

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.

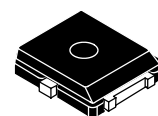
- Typical Pulse Performance: $V_{DD} = 50 \text{ Vdc}$, $I_{DQ} = 10 \text{ mA}$, $P_{out} = 10 \text{ W}$ Peak (2 W Avg.), $f = 1090 \text{ MHz}$, Pulse Width = 100 μsec , Duty Cycle = 20%
Power Gain — 25 dB
Drain Efficiency — 69%

Features

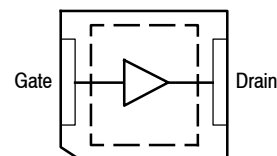
- Characterized with Series Equivalent Large-Signal Impedance Parameters
- Qualified Up to a Maximum of 50 V_{DD} Operation
- Integrated ESD Protection
- Greater Negative Gate-Source Voltage Range for Improved Class C Operation
- In Tape and Reel. R4 Suffix = 100 Units, 16 mm Tape Width, 7-inch Reel.

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 μsec Pulse Width, 20% Duty Cycle	$Z_{\theta JC}$	1.6	$^{\circ}\text{C/W}$

- 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)	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
----------------	--------	-----	-----	-----	------

Off Characteristics

Gate-Source Leakage Current ($V_{GS} = 5\text{ Vdc}$, $V_{DS} = 0\text{ Vdc}$)	I_{GSS}	—	—	10	μAdc
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	μAdc
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 ($V_{DS} = 10\text{ Vdc}$, $I_D = 36\text{ }\mu\text{Adc}$)	$V_{GS(th)}$	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 μsec Pulse Width, 20% Duty Cycle

