Freescale Semiconductor
Technical Data

Document Number: MRF8S7120N
Rev. 0, 5/2010

RoHS

RF Power Field Effect Transistor
N-Channel Enhancement-Mode Lateral MOSFET

MRF8S7120NR3

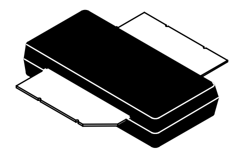
Designed for CDMA base station applications with frequencies from 728 to 768 MHz. Can be used in Class AB and Class C for all typical cellular base station modulation formats.

- Typical Single-Carrier W-CDMA Performance: V_{DD} = 28 Volts, I_{DQ} = 600 mA, P_{out} = 32 Watts Avg., IQ Magnitude Clipping, Channel Bandwidth = 3.84 MHz, Input Signal PAR = 7.5 dB @ 0.01% Probability on CCDF.

Frequency	G_{ps} (dB)	η_D (%)	Output PAR (dB)	ACPR (dBc)
728 MHz	19.2	36.6	6.3	-38.3
748 MHz	19.2	37.1	6.4	-38.2
768 MHz	19.2	38.1	6.3	-37.6

- Capable of Handling 10:1 VSWR, @ 32 Vdc, 748 MHz, 178 Watts CW Output Power (3 dB Input Overdrive from Rated P_{out}), Designed for Enhanced Ruggedness
- Typical P_{out} @ 1 dB Compression Point ≃ 125 Watts CW

728-768 MHz, 32 W AVG., 28 V
SINGLE W-CDMA
LATERAL N-CHANNEL
RF POWER MOSFET



CASE 2021-03, STYLE 1
OM-780-2
PLASTIC

Features

- 100% PAR Tested for Guaranteed Output Power Capability
- Characterized with Series Equivalent Large-Signal Impedance Parameters and Common Source S-Parameters
- Internally Matched for Ease of Use
- Integrated ESD Protection
- Greater Negative Gate-Source Voltage Range for Improved Class C Operation
- Designed for Digital Predistortion Error Correction Systems
- Optimized for Doherty Applications
- 225°C Capable Plastic Package
- RoHS Compliant
- In Tape and Reel. R3 Suffix = 250 Units per 32 mm, 13 inch Reel.

Table 1. Maximum Ratings

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DSS}	-0.5, +70	Vdc
Gate-Source Voltage	V_{GS}	-6.0, +10	Vdc
Operating Voltage	V_{DD}	32, +0	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

Table 2. Thermal Characteristics

Characteristic	Symbol	Value (2,3)	Unit
Thermal Resistance, Junction to Case Case Temperature 80°C, 31.5 W CW, 28 Vdc, I_{DQ} = 600 mA, 748 MHz Case Temperature 80°C, 120 W CW, 28 Vdc, I_{DQ} = 600 mA, 748 MHz	$R_{\theta JC}$	 0.65 0.55	°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.

freescale semiconductor

Table 3. ESD Protection Characteristics

Test Methodology	Class
Human Body Model (per JESD22-A114)	2 (Minimum)
Machine Model (per EIA/JESD22-A115)	A (Minimum)
Charge Device Model (per JESD22-C101)	IV (Minimum)

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} = 70 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 (V_{DS} = 10 Vdc, I_D = 460 μAdc)	$V_{GS(th)}$	1.5	2.3	3.0	Vdc
Gate Quiescent Voltage (V_{DD} = 28 Vdc, I_D = 600 mAdc, Measured in Functional Test)	$V_{GS(Q)}$	2.3	3.0	3.8	Vdc
Drain-Source On-Voltage (V_{GS} = 10 Vdc, I_D = 2 Adc)	$V_{DS(on)}$	0.1	0.2	0.3	Vdc

Functional Tests (1) (In Freescale Test Fixture, 50 ohm system) V_{DD} = 28 Vdc, I_{DQ} = 600 mA, P_{out} = 32 W Avg., f = 768 MHz, Single-Carrier W-CDMA, IQ Magnitude Clipping, Input Signal PAR = 7.5 dB @ 0.01% Probability on CCDF. ACPR measured in 3.84 MHz Channel Bandwidth @ ±5 MHz Offset.

