Freescale Semiconductor
Technical Data

Document Number: MRF6P24190H
Rev. 3, 2/2009

RoHS

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.

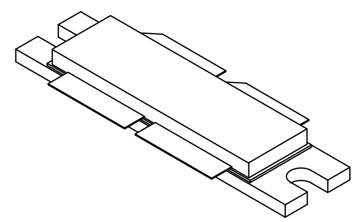
- Typical CW Performance at 2450 MHz, V_{DD} = 28 Volts, I_{DQ} = 1900 mA, P_{out} = 190 Watts
  Power Gain — 13.2 dB
  Drain Efficiency — 46.2%
- Capable of Handling 10:1 VSWR, @ 28 Vdc, 2340 MHz, 190 Watts CW Output Power

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°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.

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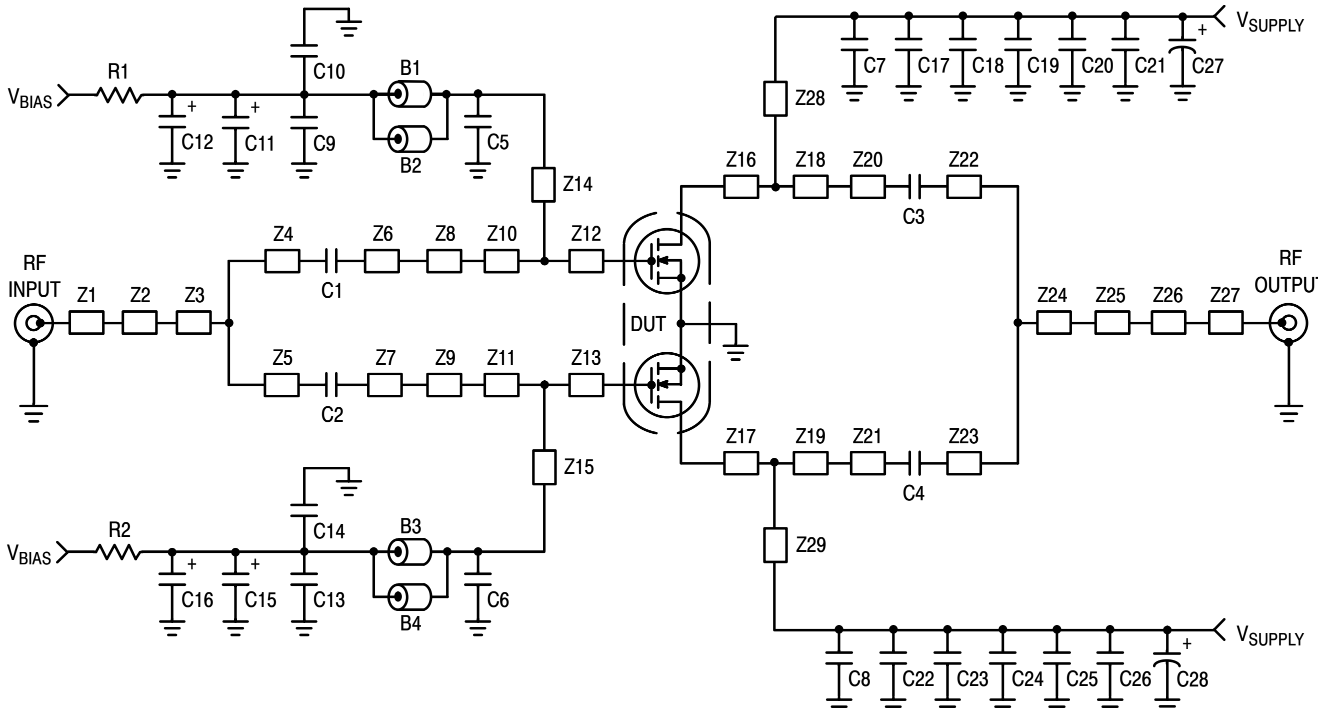
Table 3. ESD Protection Characteristics