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

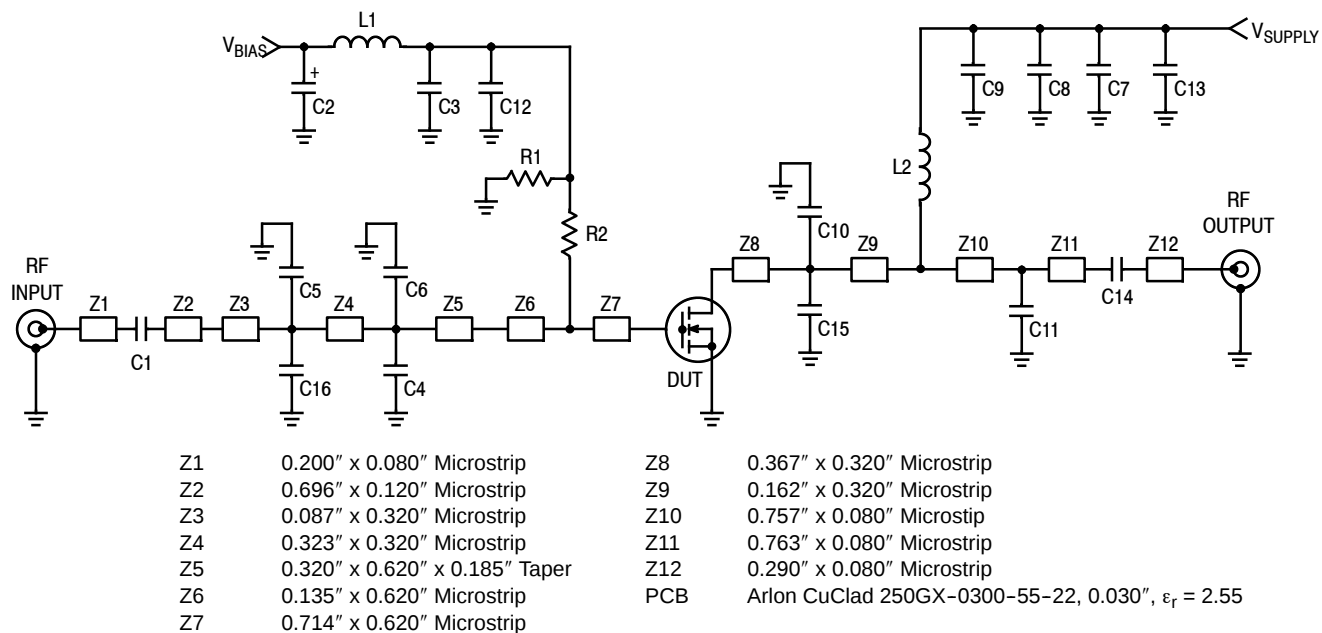


Figure 2. MMRF1019NR4 Test Circuit Schematic

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 μF, 35 V Tantalum Capacitor	T491D106K035AT	Kemet
C3, C8	2.2 μF, 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 μF Chip Capacitor	C1206C104K5RACTR	Kemet
C10, C15	0.3 pF Chip Capacitors	ATC100B0R3BT500XT	ATC
C11	5.6 pF Chip Capacitor	ATC100B5R6CT500XT	ATC
C13	470 μF, 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 Ω, 1/4 W Chip Resistor	CRCW12063301FKEA	Vishay
R2	10 Ω, 1/4 W Chip Resistor	CRCW120610R0FKEA	Vishay

