NXP Semiconductors
Technical Data

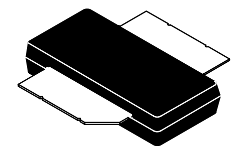
Document Number: MRF7S24250N
Rev. 1, 9/2016

RF Power LDMOS Transistor

N-Channel Enhancement-Mode Lateral MOSFET

MRF7S24250N

2450 MHz, 250 W, 32 V
RF POWER LDMOS TRANSISTOR



OM-780-2L
PLASTIC

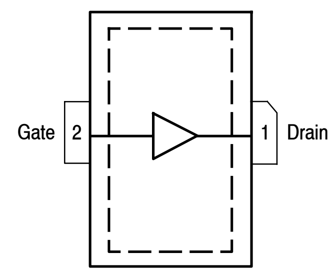
The 250 W CW RF power transistor is designed for industrial, scientific, medical (ISM) and industrial heating applications at 2450 MHz. This device is suitable for use in CW, pulse and linear applications. This high gain, high efficiency rugged device is targeted to replace industrial magnetrons and will provide longer life and easier servicing.

Typical Performance: In 2400–2500 MHz reference circuit, V_{DD} = 32 Vdc

Frequency (MHz)	Signal Type	P_{in} (W)	G_{ps} (dB)	η_D (%)	P_{out} (W)
2400	CW	9.0	14.5	55.5	255
2450		9.0	14.7	54.8	263
2500		9.0	14.3	55.5	242

Load Mismatch/Ruggedness

Frequency (MHz)	Signal Type	VSWR	P_{in} (W)	Test Voltage	Result
2450	CW	> 10:1 at all Phase Angles	14 (3 dB Overdrive)	32	No Device Degradation



(Top View)

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

Figure 1. Pin Connections

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 high performance ESD protection

Typical Applications

- Industrial heating and drying
- Material welding
- Plasma lighting
- Scientific
- Medical: skin treatment, blood therapy, electrosurgery

Table 1. Maximum Ratings

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DSS}	–0.5, +65	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
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	769 3.85	W W/°C

Table 2. Thermal Characteristics

Characteristic	Symbol	Value (2,3)	Unit
Thermal Resistance, Junction to Case CW: Case Temperature 98°C, 250 W CW, I_{DQ} = 100 mA, 2450 MHz	$R_{\theta JC}$	0.26	°C/W
Thermal Impedance, Junction to Case Pulse: Case Temperature 53°C, 250 W Peak, 100 μsec Pulse Width, 10% Duty Cycle, I_{DQ} = 100 mA, 2450 MHz	$Z_{\theta JC}$	0.024	°C/W

Table 3. ESD Protection Characteristics

Test Methodology	Class
Human Body Model (per JESD22-A114)	2, passes 2500 V
Machine Model (per EIA/JESD22-A115)	B, passes 250 V
Charge Device Model (per JESD22-C101)	IV, passes 2000 V

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					
Zero Gate Voltage Drain Leakage Current (V_{DS} = 65 Vdc, V_{GS} = 0 Vdc)	I_{DSS}	—	—	10	μAdc
Zero Gate Voltage Drain Leakage Current (V_{DS} = 32 Vdc, V_{GS} = 0 Vdc)	I_{DSS}	—	—	2	μAdc
Gate-Source Leakage Current (V_{GS} = 5 Vdc, V_{DS} = 0 Vdc)	I_{GSS}	—	—	1	μAdc
On Characteristics					
Gate Threshold Voltage (V_{DS} = 10 Vdc, I_D = 303 μAdc)	$V_{GS(th)}$	—	1.2	—	Vdc
Gate Quiescent Voltage (V_{DD} = 30 Vdc, I_D = 100 mAdc, Measured in Functional Test)	$V_{GS(Q)}$	1.1	1.6	2.1	Vdc
Drain-Source On-Voltage (V_{GS} = 10 Vdc, I_D = 3.7 Adc)	$V_{DS(on)}$	—	0.2	—	Vdc
Dynamic Characteristics (4)					
Reverse Transfer Capacitance (V_{DS} = 32 Vdc ± 30 mV(rms)ac @ 1 MHz, V_{GS} = 0 Vdc)	C_{rss}	—	4.3	—	pF

1. Continuous use at maximum temperature will affect MTTF.
2. MTTF calculator available at http://www.nxp.com/RF/calculators.
3. Refer to AN1955, *Thermal Measurement Methodology of RF Power Amplifiers.* Go to http://www.nxp.com/RF and search for AN1955.
4. Part internally matched both on input and output.