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°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
Off Characteristics (1)					
Zero Gate Voltage Drain Leakage Current (V_{DS} = 68 Vdc, V_{GS} = 0 Vdc)	I_{DSS}	—	—	10	μAdc
Zero Gate Voltage Drain Leakage Current (V_{DS} = 28 Vdc, V_{GS} = 0 Vdc)	I_{DSS}	—	—	1	μAdc
Gate-Source Leakage Current (V_{GS} = 5 Vdc, V_{DS} = 0 Vdc)	I_{GSS}	—	—	1	μAdc
On Characteristics					
Gate Threshold Voltage (1) (V_{DS} = 10 Vdc, I_D = 200 μAdc)	$V_{GS(th)}$	1	2	3	Vdc
Gate Quiescent Voltage (3) (V_{DD} = 28 Vdc, I_D = 1900 mAdc, Measured in Functional Test)	$V_{GS(Q)}$	2	2.8	4	Vdc
Drain-Source On-Voltage (1) (V_{GS} = 10 Vdc, I_D = 2.2 Adc)	$V_{DS(on)}$	0.1	0.21	0.3	Vdc
Dynamic Characteristics (1,2)					
Reverse Transfer Capacitance (V_{DS} = 28 Vdc ± 30 mV(rms)ac @ 1 MHz, V_{GS} = 0 Vdc)	C_{rss}	—	1.5	—	pF
Functional Tests (3) (In Freescale Test Fixture, 50 ohm system) V_{DD} = 28 Vdc, I_{DQ} = 1900 mA, P_{out} = 40 W Avg., f = 2390 MHz, 2-Carrier W-CDMA, 3.84 MHz Channel Bandwidth Carriers. ACPR measured in 3.84 MHz Channel Bandwidth @ ±5 MHz Offset. IM3 measured in 3.84 MHz Bandwidth @ ±10 MHz Offset. Input Signal PAR = 8.5 dB @ 0.01% Probability on CCDF.					
Power Gain	G_{ps}	13	14	16	dB
Drain Efficiency	η_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.

