Freescale Semiconductor
Technical Data

Document Number: MMRF1019N
Rev. 0, 7/2014

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.

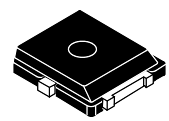
- Typical Pulse Performance: V_{DD} = 50 Vdc, I_{DQ} = 10 mA, P_{out} = 10 W Peak (2 W Avg.), f = 1090 MHz, Pulse Width = 100 μsec, Duty Cycle = 20%
  Power Gain — 25 dB
  Drain Efficiency — 69%

Features

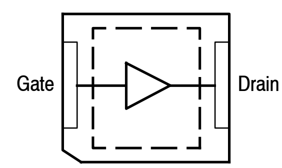
- Characterized with Series Equivalent Large–Signal Impedance Parameters
- Qualified Up to a Maximum of 50 V_{DD} Operation
- Integrated ESD Protection
- Greater Negative Gate–Source Voltage Range for Improved Class C Operation
- In Tape and Reel. R4 Suffix = 100 Units, 16 mm Tape Width, 7–inch Reel.

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	°C
Case Operating Temperature	T_C	150	°C
Operating Junction Temperature	T_J	200	°C

Table 2. Thermal Characteristics

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

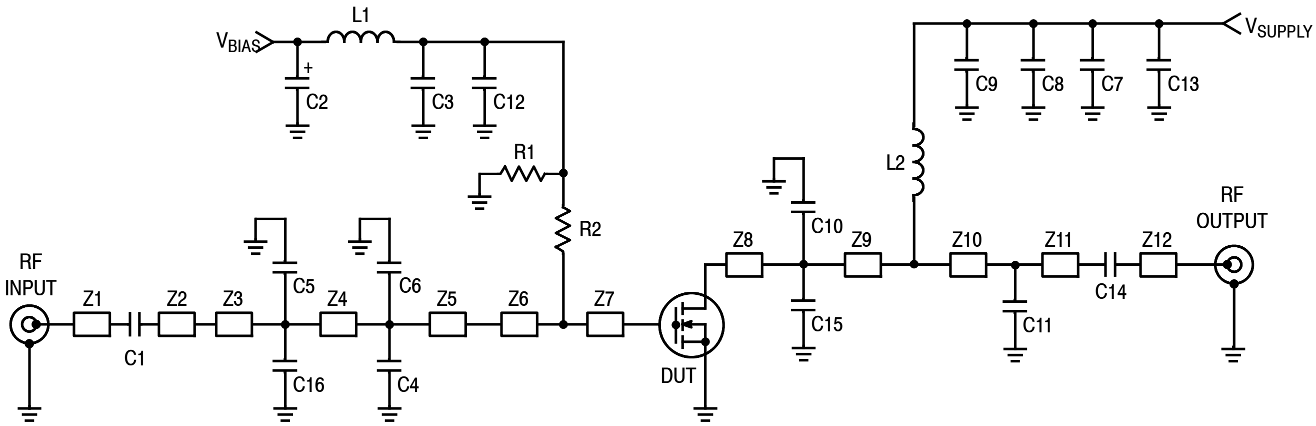
Test Methodology	Class
Human Body Model (per JESD22−A114)	1C
Machine Model (per EIA/JESD22−A115)	A
Charge Device Model (per JESD22−C101)	IV