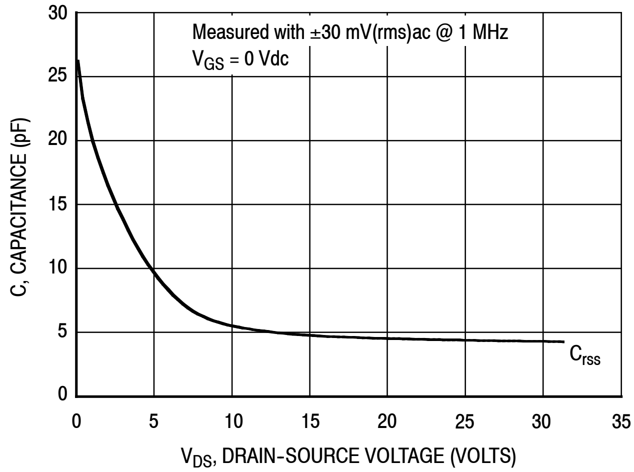
(continued)

Table 5. Electrical Characteristics (T_A = 25°C unless otherwise noted) **(continued)**

Characteristic	Symbol	Min	Typ	Max	Unit
Functional Tests (In NXP Test Fixture, 50 ohm system) V_{DD} = 30 Vdc, I_{DQ} = 100 mA, P_{in} = 9 W Peak (0.9 W Avg.), f = 2450 MHz, 100 μsec Pulse Width, 10% Duty Cycle					
Output Power	P_{out}	237	256	319	W
Drain Efficiency	η_D	48	50	—	%
Input Return Loss	IRL	—	–15.0	–8.5	dB

Table 6. Ordering Information

Device	Tape and Reel Information	Package
MRF7S24250NR3	R3 Suffix = 250 Units, 32 mm Tape Width, 13-inch Reel	OM-780-2L



Note: Each side of device measured separately.

Figure 2. Capacitance versus Drain-Source Voltage

2400–2500 MHz REFERENCE CIRCUIT — 2″ × 3″ (5.1 cm × 7.6 cm)

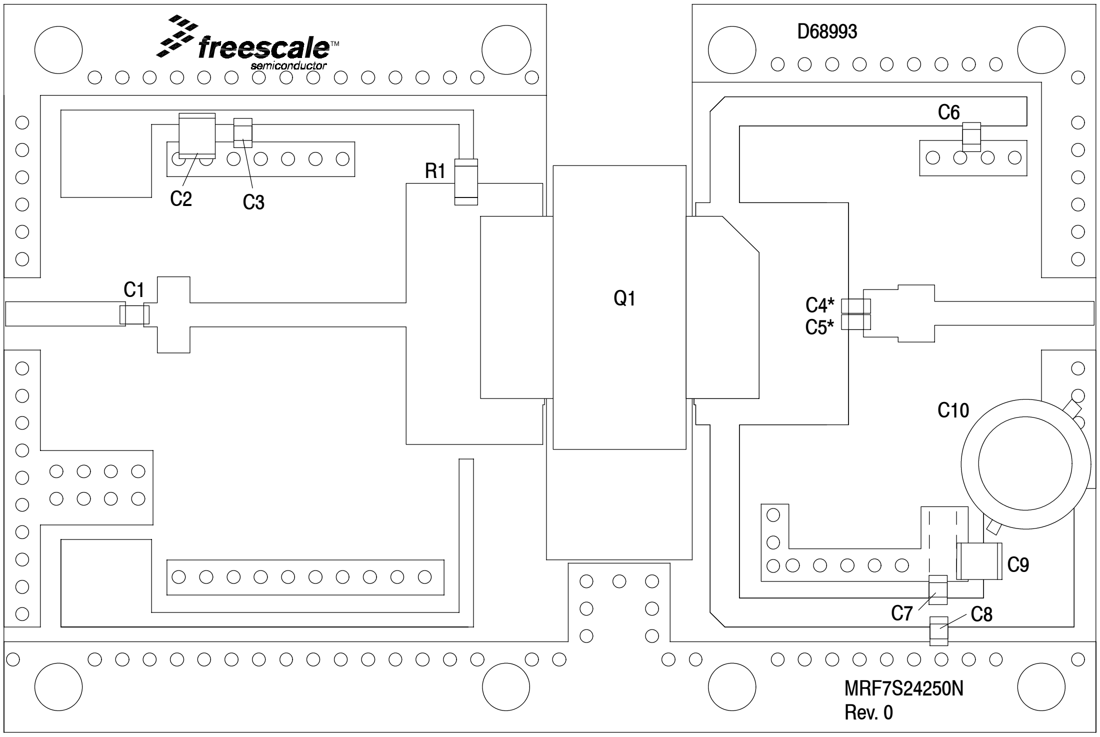
Table 7. 2400–2500 MHz Performance (In NXP Reference Circuit, 50 ohm system)
V_{DD} = 32 Vdc, I_{DQ} = 100 mA, T_C = 25°C