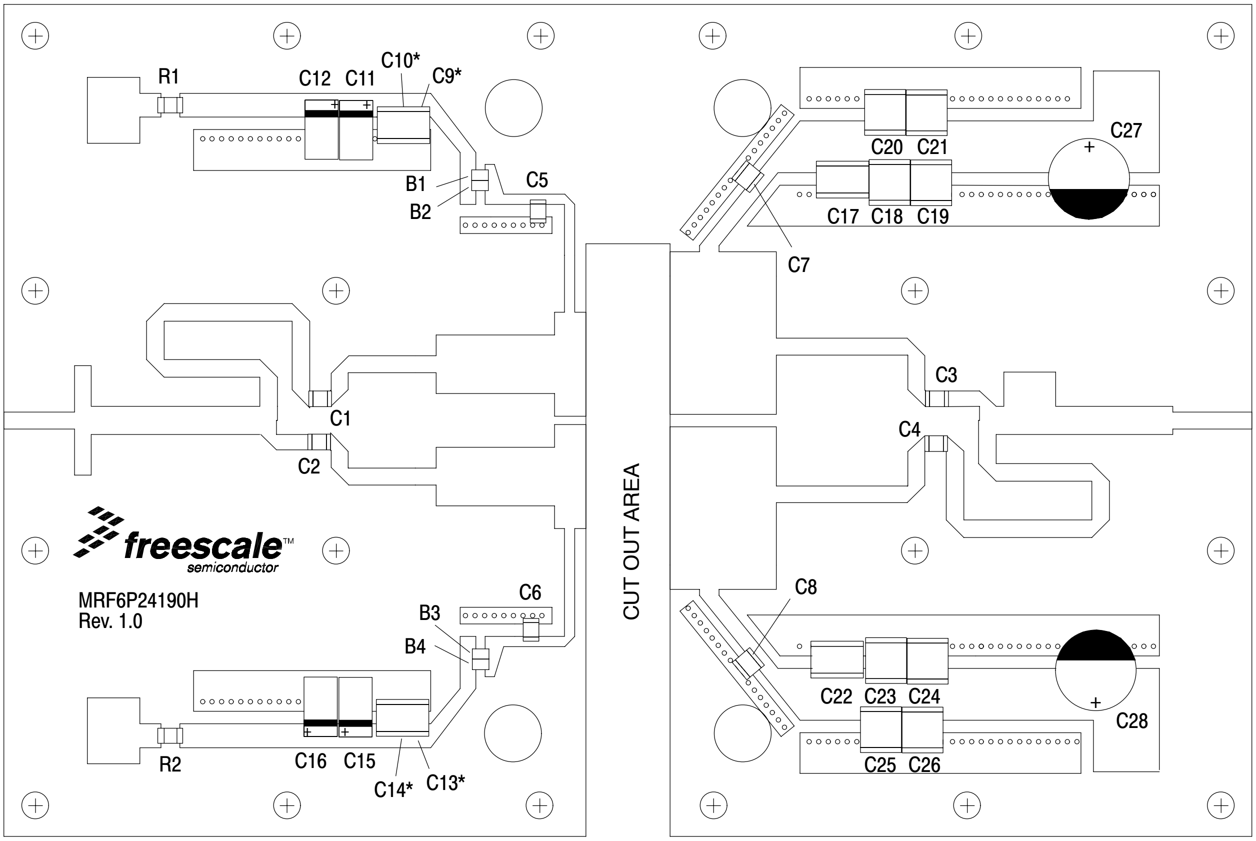


Z1	0.340″ x 0.081″ Microstrip	Z16, Z17	0.189″ x 0.782″ Microstrip
Z2	0.080″ x 0.526″ Microstrip	Z18, Z19	0.321″ x 0.782″ Microstrip
Z3	0.895″ x 0.135″ Microstrip	Z20, Z21	0.630″ x 0.081″ Microstrip
Z4	1.736″ x 0.074″ Microstrip	Z22	0.150″ x 0.081″ Microstrip
Z5	0.151″ x 0.074″ Microstrip	Z23	1.728″ x 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″, ε_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 μF, 100 V Chip Capacitors	C1825C103J1RAC	Kemet
C10, C14, C17, C22	2.2 μF, 50 V Chip Capacitors	C1825C225J5RAC	Kemet
C11, C15	22 μF, 25 V Tantalum Capacitors	T491D226K025AT	Kemet
C12, C16	47 μF, 16 V Tantalum Capacitors	T491D476K016AT	Kemet
C18, C19, C20, C21, C23, C24, C25, C26	10 μF, 50 V Chip Capacitors	GRM55DR61H106KA88B	Murata
C27, C28	330 μF, 63 V Electrolytic Capacitors	NACZF331M63V	Nippon
R1, R2	240 Ω, 1/4 W Chip Resistors	CRCW12062400FKEA	Vishay



