Freescale Semiconductor
Technical Data

Document Number: MMRF1312H
Rev. 0, 3/2016

RF Power LDMOS Transistors

High Ruggedness N-Channel Enhancement-Mode Lateral MOSFETs

These RF power devices are designed for pulse applications operating at frequencies from 900 to 1215 MHz. The devices are suitable for use in pulse applications with large duty cycles and long pulses and are ideal for use in high power military and commercial L-Band radar applications such as IFF and DME/TACAN.

Typical Short Pulse Performance: In 900–1215 MHz reference circuit, V_{DD} = 52 Vdc, $I_{DQ(A+B)}$ = 100 mA

Frequency (MHz)	Signal Type	P_{out} (W)	G_{ps} (dB)	η_D (%)
900	Pulse (128 μsec, 10% Duty Cycle)	1615 Peak	15.2	54.0
960		1560 Peak	17.3	55.7
1030		1500 Peak	17.8	53.8
1090		1530 Peak	18.0	54.5
1215		1200 Peak	19.2	58.5

Load Mismatch/Ruggedness

Frequency (MHz)	Signal Type	VSWR	P_{in} (W)	Test Voltage	Result
1030 (1)	Pulse (128 μsec, 10% Duty Cycle)	> 20:1 at all Phase Angles	20.2 Peak (3 dB Overdrive)	52	No Device Degradation

1. Measured in 1030 MHz narrowband reference circuit.

Features

- Internally input and output matched for broadband operation and ease of use
- Device can be used in a single-ended, push-pull or quadrature configuration
- Qualified up to a maximum of 52 V_{DD} operation
- High ruggedness, handles > 20:1 VSWR
- Integrated ESD protection with greater negative voltage range for improved Class C operation and gate voltage pulsing
- Characterized with series equivalent large-signal impedance parameters

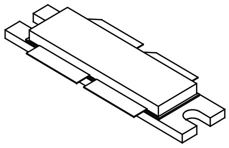
Typical Applications

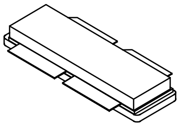
- Air traffic control systems (ATC), including ground-based secondary radars such as IFF interrogators or transponders
- Distance measuring equipment (DME)
- Tactical air navigation (TACAN)

MMRF1312H
MMRF1312HS
MMRF1312GS

900–1215 MHz, 1000 W PEAK, 52 V AIRFAST RF POWER LDMOS TRANSISTORS

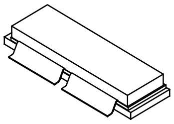
NI-1230H-4S
MMRF1312H

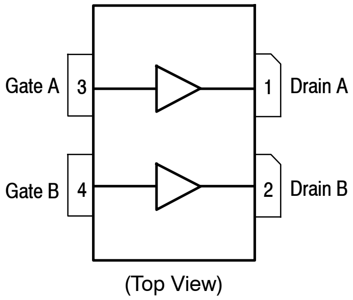




NI-1230S-4S
MMRF1312HS

NI-1230GS-4L
MMRF1312GS





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, +112	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)	T_J	–40 to 225	°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	1053 5.26	W W/°C

Table 2. Thermal Characteristics

Characteristic	Symbol	Value (2)	Unit
Thermal Impedance, Junction to Case Pulse: Case Temperature 64°C, 1000 W Peak, 128 μsec Pulse Width, 10% Duty Cycle, 50 Vdc, I_{DQ} = 100 mA, 1030 MHz	$Z_{\theta JC}$	0.017	°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. Electrical Characteristics (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
Off Characteristics (3)					
Gate-Source Leakage Current (V_{GS} = 5 Vdc, V_{DS} = 0 Vdc)	I_{GSS}	—	—	1	μAdc
Drain-Source Breakdown Voltage (V_{GS} = 0 Vdc, I_D = 10 μA)	$V_{(BR)DSS}$	112	—	—	Vdc
Zero Gate Voltage Drain Leakage Current (V_{DS} = 50 Vdc, V_{GS} = 0 Vdc)	I_{DSS}	—	—	1	μAdc
Zero Gate Voltage Drain Leakage Current (V_{DS} = 112 Vdc, V_{GS} = 0 Vdc)	I_{DSS}	—	—	10	μAdc
On Characteristics					
Gate Threshold Voltage (3) (V_{DS} = 10 Vdc, I_D = 520 μAdc)	$V_{GS(th)}$	1.3	1.8	2.3	Vdc
Gate Quiescent Voltage (4) (V_{DD} = 50 Vdc, I_D = 100 mAdc, Measured in Functional Test)	$V_{GS(Q)}$	1.5	2.0	2.5	Vdc
Drain-Source On-Voltage (3) (V_{GS} = 10 Vdc, I_D = 2.6 Adc)	$V_{DS(on)}$	0.05	0.17	0.35	Vdc
Dynamic Characteristics (3)					
Reverse Transfer Capacitance (V_{DS} = 50 Vdc ± 30 mV(rms)ac @ 1 MHz, V_{GS} = 0 Vdc)	C_{rss}	—	2.5	—	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. Each side of device measured separately.
4. Measurement made with device in push-pull configuration.