Frequency (MHz)	P_{in} (W)	G_{ps} (dB)	η_D (%)	P_{out} (W)
2400	9.0	14.5	55.5	255
2450	9.0	14.7	54.8	263
2500	9.0	14.3	55.5	242

Table 8. Load Mismatch/Ruggedness (In NXP Reference Circuit)

Frequency (MHz)	Signal Type	VSWR	P_{in} (W)	Test Voltage, V_{DD}	Result
2450	CW	> 10:1 at all Phase Angles	14 (3 dB Overdrive)	32	No Device Degradation

2400–2500 MHz REFERENCE CIRCUIT — 2″ × 3″ (5.1 cm × 7.6 cm)



*C4 and C5 are mounted vertically.

Figure 3. MRF7S24250N Reference Circuit Component Layout — 2400–2500 MHz

Table 9. MRF7S24250N Reference Circuit Component Designations and Values — 2400–2500 MHz

Part	Description	Part Number	Manufacturer
C1, C3, C4, C5, C6, C7, C8	27 pF Chip Capacitors	ATC600F270JT250XT	ATC
C2, C9	10 μF Chip Capacitors	GRM32ER61H106KA12L	Murata
C10	220 μF, 50 V Electrolytic Capacitor	227CKE050M	Illinois Capacitor
Q1	RF Power LDMOS Transistor	MRF7S24250NR3	NXP
R1	10 Ω, 1/4 W Chip Resistor	CRCW120610R0FKEA	Vishay
PCB	Rogers RT6035HTC, 0.030″, ε_r = 3.66	D68993	MTL

TYPICAL CHARACTERISTICS — 2400–2500 MHz REFERENCE CIRCUIT

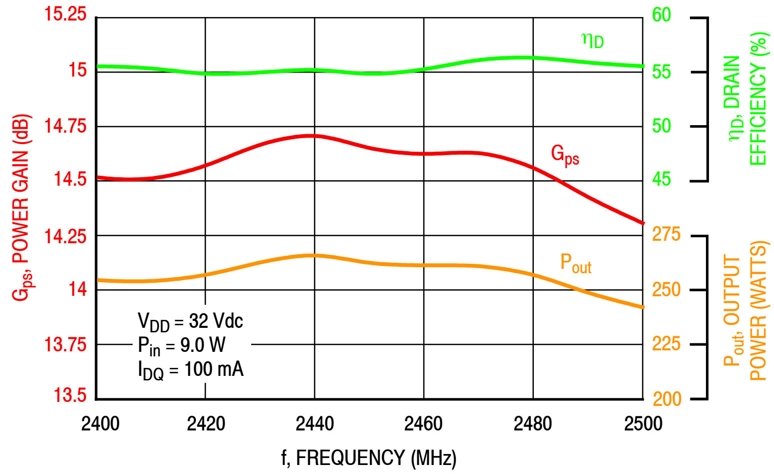


Figure 4. Power Gain, Drain Efficiency and Output Power versus Frequency at a Constant Input Power