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°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
Off Characteristics					
Gate−Source Leakage Current (V_{GS} = 5 Vdc, V_{DS} = 0 Vdc)	I_{GSS}	—	—	10	μAdc
Drain−Source Breakdown Voltage (V_{GS} = 0 Vdc, I_D = 7 mA)	$V_{(BR)DSS}$	110	—	—	Vdc
Zero Gate Voltage Drain Leakage Current (V_{DS} = 50 Vdc, V_{GS} = 0 Vdc)	I_{DSS}	—	—	50	μAdc
Zero Gate Voltage Drain Leakage Current (V_{DS} = 100 Vdc, V_{GS} = 0 Vdc)	I_{DSS}	—	—	2.5	mA
On Characteristics					
Gate Threshold Voltage (V_{DS} = 10 Vdc, I_D = 36 μAdc)	$V_{GS(th)}$	1	1.7	2.5	Vdc
Gate Quiescent Voltage (V_{DD} = 50 Vdc, I_D = 10 mAdc, Measured in Functional Test)	$V_{GS(Q)}$	1.7	2.4	3.2	Vdc
Drain−Source On−Voltage (V_{GS} = 10 Vdc, I_D = 70 mAdc)	$V_{DS(on)}$	—	0.2	—	Vdc
Dynamic Characteristics					
Reverse Transfer Capacitance (V_{DS} = 50 Vdc ± 30 mV(rms)ac @ 1 MHz, V_{GS} = 0 Vdc)	C_{rss}	—	0.1	—	pF
Output Capacitance (V_{DS} = 50 Vdc ± 30 mV(rms)ac @ 1 MHz, V_{GS} = 0 Vdc)	C_{oss}	—	3.38	—	pF
Input Capacitance (V_{DS} = 50 Vdc, V_{GS} = 0 Vdc ± 30 mV(rms)ac @ 1 MHz)	C_{iss}	—	9.55	—	pF
Functional Tests (In Freescale Test Fixture, 50 ohm system) V_{DD} = 50 Vdc, I_{DQ} = 10 mA, P_{out} = 10 W Peak (2 W Avg.), f = 1090 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



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″ Microstip
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″, ε_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 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	Illlinois 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