Characteristic	Symbol	Min	Typ	Max	Unit
Power Gain	G_{ps}	18.0	19.2	21.0	dB
Drain Efficiency	η_D	35.0	38.1	—	%
Output Peak-to-Average Ratio @ 0.01% Probability on CCDF	PAR	5.7	6.3	—	dB
Adjacent Channel Power Ratio	ACPR	—	-37.6	-36.0	dBc
Input Return Loss	IRL	—	-18	-9	dB

Typical Broadband Performance (In Freescale Test Fixture, 50 ohm system) V_{DD} = 28 Vdc, I_{DQ} = 600 mA, P_{out} = 32 W Avg., Single-Carrier W-CDMA, IQ Magnitude Clipping, Input Signal PAR = 7.5 dB @ 0.01% Probability on CCDF. ACPR measured in 3.84 MHz Channel Bandwidth @ ±5 MHz Offset.

Frequency	G_{ps} (dB)	η_D (%)	Output PAR (dB)	ACPR (dBc)	IRL (dB)
728 MHz	19.2	36.6	6.3	-38.3	-13
748 MHz	19.2	37.1	6.4	-38.2	-15
768 MHz	19.2	38.1	6.3	-37.6	-18

1. 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
Typical Performances (In Freescale Test Fixture, 50 ohm system) V_{DD} = 28 Vdc, I_{DQ} = 600 mA, 728–768 MHz Bandwidth					
P_{out} @ 1 dB Compression Point, CW	P1dB	—	125	—	W
IMD Symmetry @ 111 W PEP, P_{out} where IMD Third Order Intermodulation ≅ 30 dBc (Delta IMD Third Order Intermodulation between Upper and Lower Sidebands > 2 dB)	IMD_{sym}	—	12	—	MHz
VBW Resonance Point (IMD Third Order Intermodulation Inflection Point)	VBW_{res}	—	45	—	MHz
Gain Flatness in 40 MHz Bandwidth @ P_{out} = 32 W Avg.	G_F	—	0.1	—	dB
Gain Variation over Temperature (–30°C to +85°C)	ΔG	—	0.016	—	dB/°C
Output Power Variation over Temperature (–30°C to +85°C)	ΔP1dB	—	0.0047	—	dB/°C

