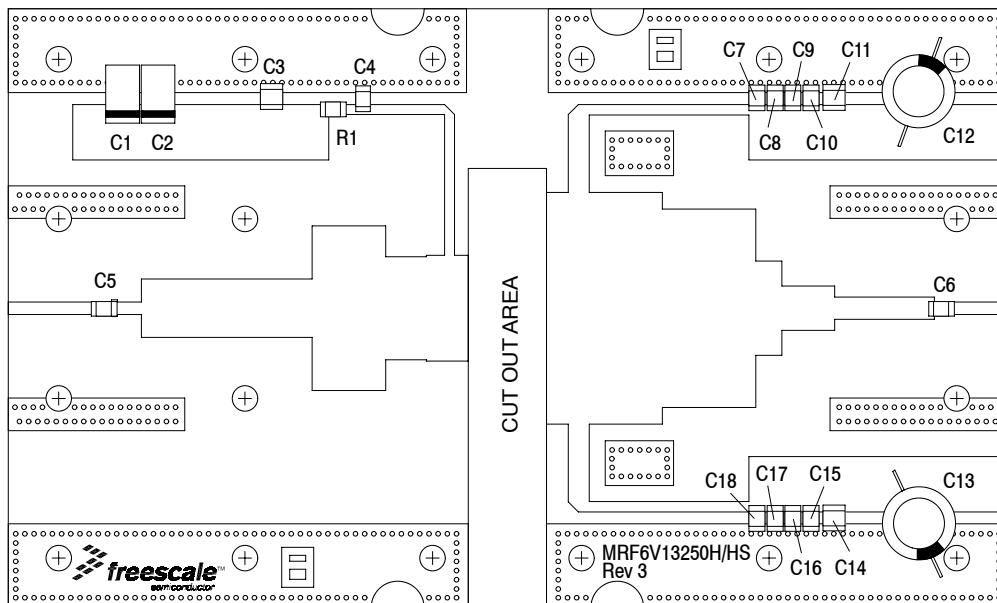


Figure 2. MRF6V13250HR3(HSR3) Test Circuit Component Layout — 1300 MHz

TYPICAL CHARACTERISTICS — PULSED

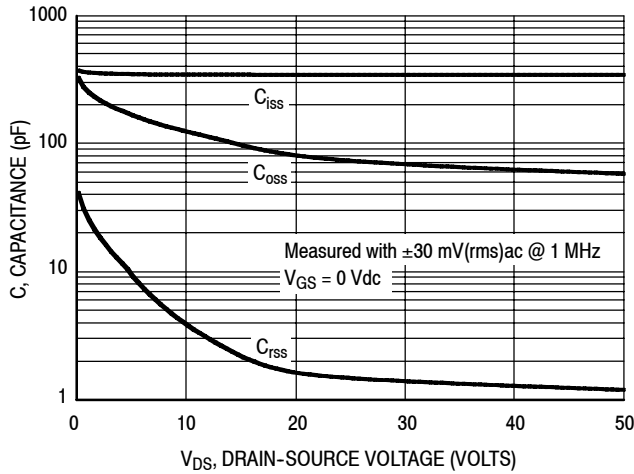


Figure 3. Capacitance versus Drain-Source Voltage

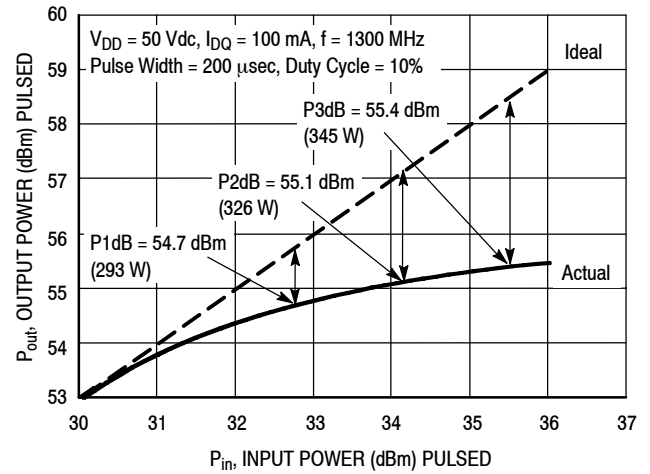


Figure 4. Pulsed Output Power versus Input Power