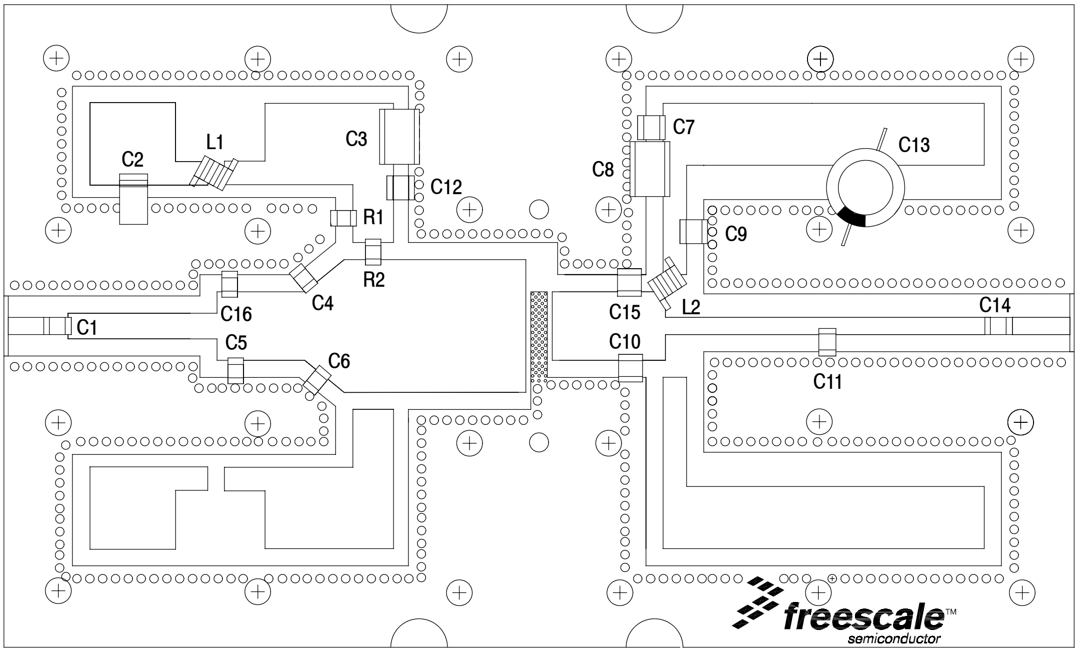


Figure 3. MMRF1019NR4 Test Circuit Component Layout

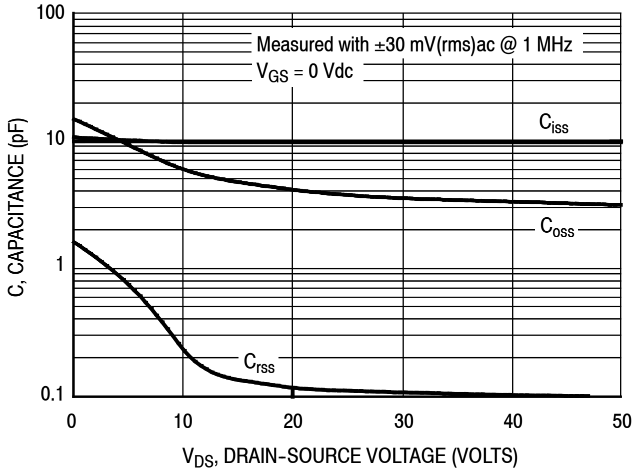


Figure 4. Capacitance versus Drain-Source Voltage

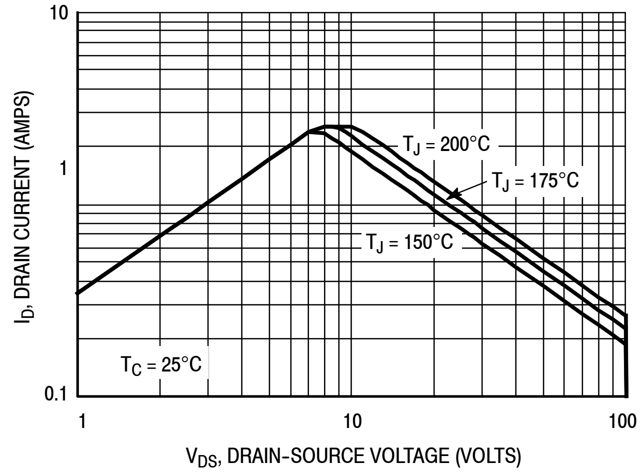


Figure 5. DC Safe Operating Area

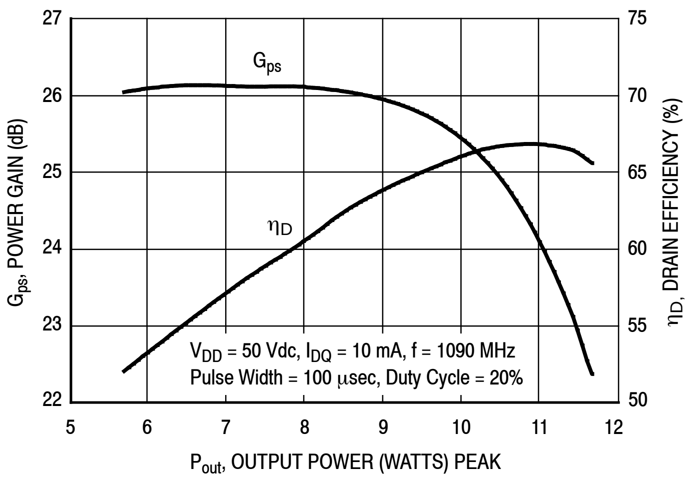


Figure 6. Power Gain and Drain Efficiency versus Output Power

