

# RF Power Field Effect Transistor

## N-Channel Enhancement-Mode Lateral MOSFET

Designed primarily for large-signal output applications at 2450 MHz. Device is suitable for use in industrial, medical and scientific applications.

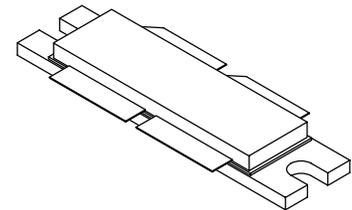
- Typical CW Performance at 2450 MHz,  $V_{DD} = 28$  Volts,  $I_{DQ} = 1900$  mA,  $P_{out} = 190$  Watts  
 Power Gain — 13.2 dB  
 Drain Efficiency — 46.2%
- Capable of Handling 10:1 VSWR, @ 28 Vdc, 2340 MHz, 190 Watts CW Output Power

### 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
- RoHS Compliant
- In Tape and Reel. R6 Suffix = 150 Units per 56 mm, 13 inch Reel.

**MRF6P24190HR6**

**2450 MHz, 190 W, 28 V  
 CW  
 LATERAL N-CHANNEL  
 RF POWER MOSFET**



**CASE 375D-05, STYLE 1  
 NI-1230**

**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
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
CW Operation @ $T_C = 25^\circ\text{C}$ Derate above 25°C	CW	250 1.3	W W/°C

**Table 2. Thermal Characteristics**

Characteristic	Symbol	Value (2,3)	Unit
Thermal Resistance, Junction to Case Case Temperature 100°C, 160 W CW Case Temperature 83°C, 40 W CW	$R_{\theta JC}$	0.22 0.24	°C/W

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.
3. 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)	1C (Minimum)
Machine Model (per EIA/JESD22-A115)	A (Minimum)
Charge Device Model (per JESD22-C101)	III (Minimum)

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

Characteristic	Symbol	Min	Typ	Max	Unit
<b>Off Characteristics</b> <sup>(1)</sup>					
Zero Gate Voltage Drain Leakage Current ( $V_{DS} = 68\text{ Vdc}$ , $V_{GS} = 0\text{ Vdc}$ )	$I_{DSS}$	—	—	10	$\mu\text{A}$
Zero Gate Voltage Drain Leakage Current ( $V_{DS} = 28\text{ Vdc}$ , $V_{GS} = 0\text{ Vdc}$ )	$I_{DSS}$	—	—	1	$\mu\text{A}$
Gate-Source Leakage Current ( $V_{GS} = 5\text{ Vdc}$ , $V_{DS} = 0\text{ Vdc}$ )	$I_{GSS}$	—	—	1	$\mu\text{A}$

**On Characteristics**

Gate Threshold Voltage <sup>(1)</sup> ( $V_{DS} = 10\text{ Vdc}$ , $I_D = 200\ \mu\text{A}$ )	$V_{GS(th)}$	1	2	3	Vdc
Gate Quiescent Voltage <sup>(3)</sup> ( $V_{DD} = 28\text{ Vdc}$ , $I_D = 1900\text{ mA}$ , Measured in Functional Test)	$V_{GS(Q)}$	2	2.8	4	Vdc
Drain-Source On-Voltage <sup>(1)</sup> ( $V_{GS} = 10\text{ Vdc}$ , $I_D = 2.2\text{ A}$ )	$V_{DS(on)}$	0.1	0.21	0.3	Vdc