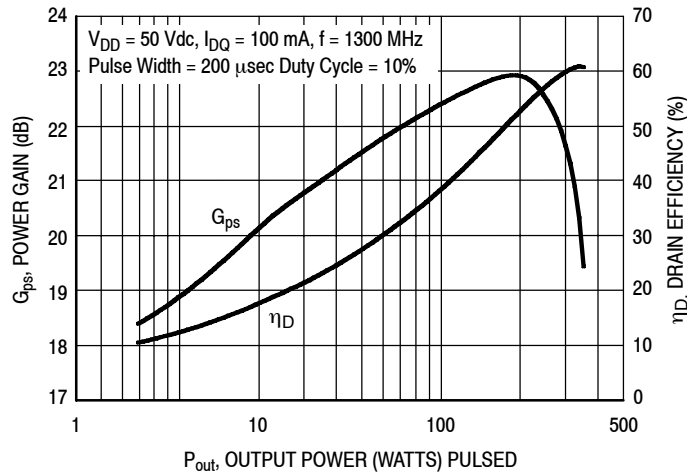


Figure 5. Pulsed Power Gain and Drain Efficiency versus Output Power

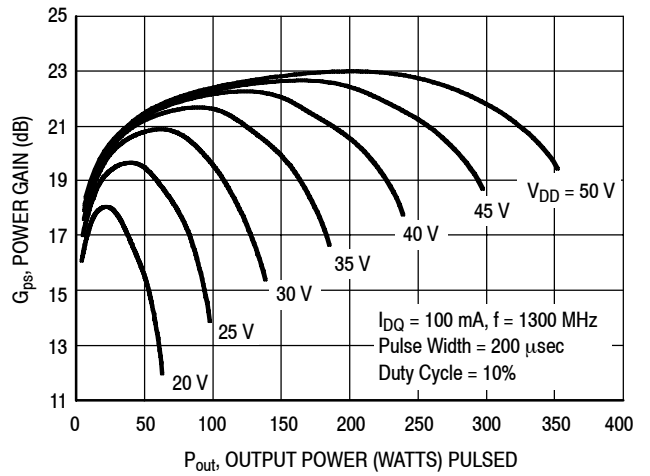


Figure 6. Pulsed Power Gain versus Output Power

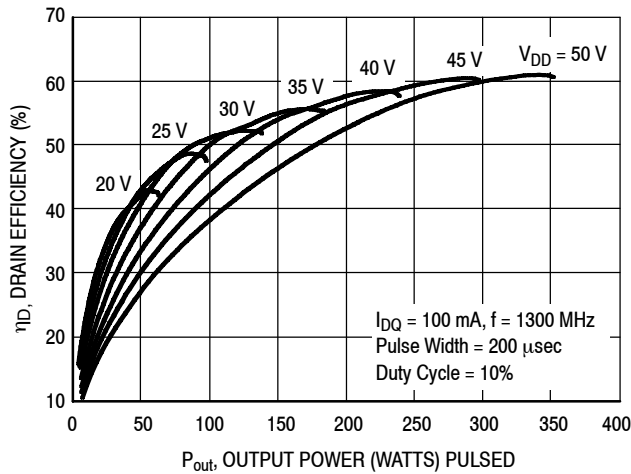


Figure 7. Pulsed Efficiency versus Output Power

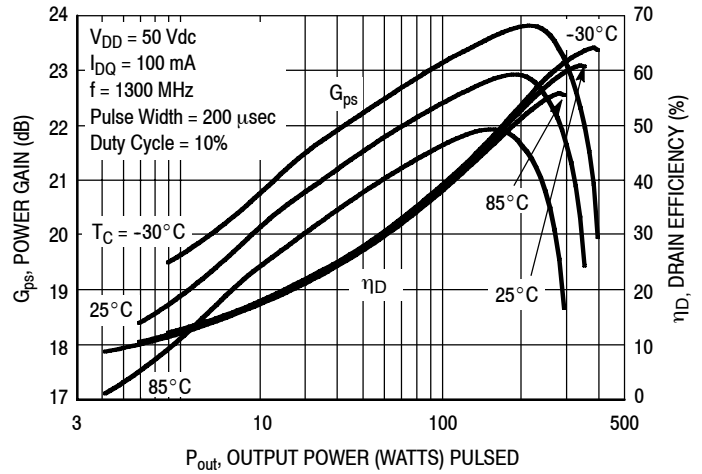