*Stacked

Figure 2. MRF6P24190HR6 Test Circuit Component Layout — 2450 MHz

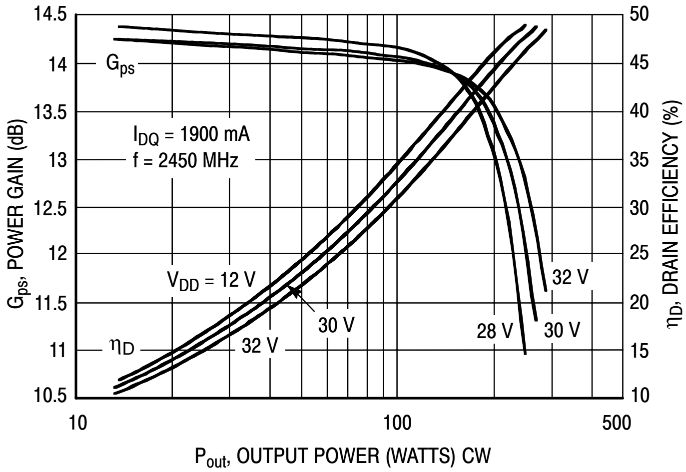


Figure 3. Power Gain and Drain Efficiency versus CW Output Power

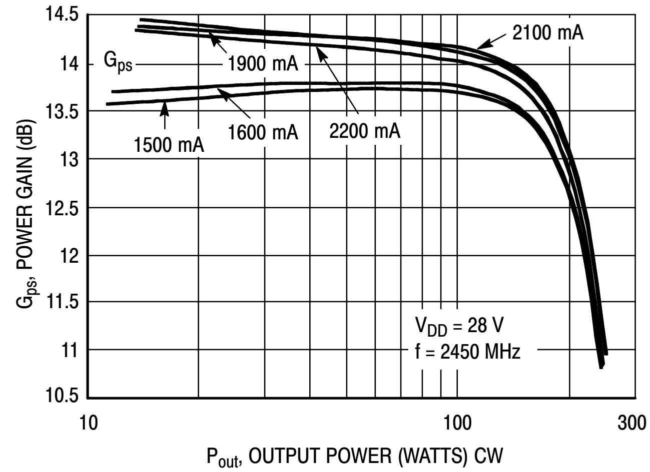


Figure 4. Power Gain and Drain Efficiency versus CW Output Power

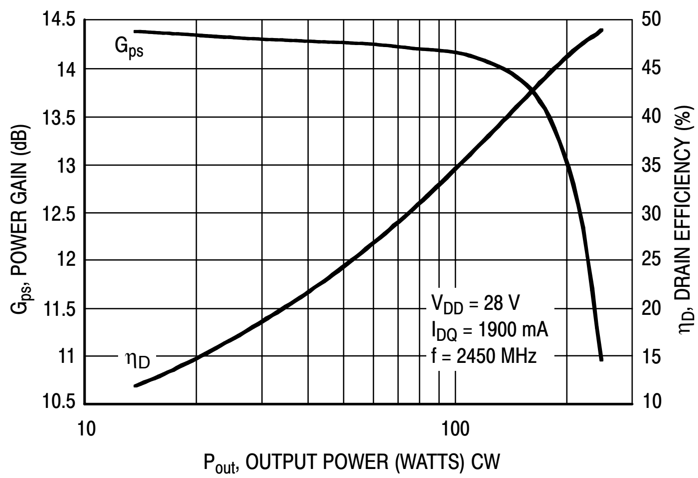
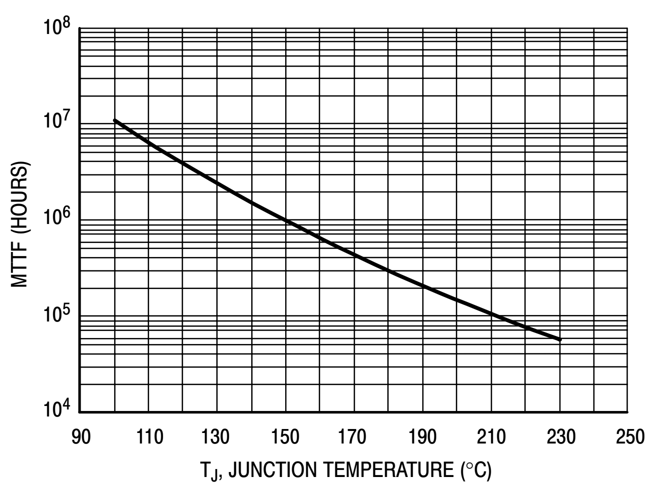


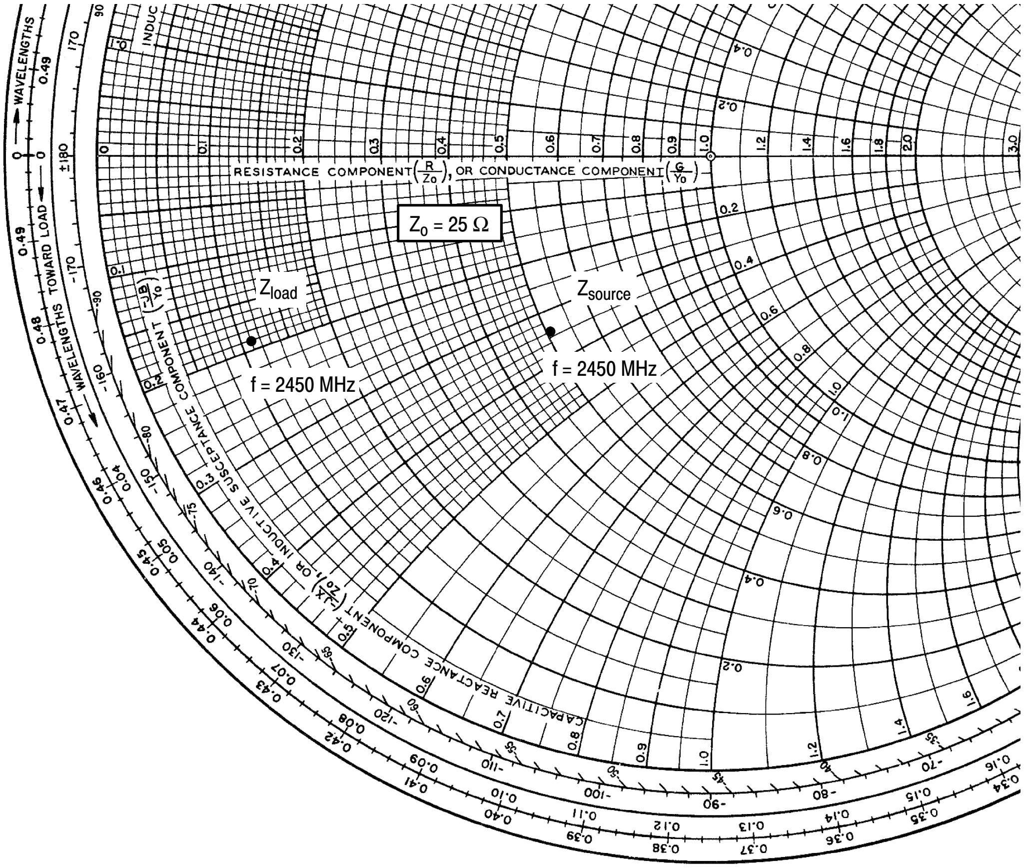
Figure 5. Power Gain and Drain Efficiency versus CW Output Power



