Freescale Semiconductor
Technical Data

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RoHS

RF Power LDMOS Transistor

High Ruggedness N-Channel Enhancement-Mode Lateral MOSFET

MMRF1304LR5

1.8-2000 MHz, 25 W, 50 V WIDEBAND RF POWER LDMOS TRANSISTOR

RF power transistor suitable for both narrowband and broadband CW or pulse applications operating at frequencies from 1.8 to 2000 MHz, such as military radio communications and radar. This device is fabricated using Freescale's enhanced ruggedness platform and is suitable for use in applications where high VSWRs are encountered.

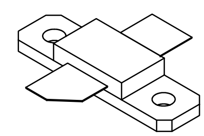
Typical Performance: V_{DD} = 50 Vdc

Frequency (MHz)	Signal Type	P_{out} (W)	G_{ps} (dB)	η_D (%)	IMD (dBc)
1.8-30 (1,3)	Two-Tone (10 kHz spacing)	25 PEP	25.0	50.0	-28
30-512 (2,3)	Two-Tone (200 kHz spacing)	25 PEP	17.3	32.0	-32
512 (4)	Pulse (100 μsec, 20% Duty Cycle)	25 Peak	25.9	74.0	—
512 (4)	CW	25	26.0	75.0	—

Load Mismatch/Ruggedness

Frequency (MHz)	Signal Type	VSWR	P_{in} (W)	Test Voltage	Result
30 (1)	CW	>65:1 at all Phase Angles	0.11 (3 dB Overdrive)	50	No Device Degradation
512 (2)	CW		0.95 (3 dB Overdrive)		
512 (4)	Pulse (100 μsec, 20% Duty Cycle)		0.14 Peak (3 dB Overdrive)		
512 (4)	CW		0.14 (3 dB Overdrive)		

1. Measured in 1.8-30 MHz broadband reference circuit.
2. Measured in 30-512 MHz broadband reference circuit.
3. The values shown are the minimum measured performance numbers across the indicated frequency range.
4. Measured in 512 MHz narrowband test circuit.



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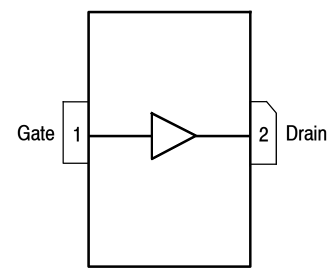


(Top View)

Note: The backside of the package is the source terminal for the transistor.

Figure 1. Pin Connections

Features

- Wide Operating Frequency Range
- Extreme Ruggedness
- Unmatched, Capable of Very Broadband Operation
- Integrated Stability Enhancements
- Low Thermal Resistance
- Extended ESD Protection Circuit
- In Tape and Reel. R5 Suffix = 50 Units, 32 mm Tape Width, 13-inch Reel.

Table 1. Maximum Ratings

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DSS}	-0.5, +133	Vdc
Gate-Source Voltage	V_{GS}	-6.0, +10	Vdc
Storage Temperature Range	T_{stg}	-65 to +150	°C
Case Operating Temperature Range	T_C	-40 to +150	°C
Operating Junction Temperature Range [1,2]	T_J	-40 to +225	°C

Table 2. Thermal Characteristics

Characteristic	Symbol	Value [2]	Unit
Thermal Resistance, Junction to Case CW: Case Temperature 81°C, 25 W CW, 50 Vdc, I_{DQ} = 10 mA, 512 MHz	$R_{\theta JC}$	1.4	°C/W
Thermal Impedance, Junction to Case Pulse: Case Temperature 77°C, 25 W Peak, 100 μsec Pulse Width, 20% Duty Cycle, 50 Vdc, I_{DQ} = 10 mA, 512 MHz	$Z_{\theta JC}$	0.32	°C/W

Table 3. ESD Protection Characteristics

Test Methodology	Class
Human Body Model (per JESD22-A114)	2, passes 2000 V
Machine Model (per EIA/JESD22-A115)	B, passes 200 V
Charge Device Model (per JESD22-C101)	IV, passes 1200 V