Figure 8. Pulsed Power Gain and Drain Efficiency versus Output Power

TYPICAL CHARACTERISTICS — CW

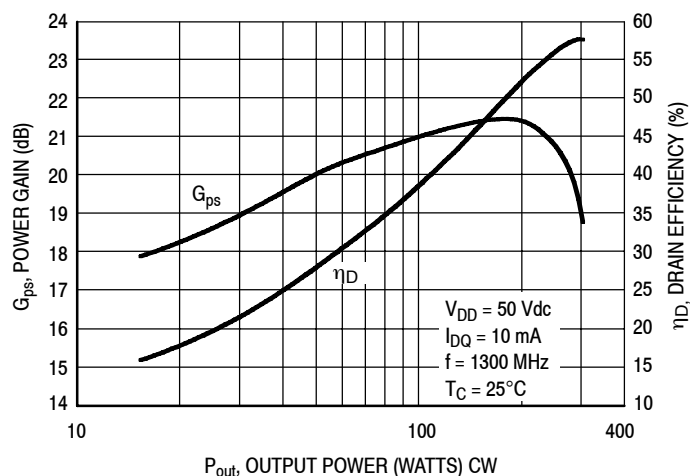


Figure 9. CW Power Gain and Drain Efficiency versus Output Power

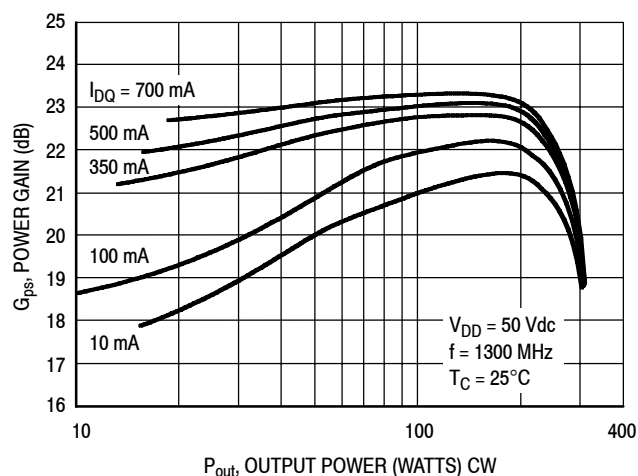


Figure 10. CW Power Gain versus Output Power

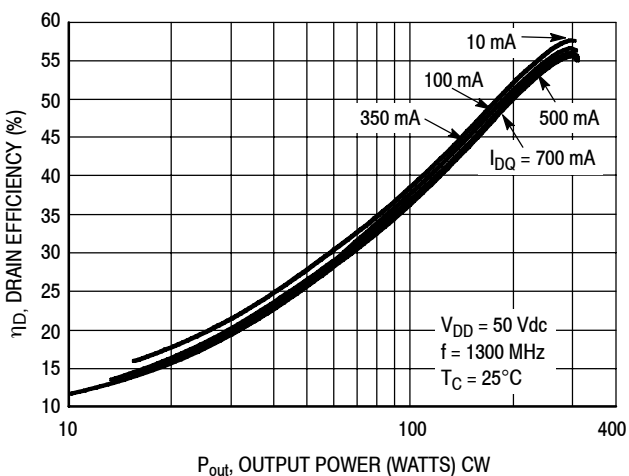
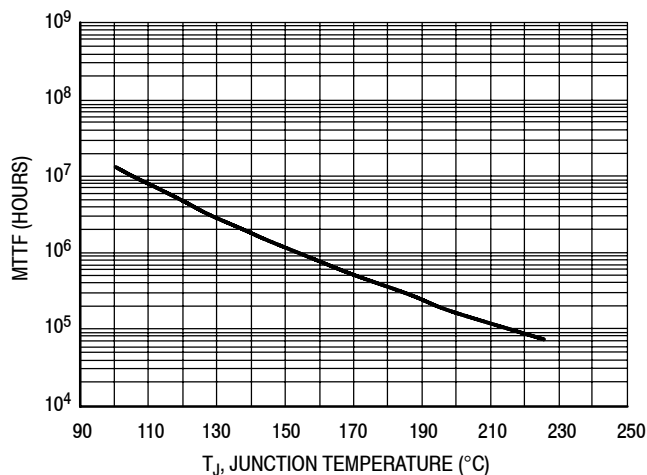


