Freescale Semiconductor
Technical Data

Document Number: MMRF1008H
Rev. 1, 5/2016

√RoHS

RF Power Field Effect Transistors

N-Channel Enhancement-Mode Lateral MOSFETs

RF power transistors designed for applications operating at frequencies from 900 to 1215 MHz. These devices are suitable for use in defense and commercial pulse applications, such as IFF and DME.

- Typical Pulse Performance: V_{DD} = 50 Vdc, I_{DQ} = 100 mA, P_{out} = 275 W Peak (27.5 Watts Avg.), f = 1030 MHz, Pulse Width = 128 μsec, Duty Cycle = 10%
  - Power Gain — 20.3 dB
  - Drain Efficiency — 65.5%
- Capable of Handling 10:1 VSWR, @ 50 Vdc, 1030 MHz, 275 W Peak Power
- Typical Broadband Performance: V_{DD} = 50 Vdc, I_{DQ} = 100 mA, P_{out} = 250 W Peak (25 Watts Avg.), f = 960-1215 MHz, Pulse Width = 128 μsec, Duty Cycle = 10%
  - Power Gain — 19.8 dB
  - Drain Efficiency — 58%

Features

- Characterized with Series Equivalent Large-Signal Impedance Parameters
- Internally Matched for Ease of Use
- Qualified up to a Maximum of 50 V_{DD} Operation
- Integrated ESD Protection
- Greater Negative Gate-Source Voltage Range for Improved Class C Operation

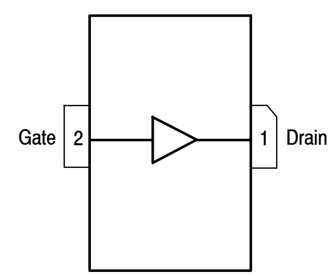
MMRF1008H
MMRF1008HS
MMRF1008GH

960-1215 MHz, 275 W, 50 V PULSE LATERAL N-CHANNEL RF POWER MOSFETs

NI-780H-2L
MMRF1008H

NI-780S-2L
MMRF1008HS

NI-780GH-2L
MMRF1008GH



(Top View)

Note: 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 (1)	T_J	225	°C

Table 2. Thermal Characteristics

Characteristic	Symbol	Value (2)	Unit
Thermal Resistance, Junction to Case Case Temperature 80°C, 275 W Peak 128 μsec Pulse Width, 10% Duty Cycle, 50 Vdc, I_{DQ} = 100 mA, 1030 MHz	$Z_{\theta JC}$	0.08	°C/W

Table 3. ESD Protection Characteristics

Test Methodology	Class
Human Body Model (per JESD22-A114)	2, passes 2600 V
Machine Model (per EIA/JESD22-A115)	B, passes 200 V
Charge Device Model (per JESD22-C101)	IV, passes 2000 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}	—	—	10	μAdc
Drain-Source Breakdown Voltage (V_{GS} = 0 Vdc, I_D = 100 mA)	$V_{(BR)DSS}$	110	—	—	Vdc
Zero Gate Voltage Drain Leakage Current (V_{DS} = 50 Vdc, V_{GS} = 0 Vdc)	I_{DSS}	—	—	10	μAdc
Zero Gate Voltage Drain Leakage Current (V_{DS} = 90 Vdc, V_{GS} = 0 Vdc)	I_{DSS}	—	—	100	μAdc
On Characteristics					
Gate Threshold Voltage (V_{DS} = 10 Vdc, I_D = 662 μAdc)	$V_{GS(th)}$	0.9	1.7	2.4	Vdc
Gate Quiescent Voltage (V_{DD} = 50 Vdc, I_D = 100 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 = 1.6 Adc)	$V_{DS(on)}$	—	0.25	—	Vdc
Dynamic Characteristics (3)					
Reverse Transfer Capacitance (V_{DS} = 50 Vdc ± 30 mV(rms)ac @ 1 MHz, V_{GS} = 0 Vdc)	C_{rss}	—	0.46	—	pF
Output Capacitance (V_{DS} = 50 Vdc ± 30 mV(rms)ac @ 1 MHz, V_{GS} = 0 Vdc)	C_{oss}	—	352	—	pF
Input Capacitance (V_{DS} = 50 Vdc, V_{GS} = 0 Vdc ± 30 mV(rms)ac @ 1 MHz)	C_{iss}	—	695	—	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.nxp.com/RF and search for AN1955.
3. Part internally matched both on input and output.

(continued)

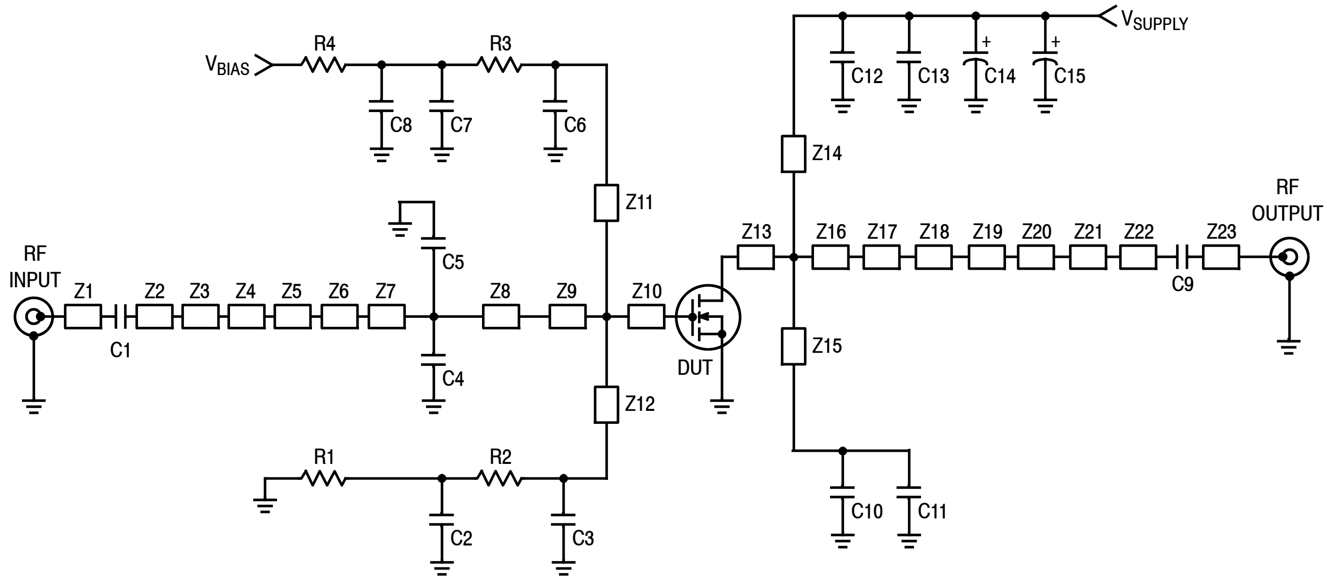
Table 4. Electrical Characteristics (T_A = 25°C unless otherwise noted) **(continued)**