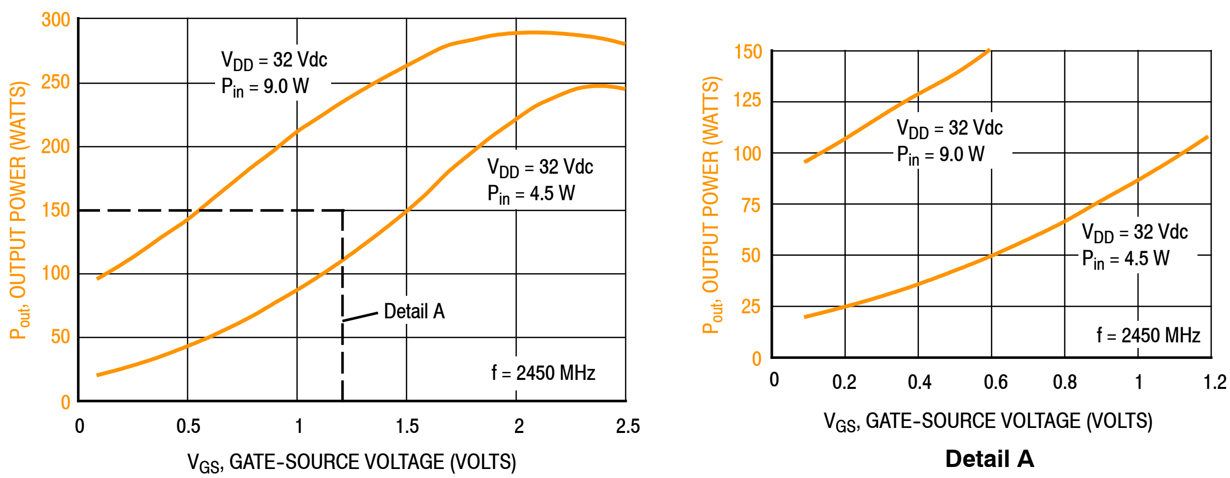


Figure 5. Output Power versus Gate-Source Voltage

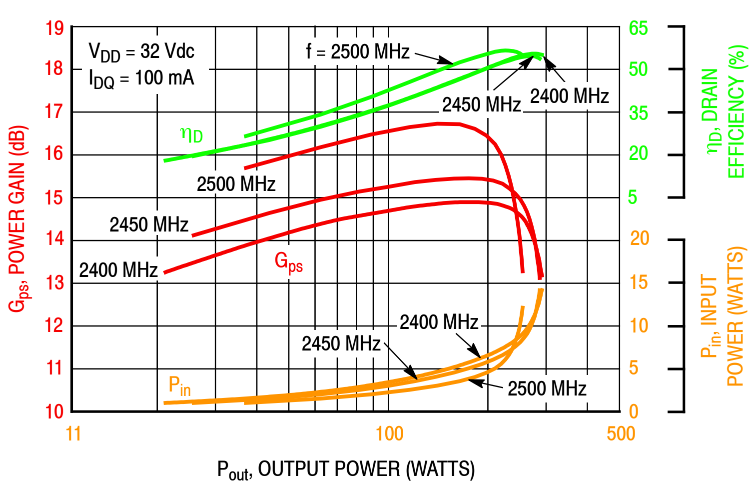
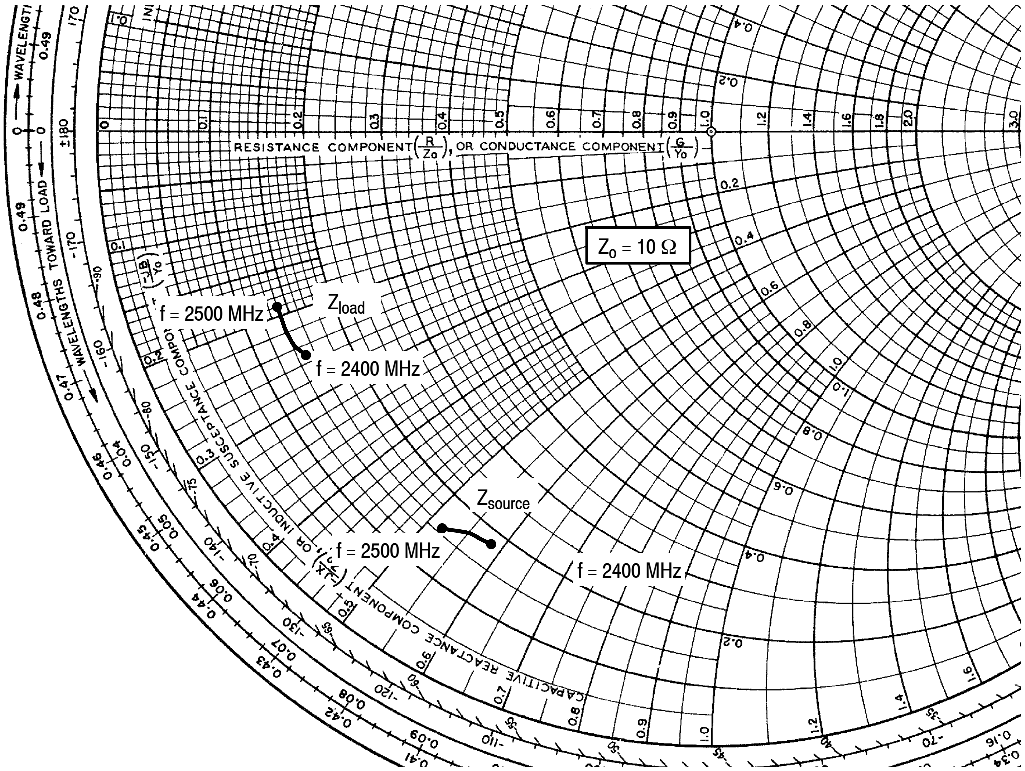


Figure 6. Power Gain, Drain Efficiency and Input Power versus Output Power and Frequency

2400–2500 MHz REFERENCE CIRCUIT



f MHz	Z_{source} Ω	Z_{load} Ω
2400	1.76 – j5.76	1.49 – j2.45
2450	1.66 – j5.50	1.43 – j2.18
2500	1.56 – j5.23	1.36 – j1.90