(continued)

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

Characteristic	Symbol	Min	Typ	Max	Unit
Functional Tests [1,2] (In Freescale Narrowband Production Test Fixture, 50 ohm system) V_{DD} = 50 Vdc, $I_{DQ(A+B)}$ = 100 mA, P_{out} = 1000 W Peak (100 W Avg.), f = 1030 MHz, 128 μsec Pulse Width, 10% Duty Cycle					
Power Gain	G_{ps}	18.5	19.6	22.0	dB
Drain Efficiency	η_D	55.5	59.7	—	%
Input Return Loss	IRL	—	–15	–9	dB

Table 5. Load Mismatch/Ruggedness (In Freescale Narrowband Production Test Fixture, 50 ohm system) $I_{DQ(A+B)}$ = 100 mA

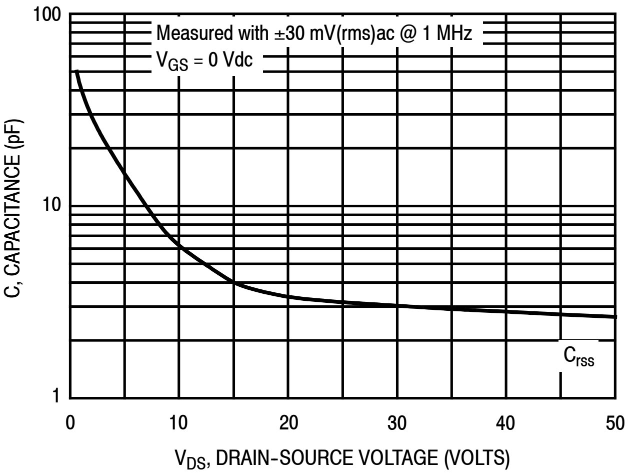
Frequency (MHz)	Signal Type	VSWR	P_{in} (W)	Test Voltage, V_{DD}	Result
1030	Pulse (128 μsec, 10% Duty Cycle)	> 20:1 at all Phase Angles	20.2 Peak (3 dB Overdrive)	52	No Device Degradation

Table 6. Ordering Information

Device	Tape and Reel Information	Package
MMRF1312HR5	R5 Suffix = 50 Units, 56 mm Tape Width, 13-inch Reel	NI-1230H-4S, Eared
MMRF1312HSR5		NI-1230S-4S, Earless
MMRF1312GSR5		NI-1230GS-4L, Gull Wing

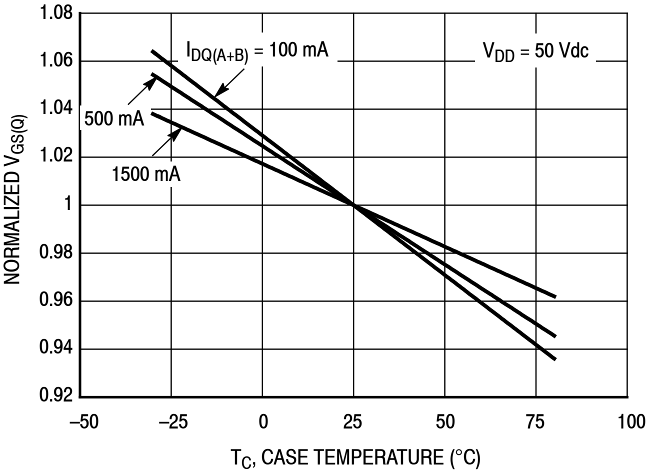
1. Measurement made with device in push-pull configuration.
2. Measurements made with device in straight lead configuration before any lead forming operation is applied. Lead forming is used for gull wing (GS) parts.

TYPICAL CHARACTERISTICS



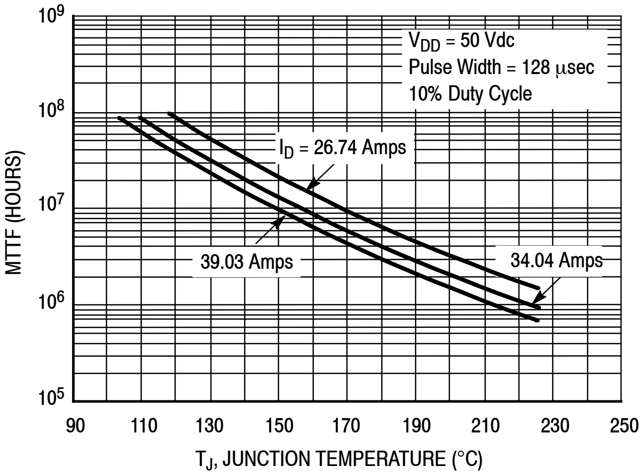
Note: Each side of device measured separately.