Characteristic	Symbol	Min	Typ	Max	Unit
Functional Tests [1] (In Freescale Test Fixture, 50 ohm system) V_{DD} = 50 Vdc, I_{DQ} = 100 mA, P_{out} = 275 W Peak (27.5 W Avg.), f = 1030 MHz, Pulse, 128 μsec Pulse Width, 10% Duty Cycle					
Power Gain	G_{ps}	19	20.3	22	dB
Drain Efficiency	η_D	63	65.5	—	%
Input Return Loss	IRL	—	-14	-9	dB
Typical Broadband Performance — 960-1215 MHz (In Freescale 960-1215 MHz Test Fixture, 50 ohm system) V_{DD} = 50 Vdc, I_{DQ} = 100 mA, P_{out} = 250 W Peak (25 W Avg.), f = 960-1215 MHz, Pulse, 128 μsec Pulse Width, 10% Duty Cycle					
Power Gain	G_{ps}	—	19.8	—	dB
Drain Efficiency	η_D	—	58	—	%

Table 5. Ordering Information

Device	Tape and Reel Information	Package
MMRF1008HR5	R5 Suffix = 50 Units, 56 mm Tape Width, 13-inch Reel	NI-780H-2L
MMRF1008HSR5		NI-780S-2L
MMRF1008GHR5		NI-780GH-2L

1. Measurements made with device in straight lead configuration before any lead forming operation is applied. Lead forming is used for gull wing (GH) parts.



Z1	1.055″ x 0.082″ Microstrip	Z13	0.190″ x 1.250″ Microstrip
Z2	0.100″ x 0.082″ Microstrip	Z14, Z15	0.517″ x 0.080″ Microstrip
Z3	0.084″ x 0.395″ Microstrip	Z16	0.225″ x 1.250″ Microstrip
Z4	0.419″ x 0.040″ Microstrip	Z17	0.860″ x 0.975″ Microstrip
Z5	0.498″ x 0.466″ Microstrip	Z18	0.140″ x 0.950″ Microstrip
Z6	0.110″ x 1.060″ Microstrip	Z19	0.028″ x 0.110″ Microstrip
Z7	0.050″ x 1.300″ Microstrip	Z20	0.397″ x 0.040″ Microstrip
Z8	0.092″ x 1.300″ Microstrip	Z21	0.264″ x 0.480″ Microstrip
Z9	0.219″ x 1.420″ Microstrip	Z22	0.100″ x 0.082″ Microstrip
Z10	0.087″ x 1.420″ Microstrip	Z23	0.521″ x 0.082″ Microstrip
Z11, Z12	0.187″ x 0.050″ Microstrip	PCB	Arlon CuClad 250GX-0300-55-22, 0.030″, ε_r = 2.55

Figure 2. MMRF1008H(HS) Test Circuit Schematic

Table 6. MMRF1008H(HS) Test Circuit Component Designations and Values

Part	Description	Part Number	Manufacturer
C1, C4, C5	1.5 pF Chip Capacitors	ATC100B1R5BT500XT	ATC
C2, C7, C11, C13	2.2 μF, 100 V Chip Capacitors	G2225X7R225KT3AB	ATC
C3, C6, C10, C12	33 pF Chip Capacitors	ATC100B330JT500XT	ATC
C8	22 μF, 25 V Chip Capacitor	TPSD226M025R0200	AVX
C9	9.1 pF Chip Capacitor	ATC100B9R1CT500XT	ATC
C14, C15	470 μF, 63 V Electrolytic Capacitors	MCGPA63V477M13X26-RH	Multicomp
R1, R2, R3, R4	0 Ω, 3.5 A Chip Resistors	CRCW12060000Z0EA	Vishay