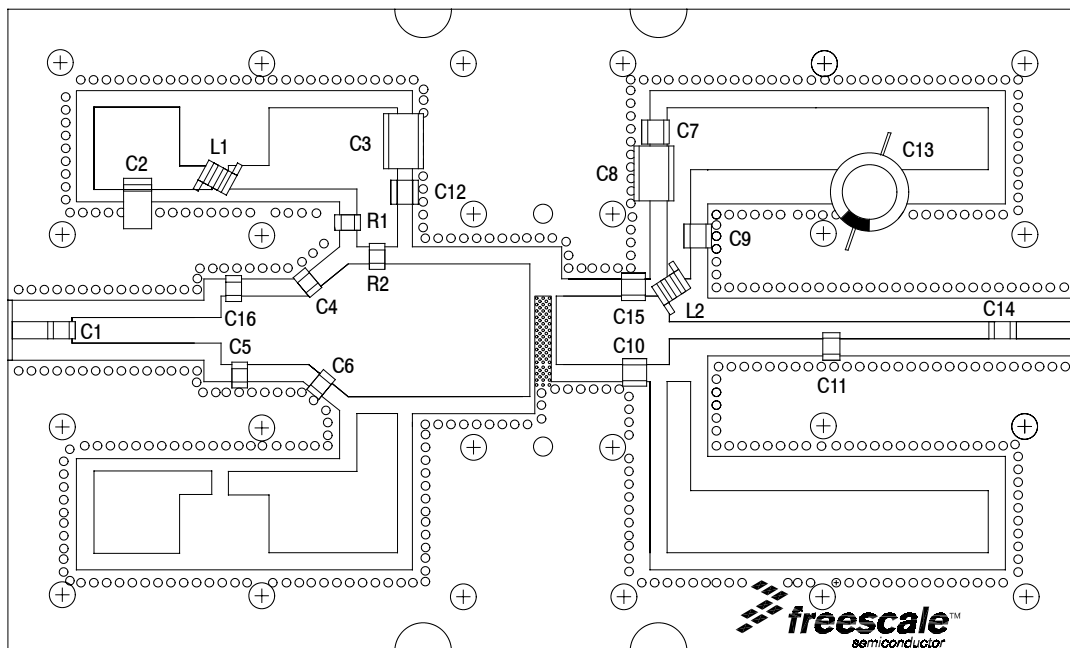


Figure 3. MMRF1019NR4 Test Circuit Component Layout

TYPICAL CHARACTERISTICS

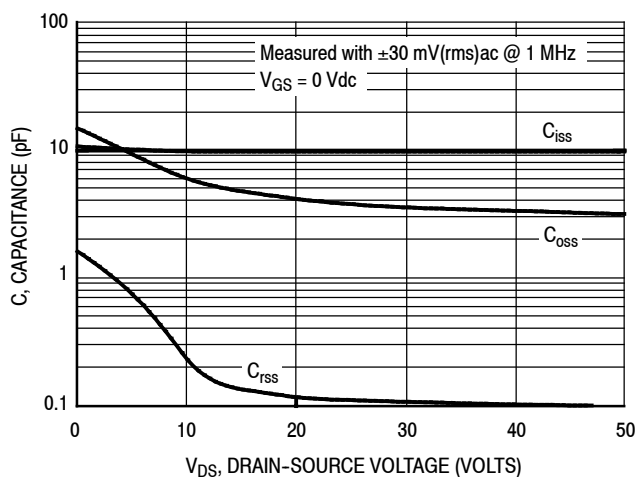


Figure 4. Capacitance versus Drain-Source Voltage

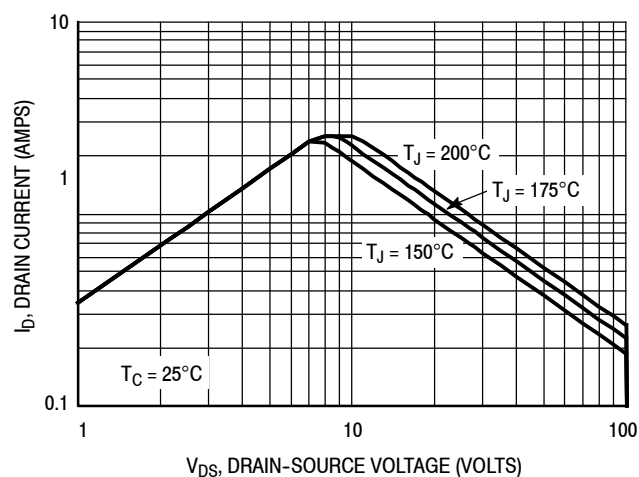


Figure 5. DC Safe Operating Area

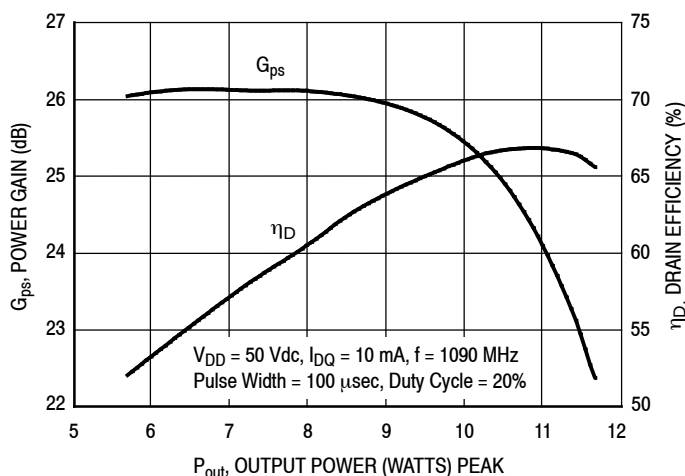


Figure 6. Power Gain and Drain Efficiency versus Output Power

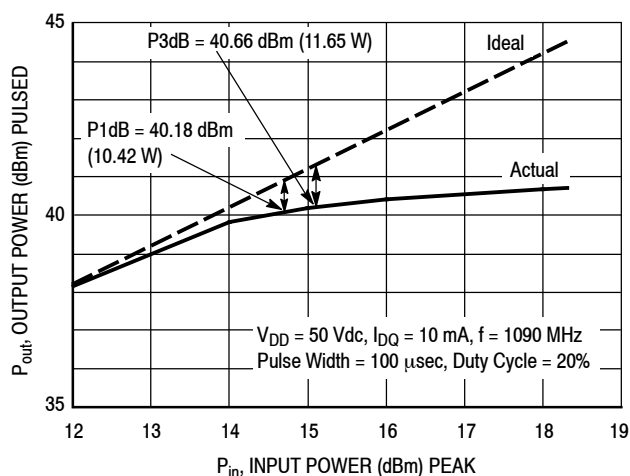