Figure 2. Capacitance versus Drain-Source Voltage



I_{DQ} (mA)	Slope (mV/°C)
100	–2.36
500	–2.26
1500	–1.84

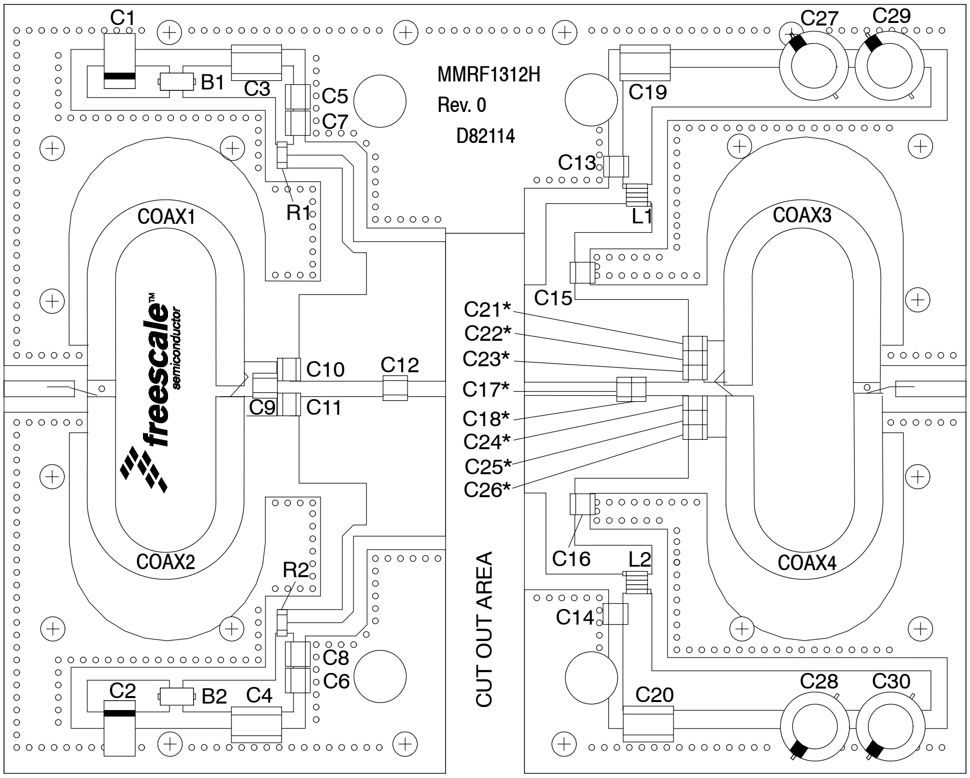
Figure 3. Normalized V_{GS} versus Quiescent Current and Case Temperature



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

Figure 4. MTTF versus Junction Temperature — Pulse

1030 MHz NARROWBAND PRODUCTION TEST FIXTURE — 4.0″ × 5.0″ (10.2 cm × 12.7 cm)



* C17, C18, C21, C22, C23, C24, C25 and C26 are mounted vertically.

Figure 5. MMRF1312H(HS) Narrowband Test Circuit Component Layout — 1030 MHz

Table 7. MMRF1312H(HS) Narrowband Test Circuit Component Designations and Values — 1030 MHz

Part	Description	Part Number	Manufacturer
B1, B2	Short RF Bead	2743019447	Fair-Rite
C1, C2	22 μF, 35 V Tantalum Capacitors	T491X226K035AT	Kemet
C3, C4	2.2 μF Chip Capacitors	C1825C225J5RACTU	Kemet
C5, C6	0.1 μF Chip Capacitors	CDR33BX104AKWS	AVX
C7, C8	36 pF Chip Capacitors	ATC100B360JT500XT	ATC
C9	2.7 pF Chip Capacitor	ATC100B2R7CT500XT	ATC
C10, C11	30 pF Chip Capacitors	ATC100B300JT500XT	ATC
C12	8.2 pF Chip Capacitor	ATC100B8R2CT500XT	ATC
C13, C14	36 pF Chip Capacitors	ATC100B360JT500XT	ATC
C15, C16	7.5 pF Chip Capacitors	ATC100B7R5CT500XT	ATC
C17	4.7 pF Chip Capacitor	ATC100B4R7CT500XT	ATC
C18	4.3 pF Chip Capacitor	ATC100B4R3CT500XT	ATC
C19, C20	0.01 μF Chip Capacitors	C1825C103K1GACTU	Kemet
C21, C22, C23, C24, C25, C26	43 pF Chip Capacitors	ATC100B430JT500XT	ATC
C27, C28, C29, C30	470 μF, 63 V Electrolytic Capacitors	MCGPR63V477M13X26-RH	Multicomp
Coax1, Coax2, Coax3, Coax4	35 Ω Flex Cable 1.98″	HSF-141C-35	Hongsen Cable
L1, L2	12 ηH, 3 Turn Inductors	GA3094-ALC	Coilcraft
R1, R2	1.1 kΩ, 1/4 W Chip Resistors	CRCW12061K10FKEA	Vishay
PCB	Arlon, AD255A, 0.03″, ε_r = 2.55	D82114	MTL