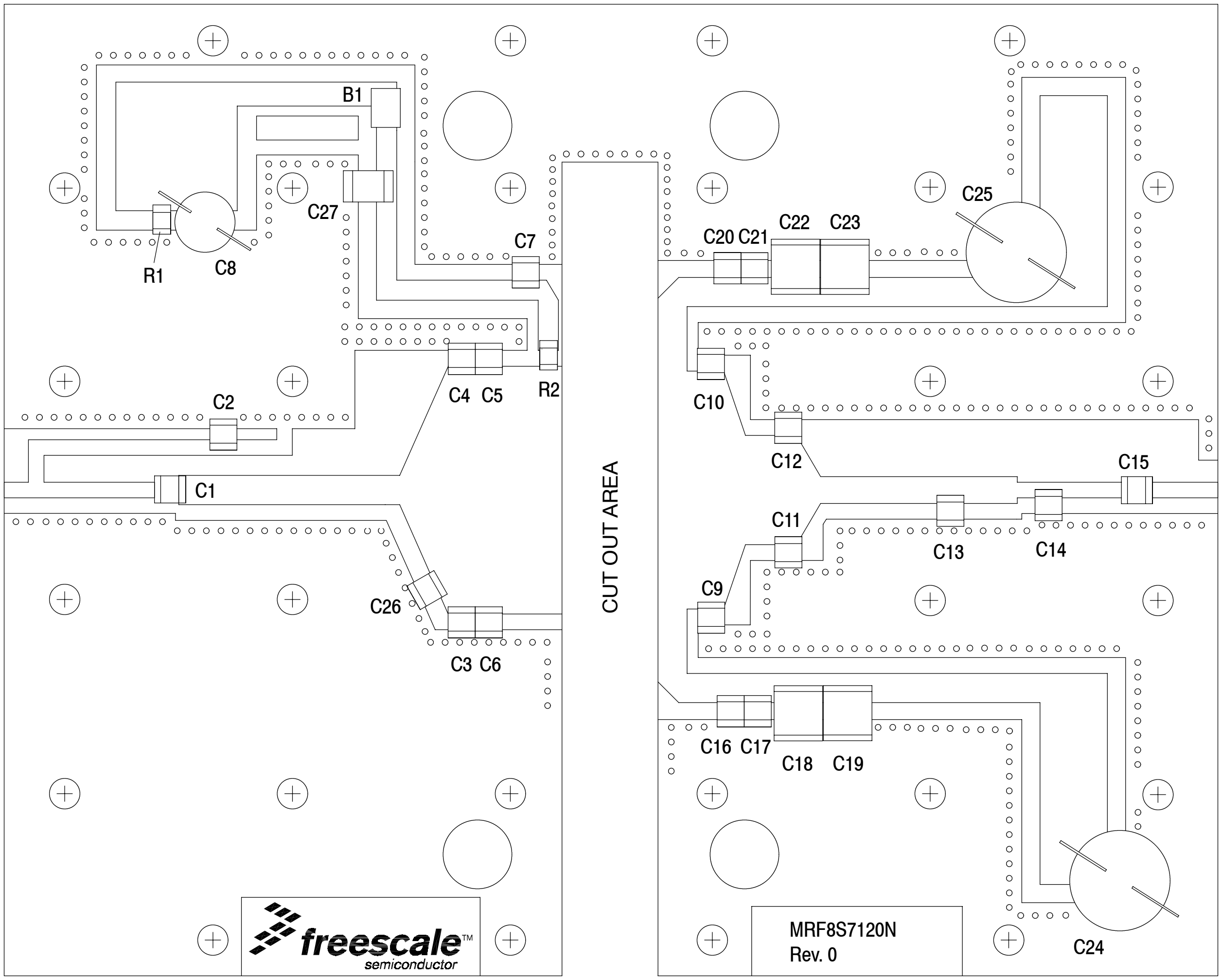


Figure 1. MRF8S7120NR3 Test Circuit Component Layout

Table 6. MRF8S7120NR3 Test Circuit Component Designations and Values

Part	Description	Part Number	Manufacturer
B1	RF Ferrite Bead	MPZ2012S300AT000	TDK
C1, C3, C4	2.7 pF Chip Capacitors	ATC100B2R7BT500XT	ATC
C2, C7	100 pF Chip Capacitors	ATC100B101JT500XT	ATC
C5, C6, C11, C12	8.2 pF Chip Capacitors	ATC100B8R2CT500XT	ATC
C8	47 μF, 50 V Electrolytic Capacitor	476KXM050M	Illinois Cap
C9, C10	12 pF Chip Capacitors	ATC100B120JT500XT	ATC
C13	5.6 pF Chip Capacitor	ATC100B5R6CT500XT	ATC
C14	1.2 pF Chip Capacitor	ATC100B1R2BT500XT	ATC
C15, C16, C17, C20, C21	39 pF Chip Capacitors	ATC100B390JT500XT	ATC
C18, C19, C22, C23	10 μF, 50 V Chip Capacitors	C5750X7R1H106KT	TDK
C24, C25	470 μF, 63 V Electrolytic Capacitors	MCGPR63V477M13X26-RH	Multicomp
C26	1 pF Chip Capacitor	ATC100B1R0BT500XT	ATC
C27	4.7 μF, 50 V Chip Capacitor	C4532X7R1H475MT	TDK
R1	1 kΩ, 1/4 W Chip Resistor	CRCW12061K00FKEA	Vishay
R2	6.2 Ω, 1/4 W Chip Resistor	CRCW12066R20JNEA	Vishay
PCB	0.030″, ε_r = 3.5	TC350	Arlon

