



# RF Power LDMOS Transistor

## N-Channel Enhancement-Mode Lateral MOSFET

RF power transistor designed for pulse applications operating at frequencies between 960 and 1400 MHz, 1% to 20% duty cycle. This device is suitable for aerospace and defense applications such as DME, IFF, and L-band radar.

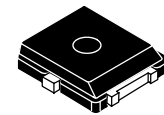
- Typical Pulse Performance:  $V_{DD} = 50 \text{ Vdc}$ ,  $I_{DQ} = 10 \text{ mA}$ ,  $P_{out} = 10 \text{ W Peak}$  (2 W Avg.),  $f = 1090 \text{ MHz}$ , Pulse Width = 100  $\mu\text{sec}$ , Duty Cycle = 20%  
 Power Gain — 25 dB  
 Drain Efficiency — 69%

### Features

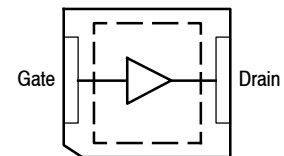
- Characterized with Series Equivalent Large-Signal Impedance Parameters
- Qualified Up to a Maximum of 50  $V_{DD}$  Operation
- Integrated ESD Protection
- Greater Negative Gate-Source Voltage Range for Improved Class C Operation
- In Tape and Reel. R4 Suffix = 100 Units, 16 mm Tape Width, 7-inch Reel.

**MMRF1019NR4**

**1090 MHz, 10 W, 50 V  
 PULSE  
 RF POWER LDMOS TRANSISTOR**



**PLD-1.5  
 PLASTIC**



Note: The center pad on the 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, +100	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	$T_J$	200	$^{\circ}\text{C}$

**Table 2. Thermal Characteristics**

Characteristic	Symbol	Value (1,2)	Unit
Thermal Resistance, Junction to Case Case Temperature 79 $^{\circ}\text{C}$ , 10 W Peak, 100 $\mu\text{sec}$ Pulse Width, 20% Duty Cycle	$Z_{\theta JC}$	1.6	$^{\circ}\text{C/W}$

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.

**Table 3. ESD Protection Characteristics**

Test Methodology	Class
Human Body Model (per JESD22-A114)	1C
Machine Model (per EIA/JESD22-A115)	A
Charge Device Model (per JESD22-C101)	IV

**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 ( $V_{GS} = 0\text{ Vdc}$ , $I_D = 7\text{ mA}$ )	$V_{(BR)DSS}$	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**

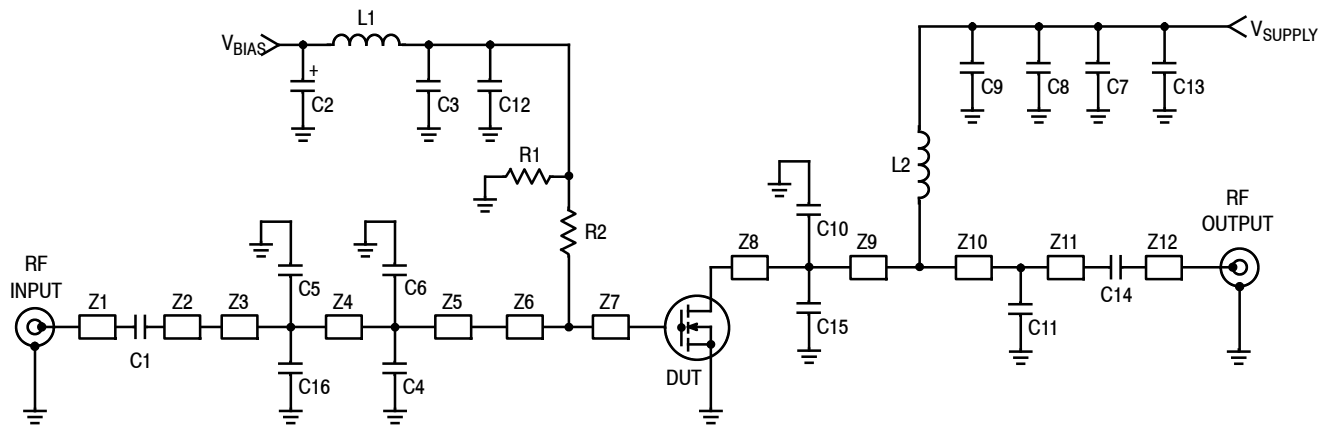
Gate Threshold Voltage ( $V_{DS} = 10\text{ Vdc}$ , $I_D = 36\ \mu\text{Adc}$ )	$V_{GS(th)}$	1	1.7	2.5	Vdc
Gate Quiescent Voltage ( $V_{DD} = 50\text{ Vdc}$ , $I_D = 10\text{ mAdc}$ , Measured in Functional Test)	$V_{GS(Q)}$	1.7	2.4	3.2	Vdc
Drain-Source On-Voltage ( $V_{GS} = 10\text{ Vdc}$ , $I_D = 70\text{ mAdc}$ )	$V_{DS(on)}$	—	0.2	—	Vdc