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

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

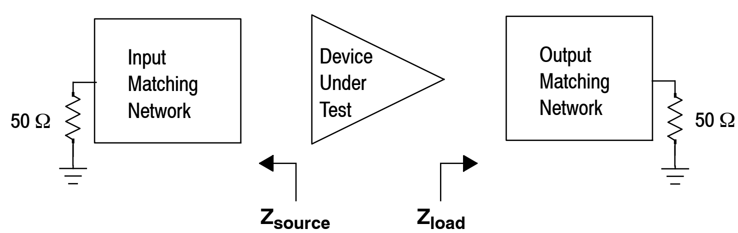


Figure 7. Series Equivalent Source and Load Impedance — 2400–2500 MHz

2450 MHz NARROWBAND PRODUCTION TEST FIXTURE — 3″ × 5″ (7.6 cm × 12.7 cm)

Table 10. 2450 MHz Narrowband Performance (In NXP Test Fixture, 50 ohm system) V_{DD} = 30 Vdc, I_{DQ} = 100 mA, P_{in} = 9 W Peak (0.9 W Avg.), f = 2450 MHz, 100 μsec Pulse Width, 10% Duty Cycle

Characteristic	Symbol	Min	Typ	Max	Unit
Output Power	P_{out}	—	256	—	W
Drain Efficiency	η_D	—	49.0	—	%
Input Return Loss	IRL	—	–17	–9	dB

2450 MHz NARROWBAND PRODUCTION TEST FIXTURE — 3″ × 5″ (7.6 cm × 12.7 cm)

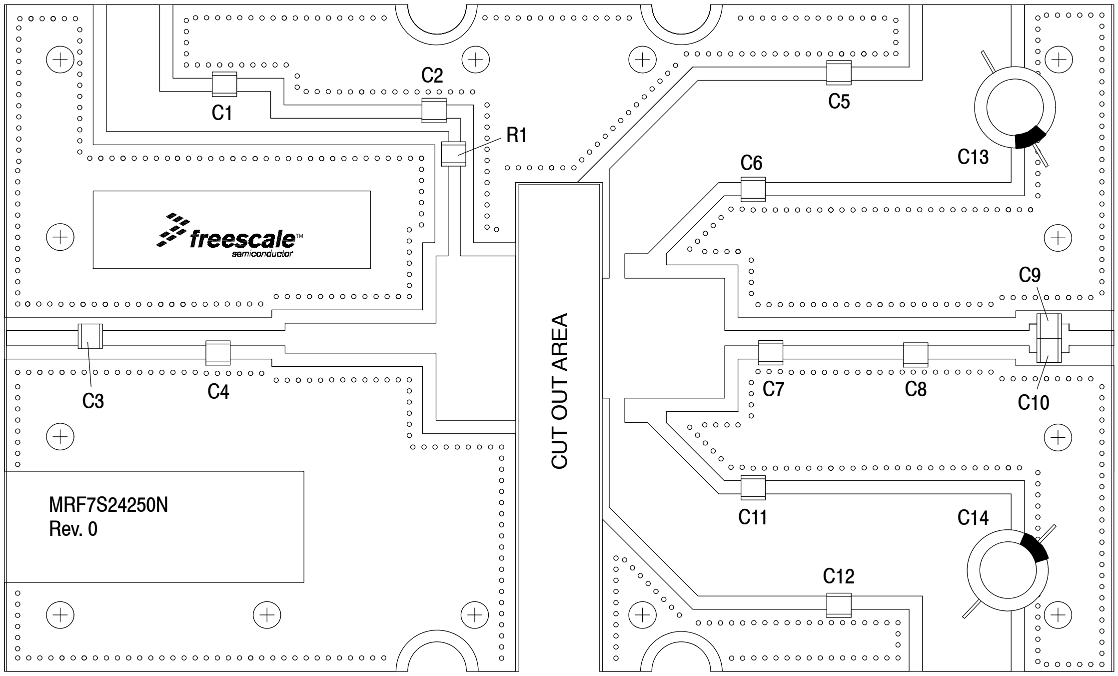


Figure 8. MRF7S24250N Narrowband Test Circuit Component Layout — 2450 MHz

Table 11. MRF7S24250N Narrowband Test Circuit Component Designations and Values — 2450 MHz