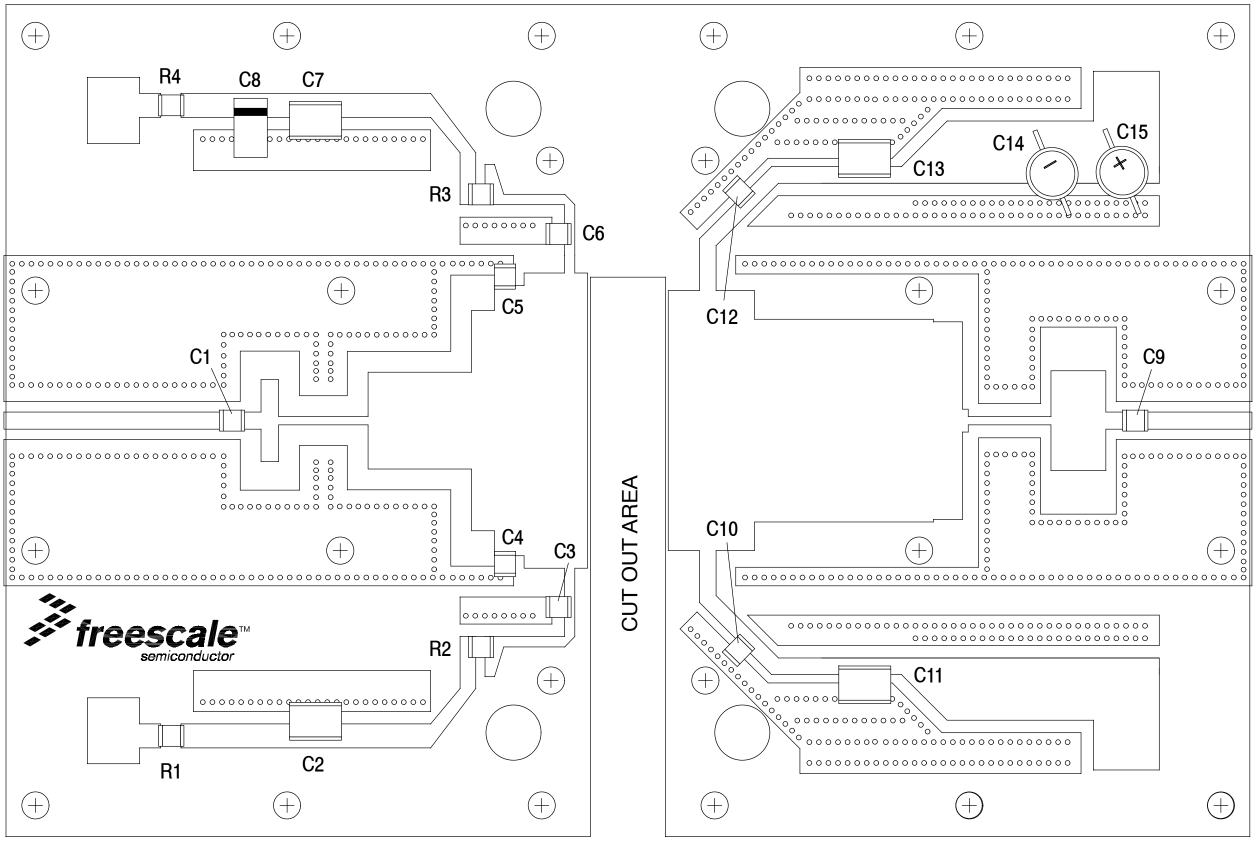


Figure 3. MMRF1008H(HS) Test Circuit Component Layout

TYPICAL CHARACTERISTICS

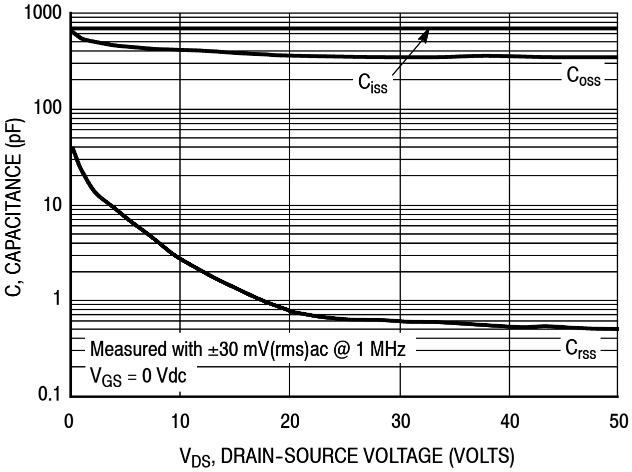


Figure 4. Capacitance versus Drain-Source Voltage

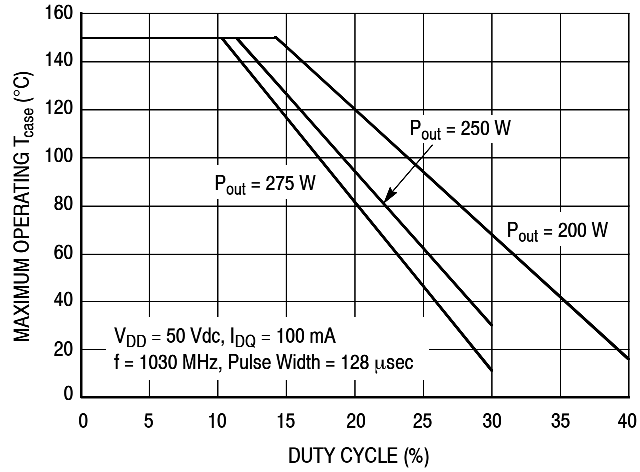


Figure 5. Safe Operating Area

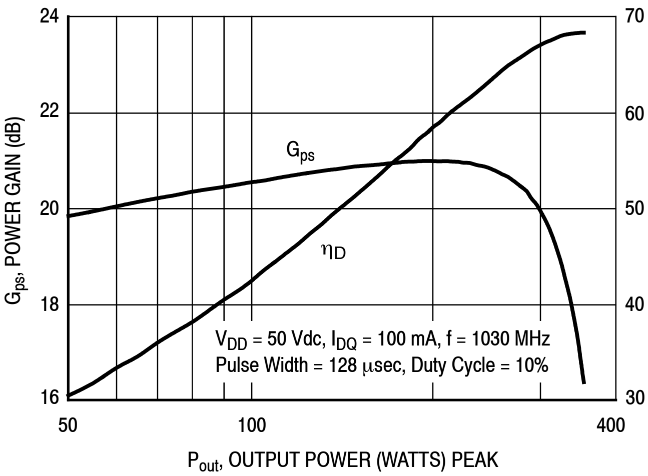


Figure 6. Power Gain and Drain Efficiency versus Output Power

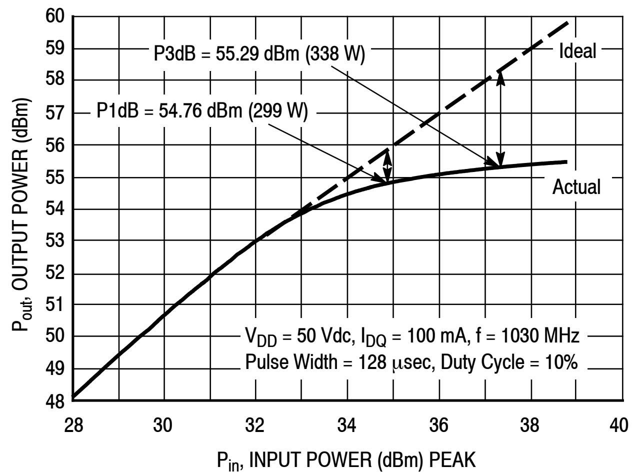


Figure 7. Output Power versus Input Power

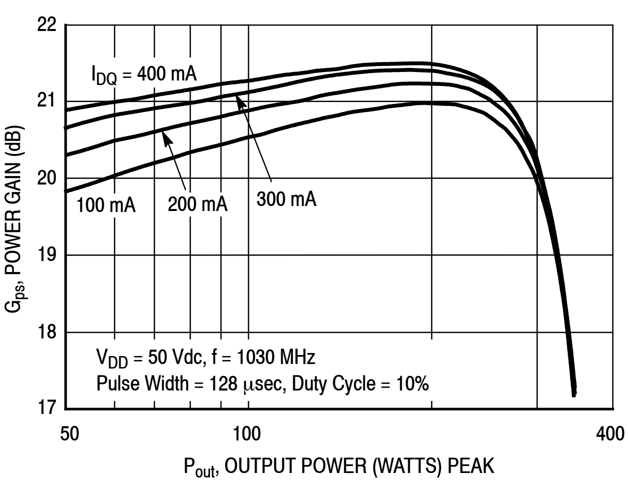


Figure 8. Power Gain versus Output Power