**Dynamic Characteristics**

Reverse Transfer Capacitance ( $V_{DS} = 50\text{ Vdc} \pm 30\text{ mV(rms)ac}$ @ 1 MHz, $V_{GS} = 0\text{ Vdc}$ )	$C_{rss}$	—	0.1	—	pF
Output Capacitance ( $V_{DS} = 50\text{ Vdc} \pm 30\text{ mV(rms)ac}$ @ 1 MHz, $V_{GS} = 0\text{ Vdc}$ )	$C_{oss}$	—	3.38	—	pF
Input Capacitance ( $V_{DS} = 50\text{ Vdc}$ , $V_{GS} = 0\text{ Vdc} \pm 30\text{ mV(rms)ac}$ @ 1 MHz)	$C_{iss}$	—	9.55	—	pF

**Functional Tests** (In Freescale Test Fixture, 50 ohm system)  $V_{DD} = 50\text{ Vdc}$ ,  $I_{DQ} = 10\text{ mA}$ ,  $P_{out} = 10\text{ W Peak}$  (2 W Avg.),  $f = 1090\text{ MHz}$ , 100  $\mu\text{sec}$  Pulse Width, 20% Duty Cycle

Power Gain	$G_{ps}$	23	25	28	dB
Drain Efficiency	$\eta_D$	66	69	—	%
Input Return Loss	IRL	—	-12	-8	dB