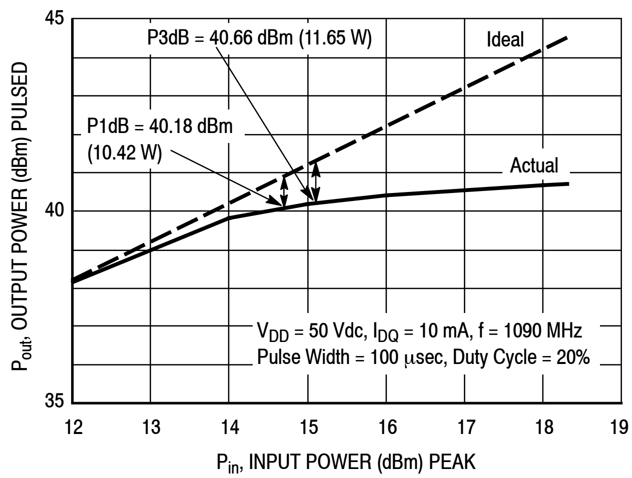


Figure 7. Output Power versus Input Power

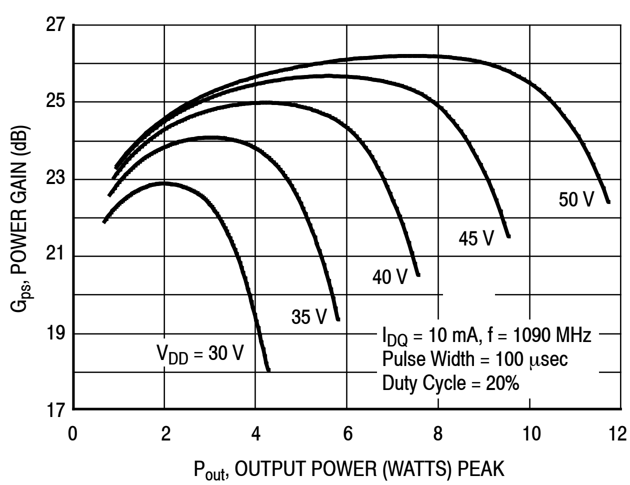


Figure 8. Power Gain versus Output Power

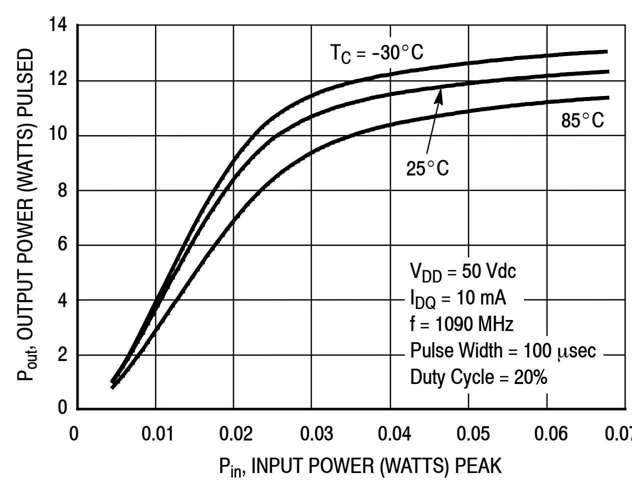


Figure 9. Output Power versus Input Power

TYPICAL CHARACTERISTICS

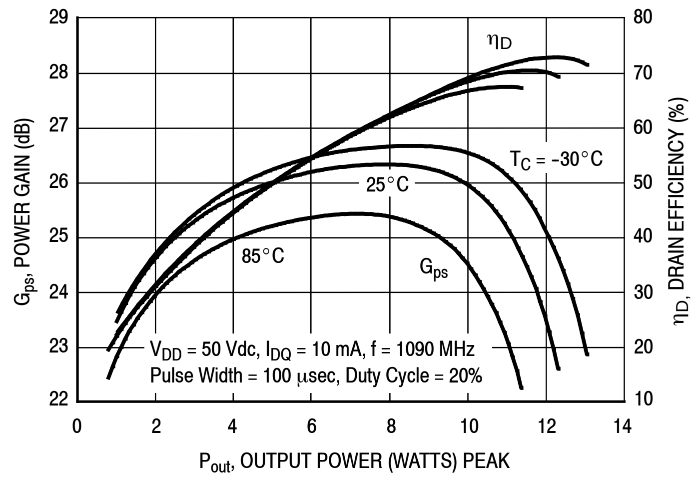
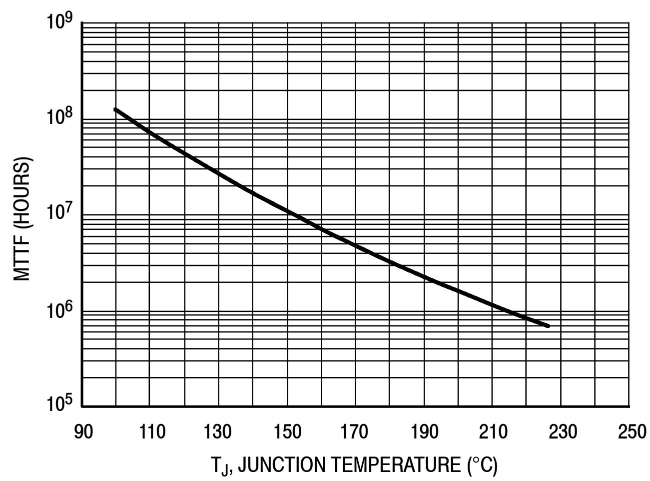