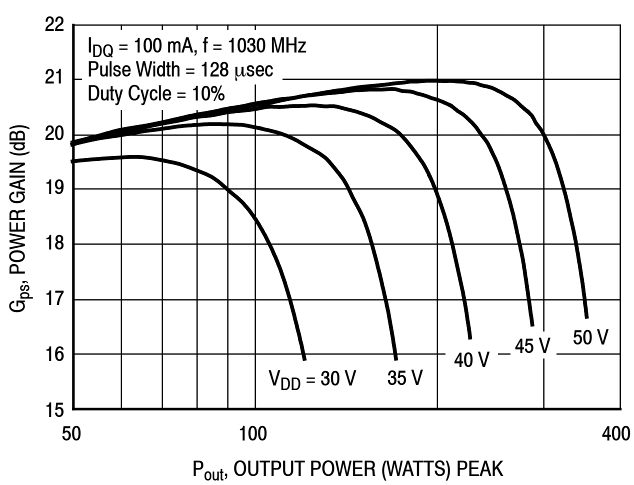


Figure 9. Power Gain versus Output Power

TYPICAL CHARACTERISTICS

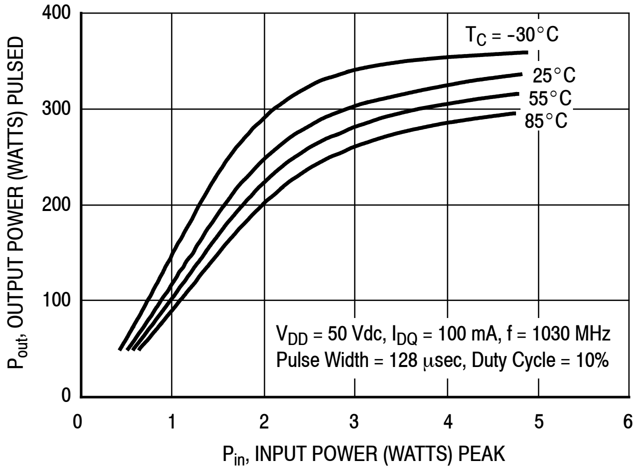


Figure 10. Output Power versus Input Power

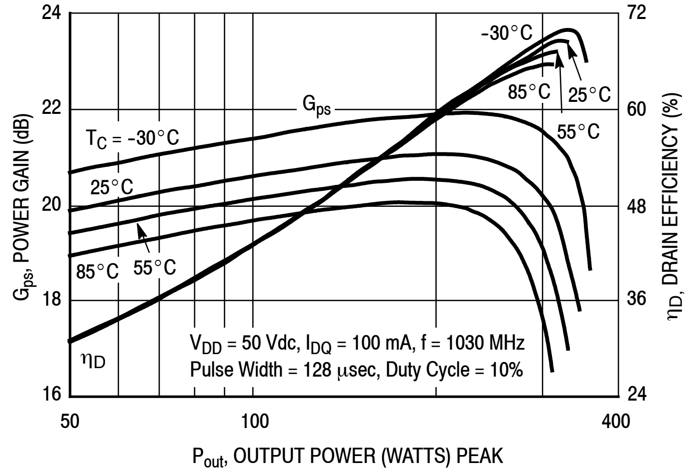
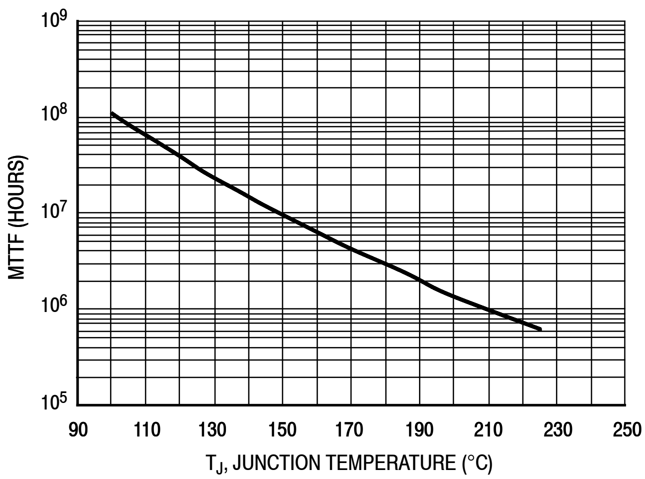
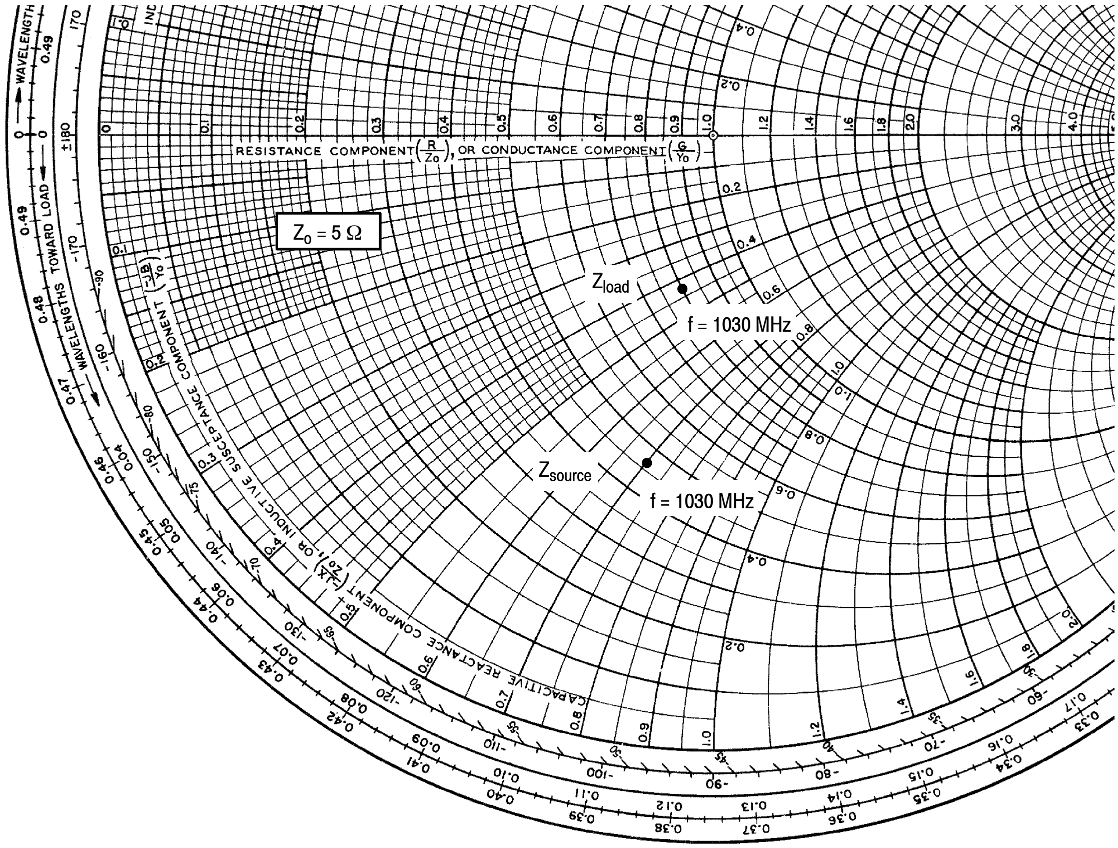


Figure 11. Power Gain and Drain Efficiency versus Output Power



This above graph displays calculated MTTF in hours when the device is operated at V_{DD} = 50 Vdc, P_{out} = 275 W Peak, Pulse Width = 128 μsec, Duty Cycle = 10%, and η_D = 65.5%.