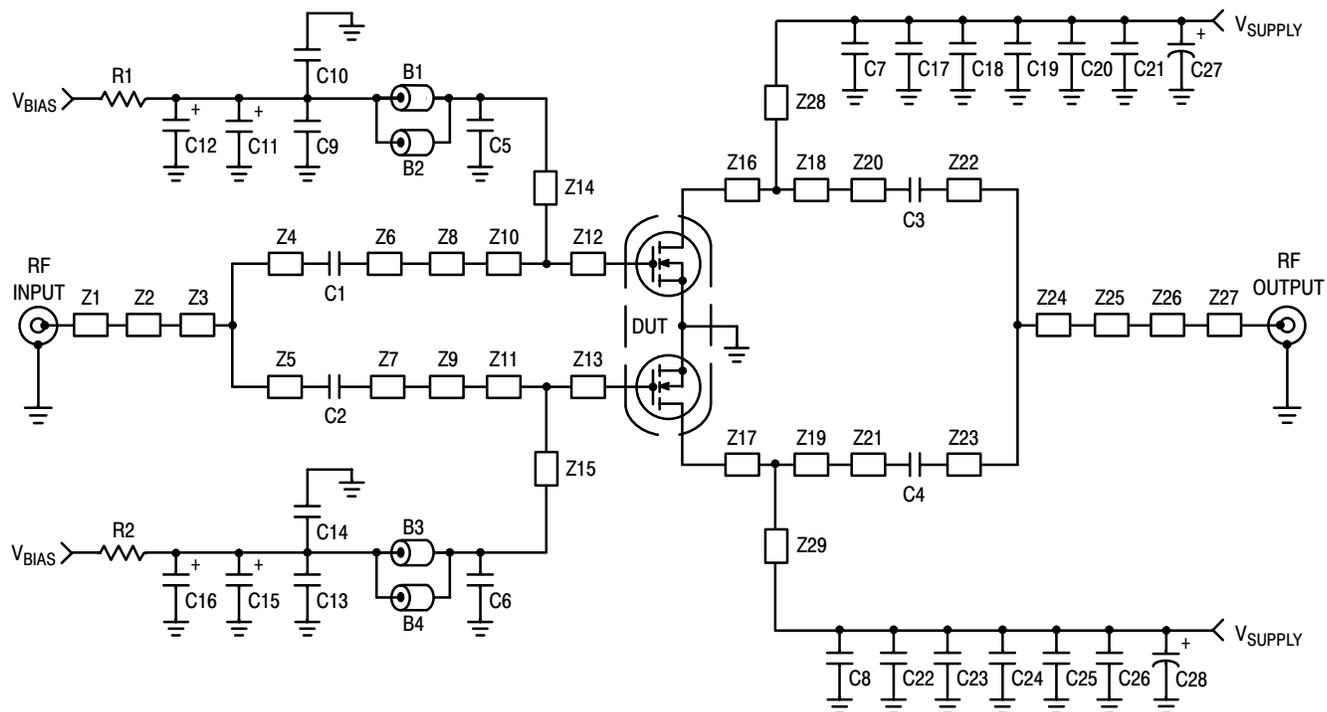
**Dynamic Characteristics** <sup>(1,2)</sup>

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** <sup>(3)</sup> (In Freescale Test Fixture, 50 ohm system)  $V_{DD} = 28\text{ Vdc}$ ,  $I_{DQ} = 1900\text{ mA}$ ,  $P_{out} = 40\text{ W Avg.}$ ,  $f = 2390\text{ MHz}$ , 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. Input Signal PAR = 8.5 dB @ 0.01% Probability on CCDF.

Power Gain	$G_{ps}$	13	14	16	dB
Drain Efficiency	$\eta_D$	22	23.5	—	%
Intermodulation Distortion	IM3	—	-37.5	-35	dBc
Adjacent Channel Power Ratio	ACPR	—	-41	-38	dBc
Input Return Loss	IRL	—	-13	—	dB

1. Each side of device measured separately.
2. Part internally matched both on input and output.
3. Measurement made with device in push-pull configuration.

