

# RF Power Field Effect Transistors

## N-Channel Enhancement-Mode Lateral MOSFETs

Designed primarily for CW large-signal output and driver applications with frequencies up to 600 MHz. Devices are unmatched and are suitable for use in industrial, medical and scientific applications.

- Typical CW Performance:  $V_{DD} = 50$  Volts,  $I_{DQ} = 900$  mA,  $P_{out} = 300$  Watts,  $f = 450$  MHz  
Power Gain — 22 dB  
Drain Efficiency — 60%
- Capable of Handling 10:1 VSWR, @ 50 Vdc, 450 MHz, 300 Watts CW Output Power

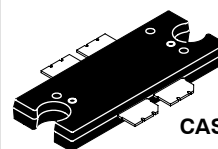
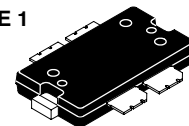
### Features

- Characterized with Series Equivalent Large-Signal Impedance Parameters
- Qualified Up to a Maximum of 50  $V_{DD}$  Operation
- Integrated ESD Protection
- Greater Negative Gate-Source Voltage Range for Improved Class C Operation
- 225°C Capable Plastic Package
- RoHS Compliant
- In Tape and Reel. R1 Suffix = 500 Units per 44 mm, 13 inch Reel.

**MRF6V4300NR1**  
**MRF6V4300NBR1**

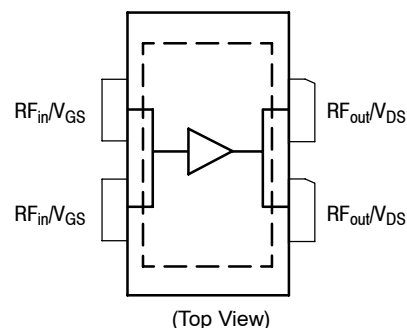
**10-600 MHz, 300 W, 50 V**  
**LATERAL N-CHANNEL**  
**SINGLE-ENDED**  
**BROADBAND**  
**RF POWER MOSFETs**

**CASE 1486-03, STYLE 1**  
**TO-270 WB-4**  
**PLASTIC**  
**MRF6V4300NR1**



**CASE 1484-04, STYLE 1**  
**TO-272 WB-4**  
**PLASTIC**  
**MRF6V4300NBR1**

**PARTS ARE SINGLE-ENDED**



Note: Exposed backside of the package is the source terminal for the transistor.

**Figure 1. Pin Connections**

**Table 1. Maximum Ratings**

Rating	Symbol	Value	Unit
Drain-Source Voltage	$V_{DSS}$	-0.5, +110	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 (1,2)	$T_J$	225	°C

1. Continuous use at maximum temperature will affect MTTF.
2. MTTF calculator available at <http://www.freescale.com/rf>. Select Software & Tools/Development Tools/Calculators to access MTTF calculators by product.

**Table 2. Thermal Characteristics**

Characteristic	Symbol	Value (1,2)	Unit
Thermal Resistance, Junction to Case Case Temperature 83°C, 300 W CW	$R_{\theta JC}$	0.24	°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)	IV (Minimum)

**Table 4. Moisture Sensitivity Level**

Test Methodology	Rating	Package Peak Temperature	Unit
Per JESD22-A113, IPC/JEDEC J-STD-020	3	260	°C

**Table 5. 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 ( $V_{GS} = 5\text{ Vdc}$ , $V_{DS} = 0\text{ Vdc}$ )	$I_{GSS}$	—	—	10	$\mu\text{Adc}$
Drain-Source Breakdown Voltage ( $I_D = 150\text{ mA}$ , $V_{GS} = 0\text{ Vdc}$ )	$V_{(BR)DSS}$	110	—	—	Vdc
Zero Gate Voltage Drain Leakage Current ( $V_{DS} = 50\text{ Vdc}$ , $V_{GS} = 0\text{ Vdc}$ )	$I_{DSS}$	—	—	50	$\mu\text{Adc}$
Zero Gate Voltage Drain Leakage Current ( $V_{DS} = 100\text{ Vdc}$ , $V_{GS} = 0\text{ Vdc}$ )	$I_{DSS}$	—	—	2.5	mA

**On Characteristics**

Gate Threshold Voltage ( $V_{DS} = 10\text{ Vdc}$ , $I_D = 800\ \mu\text{Adc}$ )	$V_{GS(th)}$	0.9	1.65	2.4	Vdc
Gate Quiescent Voltage ( $V_{DD} = 50\text{ Vdc}$ , $I_D = 900\ \text{mAdc}$ , Measured in Functional Test)	$V_{GS(Q)}$	1.9	2.7	3.4	Vdc
Drain-Source On-Voltage ( $V_{GS} = 10\text{ Vdc}$ , $I_D = 2\text{ Adc}$ )	$V_{DS(on)}$	—	0.25	—	Vdc

**Dynamic Characteristics**

Reverse Transfer Capacitance ( $V_{DS} = 50\text{ Vdc} \pm 30\text{ mV(rms)ac}$ @ 1 MHz, $V_{GS} = 0\text{ Vdc}$ )	$C_{rss}$	—	2.8	—	pF
Output Capacitance ( $V_{DS} = 50\text{ Vdc} \pm 30\text{ mV(rms)ac}$ @ 1 MHz, $V_{GS} = 0\text{ Vdc}$ )	$C_{oss}$	—	105	—	pF
Input Capacitance ( $V_{DS} = 50\text{ Vdc}$ , $V_{GS} = 0\text{ Vdc} \pm 30\text{ mV(rms)ac}$ @ 1 MHz)	$C_{iss}$	—	304	—	pF