TYPICAL CHARACTERISTICS — 1030 MHz
NARROWBAND PRODUCTION TEST FIXTURE

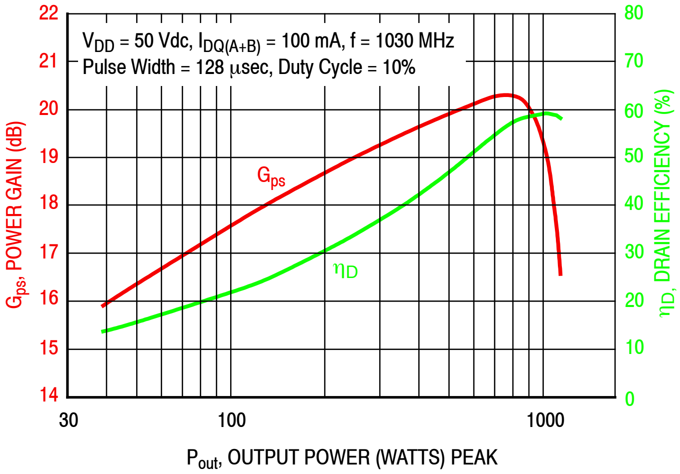
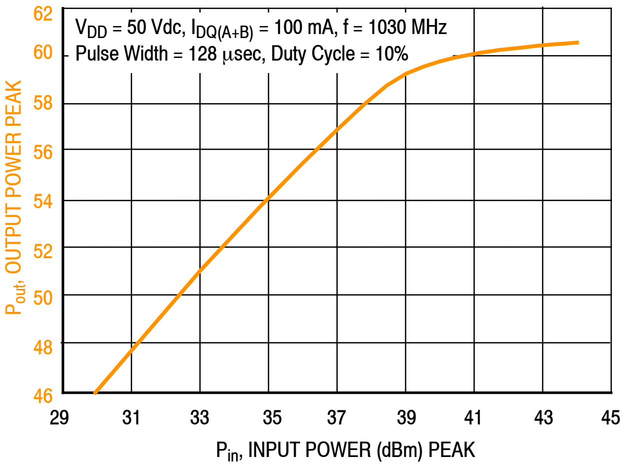