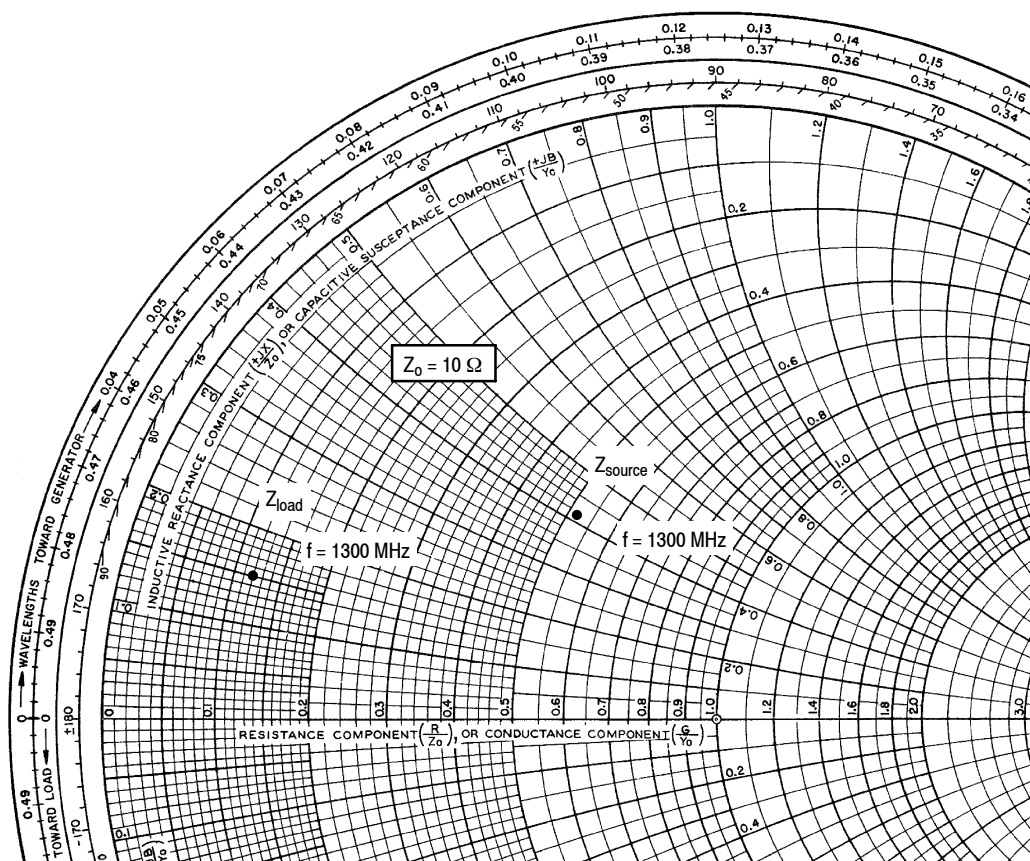
Figure 11. CW Efficiency versus Output Power



This above graph displays calculated MTTF in hours when the device is operated at $V_{DD} = 50 \text{ Vdc}$, $P_{out} = 230 \text{ W CW}$, and $\eta_D = 55\%$.

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

Figure 12. MTTF versus Junction Temperature — CW



$V_{DD} = 50 \text{ Vdc}$, $I_{DQ} = 100 \text{ mA}$, $P_{out} = 250 \text{ W Peak}$