Figure 12. MTTF versus Junction Temperature — Pulse



f MHz	Z_{source} Ω	Z_{load} Ω
1030	2.30 – j3.51	4.0 – j2.14

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

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

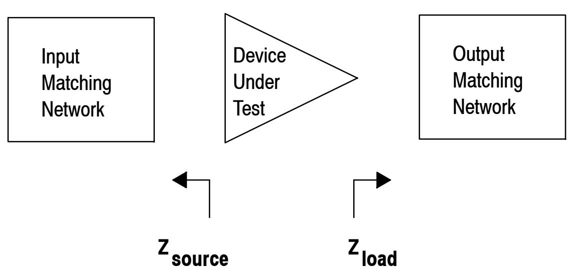


Figure 13. Series Equivalent Source and Load Impedance

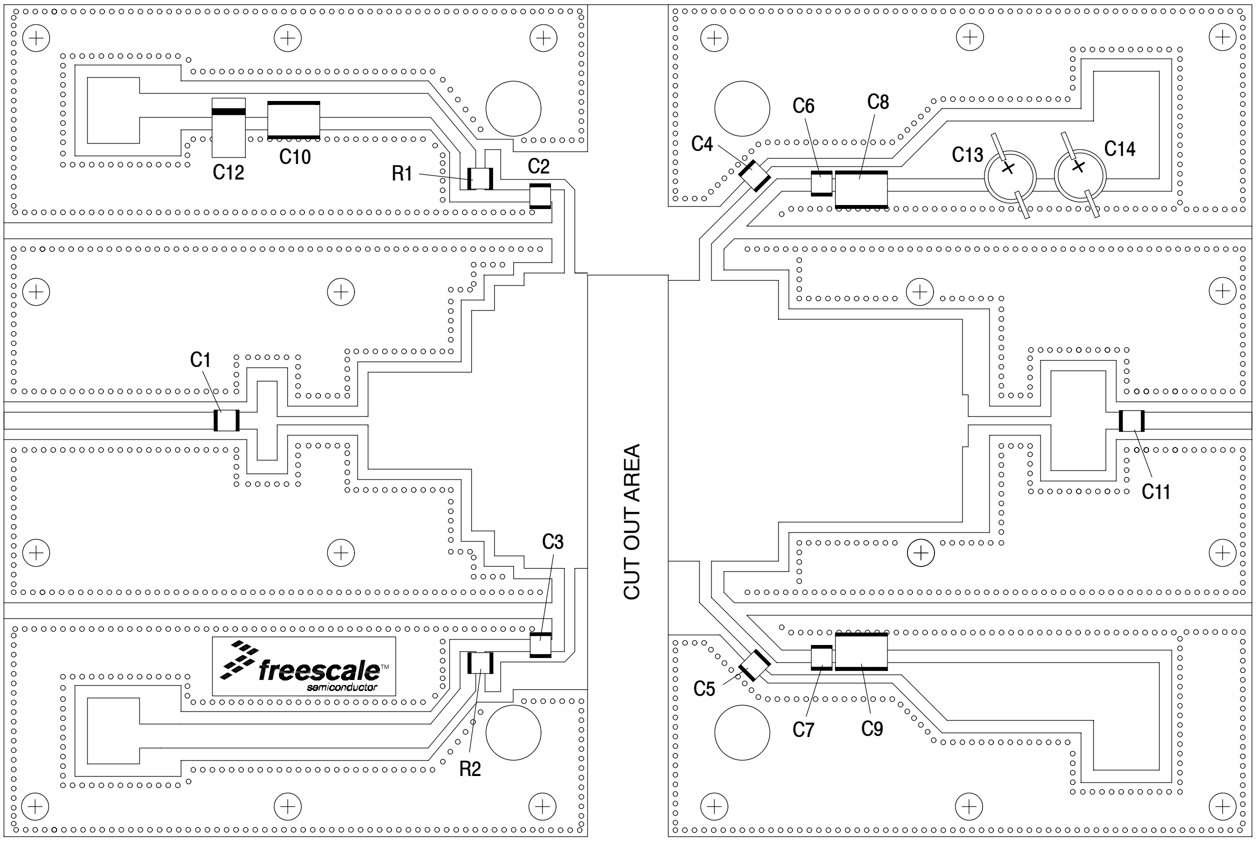


Figure 14. MMRF1008H(HS) Test Circuit Component Layout — 960-1215 MHz

Table 7. MMRF1008H(HS) Test Circuit Component Designations and Values — 960-1215 MHz

Part	Description	Part Number	Manufacturer
C1	2.7 pF Chip Capacitor	ATC100B2R7BT500XT	ATC
C2, C3, C4, C5	33 pF Chip Capacitors	ATC100B330JT500XT	ATC
C6, C7	1000 pF Chip Capacitors	ATC100B102JT50XT	ATC
C8, C9, C10	2.2 μF, 100 V Chip Capacitors	G2225X7R225KT3AB	ATC
C11	9.1 pF Chip Capacitor	ATC100B9R1CT500XT	ATC
C12	22 μF, 25 V Tantalum Capacitor	TPSD226M025R0200	AVX
C13, C14	470 μF, 63 V Electrolytic Capacitors	MCGPR63V477M13X26-RH	Multicomp
R1, R2	47 Ω, 1/4 W Chip Resistors	CRCW120647R0FKEA	Vishay
PCB	0.030″, ε_r = 2.55	AD255A	Arlon