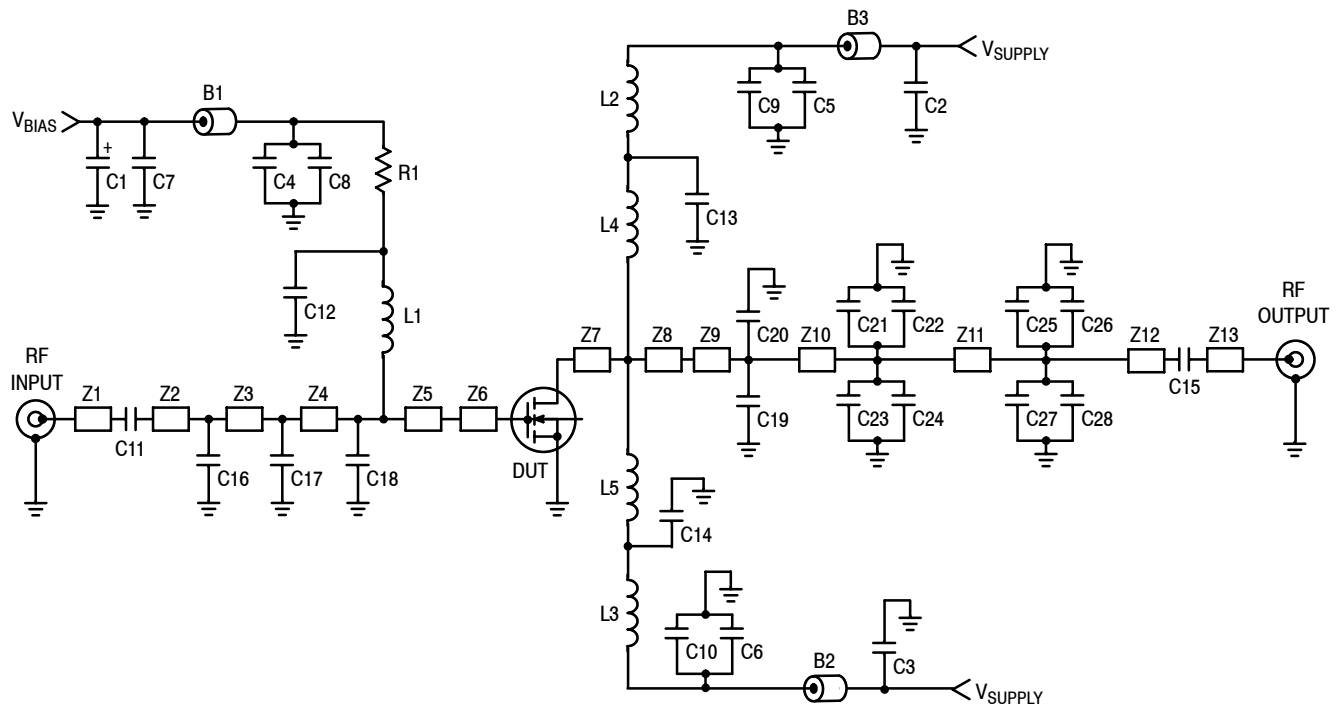
**Functional Tests** (In Freescale Test Fixture, 50 ohm system)  $V_{DD} = 50\text{ Vdc}$ ,  $I_{DQ} = 900\text{ mA}$ ,  $P_{out} = 300\text{ W}$ ,  $f = 450\text{ MHz}$ , CW

Power Gain	$G_{ps}$	20	22	24	dB
Drain Efficiency	$\eta_D$	58	60	—	%
Input Return Loss	IRL	—	-16	-9	dB

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



ATTENTION: The MRF6V4300N and MRF6V4300NB are high power devices and special considerations must be followed in board design and mounting. Incorrect mounting can lead to internal temperatures which exceed the maximum allowable operating junction temperature. Refer to Freescale Application Note AN3263 (for bolt down mounting) or AN1907 (for solder reflow mounting) **PRIOR TO STARTING SYSTEM DESIGN** to ensure proper mounting of these devices.



Z1	0.900" x 0.082" Microstrip	Z8	0.380" x 0.220" Microstrip
Z2	0.115" x 0.170" Microstrip	Z9	0.040" x 0.170" Microstrip
Z3	0.260" x 0.170" Microstrip	Z10	0.315" x 0.170" Microstrip
Z4	0.380" x 0.170" Microstrip	Z11	0.230" x 0.170" Microstrip
Z5	0.220" x 0.220" Microstrip	Z12	0.390" x 0.170" Microstrip
Z6	0.290" x 0.630" Microstrip	Z13	0.680" x 0.082" Microstrip
Z7	0.220" x 0.630" Microstrip	PCB	Arlon CuClad 250GX-0300-55-22, 0.030", $\epsilon_r = 2.55$

**Figure 2. MRF6V4300NR1 (NBR1) Test Circuit Schematic**

**Table 6. MRF6V4300NR1 (NBR1) Test Circuit Component Designations and Values**

Part	Description	Part Number	Manufacturer
B1	Short Ferrite Bead	2743019447	Fair-Rite
B2, B3	Long Ferrite Beads	2743021447	Fair-Rite
C1	47 $\mu$ F, 25 V, Tantalum Capacitor	T491B476M025AT	Kemet
C2, C3	22 $\mu$ F, 50 V, Chip Capacitors	C5750JF1H226ZT	TDK
C4, C5, C6, C7	1 $\mu$ F, 100 V, Chip Capacitors	C3225JB2A105KT	TDK
C8, C9, C10	15 nF, 100 V, Chip Capacitors	C3225CH2A153JT	TDK
C11, C12, C13, C14, C15	240 pF, Chip Capacitors	ATC100B241JT500XT	ATC
C16	9.1 pF, Chip Capacitor	ATC100B9R1JT500XT	ATC
C17	15 pF, Chip Capacitor	ATC100B150JT500XT	ATC
C18	51 pF, Chip Capacitor	ATC100B510JT500XT	ATC
C19, C20	5.6 pF, Chip Capacitors	ATC100B5R6JT500XT	ATC
C21, C22, C23, C24	4.3 pF, Chip Capacitors	ATC100B4R3JT500XT	ATC
C25, C26, C27, C28	4.7 pF, Chip Capacitors	ATC100B4R7JT500XT	ATC
L1	27 nH Inductor	1812SMS-27NJLC	Coilcraft
L2, L3	47 nH Inductors	1812SMS-47NJLC	Coilcraft
L4, L5	5 Turn, #18 AWG Inductors, Hand Wound	Copper Wire	
R1	10 $\Omega$ , 1/4 W, Chip Resistor	CRCW120610R1FKEA	Vishay