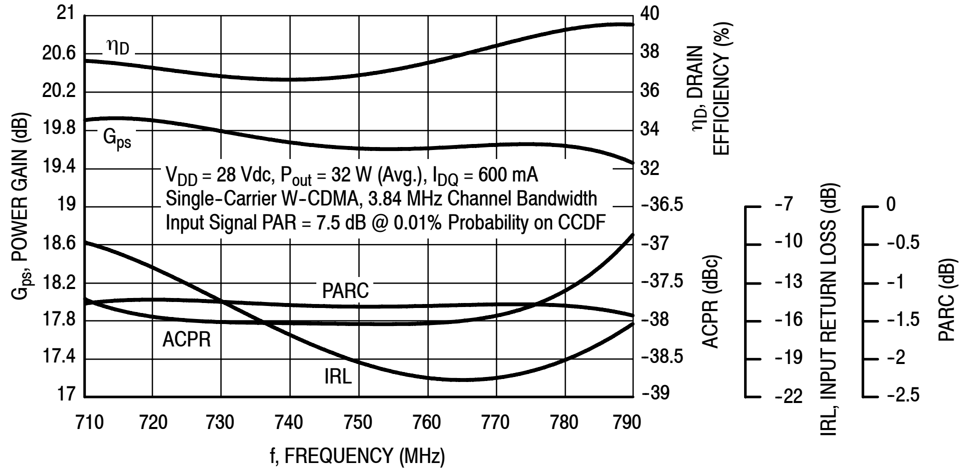


Figure 2. Output Peak-to-Average Ratio Compression (PARC) Broadband Performance @ P_{out} = 32 Watts Avg.