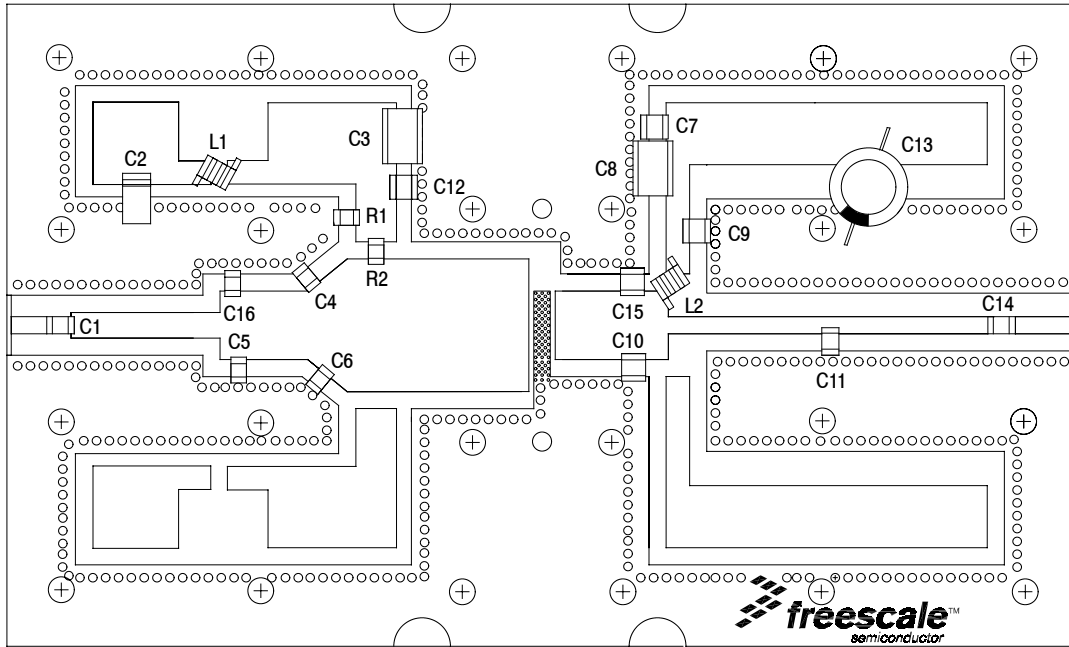


Z1	0.200" x 0.080" Microstrip	Z8	0.367" x 0.320" Microstrip
Z2	0.696" x 0.120" Microstrip	Z9	0.162" x 0.320" Microstrip
Z3	0.087" x 0.320" Microstrip	Z10	0.757" x 0.080" Microstrip
Z4	0.323" x 0.320" Microstrip	Z11	0.763" x 0.080" Microstrip
Z5	0.320" x 0.620" x 0.185" Taper	Z12	0.290" x 0.080" Microstrip
Z6	0.135" x 0.620" Microstrip	PCB	Arlon CuClad 250GX-0300-55-22, 0.030", $\epsilon_r = 2.55$
Z7	0.714" x 0.620" Microstrip		

**Figure 2. MMRF1019NR4 Test Circuit Schematic**

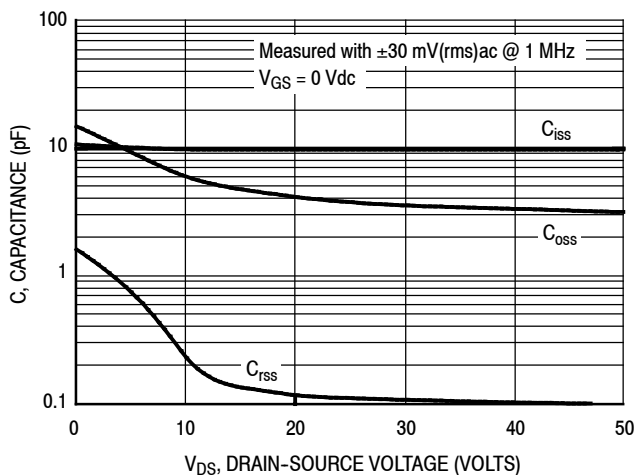
**Table 6. MMRF1019NR4 Test Circuit Component Designations and Values**

Part	Description	Part Number	Manufacturer
C1, C9, C12	43 pF Chip Capacitors	ATC100B430JT500XT	ATC
C2	10 $\mu$ F, 35 V Tantalum Capacitor	T491D106K035AT	Kemet
C3, C8	2.2 $\mu$ F, 100 V Chip Capacitors	GQM1885C2A2R2CB01B	Murata
C4, C6	7.5 pF Chip Capacitors	ATC100B7R5CT500XT	ATC
C5, C16	3.0 pF Chip Capacitors	ATC100B3R0CT500XT	ATC
C7	0.1 $\mu$ F Chip Capacitor	C1206C104K5RACTR	Kemet
C10, C15	0.3 pF Chip Capacitors	ATC100B0R3BT500XT	ATC
C11	5.6 pF Chip Capacitor	ATC100B5R6CT500XT	ATC
C13	470 $\mu$ F, 63 V Chip Capacitor	477KXM063M	Illinois Capacitor
C14	47 pF Chip Capacitor	ATC100B470JT500XT	ATC
L1	8 nH Inductor	A03TKLC	Coilcraft
L2	5 nH Inductor	A02TKLC	Coilcraft
R1	3300 $\Omega$ , 1/4 W Chip Resistor	CRCW12063301FKEA	Vishay
R2	10 $\Omega$ , 1/4 W Chip Resistor	CRCW120610R0FKEA	Vishay