Table 4. 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}	—	—	400	nAdc
Drain-Source Breakdown Voltage (V_{GS} = 0 Vdc, I_D = 50 mA)	$V_{(BR)DSS}$	133	140	—	Vdc
Zero Gate Voltage Drain Leakage Current (V_{DS} = 50 Vdc, V_{GS} = 0 Vdc)	I_{DSS}	—	—	2	μAdc
Zero Gate Voltage Drain Leakage Current (V_{DS} = 100 Vdc, V_{GS} = 0 Vdc)	I_{DSS}	—	—	7	μAdc
On Characteristics					
Gate Threshold Voltage (V_{DS} = 10 Vdc, I_D = 85 μAdc)	$V_{GS(th)}$	1.5	2.0	2.5	Vdc
Gate Quiescent Voltage (V_{DD} = 50 Vdc, I_D = 10 mAdc, Measured in Functional Test)	$V_{GS(Q)}$	2.0	2.4	3.0	Vdc
Drain-Source On-Voltage (V_{GS} = 10 Vdc, I_D = 210 mAdc)	$V_{DS(on)}$	—	0.23	—	Vdc
Dynamic Characteristics					
Reverse Transfer Capacitance (V_{DS} = 50 Vdc ± 30 mV(rms)ac @ 1 MHz, V_{GS} = 0 Vdc)	C_{rss}	—	0.17	—	pF
Output Capacitance (V_{DS} = 50 Vdc ± 30 mV(rms)ac @ 1 MHz, V_{GS} = 0 Vdc)	C_{oss}	—	14.7	—	pF
Input Capacitance (V_{DS} = 50 Vdc, V_{GS} = 0 Vdc ± 30 mV(rms)ac @ 1 MHz)	C_{iss}	—	39.0	—	pF

1. Continuous use at maximum temperature will affect MTTF.
2. Refer to AN1955, *Thermal Measurement Methodology of RF Power Amplifiers.* Go to http://www.freescale.com/rf. Select Documentation/Application Notes - AN1955.

(continued)

Table 4. Electrical Characteristics (T_A = 25°C unless otherwise noted) **(continued)**

Characteristic	Symbol	Min	Typ	Max	Unit
Functional Tests (In Freescale Test Fixture, 50 ohm system) V_{DD} = 50 Vdc, I_{DQ} = 10 mA, P_{out} = 25 W Peak (5 W Avg.), f = 512 MHz, Pulse, 100 μsec Pulse Width, 20% Duty Cycle					
Power Gain	G_{ps}	24.5	25.9	27.5	dB
Drain Efficiency	η_D	70.0	74.0	—	%
Input Return Loss	IRL	—	-16	-10	dB

Load Mismatch/Ruggedness (In Freescale Test Fixture, 50 ohm system) I_{DQ} = 150 mA

Frequency (MHz)	Signal Type	VSWR	P_{in} (W)	Test Voltage, V_{DD}	Result
512	Pulse (100 μsec, 20% Duty Cycle)	>65:1 at all Phase Angles	0.14 Peak (3 dB Overdrive)	50	No Device Degradation
	CW		0.14 (3 dB Overdrive)		