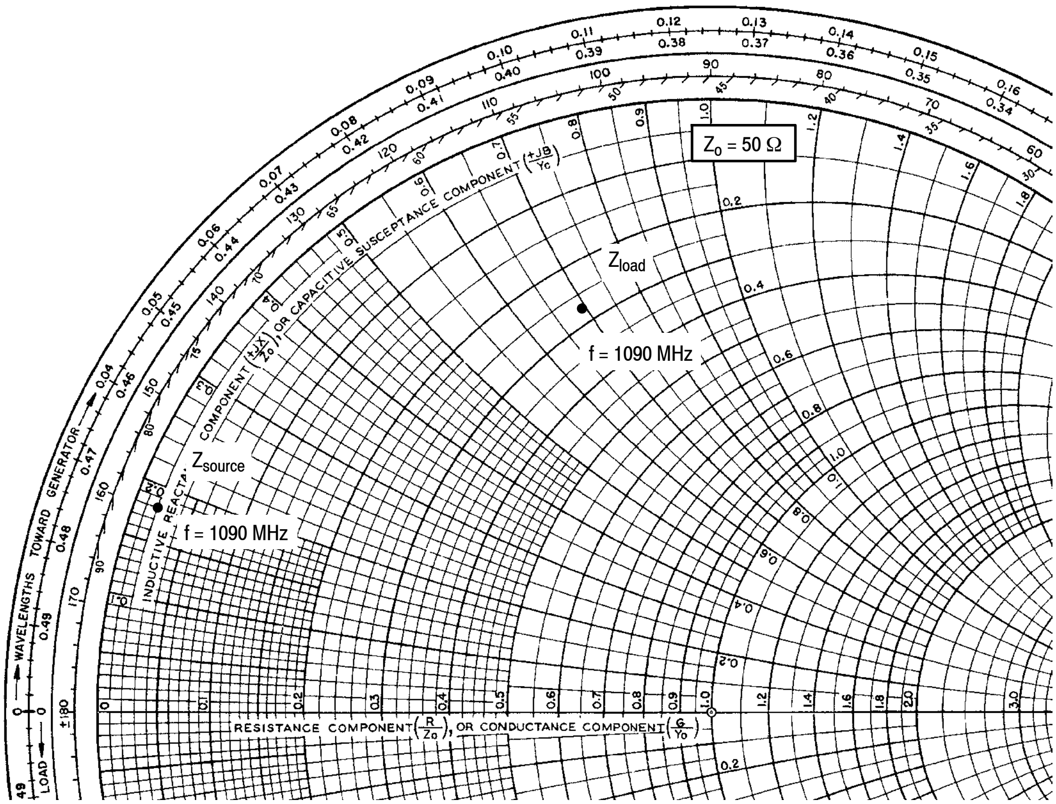
Figure 10. Power Gain and Drain Efficiency versus Output Power



This above graph displays calculated MTTF in hours when the device is operated at V_{DD} = 50 Vdc, P_{out} = 10 W Peak, Pulse Width = 100 μsec, Duty Cycle = 20%, and η_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 Vdc, I_{DQ} = 10 mA, P_{out} = 10 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.