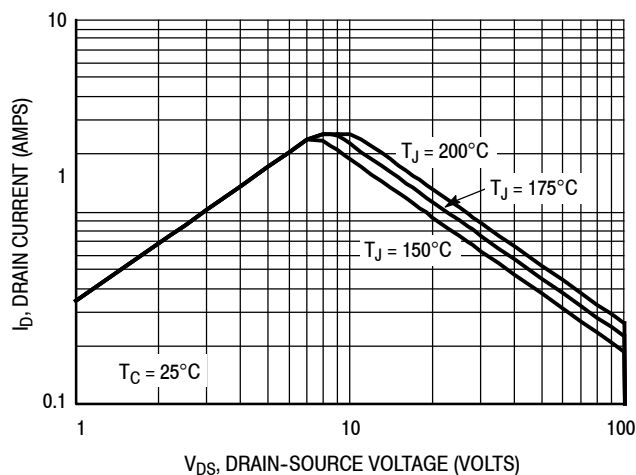


**Figure 3. MMRF1019NR4 Test Circuit Component Layout**

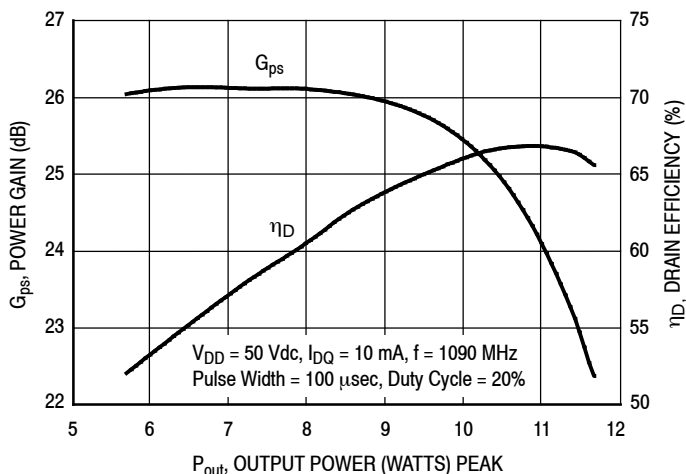
## TYPICAL CHARACTERISTICS



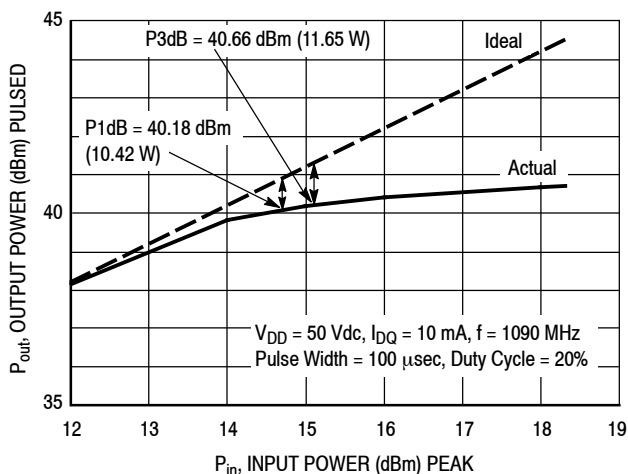
**Figure 4. Capacitance versus Drain-Source Voltage**



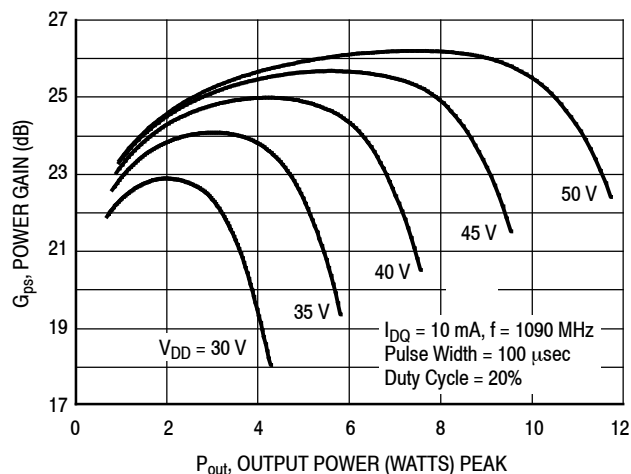
**Figure 5. DC Safe Operating Area**



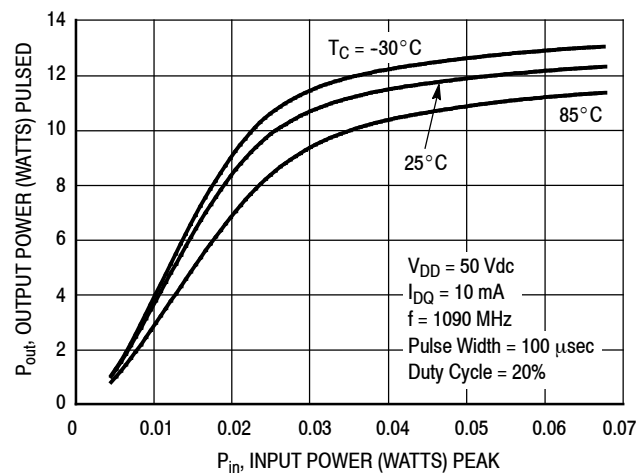
**Figure 6. Power Gain and Drain Efficiency versus Output Power**