Figure 6. Power Gain and Drain Efficiency versus Output Power



f (MHz)	P1dB (W)	P3dB (W)
1030	1002	1115

Figure 7. Output Power versus Input Power

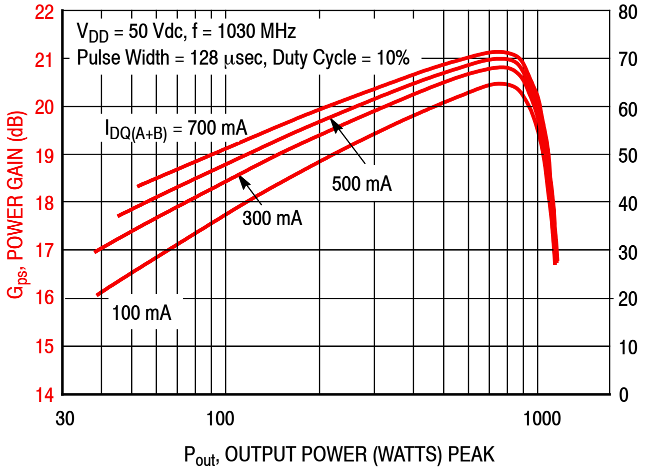


Figure 8. Power Gain versus Output Power

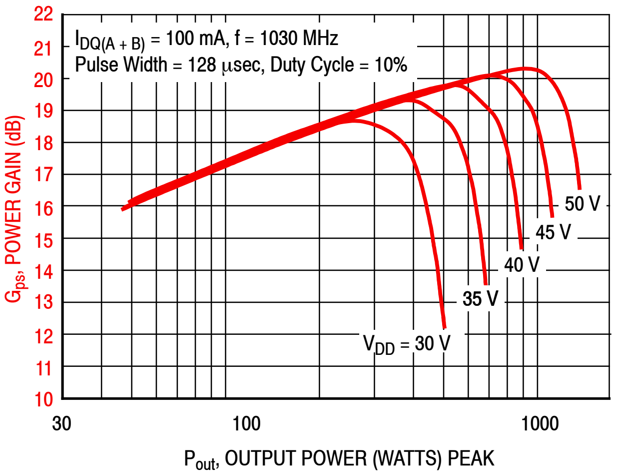


Figure 9. Power Gain versus Output Power

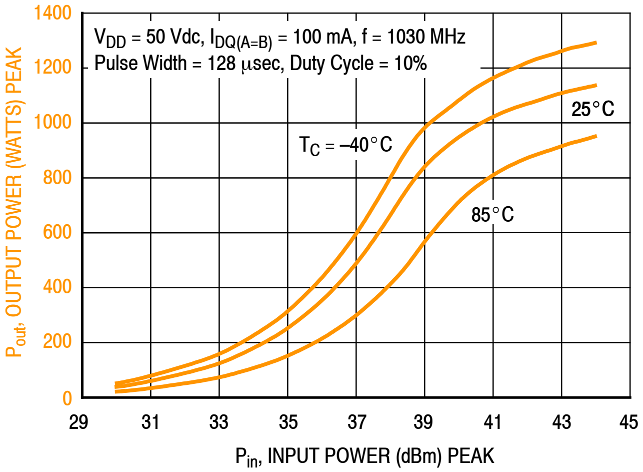


Figure 10. Output Power versus Input Power

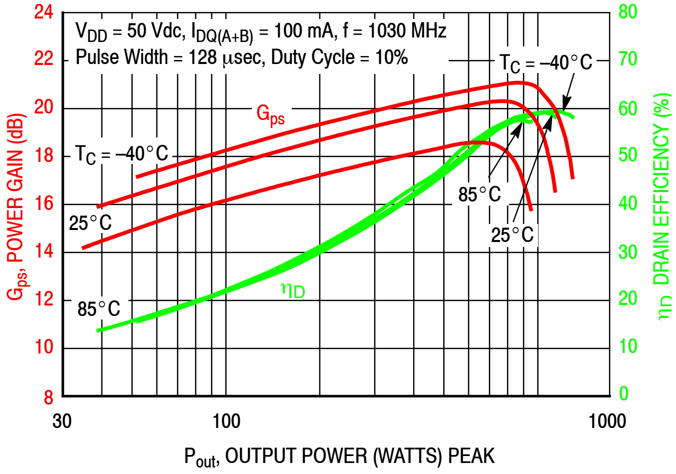


Figure 11. Power Gain and Drain Efficiency versus Output Power

1030 MHz NARROWBAND PRODUCTION TEST FIXTURE

f MHz	Z_{source} Ω	Z_{load} Ω
1030	2.40 – j3.73	1.9 + j1.00

Z_{source} = Test circuit impedance as measured from gate to gate, balanced configuration.

Z_{load} = Test circuit impedance as measured from drain to drain, balanced configuration.

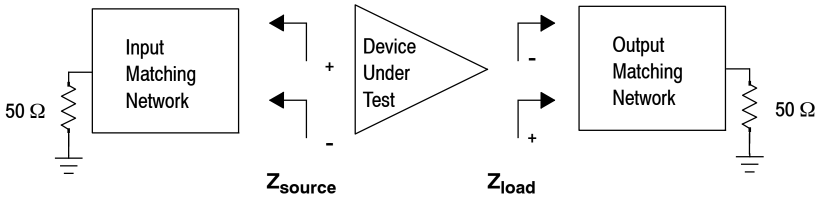
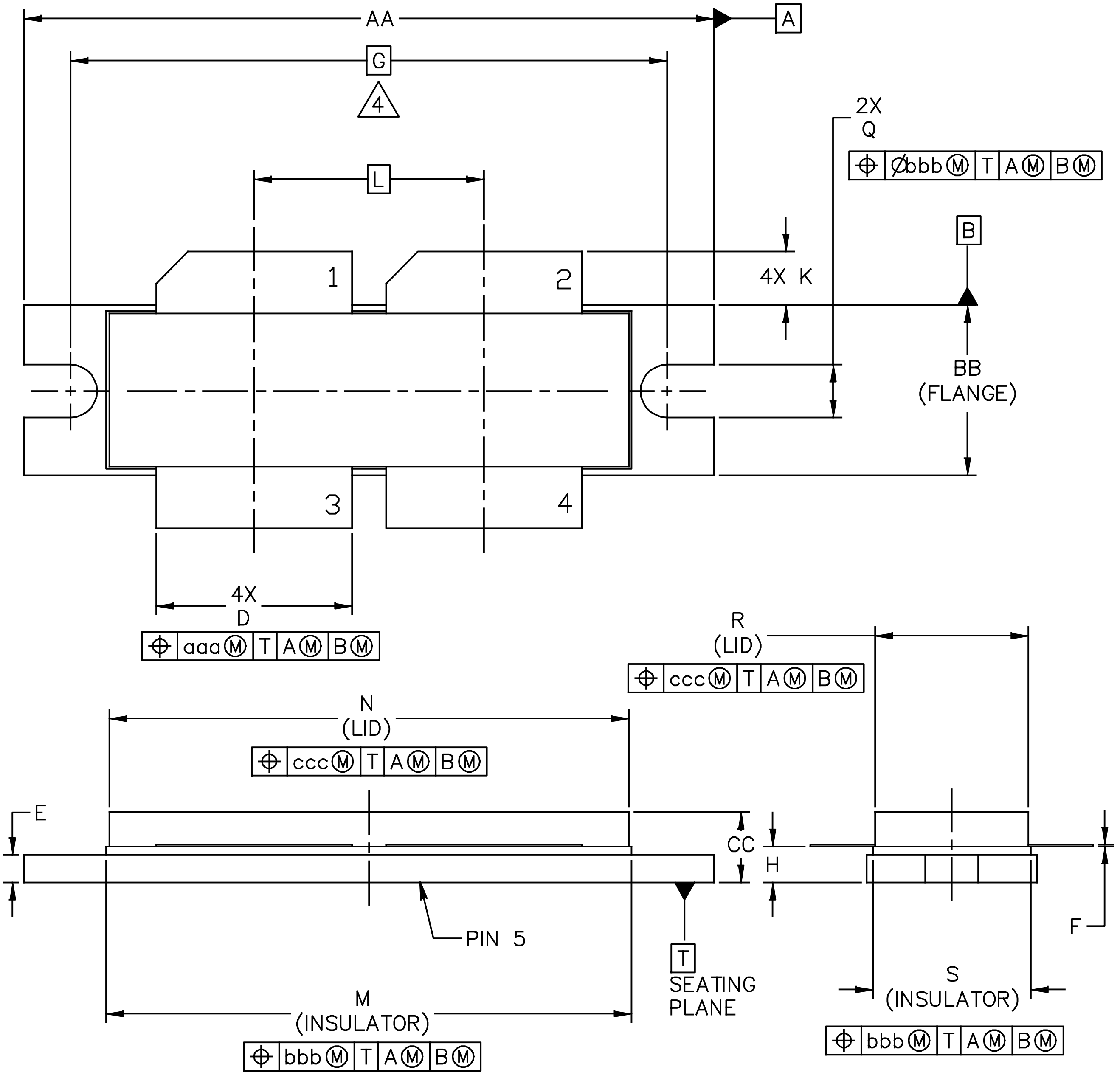