f MHz	Z_{source} Ω	Z_{load} Ω
1300	$5.32 + j4.11$	$1.17 + j1.48$

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

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

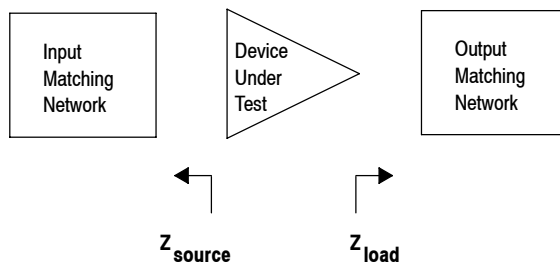
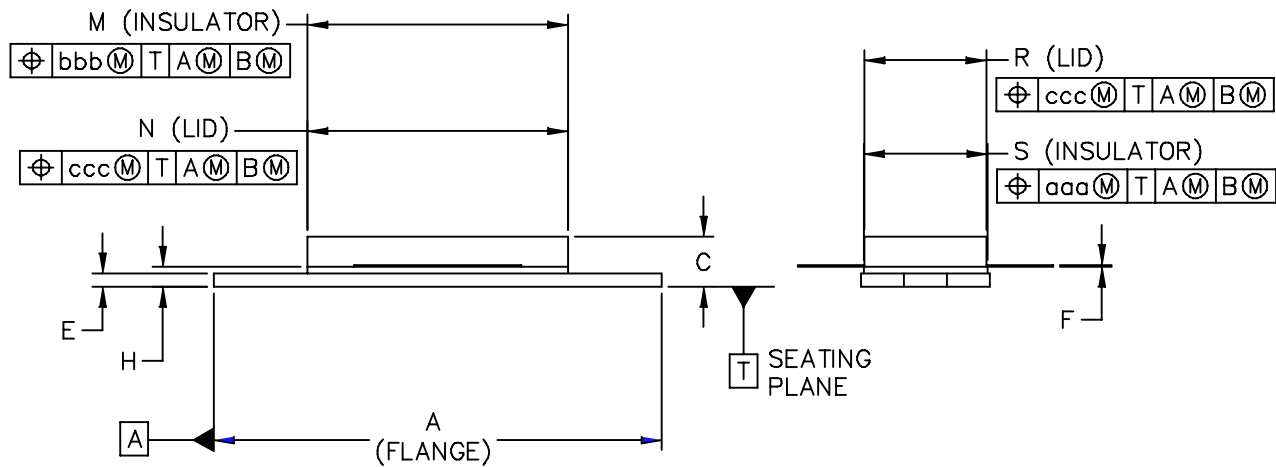
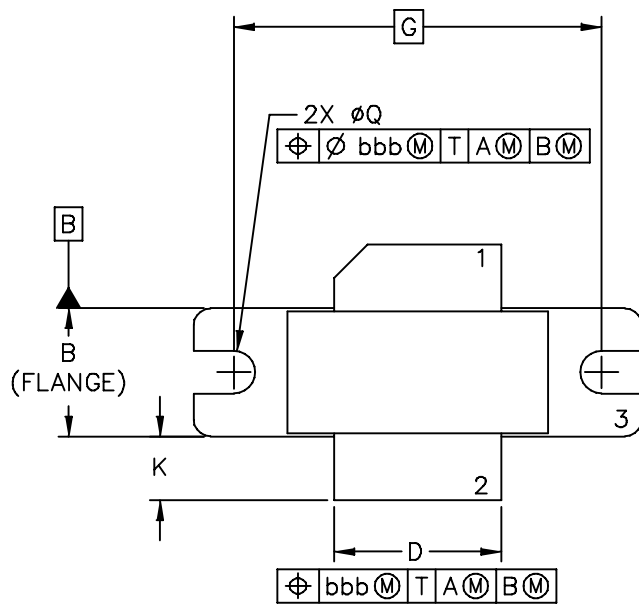


Figure 13. Series Equivalent Source and Load Impedance — Pulsed

PACKAGE DIMENSIONS



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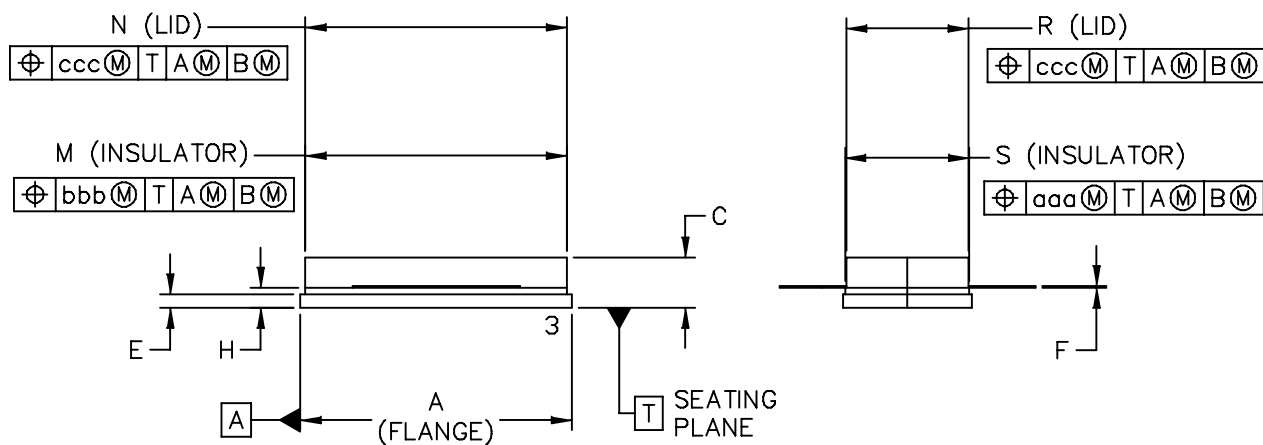
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2. CONTROLLING DIMENSION: INCH.
3. DELETED
4. DIMENSION H IS MEASURED .030 (.762) AWAY FROM PACKAGE BODY.