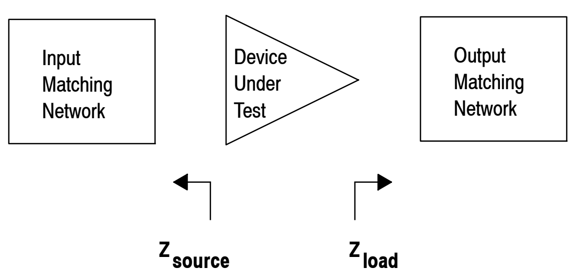


Figure 12. Series Equivalent Source and Load Impedance

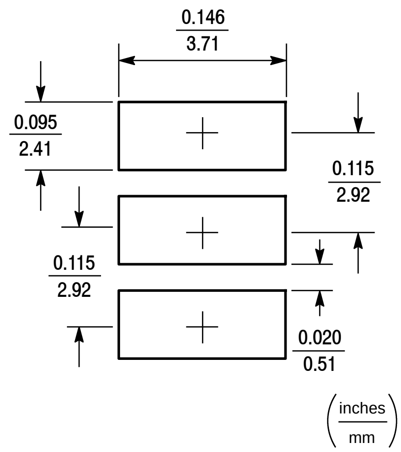


Figure 13. Solder Footprint for PLD-1.5

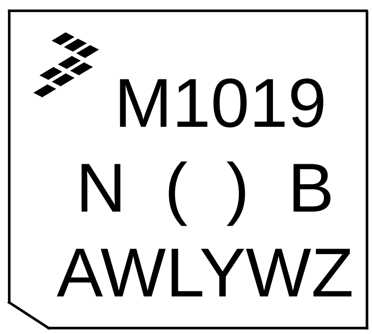
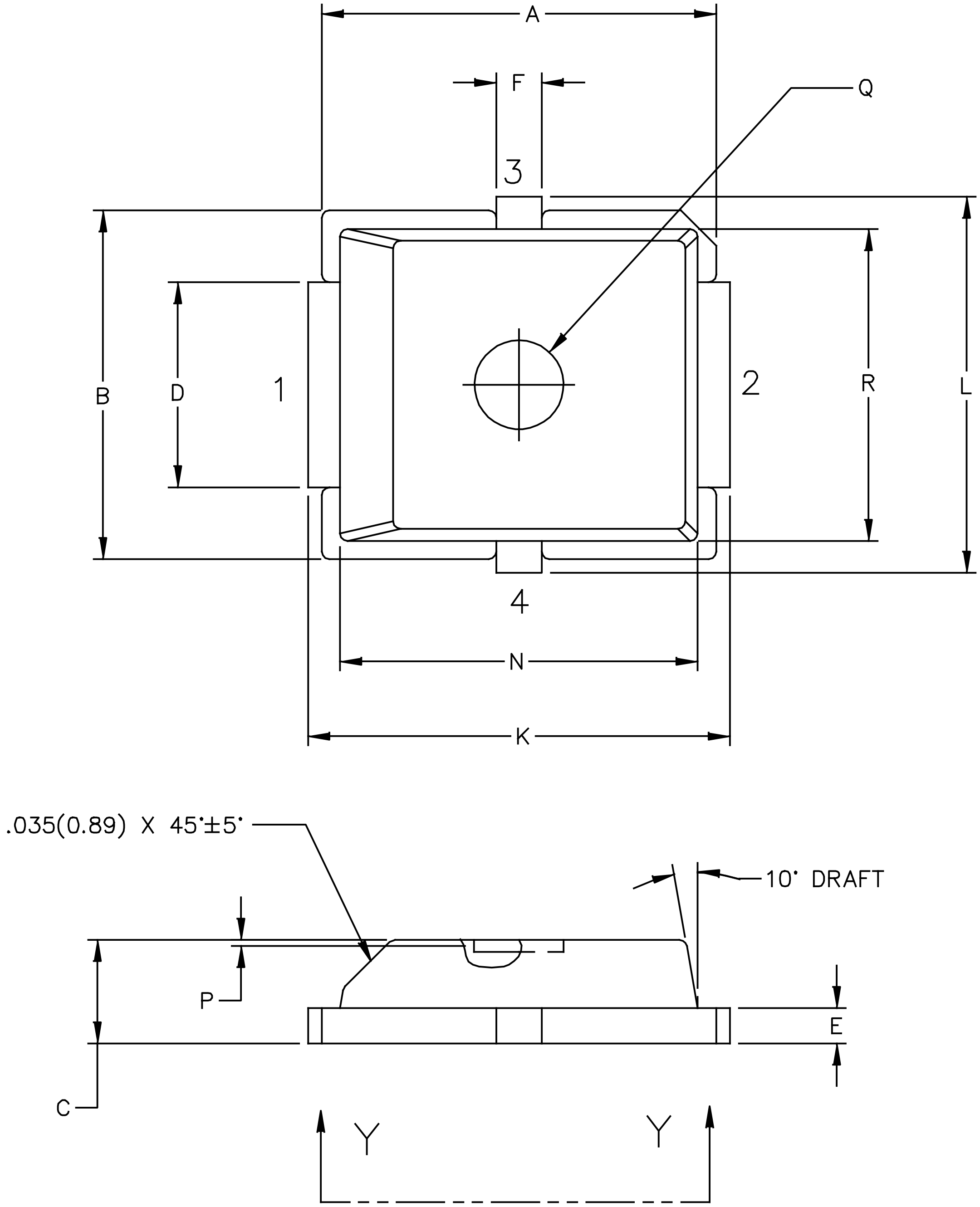