Part	Description	Part Number	Manufacturer
C1, C5, C12	10 μF Chip Capacitors	C5750X7S2A106M230KB	TDK
C2, C6, C11	3 pF Chip Capacitors	ATC100B3R0CT500XT	ATC
C3	7.5 pF Chip Capacitor	ATC100B7R5CT500XT	ATC
C4	1.5 pF Chip Capacitor	ATC100B1R5BT500XT	ATC
C7	0.3 pF Chip Capacitor	ATC100B0R3BT500XT	ATC
C8	1.5 pF Chip Capacitor	ATC100B1R5BT500XT	ATC
C9. C10	8.2 pF Chip Capacitors	ATC100B8R2CT500XT	ATC
C13, C14	470 μF, 100 V Electrolytic Capacitors	MCGPR100V477M16X32-RH	Multicomp
R1	5.9 Ω, 1/4 W Chip Resistor	CRCW12065R90FKEA	Vishay
PCB	Taconic RF35, 0.030″, ε_r = 3.5	—	MTL

f MHz	Z_{source} Ω	Z_{load} Ω
2450	1.96 – j5.61	1.55 – j1.76

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

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

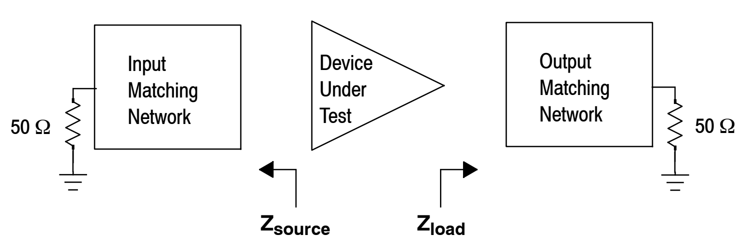
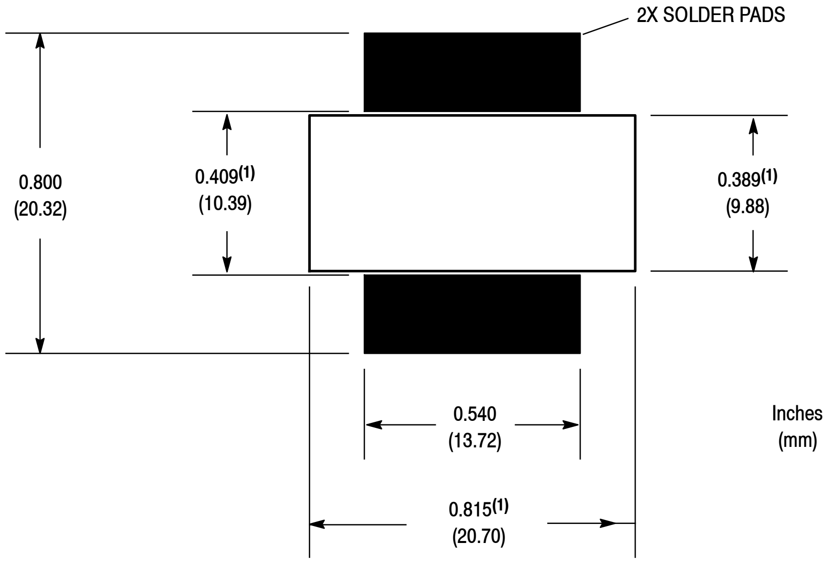


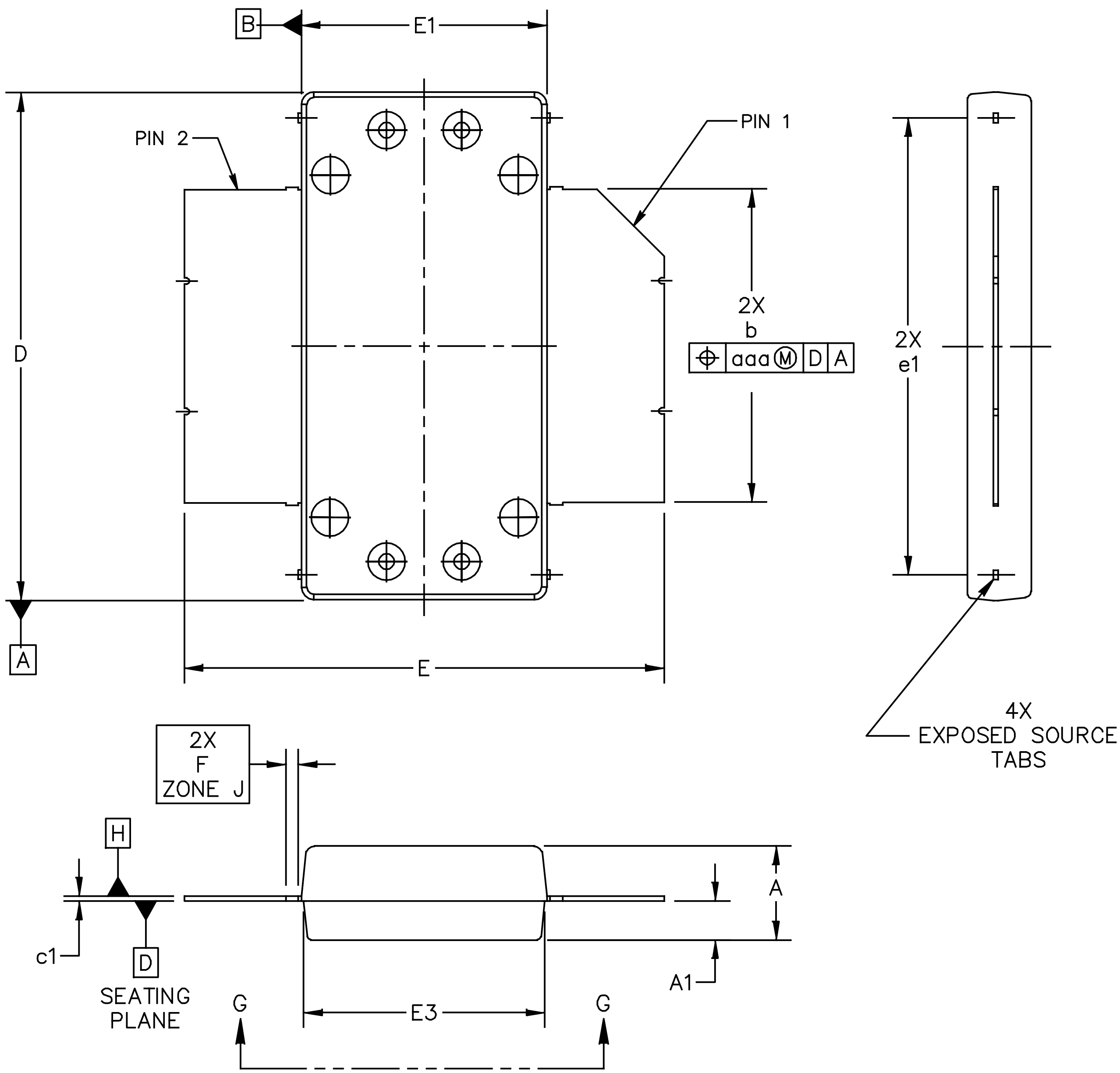
Figure 9. Narrowband Series Equivalent Source and Load Impedance — 2450 MHz