TYPICAL CHARACTERISTICS — 960-1215 MHz

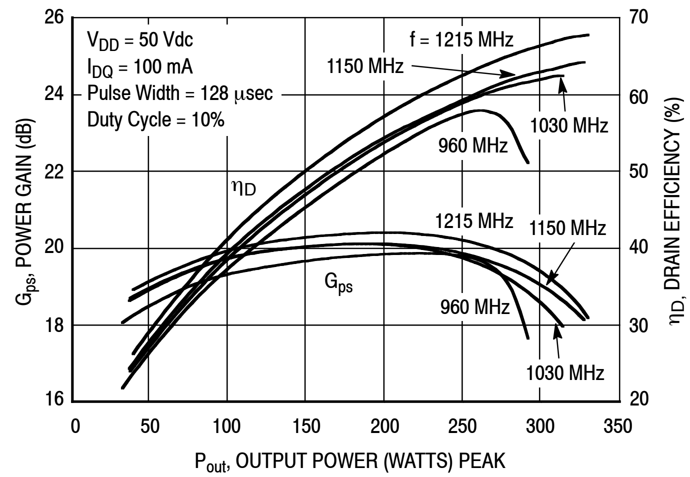


Figure 15. Power Gain and Drain Efficiency versus Output Power

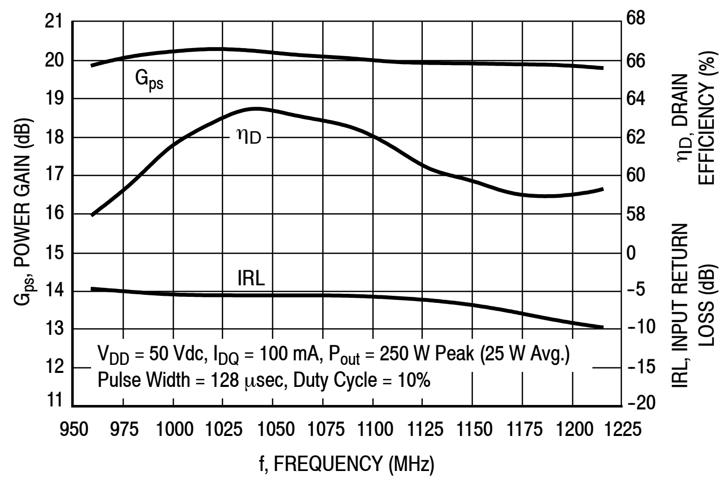
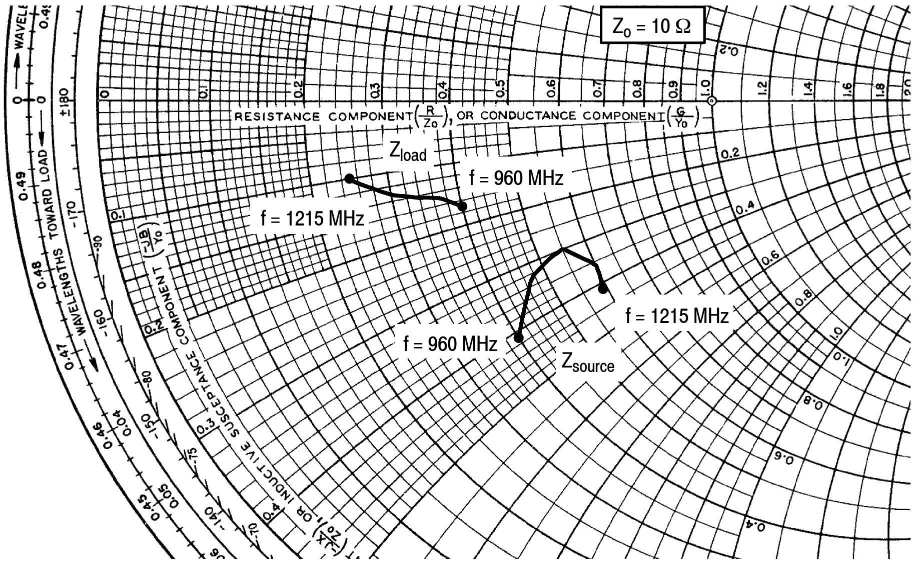


Figure 16. Broadband Performance @ P_{out} = 250 Watts Peak



f MHz	Z_{source} Ω	Z_{load} Ω
960	4.00 – j4.14	3.96 – j1.70
970	4.05 – j3.99	3.90 – j1.67
980	4.16 – j3.86	3.83 – j1.66
990	4.33 – j3.71	3.75 – j1.66
1000	4.49 – j3.57	3.70 – j1.65
1010	4.61 – j3.43	3.68 – j1.62
1020	4.66 – j3.33	3.69 – j1.59
1030	4.68 – j3.26	3.69 – j1.54
1040	4.72 – j3.20	3.67 – j1.52
1050	4.83 – j3.13	3.59 – j1.53
1060	5.02 – j3.06	3.48 – j1.53
1070	5.24 – j2.99	3.38 – j1.53
1080	5.42 – j2.96	3.32 – j1.51
1090	5.51 – j2.99	3.30 – j1.47

f MHz	Z_{source} Ω	Z_{load} Ω
1100	5.49 – j3.04	3.32 – j1.43
1110	5.47 – j3.07	3.31 – j1.42
1120	5.52 – j3.09	3.24 – j1.40
1130	5.68 – j3.13	3.12 – j1.39
1140	5.89 – j3.20	2.99 – j1.36
1150	6.06 – j3.32	2.88 – j1.30
1160	6.09 – j3.47	2.83 – j1.23
1170	5.98 – j3.60	2.83 – j1.19
1180	5.85 – j3.69	2.80 – j1.15
1190	5.78 – j3.76	2.75 – j1.11
1200	5.81 – j3.87	2.65 – j1.07
1210	5.89 – j4.02	2.52 – j1.01
1215	5.91 – j4.11	2.47 – j0.97

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

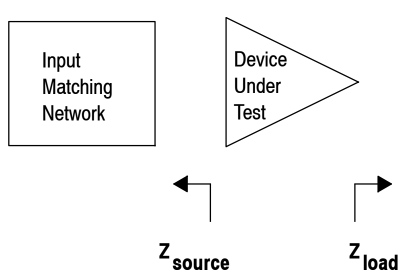
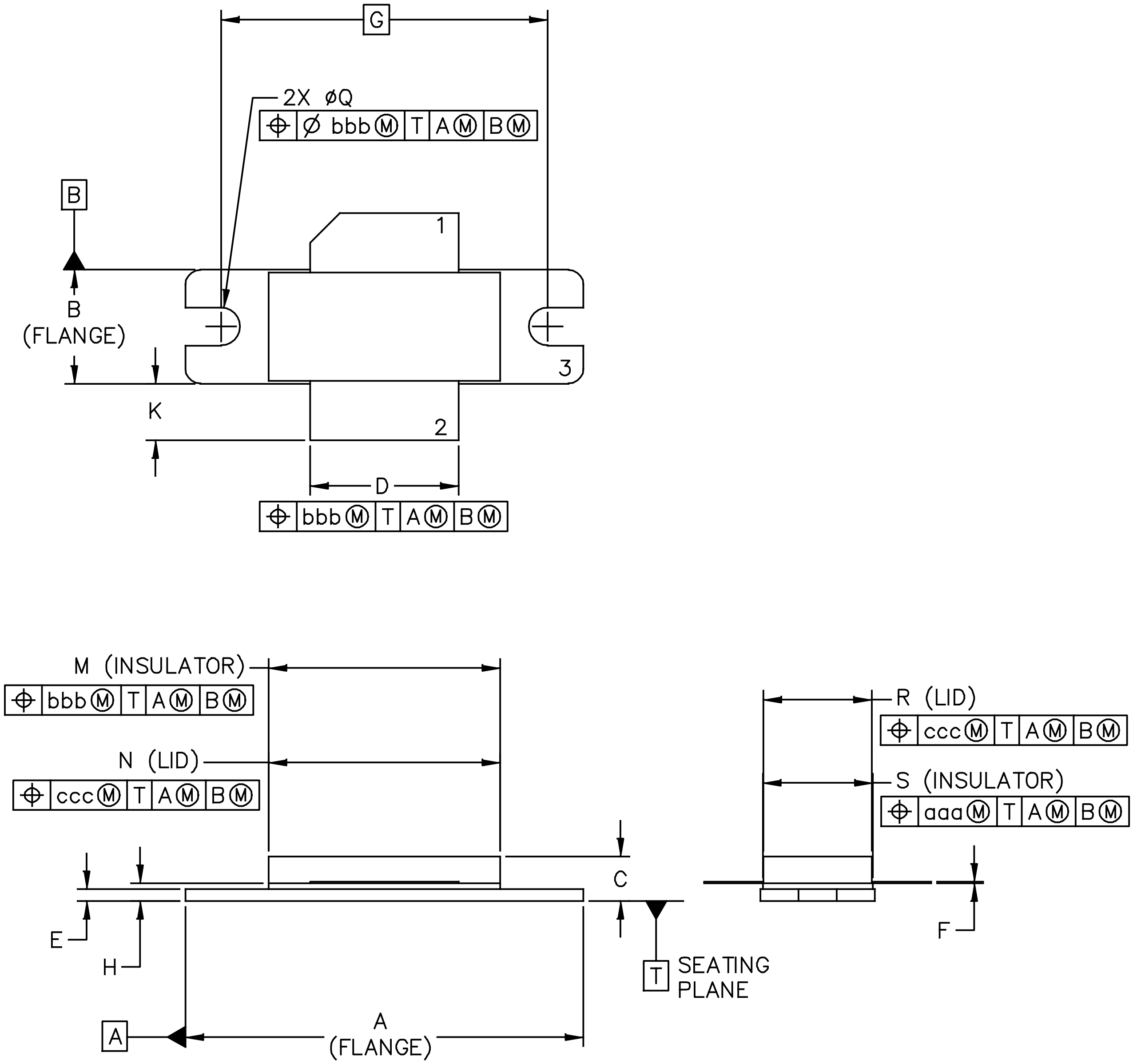