Figure 14. Product Marking

PACKAGE DIMENSIONS



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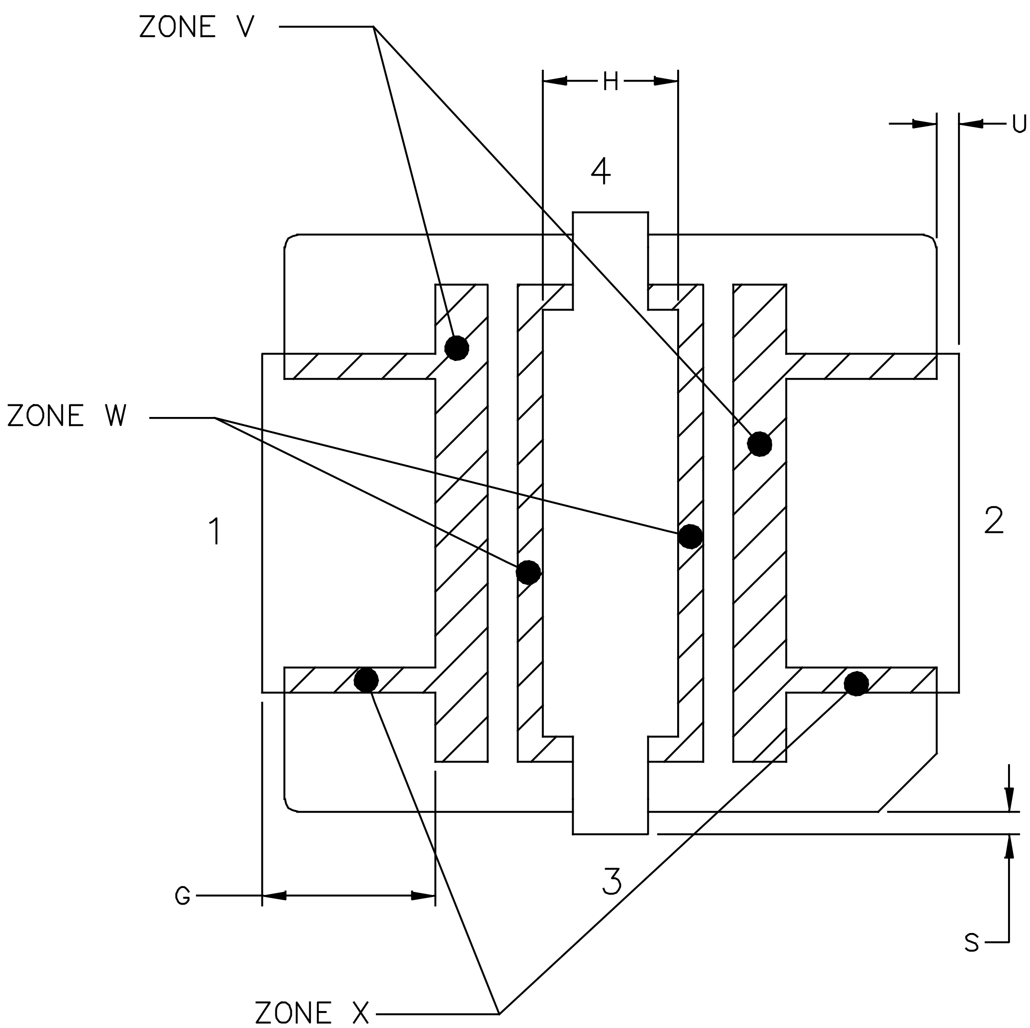
	CASE NUMBER: 466−03	31 MAR 2005
	STANDARD: NON−JEDEC	



VIEW Y–Y

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	STANDARD: NON–JEDEC	

NOTES:

1. CONTROLLING DIMENSION: INCH

2. INTERPRET DIMENSIONS AND TOLERANCES PER ASME Y14.5M–1994.

3. RESIN BLEED/FLASH ALLOWABE 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					

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	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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Rev. 0, 7/2014

LifeElectronics
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