1. Slot dimensions are minimum dimensions and exclude milling tolerances

Figure 10. PCB Pad Layout for OM-780-2L

PACKAGE DIMENSIONS



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	STANDARD: NON-JEDEC	
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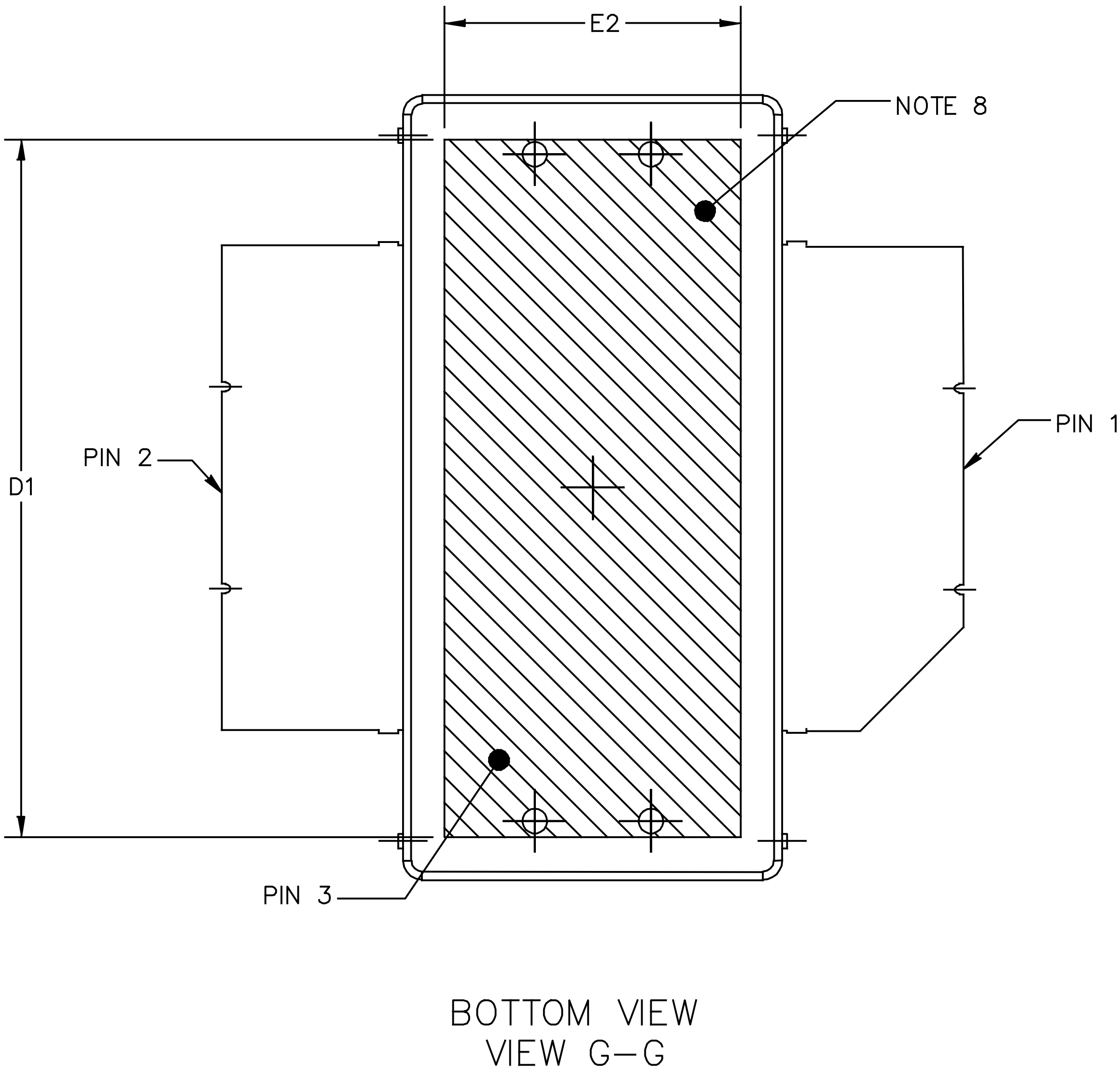