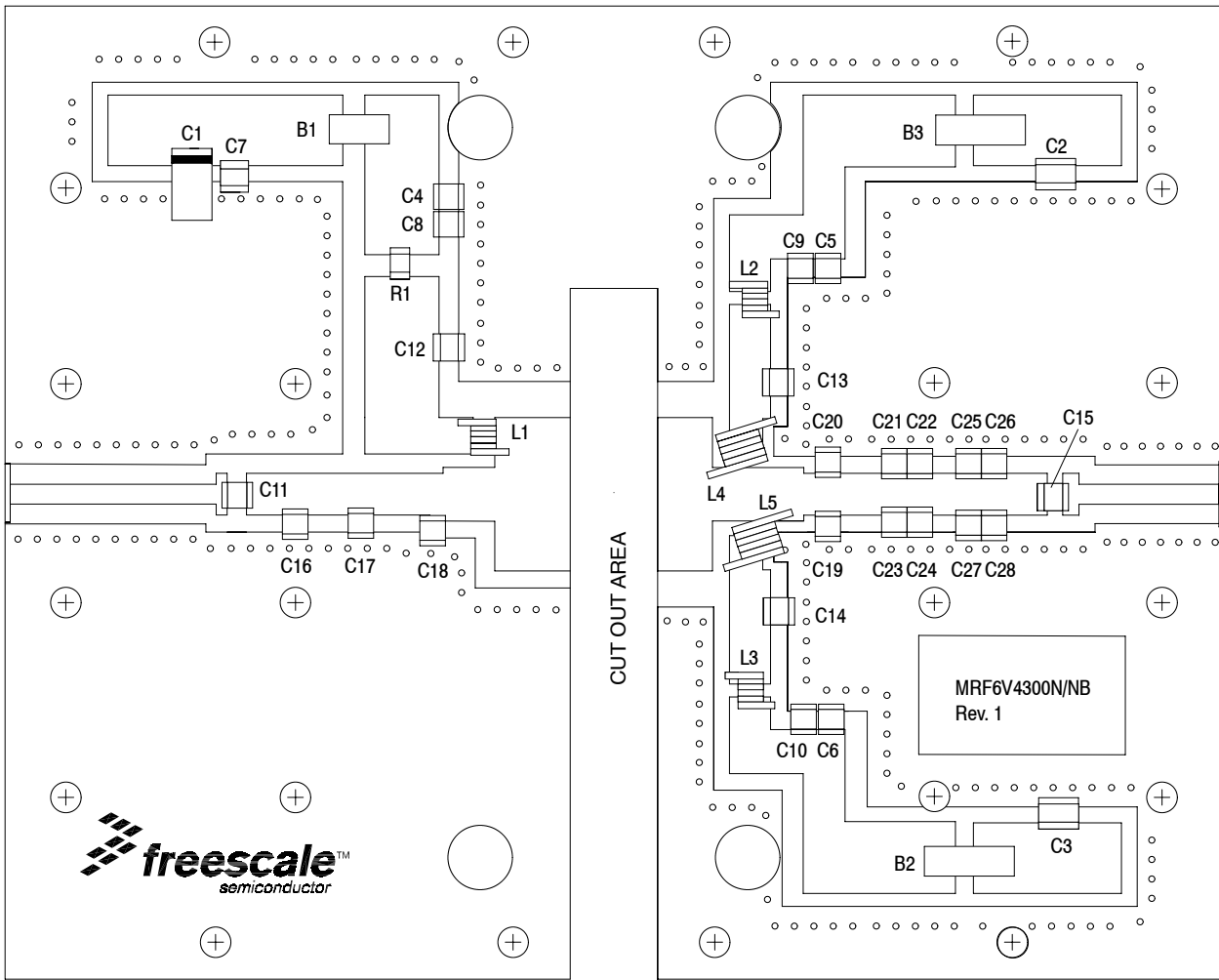


Figure 3. MRF6V4300NR1(NBR1) Test Circuit Component Layout

## TYPICAL CHARACTERISTICS

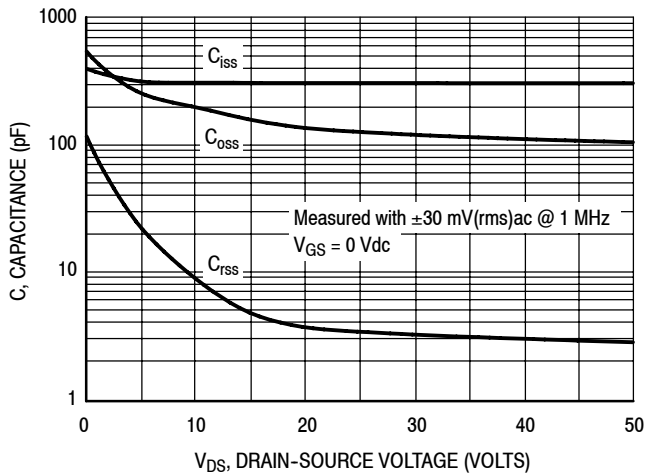


Figure 4. Capacitance versus Drain-Source Voltage

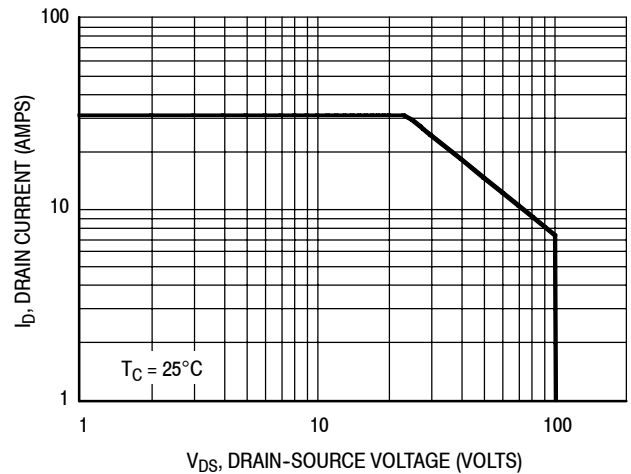


Figure 5. DC Safe Operating Area

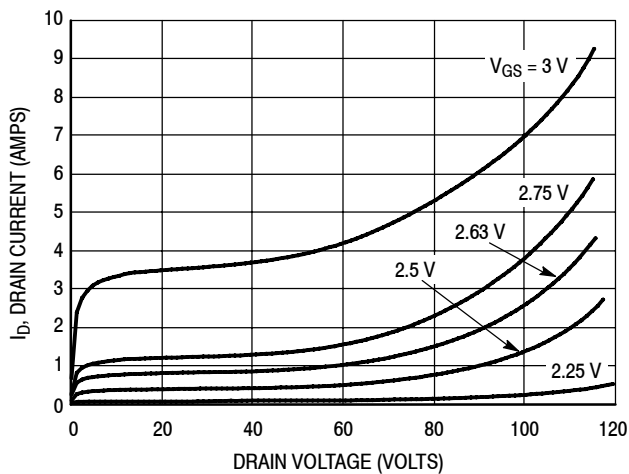


Figure 6. DC Drain Current versus Drain Voltage

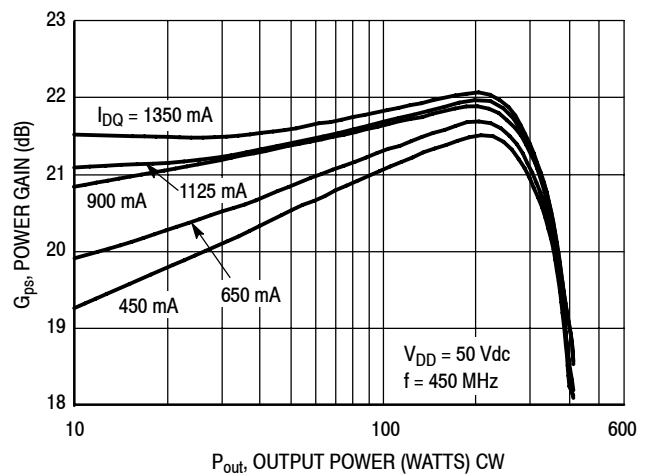


Figure 7. CW Power Gain versus Output Power