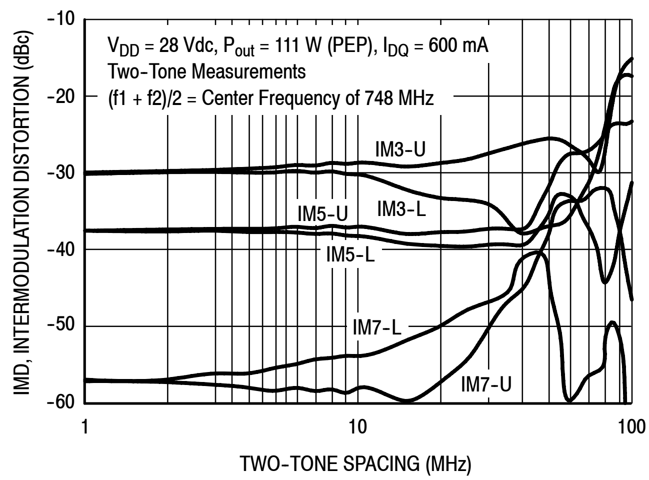


Figure 3. Intermodulation Distortion Products versus Two-Tone Spacing

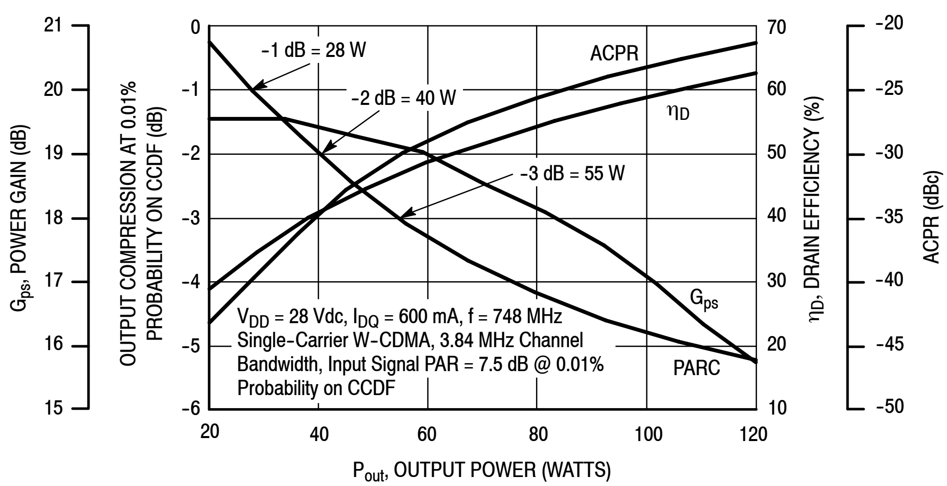


Figure 4. Output Peak-to-Average Ratio Compression (PARC) versus Output Power

TYPICAL CHARACTERISTICS

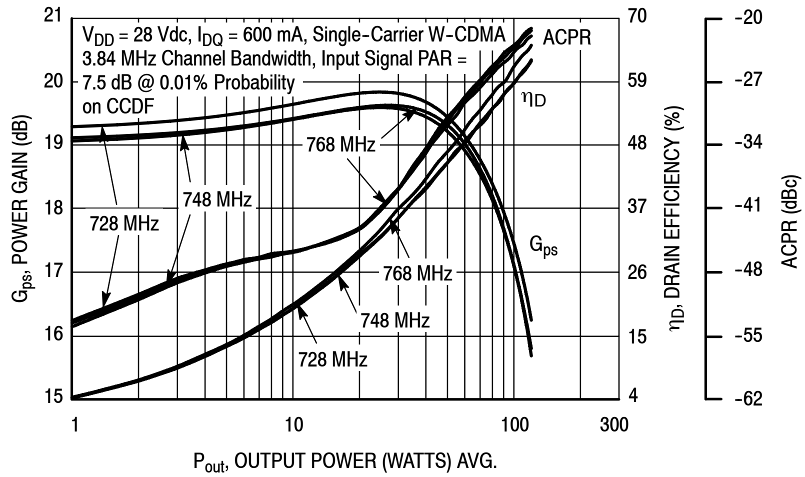


Figure 5. Single-Carrier W-CDMA Power Gain, Drain Efficiency and ACPR versus Output Power