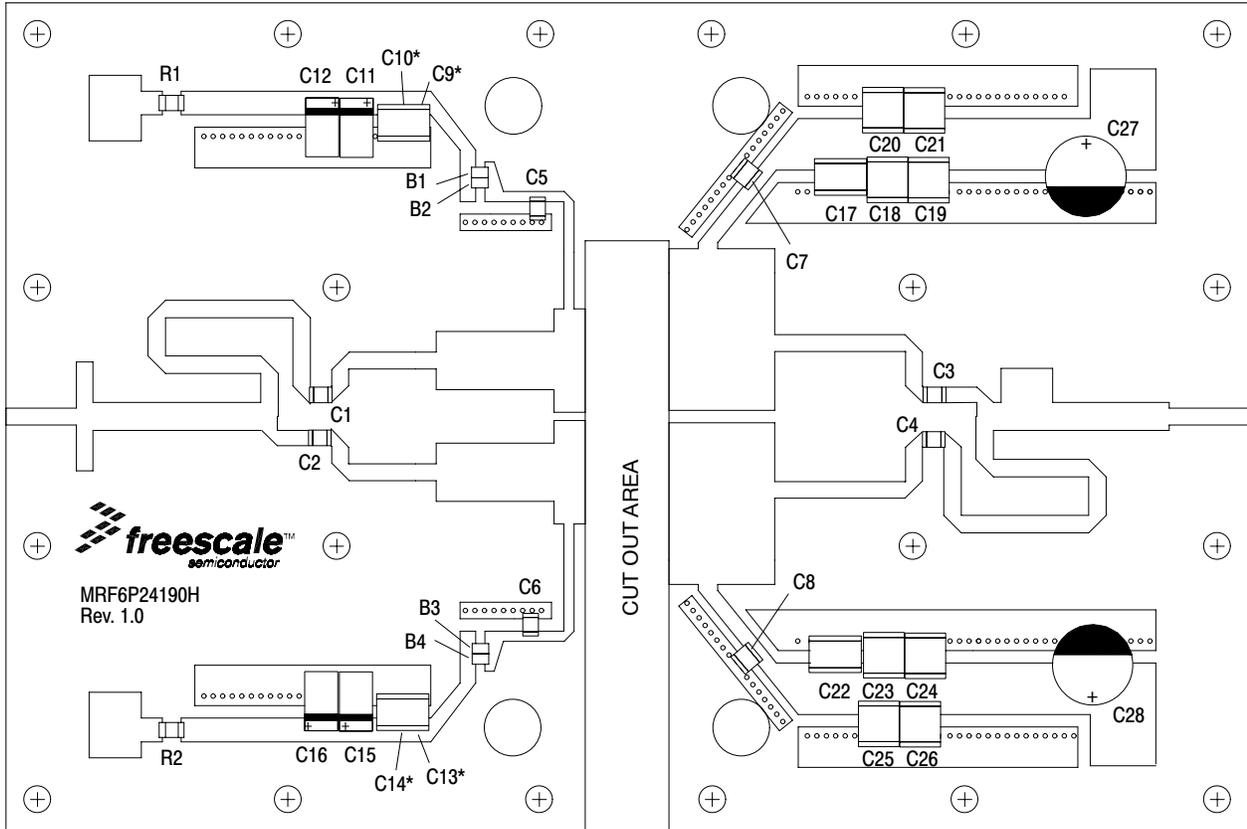


Z1	0.340" x 0.081" Microstrip	Z16, Z17	0.189" x 0.782" Microstrip
Z2	0.080" x 0.526" Microstrip	Z18, Z19	0.321" x 0.782" Microstrip
Z3	0.895" x 0.135" Microstrip	Z20, Z21	0.630" x 0.081" Microstrip
Z4	1.736" x 0.074" Microstrip	Z22	0.150" x 0.081" Microstrip
Z5	0.151" x 0.074" Microstrip	Z23	1.728" x 0.085" Microstrip
Z6, Z7	0.505" x 0.081" Microstrip	Z24	0.122" x 0.135" Microstrip
Z8, Z9	0.570" x 0.282" Microstrip	Z25	0.250" x 0.300" Microstrip
Z10, Z11	0.072" x 0.500" Microstrip	Z26	0.563" x 0.135" Microstrip
Z12, Z13	0.078" x 0.500" Microstrip	Z27	0.380" x 0.081" Microstrip
Z14	0.664" x 0.050" Microstrip	Z28, Z29	0.305" x 0.057" Microstrip
Z15	0.680" x 0.050" Microstrip	PCB	Arlon CuClad 250GX-0300-55-22, 0.030", $\epsilon_r = 2.55$

Figure 1. MRF6P24190HR6 Test Circuit Schematic — 2450 MHz

Table 5. MRF6P24190HR6 Test Circuit Component Designations and Values

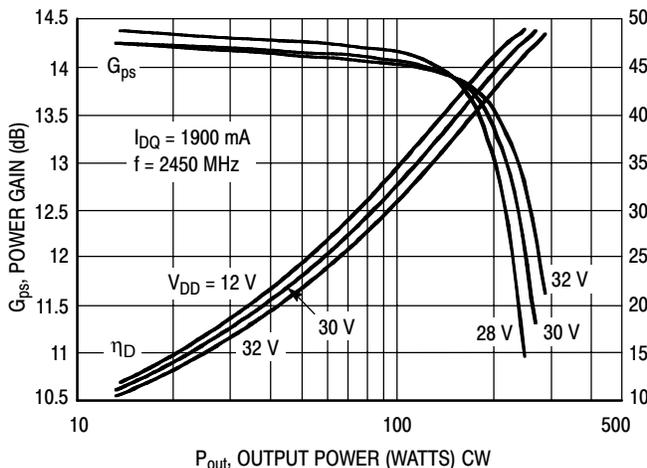
Part	Description	Part Number	Manufacturer
B1, B2, B3, B4	Ferrite Beads	2508051107Y0	Fair-Rite
C1, C2, C3, C4	5.1 pF, Chip Capacitors	ATC100B5R1CT500XT	ATC
C5, C6, C7, C8	5.6 pF, Chip Capacitors	ATC100B5R6CT500XT	ATC
C9, C13	0.01 $\mu$ F, 100 V Chip Capacitors	C1825C103J1RAC	Kemet
C10, C14, C17, C22	2.2 $\mu$ F, 50 V Chip Capacitors	C1825C225J5RAC	Kemet
C11, C15	22 $\mu$ F, 25 V Tantalum Capacitors	T491D226K025AT	Kemet
C12, C16	47 $\mu$ F, 16 V Tantalum Capacitors	T491D476K016AT	Kemet
C18, C19, C20, C21, C23, C24, C25, C26	10 $\mu$ F, 50 V Chip Capacitors	GRM55DR61H106KA88B	Murata
C27, C28	330 $\mu$ F, 63 V Electrolytic Capacitors	NACZF331M63V	Nippon
R1, R2	240 $\Omega$ , 1/4 W Chip Resistors	CRCW12062400FKEA	Vishay