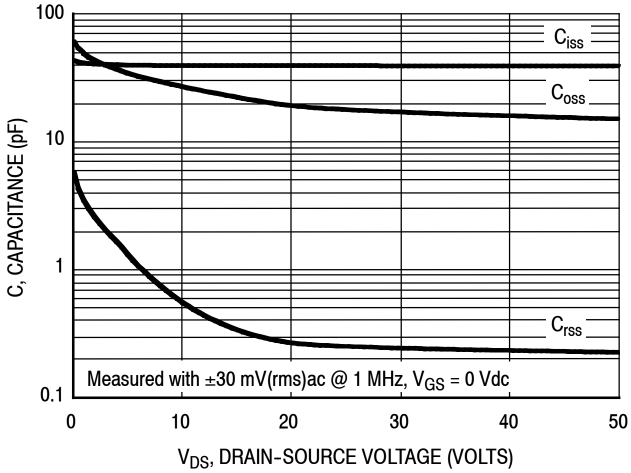
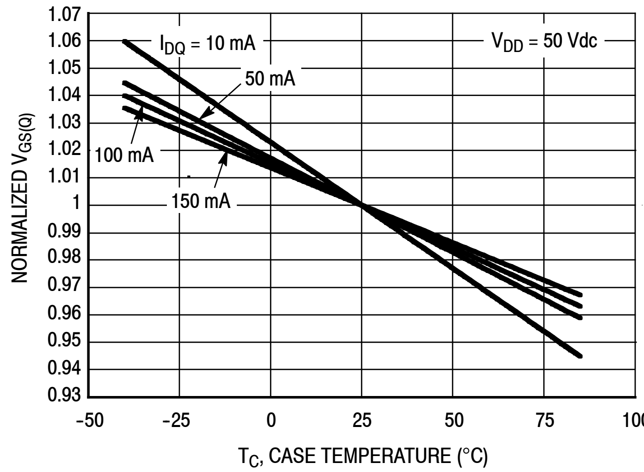
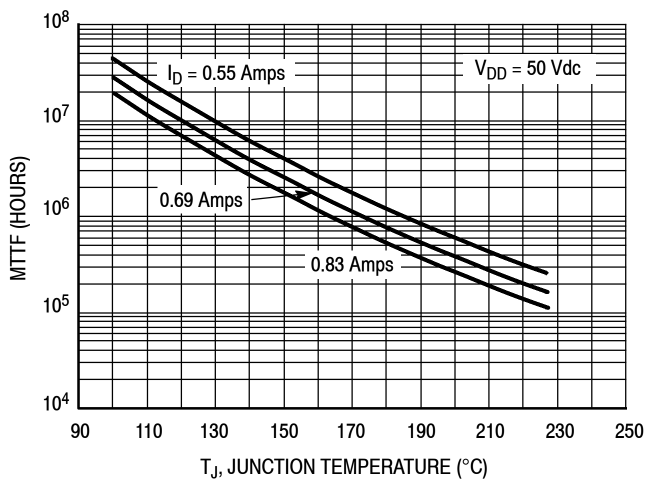


Figure 2. Capacitance versus Drain-Source Voltage



I_{DQ} (mA)	Slope (mV/°C)
10	-2.16
50	-1.79
100	-1.76
150	-1.68

Figure 3. Normalized V_{GS} versus Quiescent Current and Case Temperature



Note: MTTF value represents the total cumulative operating time under indicated test conditions.

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

NOTE**:** For pulse applications or CW conditions, use the MTTF calculator referenced above.

Figure 4. MTTF versus Junction Temperature - CW

512 MHz NARROWBAND PRODUCTION TEST FIXTURE

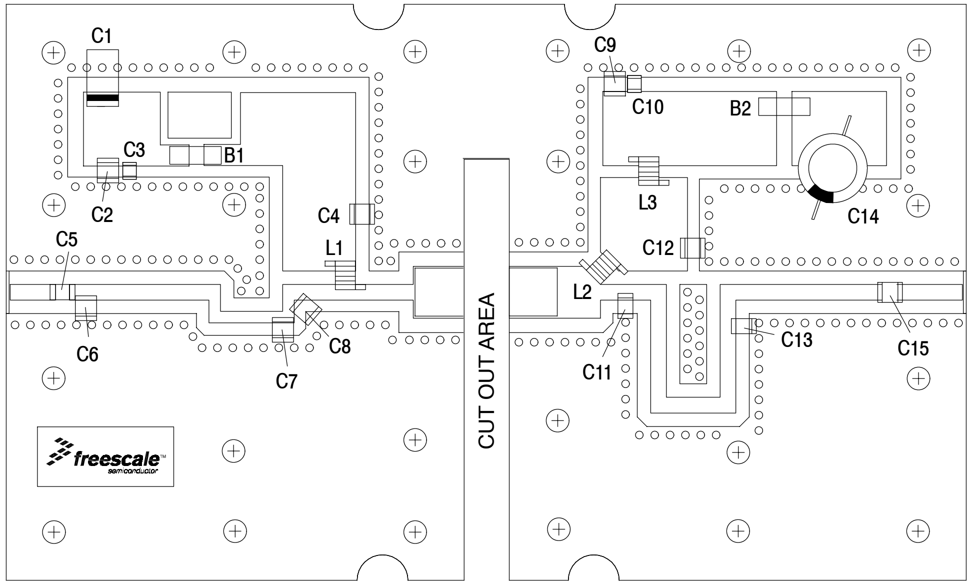


Figure 5. MMRF1304LR5 Narrowband Test Circuit Component Layout — 512 MHz

Table 5. MMRF1304LR5 Narrowband Test Circuit Component Designations and Values — 512 MHz