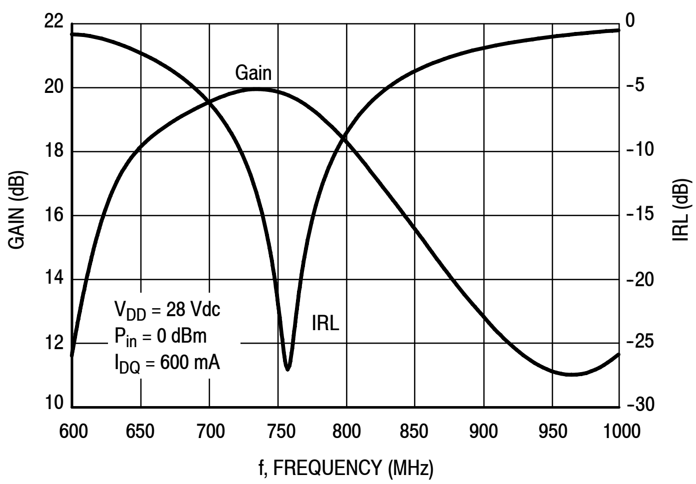


Figure 6. Broadband Frequency Response

W-CDMA TEST SIGNAL

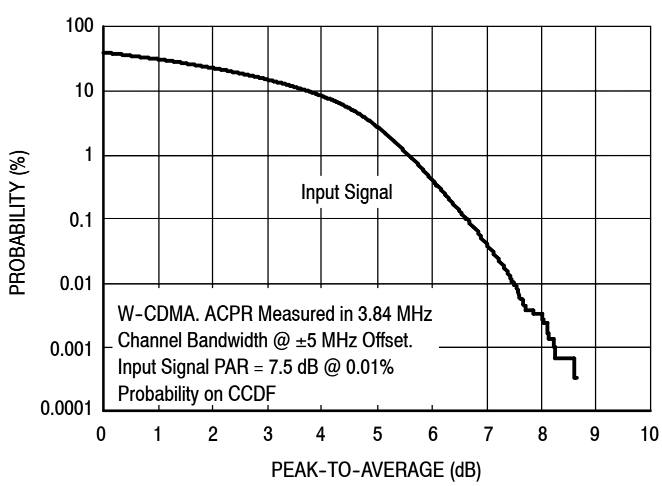


Figure 7. CCDF W-CDMA IQ Magnitude Clipping, Single-Carrier Test Signal

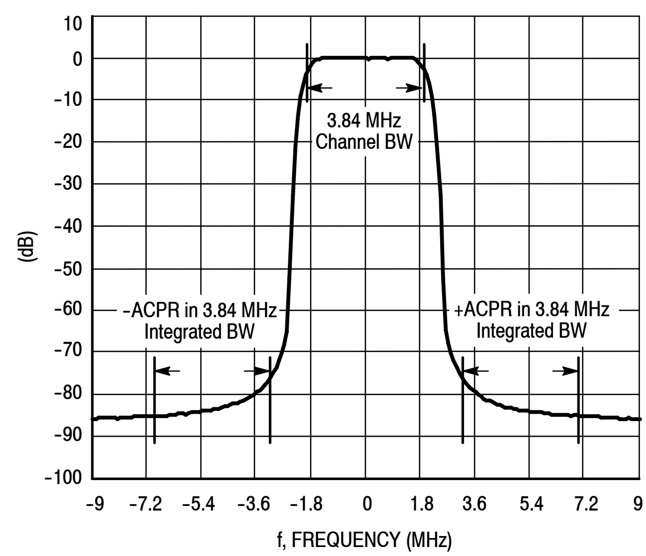


Figure 8. Single-Carrier W-CDMA Spectrum

V_{DD} = 28 Vdc, I_{DQ} = 600 mA, P_{out} = 32 W Avg.

f MHz	Z_{source} Ω	Z_{load} Ω
710	0.83 – j1.35	2.23 – j1.62
720	0.93 – j1.28	2.18 – j1.47
730	1.01 – j1.25	2.16 – j1.37
740	1.08 – j1.25	2.15 – j1.29
750	1.11 – j1.28	2.12 – j1.24
760	1.10 – j1.29	2.06 – j1.18
770	1.06 – j1.28	2.00 – j1.09
780	1.02 – j1.24	1.95 – j0.97
790	0.99 – j1.18	1.94 – j0.85

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

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

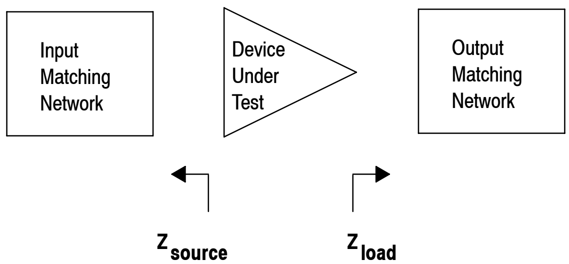
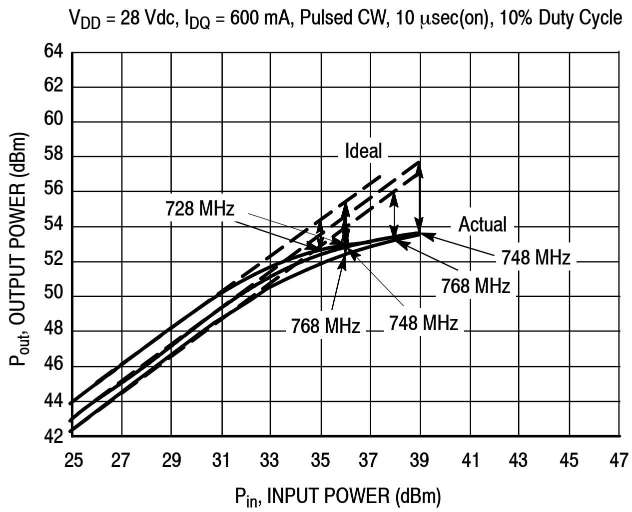