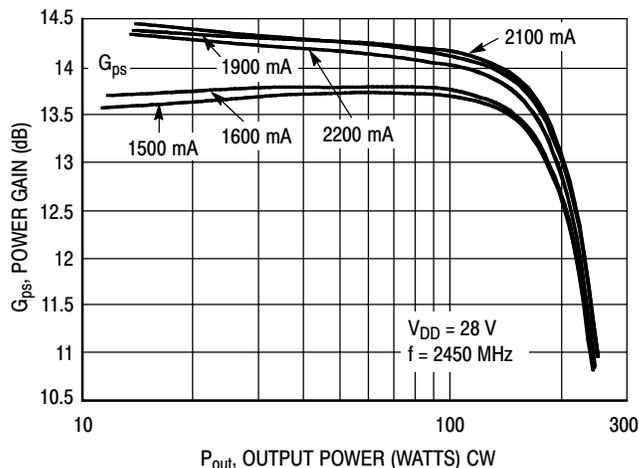
\*Stacked

Figure 2. MRF6P24190HR6 Test Circuit Component Layout — 2450 MHz

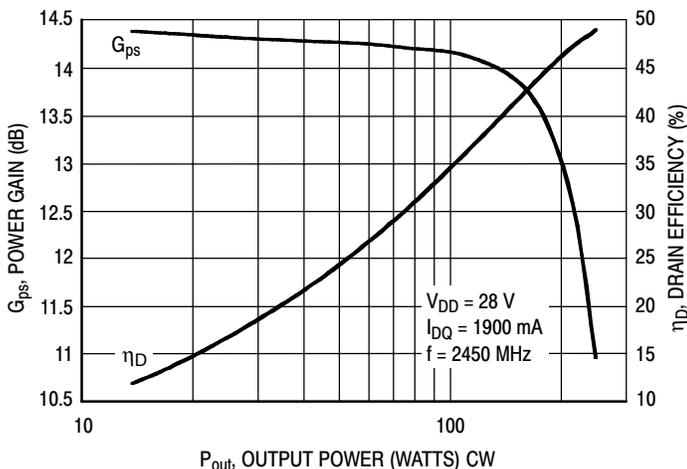
**TYPICAL CHARACTERISTICS — 2450 MHz**



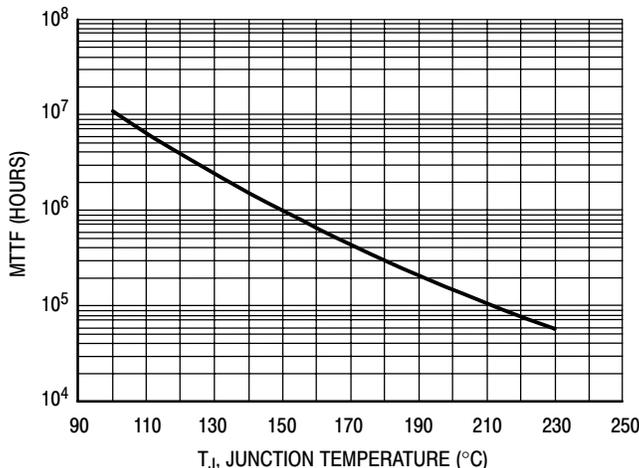
**Figure 3. Power Gain and Drain Efficiency versus CW Output Power**