Part	Description	Part Number	Manufacturer
B1, B2	Long Ferrite Beads	2743021447	Fair-Rite
C1	22 μF, 35 V Tantalum Capacitor	T491X226K035AT	Kemet
C2, C9	0.1 μF Chip Capacitors	CDR33BX104AKWS	AVX
C3, C10	0.01 μF Chip Capacitors	C0805C103K5RAC	Kemet
C4, C12, C15	180 pF Chip Capacitors	ATC100B181JT500XT	ATC
C5	18 pF Chip Capacitor	ATC100B180JT500XT	ATC
C6	2.7 pF Chip Capacitor	ATC100B2R7BT500XT	ATC
C7	15 pF Chip Capacitor	ATC100B150JT500XT	ATC
C8	36 pF Chip Capacitor	ATC100B360JT500XT	ATC
C11	4.3 pF Chip Capacitor	ATC100B4R3CT500XT	ATC
C13	13 pF Chip Capacitor	ATC100B130JT500XT	ATC
C14	470 μF, 63 V Electrolytic Capacitor	MCGPR63V477M13X26-RH	Multicomp
L1	33 nH Inductor	1812SMS-33NJLC	Coilcraft
L2	12.5 nH Inductor	A04TJLC	Coilcraft
L3	82 nH Inductor	1812SMS-82NJLC	Coilcraft
PCB	0.030″, ε_r = 2.55	AD255A	Arlon

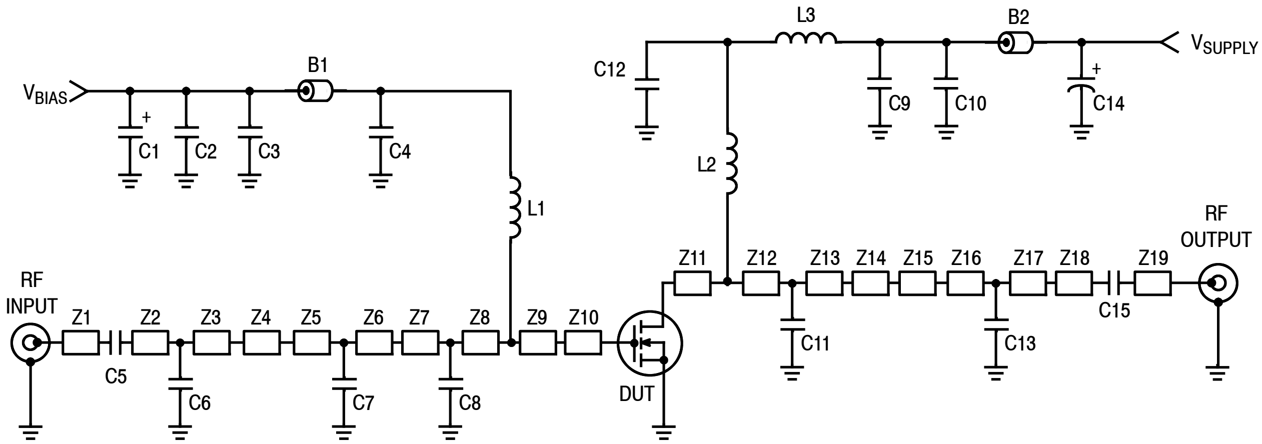


Figure 6. MMRF1304LR5 Narrowband Test Circuit Schematic — 512 MHz

Table 6. MMRF1304LR5 Narrowband Test Circuit Microstrips — 512 MHz

Microstrip	Description
Z1	0.235″ × 0.082″ Microstrip
Z2	0.042″ × 0.082″ Microstrip
Z3	0.682″ × 0.082″ Microstrip
Z4*	0.200″ × 0.060″ Microstrip
Z5	0.324″ × 0.060″ Microstrip
Z6*	0.200″ × 0.060″ Microstrip
Z7	0.089″ × 0.082″ Microstrip
Z8	0.120″ × 0.082″ Microstrip
Z9	0.411″ × 0.082″ Microstrip
Z10	0.260″ × 0.270″ Microstrip