Figure 9. Series Equivalent Source and Load Impedance



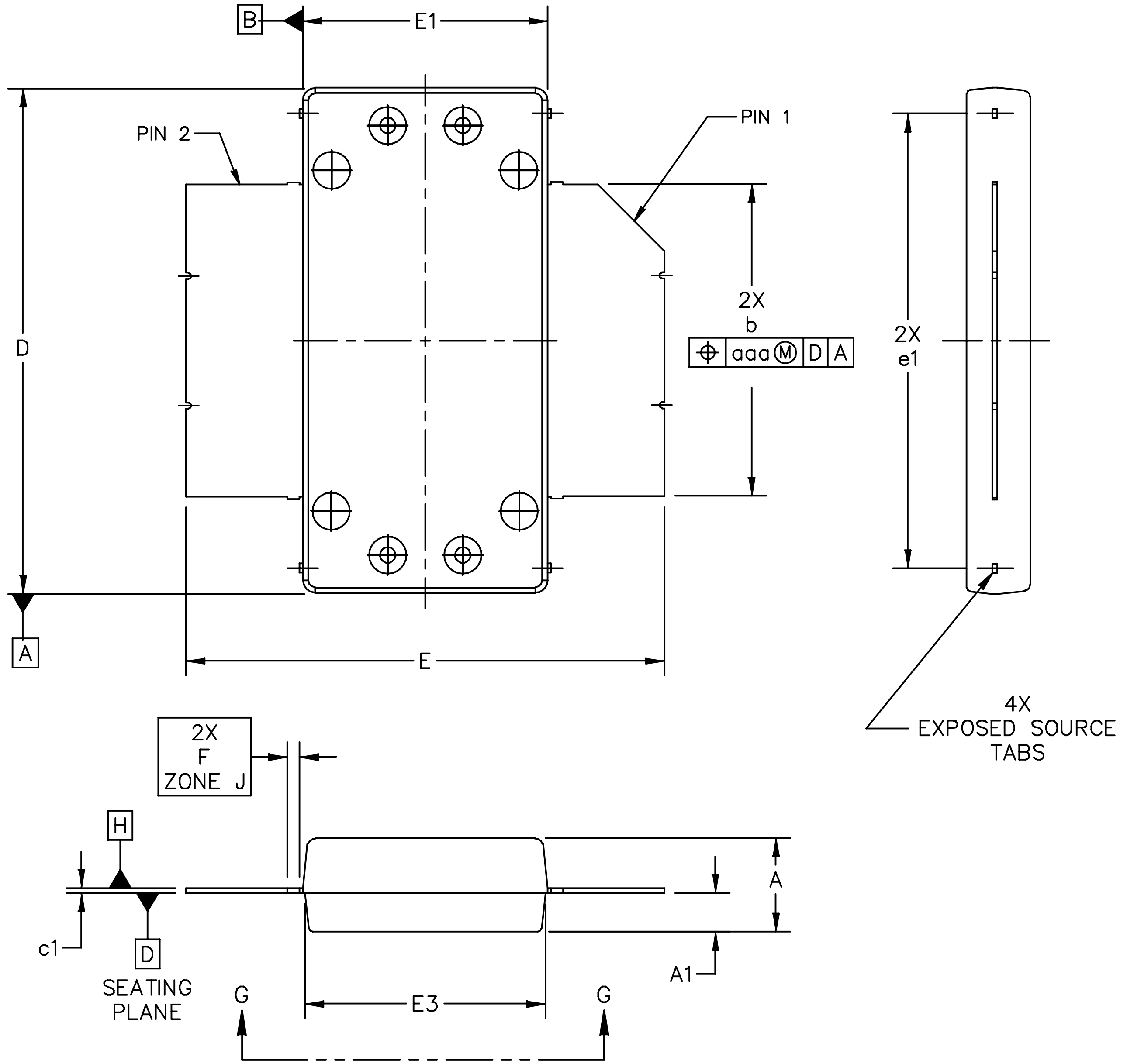
NOTE: Load Pull Test Fixture Tuned for Peak P1dB Output Power @ 28 V

f (MHz)	P1dB		P3dB	
	Watts	dBm	Watts	dBm
728	185	52.7	200	53.0
748	189	52.8	232	53.7
768	165	52.2	215	53.3

Test Impedances per Compression Level

f (MHz)		Z_{source} Ω	Z_{load} Ω
728	P1dB	0.87 – j2.04	1.25 – j1.39
748	P1dB	1.05 – j2.23	1.16 – j1.88
768	P1dB	1.07 – j2.05	1.15 – j2.58