Figure 7. Output Power versus Input Power

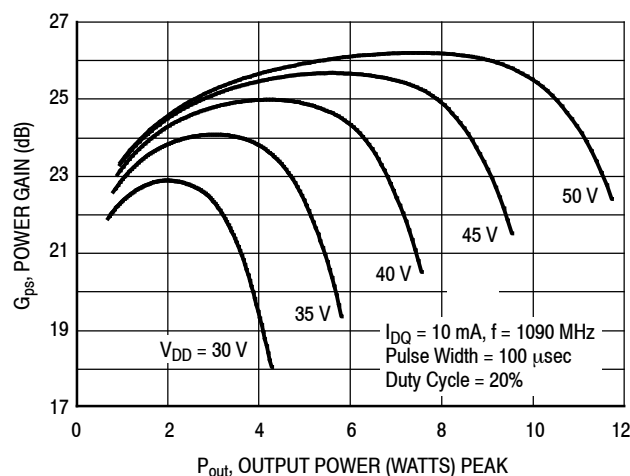


Figure 8. Power Gain versus Output Power

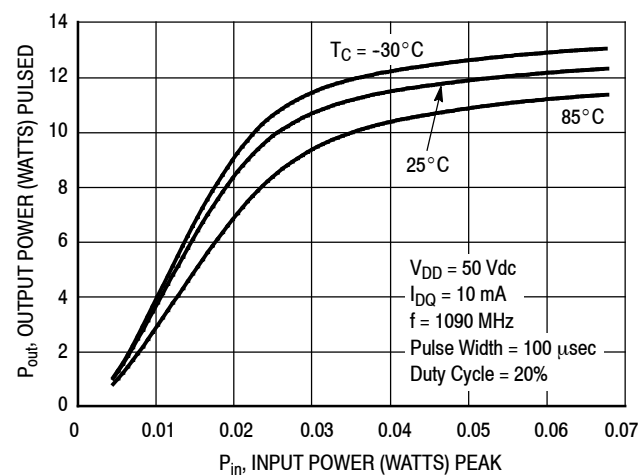


Figure 9. Output Power versus Input Power

TYPICAL CHARACTERISTICS

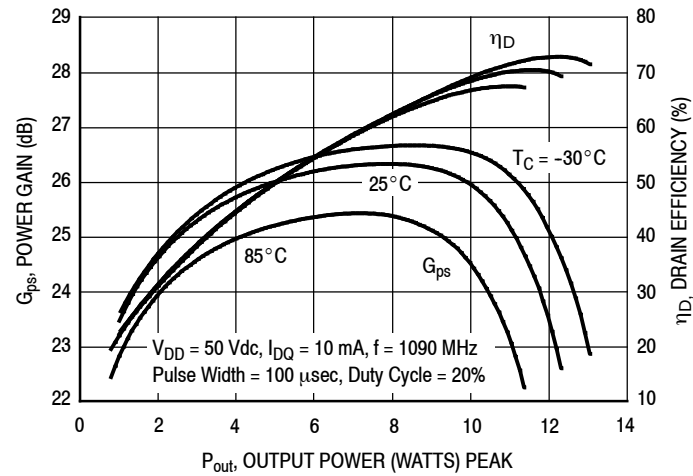
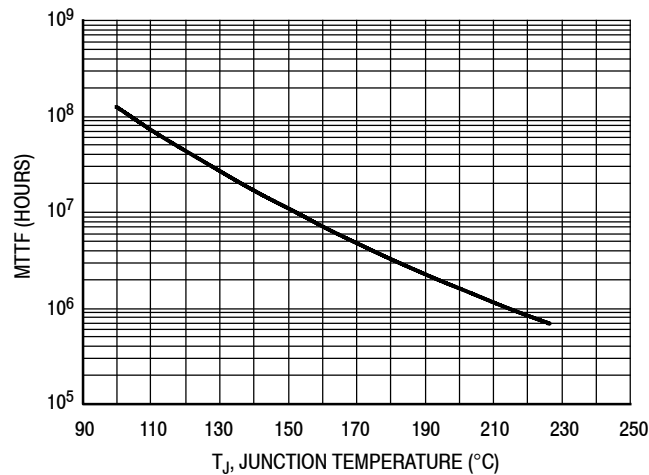


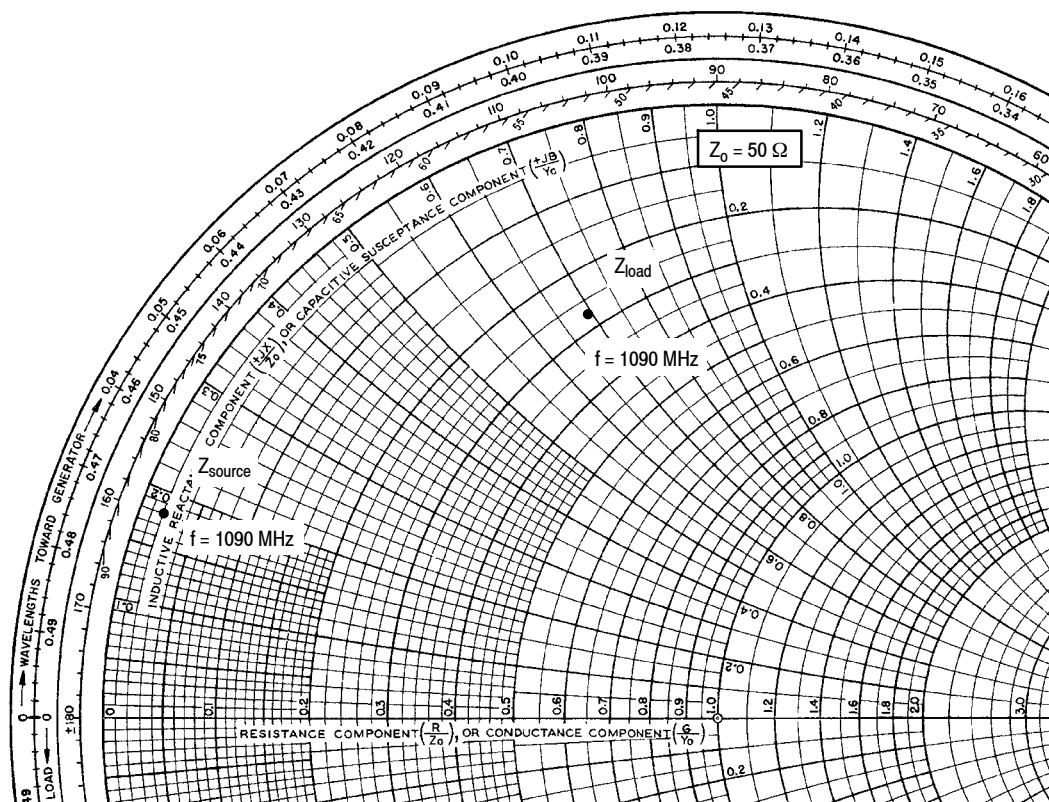
Figure 10. Power Gain and Drain Efficiency versus Output Power