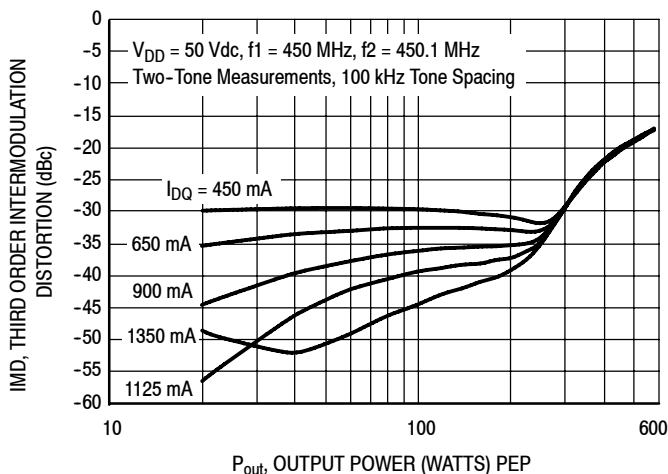


Figure 8. Third Order Intermodulation Distortion versus Output Power

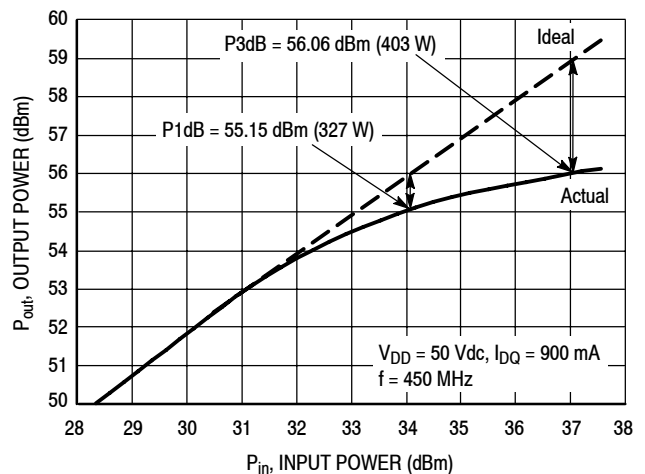
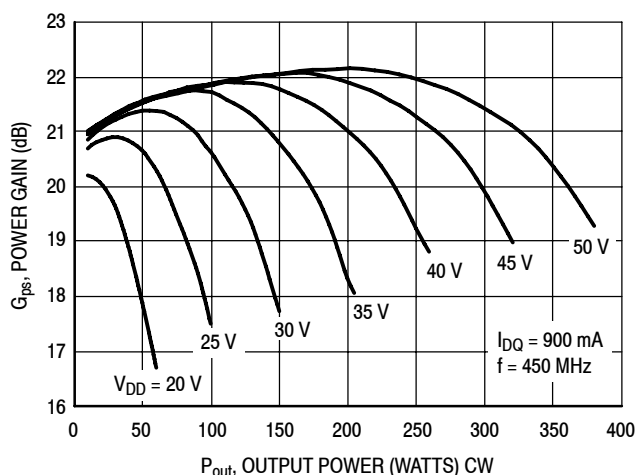
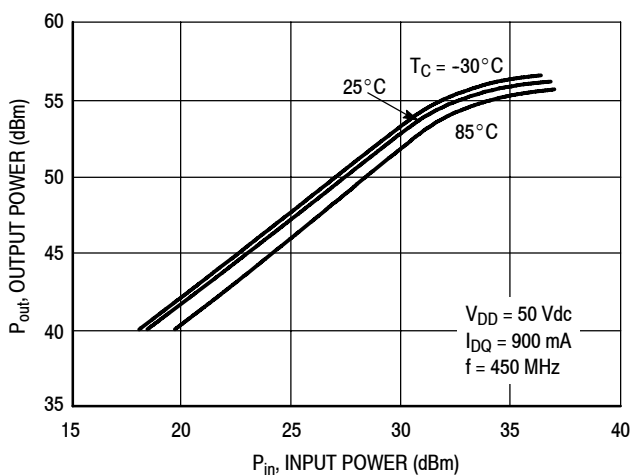


Figure 9. CW Output Power versus Input Power

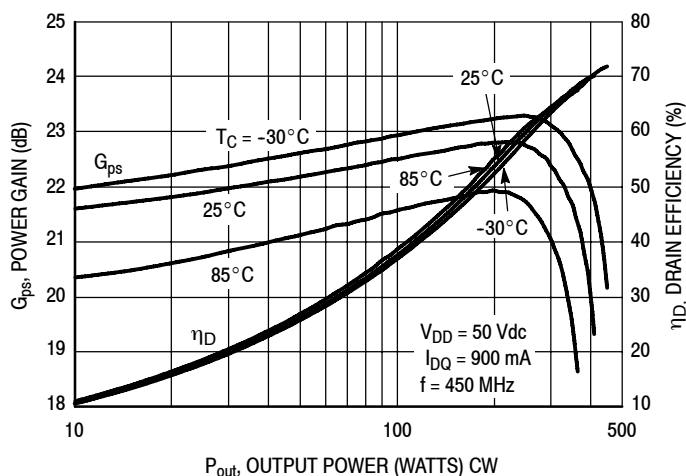
### TYPICAL CHARACTERISTICS



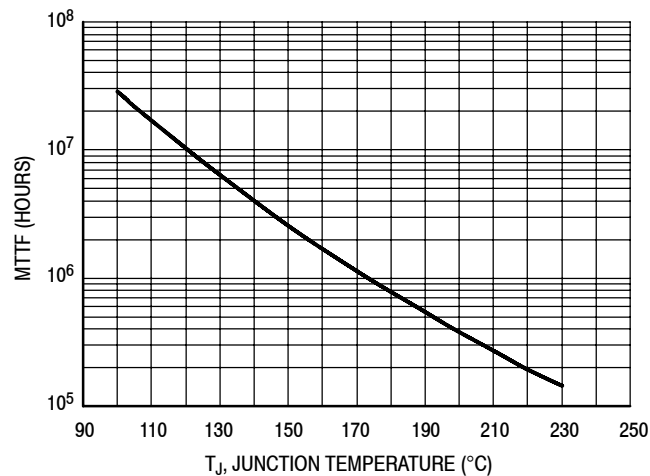
**Figure 10. Power Gain versus Output Power**