Figure 10. Pulsed CW Output Power versus Input Power @ 28 V



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	CASE NUMBER: 2021–03	22 OCT 2009
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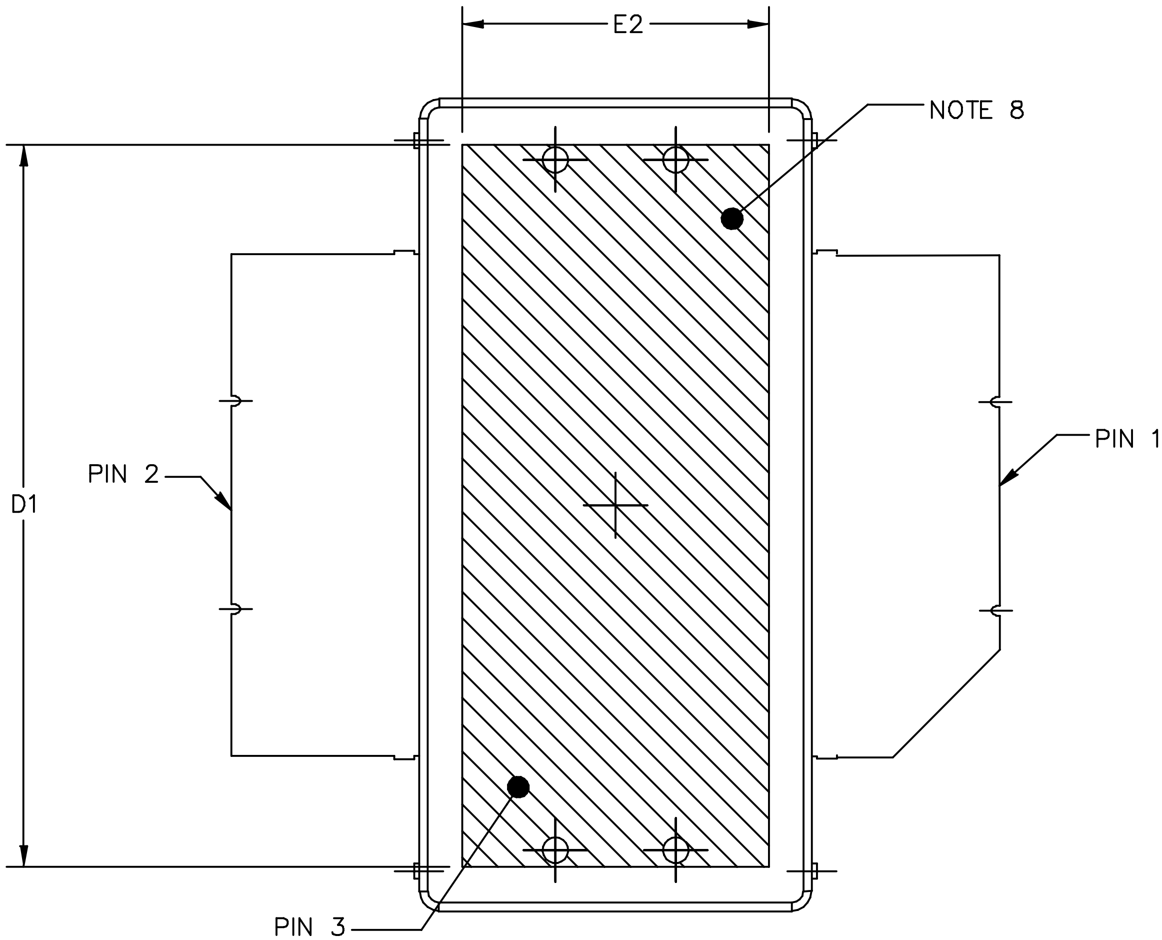

BOTTOM VIEW
VIEW G–G

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	CASE NUMBER: 2021–03		22 OCT 2009
	STANDARD: NON–JEDEC		

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 AND SOFTWARE

Refer to the following documents, tools and software to aid your design process.

Application Notes

- AN1907: Solder Reflow Attach Method for High Power RF Devices in 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

Software

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

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	May 2010	• Initial Release of Data Sheet

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