**Figure 4. Power Gain and Drain Efficiency versus CW Output Power**



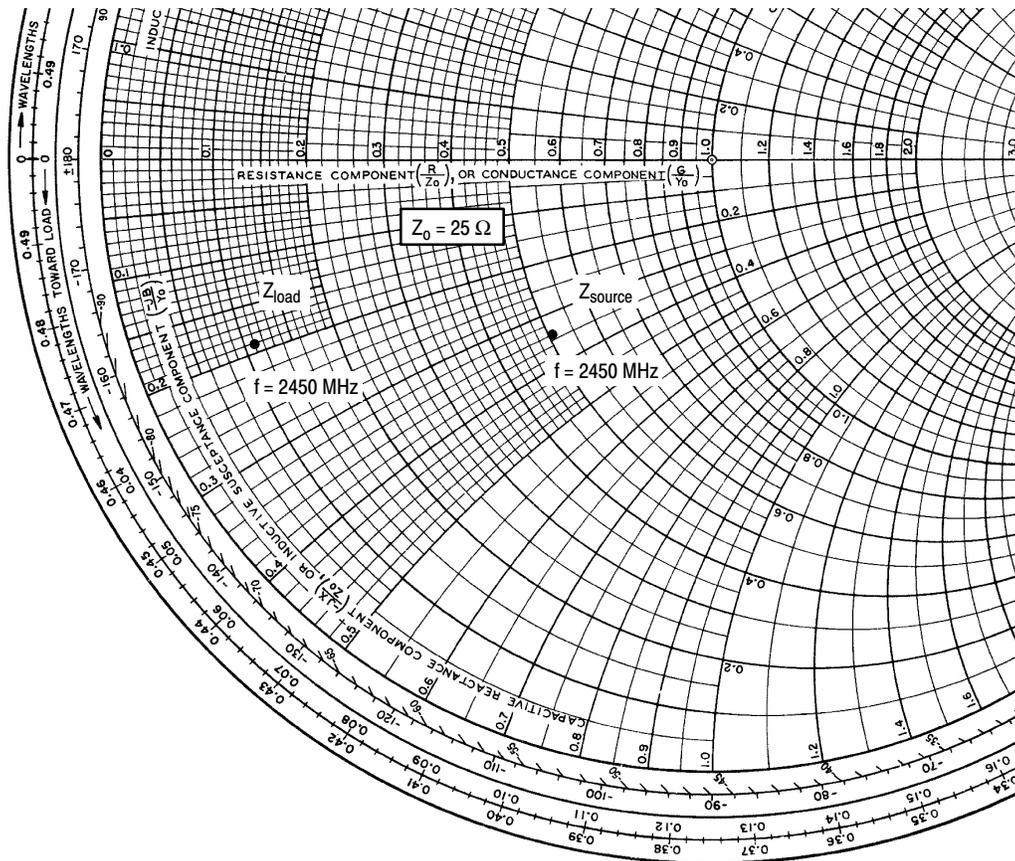
**Figure 5. Power Gain and Drain Efficiency versus CW Output Power**



This above graph displays calculated MTTF in hours when the device is operated at  $V_{DD} = 28$  Vdc,  $P_{out} = 190$  W CW, and  $\eta_D = 46.2\%$ .

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

**Figure 6. MTTF versus Junction Temperature**



$V_{DD} = 28 \text{ Vdc}$ ,  $I_{DQ} = 1900 \text{ mA}$ ,  $P_{out} = 190 \text{ W CW}$

f MHz	$Z_{source}$ $\Omega$	$Z_{load}$ $\Omega$
2450	$12.72 - j8.48$	$2.75 - j4.85$