Figure 17. Series Equivalent Source and Load Impedance — 960-1215 MHz

PACKAGE DIMENSIONS



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TITLE: NI-780	DOCUMENT NO: 98ASB15607C REV: H	
	STANDARD: NON-JEDEC	
	SOT1792-1 14 MAR 2016	

NOTES:

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M–1994.
2. CONTROLLING DIMENSION: INCH.
3. DELETED
4. DIMENSION H IS MEASURED .030 (.762) AWAY FROM PACKAGE BODY.

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

DIM	INCH			MILLIMETER			DIM	INCH			MILLIMETER		
	MIN		MAX	MIN		MAX		MIN		MAX	MIN		MAX
A	1.335	–	1.345	33.91	–	34.16	R	.365	–	.375	9.27	–	9.53
B	.380	–	.390	9.65	–	9.91	S	.365	–	.375	9.27	–	9.52
C	.125	–	.170	3.18	–	4.32	aaa	–	.005	–	–	0.127	–
D	.495	–	.505	12.57	–	12.83	bbb	–	.010	–	–	0.254	–
E	.035	–	.045	0.89	–	1.14	ccc	–	.015	–	–	0.381	–
F	.003	–	.006	0.08	–	0.15	–	–	–	–	–	–	–
G	1.100 BSC			27.94 BSC			–	–	–	–	–	–	–
H	.057	–	.067	1.45	–	1.7	–	–	–	–	–	–	–
K	.170	–	.210	4.32	–	5.33	–	–	–	–	–	–	–
M	.774	–	.786	19.66	–	19.96	–	–	–	–	–	–	–
N	.772	–	.788	19.6	–	20	–	–	–	–	–	–	–
Q	⌀.118	–	⌀.138	⌀3	–	⌀3.51	–	–	–	–	–	–	–

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	STANDARD: NON–JEDEC	
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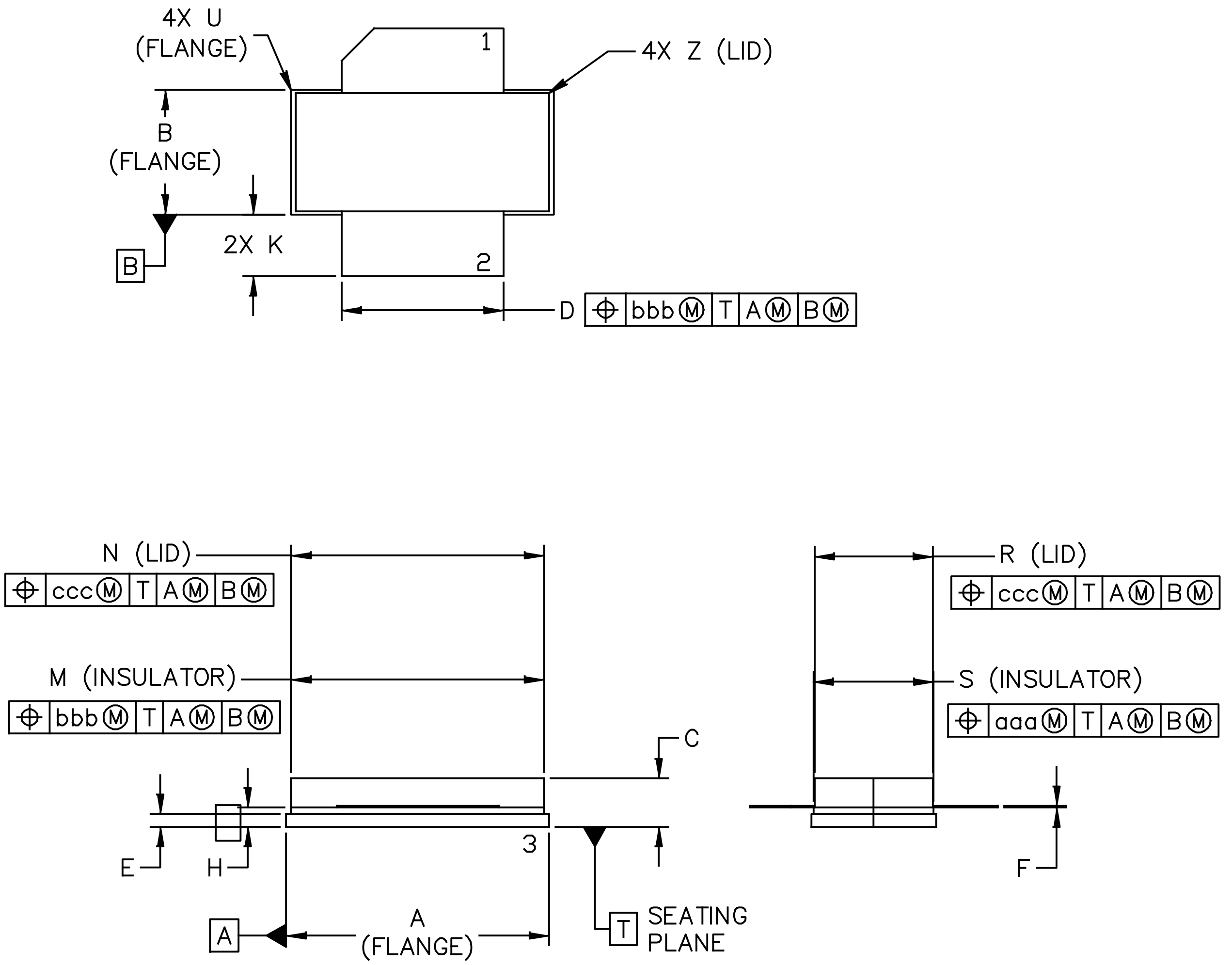

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	STANDARD: NON-JEDEC	
	SOT1793-1 15 MAR 2016	

NOTES:

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M−1994.