Figure 12. Narrowband Series Equivalent Source and Load Impedance — 1030 MHz

PACKAGE DIMENSIONS



MECHANICAL OUTLINE

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NI–1230–4H

DOCUMENT NO: 98ASB16977C REV: F

STANDARD: NON–JEDEC

28 FEB 2013

NOTES:

1. INTERPRET DIMENSIONS AND TOLERANCES PER ASME Y14.5M-1994.
2. CONTROLLING DIMENSION: INCH
3. DIMENSION H IS MEASURED .030 INCH (0.762 MM) AWAY FROM PACKAGE BODY.
4. RECOMMENDED BOLT CENTER DIMENSION OF 1.52 INCH (38.61 MM) BASED ON M3 SCREW.

	INCH		MILLIMETER			INCH		MILLIMETER	
DIM	MIN	MAX	MIN	MAX	DIM	MIN	MAX	MIN	MAX
AA	1.615	1.625	41.02	41.28	N	1.218	1.242	30.94	31.55
BB	.395	.405	10.03	10.29	Q	.120	.130	3.05	3.30
CC	.170	.190	4.32	4.83	R	.355	.365	9.02	9.27
D	.455	.465	11.56	11.81	S	.365	.375	9.27	9.53
E	.062	.066	1.57	1.68					
F	.004	.007	0.10	0.18					
G	1.400 BSC		35.56 BSC		aaa	.013		0.33	
H	.082	.090	2.08	2.29	bbb	.010		0.25	
K	.117	.137	2.97	3.48	ccc	.020		0.51	
L	.540 BSC		13.72 BSC						
M	1.219	1.241	30.96	31.52					