**Figure 7. Output Power versus Input Power**

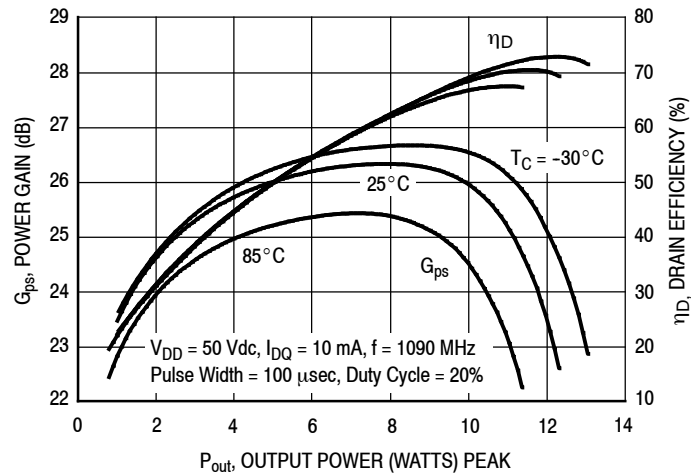


**Figure 8. Power Gain versus Output Power**

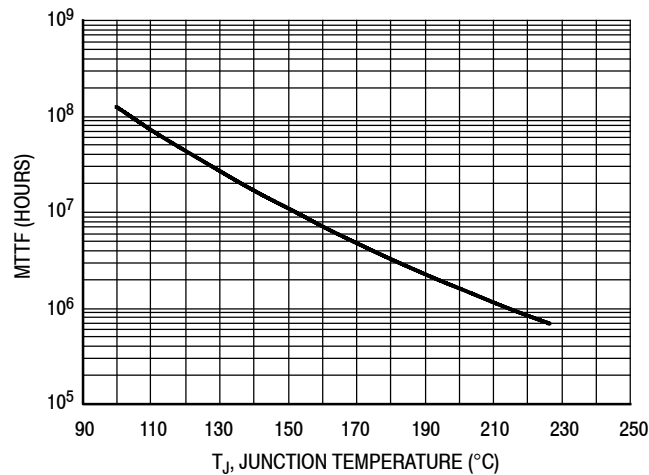


**Figure 9. Output Power versus Input Power**

## TYPICAL CHARACTERISTICS



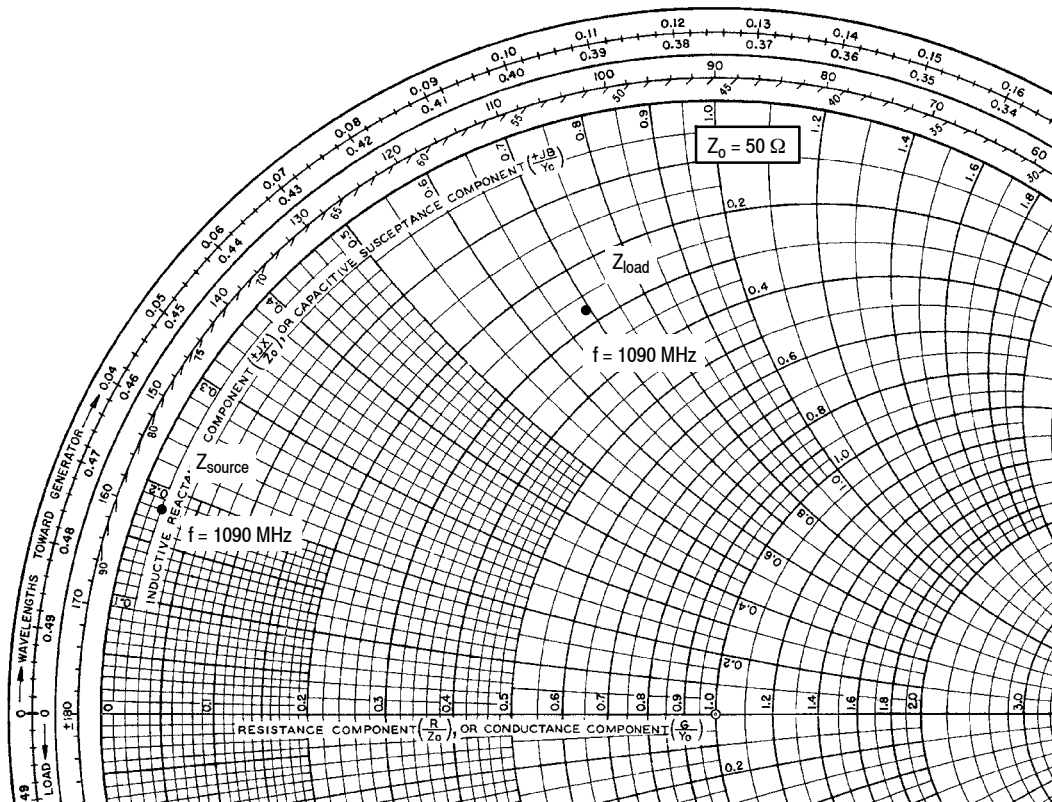
**Figure 10. Power Gain and Drain Efficiency versus Output Power**