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NOTES:

1. CONTROLLING DIMENSION: INCH
2. INTERPRET DIMENSIONS AND TOLERANCES PER ASME Y14.5M-1994.
3. DATUM PLANE -H- IS LOCATED AT TOP OF LEAD AND IS COINCIDENT WITH THE LEAD WHERE THE LEAD EXITS THE PLASTIC BODY AT THE TOP OF THE PARTING LINE.
4. DIMENSIONS "D" AND "E1" DO NOT INCLUDE MOLD PROTRUSION. ALLOWABLE PROTRUSION IS .006 PER SIDE. DIMENSIONS "D AND "E1" DO INCLUDE MOLD MISMATCH AND ARE DETERMINED AT DATUM PLANE -H-.
5. DIMENSION b DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE .005 TOTAL IN EXCESS OF THE b DIMENSION AT MAXIMUM MATERIAL CONDITION.
6. DATUMS -A- AND -B- TO BE DETERMINED AT DATUM PLANE -H-.
7. DIMENSION A1 APPLIES WITHIN ZONE "J" ONLY
8. HATCHING REPRESENTS THE EXPOSED AREA OF THE HEAT SLUG. THE DIMENSIONS D1 AND E2 REPRESENT THE VALUES BETWEEN THE TWO OPPOSITE POINTS ALONG THE EDGES OF EXPOSED AREA OF HEAT SLUG.

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

DIM	INCH MIN	INCH MAX	MILLIMETER MIN	MILLIMETER MAX	DIM	INCH MIN	INCH MAX	MILLIMETER MIN	MILLIMETER MAX
A	0.148	.152	3.76	3.86	b	.497	.503	12.62	12.78
A1	.059	.065	1.50	1.65	c1	.007	.011	0.18	0.28
D	.808	.812	20.52	20.62	e1	.721	.729	18.31	18.52
D1	.720	----	18.29	----					
E	.762	.770	19.36	19.56	aaa	.004		0.10	
E1	.390	.394	9.91	10.01					
E2	.306	----	7.77	----					
E3	.383	.387	9.73	9.83					
F	.025 BSC		0.635 BSC						

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PRODUCT DOCUMENTATION, SOFTWARE AND TOOLS

Refer to the following resources to aid your design process.

Application Notes

- AN1907: Solder Reflow Attach Method for High Power RF Devices in Over-Molded Plastic Packages
- AN1955: Thermal Measurement Methodology of RF Power Amplifiers
- AN3789: Clamping of High Power RF Transistors and RFICs in Over-Molded Plastic Packages

Engineering Bulletins

- EB212: Using Data Sheet Impedances for RF LDMOS Devices

White Paper

- RFPLASTICWP: Designing with Plastic RF Power Transistors

Software

- Electromigration MTTF Calculator
- RF High Power Model
- .s2p File

Development Tools

- Printed Circuit Boards

To Download Resources Specific to a Given Part Number:

1. Go to http://www.nxp.com/RF
2. Search by part number
3. Click part number link
4. Choose the desired resource from the drop down menu

REVISION HISTORY

The following table summarizes revisions to this document.

Revision	Date	Description
0	Aug. 2015	• Initial Release of Data Sheet
1	Sept. 2016	• Table 2, Thermal Characteristics: added Thermal Impedance $Z_{\theta JC}$ data, p. 2 • Functional Tests table: table values updated to reflect current test data results. Added Min and Max values, p. 3

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