Microstrip	Description
Z11	0.475″ × 0.270″ Microstrip
Z12	0.091″ × 0.082″ Microstrip
Z13	0.170″ × 0.082″ Microstrip
Z14*	0.670″ × 0.082″ Microstrip
Z15	0.280″ × 0.082″ Microstrip
Z16*	0.413″ × 0.082″ Microstrip
Z17*	0.259″ × 0.082″ Microstrip
Z18	0.761″ × 0.082″ Microstrip
Z19	0.341″ × 0.082″ Microstrip

* Line length includes microstrip bends

TYPICAL CHARACTERISTICS — 512 MHz

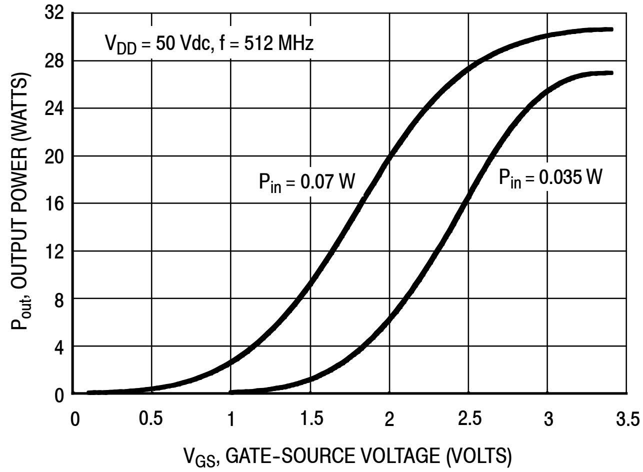
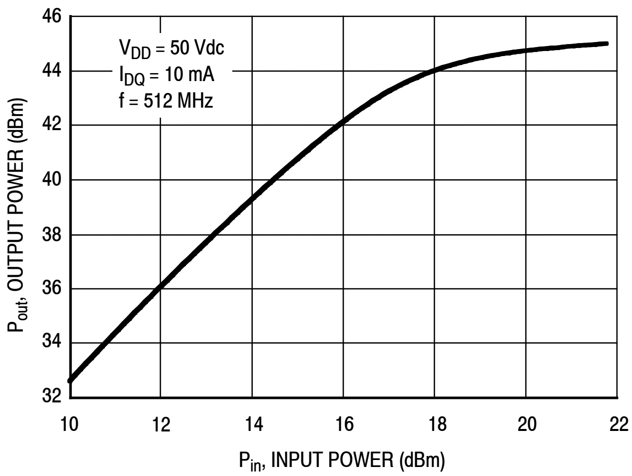


Figure 7. CW Output Power versus Gate-Source Voltage at a Constant Input Power



f (MHz)	P1dB (W)	P3dB (W)
512	28.7	31.6

Figure 8. CW Output Power versus Input Power

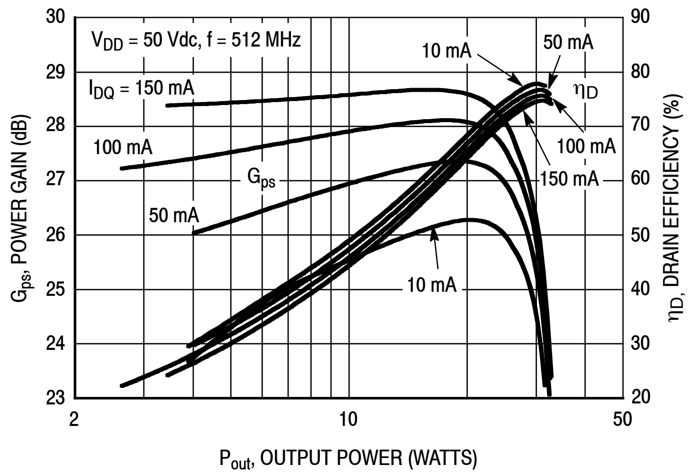


Figure 9. Power Gain and Drain Efficiency versus CW Output Power and Quescient Current