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

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

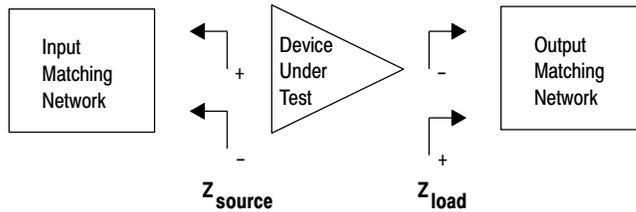
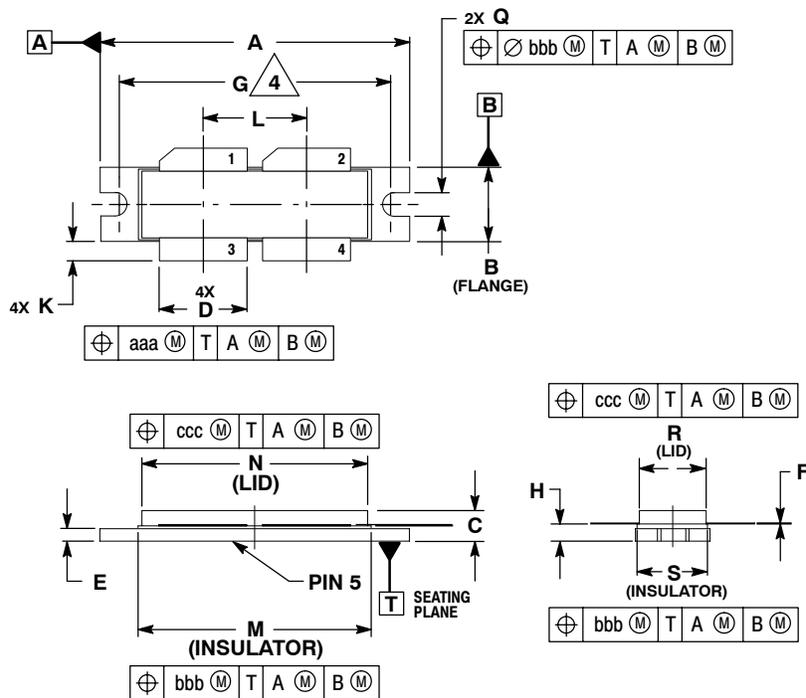


Figure 7. Series Equivalent Source and Load Impedance

# PACKAGE DIMENSIONS



- NOTES:
1. INTERPRET DIMENSIONS AND TOLERANCES PER ASME Y14.5M-1994.
  2. CONTROLLING DIMENSION: INCH.
  3. DIMENSION H IS MEASURED 0.030 (0.762) AWAY FROM PACKAGE BODY.
  4. RECOMMENDED BOLT CENTER DIMENSION OF 1.52 (38.61) BASED ON M3 SCREW.

DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	1.615	1.625	41.02	41.28
B	0.395	0.405	10.03	10.29
C	0.150	0.200	3.81	5.08
D	0.455	0.465	11.56	11.81
E	0.062	0.066	1.57	1.68
F	0.004	0.007	0.10	0.18
G	1.400 BSC		35.56 BSC	
H	0.082	0.090	2.08	2.29
K	0.117	0.137	2.97	3.48
L	0.540 BSC		13.72 BSC	
M	1.219	1.241	30.96	31.52
N	1.218	1.242	30.94	31.55
Q	0.120	0.130	3.05	3.30
R	0.355	0.365	9.01	9.27
S	0.365	0.375	9.27	9.53
aaa	0.013 REF		0.33 REF	
bbb	0.010 REF		0.25 REF	
ccc	0.020 REF		0.51 REF	

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

**CASE 375D-05  
 ISSUE E  
 NI-1230**

## PRODUCT DOCUMENTATION

Refer to the following documents 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

## REVISION HISTORY

The following table summarizes revisions to this document.

Revision	Date	Description
0	Dec. 2006	<ul style="list-style-type: none"><li>• Initial Release of Data Sheet</li></ul>
1	Mar. 2007	<ul style="list-style-type: none"><li>• Removed Lower Thermal Resistance and Low Gold Plating bullets from Features section as functionality is standard, p. 1</li><li>• Added maximum CW operation limitation and derating values to the Maximum Rating table to prevent a 200°C+ hot wire operating condition, p. 1</li><li>• Corrected <math>V_{DS}</math> to <math>V_{DD}</math> in the RF test condition voltage callout for <math>V_{GS(Q)}</math>, On Characteristics table, p. 2</li><li>• Added frequency to title of schematic, component part layout and typical characteristic curves, p. 3-5</li><li>• Added Fig. 6, MTTF versus Junction Temperature graph, p. 5</li></ul>
2	Apr. 2008	<ul style="list-style-type: none"><li>• Operating Junction Temperature increased from 200°C to 225°C in Maximum Ratings table and related "Continuous use at maximum temperature will affect MTTF" footnote added, p. 1</li><li>• Updated PCB information to show more specific material details, Fig. 1, Test Circuit Schematic, p. 3</li><li>• Updated Part Numbers in Table 5, Component Designations and Values, to latest RoHS compliant part numbers, p. 3</li></ul>
3	Feb. 2009	<ul style="list-style-type: none"><li>• Modified data sheet to reflect RF Test Reduction described in Product and Process Change Notification number, PCN13232, p. 2</li></ul>

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