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 = $100\text{ }\mu\text{sec}$, 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.

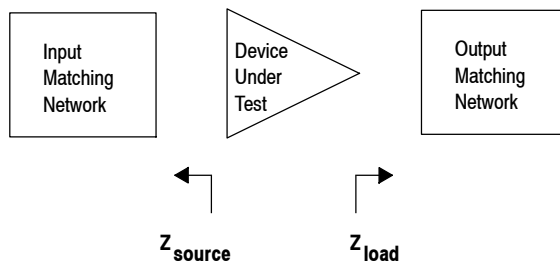


Figure 12. Series Equivalent Source and Load Impedance

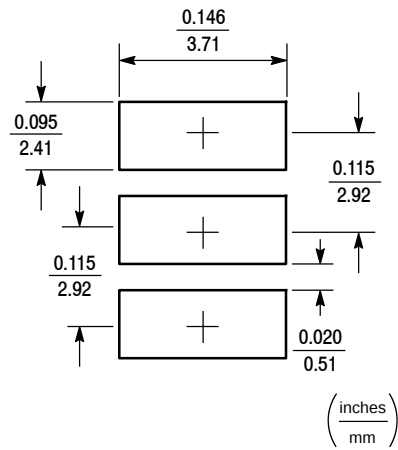


Figure 13. Solder Footprint for PLD-1.5

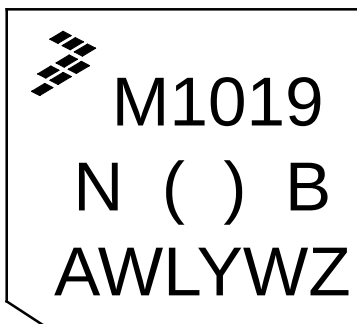
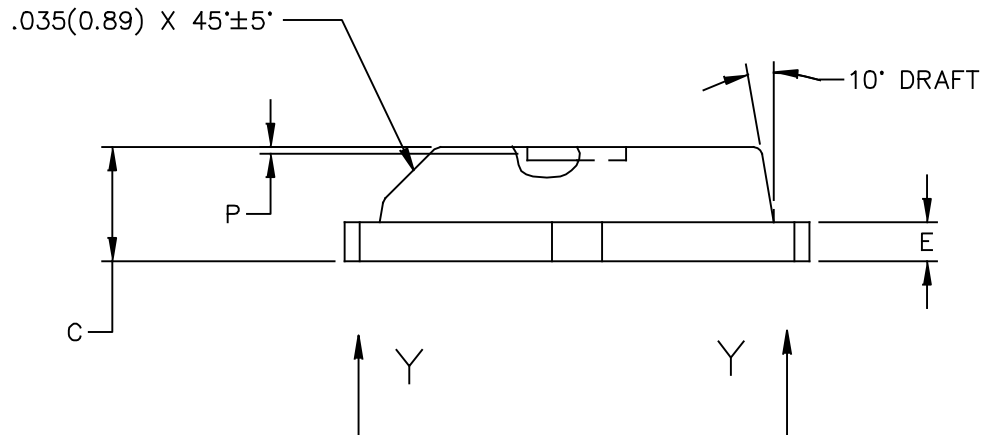
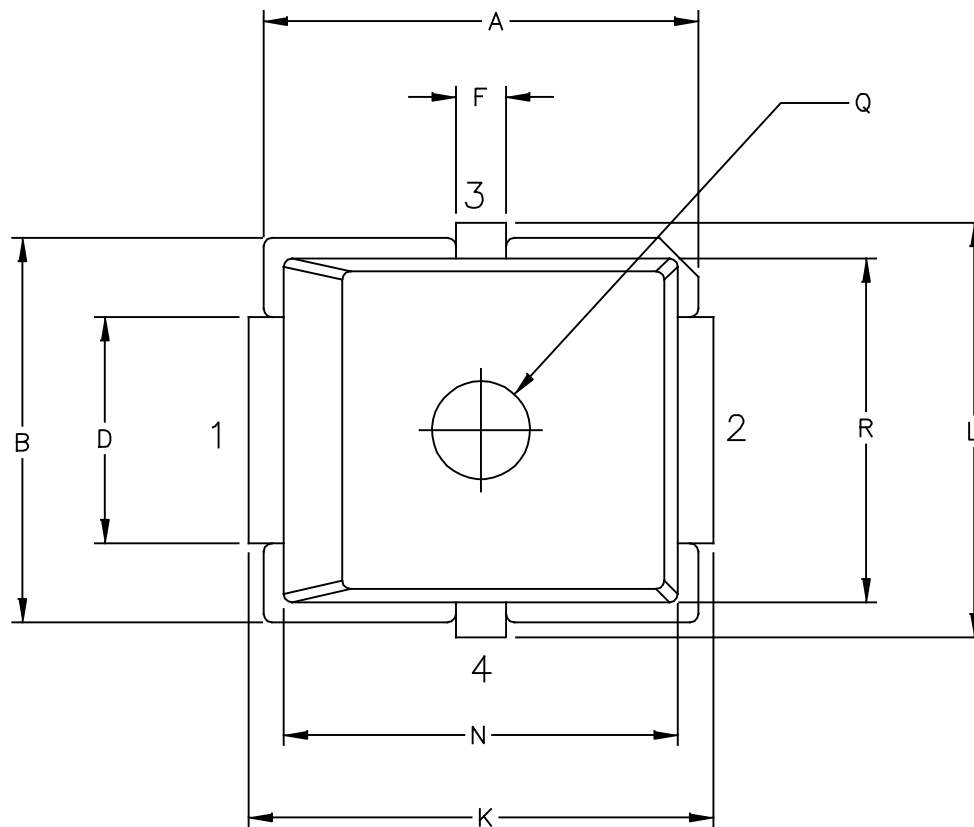
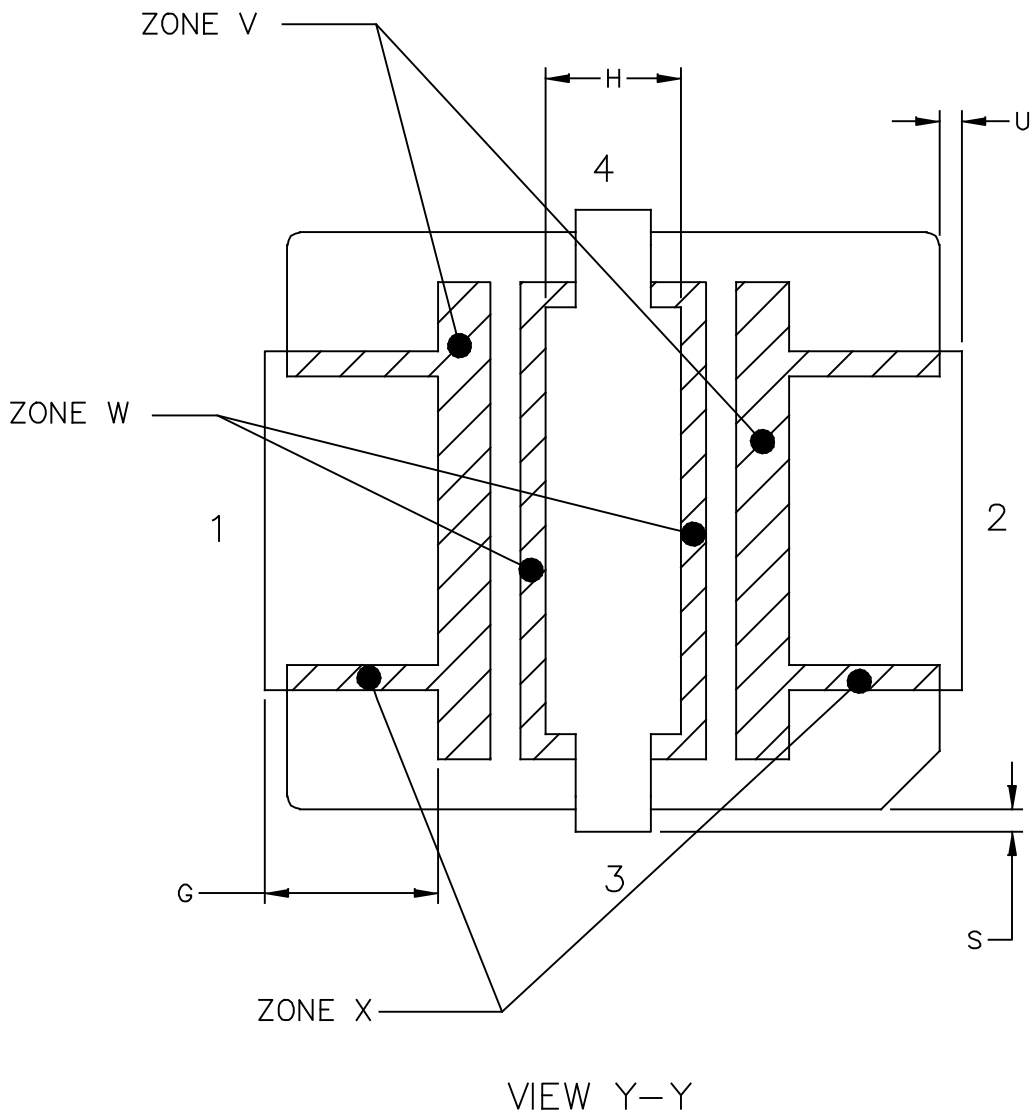