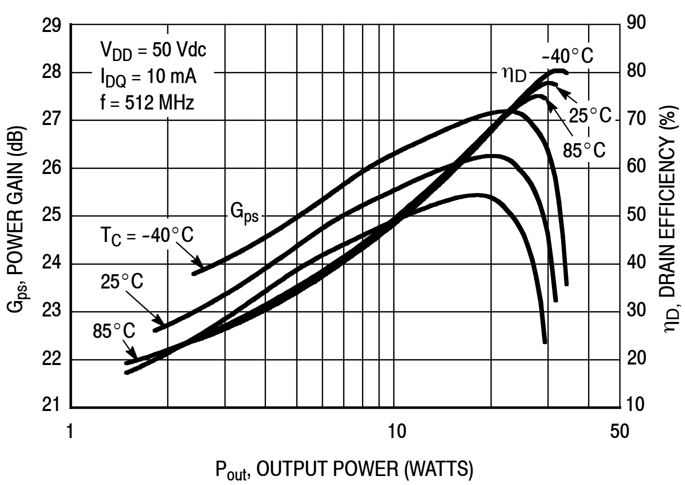


Figure 10. Power Gain and Drain Efficiency versus CW Output Power

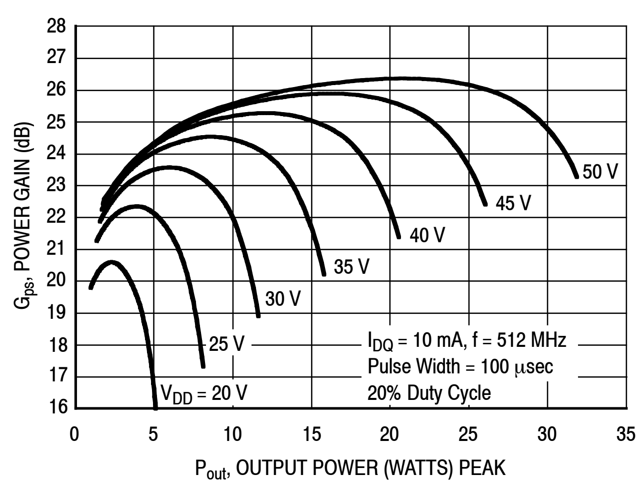


Figure 11. Power Gain versus Output Power and Drain-Source Voltage

512 MHz NARROWBAND PRODUCTION TEST FIXTURE

V_{DD} = 50 Vdc, I_{DQ} = 10 mA, P_{out} = 25 W Peak

f MHz	Z_{source} Ω	Z_{load} Ω
512	0.72 + j10.8	8.8 + j17.5

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

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

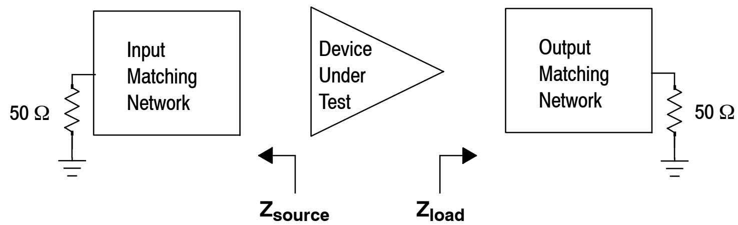
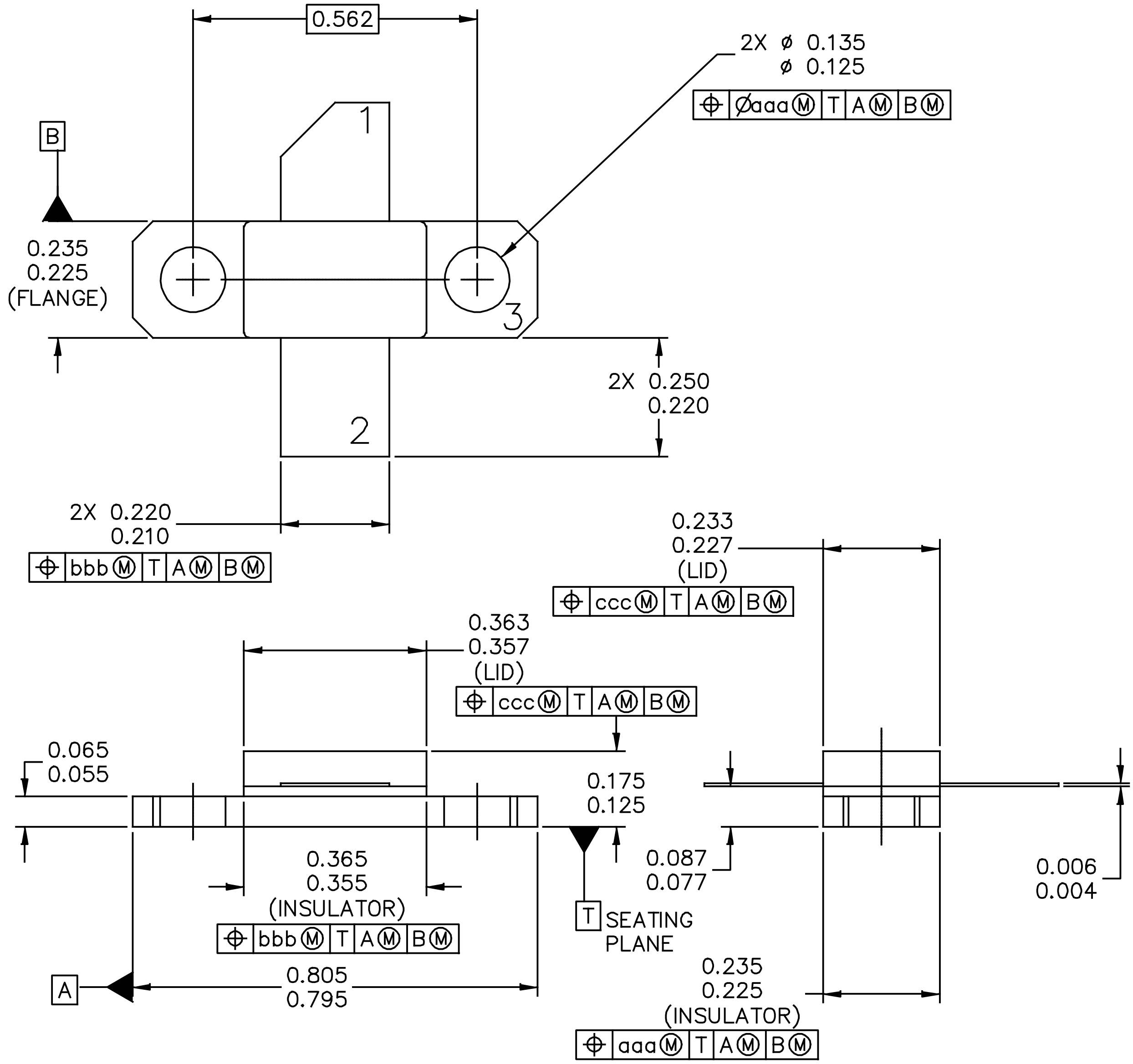


Figure 12. Narrowband Series Equivalent Source and Load Impedance — 512 MHz

PACKAGE DIMENSIONS



	MECHANICAL OUTLINE	PRINT VERSION NOT TO SCALE
TITLE: NI–360	DOCUMENT NO: 98ASB42968B	REV: G
	CASE NUMBER: 360B–05	05 AUG 2005
	STANDARD: NON–JEDEC	

NOTES:

1. INTERPRET DIMENSIONS AND TOLERANCES PER ASME Y14.5M-1994.

2. CONTROLLING DIMENSION: INCH

3. DIMENSION H IS MEASURED .030 (0.762) AWAY FROM PACKAGE BODY

STYLE 1:
PIN 1 - DRAIN
2 - GATE
3 - SOURCE

	MECHANICAL OUTLINE	PRINT VERSION NOT TO SCALE
TITLE: NI-360	DOCUMENT NO: 98ASB42968B	REV: G
	CASE NUMBER: 360B-05	05 AUG 2005
	STANDARD: NON-JEDEC	

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. 2013	• Initial Release of Data Sheet

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