**Figure 11. Power Output versus Power Input**



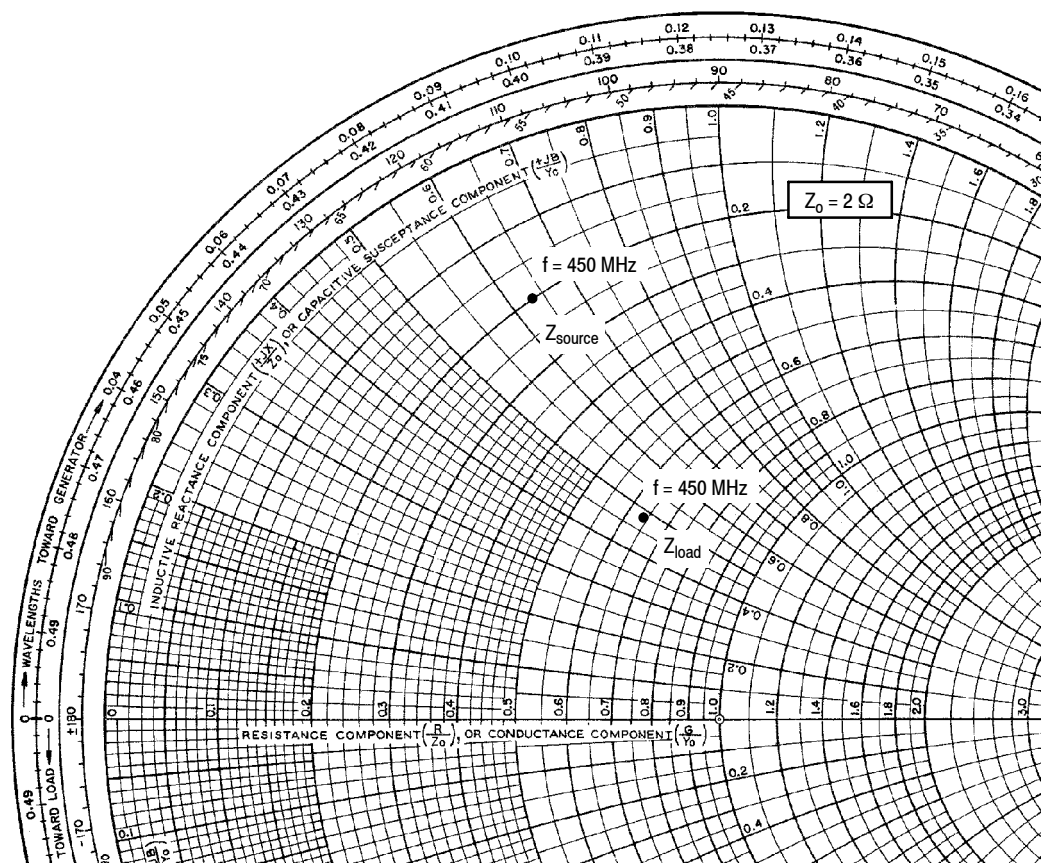
**Figure 12. Power Gain and Drain Efficiency versus CW Output Power**



This above graph displays calculated MTTF in hours when the device is operated at  $V_{DD} = 50$  Vdc,  $P_{out} = 300$  W, and  $\eta_D = 60\%$ .

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

**Figure 13. MTTF versus Junction Temperature**



$V_{DD} = 50 \text{ Vdc}$ ,  $I_{DQ} = 900 \text{ mA}$ ,  $P_{out} = 300 \text{ W CW}$

f MHz	Z <sub>source</sub> Ω	Z <sub>load</sub> Ω
450	0.39 + j1.26	1.27 + j0.96

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.