Figure 14. Product Marking

PACKAGE DIMENSIONS



© FREESCALE SEMICONDUCTOR, INC. ALL RIGHTS RESERVED.		MECHANICAL OUTLINE		PRINT VERSION NOT TO SCALE	
TITLE: PLD-1.5			DOCUMENT NO: 98ASB15740C		REV: D
			CASE NUMBER: 466-03		31 MAR 2005
			STANDARD: NON-JEDEC		



© FREESCALE SEMICONDUCTOR, INC. ALL RIGHTS RESERVED.		MECHANICAL OUTLINE	PRINT VERSION NOT TO SCALE	
TITLE: PLD-1.5		DOCUMENT NO: 98ASB15740C		REV: D
		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

INCH			MILLIMETER		INCH			MILLIMETER	
DIM	MIN	MAX	MIN	MAX	DIM	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					
© FREESCALE SEMICONDUCTOR, INC. ALL RIGHTS RESERVED.			MECHANICAL OUTLINE			PRINT VERSION NOT TO SCALE			
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 MTF 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

How to Reach Us:

Home Page:
freescale.com

Web Support:
freescale.com/support

Information in this document is provided solely to enable system and software implementers to use Freescale products. There are no express or implied copyright licenses granted hereunder to design or fabricate any integrated circuits based on the information in this document.

Freescale reserves the right to make changes without further notice to any products herein. Freescale makes no warranty, representation, or guarantee regarding the suitability of its products for any particular purpose, nor does Freescale assume any liability arising out of the application or use of any product or circuit, and specifically disclaims any and all liability, including without limitation consequential or incidental damages. "Typical" parameters that may be provided in Freescale data sheets and/or specifications can and do vary in different applications, and actual performance may vary over time. All operating parameters, including "typicals," must be validated for each customer application by customer's technical experts. Freescale does not convey any license under its patent rights nor the rights of others. Freescale sells products pursuant to standard terms and conditions of sale, which can be found at the following address: freescale.com/SalesTermsandConditions.

Freescale and the Freescale logo are trademarks of Freescale Semiconductor, Inc., Reg. U.S. Pat. & Tm. Off. All other product or service names are the property of their respective owners.

© 2014 Freescale Semiconductor, Inc.