2. CONTROLLING DIMENSION: INCH.

3. DELETED

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

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

DIM	INCH MIN		INCH MAX	MILLIMETER MIN		MILLIMETER MAX	DIM	INCH MIN		INCH MAX	MILLIMETER MIN		MILLIMETER MAX
A	.805	–	.815	20.45	–	20.7	U	–	–	.040	–	–	1.02
B	.380	–	.390	9.65	–	9.91	Z	–	–	.030	–	–	0.76
C	.125	–	.170	3.18	–	4.32	aaa	–	.005	–	–	0.127	–
D	.495	–	.505	12.57	–	12.83	bbb	–	.010	–	–	0.254	–
E	.035	–	.045	0.89	–	1.14	ccc	–	.015	–	–	0.381	–
F	.003	–	.006	0.08	–	0.15	–	–	–	–	–	–	–
H	.057	–	.067	1.45	–	1.7	–	–	–	–	–	–	–
K	.170	–	.210	4.32	–	5.33	–	–	–	–	–	–	–
M	.774	–	.786	19.61	–	20.02	–	–	–	–	–	–	–
N	.772	–	.788	19.61	–	20.02	–	–	–	–	–	–	–
R	.365	–	.375	9.27	–	9.53	–	–	–	–	–	–	–
S	.365	–	.375	9.27	–	9.52	–	–	–	–	–	–	–

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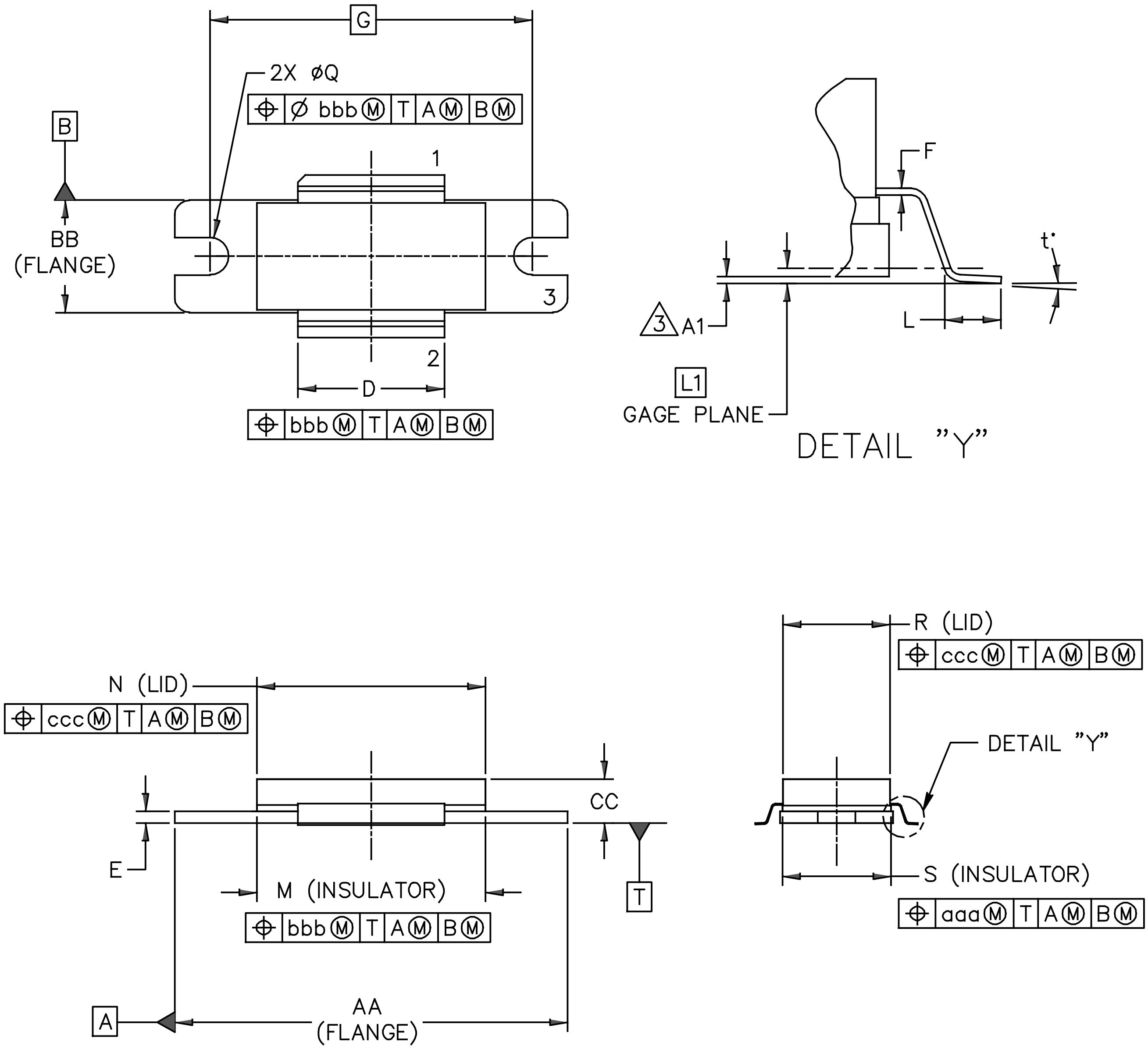

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	STANDARD: NON-JEDEC	
	SOTxxxx 11 FEB 2016	

NOTES:

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M–1994.

2. CONTROLLING DIMENSION: INCH.

3. DIMENSION A1 MEASURED WITH REFERENCE TO DATUM T. THE POSITIVE VALUE IMPLIES THAT THE PACKAGE BOTTOM IS HIGHER THAN THE LEAD BOTTOM. TOLERANCE ON DIMENSION A1 IS TENTATIVE. WILL BE FINALIZED AT PACKAGE CERTIFICATION.

	INCH		MILLIMETER			INCH		MILLIMETER	
DIM	MIN	MAX	MIN	MAX	DIM	MIN	MAX	MIN	MAX
AA	1.335	1.345	33.91	34.16	N	.772	.788	19.60	20.02
BB	.380	.390	9.65	9.91	Q	⌀.118	⌀.138	⌀3.00	⌀3.51
CC	.125	.170	3.18	4.32	R	.365	.375	9.27	9.53
A1	.002	.008	0.05	0.20	S	.365	.375	9.27	9.53
B1	.546	.562	13.87	14.27	t°	0°	8°	0°	8°
D	.495	.505	12.57	12.83	aaa	.005		0.13	
E	.035	.045	0.89	1.14	bbb	.010		0.25	
F	.003	.006	0.08	0.15	ccc	.015		0.38	
G	1.100 BSC		27.94 BSC						
L	.038	.046	0.97	1.17					
L1	.010 BSC		0.25 BSC						
M	.774	.786	19.66	19.96					

	MECHANICAL OUTLINE	PRINT VERSION NOT TO SCALE
TITLE: NI–780GH–2L	DOCUMENT NO: 98ASA00961D	REV: 0
	STANDARD: NON–JEDEC	
	SOTxxxx	11 FEB 2016

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
1	May 2016	• Added part number MMRF1008GH, p. 1 • Added NI-780GH-2L package photo, p. 1, and Mechanical Outline, pp. 16-17 • Added Fig. 1, Pin Connections, p. 1 • Table 5, Ordering Information: tape and reel information, p. 1, placed in Ordering Information table, p. 3

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ИНН 7805602321 КПП 780501001 Р/С 40702810122510004610 ФАКБ "АБСОЛЮТ БАНК" (ЗАО) в г.Санкт-Петербурге К/С 30101810900000000703 БИК 044030703

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