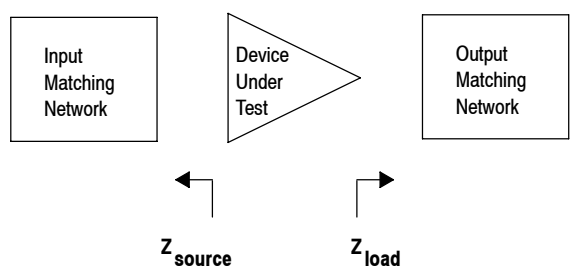
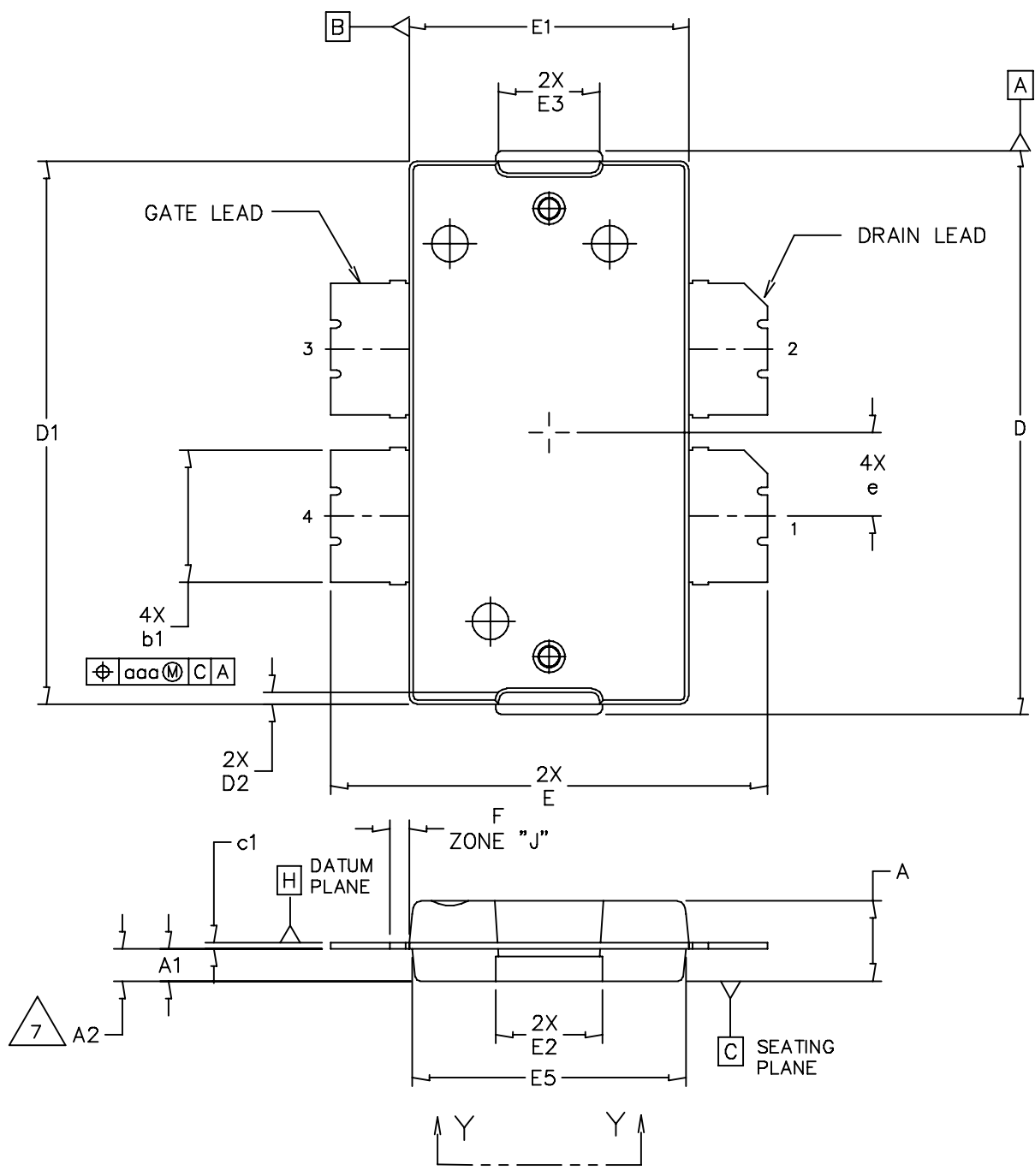


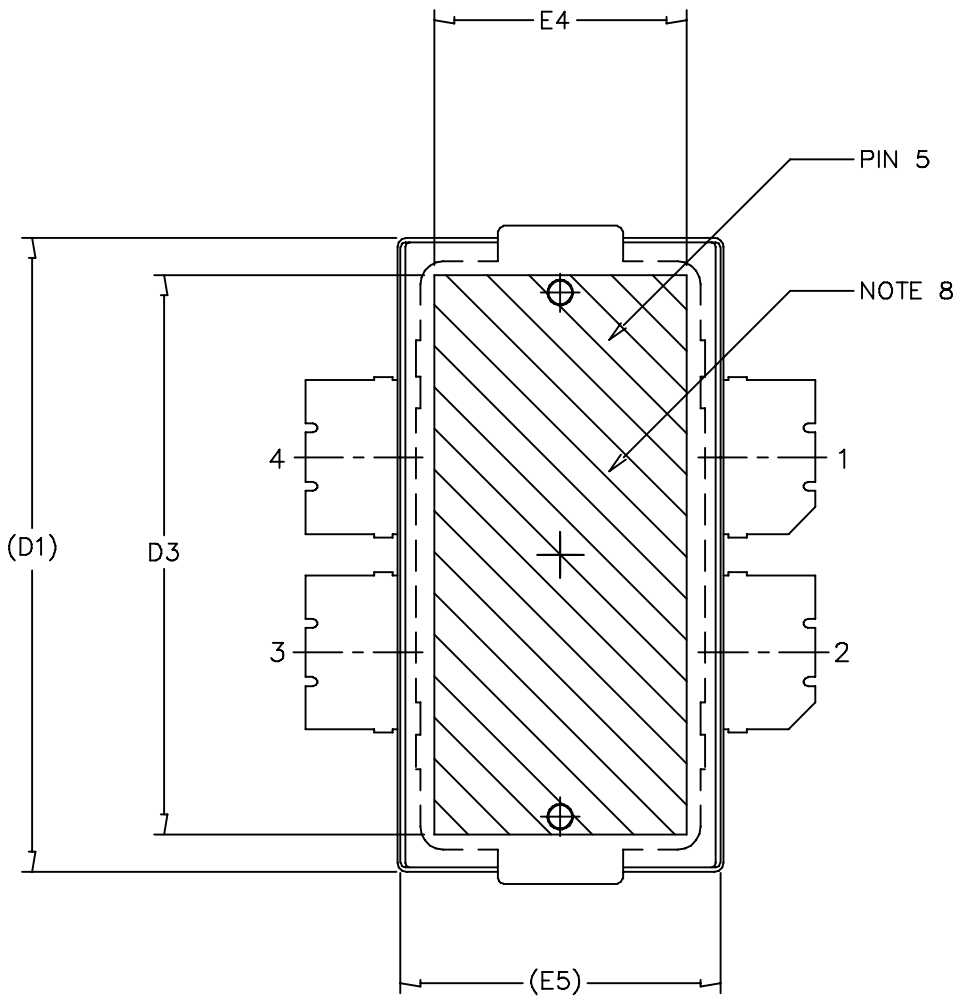
Figure 14. Series Equivalent Source and Load Impedance