This above graph displays calculated MTTF in hours when the device is operated at  $V_{DD} = 50\text{ Vdc}$ ,  $P_{out} = 10\text{ W Peak}$ , Pulse Width =  $100\ \mu\text{sec}$ , Duty Cycle = 20%, and  $\eta_D = 69\%$ .

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**



$V_{DD} = 50 \text{ Vdc}$ ,  $I_{DQ} = 10 \text{ mA}$ ,  $P_{out} = 10 \text{ W Peak}$

f MHz	$Z_{source}$ Ω	$Z_{load}$ Ω
1090	$1.15 + j8.96$	$13.47 + j34.32$

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

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

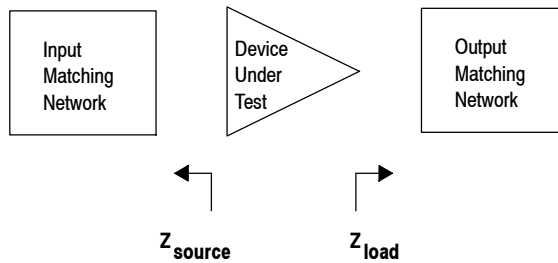


Figure 12. Series Equivalent Source and Load Impedance

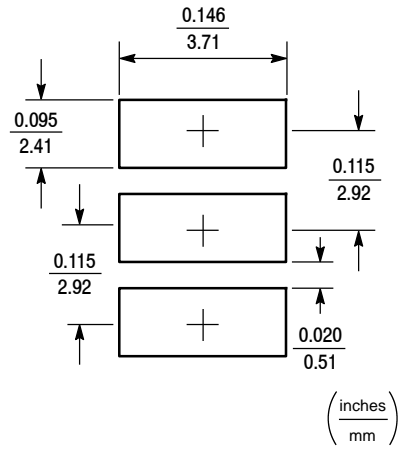


Figure 13. Solder Footprint for PLD-1.5

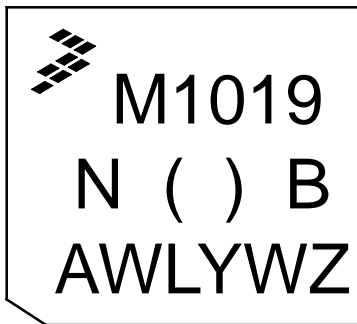
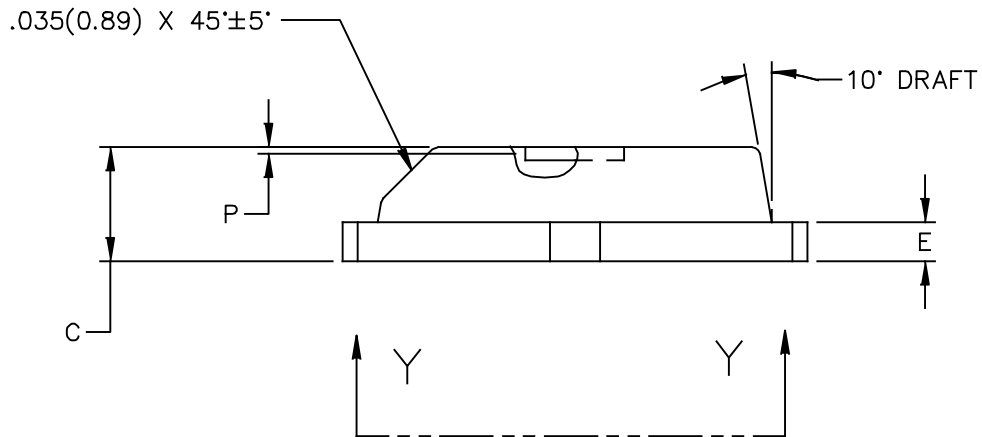
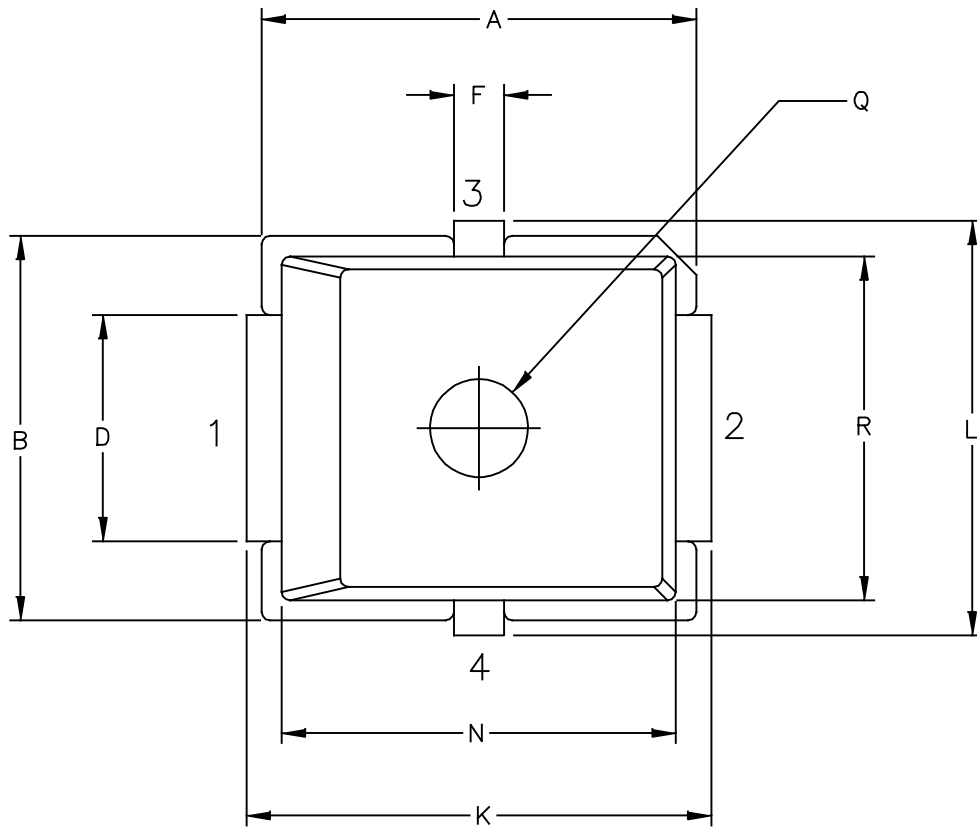