MECHANICAL OUTLINE

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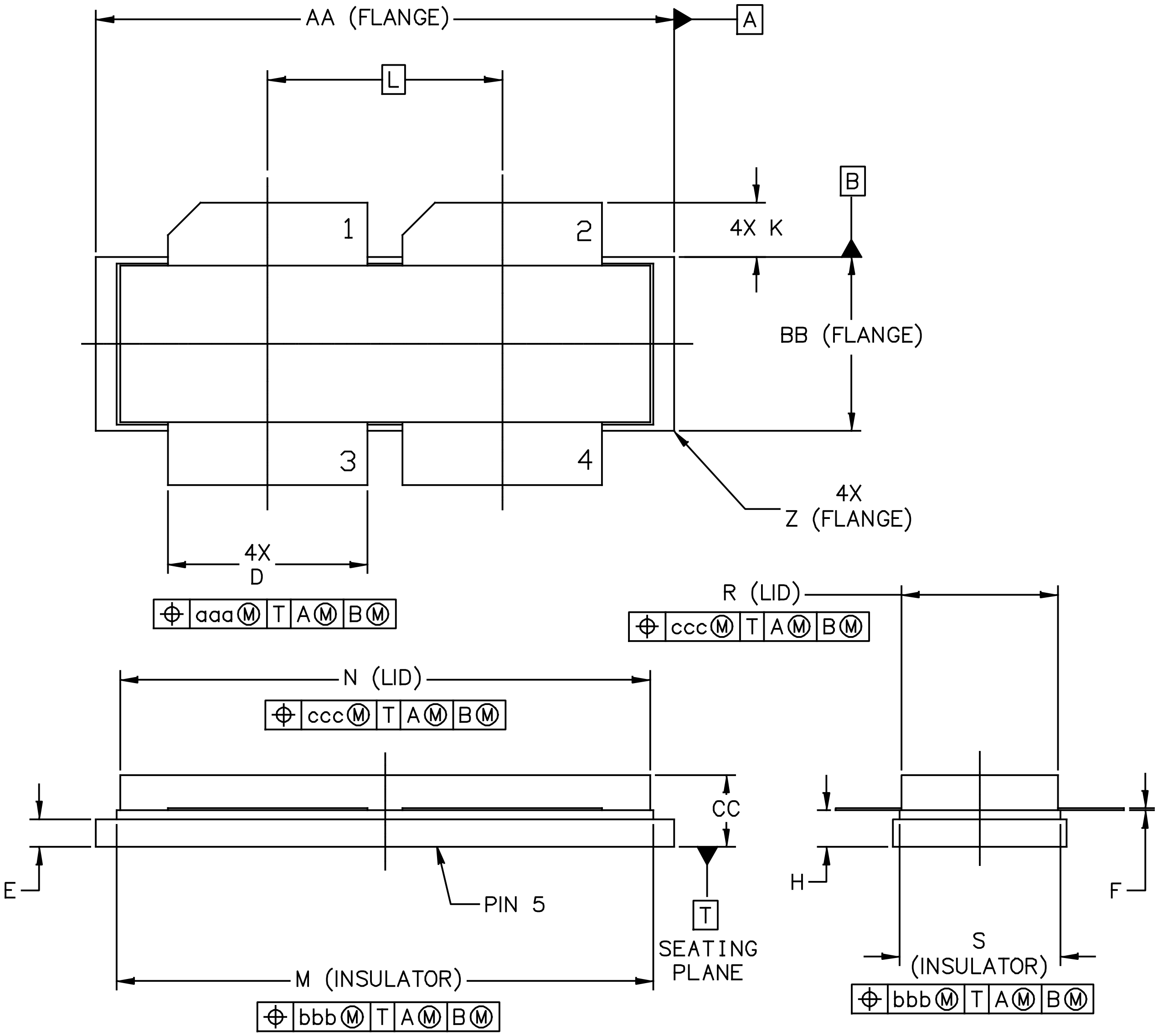

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NOTES:

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

2. CONTROLLING DIMENSION: INCH

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

DIM	INCHES		MILLIMETERS		DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX		MIN	MAX	MIN	MAX
AA	1.265	1.275	32.13	32.39	R	.355	.365	9.02	9.27
BB	.395	.405	10.03	10.29	S	.365	.375	9.27	9.53
CC	.170	.190	4.32	4.83	Z	R.000	R.040	R0.00	R1.02
D	.455	.465	11.56	11.81					
E	.062	.066	1.57	1.68	aaa	.013		0.33	
F	.004	.007	0.10	0.18	bbb	.010		0.25	
H	.082	.090	2.08	2.29	ccc	.020		0.51	
K	.117	.137	2.97	3.48					
L	.540 BSC		13.72 BSC						
M	1.219	1.241	30.96	31.52					
N	1.218	1.242	30.94	31.55					

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TITLE:

NI-1230-4S

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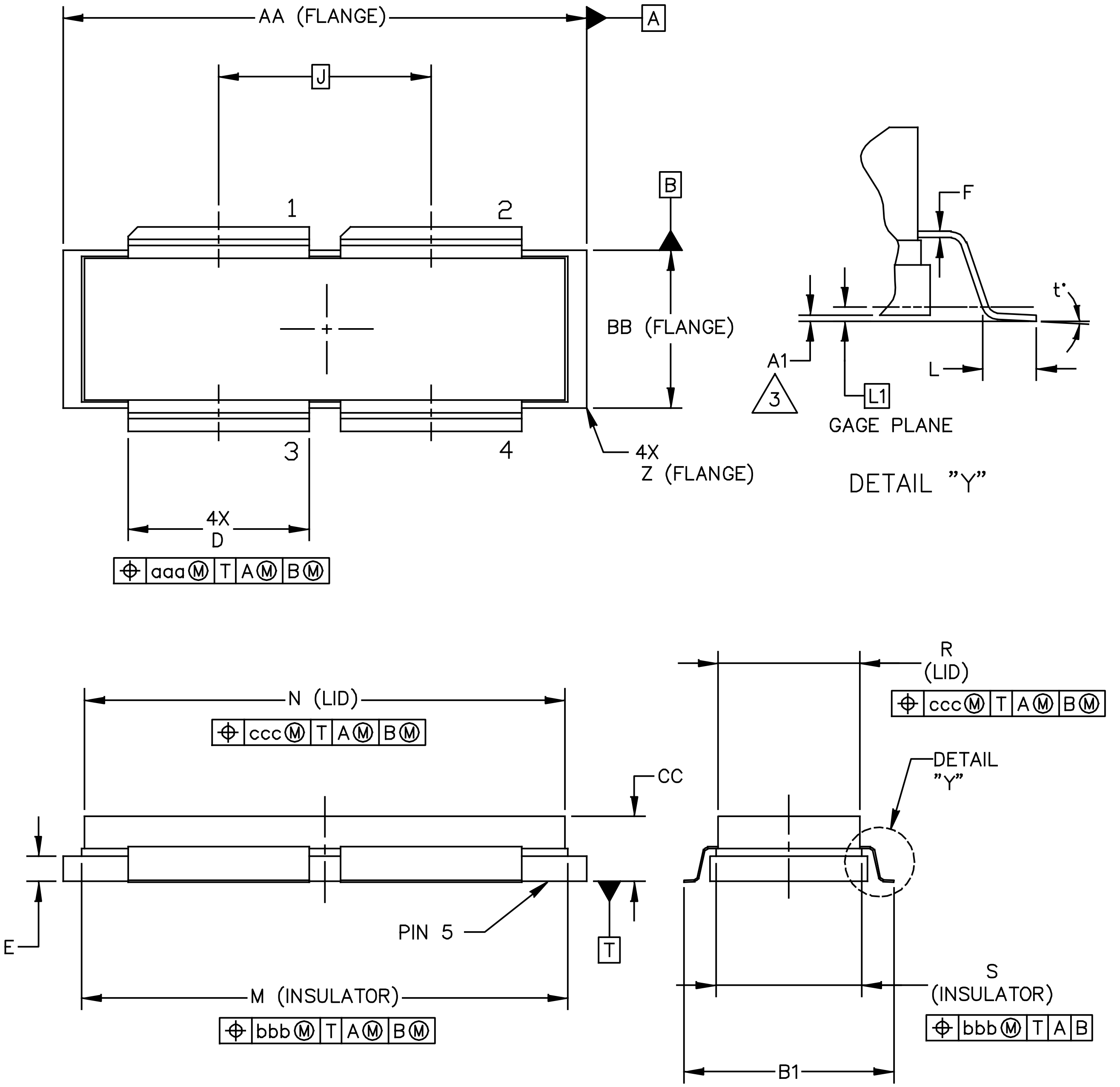
STANDARD: NON-JEDEC

SOT1829-1 19 FEB 2016



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NOTES:

1. INTERPRET DIMENSIONS AND TOLERANCES PER ASME Y14.5M–1994.
2. CONTROLLING DIMENSION: INCH
3. DIMENSION A1 IS MEASURED WITH REFERENCE TO DATUM T. THE POSITIVE VALUE IMPLIES THAT THE PACKAGE BOTTOM IS HIGHER THAN THE LEAD BOTTOM.

DIM	INCHES		MILLIMETERS		DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX		MIN	MAX	MIN	MAX
AA	1.265	1.275	32.13	32.39	R	.355	.365	9.02	9.27
A1	–.001	.011	–0.03	0.28	S	.365	.375	9.27	9.53
BB	.395	.405	10.03	10.29	Z	R.000	R.040	R0.00	R1.02
B1	.564	.574	14.32	14.58	t°	0°	8°	0°	8°
CC	.170	.190	4.32	4.83					
D	.455	.465	11.56	11.81	aaa	.013		0.33	
E	.062	.066	1.57	1.68	bbb	.010		0.25	
F	.004	.007	0.10	0.18	ccc	.020		0.51	
J	.540 BSC		13.72 BSC						
L	.038	.046	0.97	1.17					
L1	.01 BSC		0.25 BSC						
M	1.219	1.241	30.96	31.52					
N	1.218	1.242	30.94	31.55					

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TITLE:

NI–1230–4S GULL

DOCUMENT NO: 98ASA00459D REV: B

STANDARD: NON–JEDEC

SOT1806–2 23 FEB 2016

PRODUCT DOCUMENTATION

Refer to the following resources to aid your design process.

Application Notes

- AN1908: Solder Reflow Attach Method for High Power RF Devices in Air Cavity Packages
- AN1955: Thermal Measurement Methodology of RF Power Amplifiers

Engineering Bulletins

- EB212: Using Data Sheet Impedances for RF LDMOS Devices

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	Mar. 2016	• Initial Release of Data Sheet

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