STYLE 1:

- PIN 1. DRAIN
2. GATE
3. SOURCE

DIM	INCH MIN MAX	MILLIMETER MIN MAX	DIM	INCH MIN MAX	MILLIMETER MIN MAX
A	1.335 – 1.345	33.91 – 34.16	R	.365 – .375	9.27 – 9.53
B	.380 – .390	9.65 – 9.91	S	.365 – .375	9.27 – 9.52
C	.125 – .170	3.18 – 4.32	aaa	– .005 –	– 0.127 –
D	.495 – .505	12.57 – 12.83	bbb	– .010 –	– 0.254 –
E	.035 – .045	0.89 – 1.14	ccc	– .015 –	– 0.381 –
F	.003 – .006	0.08 – 0.15	–	– – –	– – –
G	1.100 BSC	27.94 BSC	–	– – –	– – –
H	.057 – .067	1.45 – 1.7	–	– – –	– – –
K	.170 – .210	4.32 – 5.33	–	– – –	– – –
M	.774 – .786	19.66 – 19.96	–	– – –	– – –
N	.772 – .788	19.6 – 20	–	– – –	– – –
Q	Ø.118 – Ø.138	Ø3 – Ø3.51	–	– – –	– – –
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STYLE 1:

- PIN 1. DRAIN
2. GATE
3. SOURCE

INCH			MILLIMETER			INCH				MILLIMETER		
DIM	MIN	MAX	MIN	MAX	DIM	MIN	MAX	MIN	MAX	MIN	MAX	
A	.805	— .815	20.45	— 20.7	U	—	— .040	—	— 1.02			
B	.380	— .390	9.65	— 9.91	Z	—	— .030	—	— 0.76			
C	.125	— .170	3.18	— 4.32	aaa	—	.005 —	—	0.127 —			
D	.495	— .505	12.57	— 12.83	bbb	—	.010 —	—	0.254 —			
E	.035	— .045	0.89	— 1.14	ccc	—	.015 —	—	0.381 —			
F	.003	— .006	0.08	— 0.15	—	—	— —	—	— —			
H	.057	— .067	1.45	— 1.7	—	—	— —	—	— —			
K	.170	— .210	4.32	— 5.33	—	—	— —	—	— —			
M	.774	— .786	19.61	— 20.02	—	—	— —	—	— —			
N	.772	— .788	19.61	— 20.02	—	—	— —	—	— —			
R	.365	— .375	9.27	— 9.53	—	—	— —	—	— —			
S	.365	— .375	9.27	— 9.52	—	—	— —	—	— —			
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PRODUCT DOCUMENTATION AND SOFTWARE

Refer to the following documents 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
- RF High Power Model
- .s2p File

For Software, 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.

R5 TAPE AND REEL OPTION

R5 Suffix = 50 Units, 56 mm Tape Width, 13 inch Reel.

The R5 tape and reel option for MRF6V13250H and MRF6V13250HS parts will be available for 2 years after release of MRF6V13250H and MRF6V13250HS. Freescale Semiconductor, Inc. reserves the right to limit the quantities that will be delivered in the R5 tape and reel option. At the end of the 2 year period customers who have purchased these devices in the R5 tape and reel option will be offered MRF6V13250H and MRF6V13250HS in the R3 tape and reel option.

REVISION HISTORY

The following table summarizes revisions to this document.

Revision	Date	Description
0	June 2011	• Initial Release of Data Sheet

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