Figure 14. Product Marking

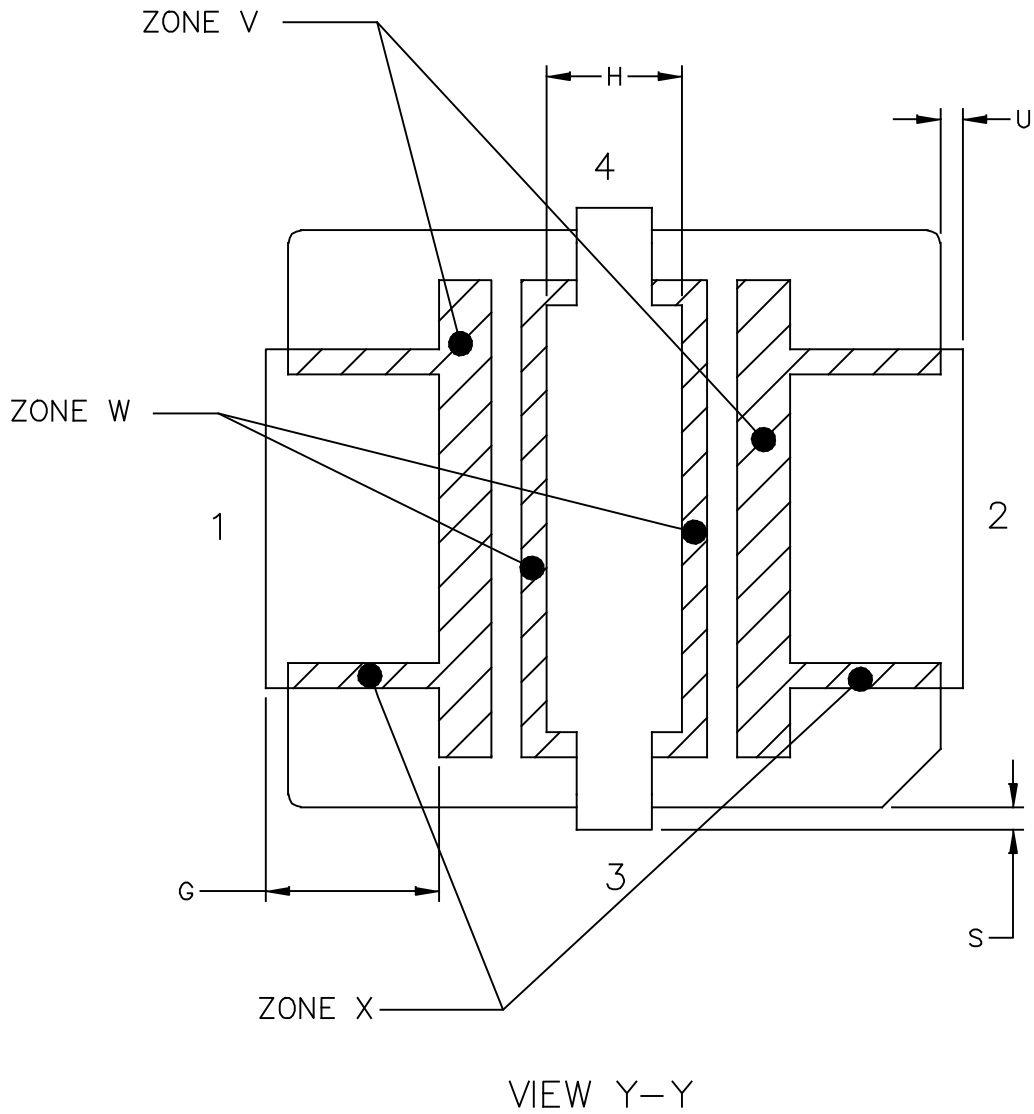


PACKAGE DIMENSIONS



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	CASE NUMBER: 466-03	31 MAR 2005	
	STANDARD: NON-JEDEC		

MMRF1019NR4



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	CASE NUMBER: 466-03	31 MAR 2005	
	STANDARD: NON-JEDEC		

NOTES:

1. CONTROLLING DIMENSION: INCH
2. INTERPRET DIMENSIONS AND TOLERANCES PER ASME Y14.5M-1994.
3. RESIN BLEED/FLASH ALLOWABLE IN ZONES V, W AND X.

STYLE 1:

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

DIM	INCH		MILLIMETER		DIM	INCH		MILLIMETER	
	MIN	MAX	MIN	MAX		MIN	MAX	MIN	MAX
A	.255	.265	6.48	6.73	Q	.055	.063	1.40	1.60
B	.225	.235	5.72	5.97	R	.200	.210	5.08	5.33
C	.065	.072	1.65	1.83	S	.006	.012	0.15	0.31
D	.130	.150	3.30	3.81	U	.006	.012	0.15	0.31
E	.021	.026	0.53	0.66	ZONE V	.000	.021	0.00	0.53
F	.026	.044	0.66	1.12	ZONE W	.000	.010	0.00	0.25
G	.050	.070	1.27	1.78	ZONE X	.000	.010	0.00	0.25
H	.045	.063	1.14	1.60					
J	.160	.180	4.06	4.57					
K	.273	.285	6.93	7.24					
L	.245	.255	6.22	6.48					
N	.230	.240	5.84	6.10					
P	.000	.008	0.00	0.20					
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TITLE:  PLD-1.5					DOCUMENT NO: 98ASB15740C			REV: D	
					CASE NUMBER: 466-03			31 MAR 2005	
					STANDARD: NON-JEDEC				

## PRODUCT DOCUMENTATION AND SOFTWARE

Refer to the following resources 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, 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 2014	• Initial Release of Data Sheet

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