This above graph displays calculated MTTF in hours when the device is operated at V_{DD} = 28 Vdc, P_{out} = 190 W CW, and η_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 Vdc, I_{DQ} = 1900 mA, P_{out} = 190 W CW

f MHz	Z_{source} Ω	Z_{load} Ω
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.

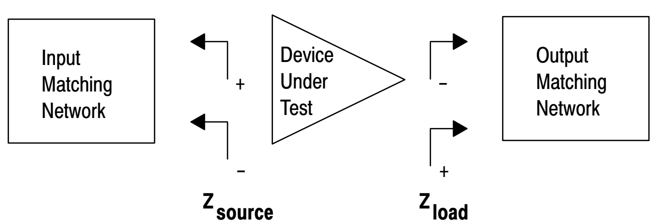
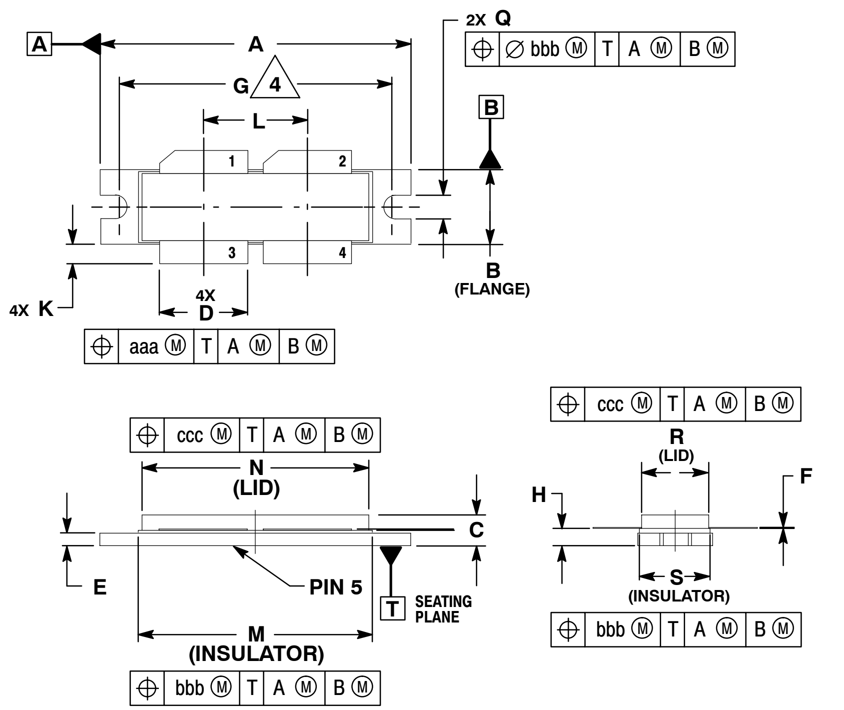


Figure 7. Series Equivalent Source and Load Impedance

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.

	INCHES		MILLIMETERS	
DIM	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	• Initial Release of Data Sheet
1	Mar. 2007	• Removed Lower Thermal Resistance and Low Gold Plating bullets from Features section as functionality is standard, p. 1 • Added maximum CW operation limitation and derating values to the Maximum Rating table to prevent a 200°C+ hot wire operating condition, p. 1 • Corrected V_{DS} to V_{DD} in the RF test condition voltage callout for $V_{GS(Q)}$, On Characteristics table, p. 2 • Added frequency to title of schematic, component part layout and typical characteristic curves, p. 3-5 • Added Fig. 6, MTTF versus Junction Temperature graph, p. 5
2	Apr. 2008	• 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 • Updated PCB information to show more specific material details, Fig. 1, Test Circuit Schematic, p. 3 • Updated Part Numbers in Table 5, Component Designations and Values, to latest RoHS compliant part numbers, p. 3
3	Feb. 2009	• Modified data sheet to reflect RF Test Reduction described in Product and Process Change Notification number, PCN13232, p. 2

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