**PACKAGE DIMENSIONS**



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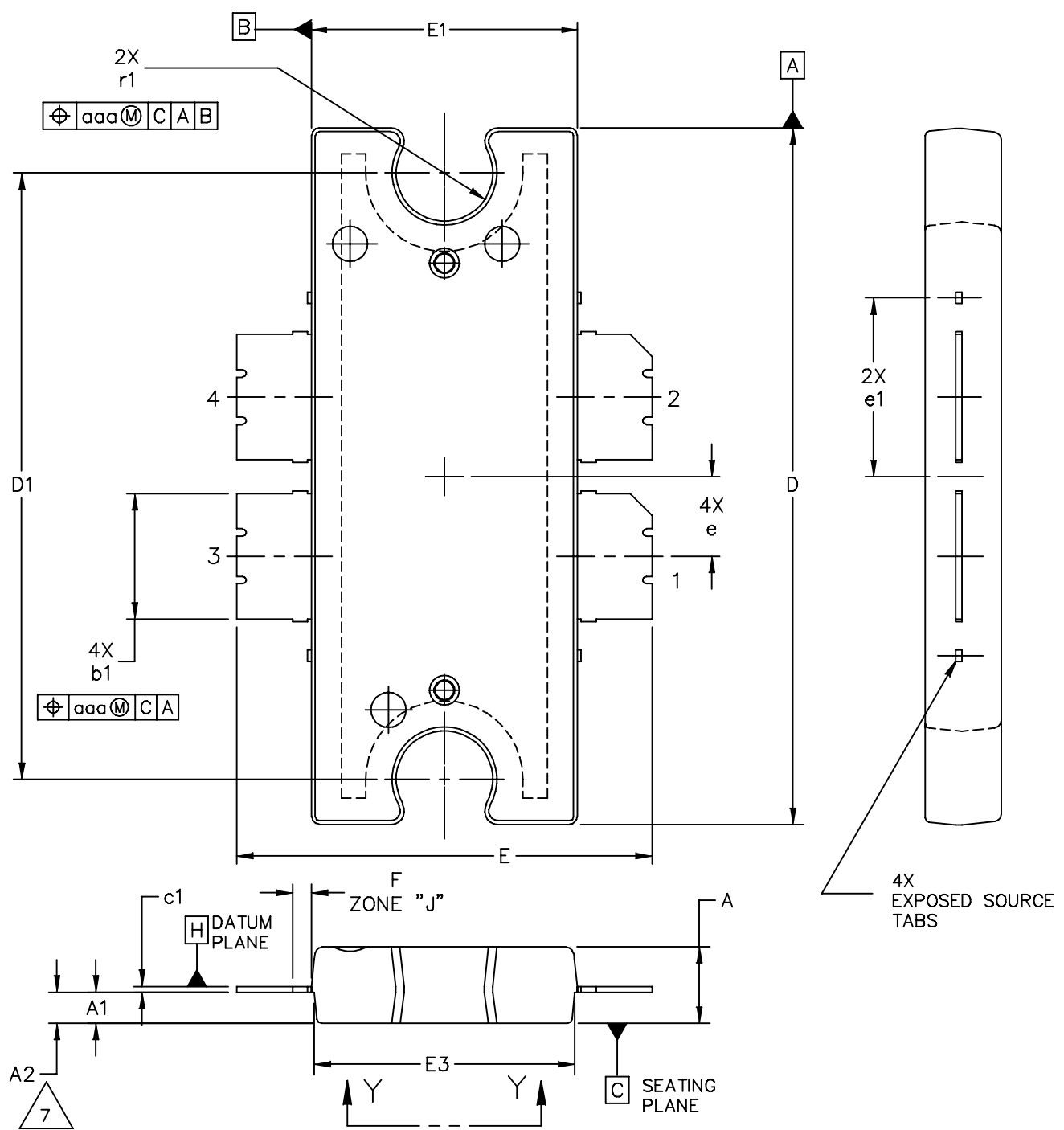
NOTES:

1. CONTROLLING DIMENSION: INCH
2. INTERPRET DIMENSIONS AND TOLERANCES PER ASME Y14.5M-1994.
3. DATUM PLANE -H- IS LOCATED AT THE TOP OF LEAD AND IS COINCIDENT WITH THE LEAD WHERE THE LEAD EXITS THE PLASTIC BODY AT THE TOP OF THE PARTING LINE.
4. DIMENSIONS "D" AND "E1" DO NOT INCLUDE MOLD PROTRUSION. ALLOWABLE PROTRUSION IS .006 PER SIDE. DIMENSIONS "D" AND "E1" DO INCLUDE MOLD MISMATCH AND ARE DETERMINED AT DATUM PLANE -H-.
5. DIMENSIONS "b1" DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE .005 TOTAL IN EXCESS OF THE "b1" DIMENSION AT MAXIMUM MATERIAL CONDITION.
6. DATUMS -A- AND -B- TO BE DETERMINED AT DATUM PLANE -H-.
7. DIMENSION A2 APPLIES WITHIN ZONE "J" ONLY.
8. HATCHING REPRESENTS THE EXPOSED AREA OF THE HEAT SLUG.

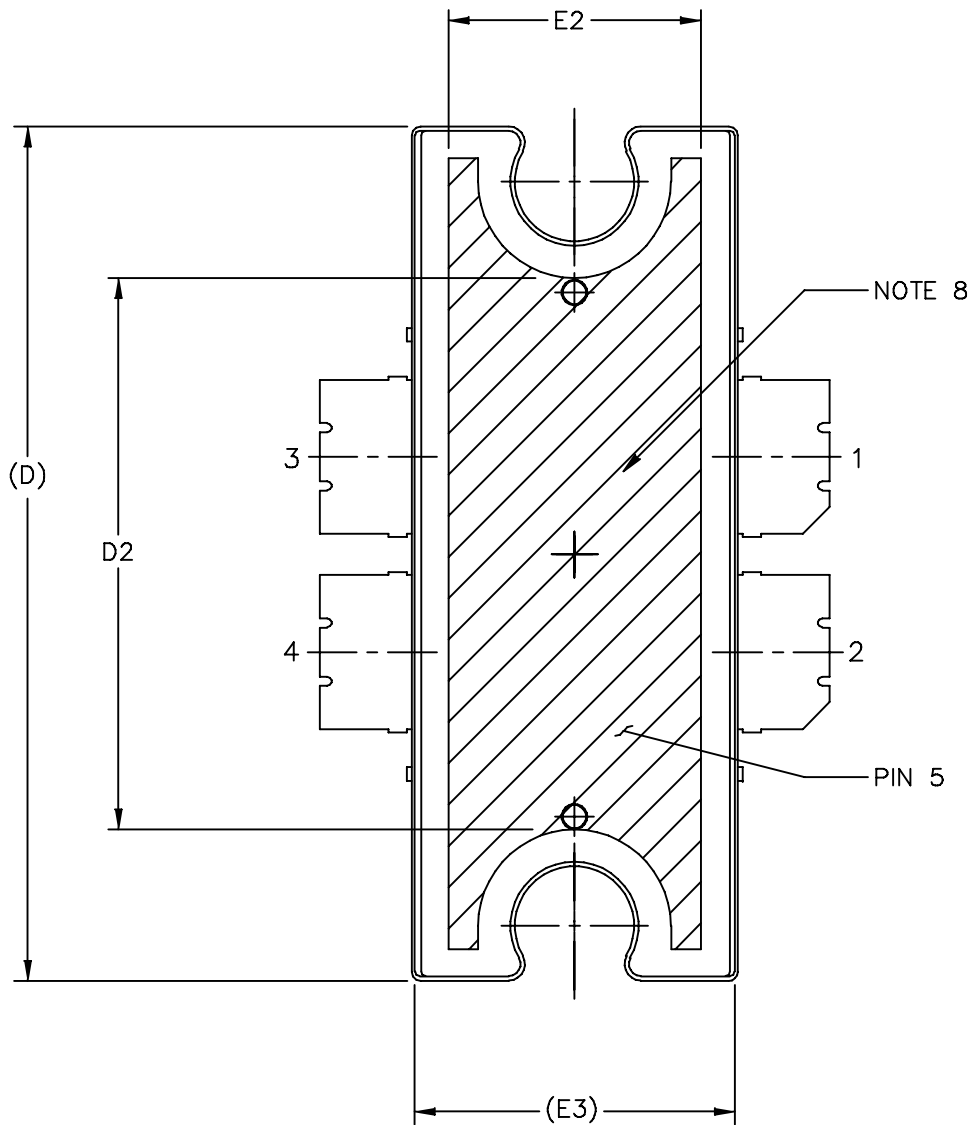
STYLE 1:

PIN 1 - DRAIN      PIN 2 - DRAIN  
 PIN 3 - GATE      PIN 4 - GATE  
 PIN 5 - SOURCE

DIM	INCH		MILLIMETER		DIM	INCH		MILLIMETER	
	MIN	MAX	MIN	MAX		MIN	MAX	MIN	MAX
A	.100	.104	2.54	2.64	F	.025 BSC		0.64 BSC	
A1	.039	.043	0.99	1.09	b1	.164	.170	4.17	4.32
A2	.040	.042	1.02	1.07	c1	.007	.011	.18	.28
D	.712	.720	18.08	18.29	e	.106 BSC		2.69 BSC	
D1	.688	.692	17.48	17.58	aaa	.004		.10	
D2	.011	.019	0.28	0.48					
D3	.600	---	15.24	---					
E	.551	.559	14	14.2					
E1	.353	.357	8.97	9.07					
E2	.132	.140	3.35	3.56					
E3	.124	.132	3.15	3.35					
E4	.270	---	6.86	---					
E5	.346	.350	8.79	8.89					
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NOTES:

1. CONTROLLING DIMENSION: INCH
2. INTERPRET DIMENSIONS AND TOLERANCES PER ASME Y14.5M-1994.
3. DATUM PLANE H IS LOCATED AT THE TOP OF LEAD AND IS COINCIDENT WITH THE LEAD WHERE THE LEAD EXITS THE PLASTIC BODY AT THE TOP OF THE PARTING LINE.
4. DIMENSIONS "D" AND "E1" DO NOT INCLUDE MOLD PROTRUSION. ALLOWABLE PROTRUSION IS .006 PER SIDE. DIMENSIONS "D" AND "E1" DO INCLUDE MOLD MISMATCH AND ARE DETERMINED AT DATUM PLANE H.
5. DIMENSIONS "b1" DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE .005 TOTAL IN EXCESS OF THE "b1" DIMENSION AT MAXIMUM MATERIAL CONDITION.
6. DATUM A AND B TO BE DETERMINED AT DATUM PLANE H.
7. DIMENSION A2 APPLIES WITHIN ZONE "J" ONLY.
8. HATCHING REPRESENTS EXPOSED AREA OF THE HEAT SLUG. HATCHED AREA SHOWN IS ON THE SAME PLANE.

STYLE 1:

PIN 1 - DRAIN      PIN 2 - DRAIN  
 PIN 3 - GATE      PIN 4 - GATE  
 PIN 5 - SOURCE

DIM	INCH		MILLIMETER		DIM	INCH		MILLIMETER	
	MIN	MAX	MIN	MAX		MIN	MAX	MIN	MAX
A	.100	.104	2.54	2.64	b1	.164	.170	4.17	4.32
A1	.039	.043	0.99	1.09	c1	.007	.011	.18	.28
A2	.040	.042	1.02	1.07	r1	.063	.068	1.60	1.73
D	.928	.932	23.57	23.67	e	.106 BSC		2.69 BSC	
D1	.810 BSC		20.57 BSC		e1	.239 INFO ONLY		6.07 INFO ONLY	
D2	.600	---	15.24	---	aaa	.004		.10	
E	.551	.559	14	14.2					
E1	.353	.357	8.97	9.07					
E2	.270	---	6.86	---					
E3	.346	.350	8.79	8.89					
F	.025 BSC		0.64 BSC						

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			STANDARD: NON-JEDEC		

## PRODUCT DOCUMENTATION AND SOFTWARE

Refer to the following documents to aid your design process.

### Application Notes

- AN1907: Solder Reflow Attach Method for High Power RF Devices in Plastic Packages
- AN1955: Thermal Measurement Methodology of RF Power Amplifiers
- AN3263: Bolt Down Mounting Method for High Power RF Transistors and RFICs in Over-Molded Plastic Packages
- AN3789: Clamping of High Power RF Transistors and RFICs in Over-Molded Plastic Packages

### Engineering Bulletins

- EB212: Using Data Sheet Impedances for RF LDMOS Devices

### Software

- Electromigration MTTF Calculator
- RF High Power Model

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.

## REVISION HISTORY

The following table summarizes revisions to this document.

Revision	Date	Description
0	July 2008	<ul style="list-style-type: none"> <li>• Initial Release of Data Sheet</li> </ul>
1	Oct. 2008	<ul style="list-style-type: none"> <li>• Added Fig. 13, MTTF versus Junction Temperature, p. 6</li> </ul>
2	Mar. 2009	<ul style="list-style-type: none"> <li>• Corrected <math>Z_{source}</math>, “0.40 + j5.93” to “0.39 + j1.26” and <math>Z_{load}</math>, “1.42 + j5.5” to “1.27 + j0.96” in Fig. 14, Series Equivalent Source and Load Impedance data table and replotted data, p. 7</li> </ul>
3	Apr. 2010	<ul style="list-style-type: none"> <li>• Operating Junction Temperature increased from 200°C to 225°C in Maximum Ratings table, related “Continuous use at maximum temperature will affect MTTF” footnote added and changed 200°C to 225°C in Capable Plastic Package bullet, p. 1</li> <li>• Added Electromigration MTTF Calculator and RF High Power Model availability to Product Software, p. 14</li> </ul>

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